A McGraw-Hill Publication 75 Cents November 2, 1962

# electronics®

## NEREM PREVIEW

*Next week's technical revelations, p 35*

## Y-GUIDE RADAR

*New waveguide stops trains, p 44*

## BALANCED-INPUT MIXER

*Circuit insensitive to frequency, p 46*

*Tunnel diode formed on vapor-deposited pyrocrystallite, p 58*

# SIX reasons

## why you're seeing more and more G-R 874 coaxial connectors

**1** **Hermaphroditic Design** — Any 874 Connector mates with any other 874 Connector; eliminates searching for male and female components.

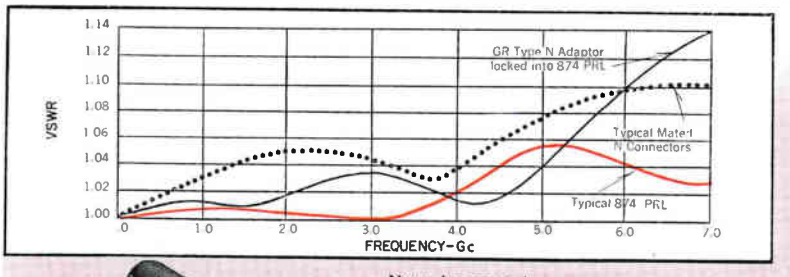
**2** **Extremely Low VSWR** — typically less than 1.02 to 4 Gc; less than 1.06 to 7 Gc. Total VSWR of 874 Connector plus 874 Adaptor is comparable to that of typical military connector alone.

**3** **Low Leakage** — 115 db down for locking types at frequencies up to 7 Gc.

**4** **Convertible, Without Sacrifice in Performance** — Equipment using 874 Connectors can be quickly converted to other coaxial connector systems by means of low-VSWR 874 Adaptors.

**5** **Locking and Non-Locking Types** — for semi-permanent or quick connect-disconnect setups.

**6** **Rigid, Uniform 50-Ohm Section When Connected** — strong friction-grip contact through multiple-spring fingers.




## The 874 Family of Coaxial Connectors

New, Improved
**874-CLA**
Locking Cable Connector
$3.50

New, Improved
**874-CA**
Cable Connector
(Non-Locking)
$2.50

**874-PLA**
Locking Panel Connector
$3.75

**874-B**
Basic Non-Locking Connector
(For use with rigid air line)
$1.95

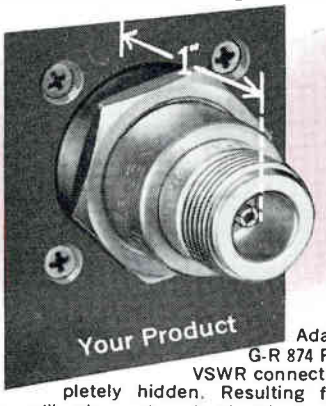
**874-BL**
Basic Locking Connector
(For use with rigid air line)
$2.50

**874-PRLA**
Locking Recessed Panel Connector
$4.00

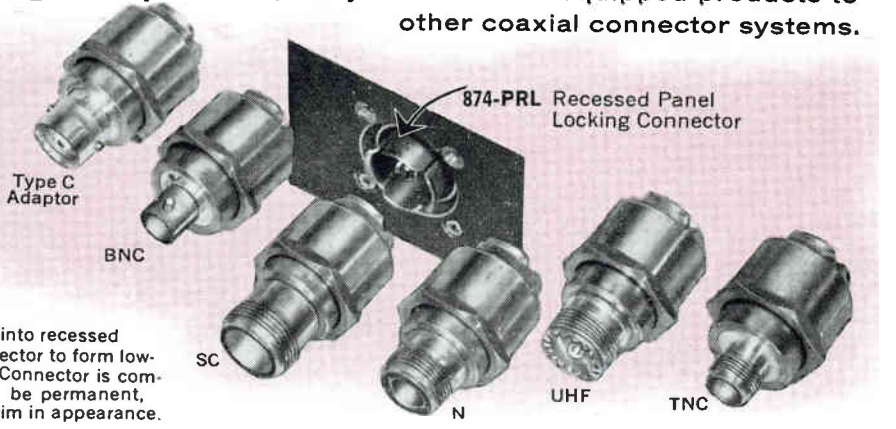
**874-PBA**
Panel Connector
(Non-Locking)
$3.40

## The 874 Family of Locking Adaptors

Quickly convert 874-equipped products to other coaxial connector systems.




Adaptor locks into recessed G-R 874 Panel Connector to form low-VSWR connection. Panel Connector is completely hidden. Resulting fitting can be permanent, or readily changed . . . is electrically excellent, trim in appearance.




Locking Adaptors priced from $5.75 to $10.00  Non-Locking Adaptors also available.

# GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

General Radio (Overseas)
Zurich, Switzerland

NEW YORK, N. Y., 964-2722
Ridgefield, N. J., 943-3140

CHICAGO
(Oak Park) 848-9400

PHILADELPHIA, 424-7419
Abington, 887-8486

WASHINGTON, D.C.
(Rockville, Md.) 946-1600

SYRACUSE
454-9323

SAN FRANCISCO
(Los Altos) 948-8233

LOS ANGELES
HO 9-6201

ORLANDO, FLA.
425-4671

IN CANADA
(Toronto) 246-2171

CIRCLE 900 READERS SERVICE CARD

November 2, 1962

# electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor





*Contents Continued*

**electronics**

November 2, 1962 Volume 35 No. 44

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



Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 212-640-4646. Cable McGrawhill, N. Y. PRINTED IN ALBANY, N. Y.; second class postage paid at Albany, N. Y.

OFFICERS OF THE PUBLICATION DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator; Daniel F. Crowley, Vice President and Controller.

OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Executive Vice President and 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, $6.00 one year, $9.00 two years, $12.00 three years. Canada: $10.00 one year. All other countries $20.00 one year. Single Copies, United States and Possessions and Canada 75¢. Single copies all other countries $1.50.

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

Subscribers: Please address change of address notices, subscription orders or complaints to Fulfillment Manager, Electronics, at above address. 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, 330 West 42nd Street, New York 36, New York.

Audited Paid Circulation

## CONTENTS continued



## DEPARTMENTS

# Who's Minding the Stockroom?

ANY WELL-RUN electronics company keeps its stockroom inventory in good shape. When stocks of vital components become sparse, good management dictates rapid and often automatic reorders to replenish depleted supplies.

The electronics industry continues to be confronted with a shortage of the most vital component of all—engineers. Unfortunately, requisitions and purchase orders cannot solve the problem—the sources of supply appear to be drying up because of depletion of raw materials.

The shortage of engineers has been well publicized but we feel that the problem has reached sufficient proportions to justify additional comment here. Consider the following evidence:

- Since 1957, the number of freshmen entering accredited engineering curricula has declined each year.
- The percentage of the total college population entering engineering or science courses has declined at an even faster rate.
- There is some evidence that students of highest intellectual capacity are shifting into pure science or out of science altogether. In other words, engineering is losing the interest of the most creative students.

The eventual results of these trends are self-evident. In an age when the emphasis is on more technology, we are training fewer and lower-quality men. Returning to the stockroom analogy, when incoming quality control breaks down, production suffers. In the end, we stand a good chance of going out of business.

Much of the trouble obviously lies at the high school level. Somehow we are failing to persuade our youth that in engineering lies a satisfying and rewarding career. The incentive for becoming an engineering student is apparently small. Should we pay engineers more money? This obviously isn't the answer. Engineering starting salaries are excellent, as are future prospects for advancement of competent people. Should we build modern educational facilities? CCNY recently opened a new $9,000,000 engineering laboratory to an incoming class of only 530, almost 300 fewer than 1960. Give more scholarships? Cooper Union received 363 less applications for its free scholarships this year than the year before.

To some educators, the solution lies in revamping of the "brutal" engineering curriculum. They point out that liberal arts students, for example, get degrees with from 20 to 30 less credit hours than engineers. Engineering undergrads work like dogs, they say, with little opportunity to participate in activities such as athletics.

Others attribute the shortage to the public's erroneous concept of engineers, or their lack of knowledge of what an engineer does. Each succeeding achievement of the space program is greeted in the public press by paeans of praise and gratitude to America's "scientists." But we know that each satellite and space vehicle launched is a triumph of engineering skill—a fact that appears to be singularly ignored by the public at large. Hence more students are being attracted to the glamorous "pure science" curricula, they say.

We believe that both arguments are in large measure valid. We also believe that industry must be prepared to take a larger share of responsibility for bringing our stockroom reserves up to full strength. Here are some of the things we believe industry can do to help solve this problem:

- Divert some of the effort and money expended on intra-industry personnel recruitment (sometimes known as pirating) to recruitment at the high school level.
- Increase institutional advertising budgets and establish campaigns to allow dissemination of the correct "image" of engineering as a profession to the public.
- Establish industry committees in conjunction with the professional societies to work with educators to establish truly modern, effective and above all, stimulating engineering curricula.
- Encourage and make it possible for engineers to teach high school students, and to participate in local educational affairs.

Some of this is being done already on a small scale. But in the face of the challenges of the space age to the engineering community, no less than a massive effort is called for.

## COMMENT

### And-Or Algebra

Recently, Bell Labs applicants were given a little test question in logic to do in 10 minutes: "Solve the following code addition, with no repetition of digits, and give the digit equivalents of the letters—given that $d = 5$." [Subscript 1 or 0 indicates carry-over.]

$$\begin{array}{r} d\ o\ n\ a\ l\ d \\ +\ g\ e\ r\ a\ l\ d \\ \hline r\ o\ b\ e\ r\ t \end{array} \quad \text{or} \quad \begin{array}{r} 5\ o\ n\ a\ l\ 5 \\ g\ e\ r\ a\ l_1\ 5 \\ \hline r\ o\ b\ e\ r\ 0 \end{array}$$

Not as simple as it looks. Note that $e$ and $r$ in *gerald* may not be the same as $e$ and $r$ in *robert*, because of a possible carry-over of a "10-digit" 1. Also, it might be recalled that any 3-digit arithmetical number can be represented by the algebraic term $(100x + 10y + z)$.

One of our lab men (Howie Saltzman) solved it in about 20 minutes, using logic deduction and a bit of trial-and-error, which is pretty darned good. Upon a little thought, it was decided that this might actually be a computer shift-register, slyly masqueraded by a cryptogram code and quickly solvable with a bit of Boolean algebra. So who knows Mr. Boole? So we can go ahead and invent a "Fufnik" "and-or" algebra and go right ahead and set up the simultaneous equations—

$$\begin{aligned} d + d &= t \quad \text{or} \quad 5 + 5 = 0 + (10) \\ &\qquad (\text{where } d = 5,\ t = 0) \\ l + l + 1 &= r + (0 \text{ or } 10) \\ a + a + (0 \text{ or } 1) &= e + (0 \text{ or } 10) \\ n + r + (0 \text{ or } 1) &= b + (0 \text{ or } 10) \\ o + e + (0 \text{ or } 1) &= o + (0 \text{ or } 10) \\ 5 + g + (0 \text{ or } 1) &= r + (0 \text{ or } 10) \end{aligned}$$

We have two sets of relations involving three $r$ and two $e$. Note that the (0 or 1) and (0 or 10) unknowns *cannot* be freely cancelled out, since one may be actually 0 *or* 1 or 10.

$$\begin{aligned} o + e + (0 \text{ or } 1) &= o + (0 \text{ or } 10) \\ e &= (0 \text{ or } 10) - (0 \text{ or } 1) \\ e &= 0, -1, 10 \text{ or } 9 \text{ (4 possibilities)} \end{aligned}$$

We already have zero, and take for granted only positive single integers are involved, so $e = 9$.

$$\begin{aligned} a + a + (0 \text{ or } 1) &= e + (0 \text{ or } 10) \\ 2a &= 9 + (0 \text{ or } 10) - (0 \text{ or } 1) \\ a &= 4\tfrac{1}{2},\ 4,\ 9\tfrac{1}{2}, \text{ or } -\tfrac{1}{4} \end{aligned}$$

For reasons above, $a = 4$.

We now have

$$\begin{array}{r} 5\ o\ n\ 4\ l\ 5 \\ g_1\ 9_1\ r_0\ 4_1\ l_1\ 5 \\ \hline r\ o\ b\ 9\ r\ 0 \end{array}$$

We now know all the carry-overs. We eliminate the four digits 0,4,5,9. We know $l \geqq 5$, and must be 7 or 8. We know $g$ must be $\leqq 3$, and must be 1 or 2. We also know now that $r$ must be odd, hence $r = 7$ and $g = 1$. We now eliminate the six digits 0,1,4,5,7,9, and we now have

$$\begin{array}{r} 5\ o\ n\ 4\ l\ 5 \\ 1_1\ 9_1\ 7_0\ 4_1\ l_1\ 5 \\ \hline 7\ o\ b\ 9\ 7\ 0 \end{array}$$

Going back to the equations,

$$\begin{aligned} &l + l + 1 = r + (0 \text{ or } 10), \\ &2l + 1 = 7 + 10 \quad (\text{since } l \geqq 5) \\ &l = 8 \text{ (we now eliminate 0, 1, 4, 5, 7, 8, 9)} \\ &n + r + (0 \text{ or } 1) = b + (0 \text{ or } 10) \\ &n + 7 + 0 \qquad\quad = b + 10 \text{ (we know the carry-overs)} \\ &n = b + 3 \end{aligned}$$

$n$ can only be 2, 3 or 6, and must be $\geqq 3$ and is 6. Then $b = 3$, and $o$ has to be the remaining digit 2.

Hence we get

$$\begin{array}{r} 5\ 2\ 6\ 4\ 8\ 5 \\ 1_1\ 9_1\ 7\ 4_1\ 8_1\ 5 \\ \hline 7\ 2\ 3\ 9\ 7\ 0 \end{array}$$

Ten minutes! Egad! Ten hours would be more like it. Call the secretary, tell her to prepare a patent form and ask her what the heck did she do with the aspirins!

TED POWELL
Glen Oaks, New York

### Lincoln Laboratory

I take the liberty of calling to your attention that the name of Lincoln Laboratory uses the word Laboratory in the singular, and not in the plural. This is a very small point, in the enormous amount of material that I know you have to cover, but it is a point that might will be of personal interest to members of our staff who read ELECTRONICS.

Several instances of lapses into the plural occurred in one of your recent articles, in which the plural is used twice, while the singular is correctly used twice. I am perfectly sure that the pluralization is unintentional, and I hope you will not mind my bringing it to your attention.

JOHN A. KESSLER
Massachusetts Institute of Technology
Lexington, Massachusetts

**Sorry. We'll try to keep it singular from now on.**

# A modest proposal

**In selecting a microwave signal generator,** we urge you to ignore the "specification race". Give or take a split hair, each manufacturer's *performance* specification is conspicuous only by its similarity to the others. We say this despite the fact that many of our signal generators have led the pack in this frantic race for years.

**The numbers game** is fun to play, particularly when one is so often ahead, but we cannot, in good conscience, urge you to choose a Polarad Generator merely because it has a few megacycles more range, a wider choice of prfs, more linear frequency modulation, or even an intriguing and exclusive operational feature or two.

**We propose,** instead, that you go *beyond the specification* and ask: "How is this performance achieved? . . . How long will this instrument continue to perform within specification? . . . How much will it cost to maintain in perfect working order? . . . What percentage of the time will it be out of service for repair and recalibration?" Isn't each of these criteria at least as important as the performance specification? Of course it is *You want and need to buy the instrument that is very well designed and very well built . . . not just very well specified.*

**We say this**: look beyond the specification, at the instrument itself. Examine the panel critically — but then take off the cover, and look inside. In a Polarad Generator, you will see:

- The highest quality components, generously derated. (You may be surprised at the distinguished labels that flunk this simple test!)
- The meticulous craftsmanship that is uniquely essential to precision and stability in microwave instrumentation (you'll find no "bailing-wire" mechanics here!).
- Non-contacting-short cavity tuning, for complete freedom from noise, wear, and frequency skip or drift.
- Clean, modular layout, rugged construction, and an advanced thermo-mechanical design, ensuring rock-solid stability despite hard usage and repeated environmental stress. (Polarad Generators are the *"work-horses"* of the industry.)

**It is no accident** that Polarad is consistently selected to furnish microwave signal generators for the toughest, most reliability-conscious programs. We design them and build them so that the finished instrument is as impressive as the specification.

**Call your Polarad Field Engineer today.** Ask him to show you the quality of our instruments.

**MODEL MSG-34**
4.2 — 11.0 KMC. Accurately calibrated absolute power-level. Adjustable from 0 to −127 dbm from 1 MW.

| MODEL | FREQUENCY KMC | CALIBRATED POWER OUTPUT | INTERNAL MODULATION |
|---|---|---|---|
| PMR | 0.5 - 1.0 | 0.5 MW (−3 dbm) to −127 dbm | Ultra-linear FM modulation standard sq-wave, 25-10,000 pps } with optional plug-pulse, 10-10,000 pps } in pulse modulator |
| PMX | 4.45 - 11.0 (2 plug-ins) | 1 MW (0 dbm) to −127 dbm | All instruments in this group: pulse modulation: 10-10,000 pps. *pulse width: 0.2-10 μsec. pulse delay: 2-2,000 μsec. square-wave modulation: 10-10,000 pps. FM deviation: ±2.5 MC min. |
| MSG-34 (Ultra Broadband) | 4.2 - 11.0 digital freq. indicator | 1 MW (0 dbm) to −127 dbm | |
| MSG-1R | 0.95 - 2.40 | 1 MW (0 dbm) to −127 dbm | |
| MSG-2R | 2.0 - 4.60 | 1 MW (0 dbm) to −127 dbm | *0.3-10 μsec. in MSG-1R and 2R. |
| KSS (Signal Source) | 1.05 - 11.0 (4 plug-ins) | Uncalibrated Power Output: 14-400 MW, depending on freq. | sq-wave, 10-10,000 pps (external pulse, sq-wave FM) |

**HAVE YOU MADE RESERVATIONS YET?**


Polarad's new "Project Mohammed" is now bringing the "Mountain" (our new Mobile Microwave Calibration Laboratory) to "Mohammed" (your microwave instruments). Be sure to take advantage of this opportunity to have your gear checked — at your doorstep. Save weeks of delay and needless expense. Call your Polarad field engineer for details and schedules!

POLARAD

**Polarad Electronics Corporation**
*World Leader in Microwave Instrumentation*
43-20 E 34th Street
Long Island City 1, New York

# 3 PROBLEMS

**1.** Light-weight, frequency-stable, efficient 10-watt S-Band oscillator for telemetry. Must operate at low voltage, be easily frequency-modulated, small, simple and reliable; must generate minimum stray electromagnetic interference; and must meet typical missile environment specifications.

**2.** Amplifier of at least 10 watts output over octave bandwidth 4.0 to 8.0 Gc, with minimum of 40 db saturated gain. Must not require separate power for focussing, nor forced air or liquid cooling. Size and weight must be minimum to meet typical missile environment specifications.

**3.** 15-watt oscillator voltage-tunable over 12% bandwidth in L-Band. Linear frequency/anode voltage characteristic required. Minimize frequency drift with temperature. Must be self-contained; only electrical connections; no mechanical adjustments. Minimum size and weight to meet typical missile environment specifications.

# 3 SOLUTIONS

# 1 COMPANY

**Three examples of the way Eimac, by creative engineering, meets tomorrow's tube needs today.**

**X1005 Supported Drift Tube Klystron... developed under AF33 (616)-8403...**

Weight: 2⅝ pounds
Frequency Stability: 0.005%
Efficiency: Above 15%
Power Output: 10 watts CW
Frequency: 2.2 to 2.3 Gc.
Beam Voltage: 1500
Size: 4 x 4 x 4½ inches overall
Focussing: Entirely internal, no magnets or coils
Environmental: Meets typical missile specifications.

**X1021 Traveling Wave Tube**

Power Output: 10 watts min.
Frequency Range: 4.0 to 8.0 Gc.
Saturated Gain: 40 db
Focussing: PPM
Cooling: Heat sink
Size: 13 x 1.83 x 1.89 inches
Weight: 3.5 pounds
Environmental: Meets typical missile specifications

**X1086 Voltage Tunable Magnetron**

Power Output: 15 watts min.
Power Output Variation: 1.5 db
Freq. & Bandwidth: 12% in L-Band
Frequency/Anode Voltage: Linear
Temperature Compensation: 0.008% of operating frequency/°C.
Electrical Connections: Heater, anode, injection voltage only
Output: Coaxial
Focussing: Permanent magnet
Size & Weight: 5 x 3 x 2 in.; 3.2 lbs.
Environmental: Meets typical missile specifications

More reasons to keep your eye on Eimac—for advanced microwave tubes, high power klystrons, power grid tubes, accessories. Eitel-McCullough, Inc., San Carlos, California. Subsidiaries: Eitel-McCullough, S.A., Geneva, Switzerland; National Electronics, Geneva, Ill. **KEEP YOUR EYE ON**

# ELECTRONICS NEWSLETTER

## Heterojunction Diode Switches in Picoseconds

WASHINGTON—A diode that may permit switching in picoseconds ($10^{-12}$ second) was reported last week at the IRE Electron Devices meeting by F. F. Fang and W. E. Howard, of IBM. The diode, operated experimentally at IBM's Thomas J. Watson Research Center, has a calculated recovery or storage time of about 1 psec.

The device is made by vapor-growing *n*-type germanium on *n*-type gallium arsenide. Since *n*-type material is on both sides of the junction, practically all conduction is by majority carriers, eliminating the time required for removal of stored minority carriers after switching.

Switching time is independent of current switched, so the diode may provide for high-speed switching of currents as large as 40 to 50 ma. Fang and Howard reported that in measurements at less than 1 nsec they could detect no storage time, indicating speed is limited only by circuit impedance and rise time of the triggering pulse. The diode begins to conduct at a bias of 0.3 v; reverse breakdown voltage is about 3 v.

Another possible application is as a microwave detector. The diode would put out a larger average signal than other diode detectors at frequencies of 100 Gc and higher. Gallium arsenide purity and crystal orientation are major factors in performance of the diode. After the junctions are formed, they are etched to a size that results in a capacitance of about 1 pf.

## Japanese Firm Plans Single-Gun Color Tv

TOKYO—Masaru Ibuka, president of Sony Corp., told ELECTRONICS last week that his company will have a color-tv set, using the one-gun Chromatron tube, on the market by the end of next year. Production at first probably will not exceed several hundred a month and the first sets will be sold only in Japan, he said. Japan uses the same NTSC color tv signal as the U.S.

Ibuka said the tube size will probably be determined before the end of this year. The experimental tubes are being fabricated with 8-inch and 23-inch bulbs bought from Paramount Pictures Corp. Ibuka said they are too costly for commercial use. New molds are to be made in Japan. The sets will probably be normal size and use vacuum tubes. Pending a size decision, price of sets has not been determined.

## 500-C Thermistors Made of Silicon Carbide Crystal

NIAGARA FALLS, N. Y.—Carborundum Co. is tooling up for mass production of its newly developed, miniature, single-crystal, silicon-carbide thermistors. The thermistors are useful at temperatures to above 500 C.

Company officials declined to announce parameters until after evaluating mass production runs, but they consider the pilot-plant units exceptionally sensitive. In a press demonstration last week, one unit sensed changes in color filters on a nearby lamp. Among anticipated applications are sensors in radioisotope power supplies.

Carborundum expects to develop other high-temperature semiconductor devices within the next 12 to 18 months. It said its research on silicon carbide and other refractory materials has been "very encouraging."

Also introduced was a series of positive-temperature-coefficient ceramic thermistors. One can act like a switch, its resistance remaining constant until about 90 C, then rising sharply.

## Sergeant Missile Passes Test, Germany Buys It

WHITE SANDS, N. M.—In its first tactical firing last week, the Army's Sergeant missile made a successful "kill" on a target more than 75 nautical miles up the White Sands Missile Range.

Early next year, U.S. forces overseas will get operationally ready Sergeant missiles. The Federal Republic of Germany has bought the missile system to deploy in Germany by early 1963 for NATO defense.

Sergeant is a surface-to-surface, solid-fuel, ballistic missile. It is

## Semiconductor Laser Has Coherent Output

IBM SCIENTISTS have succeeded in operating a new laser, using a semiconductor diode, that is powered directly by an electrical current rather than by an external light source. IBM said the discovery makes available for the first time a laser that can easily be modulated at high frequencies.

The injection laser produces an extremely monochromatic, intense and narrow beam of coherent light. Incoherent light from diodes had previously been observed. However, IBM said its device is the first known to exhibit laser action.

In the new injection laser, which consists simply of a specially-prepared gallium arsenide diode, energy is supplied directly by injection of electrons into the diode, rather than from a light source. The output light can be modulated before it leaves the crystal simply by modulating the incoming current.

In addition to allowing modulation at high frequencies, the direct injection of current is more convenient and efficient than the use of external light sources, IBM said. It eliminates the need for flash tube apparatus, and it does not need the large power supplies previously required for laser operation

inertially guided and can carry a nuclear, chemical or biological warhead. U.S. investment in the system is about $\frac{1}{2}$ billion, not all of which has been spent. Prime contractor is Sperry Utah Co.

## Proposal for Tv Stereo Sound Placed before FCC

GENERAL ELECTRIC last week announced that it has asked FCC to take steps to adopt standards for compatible stereophonic sound transmission for television. The company also proposed a tv stereo sound system developed by Robert B. Dome, of the company's tv receiver department. Dome presented a paper on the system at an IRE conference last spring (p 28, July 6). GE said that the system has been field-tested by the company.

## Swedish Subway Plans To Automate Trains

STOCKHOLM—The Swedish Asea Co. and the Stockhold Transit Co. have developed an autopilot for subway trains. When put in operation on the Stockholm subway net, it is expected to replace some 160 drivers and save some $750,000 a year in labor and power costs.

The system receives digital information on speed, track length, speed limits, and so on from an engine tachometer and from induction antennas along the track. The information is stored and processed to provide operating signals for engines and brakes. The trains can be programmed to run at economical speeds at nonrush hours.

## British and French Buy 51 More 301's

R.C.A. REPORTS that Compagnie des Machines Bull, of France, and International Computers and Tabulators, Ltd., of England, have raised their original orders of RCA 301 computers by 51, making the total order to the two companies now 151 machines.

Bull has also ordered some $5 million in components and peripheral equipment. Bull plans to start manufacturing the 301, which it calls the Gamma 30, in 1963, in a new plant near Angers, France.

In a separate announcement last week, Bull introduced a new, low-cost punched-card computer, the Gamma 10. Its central processing unit works with a stored program and has a magnetic core memory.

## Predicts Translation Will Be Automated in Few Years

CHICAGO — Useful automated—though not fully automatic—language translators can be expected in the next few years, predicted Warren Plath, of Harvard, at the Computer Applications Symposium.

Limited-ambiguity retrieval and programming systems can discover and report locations and types of ambiguity in machine translations, leaving final interpretations to human operators, he explained. He described a technique called predictive syntactic analysis that could deliver parallel outputs for all possible interpretations of inputs. Aimed at better translations than word-to-word and phrase-to-phrase techniques provide, it takes into account sentence structures.

As yet, precise analyses are obtained for only one in four or five Russian sentences. It entirely misses correct analysis in about one sentence in ten.

## Another Japanese Micro-Tv on Sale

TOKYO—Mitsubishi Electric placed its 6-inch tv set on the domestic market late last month. It can be operated with a rechargeable battery, car battery or detachable a-c power supply. The company expects to sell most of the sets overseas, but says it is still studying the proper time and price. Domestic price is $156, not including battery and other accessories. This is about $25 less than Sony's 5-inch set. A Sony spokesman said his company was not worried because it understands Mitsubishi's production is limited at present by the availability of transistors, especially high-frequency mesa and power types.

## In Brief . . .

EIA REPORTS that August factory sales of transistors was 20.4 million, 5 million higher than the year's low in July. Seven-month sales were 158.8 million worth $193.8 million, compared to 117.1 million and $199.8 million in the 1961 period.

BASICPAC, a portable Fieldata computer developed by Philco, has passed operational acceptance tests, Army reports.

DATA ACQUISITION and communications subsystem for Project Fire reentry study (p 8, April 6) will be built by RCA for $1.3 million. Data will be stored during reentry blackout and transmitted later.

WINSTON RESEARCH, communications R&D company, is to be acquired by Fairchild Camera and Instrument. Uniform Tubes, Inc., has acquired Franklin Technical Corp., microwave delay firm.

HUMPHREYS & GLASGOW, of England, have an $8 million contract to supply the Czech government with a computer-controlled gas-separation plant. West Germany competed for the contract.

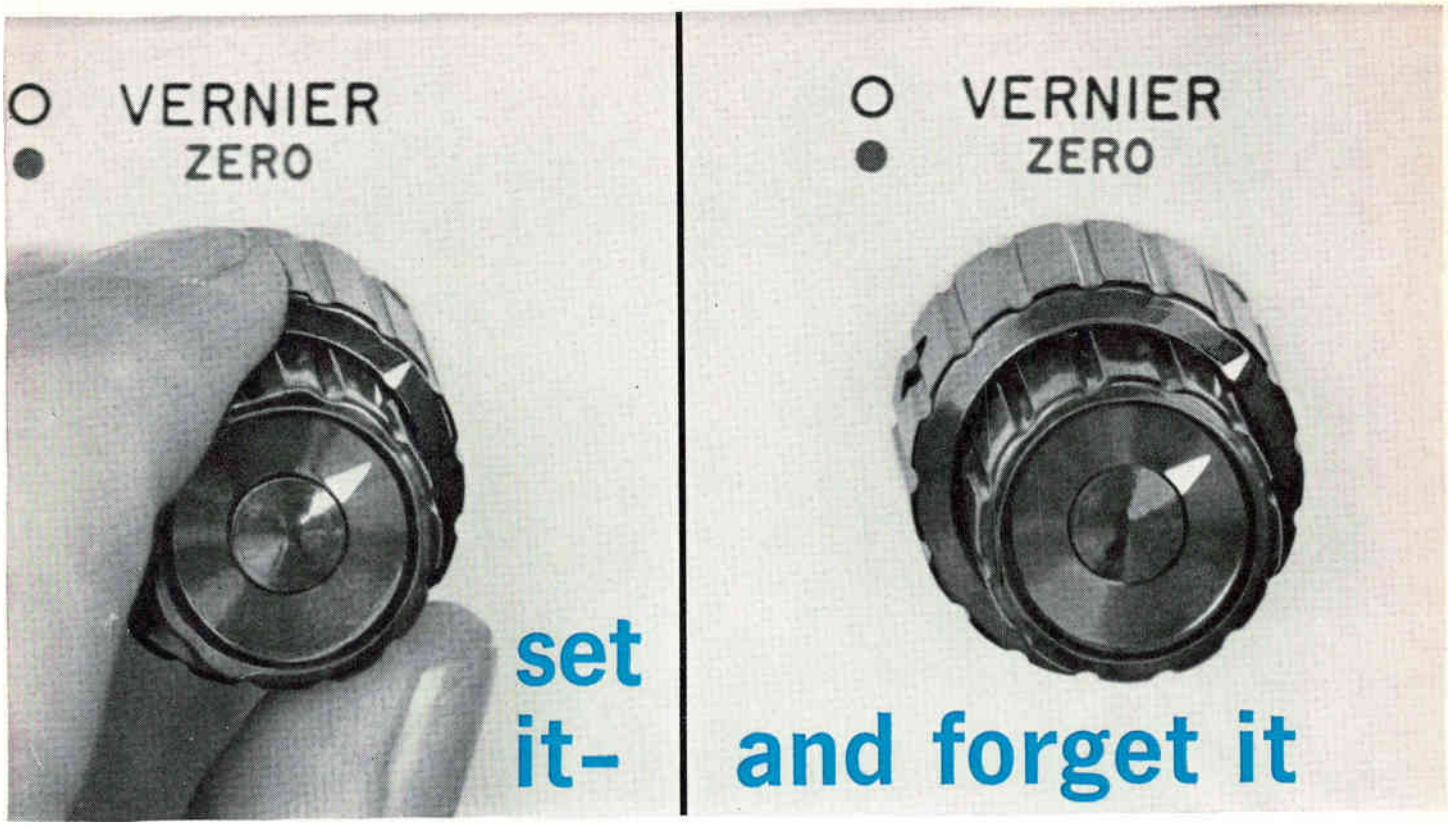
SANYO ELECTRIC, of Japan, reports it will supply RCA-Whirlpool with thermoelectric refrigerators, starting with 250 in November.

WEST POINT cadets will receive instruction in digital computers. Equipment will be rented from GE.

UNIVERSITY of Alabama Research Institute will get a Univac 1107. The institute anticipates contracts from NASA and Army at Redstone Arsenal, plus educational and medical work.

STANFORD UNIVERSITY has given Ling Electronics a $400,000 order for 10 65-Mw pulse modulators for testing klystrons and other high-power devices.

AUTONETICS will build another 163 terrain avoidance radars for B-52's, under $3.5-million follow-on contract from AC Spark Plug.




# New hp 431B Power Meter measures 10 μw to 10 mw with one zero-set good for hours

Continual zero-setting and constant attention are eliminated with the new hp 431B Power Meter, which automatically and directly reads microwave power, 10 mc to 40 gc, with appropriate thermistor mounts.

Just a single zero setting, good for hours, keeps the 431B accurate even on the 10 μw range. Direct-reading accuracy of ±3% is provided on all ranges, even greater accuracy using simple external calibration procedures.

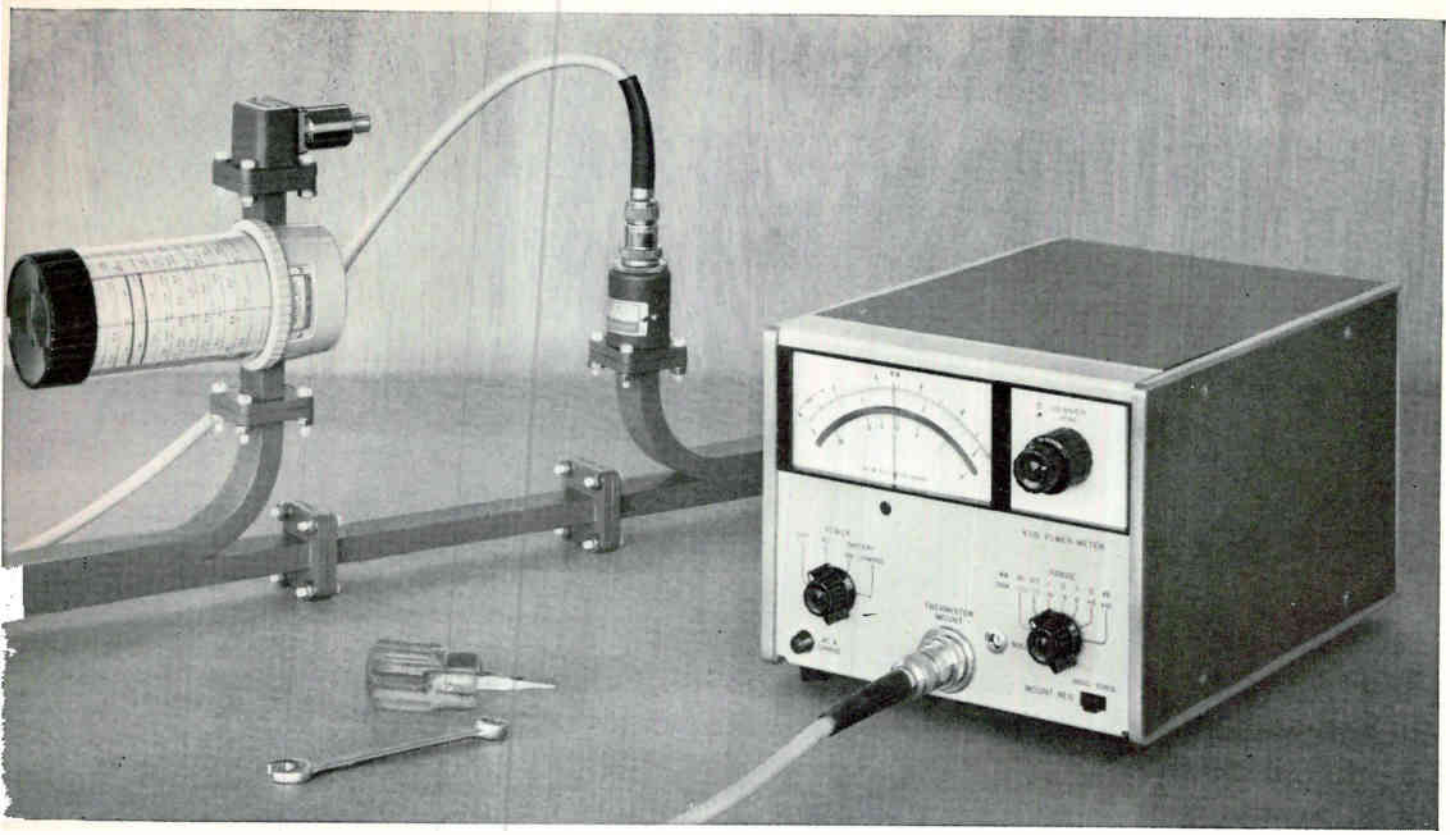
The extremely high stability of the hp 431B Power Meter makes possible an additional 10 db sensitivity over previously available instruments of its kind.

The solid state 431B employs two self-balancing bridges with associated measuring thermistors. One bridge and thermistor sense and measure rf power. The other bridge and thermistor correct the meter reading for ambient temperature changes.

The 431B provides a grounded recorder output, so that overnight records of power vs time are practical. An optional rechargeable battery pack gives up to 24 hours of continuous operation and is available to make the 431B completely portable.

| Model | Frequency | Price |
|---|---|---|
| 478A | 10 mc - 10 gc | $145.00 |
| S486A | 2.6 - 3.95 gc | 195.00 |
| G486A | 3.95 - 5.85 gc | 180.00 |
| J486A | 5.3 - 8.2 gc | 170.00 |
| H486A | 7.05 - 10.0 gc | 165.00 |
| X486A | 8.2 - 12.4 gc | 145.00 |
| M486A | 10.0 - 15.0 gc | 195.00 |
| P486A | 12.4 - 18.0 gc | 195.00 |
| K486A | 18.0 - 26.5 gc | 300.00 |
| R486A | 26.5 - 40.0 gc | 375.00 |

Compact, lightweight temperature compensated thermistor mounts (listed at left) are required for operating the hp 431B Power Meter. The hp 478A is designed for 50-ohm coaxial systems which operate from 10 mc to 10 gc. The hp 486A series is designed for waveguide systems, 2.6 to 40 gc. No tuning is required on any of the mounts. Each contains a matched pair of thermistors in identical thermal environments. Close tracking is achieved, even under thermal shock, so that you can make power measurements remarkably free from drift.



# Specifications, 431B Power Meter

| | |
|---|---|
| **Power Range:** | 10 μw to 10 mw full scale, 7 ranges; also calibrated —30 to +10 dbm |
| **External Bolometer:** | Thermistor mounts required (478A and 486A) |
| **Accuracy:** | ±3% of full scale, +20° to 35° C; ±5%, 0° C to +52° C |
| **Zero Carry-over:** | Less than 2% of full scale when zeroed on most sensitive range |
| **Recorder/Voltmeter Output:** | Rear panel phone jack, 1 ma maximum into 1,000 ohms; one side grounded |
| **Calibration Input:** | Binding posts on rear panel for calibration of bridge with precise dc standards |
| **Dimensions:** | 6½" high, 7¾" wide, 12½" deep, 8 lbs. |
| **Price:** | $425.00 |
| **Options:** | Rechargeable battery installed, add $100.00. Rear input connector wired in parallel with front panel input connector, add $15.00. Rack mounting kit, $25.00 |

## New 8402A Power Meter Calibrator

Verify full-scale calibration and check meter tracking of your 431B (or 431A) Power Meter easily and quickly. The 8402A supplies an accurate dc current to the thermistor with ±0.1% of the thermistor's nominal operating resistance or typically ±0.5% dc substituted power. Using the 8402A with the 431B and a precision dc voltmeter, accurate measurements of rf power by the dc substitution method are possible. 8402A Power Meter Calibrator, $475.00.

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

## New H01-8401 Leveler Amplifier

The H01-8401 Leveler Amplifier, together with an 431B Power Meter, provides level microwave power from any sweeper, TWT amplifier or power source that can be AM modulated. Output variations from BWO's and TWT's are greatly reduced and fine-grain discrepancies are eliminated. This precludes the need for ratio measurements in many applications. For example, the H01-8401 and 431B when controlling the new 8714A Modulator, provides level power from an 614A Signal Generator (klystron power sources) from 800 to 2,100 mc. In addition, the H01-8401 permits continuous monitoring of power and instant adjustment of output in 5 db steps. H01-8401 Leveler Amplifier, $200.00.

**HEWLETT PACKARD COMPANY**

1501 Page Mill Road, Palo Alto, California, Area Code 415, DA 6-7000
Sales and service representatives in all principal areas; Europe, Hewlett-Packard S.A., 54-54bis Route des Acacias, Geneva; Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand Street, Montreal

8066

# WASHINGTON OUTLOOK

## WHAT EFFECT WILL CUBAN CRISIS HAVE ON ECONOMY?

IF THE SOVIET-U. S. SHOWDOWN OVER CUBA continues to take a middle course, Washington's economic experts believe the new cold war atmosphere will have a moderately strengthening impact on the economy. The effect, presuming a continued spirt of accommodation between the two powers, will be largely psychological. The Cuba blockade and its attendant military atmsophere was just the sort of situation for which on-hand Pentagon stocks were built. Military chiefs had no plans to raise the level of orders.

With Khrushchev's abrupt backdown in Cuba, the short-range outlook is for continued U. S. military vigilance. This stems from two considerations. First, U. S. policy makers aren't discounting the possibility of a hardened Soviet attitude at other crisis points with shorter supply lines to Russia. Second is the distant hope that some progress in arms control may evolve from the frank exchanges between Khrushchev and President Kennedy. Any such progress would depend on Khrushchev's continued recognition that the U. S. has the will to use its military might to protect its interests and a corresponding recognition that Russian armaments, as instruments of blackmail, have diminished value.

Consumer and industrial buying is likely to spurt ahead, but not enough to activate price or wage-control plans. However, all bets are off if talking ends and the situation heats up.

## PENTAGON IS EXPECTED TO RELAX ITS BUYING RULES

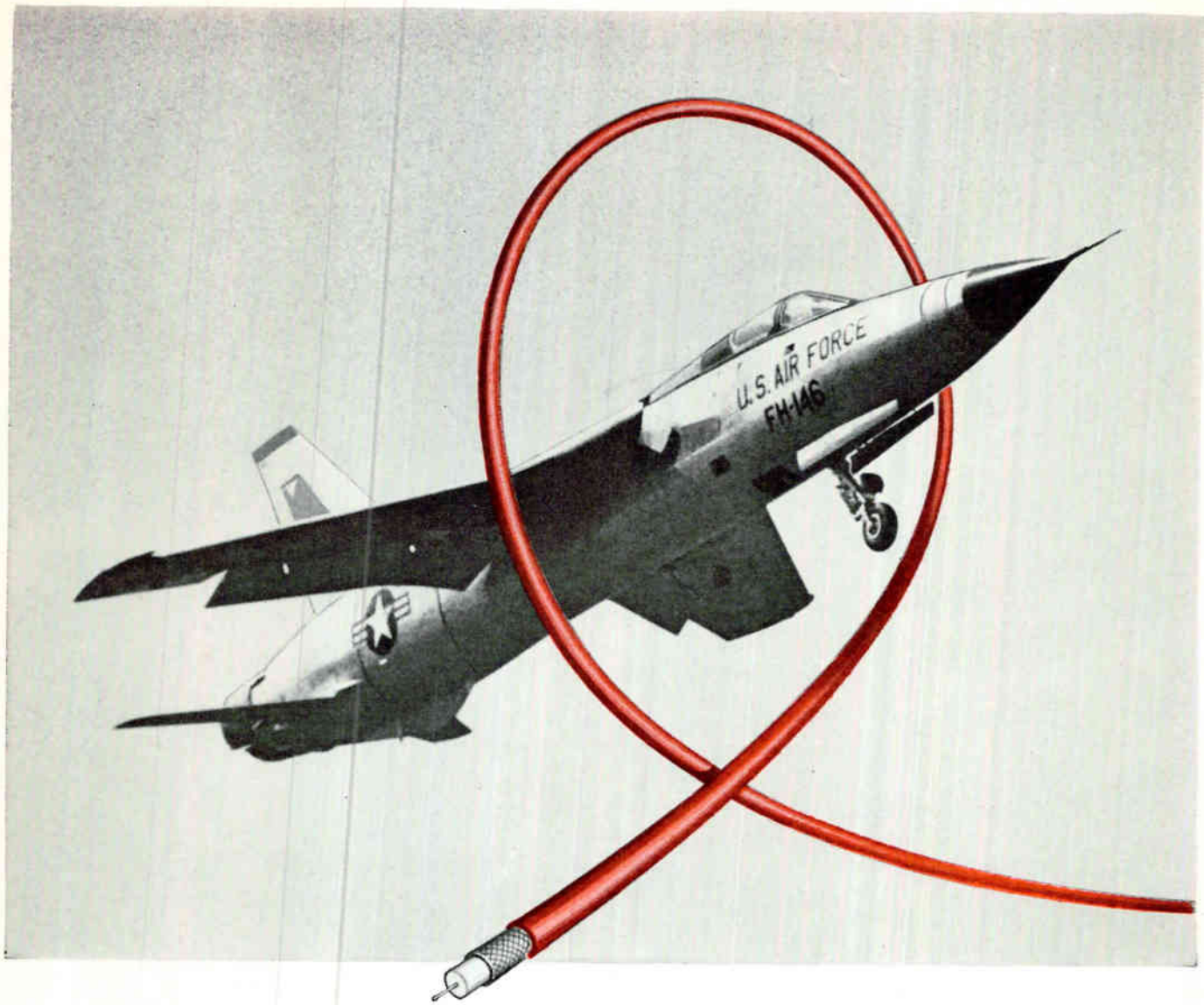
MILITARY BUYING that might have been delayed or questioned is now more likely to be approved. Even if procurement volume is not expanded, a Pentagon official privately concedes that the crisis atmosphere brings an imperceptible but real "unloosening" of procurement practices. Contracting officials, under the gun, could conceivably be less hard-nosed about such things as debatable cost allowances.

The expected rise in procurement from $48 to $50 billion in the next fiscal year will probably be exceeded. Spending for space, too, will get a jolt from the new atmosphere. NASA is working on boosters to match the Soviets' and also backs satellite surveillance of Russia, the substitute for the U-2 airplane.

If the diplomats continue to hold center stage, the diplomatic contest will be in sharper terms. Tensions—and maximum military readiness—will remain at their new peak for some time to come, until it becomes clear whether Russia wants to move from Cuba to a broader settlement of cold war issues, or wants to recoup prestige lost in Cuba with tougher attitudes elsewhere.

## CUBA SHOWS INTELLIGENCE ADVANCES

THE CUBAN REVELATIONS illustrate the military's growing dependence on photo-intelligence. In the week after Kennedy received the first photographic evidence of the missile bases, 97 percent of the island was photographed by U-2's and other planes flying as far as 18 miles from the Cuban coast, using sophisticated oblique photography techniques. These techniques join the U-2 photo flights and the Samos-Midas family of prying satellites in the modern intelligence book. Samos is photo-equipped and Midas has infrared sensors.




# Jackets of TEFLON® FEP on coaxial cables save space, weight...increase reliability

The multiple advantages of switching to coaxial-cable jacketing of a TEFLON FEP resin are clearly demonstrated in Republic Aviation Corporation's new F-105 Thunderchief fighter bomber. When the coax jackets in Communications, Interrogation, and Navigation electronic systems were switched from glass braid to FEP...

- weight savings of approximately 20 lbs. per plane were realized;
- over-all cable diameter was significantly reduced;
- system reliability was increased because of better abrasion resistance;
- snagging and fraying during installation were virtually eliminated.

And last, but far from least—in the quantities used by Republic, the cost of coax jacketed with FEP resin was lower than that of the glass-braid construction.

Du Pont TEFLON FEP resin offers outstanding electrical properties over a wide range of temperatures and frequencies. Like the familiar TFE resins, FEP resin is inert to virtually all chemicals and solvents, and has excellent mechanical properties. Because FEP resin is melt-processible, it can be extruded in long, continuous lengths of jacketing and wire insulation.

Find out more about jacketing of FEP resin and the design advantages it offers *you*. Write to: E. I. du Pont de Nemours & Co. (Inc.), Dept. E-112, Room 2526 Nemours Bldg., Wilmington 98, Delaware. **In Canada:** Du Pont of Canada Limited, P.O. Box 660, Montreal, Que.

DU PONT REG. U.S. PAT. OFF.

TEFLON® FLUOROCARBON RESINS

*TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, fibers and film, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.*

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*


# AVNET

## markets these components

BENDIX CONNECTORS: Pygmy types PT and SP; Pygmy crimp types PTCE and PTSE; MS; QWLD: SR rack and panel.

STC: NPN Silicon Power Transistors with isolated collector; PNP Silicon Power Transistors with complementary NPN types.

MICRODOT CONNECTORS and CABLE: Multipin Connectors with power and coaxial contacts; Microminiature coaxial connectors in 50, 70 and 90 ohm types; a complete line of coaxial, twinax, and triaxial cables (RG approved to MIL C-17C).

SPERRY: PNP Silicon alloy junction transistors, and NPN Silicon planar transistors.

U.S. SEMCOR: Zener diodes, rectifier diodes, and tantalum capacitors.

Avnet markets highly specialized lines, in depth. Therefore your requirements on either standard or hard-to-get items can be met on time.

## generates this service

Customer service at Avnet, just like components, is available for instant use. Avnet gives you the quickest, most modern marketing service on electronic components.

SPEED OF DELIVERY: Assembled items to meet your requirements, off the shelf items within hours, to any point in the U.S.

INFORMATION DATA: Avnet matches its inventory and assembly facilities with experienced, knowledgeable Sales Engineers.

PERSONALIZED ASSISTANCE: Avnet's 48 field men are ready to assist you on immediate notice. The "service switch" turns ON when you phone Avnet.

**AVNET**

**ELECTRONIC COMPONENTS**

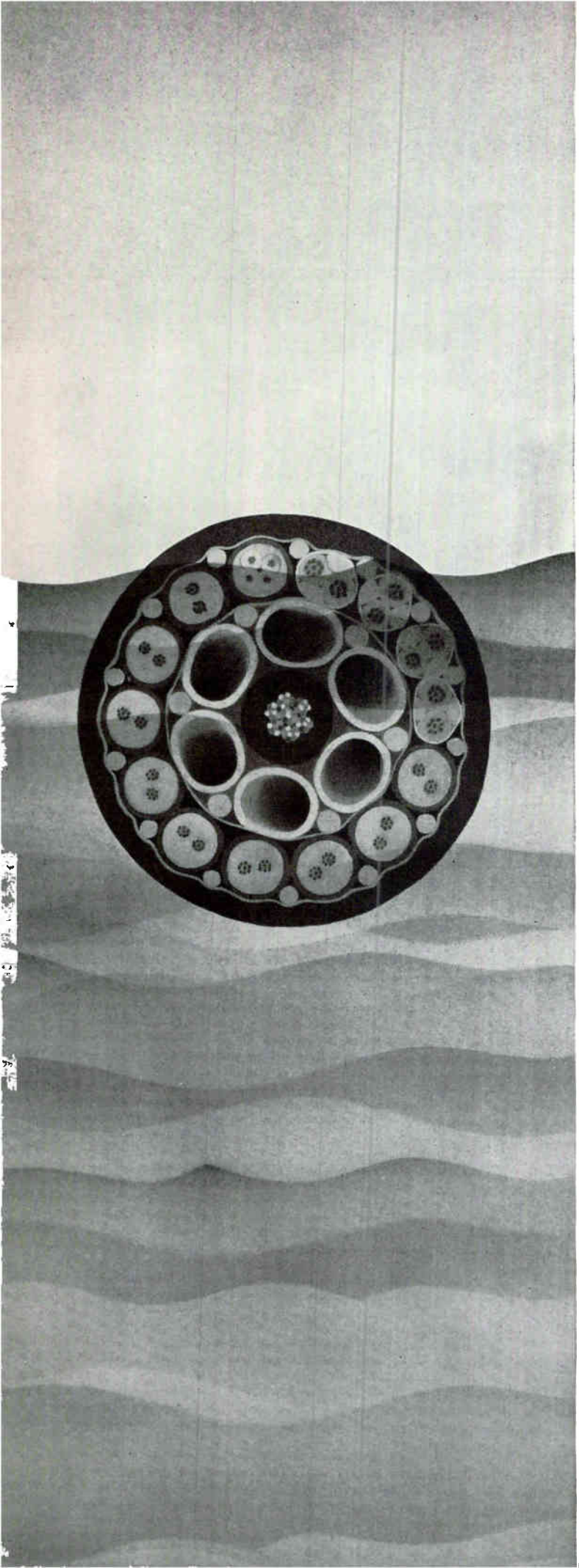
**AVNET**

AVNET ELECTRONICS CORP.

*THE AVNET SYSTEM*

*Men / Methods / Materials / Management*

LOS ANGELES, CAL., 213 UP 0-6141; SUNNYVALE, CAL., 408 RE 6-0300; SEATTLE, WASH., 206 GL 4-4911; PHOENIX, ARIZ., 602-273-1261; SALT LAKE CITY, UTAH, 801-487-7566; CHICAGO, ILL., 312 GL 5-8160; WESTBURY, L. I., N. Y., 516 ED 3-5800; BURLINGTON, MASS., 617 BR 2-3060.



*Simplex Electronic Cables . . .*

# Float at Sea
# Eliminate Hosing Problems
# Link Rockets to Ground Control

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

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

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

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

**Simplex**

**WIRE & CABLE CO.**

EXECUTIVE OFFICES: Cambridge, Mass.

Plants at Cambridge, Mass., Portsmouth, N.H., Westbury, L.I., Monrovia, Calif.

CIRCLE 15 ON READER SERVICE CARD

# Here's A Way Colleges Can Tap A Major Source Of Business Help

The purpose of this editorial is two-fold:

1. To give recognition to the remarkable job the business community has been and is doing in providing financial help to our colleges and universities, and

2. To suggest a way by which more help, which is badly needed, might be stimulated.

**The Council for Financial Aid to Education estimates that U. S. business firms are currently providing financial support for our colleges and universities at a rate of about $200,000,000 a year. This is an all-time high by a substantial margin.** It is being attained in the face of a severe and persistent "profits squeeze" which was the subject of a recent editorial in this series. And it represents the highest point in a steadily increasing volume of business aid to education which has been sustained in spite of marked ups and downs in business along the way.

## One Worry Laid At Rest

This record should go a long way toward laying at rest what has been a widespread worry about reliance upon business firms for any large measure of support for higher education. The worry has been that perforce this support would be a fair weather operation, expanding with business expansion and rising profits and shrinking in recessions, to leave the colleges and universities riding on an untenable financial teeter-totter.

The record makes it clear that business firms, often aided in the process by the creation of foundations to handle them, give a high priority to their commitments to help higher education financially. They tend strongly to stick to these commitments even when the going gets rough financially for them, and thus contribute a basic element of stability to these commitments.

## Too Much Concentration Of Givers And Giving

In two key dimensions, however, the total program of financial aid for higher education leaves much to be desired and accomplished. In the dimension of donors the aid is coming from far too few business firms. And in the dimension of recipient colleges and universities, it is concentrated in far too few institutions. For example, about a fourth of the total volume of business aid for higher education is being currently supplied by 64 companies. And of the total aid provided by business in 1960-61 about one-half went to 20 universities, out of a total of 1,900 colleges and universities. The degree of concentration of business support is much the same currently.

**If the goal of $500 million a year in a well-balanced program of business financial aid for higher education by 1970 is to be attained, two things must obviously be done. A great many more companies must develop programs of financial aid, and the aid must be much more widely spread through our colleges and universities than it now is.**

Previous editorials in this series have dealt with a variety of methods by which business firms can effectively provide financial aid.* **This editorial suggests a method where the initiative lies with the colleges and universities, but by which they have a good chance of doing much to increase the flow of financial help from business and the dispersion of it, both in terms of donors and recipients.**

## Business Executives As A Source Of Board Strength

**The method, thus far neglected by many colleges and universities, is simply that of adding to their governing boards notably successful business executives.** There are literally legions of such executives with a demonstrated interest in advancing higher education in the United States who are not now involved in the process. Strangely enough, there is no national directory of college and university trustees and regents. (Providing one and keeping it up to date would be a very useful job for some educational foundation.) But officers of the Council for Financial Aid to Education, who are broadly familiar with the subject matter involved, find that the strongest colleges and universities financially as well as academically have strong representation of successful business executives on their governing boards while many of the institutions which are weaker in both dimensions commonly don't.

There is good reason to believe that this state of affairs is no accident and that many of our colleges and universities could strengthen their position both financially and academically by adding to their governing boards the talents of successful business executives available to them. These talents are by no means restricted to money raising. They have great potentialities of constructive accomplishment in coping with the problems of effective internal management by which almost all of our colleges and universities are plagued. And the uniform record of business respect for academic freedom, which has been part and parcel of the great expansion of business aid for higher education in recent years, provides assurance that these talents would be applied with abundant regard for educational prerogatives and necessities.

## Initiative Lies With Colleges

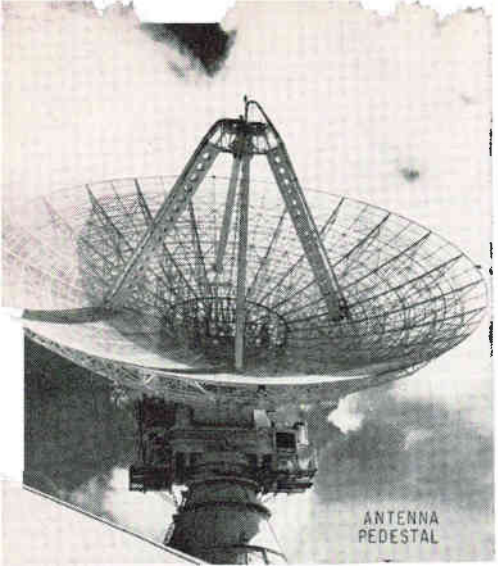
**In the prevailing pattern of academic manners and conventions, business executives cannot apply for posts on college and university governing boards. But there are many, many of them who would, if asked, be disposed to serve and who would be capable of doing it most effectively. By aggressively seeking to utilize this largely unused resource of notably competent man- and brainpower on their boards, many colleges and universities which have not done so can, we believe, make an important advance in strengthening both their own institutions and higher education in the United States as a whole.**

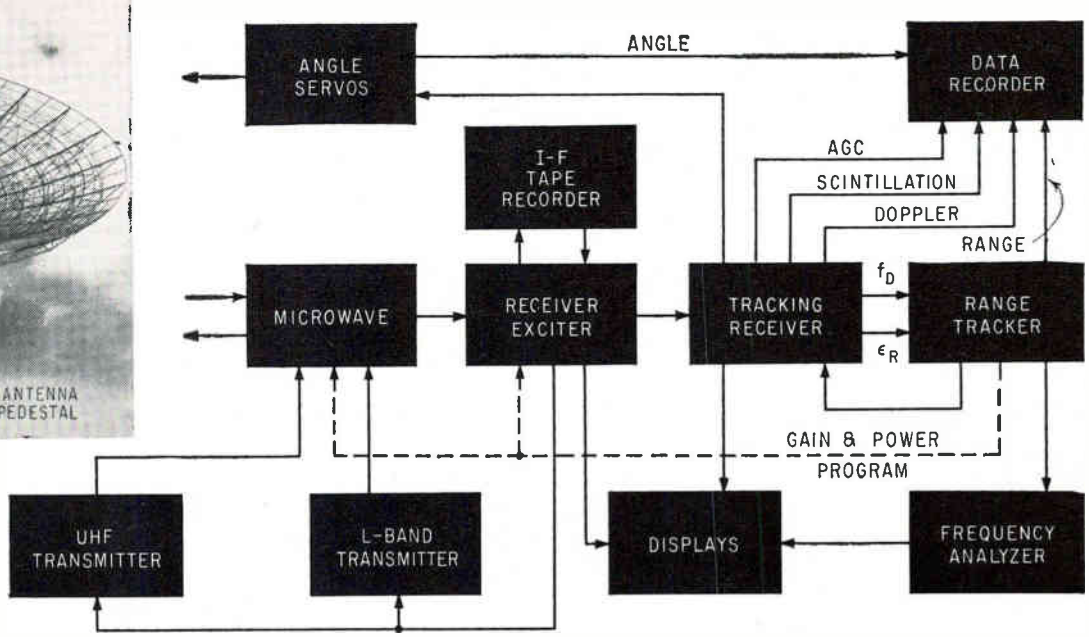


PRESIDENT

McGRAW-HILL PUBLISHING COMPANY

*This series of 14 editorials includes those dealing with specific plans such as those of Gift Matching and Supplemental Tuition Grants as well as a broad array of facts and figures about the financial problems of our colleges and universities. We will be glad to provide complimentary copies of any of the editorials in this series, if available, to business firms and college and university officers on request.




TWO RADARS IN ONE. *Tradex transmits simultaneously at uhf and L-band. One tracks while the other provides data on frequency sensitivity of the targets*

# Radar Trends: Superpower and Smarter

*Target resolution and discrimination system typify new designs*

MOORESTOWN, N. J.—Top radar experts, gathered here in a special government-industry radar conference last week, predicted that future radars would certainly get bigger and more powerful, but that more and more emphasis would be put on sophisticated data acquisition methods and on extensive signal analysis. They cited Tradex as an instance of this trend.

The importance of data processing in all future radar systems was stressed during the two-day meeting by many speakers including Hector Skifter, consultant to the President's Science Advisory Committee, and by H. G. Weiss, head of Project Haystack at MIT Lincoln Laboratory. Skifter said that emphasis would be placed on sophisticated signal analysis to get out all information buried in signals.

TRADEX RADAR—Tradex (Target Resolution And Discrimination Experiments), really two radars in one, claims some impressive characteristics. R. A. Newell, RCA program manager of Tradex-Press (Pacific Range Electromagnetic Signature Study—see ELECTRONICS, p 20, May 18), stated that it is the first radar to combine pulse compression with pulse doppler and velocity tracking, to separate targets in a single pulse and the highest-power L-band radar.

J. T. Nessmith, Jr., RCA's manager of advanced systems projects, pointed out that although certain techniques used in Tradex, taken singly, do not necessarily represent first-time art, their combination represents an advance in systems.

Tradex transmits simultaneously with two high-power transmitters, one at uhf (425 Mc, 4 Mw peak, 300 Kw average), the other at L-band (1,320 Mc, 1.25 Mw, 75 Kw average at present, 5 Mw, 300 Kw goal). It is capable of linearly or circularly polarized transmission and reception with simultaneous pulse operation at both frequencies. Monopulse techniques at uhf perform tracking. Illumination at L-band obtains data on the frequency sensitivity of targets being tracked through correlation of the two returns at uhf and L-band. The radar can measure velocity to about one foot a second on skin-tracked targets.

All raw data is recorded at i-f in a form that preserves all information. The system can obtain multiparameter information simultaneously on all targets in the beam.

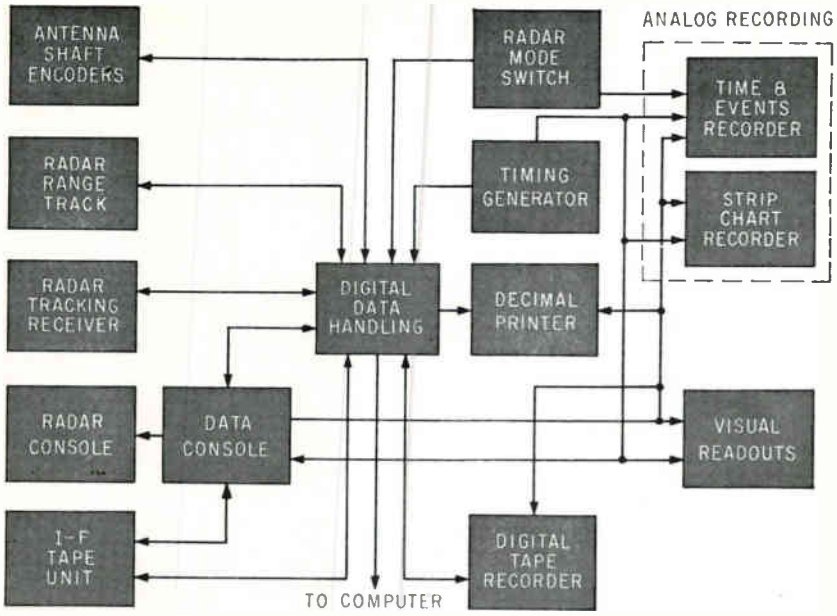
A combination of high signal-to-noise ratio, high repetition rates, with precise range-doppler resolution, coupled with an i-f tape recoder enables the Tradex to gather extensive detailed information.

In a playback mode, transmitter and antenna-pedestal are turned off, and each element of a multibody target is tracked independently within the resolution capability of the radar from the recording.

Tradex has passed uhf acceptance tests at Kwajalein atoll and final acceptance of Tradex is expected by December. The new radar has already been used in recent missile and satellite launches.

FUTURE USES—Skifter classed radars in three types: intra-atmospheric—the radars of the past and up to the present; extra-atmospheric, probing space from an earth base—the radars being worked on today; and space radars, not earth-based—the radars of the future.

He saw as probable further development of the first type for ex-




DATA-HANDLING SUBSYSTEM *for Tradex. Analog signal recordings give immediate information and help screen digital data for analysis*

# Signal Processing

By NILO LINDGREN
Assistant Editor

perimental work and surveying. Though radar might be mounted in aircraft as an avoidance device, this problem would probably be licked by air traffic control methods instead. Sophisticated but not high-powered radars would be used to cope with landing problems.

Extra-atmospheric, earth-based radar still shows a trend to "superpower," Skifter said. He cited the missile-warning Millstone radar of eight years ago, BMEWS, and now Haystack. The trend has been to bigger equipment and dishes, with talk about megawatts of peak power and sometimes average power.

Skifter also stressed the potential of phased arrays which do not involve the movement of a giant dish. However, at present, these require an enormous number of components and have a reliability problem. Weiss later stated that phased arrays provide rapid scanning and concentrate on targets. However, one such array demanded $10^7$ passive and $10^4$ active elements.

Radars in outer space would have no frequency limits imposed by atmosphere or absorption.

RADAR DESIGN—Weiss also discussed the future of radars and reviewed recent large radars. One Russian radar, with a 72-foot dish, was designed with such close tolerances that it had unique capacities, working out to 35 Gc.

Haystack, with a 120-foot dish, and 100 Kw power will work nominally at 9 Gc but will eventually have a capability out to 20 Gc and possibly higher. It will be sensitive enough to view the planet Venus at any time of the year.

The use of digital computers in the design of high-power tubes has led to far better analyses and to klystrons only a foot long that can deliver 50 Kw at X-band. Klystrons in Haystack will eventually be upgraded to 75 Kw each as these tubes become available. "A door is really opening up in this area (of high-power tubes)," Weiss said.

Weiss stressed the importance of elaborate digital analyses of radar structures before such structures were built. For instance, he said, the Haystack structure (ELECTRONICS, p 7, Sept. 29) had been simulated and rebuilt 42 times on computer before the final design was achieved. He cited the ill-fated Sugar Grove 600-foot diameter structure as a case of inadequate advance design calculations.

**BRUTE STRENGTH** **DELICATE BALANCE**

**From huge high precision rotary pivots to the tiniest shaft connections**

# THOMAS FLEXIBLE COUPLINGS

**are indispensable for reliable power and motion transmission.**

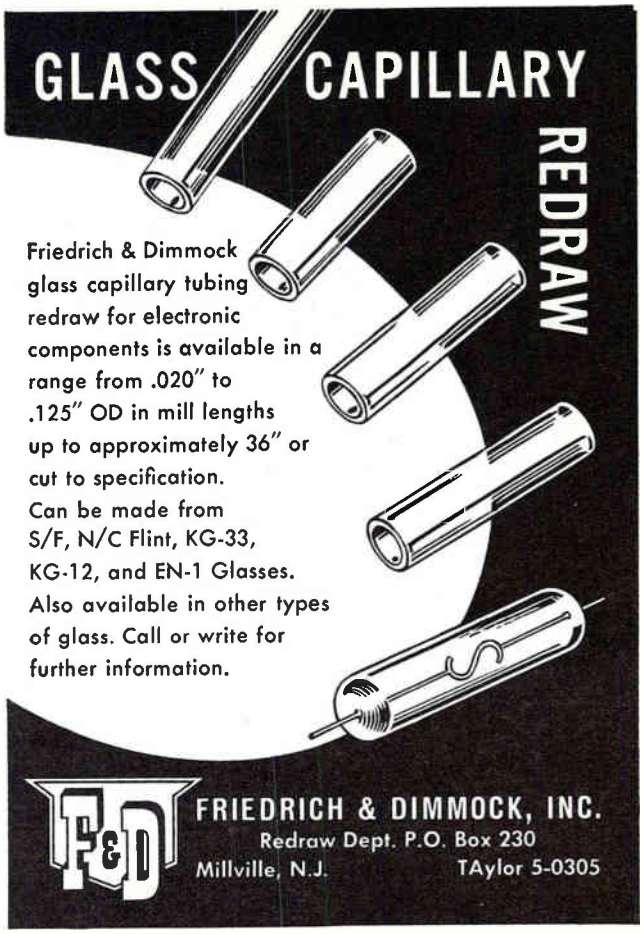
Designed especially to meet critical operating requirements, Thomas Flexible Couplings offer many important advantages plus long life, reliability and a wide range of styles and sizes to meet the particular requirements of your application. Special materials may be specified where high temperatures, corrosive atmospheres or other unusual conditions exist.

THOMAS FLEXIBLE COUPLINGS REX

Write for Engineering Catalog 760

**THOMAS COUPLING DIVISION**
**CHAIN BELT COMPANY**
**WARREN, PENNSYLVANIA, U.S.A.**

# GLASS CAPILLARY REDRAW

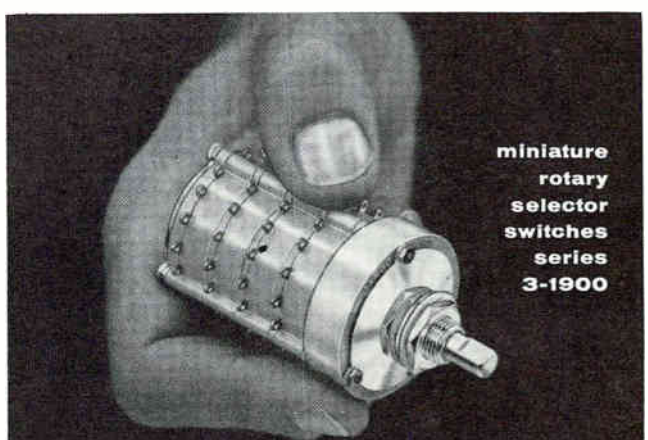


Friedrich & Dimmock glass capillary tubing redraw for electronic components is available in a range from .020" to .125" OD in mill lengths up to approximately 36" or cut to specification. Can be made from S/F, N/C Flint, KG-33, KG-12, and EN-1 Glasses. Also available in other types of glass. Call or write for further information.

F&D

**FRIEDRICH & DIMMOCK, INC.**
Redraw Dept. P.O. Box 230
Millville, N.J. TAylor 5-0305

**CIRCLE 200 ON READER SERVICE CARD**




# RELIABLE VERSATILE RUGGED

MIL specs are exceeded by all Janco switches. Outstanding features include an electrical rating of make and break up to 5 amps 115 V AC and 28 V DC and carry 10 amps continuous. They are equally capable of switching signal loads with low uniform contact resistance. Two to twenty-four contact positions are available with an indexing of 15°, 22½°, 30°, 36°, 45°, 60°, and 90°. In addition, Janco offers the versatility of 1 to 32 poles in single or multi-pole construction . . . Write today for new, complete 12-page switch catalog.

**JANCO CORPORATION**
3111 Winona Avenue · Burbank, California

**CIRCLE 201 ON READER SERVICE CARD**

# Now...Nationwide!

Meet the fastest-growing member of America's first family in highway transportation: Greyhound Van Lines! Building on a multi-million mile reputation for swiftness, economy, dependability and care, Greyhound Van Lines now provides you with nationwide service.

The combination of fully equipped Greyhound offices and agents is uniquely designed to cope with today's moving needs. Every move is supervised, controlled and coordinated by the best private communications network of its kind in the country. You know the exact status of your shipment...from loading time to arrival time. And the Greyhound one-van, one-driver service assures the ultimate in worry-free moving.

For the long move, any move—insist on Greyhound Van Lines, now nationwide...and leave the moving to us. For details call your local GREYHOUND VAN LINES representative or write Greyhound Van Lines, 57 W. Grand Avenue, Chicago 10, Ill.

## "Leave the moving to us!"


GREYHOUND®
VAN LINES

Nationwide joint thru van service with CF Van Lines, Division of Consolidated Freightways, and Johnson Storage and Moving Company.

# MNEW FROM MNEMOTRON!*

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

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

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

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

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

**ISOLATED INPUT CIRCUITS.** Input terminals of each channel are isolated from all the others to readily accept data from floating, unbalanced or differential sources.

**VERSATILITY.** 700 Series plug-in accessories expand instrumentation capability. Typical: Electrocardiogram preamplifiers for recording directly from electrodes. Pulse Record unit for recording trigger pulses, time markers, or stimulus pulses in medical research . . .

**PRICE.** 7 Channel System from $6,495

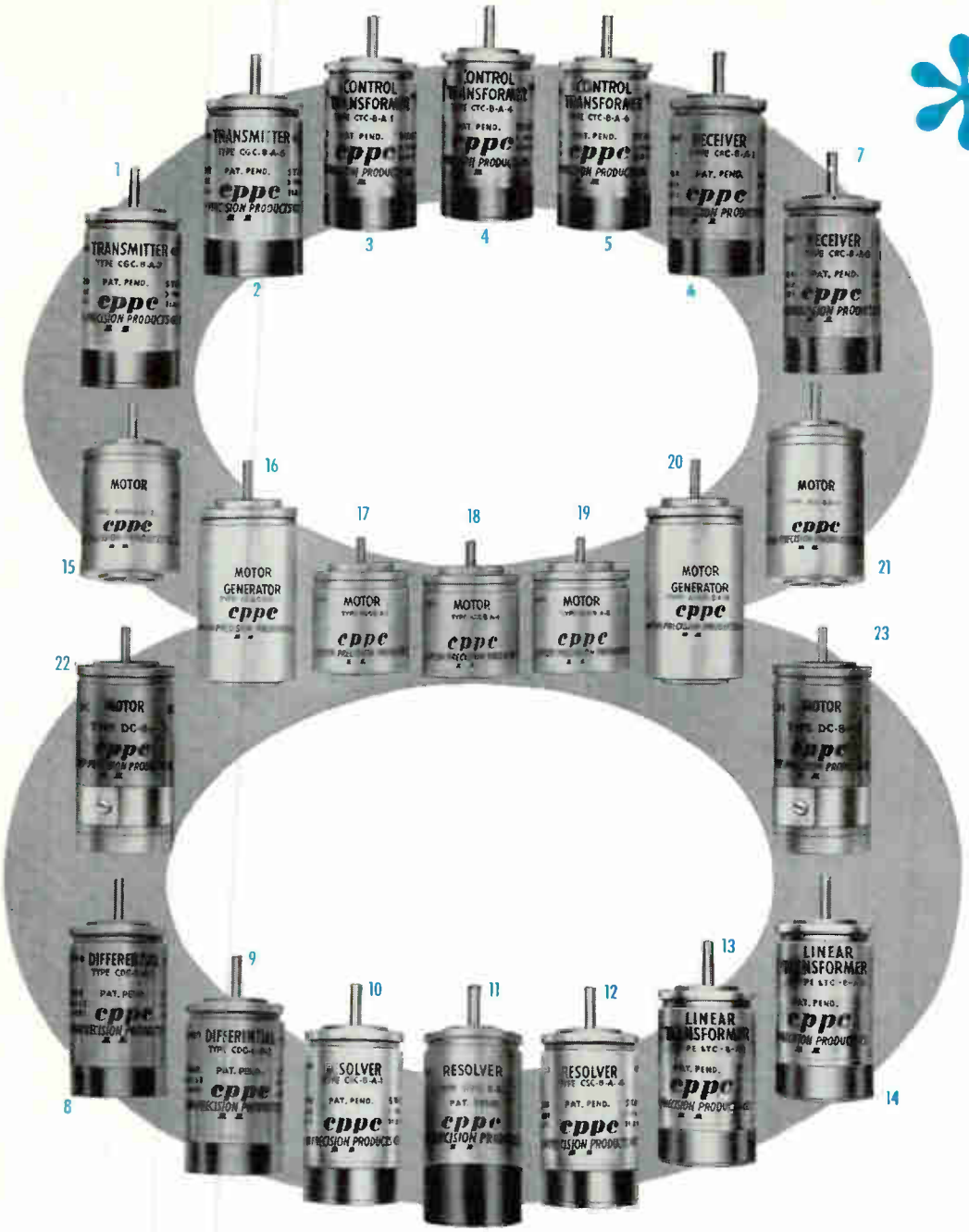
**COMPLETE SPECIFICATIONS.** Send for your copy today.

*To answer the many inquiries, Mnemotron comes from Mnemosyne, Greek Goddess of Memory.

## MNEMOTRON CORPORATION

45 South Main St., Pearl River, New York, 914 PEarl River 5-4015, Cables: Mnemotron, TWX: H99

Subsidiary of Technical Measurement Corporation, North Haven, Conn.




# A PARTIAL SHOWING. OVER 556 DIFFERENT SIZE 8 ROTARY COMPONENTS AVAILABLE

**Clifton Precision's size 8 rotary components have been tried and proven by customers over the past 8 years. These are the most accurate and best tested (because they are use tested) size 8 rotary components on the market today.**

1. Torque transmitter (26v. input) 2. Torque transmitter (115v. input) 3. Control transformer (lo Z) 4. Control transformer (hi Z) 5. Control transformer (very hi Z) 6. Torque receiver (26v. input) 7. Torque receiver (115v. input) 8. Torque differential (lo Z) 9. Torque differential (hi Z) 10. Electrical resolver (.5 t.r.) 11. Precision computing resolver (feedback winding) 12. Electrical resolver (1 t.r.) 13. Linear transformer (115v. input) 14. Linear transformer (26v. input) 15. Servo motor (1" length, .40 in-oz stall torque) 16. Motor generator (10v. input) 17. Servo motor (53/64" long) 18. Servo motor (35v. center tap) 19. Servo motor (26v. center tap) 20. Motor generator (26v. input) 21. Servo motor (.30 in-oz stall torque) 22. D.C. motor (14v. input) 23. D.C. motor (28v. input)

**For Information: 5050 State Rd., Drexel Hill, Pa.—215 MAdison 2-1000, TWX 215 623-6068—or our Representative**

## CLIFTON PRECISION PRODUCTS CO., INC.

CLIFTON HEIGHTS, PA.
COLORADO SPRINGS, COLO.

cppc

NEREM OFFICIALS, *K. C. Black, general manager; H. G. Rudenberg, general chairman, and John Rooney, committee member, look on as Gov. John A. Volpe, of Massachusetts, signs proclamation*


COMMONWEALTH ARMORY *will have 400 exhibits next*

# New England Launches Drive for More

*How to get it is question of the day as NEREM opens*

By THOMAS MAGUIRE
New England Editor

BOSTON—Will New England's comparatively minor role in the national space program be significantly upgraded?

That question mark will hover over the area as the 16th Northeast Electronics Research and Engineering Meeting convenes next week.

About 20,000 are expected to attend the three-day technical conference and exhibit opening Monday at Commonwealth Armory and the Somerset Hotel. NEREM, sponsored by the Boston, Connecticut and Western Massachusetts sections of the IRE, drew 17,000 last year.

NEREM 1962 will meet in the atmosphere of a regional drive to increase the area's relatively small share of NASA contracts, a drive generated months ago when the manned spacecraft center was assigned to Houston, not Boston. The decision pointed up the fact that the N.E. area, a prime center of military and industrial electronics, has essentially been by-passed to date in the space program.

AREA CORPORATION—Principal result of the subsequent regional awakening is the present attempt to organize a nonprofit system management corporation to bid for large NASA prime contracts—above $100 million—and farm out the work to the small electronic companies in the area. (ELECTRONICS, p. 7, Oct. 5).

The corporation, planned under the aegis of the Greater Boston Chamber of Commerce, is expected to be organized by January 1. It will lean heavily on the area's academic resources, particularly MIT, for manpower and perhaps for some facilities.

Behind the region's determination not to be by-passed in NASA work is the realization that the space program—like the military—is at the cutting edge of advanced technology, it supports extensive R&D efforts and it attracts men and facilities. Indications that some N.E. companies might move out of the area, to be closer to NASA prime contractors, spurred the Chamber's efforts to organize the company.

In a recent visit to Boston, NASA Administrator James E. Webb made it clear that an increased participation of N.E. in space work will require a closer relationship between industry and the universities.

NASA HELPING—The campaign to give the New England electronics industry a larger role in the space program obviously has NASA's blessing. Two months ago, Webb sent his top assistant, Franklyn W. Phillips, to set up a 30-member NASA North Eastern Office in Cambridge, next door to MIT. In a flying visit to Boston last month, Webb predicted unequivocally that more NASA contracts will go to N.E., now that the space effort is moving along from the "brute power" phase into the "nervous system" phase requiring the control and communications skills characteristics of N.E. electronics.

And on November 13 and 14, NASA will co-sponsor with MIT a Regional Conference on Science, Technology and Space. NASA Associate Administrator Robert C. Seamans will be a keynote speaker. James A. Van Allen will be one of five members of a symposium on "Space—National Objectives and Needs." The conference, to be held at MIT, will spell out for some 600 to 800 regional executives the impact of the space program on national life, long-range perspectives in space, and ways in which N.E. scientific and technological resources can be used more fully in the space program.

NASA MONEY—The role of New England to date in the NASA program is difficult to assess. NASA data—on prime contracts only—gives Massachusetts $30 million in fiscal 1963, compared to $830 million for California, $359 million for Louisiana, $265 million for Missouri, $174 million for Florida. NASA North East Director Phillips estimates New England has received a cumulative total of $150 million in contracts since the space effort began.

*week. This was the 1961 scene*

# Space Work

The share of space money is fractional when compared to DOD funds allocated in the area.

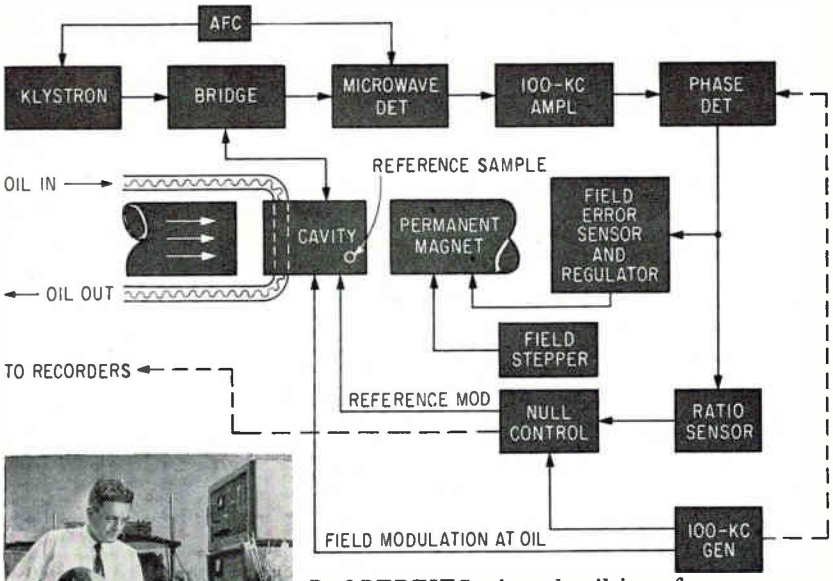
Air Force Electronic Systems Division at Hanscom Field, Bedford, Mass., is a $1.9-billion-per-year business. This includes $850 million in ESD's own fiscal 1962 budget. The remainder represents contracts let elsewhere but controlled by ESD.

ESD is the core of the "Hanscom Complex," which also includes AF Cambridge Research Laboratories, MIT Lincoln Laboratory and Mitre Corp, a cluster of R&D facilities which—combined with proximity to MIT, Harvard and other academic centers—has given the area its strong position in industrial and military electronics.

NEREM EVENTS—NEREM exhibits at Commonwealth Armory next week will number more than 400. Nearly one-half of the 105 technical papers (see p 35, this issue) are from non-New England authors, reflecting the increasingly national flavor of NEREM.

The keynote address Monday will be delivered by Ernst Weber, president of the Polytechnic Institute of Brooklyn, who will speak on "The Shape of Things to Come," an appraisal of the IRE-AIEE merger.

J. P. Molnar, executive vice president of Bell Telephone Laboratories, will speak at the NEREM banquet Tuesday night on "Communications Across Ocean Expanses."




PROPERTIES *of crude oil in refinery process stream are compared with those of reference sample in paramagnetic resonance analyzer*

DEVELOPERS *of analyzer at console of EPR spectrometer*

# Analyzer Detects Vanadium in Oil

*On-stream instrument lets refineries operate at higher temperature*

SAN FRANCISCO—Varian Associates and Gulf Research and Development Co. have developed a specialized version of Varian's Electron Paramagnetic Resonance Spectrometer. The new instrument, hopefully the forerunner of a series of EPR instruments for on-stream process control, monitors the vanadium content of crude oil going to catalytic crackers in oil refineries.

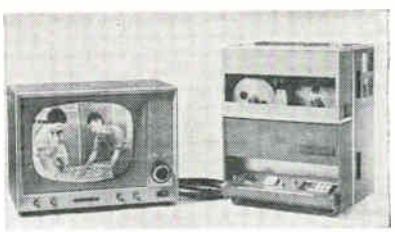
Vanadium is one of several metals that vaporizes at oil distillation temperatures. If the vaporized metal goes undetected to the catalyst, it will neutralize the catalysts. To avoid "killing the catalyst" refineries have been operating crude oil distilling units at less than optimum temperatures.

The analyzer, the companies said, will now permit refineries to operate at optimum temperatures and to adjust process controls when excess vanadium content is detected in the crude oil flow. Gulf estimates that potential savings for refineries may amount to millions of dollars annually.

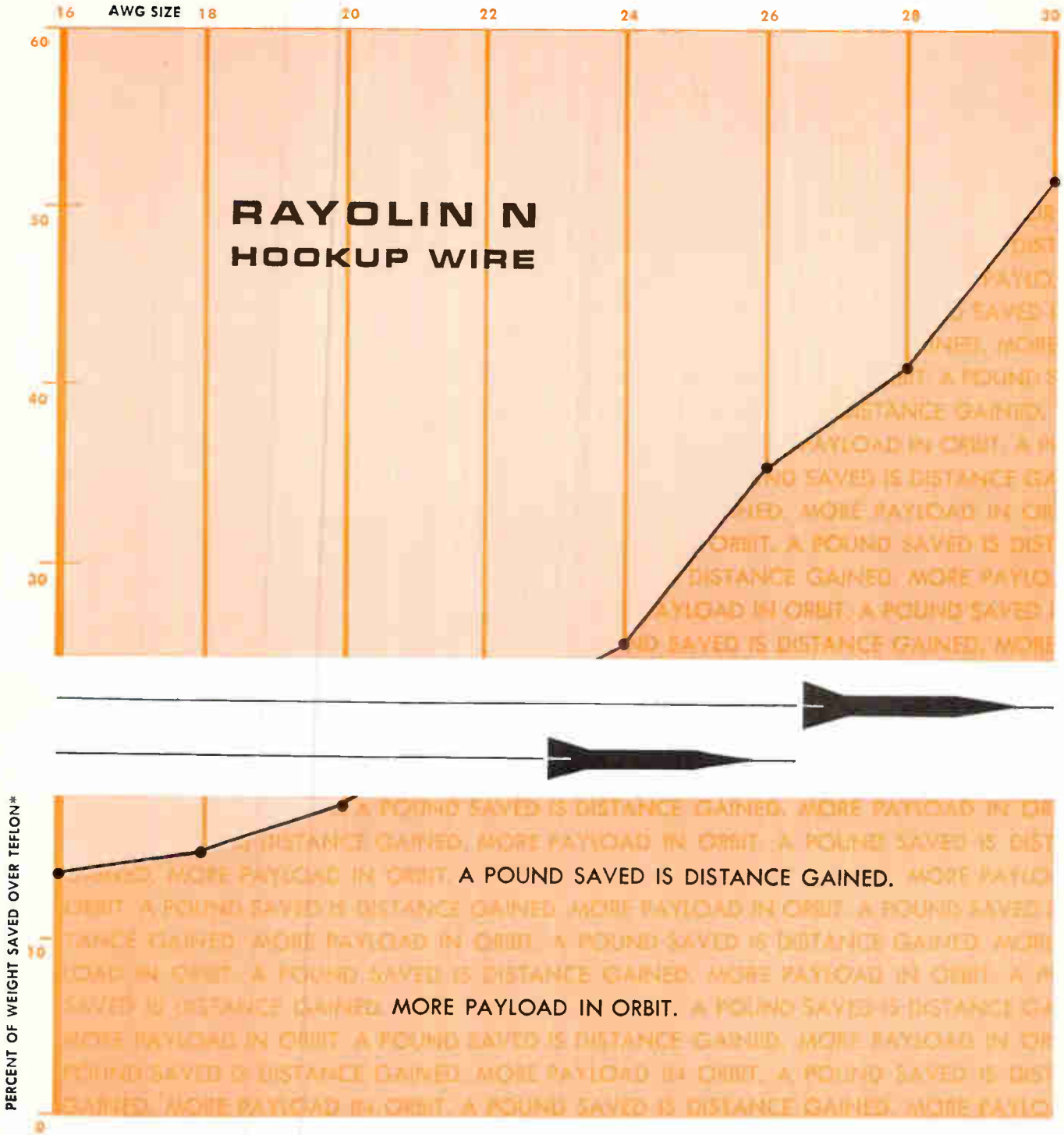
Varian's EPR Spectrometer has been used as a laboratory instrument for chemical and other analysis. The new analyzer was designed to fit into a small trailer. Development was headed by Forrest Nelson, of Varian, and Norman Coggeshall, of Gulf.

EPR is based on the fact that electrons have an intrinsic angular momentum and magnetic moment. Certain atoms can be identified by the peculiarities of their unpaired electrons, including vanadium.

## Small Recorder



VIDEO *recorder slightly larger than tv set has been announced by Sony. Tape, with audio, video and synchronization tracks, can be played back at 1/60 of normal speed*




# *lightest...by far*

**LEADER IN RADIATION CHEMISTRY FOR ELECTRONIC WIRE AND CABLE**

*T. M. DUPONT

RAYCHEM CORPORATION

# Are Satellites Needed to Detect Secret Nuclear

*Techniques for space, air and land monitoring of tests are reported*

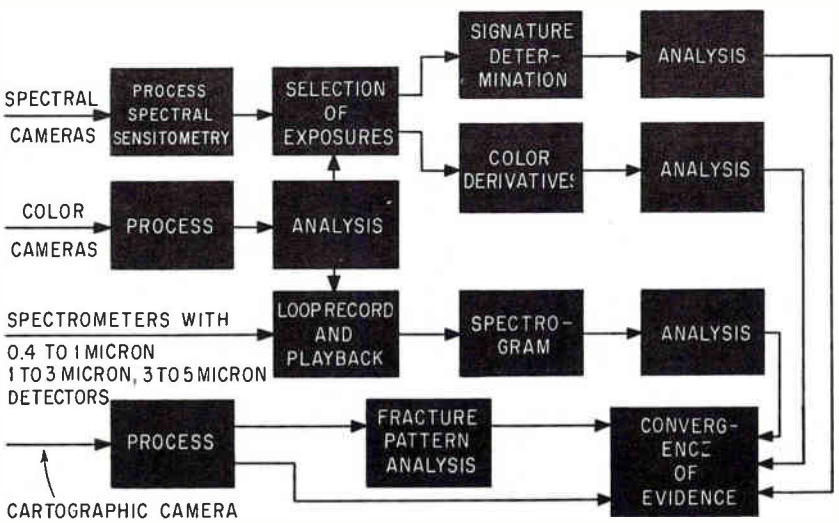
By WESLEY PERRY
McGraw-Hill News

DETROIT—Techniques for detecting nuclear tests—in space and underground—were a major topic at an International Symposium on Space Phenomena and Measurement here late last month.

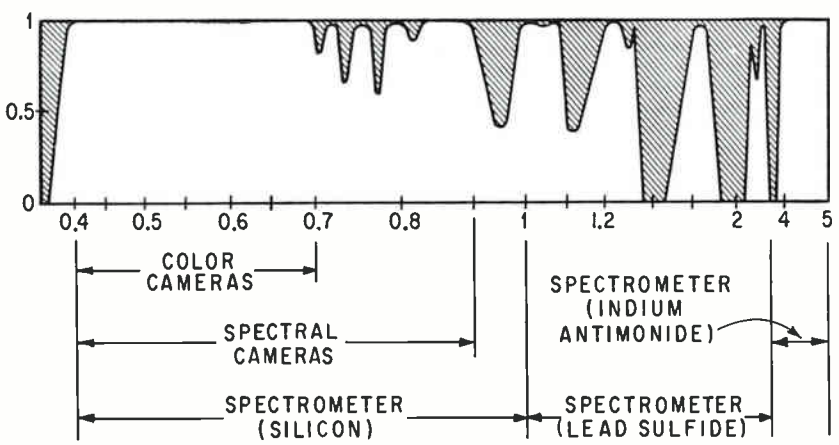
The symposium, sponsored by the Institute of Radio Engineers, the National Aeronautics and Space Administration and the Atomic Energy Commission, was held during the ninth annual meeting of the IRE Professional Group on Nuclear Science.

SPACE DETECTION—Richard F. Taschek, of the Los Alamos Scientific Laboratory, University of California, pointed out that because nuclear detonations in free space do not have the usual spectacularly visible effects, they lend themselves to the possibility of clandestine testing in space.

Thus, the objective of a cooperative program between the Department of Defense and the AEC is to study the feasibility of the use of x-ray, gamma-ray and neutron radiation detection from satellites. Eventually, satellites in orbit far from earth will carry x-ray, gamma-ray and neutron detectors so disposed that the properties of existing natural space radiations may be studied under conditions presently believed to be typical of those under which a bomb could be detected.




VELA UNIFORM *spectral reconnaissance system, an airborne data-gathering system, would detect underground explosions by analyzing the spectrum signatures of objects and conditions on earth. Diagram shows data operations flow*




SPECTRAL COVERAGE *of sensors used in the Vela Uniform system. Shaded areas are the $CO_2$ and $H_2O$ absorption bands*

DETECTOR TECHNIQUES—Fractional kilovolt and kilovolt x-radiation, characteristic of that emitted by bombs, may be transmitted by a thin window and detected as a signal by a scintillator multiplier phototube.

Since background radiations will give a continuous random counting rate, a high order of coincidence with other identical counters on the same side of the satellite has to be required before an event is considered important. This high order coincidence, which must also satisfy a minimum bias condition and a pulse duration condition, is then transferred by on-board logic through data-handling subsystems to the telemetry equipment.

A gamma-ray system, which is next most sensitive, might consist of a number of fluorescent detectors optimized for the gamma-ray energies emitted in a nuclear detonation. They could be located inside the satellite and again require a high order coincidence.

Probably the most unique characteristic of bomb radiations is the observation of neutrons. The counters themselves may be conventional depending on the detection of moderated neutrons.

SATELLITE GEAR—Accounting to Sima Miluschewa, of RCA, Princeton, for distances between 300,000 miles and 100 million miles away from the earth, only the satellite based x-ray detectors have the necessary range for detection. A proposed monitoring system, in addition to the x-rays, gamma-rays and neutron detectors, incorporates the following techniques:

- Change in plasma oscillations of the medium due to thermal x-ray emission from the explosion.
- Increased ionization of the satellite skin.
- Use of a narrow-pass interference filter (the 3,914-angstrom sensor) which permits detection of

# Tests in Space?

**NUCLEAR TENSIONS**

*Some of the work reported at this symposium was concerned with the detection of clandestine testing of nuclear weapons. And some of that work has been hopefully directed toward techniques for inspection of suspected test sites under a cooperative test control agreement.*

*A few days after the symposium adjourned, the Cuban crisis began. Unless—as now seems hopeful—the USSR heeds the President's call for a relaxation of nuclear tensions, the question of cooperative inspections may become academic. But the detection of clandestine tests will be a continuing problem*

stimulated nitrogen emission due to a nuclear explosion.

- Use of a solid-state detector.
- Use of quantum-mechanical radiation detectors.
- Detection of electromagnetic signals due to the thermal X-rays.
- Use of logic systems with *n* threshold operators.

GROUND INSPECTION—On-site inspection techniques considered for nuclear test controls were reviewed by Charles C. Bates, chief of the Vela Uniform branch of Advanced Research Project Agency.

After a suspicious seismic event is detected, an aerial reconnaissance would be made to determine the probably location of the suspected underground explosion, then a detailed ground investigation would be made by a surface team. U. S. underground explosions have shown that fractures and other surface changes can be detected by aerial photography.

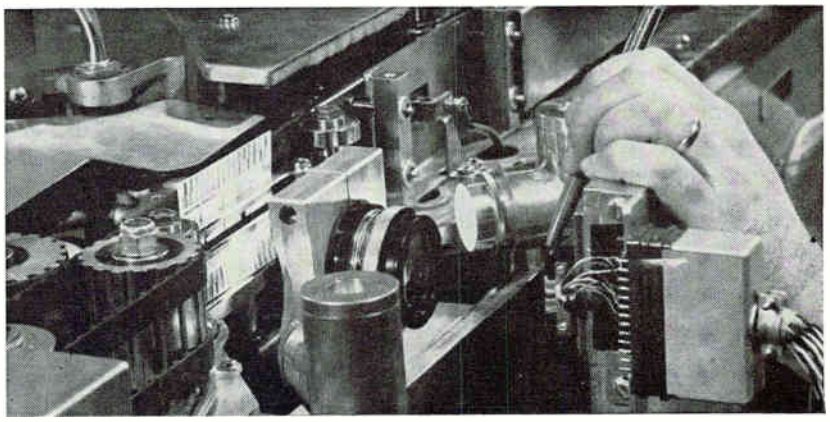
A more complex inspection technique is being developed for Vela Uniform by Itek Labs. It is based on the concept that all earth objects or conditions have distinctive electromagnetic signatures. The wavelengths of interest, 0.4 to 5 microns, are detected by cameras and spectrometers and the resulting data reduced, as illustrated.

Among techniques proposed for on-site inspection is recording and analyzing the aftershocks that fol-

low a ground disturbance. Earthquake aftershocks are erratic and normally last for two weeks. Nuclear explosion aftershocks decrease exponentially in hours, or at most in several days.

Stanford Research Institute has developed a mobile unit for detecting and recording aftershocks. Geophones are arrayed near the suspected test site, at distances of 500 to 2,500 feet from chart and tape recorders with a frequency response of 6 cps to 300 cps. The tape recording is time-coded. If any interesting events are recorded, they can be analzed by playing the tape back slowly.

## Scanner Automates Premium Plan



ENGINEERING MODEL *of scanner. Pencil points to solar-cell reading head that receives reflected images of code tracks. Head has 20 channels compensate for coupon movement or variation in track positions*

*Optically coded gift coupons will be tabulated by computer*

NEW YORK—Next spring, housewives in the Salt Lake and Denver areas will be getting optically coded gift coupons in the products they buy. In 1964, the program is to be extended nationwide and the number of coupons turned in for premiums is expected to rise to 11 billion annually.

Gift Stars, Inc., of Minneapolis, says the program was made possible by Minneapolis-Honeywell's Orthoscanning technique and the development by Honeywell of a scanner that can process 1,500 cards a minute. The program is entirely dependent on the speed of electronic data processing, according to Gift Stars.

A track of Honeywell's Orthocode is imprinted on the top and bottom, front and back of each coupon, so the coupons can be read with either side up, front or back. This eliminates special handling.

Orthocode is a dual phase system consisting of a vertical black bar preceded or followed by a white space of equal width. Each track contains the equivalent of 27 decimal digits, for manufacturer's code, product code, and gift point value, plus error-checking digits. The latter permits regeneration of up to 0.8 inch of missing code-track data that cannot be scanned because of defacement or mutilation of the code track. Expected reject rate is 0.1 percent.

The scanning system enters the encoded information on magnetic tape for processing on a Honeywell 400 computer. Participating manufacturers get statistical tabulations on product size, flavor and color, for marketing and sales use.

Coupons may be printed on paper of varying thickness with standard inks and can be made part of labels or advertisements. The code may also be used on other returnable media, such as bills and insurance premium stubs. Honeywell says typewriters and other printers can be equipped with Orthocode fonts.

## MEETINGS AHEAD

PRODUCT ENGINEERING & PRODUCTION NATIONAL CONFERENCE, IRE-PGPEP; Jack Tar Hotel, San Francisco, Calif., **Nov. 1-2.**

INDUSTRIAL RESEARCH INSTITUTE MEETING; Queen Elizabeth Hotel, Montreal, Canada, **Nov. 1-3.**

MEDICINE & BIOLOGY ELECTRONIC TECHNIQUES CONFERENCE, IRE, AIEE, ISA; Conrad-Hilton Hotel, Chicago, Ill., **Nov. 4-7.**

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

LASERS & LASER APPLICATIONS, Ohio State University, at OSU, Columbus, Ohio, **Nov. 7-8.**

ACOUSTICAL SOCIETY OF AMERICA FALL MEETING; Olympic Hotel, Seattle, Wash., **Nov. 7-10.**

RADIO FALL MEETING, IRE-PGBTR, PGRQC, PGED, EIA; King Edward Hotel, Toronto, Canada, **Nov. 12-14.**

MAGNETISM & MAGNETIC MATERIALS CONFERENCE & EXHIBITION, IRE-PGMTT, AIEE and Amer. Instit. of Physics; Penn Sheraton Hotel, Pittsburgh, Pa., **Nov. 12-15.**

ASTRONAUTICAL EXPOSITION, American Rocket Society; Pan Pacific Aud., Los Angeles, Calif., **Nov. 12-18.**

LOUDSPEAKER INDUSTRY MEETING; EIA; Pick-Congress Hotel, Chicago, **Nov. 14.**

CANADIAN IRE COMMUNICATIONS SYMPOSIUM, IRE Montreal Section; Queen Elizabeth Hotel, Montreal, **Nov. 16-17.**

MID-AMERICAN ELECTRONICS CONFERENCE, IRE; Continental Hotel, Kansas City, Mo., **Nov. 19-20.**

VEHICLE SYSTEMS OPTIMIZATION SYMPOSIUM, IAS; Garden City Hotel, Garden City, N. Y., **Nov. 28-29.**

ULTRASONIC SYMPOSIUM, IRE-PGUE; Columbia University, New York City, **Nov. 28-30.**

FALL JOINT COMPUTER CONFERENCE, IRE-PGEC, AIEE, ACM; Sheraton Hotel, Phila., Pa., **Dec. 4-6.**

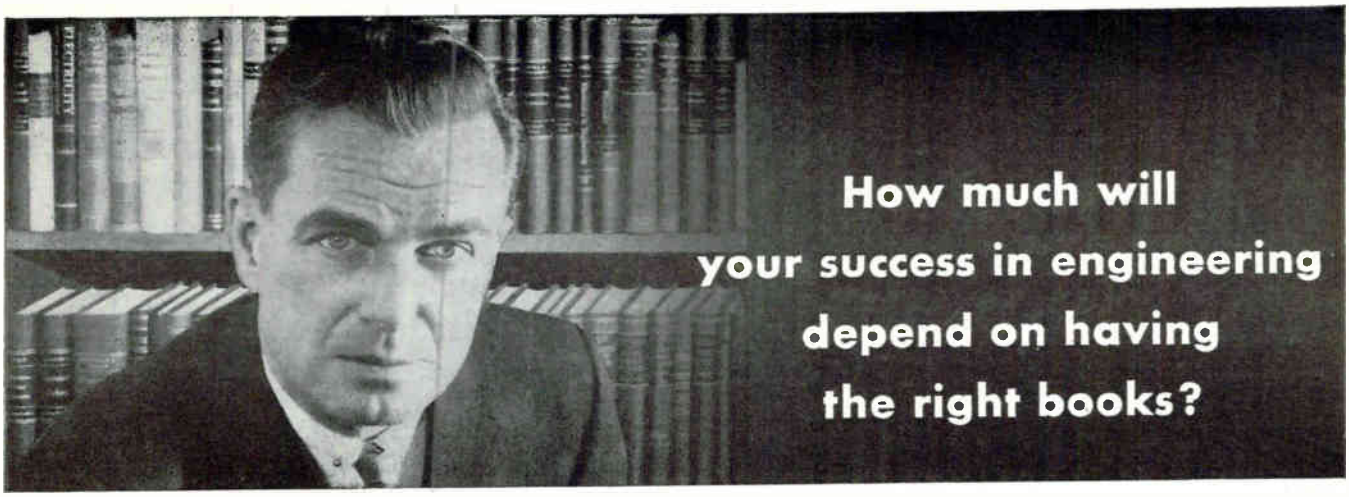
VEHICULAR COMMUNICATIONS CONFERENCE, IRE-PGVC; Disneyland Motel, Anaheim, Calif., **Dec. 6-7.**

SPACE PHYSICS CONFERENCE, American Rocket Society; Philadelphia, Pa., **Dec. 26-31.**

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

### *ADVANCE REPORT*

NATIONAL ELECTRONIC PACKAGING AND PRODUCTION CONFERENCE; *New York Hilton Hotel, New York City, June* 4-6, 1963. *Dec.* 31 *is the deadline for submitting abstracts of approximately* 500 *words in triplicate to: Technical Program Committee National Electronic Packaging and Production Conference,* 222 *West Adams Street, Chicago, Illinois. Papers will deal with various aspects of electronic packaging and production with emphasis placed on practical applications in keeping with conference theme: advanced techniques in electronic packaging and production.*




# The Electronics and Control Engineers' Book Club helps you keep ahead in your field . . . *at a savings*

**Start your membership with any of these selections:**

Electronic Switching, Timing, and Pulse Circuits by J. M. Pettit. Provides a practical understanding of operation of complex circuits.

Publisher's Price, $8.50
Club Price, $7.25

Information Transmission, Modulation, and Noise by M. Schwartz. A unified approach to communication systems.

Publisher's Price, $11.75
Club Price, $9.95

Mathematics for Electronics with Applications by H. M. Nodelman and F. W. Smith, Jr. Methods for solving practical problems.

Publisher's Price, $7.00
Club Price, $5.95

Digital Computer and Control Engineering by R. S. Ledley. Full coverage from basic electronic design to advanced programming techniques.

Publisher's Price, $14.50
Club Price, $12.35


Modern Transistor Circuits by J. Carroll. Presents almost 200 modern transistor circuits in 101 separate articles.

Publisher's Price, $9.00
Club Price, $7.65


Magnetic Recording Techniques by W. E. Stewart. Full description of magnetic recording methods and devices.

Publisher's Price, $9.00
Club Price, $7.65

Wave Generation and Shaping by L. Strauss. Essential features and techniques of practical wave-generating and -shaping circuits.

Publisher's Price, $12.50
Club Price, $10.65

Your engineering career owes a great deal to books. Why not take advantage of this convenient, economical way to have the best professional books available when you need them? THE ELECTRONICS AND CONTROL ENGINEERS' BOOK CLUB brings you the essential technical literature in your field. It also helps you overcome today's high cost of building a professional library *by saving you an average of 15% from publisher's prices.*

**How the Club Operates.** You regularly receive free of charge *The Electronics and Control Engineers' Book Bulletin.* This gives complete advance notice of the next selection-of-the-month, as well as many alternate selections. If you want the main selection you do nothing; the book will be mailed to you. If you want an alternate selection—or no book at all—you can notify the Club by returning the convenient card enclosed with each *Bulletin.*

**Saves You Time and Money.** You agree only to the purchase of three books in a year. Certainly out of the large number of books in your field offered in any twelve months there are at least three you would buy anyway. By joining the Club you save both money and the trouble of searching.

**Send No Money Now.** Just check the book you want as your first selection on the coupon below. With it you will be sent *Electronic Designers' Handbook* for only one dollar. Take advantage of this offer and receive two books for less than the regular price of one. (If coupon is detached, write to The Electronics and Control Engineers' Book Club, Dept. L-11-2, 330 W. 42nd St., New York 36, N. Y.)


ACCEPT THIS $17.50 BOOK FOR ONLY $1.00 with membership in The Electronics and Control Engineers' Book Club

**ELECTRONIC DESIGNERS' HANDBOOK**

**By R. W. Landee, D. C. Davis, and A. P. Albrecht**

Provides fundamentals and data to help you in the design of all types of electronic equipment. A large number of the circuits used in many different applications are covered, together with theoretical and technical discussions and explanations, design examples to show application of theory, and graphical and tabular data needed in day-to-day design work.

*Electronic Designers' Handbook* is typical of the selections of THE ELECTRONICS AND CONTROL ENGINEERS' BOOK CLUB. All books are chosen by qualified editors and consultants. Their thoroughgoing understanding of the standards and values of the literature in your field guarantees the authoritativeness of the selections

**NOTE: If you already own this volume, you may substitute any other book on this page as your DOLLAR book. Check two books below and you will receive the higher priced selection for only $1.00.**

## CLIP AND MAIL THIS COUPON TODAY

**The Electronics and Control Engineers' Book Club, Dept. L-11-2**
**330 West 42nd Street, New York 36, N. Y.**

Please enroll me as a member of The Electronics and Control Engineers' Book Club. You will bill me for my first selection indicated at right at the special club price and $1 for **Electronic Designers' Handbook** (or alternate choice), plus few cents delivery costs. (The Club assumes this charge on prepaid orders.) Forthcoming selections will be described in advance and I may decline any book. I need take only 3 selections or alternates in 12 months of membership. **(This offer good in U. S. only.)**

PLEASE PRINT

Name .....

Address .....

City..... Zone..... State.....

Company .....

Send as my first selection: *(If more than one book is checked we will send the higher priced selection as your $1.00 book.)*

- ☐ Electronic Switching, Timing, and Pulse Circuits, $7.25
- ☐ Information Transmission, Modulation, and Noise, $9.95
- ☐ Mathematics for Electronics with Applications, $5.95
- ☐ Digital Computer and Control Engineering, $12.35
- ☐ Modern Transistor Circuits, $7.65
- ☐ Magnetic Recording Techniques, $7.65
- ☐ Wave Generation and Shaping, $10.65

**NO RISK GUARANTEE:** If not completely satisfied, you may return your first shipment within 10 days and your membership will be canceled. L-11-2

**To Contractors and Subcontractors on U. S. Government Projects**

# NOW AVAILABLE

## from Western Electric's Laureldale Plant

# MULTI-PURPOSE DIODES

### 0.4 Watt Voltage Regulator, Rectifier or Variable Capacitor Diodes

These high-reliability devices are Bell Telephone Laboratories-designed and Western Electric-made. They have a voltage tolerance of ± 5% and a 200°C capability. The maximum forward voltage drop at 0.4 Adc is 1.0 volts DC.

| Jedec Number | BV Vdc | and | bz (max) ohms | @ | IR mAdc | $I_S$max uAdc | @ | $V_R$ Vdc | Typical TCBV %/°C | Typical Capacitance at BV/2 pf |
|---|---|---|---|---|---|---|---|---|---|---|
| USA 1N675 | 6.2 | | 3 | | 20 | 100 | | 4.5 | 0.03 | 875 |
| USA 1N664 | 8.2 | | 7 | | 10 | 2.0 | | 6.5 | 0.05 | 410 |
| USA 1N701 | 10 | | 9 | | 10 | 2.0 | | 8.0 | 0.055 | 300 |
| USA 1N665 | 12 | | 10 | | 10 | 1.0 | | 9.5 | 0.06 | 200 |
| USA 1N666 | 15 | | 24 | | 5 | 1.0 | | 12.0 | 0.07 | 160 |
| USA 1N667 | 18 | | 26 | | 5 | 1.0 | | 14.5 | 0.08 | 110 |
| USA 1N668 | 22 | | 30 | | 5 | 1.0 | | 17.5 | 0.08 | 90 |
| USA 1N669 | 27 | | 35 | | 5 | 1.0 | | 21.5 | 0.085 | 75 |
| USA 1N670 | 68 | | 290 | | 1 | 1.0 | | 55 | 0.09 | 25 |
| USA 1N671 | 100 | | 350 | | 1 | 1.0 | | 80 | 0.09 | 15 |
| USA 1N672 | 150 | | 1000 | | 1 | 1.0 | | 120 | 0.10 | 9 |

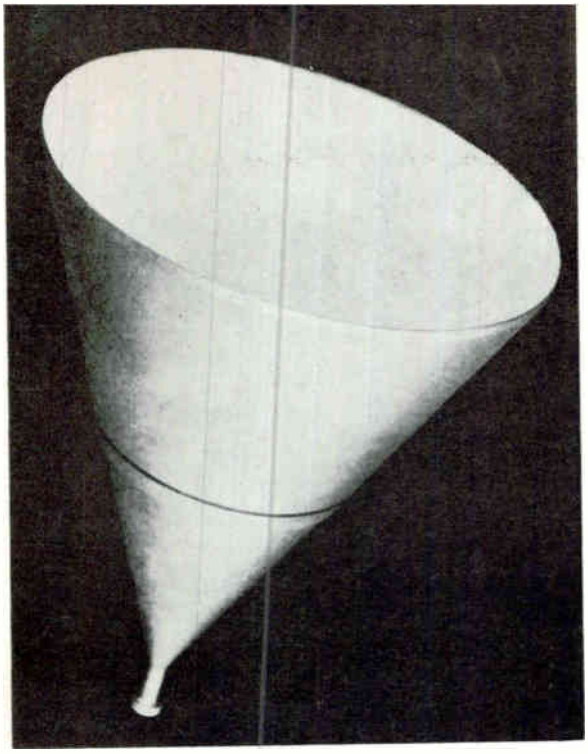
In addition to the above, similar devices with 1 and 10 watt capabilities are also available. All are available in quantity from Western Electric's Laureldale Plant. For further information, price and delivery, write to Sales Dept., Room 102, Western Electric Company, Inc., Laureldale, Pa., or call Area Code 215 — 929-5811.

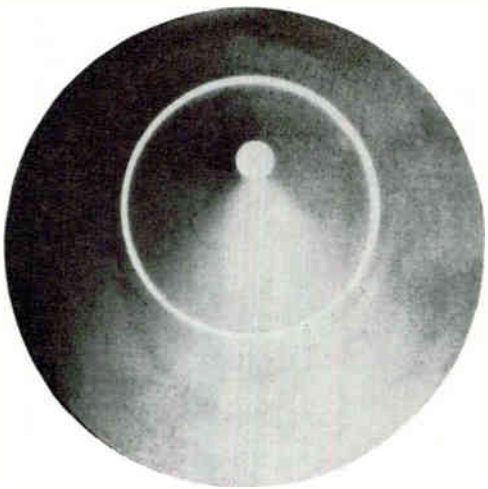
**LAURELDALE PLANT**
MAKER OF ELECTRON PRODUCTS

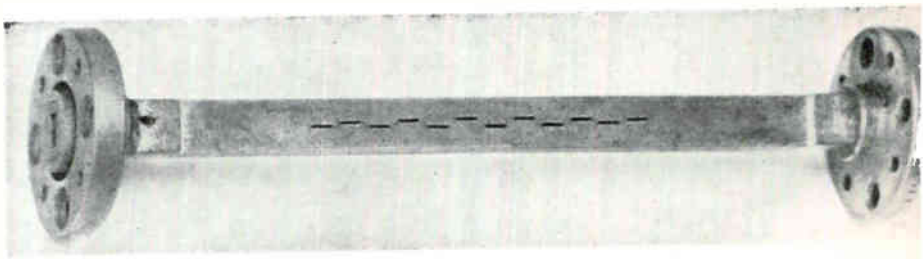
Western Electric
MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

electronics

November 2, 1962







TWO-MILLIMETER HORN LENSES, *6-inch aperture diameter (top left and right) 12-slot array for 70 Gc, produced by electroforming (right)*

# Northeast Research and Engineering Meeting:

## HIGHLIGHTS OF NEXT WEEK'S CONFERENCE

*Optical masers, microwave ultrasonic devices, antennas for millimeter wavelengths, microwave plasma interactions and thin-film amplifiers*

By THOMAS MAGUIRE
New England Editor

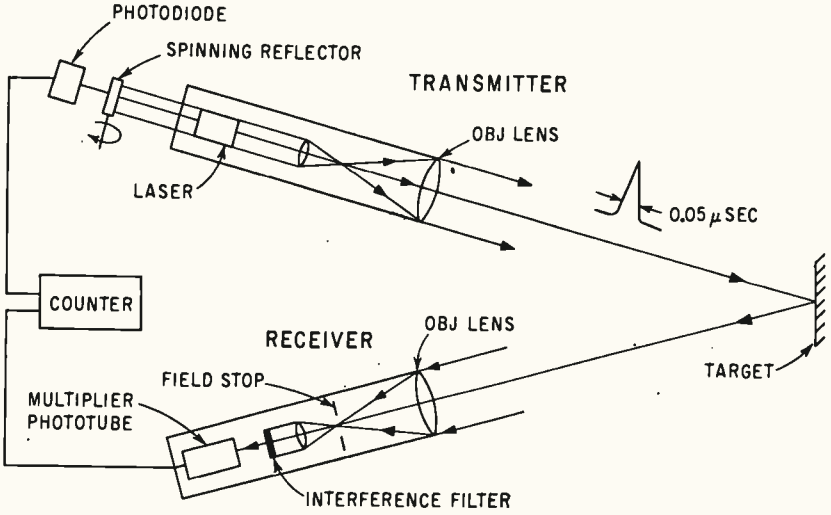
HARD-CORE engineering problems in application of optical masers to communications and radar will be spelled out next week in Boston at the Northeast Electronics Research and Engineering Meeting (NEREM).

The three-day technical program opening Monday will also spotlight work on microwave ultrasonic devices, antennas for millimeter wavelengths, microwave plasma interactions and thin-film amplifiers.

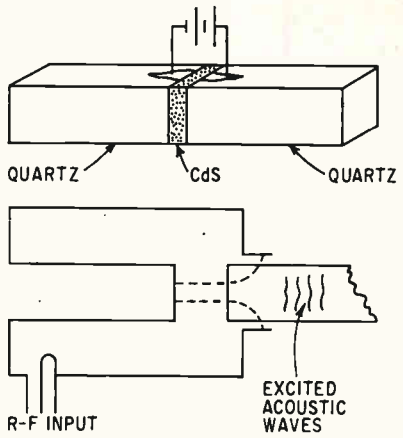
One opening-day session will be devoted entirely to electronic R&D in the Army, with all five papers from the Electronics Research and Development Laboratory, Fort Monmouth.

LASER RANGEFINDER — Included will be a report on a laser rangefinder. Developed by the Signal Corps, it employs a spinning-reflector technique to assure high-power, short-duration single pulses.[1]

The spinning reflector technique consists of a ruby rod mounted between two external reflectors, one of which is rotated at a high angular velocity so that parallelism of the reflectors—a critical requirement for laser oscillation—exists for only a brief instant. Firing of the flash lamp is synchronized with




EXPERIMENTAL *laser rangefinder. Use of Porro prism as one of the reflecting elements eliminates the problem of precise optical alignment; the prism optically corrects any slight mechanical misalignment—Fig. 1*




EXPERIMENTAL ARRANGEMENT *for coupling from electromagnetic waves to acoustic waves; crystal sandwich (top); excitation through quartz (bottom)—Fig. 2*

the 6,000-rpm reflector rotation to insure that parallelism occurs at the moment of maximum population inversion. In the experimental battery-powered laser rangefinder (Fig. 1) the transmitted pulse starts a time-interval counter and the reflected pulse stops the counter. Range is then displayed digitally.

A magnetic pickup determines the relative position of the spinning reflector. The pickup is mechanically adjusted to provide a timing pulse at the proper interval. When the firing trigger is activated, the pump flash-lamp is ignited by the next timing pulse.

Maximum pulse power obtained for single-pulse operation during the spinning reflector investigations was 3 Mw. Pulse duration at the half-power points was 0.05 microsecond.

IMAGE-DISSECTOR—An experimental image-dissector photomixer for the 2-4 Gc region will be reported. It is based on the image-dissector tube invented by Philo Farnsworth more than a quarter-century ago.[2]

The tube was developed for optical communications systems using laser sources. Use of superheterodyne detection techniques can increase significantly the sensitivity of optical receivers by making the signal-to-noise ratio independent of random noise.

The heterodyning of an incoming coherent optical signal with a local oscillator and detecting the resultant with a photosurface produces a photocurrent component at the difference frequency. The amplitude of this component is proportional to the square root of the product of the local oscillator and the incoming signal power. Increasing the local oscillator strength thus increases the beat frequency component.

Also, by making the local oscillator power large compared to the power that produces random noise, the sensitivity can be made independent of random noise. Then the sensitivity depends only upon the rate of arrival of photons, the quantum efficiency and the receiver electrical bandwidth. This is the advantage of a superheterodyne optical receiver.

For superheterodyne search and detection, the image-dissector tube is more suitable than a mechanically scanned device and than a standard tv camera tube, since the latter integrates the photoelectric current over the scanning period and cannot detect the beats.

Image dissection of an optical image, focused on the photosurface, is obtained by scanning the electron output and directing it in the scanning sequence through a collecting aperture. Aperture entrance size determines the scanning element size. In this manner an optical field can be searched for photoelectric beats.

By using broadband microwave structures for the tubes, bandwidths of many Gc are obtainable and the full promise of wideband optical communications can be realized.

The experimental S-band photomixer image tube operated at Sylvania Applied Research Laboratory has a semitransparent photocathode. Laser tests were made by aligning the laser head and the photomixer. Electron image dissection of a beat frequency optical field can be performed by supplying the tube with a magnetic deflection and focusing system. The dissecting aperture is at the entrance to the helix.

OPTICAL RADAR—According to an MIT researcher, the high spectral purity of lasers may permit their use to measure relative motion by doppler effect. This is one of the possibilities offered by optical radars in astronomical and geophysical research.[3]

Optical echoes were received last May from the lunar surface in experiments conducted by MIT (ELECTRONICS, p 7, May 18). The equipment was a relatively primitive prototype, but the experiment indicated some of the characteristics of optical radar that make it analagous to microwave radar.

Much like incoherent pulse radar, there is no control of either the phase or the amplitude of the transmitted signal, and the device is not suited to measure velocity. The detection is obtained on the photosurface without previous amplification or heterodyning; there is no possibility of matching the filter to

the received signal frequency.

High angular resolution is a feature of these devices; the limit is set by the resolving power of the receiving telescope and the atmospheric turbulence. Because of the small beamwidth, the surface to illuminate may exceed the dimensions of the beam, and the law controlling attenuation would be a square function of distance instead of a function to the fourth power. So these devices may provide an alternative to microwave radar, an alternative which is advantageous for the resolving power as well as the intensity of the echoes.

Future possible applications to radar astronomy include measuring the dimensions of the earth-moon system and of the solar system. In measurement of the lunar surface, microwaves can achieve an accuracy of the order of 1 Km, which would be the dimension of the radar beam comparable to the lunar diameter. In view of its narrow beam, and by using short pulses, an optical radar should be more accurate. It also has possibilities in high-precision tracking of space vehicles.

The terrestrial atmosphere, which limits usefulness of optical wavelengths, also presents a field of application for optical radar methods. Since the cross sections of molecules and aerosols follow the Rayleigh law, it is possible to obtain echoes of large intensity from the atmospheric components and to study, for instance, density fluctuations with high definition.

It will also be possible to observe the dust clouds and micro-meteorites around the earth; noctilucent clouds, for instance, should be visible to the radar with attenuations of about 160 db.

**NEREM APPEAL SPREADING**

*Of the more than 100 papers to be presented at the Northeast Electronic Research and Engineering Meeting, nearly half are by authors working outside New England, thus reflecting the increasingly national flavor of NEREM*

ULTRASONICS—Researchers are seeking efficient methods for coupling from electromagnetic waves to acoustic waves, partly to take advantage of the fact that ultrasonic waves can be amplified by traveling-wave interactions with drifting carriers in certain semiconductors, such as cadmium sulfide.[4]

Maximum amplification occurs when the electrons are moving with an average velocity just greater than the velocity of sound.

In amplifying acoustic waves, the coupling is provided by the electric field associated with the elastic waves in the piezoelectric material.

A Stanford experimental setup shown in Fig. 2 uses a sandwich consisting of two quartz bars and a wafer of CdS that is coated with metallic contacts and acoustically bonded to the X-cut quartz. The quartz bars convert the electromagnetic energy into acoustic energy and transmit the acoustic waves through the CdS wafer by conventional conversion mechanisms. The quartz bar extends into a region of uniform electric field in a r-f resonant cavity. The electric field generates an acoustic wave that travels down the X-axis of the quartz. A similar arrangement on the output end converts the acoustic energy into electromagnetic energy. With present techniques, approximately 0.1 percent of the energy is converted.

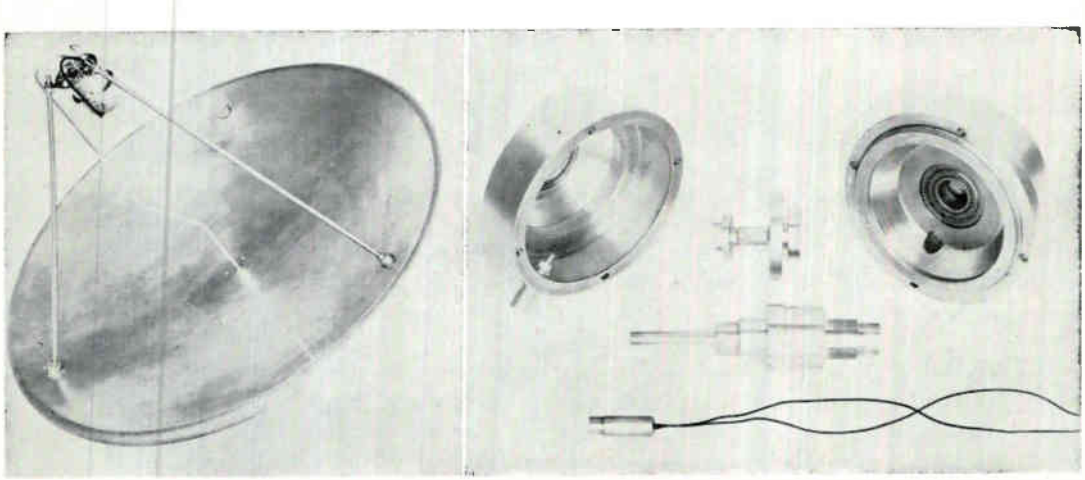
The experimental work has been carried on at 500 Mc. The r-f energy is in pulses since the acoustic system is not matched.

The device has a severe disadvantage of high losses to the electromagnetic cavities, and it is difficult to fabricate bonds that efficiently transmit acoustic waves in the microwave range. However, the inherent simplicity of this device and the large values of gain that are attainable in small length, make it attractive.

ANTENNAS—With availability of 2-3 mm generators, the high resolution and small size of millimeter wave antennas are being used to advantage in experimental short-range radar, communications, radiometry and scale-model testing.[5]

Using a scale model, at 70 Gc, of an X-band (8.4 Gc) 10-foot Cassegrainian antenna, and by cocking the subreflector and rotating it, it was possible to nutate the beam with satisfactory patterns for a conical scan radar, and the results were put to use in an X-band experimental radar.

A three-foot 70-Gc paraboloid with conically scanned feed is shown in Fig. 3 (left). The scanner consists of a hollow-shaft motor through which the waveguide extended. See Fig. 3, right. A rectangular to circular waveguide ($TE_{11}$ mode) transition is used and



*CONICALLY SCANNED ANTENNA operating at 70 Gc with feed rotated on axis of hollow-shaft motor (left); scanner components (right)—Fig. 3*

the conical scan is achieved by a bend in the circular waveguide that offsets the radiating aperture from the axis of rotation. A choke joint between the transition and the rotating circular waveguide permits rotation of the feed. A photoelectric cell and small light source, seen at bottom of Fig. 3 (right), were used in experiments to obtain a reference voltage at one point in the rotation. Horn aperture is sealed with a small cap holding a 2-mil mylar window.

Although the simple paraboloid remains the antenna of choice in the mm as well as microwave region, others are utilized for special purposes. Lead photos, top, shows a pair of 6-inch dielectric lens antennas fed by conical horns from rectangular waveguide in the 2-mm region. These lenses may be made of polystyrene, Rexolite or similar low-loss materials. Lenses of this type have been used in near-field transmission and plasma experimentation. Insertion loss going from one waveguide port, through the lenses and back into the second port is 2-3 db at distances up to $D^2/2\lambda$ where $D$ is the diameter of the lens.

Experimental 12-slot array at 70 Gc (Lead photo bottom) was made by electroforming. A mandrel having the dimensions of the inside of the waveguide was machined with raised teeth where the slots were supposed to be. After electroforming with copper, the top of the waveguide was partially milled off, exposing the teeth. The mandrel was dissolved, leaving a slot array. Measured performance indicated a 7-deg beam with 20-db side lobes.

THIN FILMS—Diode and transistor structures are being formed on thin-film silicon microcircuits with a ceramic substrate.[6]

Essence of the approach at Sylvania Microelectronics Laboratory, Waltham, Mass., is to create a highly fluid, nonreactive substrate surface condition that permits high atomic mobility at the surface and therefore permits the arriving Si to arrange itself in its lowest stress level.

This method for growing film is called a rheotaxial process, to identify the fluid state of the substrate surface. Device structures are then formed by epitaxial growth (ELECTRONICS, p 8, May 4, 1962).

To create a chemical inertness and stability at the surface of the alumina ceramic substrate and achieve the desired inert fluidity, a thin layer of selected oxides is applied to the surface. The oxides, in addition to other properties, are of a kind that will remain fluid at the temperature at which the Si film forms. The silicon vapor arriving at the surface was created by the vapor decomposition of $SiCl_4$.

Silicon deposition runs were performed at temperatures ranging from 900 C to 1,250 C. The substrate was heated by a graphite adapter, which was in turn heated by an r-f induction coil external to the reaction tube.

The device structures were formed by epitaxial growth of doped Si on the original rheotaxially grown film after oxide masking. The structure is illustrated in Fig. 4 (top), and a wafer with five film transistors is shown in Fig. 4 (bottom). The grounded emitter current gains of these transistors were measured in the range of 30 to 200 at $V_{CE} = 5$ v and $I_B = 0.1$ ma.

The experiments indicate that rheotaxially grown Si films are suitable for formation of circuit components and they appear to be compatible with other thin-film circuit elements. Rheotaxial growth appears to be adaptable to other deposition techniques and also to deposition of other materials in addition to Si.

PLASMAS—Active microwave devices that employ plasma as their working medium may soon provide amplification at millimeter wavelengths and efficient harmonic generators for the production of mm waves.[7]

To avoid the disadvantages of plasmas that are produced in a d-c gas discharge—instability, low percentage of ionization—efforts at technical development of the working medium have resulted in other methods.

At Stanford University, a cesium plasma is produced by contact ionization of cesium at a hot tungsten cathode. It is produced entirely by thermal ionization, no d-c potentials are applied.

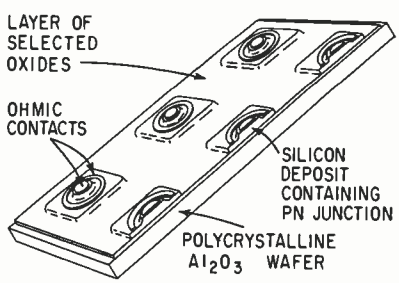
This type of stable, highly ionized plasma has been employed in a beam-plasma amplifier using helices for modulation and demodulation, as shown in Fig. 5.

The plasma is produced in a cesium vapor atmosphere by two hot tungsten spirals 2 cm. apart. Gains of as much as 30 db at S-band, or 15 db per cm, have been obtained.

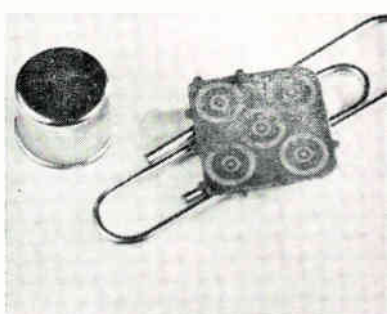
There is the possibility of coupling to the beam through the plasma without intermediate slow wave circuits. If this can be done, it should be possible to increase the plasma density to make amplifiers suitable for mm wavelengths.

A plasma harmonic generator makes use of the fact that electrons in a strong, nonuniform r-f electric field do not undergo sinusoidal motion, and consequently there may be harmonic components of current present. In the device outlined in Fig. 6 (left), a mercury-vapor plasma is formed in the glass bulb by the r-f applied on the coaxial line. The second harmonic of this input r-f signal is detected in the waveguide system. At present, the plasma used is highly unstable because the r-f input also maintains the discharge. Use of an auxiliary r-f source has obviated this difficulty in experiments.

Another way to obtain a more stable system is to use a cesium plasma to maintain the discharge.




RHEOTAXIAL-EPITAXIAL DEVICE *structure (above); wafer with five thin-film transistors (below)—Fig. 4*



As shown in Fig. 6 (right), a cesium plasma is formed at a hot tungsten button in a cesium-vapor atmosphere. The r-f fields are applied from a coaxial line with the post inserted into the cesium tube.

So far, the coupling to the plasma has been weak, so efficiencies have not been as high as in the earlier device. Schemes to improve efficiency are being investigated at Stanford. If the higher efficiency is achieved, and high stability at the same time, researchers expect no great difficulty in scaling these devices to mm wavelengths.

Thus one of the earliest applications of plasmas in active microwave devices will probably be as harmonic generators for the production of mm wavelength outputs.

## REFERENCES


All papers prepared for the 1962 Northeast Electronics Research and Engineering Meeting, Boston.

(1) R. C. Benson, 1st Lt. R. O. Godwin, M. R. Mirarchi, Army Electronics Research and Development Laboratory, New Laser Techniques for Ranging Applications

(2) Robert F. Lucy, Sylvania Electronics Systems, An Experimental Image-Dissector Photomixer for the 2-4 Gc Region

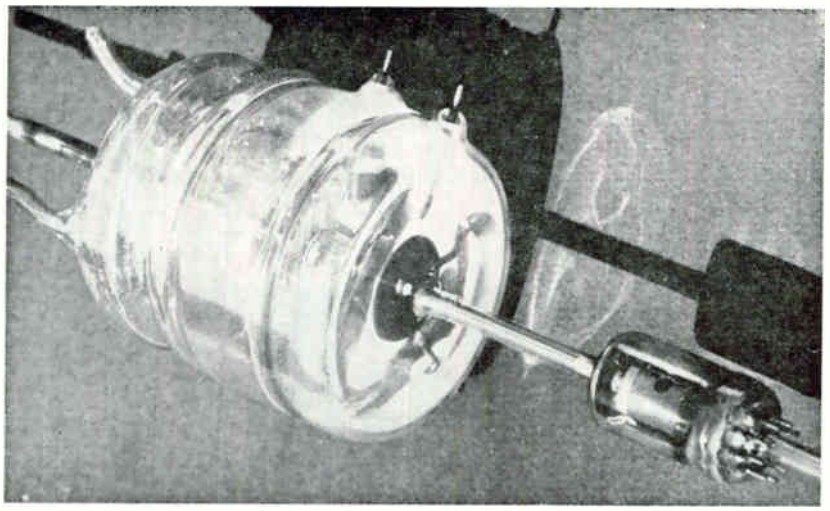
(3) Giorgio Fiocco, M.I.T. Research Laboratory of Electronics, Some Applications of Optical Radar to Astronomical and Geophysical Research

(4) C. F. Quate, Stanford University, Amplification of Ultrasonic Waves

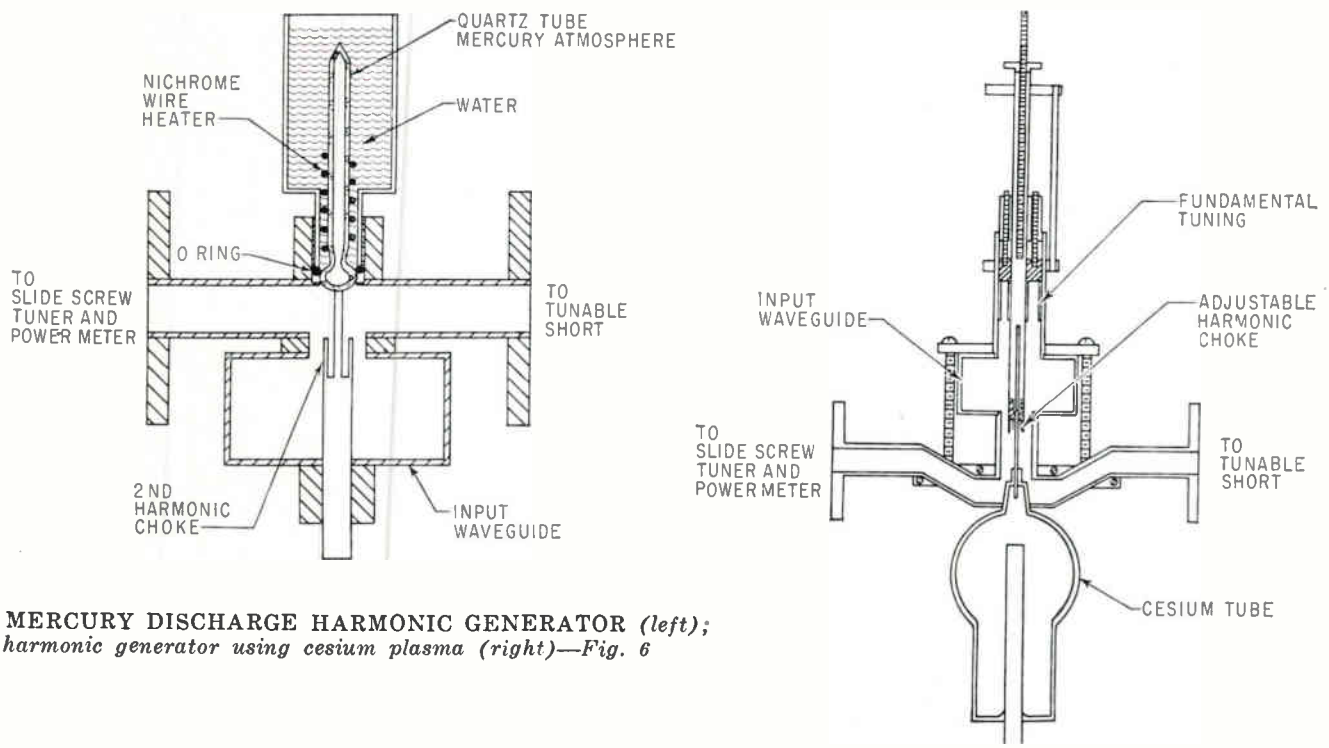
(5) Alan J. Simmons, TRG Inc., Millimeter Wave Antennas

(6) Egons Rasmanis, Sylvania Electronic Systems, Silicon Thin-Film Diodes and Transistors

(7) G. S. Kino, Stanford University, New Microwave Applications for Plasmas

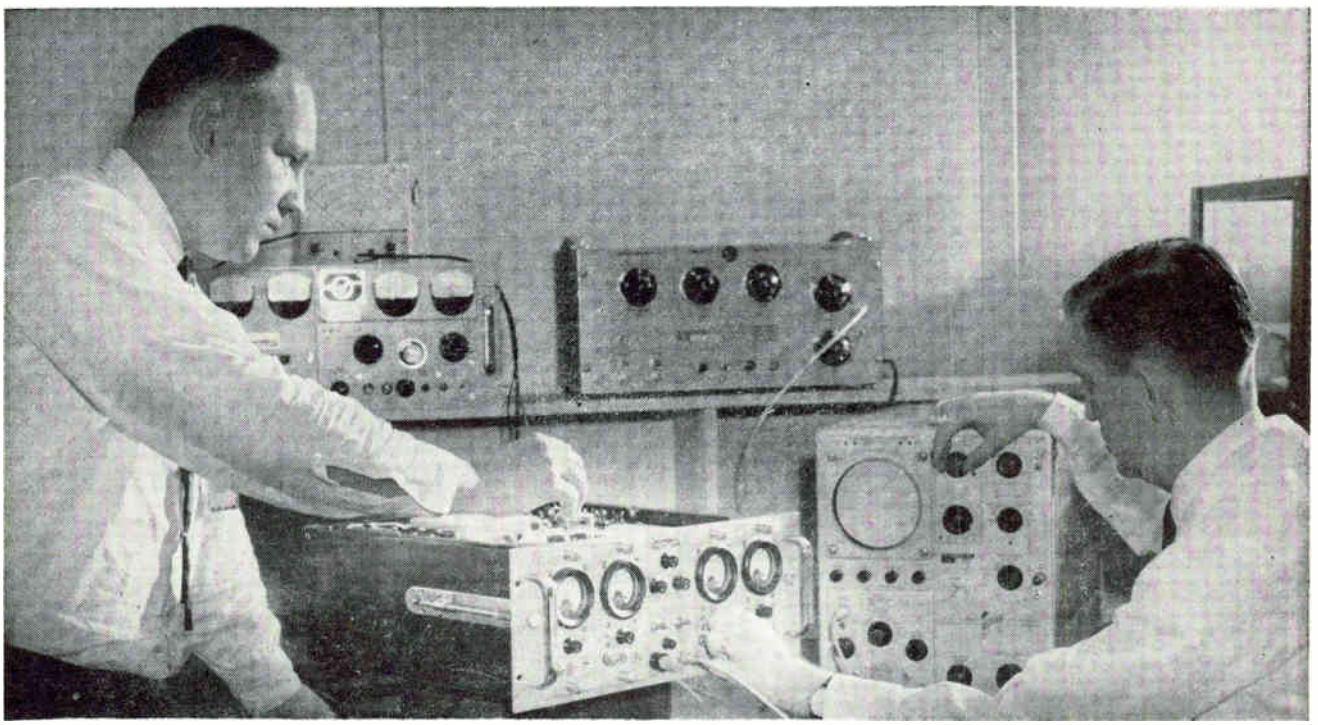

**BEAM-PLASMA AMPLIFIER** *(drawing) using a thermally ionized cesium plasma as the working medium; cesium plasma amplifier (photo), with double glass wall for circulating water to control the cesium vapor pressure—Fig. 5*



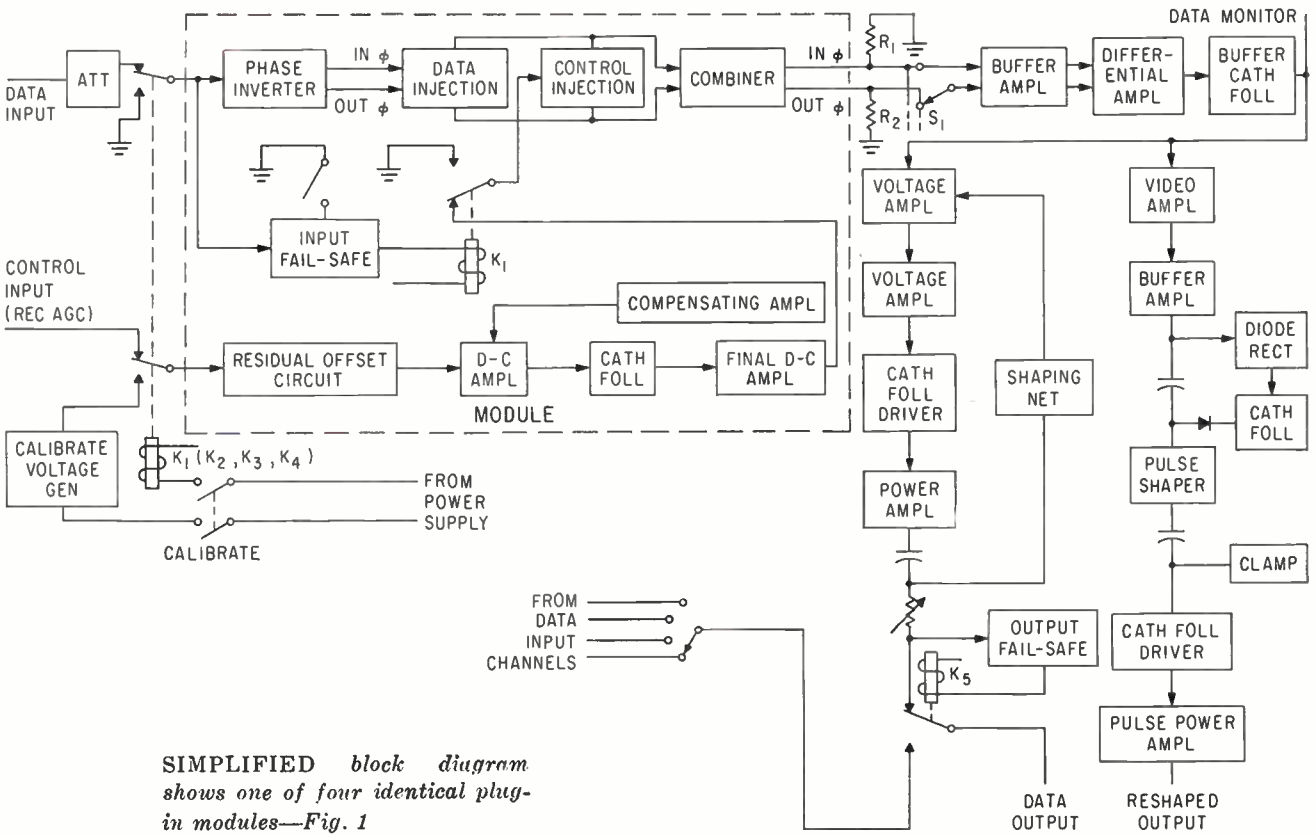

**MERCURY DISCHARGE HARMONIC GENERATOR** *(left); harmonic generator using cesium plasma (right)—Fig. 6*

# Versatile Diversity Combiner

*Telemetry diversity combiner is of the receiver agc controlled, post-detection type. It can handle any modulating signal defined under IRIG standards, and operate with any telemetry receiver that has an external agc output line*



AUTHORS *Casson and Robinson adjust reshaping circuit of diversity combiner*




SIMPLIFIED *block diagram shows one of four identical plug-in modules—Fig. 1*

# Handles Most Missile-Range Signals

By WILLIAM CASSON
Sr. Design Engineer,
R. C. ROBINSON
Project Engineer, Vitro Electronics,
Silver Spring, Maryland

FOR SEVERAL YEARS the United States Air Force has been installing telemetry diversity receiving systems on the Atlantic Missile Range, to provide reliable telemetry data records. Prior to spring 1961, a post-detection noise-sampling diversity combiner was commonly used in dual and quadruple-diversity installations. This unit provided both polarization and space-diversity telemetry reception for the types of signals then used in the programs. However, this combiner is unsuitable for reception of pcm and other types of high-sampling-rate pulse-modulated signals.

A new type of telemetry diversity combiner was developed for the Air Force Missile Test Center under Contract No. AF08(606)4632. This diversity combiner is of the receiver agc controlled, post-detection type. It is capable of handling any modulating signal defined under IRIG (Inter Range Instrumentation Group) standards and of operating with any telemetry receiver that has an external agc output line. The physical package of this combiner is shown in the photo. The data input circuit, combining stage and control amplifiers are packaged in the individual modules. The main chassis contains the differential amplifiers and video amplifiers of the combined video channel as well as the regulated power supplies.

The table summarizes the performance characteristics of the diversity combiner. The wide frequency response requirements shown in the table prevented the use of a transformer-coupled push-pull combining stage. However, the bandwidth requirements for the control signal circuits overlapped the response of the main data channel by over eight octaves. So it was necessary to combine electronically in a push-pull stage using single-ended control of the stage. This circuit is the key to the successful operation of the diversity combiner.

Figure 1 is a simplified block diagram of the diversity combiner. The circuits within the dotted line are contained in the plug-in data channel module and are repeated in each of the four modules. Each module contains the input phase inverter that converts the single-ended input to a push-pull signal. Actual combining takes place in $R_1$ and $R_2$ on the main chassis. The input fail-safe in each module cuts off the module whenever the input video level falls below 0.5 volt.

The agc voltage from the receiver is applied to a d-c control amplifier in the module where it is amplified and shaped to provide optimum combining control. The combined push-pull signals developed across resistors $R_1$ and $R_2$ are fed through a buffer amplifier to a differential amplifier. This stage restores the push-pull data signal to a single-ended output and rejects any control-signal output. Two video amplifiers follow the differential amplifier. The direct data channel is usable for any type of modulating signal and provides faithful amplitude and phase reseponse. The output is a 75-ohm low-impedance line driver. A reshaped data channel is available for pdm or pcm data.

### WHAT'S NEW IN THIS COMBINER

*Here's why this combiner is unique:*

(1) *It is agc-controlled and is therefore capable of operating with any IRIG-defined modulating signal.*

(2) *The bandwidth and amplifier characteristics are such that any defined modulating signal can be handled and the combiner can drive these characteristics into low-impedance lines to data-processing equipment at adequate voltage levels. No additional line-driver or isolation amplifiers are required.*

(3) *The equipment can be used as a two, three or four-channel combiner. Other age-controlled combiners are restricted to dual-channel operation by the technique used in the combining stage. This new type of combining can be extended to any reasonable number of parallel stages*

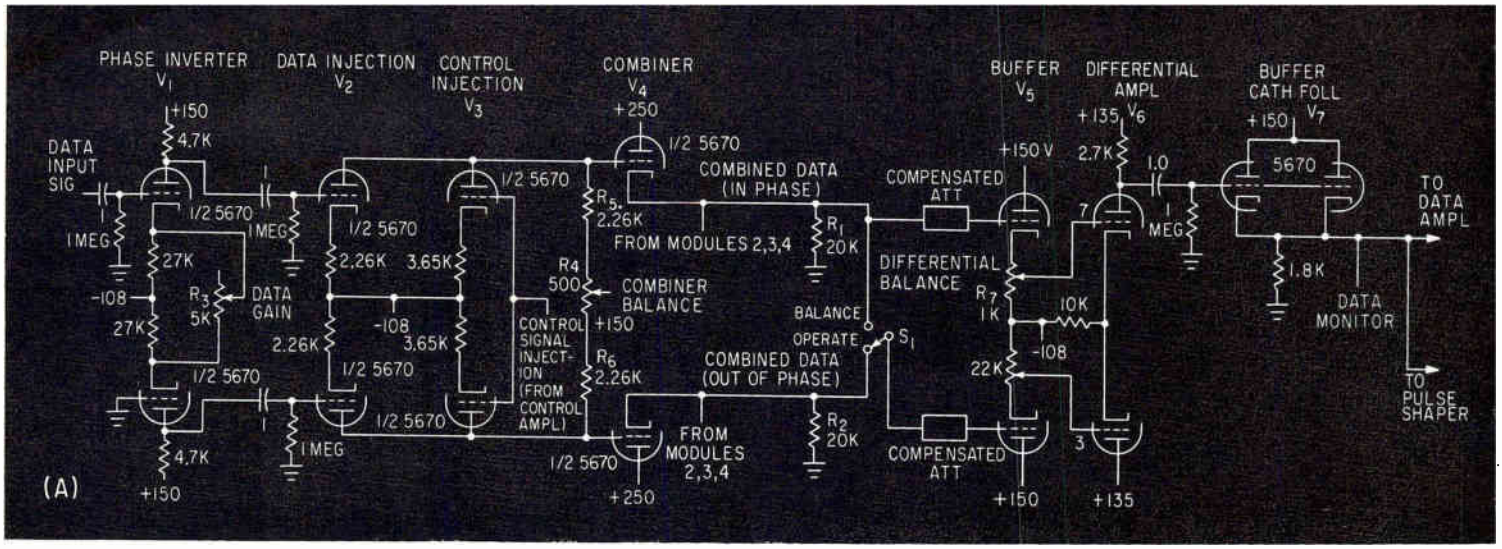
Pulse rise and decay times are sharply improved in a circuit that is operated without triggered amplifiers. The output is in phase with the input and features constant amplitude 3-volt pulses into a 75-ohm line. This is suitable for use with most pcm and pdm recording or reduction equipment. Rise times of one to two microseconds can be improved to better than 0.3 microsecond.

COMBINING STAGES — Figure 2A is a simplified schematic of the combining stages of the diversity combiner. Each of the four module channels are identical for the the circuits shown to the left of resistors $R_1$ and $R_2$. To the right, the circuit shown is on the main chassis and handles the output of all four modules.

The data input in each module is to a grid of dual triode $V_1$ connected as a cathode-coupled paraphase amplifier. Resistor $R_3$ is a gain control that compensates each module for different video output characteristics in the four receivers. The video signals at the plates of $V_1$ are 180 deg out of phase with respect to each other and are R-C coupled to the grids of data-injection tube $V_2$. The plates of this tube are connected in parallel with the plates of control injection tube $V_3$ to the grids of combining tube $V_4$. Combiner-balance potentiometer $R_4$ and resistors $R_5$, $R_6$ are the plate load resistors of both the data-injection and control-injection stages. The voltage on the grids of $V_4$ now consists of the out-of-phase data signals and in-phase bias voltages from the control-injection amplifier.

A fading signal to the receiver will decrease the signal-to-noise ratio in the data-channel input and the negative agc voltage into the module control amplifier. This decreasing negative agc input results in a positive-going input at the grids of $V_3$. This increases the current through both triode sections and drops the bias voltage at the grids of $V_4$.

For optimum diversity combining, the combined signal must re-




BASIC *combining circuit (A); pulse reshaping circuit (B)—Fig. 2*

main constant regardless of the number of channels contributing to that combined signal. To maintain a constant output, when the output of one contributing module decreases, the output of the remaining modules must increase a corresponding amount. This is achieved by connecting the cathodes of the combiner stage in each module in parallel. Combining resistor $R_1$ is a common cathode resistor for all $V_{1A}$ cathodes and combining resistor $R_2$ is a common cathode resistor for all $V_{1B}$ cathodes. With identical signal voltages applied to the control grids (either grid 3 or 7) of all combiner stages, the effect would be that all four grids are in parallel and the four cathode followers act as one. Note that this single cathode follower is operating into a 20,000-ohm cathode resistor. But in a cathode follower, the cathode voltage follows the grid voltage closely. This high cathode resistor results in only a small change in cathode current for a given change in grid voltage. Under actual operation these four cathode followers respond to a certain average of the four individual module grid voltages as a single cathode follower. On the other hand, the followers in the other three modules, and its cathode by itself, see the low output impedance of the other cathode followers.

Therefore, if the grid voltages at the combiner stage in module one change and the grid voltages in the combiner stages of the other three modules remain constant, there will be a very large change in the cathode current in the combiner stage module one, because of the low resistance it sees in its own cathode circuit.

The result is that, while the individual cathode currents in the modules changes greatly with changes in agc voltage from the different receivers, the total cathode current in $R_1$, $R_2$ remains essentially constant. Thus, the combined data output level remains constant with varying receiver rf signal strengths.

TOTAL SIGNAL — The combined signals developed across $R_1$ and $R_2$ consist of the push-pull combined data and the effect of all variations in agc control levels. This agc control signal is single-ended and may consist of complex low-frequency signals caused by fading signals in the various receiver channels. A buffer amplifier and differential amplifier consisting of tubes $V_5$ and $V_6$ on the main chassis restore the data signal to a single-ended signal and eliminate the control signal voltage in the output.

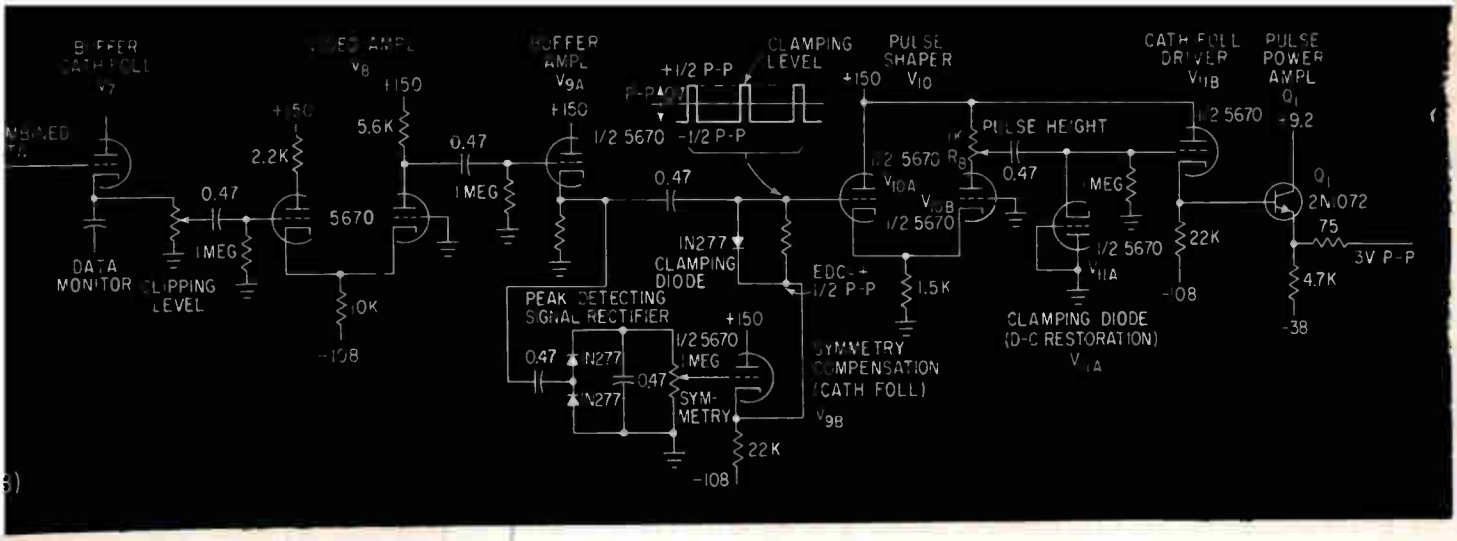
A compensated attenuator in the grid circuit of each side of $V_{5A}$ improves the high-frequency response of the video channels. The high-impedance output of this attenuator is fed into buffer stage $V_5$, which is an impedance match into the differential amplifier stage $V_6$. Resistor $R_7$ is a differential balance potentiometer in the cathode circuit of $V_{5A}$.This control balances the gain of the buffer stage to present equal amplitude signals to the differential amplifier stage.

The data signal voltages at grids 3 and 7 of $V_6$ are of equal amplitude but out of phase. Any a-c components of the control signals will be of equal amplitude and in phase. In Fig. 2A the application of equal out-of-phase signals to $V_6$ will result in an algebraic addition at the plate of $V_{6B}$. Similarly the in-phase control signal components will cancel at the plate circuit of $V_{6A}$. The result is almost complete rejection of any control signal modulation from the data signals in spite of the eight or more octaves of frequency overlap.

The paralleled twin-triode cathode follower output drives both video output channels and the data monitor output. The differential amplifier is balanced on a test agc signal by placing $S_1$ in balance position. A minimum signal at the data monitor jack is indication of balance.

The direct data channel has two stages of voltage amplification followed by a cathode follower that drives the output power amplifier. A pair of 2N1072 transistors are used in this stage. The maximum output of 10-v p-p into a 75-ohm line is more than adequate to drive fast rise time pulses through long lines to data-processing equipment. When terminated in a high-impedance load, the amplifier provides a 20-v p-p output.

PULSE RESHAPER—The pulse reshaper data channel (Fig. 2B) is the output amplifier for pcm and pdm signals. The important design feature is that triggering circuits are not used here. Over-amplification and clipping circuits provide fast rise and decay time in the pulses without risking false triggering. The circuit can accommodate any duty cycle pulse train with-




out changing characteristics. An output of 3 volts p-p into a 75-ohm terminated line is the factory preset level. Resistor $R_8$ can be reset to provide other output levels.

The agc control amplifier in the module is a compensated d-c amplifier that can match any normal receiver agc characteristic to the characteristics of the combining stage. Care in the design of this amplifier has resulted in a stable unit at any setting of the controls.

Fail-safe provisons include an input fail-safe amplifier in each module and an output line fail-safe relay. Failure of an input due to receiver failure is evidenced by a drop in the video input signal below the threshold level set in each module. This drops out relay $K_1$ (Fig. 1) and places a cut-off bias on the control injection tube $V_3$ (Fig. 2A) that takes the failed channel signal out of the combined signal. The output fail-safe circuit monitors the output of the direct-data amplifier. At any time that the video level from the amplifier drops below 0.5 v, relay $K_5$ (Fig. 1) drops out and connects the output to any one of four preset safe channels.

The power supplies are largely solid-state and feature a high degree of regulation. All B+ and B— voltages are regulated by series transistor regulators or 5787WA gas-diode regulators. The combining stage and the control amplifiers rely on highly stable supply voltages for long-term operational stability. The filament supply for these tubes is a precisely regulated and well-filtered 12.6 volts d-c.

THE FUTURE—The use of diversity reception techniques in the data telemetry field has proved to be one of the most inexpensive methods of providing reliable data reception. In the three or four years that diversity combiners have been used, predominantly at Patrick Air Force Base and the Atlantic Missile Range, the state of the art has moved slowly. This combiner is the first unit available that is capable of handling all of the signals defined under IRIG standards. It is, however, of the post-detection type and, hence, is limited in the amount of improvement that it can provide in a data-communication channel.

Future developments in diversity reception will be the development of two- and four-channel predetection diversity combiners. Predetection diversity combining can be expected to extend the effective threshold of the data communication system from two to six db beyond that presently achievable in a post-detection diversity combining system. The amount of improvement will be a function of the type of detector used in the combined data channel.

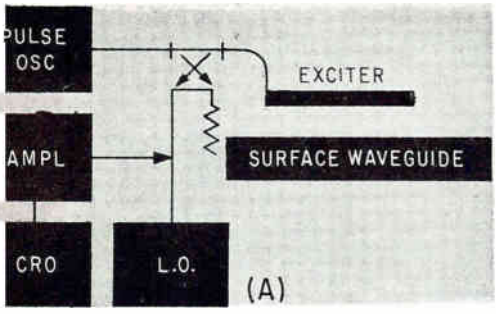
Current design optimizes receiver agc characteristics for low-level combiner control.

The majority of telemetry receivers in use have delayed-agc characteristics that are optimum for receiver operation. This characteristic is the least desirable for combiner control, in particular where efforts are being made to extend the signal threshold of the communication channel.

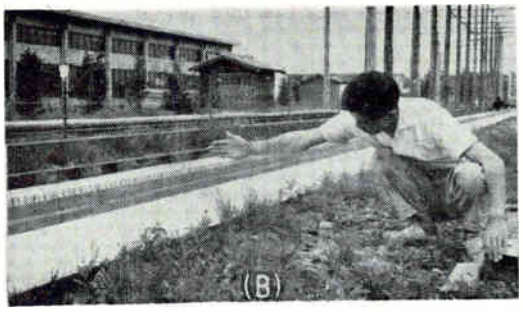
Within one year, a typical telemetry reception station will feature a complete dual-diversity predetection recording system, probably based upon right-hand and left-hand polarization feeds in the antenna system. These dual-diversity telemetary stations will have both post-detection and predetection diversity combining. The receivers will be expressly designed for use in a diversity system. The telemetry station will provide between three and six db additional system performance margin over that achievable in a single channel using receivers and preamplifiers of the same characteristics.

**DIVERSITY COMBINER CHARACTERISTICS**

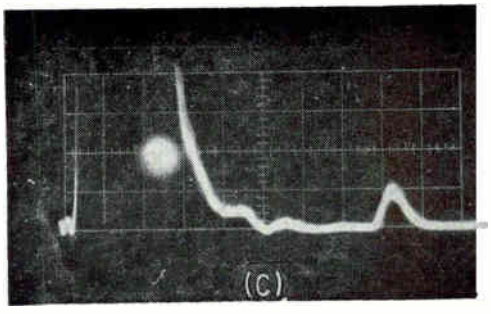
| | |
|---|---|
| S/N improvement for Equal Input Signal-to-Noise Ratios in Each Channel | Four-channel: 5 db to 6 db<br>Three-channel: 4 db to 4.7 db<br>Two-channel: 2 db to 3 db |
| Overall Frequency Response at Direct Data Output | ±1 db: 2.5 cps to 1.0 Mc<br>±3 db: 1.8 cps to 1.8 Mc |
| Overall Pulse Response at Direct Data Output | Square-wave droop: 1.0 max at 30 cps<br>Rise and decay time: 0.3 μsec max |
| Overall Pulse Response at Reshaped Output | D-c coupled output: zero square-wave droop at 30 cps<br>Rise and decay time: 0.3 μsec max |
| Control Amplifier Response | 2.0 milliseconds min |
| Output Source Impedance | 75 ohms, both channels |
| Output Level (direct) | 0.5 to 10 v p-p, 75-ohm termination |
| Output Level (reshaped) | 3 v p-p, 75-ohm termination |




PULSE RADAR *used in tests . . .*




*Hand close to experimental guide . . .*



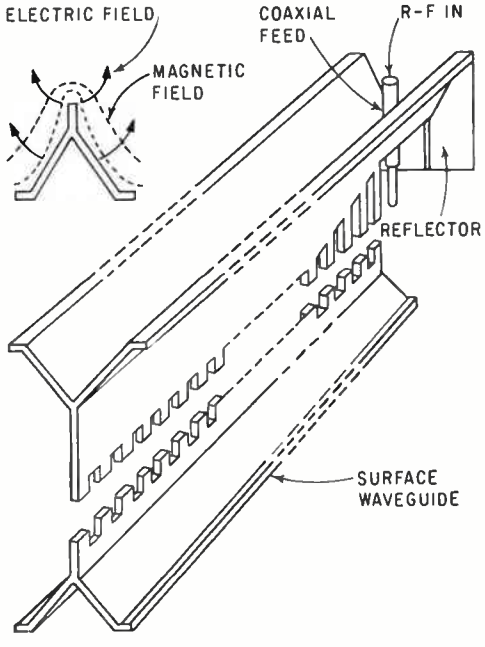

*produces above results . . .*

# The Y-Guide: A New Type of

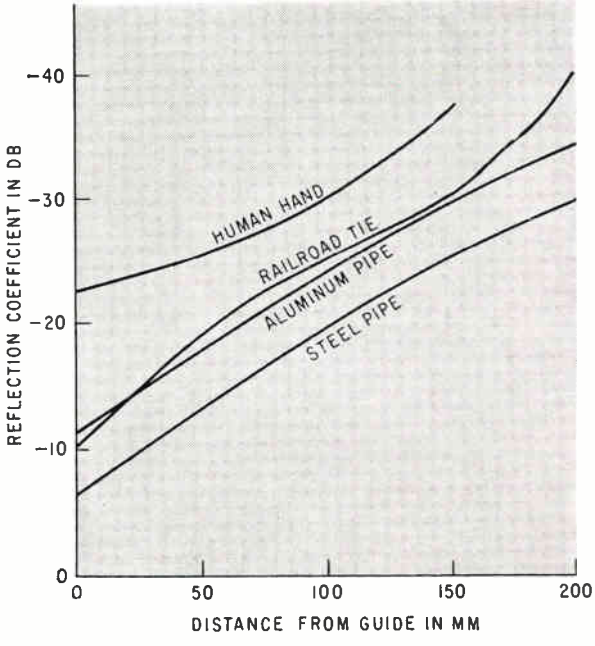
**SPEED WITH SAFETY**

*A railroad train running at near 150 mph requires almost 2 miles to come to a complete stop. Visibility must be good but weather conditions, curves, tunnels and track visibility may restrict the operators view of possible obstacles on or near the track. Electronics has come to the rescue with this surface-wave propagation system in which a train-borne radar system sends electronic feelers along the track and signals the operator when an obstacle lies within the danger zone of the locomotive*

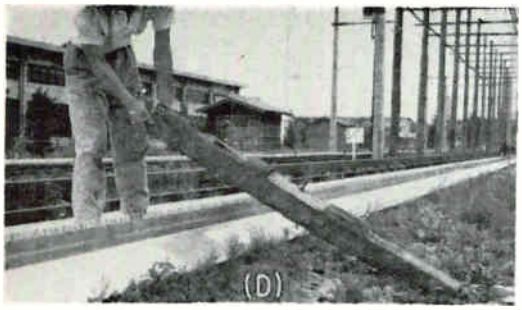
By Y. AMEMIYA, Communication Lab., Japanese National Railway
T. NAKAHARA and N. KURAUCHI, Sumitomo Electric Ltd., Tokyo, Japan



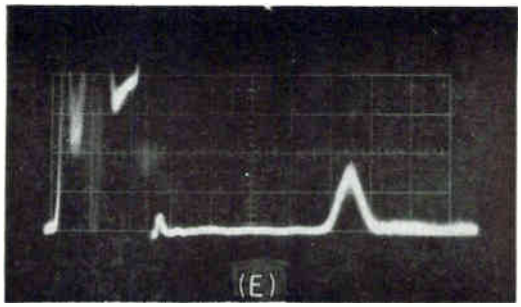

SURFACE WAVEGUIDE *with experimental feed system is 1,000 feet long—Fig. 1*



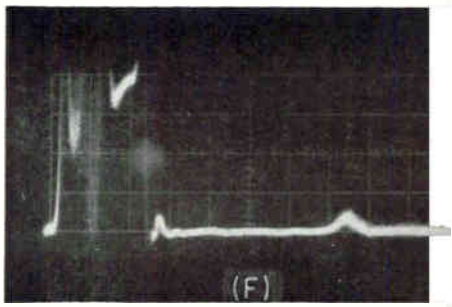

TYPICAL *results using a standing-wave detector and various obstacle materials—Fig. 2*




*Railroad tie touching track . . .*




*produces larger indication . . .*




*than when six inches away . . .*

# Surface Waveguide

*Operating with conventional railroad tracks and a train-borne pulse radar, the Y-guide may permit safe operation of 150-mph trains by giving warning of obstacles on or near the tracks*

SURFACE WAVE RADAR has been proposed as a safety device in the operation of a proposed 150-mph train operating between Tokyo and Osaka, Japan. As it normally takes about 2 miles for a train traveling at this speed to come to a complete stop, and the locomotive engineer may have only several hundreds of feet visibility, some fast-acting electronic detection and braking system had to be found.

SURFACE WAVEGUIDE—The surface wave radar tested in this investigation used the Y-guide, a surface waveguide, installed along the train tracks. A pulsed radar signal is generated within the train and coupled to the Y-guide. If an obstacle is located in close proximity to the track and Y-guide combination, a signal is returned to the train and braking operations begin. Figure 1 shows the cross-section field configuration of the Y-guide whose name is derived from its inverted Y-shaped cross section. A slow-wave structure is produced by the square teeth at the edge of the vertical plate while the sloping portions act as shields against ground besides functioning as mechanical stabilizers.

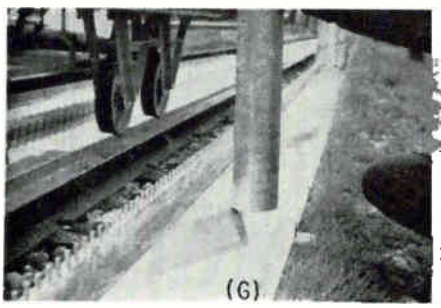
Since high physical uniformity is required to keep signal-to-noise ratio sufficiently large, mechanical joints between various sections of Y-guide had to be made with great care.

Attenuation constant of a section of guide was measured using the received signal level from a small dipole antenna attached to a sliding dummy load An experimental coupler exciter for a test section of Y-guide is also shown in Fig. 1

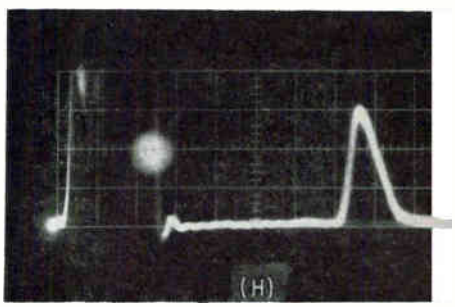
REFLECTIONS—Reflections due to artificial obstacles placed near the Y-guide railroad track combination were measured using both a standing-wave detector and a pulse radar system Some typical results using the standing-wave detector are shown in Fig. 2 while some pulse radar rseults are shown in the photos.

Figure A shows the pulse radar system used for the experiment When a man's hand was placed near the guide as shown in Fig. B, the results were as shown in Fig. C. When a railroad tie (Fig. D) was placed on the track, the result is shown in Fig. E and with the tie about 6-inches away from the track, Fig. F results. An aluminum pipe (Fig. G) touching the track is shown in Fig. H with Fig. I showing the signal from 6-inches away.

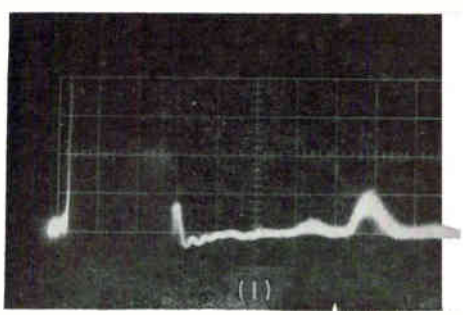
Irregularities in the track and Y-guide are far below —40 db so that operator of a high-speed locomotive is sure to be informed of obstacles lying within several inches of the track.




*Aluminum pipe touching track . . .*




*also makes larger return . . .*




*than one six inches away*

# BALINVERTER—Frequency-

*This balanced-input mixer is ideal for use with frequency-independent antennas; it possesses the noise-cancellation properties characteristic of magic-tee or coaxial hybrid mixers*

By CLAUDE STROTHER, JR.,* and CLIFFORD R. LUNDQUIST
Guidance Div., U. S. Naval Ordnance Laboratory, Corona, Calif.

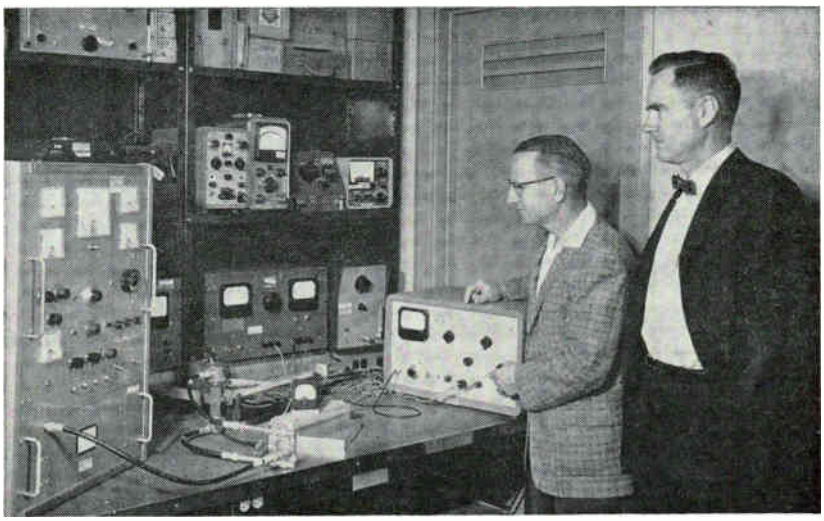
LOCAL-OSCILLATOR noise sidebands often interfers with low-level signals, thus reducing receiver sensitivity.[1] Balanced mixers are generally preferred to single-ended mixers for their noise-cancellation characteristic, which minimizes the effect of local-oscillator noise sidebands on receiver sensitivity.[2] However for conventional balanced mixers, a limitation occurs in frequency coverage on the order of one octave for mixers using 3-db hybrid couplers as the basic component. Moreover, these mixers normally have only a single input port, which necessitates the use of some type of balun, if the associated antenna is of the balanced type. On the other hand, unbalanced mixers, although frequency-insensitive, do not provide noise cancellation of local-oscillators sideband components, nor do they have two ports as required for mating directly with a balanced antenna.

The balinverter incorporates some of the advantages of the conventional unbalanced and balanced mixers, but additionally has the feature of two input ports, which is ideal for use with the balanced output of frequency-independent antennas.

Construction of the basic circuit (A) would normally be from coaxial or stripline where wide frequency bands are to be covered, since waveguide would introduce frequency limitations. The local oscillator is coupled capactively, or with a directional coupler. Frequency compensation of local oscillator power may be provided if desired. Mixer operation is conventional, except that here the two input signals are out of phase, while the oscillator signals to the two crystals are in phase. This provides in-phase components to the i-f for any noise sidebands of the local oscillator, which results in cancellation because of the balanced i-f input. If an unbalanced i-f input is required, similar operation may be obtained by using a reversed crystal in one of the mixers.

TEST DATA—To show the operation of the balinverter, a test was set up using commercial components (B). The photo shows a typical bench setup for making the noise-figure measurements. The balanced input signals were simulated with hybrid rings and magic tees as required to provide a balanced input at the various test frequencies. Various noise sources were used to obtain the data points (C). Limitation of data points was

* Now with Lockheed Missiles and Space Corp., Palo Alto, Calif.



AUTHORS *Lundquist and Strother measure noise figure of balinverter. The converters used are Sage Laboratories model 242 coaxial single-ended mixers*

**BALINVERTER PROPERTIES**

*The balinverter, a balanced-input converter, provides a mixer that can match directly to a balanced antenna, without frequency-sensitive baluns. It also has the noise-cancellation properties of hybrid balanced mixers, but can operate over greatly extended bandwidths. One application in which this device should provide improved operation is the zero-frequency i-f receiver, where mixer balance is required over the desired range of interference suppression.[3] Rejection of unwanted signals outside the region of mixer balance is frequently done with filters, thus requiring additional complexity*

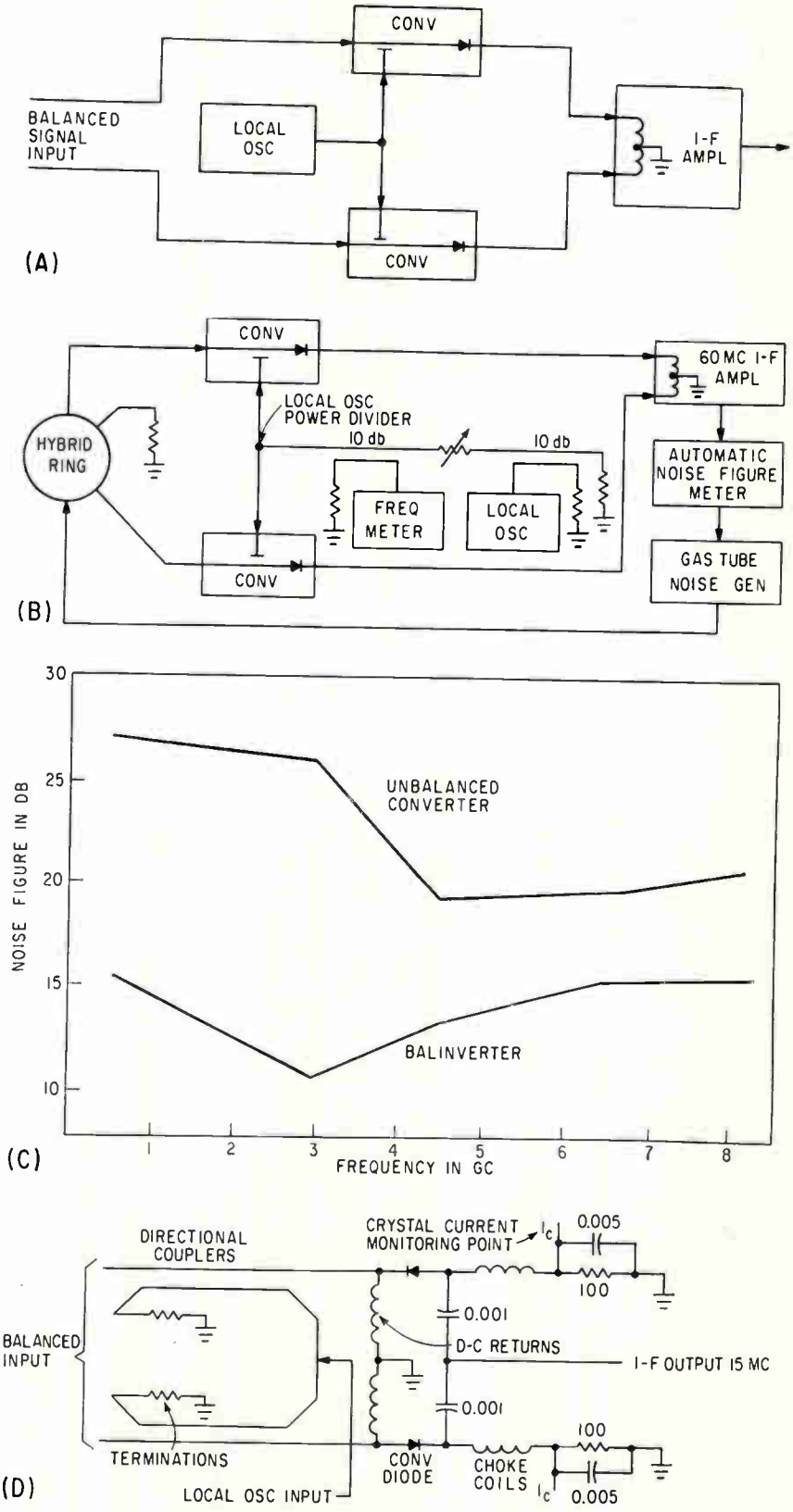
# Insensitive Balanced Converter

determined by availability of noise sources.

To show effectively the balanced operation of the converter, a noisy local oscillator was required. Initial tests were made with a klystron oscillator, frequency - modulated with a noise source. However, sufficient sidebands were not obtained to significantly lower sensitivity threshold. A voltage-tunnel magnetron was then found to be suitable. The low Q of the magnetron, required for wide-range electronic tuning, readily provided high-level noise sidebands. To provide local oscillator signals at frequencies above 4 Gc, backward-wave oscillators were used. The 500-Mc local oscillator signal was obtained from a triode modulated at the i-f frequency to simulate noise modulation.

The noise-figure tests were first made with the input to one of the unbalanced mixers disconnected. These tests were then repeated with both unbalanced mixers in use. Plotting these data (C) shows the extended range of balanced operation obtained in the true balinverter.

The design of a balinverter as a small module is planned, using stripline construction. In a preliminary design (D), the input terminals will mate directly to a broadband microwave antenna with balanced feeds. Local oscillator coupling will be made by a directional coupler. Capacitive coupling could alternatively be used, but the directional coupler has the advantage of suppressing local-oscillator radiation. The directional coupler will cause some degree of frequency limitation but not to exceed that of the local-oscillator tuning range, which now appears to establish the limits of frequency coverage.




**BALINVERTER** *basic circuit (A); test arrangement (B) for showing wide-band noise-cancellation properties (C) of the balinverter; preliminary design for stripline balinverter (D)*

## REFERENCES


(1) J. B. Wisner, Source Noise and Its Effect Upon Electronic Systems, *Trans IRE P. G. Electron Devices*, ED—4, p 5, Dec. 1954.

(2) R. W. Landee, D. C. Davis and A. P. Albrecht, "Electronics Designers Handbook," p 7, McGraw-Hill Book Co., Inc., New York, 1957.

(3) M. D. Rubin, Receivers With Zero Intermediate Frequency, *Proc IRE Corresp*, 49, No. 8, p 1327, Aug. 1961.

DESIGNING SPECIAL POWER SUPPLIES FOR

# Voltage-Tunable Oscillators

*Power supplies for backward-wave oscillators and voltage-tunable magnetrons should be considered an integral part of the system design problem. Here, such design problems and solutions are discussed*

By STEPHEN PRIGOZY,* Airborne Instruments Lab., Deer Park, L. I., N. Y.

TO UNDERSTAND power supply problems more fully, it is necessary to have some background on voltage-tunable tubes. Typcial voltage tunable oscillators are the backward-wave oscillator[1] (bwo) and the voltage-tunable magnetron[2] (vtm). Figure 1A and 1E show the two tube types.

The bwo has five elements: the helix or delay line, a slow wave periodic structure; the cathode; anode; grid; and filament. Varieties of these tubes lack either an anode or a grid. The filament and cathode perform functions similar to a conventional triode such as generating an electron supply. Electrons are accelerated by the helix to cathode voltage, and focused through the center of the helix by a magnet. The interaction of this beam and the electromagnetic wave in the helix causes the oscillation whose frequency is a function of the helix to cathode voltage. The anode and grid can be used for modulation and power leveling.

The vtm consists of: the anode, cathode, injection electrode and filament. The anode voltage determines the frequency of oscillation.

DESIGN PROBLEMS—In both tube types, the frequency-determining element is at d-c ground, and the cathode is at a high negative potential. For heat dissipation, the frequency-determining element is connected to the shell of the tube. Because r-f energy is coupled from the end of the frequency-determining element, it is expedient to have it at a low potential with respect to ground.

* Now with Electronic Energy Conversion Corp., Bethpage, New York

**FOR WANT OF A NAIL**

*Power-supply design is often taken for granted by engineers. This neglect can cause severe problems when working with voltage-tunable vacuum-tube oscillators. In such circuits the power supply must be considered from the start as an integral part of the system.*

These considerations increase the difficulties in the design of these supplies. The voltages that supply the other elements of the tube with respect to the cathode must now float at the high negative cathode potential. Therefore, power transformers in these supplies must withstand the high cathode potential between primary and secondary. Problems of coupling a-c to the cathode, due to transformer distributed capacitances, are also increased. Sector wound toroids, Faraday shields, voltage doublers to reduce the turns ratio, and a larger output capacitor on the cathode are techniques that can be used to reduce this effect

The frequency of the voltage-tuned oscillator is varied by changing the cathode to delay-line voltage in the bwo or the cathode to anode voltage in the vtm. Figure 1B and 1F show typical curves of frequency versus tuning voltage for these tubes. These characteristics, with the maximum permissible f-m of the system, determine the allowable tuning ripple voltage. If the maximum permissible f-m from the oscillator is $A$ Mc per volt and the slope or derivative of the tuning curve at a particular point is $B$ Mc per volt, then the maximum allowable ripple voltage at that point is $A/B$ volts.

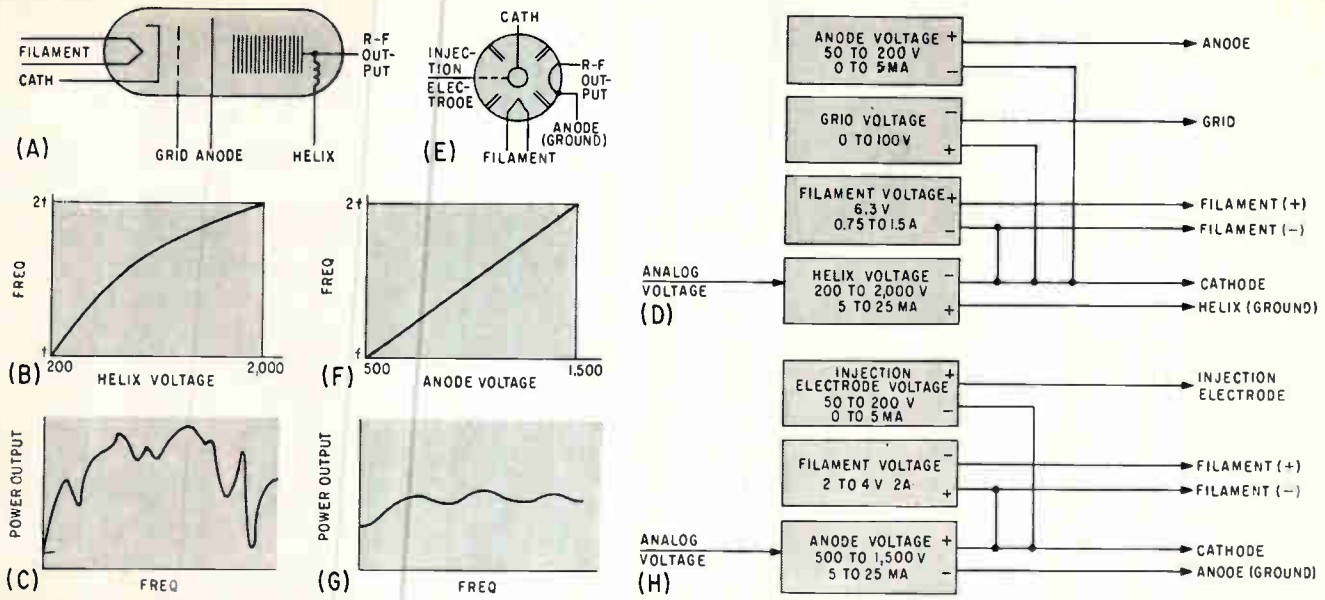
From the curves of Fig. 1B and 1F, the ripple voltage for the vtm must be less than some constant value over the complete tuning range because the tuning characteristic is linear. However, in the bwo, the ripple may increase as the tuning voltage increases because of the changing slope of the curve.

The dynamic tuning voltage range of the tubes can be seen from the curves. The vtm's fall into the dynamic range 3 to 1, while the bwo's can go as high as 10 to 1. In practice, ranges of 10 to 1 are difficult to realize with commonly used techniques such as saturable reactors used with electronic amplifiers.

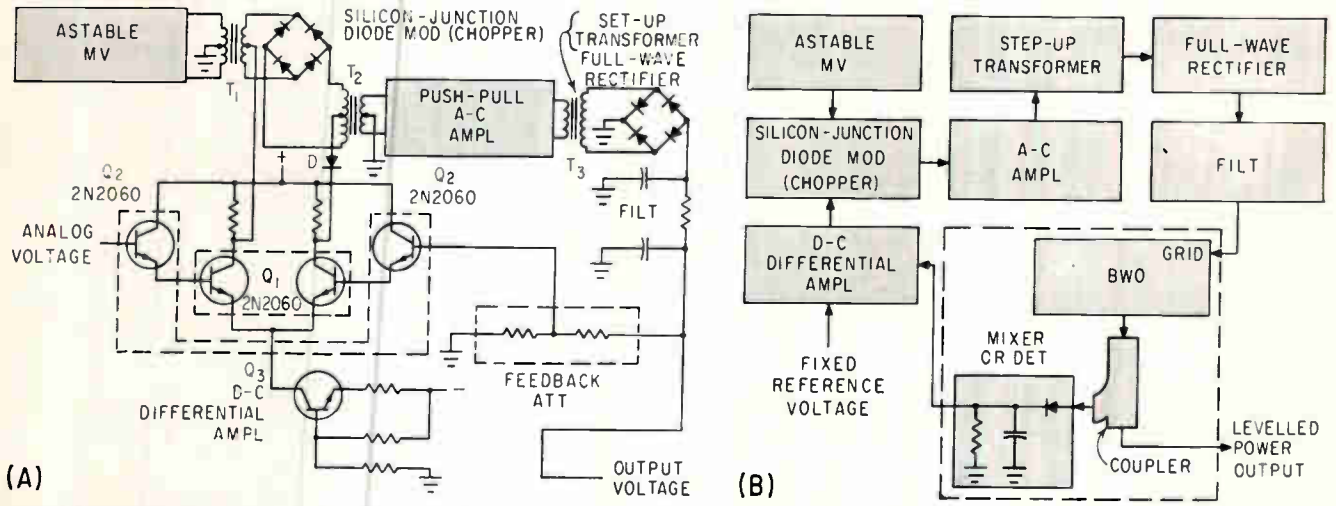
All the other elements, in both types of tubes, have secondary effects upon frequency. Therefore, these voltages must be regulated to reduce frequency drift, and to keep ripple voltages low enough to forestall appreciable amounts of f-m.

The anode and grid voltages of the bwo and the injection electrode voltage of the vtm affect output power. These elements can be used for modulation, pulsing, turn-off, and power leveling.

Figure 1C and 1G show curves of power output versus frequency for the bwo and vtm. The vtm curve is relatively flat and, in general, is suitable for most applications. However, the bwo power varies to a great extent when the frequency changes. The bwo power must be leveled by a scheme such as varying the grid voltage.




BACKWARD WAVE OSCILLATOR *(A), its frequency-voltage characteristic (B), power-frequency curve (C) and block diagram for complete supply (D). In (E), (F), (G) and (H) are shown the voltage-tunable magnetron, its frequency-voltage characteristic, power-frequency curve and complete supply—Fig. 1*




TUNING VOLTAGE *supply for the helix voltage of the bwo and the anode voltage of the vtm (A); method of leveling the power of bwo tubes (B)—Fig. 2*

In turning on the bwo, the filament and grid voltages are first applied, then, after filament warmup, the anode and helix voltages are applied simultaneously. To turn on the vtm, the filament and injection electrode voltages are applied first. Then, after filament warmup, anode voltage is applied. This sequence is necessary to insure proper starting of oscillators.

Both a-c and d-c external magnetic fields can perturb the field of the tube-focusing permanent magnet. These can cause frequency errors and f-m. Strong d-c fields or ferrous metal in proximity to the tube can stop operation. Since the power supply is usually near the tube, techniques to reduce the magnetic fields around it, such as shielding and toroids should be used.

POWER SUPPLIES—Figures 1D and 1H show block diagrams of the complete bwo and vtm supplies. Each block has typical voltage and current requirements that will accommodate a large variety of tubes. The anode, grid, filament and injection electrode voltages float at the high negative cathode potential.

The supply for the helix voltage of the bwo and the anode voltage of the vtm referred to as the tuning voltage present the most difficult problems. This voltage, applied between the cathode and the slow-wave periodic structure, controls the frequency of oscillation.

Typically this voltage must possess: range—200 to 2,000 v d-c; maximum power output—40 w; maximum ripple voltage—10 mv peak to peak; line and load regulation—0.1 percent, with 10-percent line and load changes; linearity—0.25 percent with respect to analog input voltage; stability—0.1 percent.

These characteristics are stringent and are usually found in heavy laboratory equipment. However, by novel circuit design and choice of components, a lightweight, reliable and rugged supply that meets these requirements was de-

signed. Figure 2A shows a diagram of the supply. During operation, the d-c analog input voltage, 0.5 to 5 v, which drives the supply, is compared in a differential amplifier with the attenuated output voltage. The difference is chopped[3], and applied to an a-c power amplifier. The output transformer of the amplifier supplies the step-up necessary to obtain the high voltage, which is then rectified, filtered and applied to the oscillator tube. Thus, the circuit is a high-gain feedback d-c power amplifier.

The differential amplifier is balanced; $Q_1$ and $Q_2$ are matched pairs of transistors in a single case. The base-emitter voltages and current gains are matched over a wide temperature range. Two sets of transistors insure a high input impedance so that neither the analog voltage nor the feedback attenuator is loaded. Transistor $Q_3$ is a constant-current source that provides the differential amplifier with high common-mode rejection. The chopper is driven from the balanced output of the differential amplifier. Thus, power-supply variations in the amplifier feed are canceled. Diode *D* insures that a unipolar signal is fed to the chopper. If the diode were absent, the circuit could go into a positive feedback condition and lock-up at the high voltage. The diode variations do not affect the accuracy because the diode is past the comparison point in the circuit.

The modulating frequency used in the equipment was 4 Kc. The choice of frequency depends upon system bandwidth or response time, ripple voltage and size of filter components and must be an engineering compromise. Regulation of the supply is controlled by the loop gain and can be designed using feedback theory. The circuit has operated over the −35 deg to +71 deg C range.

Filament supplies for voltage-tunable tubes can be either constant voltage or constant current, depending upon the type of tube. Most bwo's and some vtm's use constant-voltage supplies; the majority of vtm's use constant-current supplies.

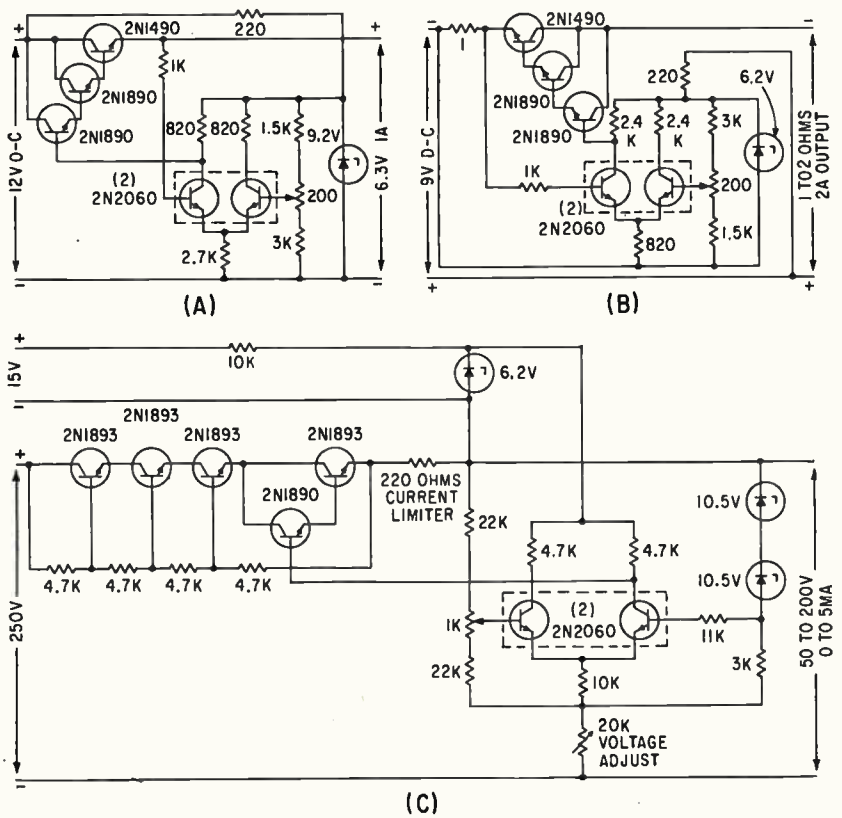
Figure 3A and 3B show practical circuits for each of the two types of supply. In the constant-voltage type, the output voltage is compared with a fixed reference in a d-c amplifier. The difference between the two controls a series pass element to keep the output voltage constant. In the constant-current supply, the voltage drop across a 1-ohm resistor, proportional to output current, is compared with a fixed reference and kept constant.

The 1,000 ohm resistors in the bases match the output impedances of the reference dividers and aid regulation. Due to manufacturing tolerances, it is necessary to provide a power supply that can be varied over a wide range for the anode or injection electrode. A voltage range from 50 to 200 volts will accommodate most tubes.

Figure 3C shows a typical supply. A constant voltage bridge floating on a variable resistor feeds a differential amplifier and a series regulator. The total current through the bridge and the differential amplifier is constant at balance. Varying the 20,000-ohm resistor sets the output voltage. The minimum limit or short-circuit current is the sum of the bridge current and the maximum normal output current.

BWO LEVELING—It is usually necessary to use some method to level the power of bwo tubes. Figure 2B shows a method for accomplishing this. The d-c output from a power detector is compared with a fixed reference voltage in a d-c differential amplifier. The difference is chopped, amplified, stepped-up, rectified, filtered and applied to the grid of the bwo. The grid voltage varies to keep the output power of the tube constant. Thus, the tube is an integral part of the feedback loop and must be considered in the design. The circuit is similar to the tuning supply. It can level power to ±1 percent.

Complete power supplies for a voltage-tunable oscillator similar to those described above can be reduced to about 250 in.[3], weighing 10 lbs. Power supplies and tubes can be integrated into packages for use as receiver local oscillators, octave sweep and signal generators.




FILAMENT SUPPLIES *for the bwo (A) and for the vtm (B); and anode or injection electrode supply (C)—Fig. 3*

## REFERENCES

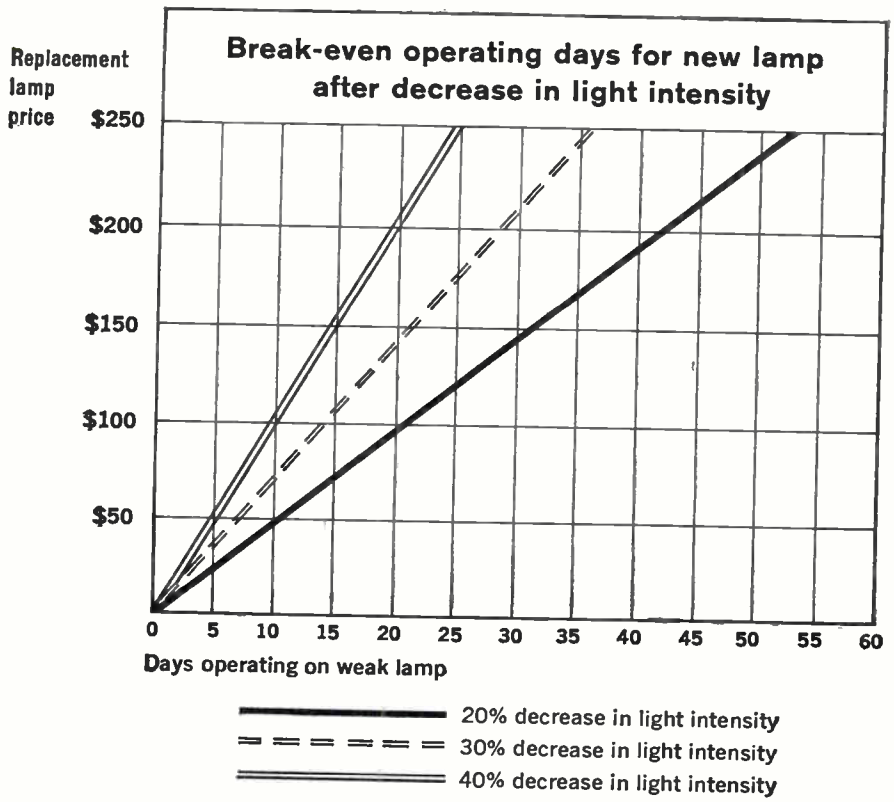

(1) F. E. Terman, "Electronic and Radio Engineering," Fourth Ed., p 683, McGraw-Hill Co., 1955.

(2) Voltage Tunable Magnetron, *G.E. Bulletin*, Aug. 1959.

(3) N. F. Moody, A Silicon-Junction Diode Modulator of $10^{-8}$ Amp Sensitivity for Use in Junction-Transistor D-C Amplifiers, *Proc NEC*, 1955.

# OZALID NEWSLETTER

*NEW IDEAS TO HELP YOU WITH ENGINEERING REPRODUCTION AND DRAWING*




## Prompt replacement of weak printing lamps doesn't cost, it pays!

Operating a diazo machine with a *weak* printing lamp is like bailing water with a sieve. *You're* working, but the lamp *isn't*. Install new lamps and pay for them with the dollars you would have lost had you tried to get the last little flicker from your old lamp.

Sound incredible? Consider expensive operator time, lower machine output, below-par copy quality, and you see why money is lost. How big a loss? Check the solid line on the graph above. Run a machine for just 21 days with a lamp that's 20% off full strength, and you've let $100 slip through your fingers. And if lamp intensity falls off 30% or 40%, your losses are all the more serious.

Pushing a weak lamp is not sound economics. Eking the last bit of light from a lamp is a costly mistake that adversely affects the operation of a reproduction department or commercial shop.

Replace weak printing lamps promptly. *It pays.*

### How do you know when the "break-even point" is reached?

Easiest way, of course, is to use a new test sheet which Ozalid supplies. This sheet, reproduced on your diazo machine, will show lamp efficiency. Merely compare the present machine speed necessary for a good print with the original speed at which a print of like quality was produced.

Copy the test sheet periodically on all your machines to keep abreast of the light intensity fall-off on each diazo printer. The Ozalid test sheet, and the instruction bulletin that comes with it, will help you determine proper replacement times.

### Whose printing lamps are the best buy?

In all cases, the best possible lamp replacement will come from the original manufacturer of your machine. Here's why:

1. A manufacturer balances lamp and transformer for each machine model. Any imbalance caused by use of another lamp could result in shorter lamp life, fluctuating light intensity, or a burned out transformer.

2. The cooling system of a machine model is designed for use with a particular lamp to maintain lamp temperature at the optimum level for long life and even print quality.

The cardinal rule: Depend on the machine manufacturer for your lamp replacements. His lamp guarantee puts money in your pocket.

### Ozalid announces new low prices on printing lamps!

Buying replacements could never be more attractive than it is right now! Even if your machines won't need replacements for a while, now would still be a good time to buy them. Keep spares on hand and hold machine down-time to a bare minimum.

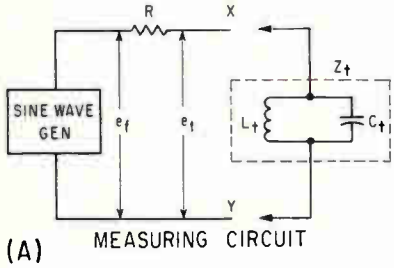
Before it slips your mind, send in for that test sheet and instruction bulletin we spoke of earlier. Use it regularly to keep track of your machines' lamp intensity.

For your valuable test sheet and the companion bulletin just write to OZALID, Dept. 188, Binghamton, New York.

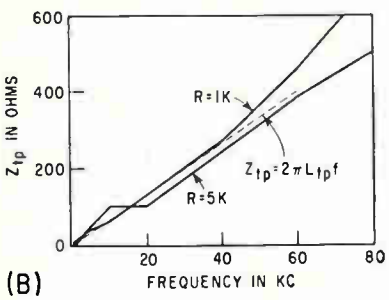
# Recently Derived Graphs Simplify Pulse Transformer Design

*Inductance and capacitance can be found by one measurement and use of three curves*

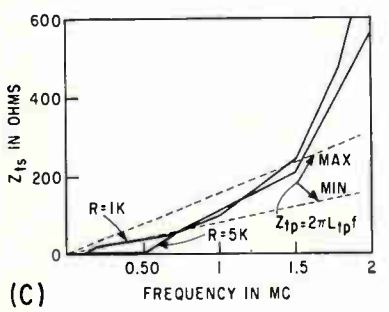
By DAN M. BOWERS, Computer Control Co., Inc., Framingham, Mass.



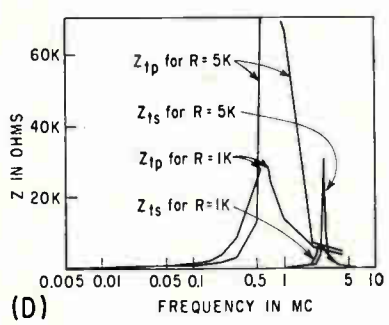

(A) MEASURING CIRCUIT




(B)




(C)




(D)

**TEST CIRCUIT** *(A) for making measurements. Low frequency range of transformer (B) yields primary inductance, (D) gives resonant frequency and allows shunt capacitance determination and (C) gives a close approximation to secondary inductance*

ELECTRICAL value of most pulse transformers, although typically small, can be determined to high accuracy graphically. Of major interest are self-inductance, mutual inductance and shunt capacitance.

One winding of the pulse transformer is placed across terminals $XY$ of the circuit shown at $(A)$ in the figure. The amplitude of $e_f$ is held constant and the amplitude of $e_t$ is measured as a function of frequency. Impedance $Z_t$ is then calculated and plotted as a function of $f$, using the relationship $Z_t = e_t R/(e_f - e_t)$. This yields the typical plot of a parallel resonant circuit.

The low-frequency linear portion of the curve is assumed to be due purely to the inductive component of $Z_t$ and therefore, in this region, $L_t = Z_t/2\pi f$. Since $Z_t$ has been plotted as a function of $f$, the slope of the curve is $Z_t/f$; this slope is determined graphically and $L_t$ is calculated.

FREQUENCY — The resonant frequency, $f_o$, of the winding is then determined graphically from the maximum value of $Z_t$ on the full plot of $Z_t$ against $f$. Since $f_o = 1/2\pi\sqrt{L_t C_t}$, with $L_t$ having been determined, and $f_o$ obtained from the graph, the shunt capacitance $C_t$ is calculated from $C_t = 1/(2\pi f_o)^2 L_t$.

Mutual inductance $M_t$ can be calculated after the primary inductance $L_{tp}$ and the secondary inductance $L_{ts}$ have been determined $M_t = \sqrt{L_{tp} L_{ts}}$.

The other parts of the sketch illustrate the use of the technique for a pulse transformer.

Core: General Ceramics F-262-Q, insulated with 1 to 2 mils plastic dip

Primary: 110 turns Awg No. 38 wire, insulated with 5 to 10 mil tape

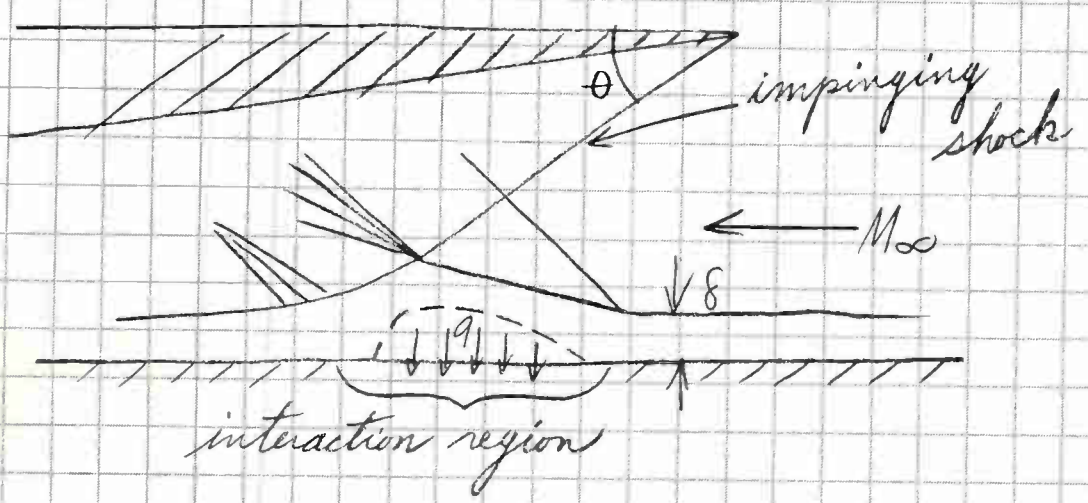
Secondary: 11 turns Awg No. 38 wire, three secondaries wound over primary

SOLUTION—In the figure, (B) is a linear plot of the low frequency portion of primary impedance $Z_{tp}$ as a function of frequency, and the linear portion of the curve due to the inductive component $2\pi f L_{tp}$ is approximated by the dotted line. The slope $Z_{tp}/f$ of this line is $6.47 \times 10^{-3}$ ohm-second. Using $L_t = 1/2\pi (Z_{tp}/f)$, primary inductance is 1.03 mh.

From (D), resonant frequency $f_o$ of the primary winding is 625 Kc. Shunt capacitance $C_{tp}$ of the primary is determined from $C_t = 1/(2\pi f_o)^2 L_t$ to be 65 pf.

Secondary inductance $L_{ts}$ is more difficult to determine because it is so small. As shown by the dotted lines in (C), $Z_{ts}/f$ lies between 81.5 and 155 micro-ohm-seconds; therefore $L_{ts}$ lies between 12.9 and 24.7 $\mu$h. (As a check, using the turns ratio of 10 to 1 and the value 1.03 mh for $L_{tp}$, $L_{ts} = L_{tp}/N^2 = 10.3$ $\mu$h.) From (D), secondary $f_o$ is 2.6 Mc and therefore $C_{ts}$ must be between 152 and 304 pf. Mutual inductance $M_t$ is calculated to be between 115 and 159 $\mu$h.

*Of interest to engineers and scientists*




# AERO-THERMODYNAMICS

*...among the more than 500 R & D programs under way at Douglas*

Extensive research in advanced aero-thermodynamics relating to missiles and space vehicles is now being performed in Douglas laboratories.

Among current areas are dissociation non-equilibrium in supersonic flows; separated supersonic boundary layer phenomena; experimental boundary layer studies; heat transfer; turbulent mass transfer; and base flow.

Support of this program is provided through a multi-million dollar laboratory complex. Included is the Douglas Aerophysics Laboratory, one of the finest fluid dynamic research facilities in the aerospace industry.

**Of career interest to engineers and scientists**

If you are seeking stimulating assignments and associates, full support of your activities, and an open door to advancement, investigate the outstanding career opportunities at Douglas.

Here, the emphasis is on the research and development that solve today's problems and lead to involvement in the biggest defense and space projects of tomorrow. Also, scholarships and financial assistance are available to continue your studies in such nearby universities as U.C.L.A., Southern California and Cal Tech.

Send us your resume or fill out and mail the coupon. Within 15 days from the receipt of your letter, we will send you specific information on opportunities in your field at Douglas.

DOUGLAS

MISSILE & SPACE SYSTEMS DIVISION

An equal opportunity employer

Mr. F. V. Edmonds
Missile and Space Systems Division
Douglas Aircraft Company
3000 Ocean Park Boulevard
Santa Monica, California

F-12

Please send me full information on professional opportunities in my field at Douglas.

Name_____

Engineering or scientific field_____

Address_____

City_____ State_____

# CRT Provides Three-Dimensional Displays

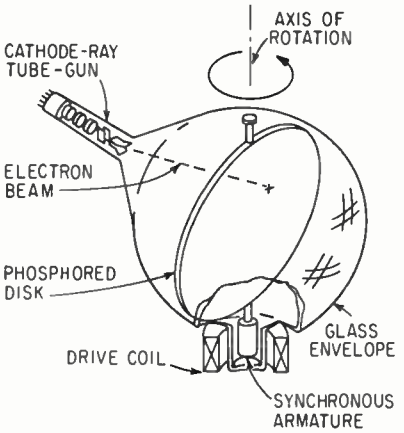
*Rotating-screen tube with suitable scanning provides brightness of tv screens*

CATHODE-RAY tube can provide three-dimensional displays of analog information. Brightness can be comparable to that of a television receiver, and multiple-color displays can be simply obtained. The three-dimensional display tube is suitable for a number of applications, including air-traffic control and spatial navigation problems.

Imaging cathode-ray tube information on a rotating screen is one method of obtaining three-dimensional displays. Despite its advantages, this approach has had the drawbacks of low brightness and complexity of the display mechanism. The system shown in Fig. 1 promises solution to many three-dimensional display problems. It has been tested in a vacuum demountable system at Hughes Research Laboratories and was described at the recent Electron Devices Meeting in a paper by Richard D. Ketchpel.

OPERATION — The phosphor-coated mesh screen rotates about the vertical axis in the evacuated glass sphere at 900 rpm. To illuminate a point within the spherical volume, the beam is deflected to the desired point and momentarily gated on when the plane of the rotating screen coincides with the point. Gating time is short (a few hundred microseconds) to avoid smearing as the screen rotates.

Since the beam can be gated on twice during each 360 degrees of rotation, point flicker is 30 cps.




ROTATING *phosphor-coated disk enables crt to form three-dimensional images—Fig. 1*

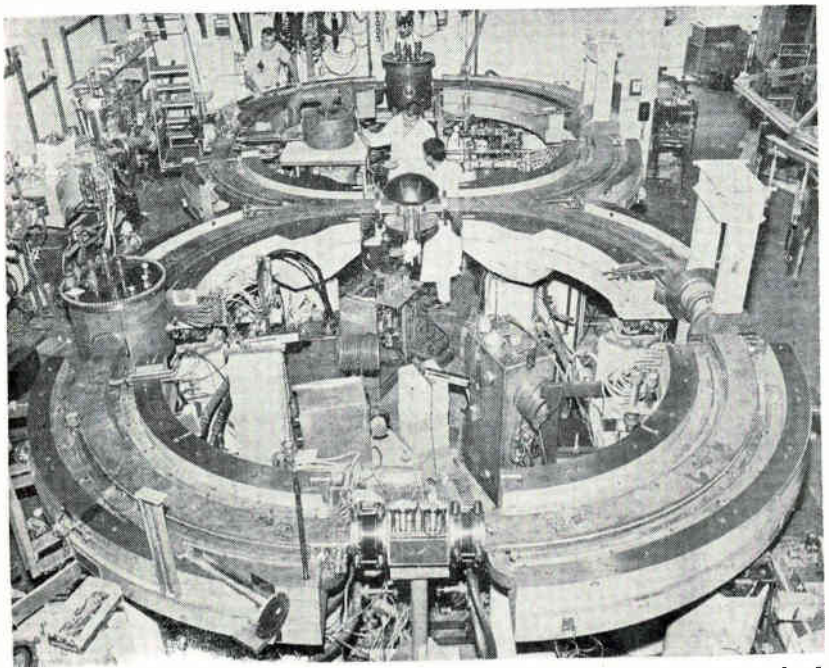
The point thus appears as a continuous spot of light floating in the sphere. The entire sphere can be filled with such floating points of light to form a three-dimensional image.

It was observed during tests that light intensity was fairly independent of observation point or of the position of the observed spot within the volume of the sphere. Simple Lissajous patterns illustrated the ease of determining line intersections. Apparently, changing perspective slightly by movement of the head is very helpful to observers in determining intersections. Surfaces generated by high-frequency Lissajous figures demonstrated the realistic geographical contour display that could be obtained.

In a simulated air-traffic control display, adding trails to the targets aided considerably in perceiving three-dimensional positions. Finally, eye strain was not noticeable after viewing the display for many minutes.

Either electrostatic or magnetic deflection crt guns can be used. When the screen is parallel to the beam, illuminating it from the edge becomes difficult. If objectionable frame shadow cannot be eliminated by a thin (0.1 inch) screen support frame, a second crt gun can be

## Billion-Electron-Volt Particle Collision Experiment



STANFORD UNIVERSITY *scientists will use this apparatus to check the laws of quantum electrodynamics at hyper-short distances. They will inject two 500-Mev particles into the rings in opposite directions and observe the effects of the collision. An r-f field will keep particle energy constant until particles collide at intersection of the two rings*


# 7 ABC REGULATED DC SUPPLIES

## from 0-2V / 1A to 0-1500V / 5ma

**KEPCO QUALITY AT COMPETITIVE PRICES!**
**EQUIP YOUR FACILITY WITH ALL SEVEN BASIC POWER SUPPLIES FOR ONLY $1248**
**AVAILABLE FROM STOCK**

**0-1500 V/0-5 ma**

- **0.05% REGULATION and STABILITY**
- **0.5 mv rms RIPPLE**
- **Adjustable Overload Protection**
- **No Voltage Overshoot**
- **Bench or Rack mounting**
- **Control Amplifier Terminals for:**
  - Programming Voltage/Current by Resistance or Voltage
  - Remote Error Sensing

| MODEL | ABC 2-1M | ABC 7.5-2M | ABC 15-1M | ABC 30-0.3M | ABC 40-0.5M | ABC 200M | ABC 1500M |
|---|---|---|---|---|---|---|---|
| DC OUTPUT VOLTS | 0-2 | 0-7.5 | 0-15 | 0-30 | 0-40 | 0-200 | 0-1500 |
| DC OUTPUT AMPS | 0-1 | 0-2 | 0-1 | 0-0.3 | 0-0.5 | 0-0.1 | 0-5 ma |
| PRICE | $179.00 | $159.00 | $159.00 | $119.00 | $159.00 | $199.00 | $274.00 |

kepco inc.®

Over 250 standard models available from stock—write for new catalog B-621
131-38 SANFORD AVENUE • FLUSHING 52, N.Y., U.S.A. • Phone (212) IN 1-7000
TWX# (212) 539-6623 • Cable Address: KEPCOPOWER NEWYORK

added at a position rotated 45 degrees from the first gun to illuminate the blank sector of the screen.

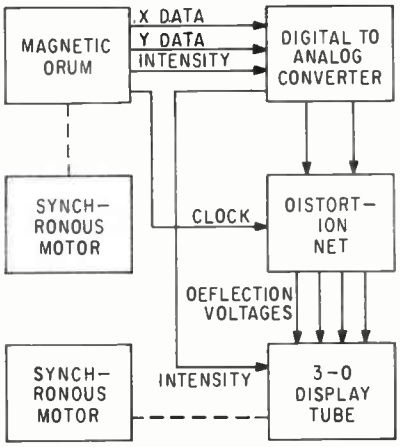
The rotating screen can be round, square or semicircular to suit display requirements. Use of a 21-inch screen is mechanically feasible because of the rotary motion of the phosphored screen.

A two-color display can be obtained by coating each half of the screen with a different color phosphor. Gating the beam once every 360 degrees of rotation can provide either pure color, or a mixture of the two colors can be obtained by gating the beam every 180 degrees. Coating the back of the screen with two additional colors could provide a four-color display. A second crt gun located at 180 degrees from the first gun would be needed to illuminate the other two phosphors. Alpha numeric information can be displayed using a shaped beam crt gun.

SCANNING — Characteristics of the display depend heavily on the scanning method used. A conventional tv raster scan could be used in which a complete raster would be traced at successive positions of the screen as it was rotated. A three-dimensional display would be formed from many two-dimensional rasters in separate planes. The entire volume could be scanned in 180 individual planes with 1-degree resolution in angular rotation.

Using this method of scanning to sweep the entire volume in 1/30 second would require wide bandwidths in deflection and gating circuits. Also, brightness would be adversely affected because of the large area scanned.

Scanning could be accomplished by a more practical method that would be completely adequate for many applications. If the data to be displayed were suitably processed, discontinuous deflection scanning could be used. For example, in a geographical contour map used for aircraft terrain avoidance, only one contour line is needed in each plane. Thus, if three-dimensional radar information were processed so that one contour line could be traced instead of an entire raster for each plane, more deflection time would be available. Since the total area swept would be about the same as in conventional crt displays, comparable brightness and resolution could be expected.




PROCESSED *data stored on drum is converted to analog form for display—Fig. 2*

In another example, only the vehicle and the runway position need be shown in a ground control approach display. Possibly separate crt guns could be used to display the vehicle and the runway.

Probably a maximum of ten separate targets would be presented in a collision-avoidance display. With as many as ten targets displayed in any of 180 separate planes, bandwidth requirements for deflection and gating would be much less severe than if complete rasters were scanned in each plane. Similarly, brightness would be greatly improved.

DRIVE CIRCUIT—The three-dimensional tube might be programmed for this application as shown in Fig. 2. Positional and intensity information about each target is recorded in digital form on the magnetic storage drum. The storage medium permits the display to be regenerated every 33 milliseconds, while the radar inputs are updated every 5 seconds, assuming the radar antenna rotates at 12 rpm.

The x and y digital data is recorded directly on 18 of the 22 parallel tracks of the drum. Three of the tracks establish any of 8 intensity levels. The remaining track is for a clock signal to establish a reference between drum position and rotation of the screen in the three-dimensional tube. Thus each 2-degree sector on the drum surface contains information about the positions and intensities of the ten possible targets to be displayed

in a particular plane.

Digital output from the magnetic storage drum is converted to analog voltage. The deflection voltages are fed through a trapezoidal distortion network to correct the distortion resulting when a plane is not perpendicular to the gun axis.

## Infrared May Permit Blind Night Landings

AIRCRAFT landings could be made in total darkness using a simple infrared tracking system. The relatively inexpensive device could also guide short-range missiles or direct space vehicles to a rendezvous.

The system, called Mirtrak for Martin infrared tracker, has no moving parts. The experimental system developed by Martin Company consists of a separate infrared light source and the tracker. The light can be modulated at any frequency between 500 and 3,000 cps, enabling the tracker to differentiate it from any other light source.

To guide a missile, the light source could be carried in the tail of the missile with the tracker stationed at the firing point. Deviations in azimuth and elevation from the intended course would be provided as positive and negative d-c voltages. These errors signals could be used by missile control equipment to correct the course of the missile.

Mirtrak is said to be much less complicated than other infrared systems or comparable equipment such as radar. It is less costly to produce and maintain. There are no moving parts, which can wear and adversely affect accuracy. Mirtrak accuracy is said to be 0.1 milliradian, the equivalent of 1 foot at about 2 miles distance.

During acquisition, the field of view is 20 degrees and during tracking it is 1 degree. The lead-sulfide detectors used provide a spectral range of 0.6 to 2.6 microns, but other detectors can also be used.

Company engineers believe Mirtrak could be adapted for use in terminal guidance of ballistic missiles, for mapping roads in battlefield situations and for other applications.

# New Vapor-Deposition Process Creates Tunnel Diodes

*Program also establishes much higher inherent reliability of films*

INCREASED emphasis is now being placed on new and improved vapor-deposition techniques for both active and passive devices, particularly for high temperature and radiation resistant circuits.

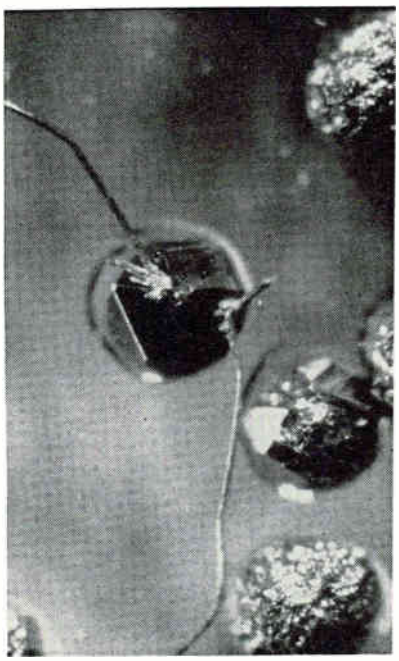
So far two approaches to vapor deposition of materials for active devices have been successful. One technique uses the properties of continuous thin films deposited on substrates, and encompasses field effect phenomena, field emission and tunneling. In a more recent approach, single crystallites of silicon are deposited on a substrate from the vapor.

The latter approach spots semiconductor crystals on a substrate by masking out definite areas, leaving free space on the substrate for fabrication of the other circuit elements.

Wire connections can be attached to crystallite facets, or leads can be made by evaporating connections to the active crystallite of silicon.

Diodes and tunnel diodes have been made at Melpar using the deposited crystal technique. Photo shows tunnel diodes formed on silicon film deposited pyrolytically on fused silica substrate. Characteristics of tunnel diodes formed in this manner are shown in Fig. 1.

FEASIBILITY—Ernest Bylander and Richard Murphey of Melpar say that formation of active devices in crystallites is basically no more difficult than forming active devices in bulk materials. However they use special techniques due to crystallite size, their adhering ability, and the nature of the insulating substrate.



TUNNEL *diode fabricated from pyrolytically-grown crystallites*

The crystallites are deposited from the vapor by the reduction of silicon chlorine in hydrogen of fused substrate heated to 1,100 deg C. Doping is done with a phosphorus pentoxide emitter-type diffusion at 1,120 deg C for 24 hours using oxygen as a carrier. The phosphorus oxide layer is removed by hydrogen fluoride. Aluminum-boron wire is alloyed to one facet and gold wire to an opposite facet. The peak to valley ratio of current-voltage curve is 2:1 in a typical unit. Future attempts to improve this ratio may center on increasing the *n*-doping level, and improving the alloying technique.

Tunneling has been observed in units formed in continuous pyrolytic films, however negative resistance was not observed even after etching. Imperfect nature of the junction may be responsible.

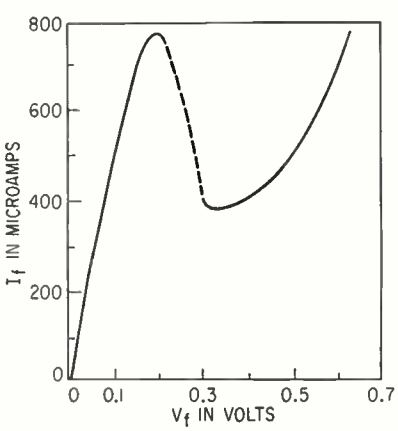
STABLE DIELECTRICS—Search for improved high-temperature dielectrics continues. Several films can go to 450 deg C with less than 10 percent change in capacitance (see Fig. 2). Melpar now has a special carbon crucible to contain the materials under study. This container has aided the study of the dielectrics.

Dielectric studies were conducted by Charles Feldman and Michael Hacskaylo of Melpar. Temperature of the crucible during deposition of the dielectrics was measured by an optical pyrometer. High substrate temperatures were controlled with a radiant heater.

A sharp peak in the dielectric constant of zinc sulfide at a particular thickness was studied rather extensively. A similar peak was observed in $SiO_2$ films. Anomalies may be connected with the piezoelectric nature of the materials, and due to stress on the deposited film. Annealing the film causes the anomaly to disappear.

Work on rhenium film resistors has been reported (see ELECTRONICS, May 11, 1962, pgs 69 and 70). Work since then confirms the fact that rhenium forms a suitable film resistor operating at 12 watts at a temperature of 850 deg C.

Vacuum-deposited germanium




CRYSTAL-*grown tunnel diode characteristics—Fig. 1*

# TRG

## MILLIMETER MICROWAVE COMPONENTS...26 to 220 kmc

Whatever your problem in millimeter waves — a component or complete systems development — TRG has more of everything it takes, including experience, to put the answers right in the palm of your hand.

**FERRITE DEVICES:** The TRG four port circulator illustrated is typical of our complete line of ferrite devices covering the 26 to 140 kmc band. Unit pictured operates at 75 kmc with 20 db isolation, 1 db loss, and 1.3 VSWR. 3% band

- Complete ferrite duplexers
- Four port circulators
- Three port reciprocal switches
- Variable attenuators
- Modulators
- On-off switches
- Isolators


**LOW LOSS CIRCULAR WAVEGUIDE COMPONENTS:** For millimeter systems involving long waveguide runs, low loss $TE_{01}$ circular waveguide components reduce waveguide losses to usable levels. TRG has all the components necessary for a $TE_{01}$ circular waveguide system.

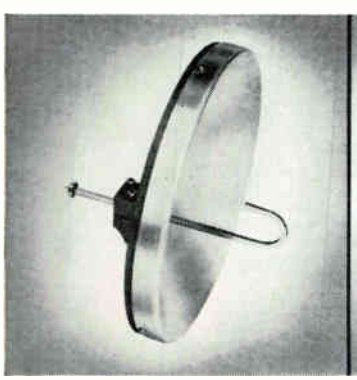
- Mode filters
- Corrugated bends
- Rectangular to circular mode transitions
- Rectangular to $TE_{11}$ transitions
- Rotary joints


**TEST BENCH:** A complete line of millimeter components for test bench measurements over the 26 to 220 kmc band.

- Slotted lines
- Directional couplers
- Wavemeters
- Variable attenuators
- Precision attenuators
- Phase shifters
- Detector mounts
- E/H tuners
- Slide screw tuners
- Sliding short circuits
- Transitions
- Tees
- Twists
- Bends
- Terminations
- Drill jigs

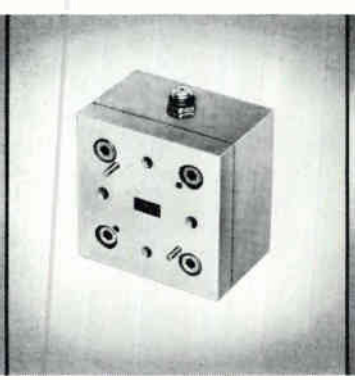

**SYSTEMS COMPONENTS:** A complete line of systems components for millimeter radar applications.

- Duplexers
- Single hybrid rings
- Triple hybrid rings
- Balanced mixers
- Waveguide switches
- Ferrite switches
- Antennas
- Rotary joints
- Flexible waveguides
- Receiver front ends
- Dual mode transducers

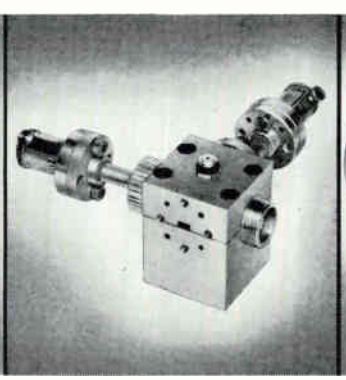


**ANTENNAS:** TRG has total capability in millimeter antennas. The 6 inch diameter unit pictured operates at 140 kmc with a one degree beamwidth. Antennas are available in the 26 to 220 kmc band.

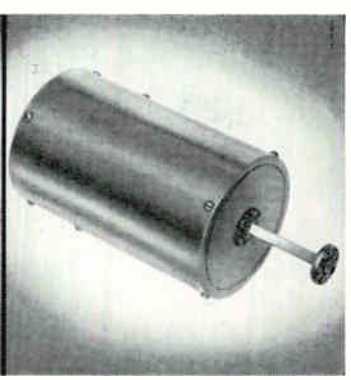
- Horn-fed paraboloids 3" to 36"
- Waveguide slot arrays
- Conical scan antennas
- Monopulse antennas
- Circular polarized feeds
- Linear-circular polarized feeds
- Solid dielectric lenses
- Electroformed gain standards



**BOLOMETERS:** TRG bolometers are available over the entire 26 to 220 kmc band. The in-guide construction eliminates noisy finger contacts and dielectric windows protect the delicate element from air currents and dust. These are the most sensitive video detecting elements known in the millimeter region.



**HARMONIC MIXERS AND GENERATORS:** TRG harmonic mixers and generators incorporate a diode element mounted directly into the waveguide structure. Mixers are available for second to eighth harmonic mixing. These devices are useful for stabilizing millimeter sources, with lower frequency standards, calibrating millimeter frequency meters with lower frequency standards and serving as the front ends of millimeter receivers in the 26 to 220 kmc region.



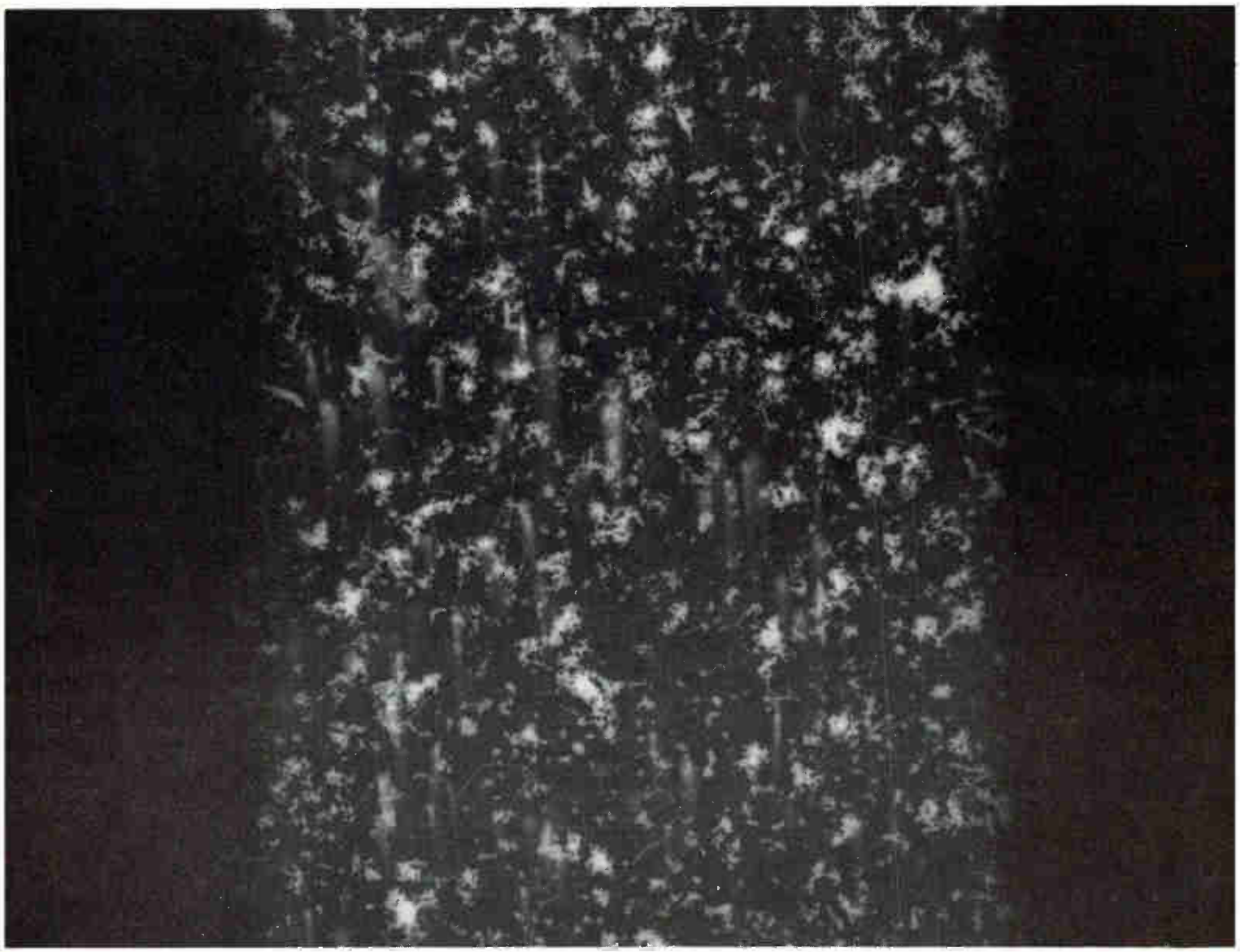
**CALORIMETERS:** TRG water calorimeters are useful laboratory standards for absolute power measurements in the millimeter bands. The measurement technique employs a DC substitution method in a balanced bridge circuit.

**TRG, INC., ANTENNA & MICROWAVE DEPT.**

400 BORDER ST., EAST BOSTON 28, MASSACHUSETTS • LOgan 9-2110

**Visit us at the NEREM SHOW—Booth 1814**

# NO ADMITTANCE



Dust magnified 1000 times.

**Tantalum Foil Capacitors meet or beat MIL specs**

Etched and plain foil, polarized and non-polarized, in MIL case styles, CL 20 and CL 30 series. Plain foil ratings up to 300 volts. Write for bulletin.

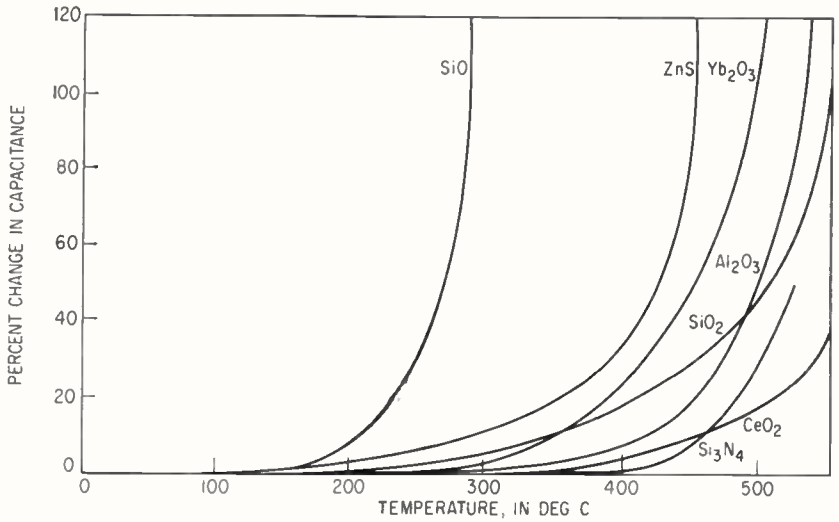
Dust is bad news for tantalum capacitors. The care we take to keep it out of our ultra-modern tantalum capacitor plant at Greencastle, Indiana, would make the fussiest housewife envious. Every week our plant climate control system takes several pounds of dust out of the "clean" country air to make it fit to associate with our capacitors.

Precautions against moisture, dust and other contaminants are typical of the advanced concepts in quality-engineered manufacturing, testing and inspection in our Greencastle plant. Mallory tantalum capacitors equal or exceed MIL specs for electrical parameters and environmental conditions. Mallory Capacitor Company, Indianapolis 6, Indiana . . . a division of P. R. Mallory & Co. Inc.

**WET SLUG, FOIL AND SOLID TANTALUM CAPACITORS**

P.R. MALLORY & CO. Inc.
MALLORY

**CIRCLE 60 ON READER SERVICE CARD**




CAPACITANCE-*temperature characteristics of several dielectric films having thicknesses greater than one micron—Fig. 2*

films with mobilities as high as 600 $cm^2$ per v-sec have been formed at 750 deg C. Increase in mobility is due to use of a substrate with an expansion coefficient similar to that of germanium.

Highest mobility observed for silicon films formed by vacuum deposition is 20 $cm^2$/v-sec on films deposited at 1,100 deg C.

Some success has been achieved with sputtered films of InSb and GaAs. C. W. Moulton reports that the sputtered films have the same conductivity type as the bulk material. Mobility of 2,400 $cm^2$/v-sec was obtained in InSb films.

PRACTICAL—Studies on materials and effects have been practically applied in the fabrication of a frequency modulated phase-shift oscillator (ELECTRONICS, Oct. 12, p 24). This circuit, composed of two functional blocks, lends verification to the predicted advantages gained in film circuits. Phase shift vs frequency characteristics have been improved, resulting in greater frequency stability. Network loss has been decreased by a factor of three from a tapered lumped constant circuit, and by a factor of nine from an untapered lumped constant ladder. The entire feedback network consists of only three vacuum-deposited layers, having a much higher inherent reliability.

## Improving Thermoelectric Materials

SINGLE crystals of lead telluride have been prepared by an improved method at Naval Ordnance Laboratories.

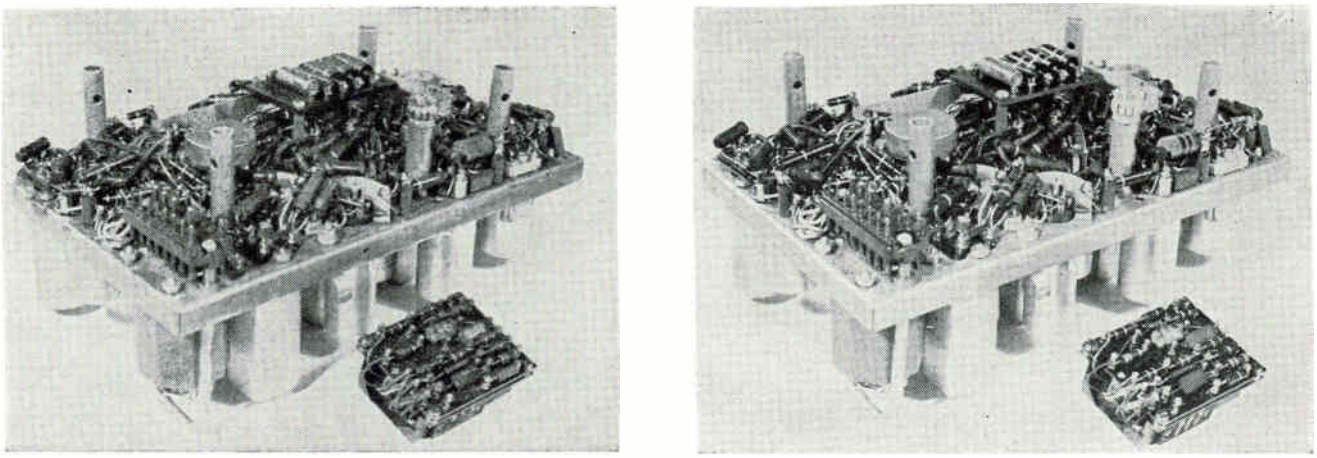
Material is a well-known semiconductor and is used in thermoelectric converters for refrigeration and power generating systems. A number of military applications are classified.

New technique combines into one operation the two separate steps of polishing and etching.

Crystal under study is placed in a special electrolyte at room temperature where it serves as an anode. A potential of six volts, applied for a period of five to 15 minutes, electropolishes the crystal until its surface becomes smooth. Then, without removing the crystal from the electrolyte, the potential is reduced to one volt for about 15 seconds. This etches the crystal surface and helps determine those areas where dislocations are abundant.

Crystals are no longer exposed to air between the two processes. Such exposure often reduces the efficiency of the etching process by causing a film to form on parts of the crystal surface.

There is no longer a problem of crystals cracking as a result of thermal shock. Technique was developed by M. K. Norr.



TRANSCEIVER *and radio receiver before and after cleaning. Much less disassembly is needed since even crevices and blind holes are cleaned efficiently*

# Ultrasonic Cleaning Speeds Maintenance

*Process saves time in cleaning and gives improved results*

By GILBERT TINT
National Ultrasonic Corp., Nutley, N.J.

ULTRASONIC CLEANING has been found to be an economic and advantageous process in repairing and maintaining electronic equipment.

Experience with ultrasonic cleaning at Decatur Signal Depot of U. S. Army—and at Tobyhanna Signal Depot after deactivation of Decatur Depot—has established three major cost reducing areas. Since ultrasonic cleaning is versatile and efficient, manual cleaning operations have been greatly reduced, thereby saving man-hours. Since ultrasonic cleaning is effective in getting soil out of small cracks and crevices, much less disassembly of equipment is required prior to cleaning; as a corollary, reassembly after cleaning is much less.

The two photographs above show before and after views of a radio receiver and a radio transceiver. The units were cleaned ultrasonically in detergent and water and then dried with heated air. Performance tests made before and after cleaning showed that the sets worked better after cleaning. A complex teletype unit that required 2½ days to clean manually is now cleaned in 20 minutes, exclusive of drying time.

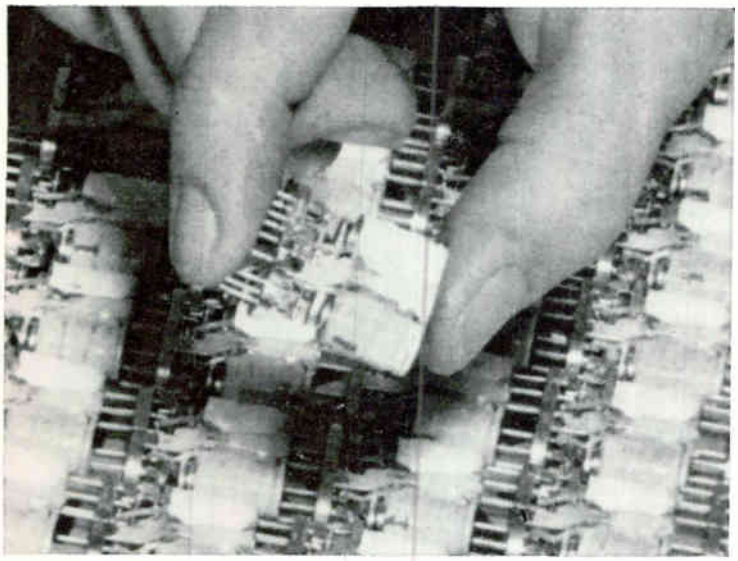
After initial studies and tests had shown the value of the process, a more elaborate cleaning facility was set up, including high power ultrasonic generators, cleaning tanks, and drying units. Tobyhanna Signal Depot processes equipment from most areas of the United States and from parts of the European Command. Parts processed range from relatively simple items through complex communications equipment.

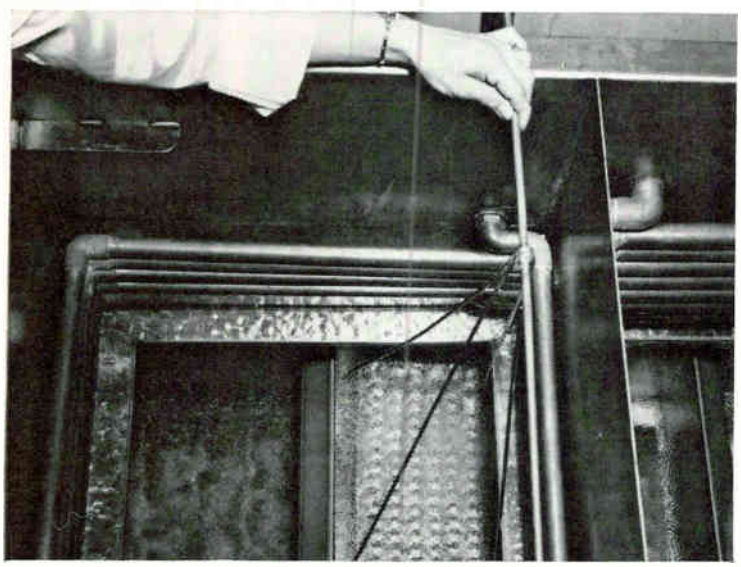
CLEANING AGENTS—The multitude of different equipment being processed requires a careful selection of proper cleaning compound and schedule for each item. Choice of cleaning solution is determined by the nature of the contaminant

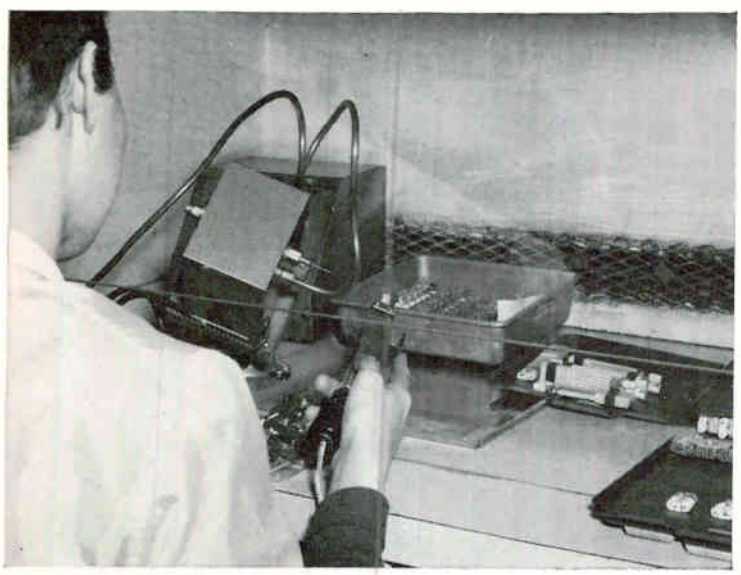
APPLYING CLEANING AGENTS

| Type of Cleaning Agent | Type of Contaminant to be Removed | Items that Cleaning Agent may Damage |
|---|---|---|
| Detergent and water | Light grease and oil<br>Dust<br>Light tarnish<br>Ink<br>Lint<br>Dirt | Care must be taken in drying items susceptible to rusting |
| Safety solvents | Grease and oil<br>Dust<br>Dirt<br>Lint | Rubber<br>Wax<br>Tar |
| Chlorinated solvents | Grease and oil<br>Dust<br>Dirt<br>Ink<br>Lint | Paint and varnish<br>Enamel<br>Plastic<br>Vinyl insulated wire<br>Wax<br>Tar |

# How Potter & Brumfield precision-cleans missile relays for top reliability!







**PROBLEM:** How to reduce an unacceptably high reject rate on critical "crystal-case" electrical relays (first photo) at Potter & Brumfield, Division of American Machine & Foundry Company... eliminate employee problems of headaches and nausea due to solvent vapors.

**SOLUTION:** A new cleaning system using "Freon" fluorinated solvents. "Freon" is an excellent selective cleaning agent. It removes solder flux, dust, lint and other contaminants, yet doesn't harm delicate relay parts. Also, "Freon" is virtually non-toxic, thus eliminating complaints about vapors.

In the cleaning process, a basket of relays is first given a 15-second ultrasonic bath in "Freon" TMC, then an ultrasonic bath in "Freon" TF for 15 seconds (second photo), and a 15-second rinse in TF vapor. Because of its low surface tension, "Freon" quickly penetrates the tiny spaces in the relays, allowing precision cleaning of delicate parts.

As a final cleaning step, the relay contacts are washed in a spray of "Freon" TF, while being electrically actuated (third photo). This assures that no particles are entrapped between the contacts. Only the high dielectric strength of "Freon" makes this operation possible.

According to Potter & Brumfield, the adoption of "Freon" solvent cleaning has upgraded product quality, meeting their critically high standards, equivalent to a 17% increase in production capacity while at the same time decreasing labor costs. They point out that "Freon" dries quickly and leaves no residue, and that its non-flammability and low toxicity let them operate without expensive ventilating equipment. They've found "Freon" solvents economical to use because they can be recovered in simple equipment for reuse... over and over again. Most important, "Freon" solvents have eliminated employee complaints on nausea and headaches.

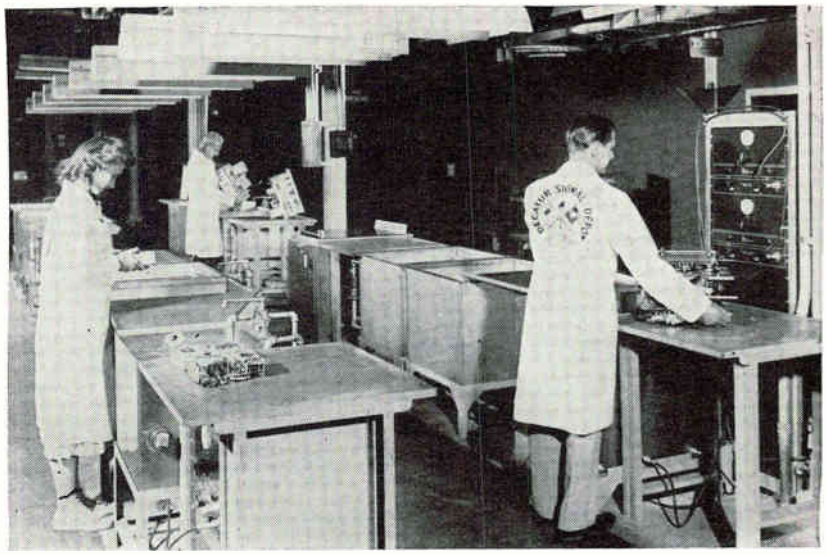
• • • •

We'll be glad to give you help in selecting "Freon" solvents for use in your own cleaning operation. Just write on your letterhead to Du Pont, 2420E11 Nemours Bldg., Wilmington 98, Delaware.

**FREON®** solvents

DU PONT REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING ... *THROUGH CHEMISTRY*



SPECIAL AREA *for ultrasonic cleaning has been set up by U.S. Army Signal Depot. Equipment includes generators, wash and rinse tanks, and drying ovens*

being removed and by the composition of the component parts of the equipment being cleaned. Assemblies using enamel, plastic, or vinyl insulated wire cannot be cleaned in perchorethylene or trichlorethylene since these solvents can soften or permanently damage this type of insulation. Naptha solvents will not affect plastic enamel or vinyl but can affect natural and reprocessed rubber. Detergent and water, on the other hand, will not affect the materials mentioned but will not efficiently remove oil and greases, and can cause rusting if the units are not properly dried. The table gives the characteristics of typical cleaning solutions.

A relatively new cleaning solvent is DuPont's Freon TF, a fluorinated hydrocarbon. The material has a high degree of solubility for oils and greases but does not attack plastics, wires, elastomers, paints and many other materials. It has a low surface tension of 19 dynes per cm and thus has high penetrating power, which is important in cleaning crevices and blind holes. It is also one of the safest solvents known and does not require any special safety equipment. Because of its combination of properties it is now being used at the depot to clean nearly all equipment.

CLEANING CYCLE — A definite cleaning procedure has now been established for most of the equipment processed: degrease in Freon TF with ultrasonics; wash in water detergent solution with ultrasonics; rinse in running tap water; blow off excess liquid with filtered compressed air; dry in oven.

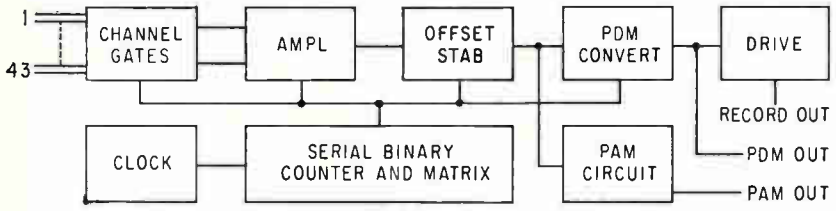
Time cycles for the various steps depends on the amount of contamination and the complexity of the equipment. For most items, a two to five minute cleaning cycle is adequate; drying time will vary somewhat, depending on the drying method. Except for the drying, the operations in the cleaning cycle are accomplished manually.

An advantage of the ultrasonic cleaning process is its ability to pinpoint equipment flaws that might otherwise escape detection. Some weak connections, caused by cold solder joints or oxidation during use, will break down during the ultrasonic processing.

Ultrasonic cleaning has also been found to break down some transistors and diodes. Production line experience as well as before and after tests indicate that these are weak or marginal components. Provided the ultrasonic cleaning system is designed with proper regard to power level and cleaning time, good semiconductors will not be damaged by the process.

The use of ultrasonic scrubbing as a quality control check for semiconductor studies or as a burn-in process for reliability studies has not so far been refined to the point where it can be used to supplement other testing methods.

# DESIGN AND APPLICATION




## Solid-State, Low-Level Sampling Switch

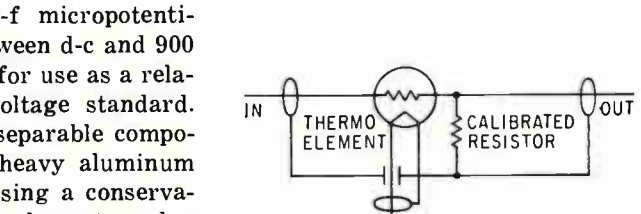
*Large number of mv level data points are sampled, amplified and time shared*

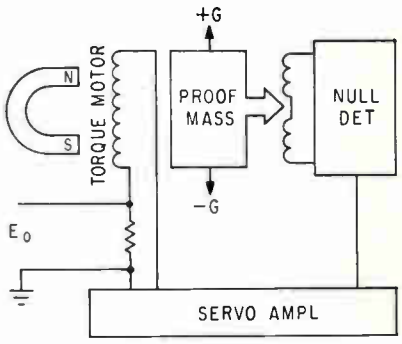
MANUFACTURED by Teleplex Corp., U.S. 206 and Cherry Valley Rd., Princeton, N.J., the type 350 low-level sampling switch samples a number of differential data inputs in any full-scale range from 5 mv or higher with sampling rate determined by internal clock. The unit samples both sides of the transducer simultaneously. Offset is adjustable to 0 $\mu$v at room temperature with 40 $\mu$v maximum over temperature range. A common low-level amplifier introduces less than 2 $\mu$v noise, and rejection of common-mode voltages is over 100 db. Simultaneous PAM and PDM outputs are available, crosstalk is less than 0.1 percent, linearity deviation from a best straight line will be less than 0.1 percent, backcurrent to transducers is less than $\pm$0.5 $\mu$a and overall power drain is approximately 100 ma. The common low-level amplifier is stabilized against offset errors between each data sample. The clock samples all data inputs in sequence. Output of the matrix causes both transistor input gates of an individual channel to be simultaneously connected to and amplified by an extremely low-noise common pulse amplifier. Amplifier output is a single composite time division multiplexed signal consisting of sequences of pulses of constant duration with amplitudes varying between 0 and 5 v. Each pulse amplitude is directly proportional to the specific input signal of the data channel being sampled.

CIRCLE 301, READER SERVICE CARD

## Microvolt Reference From D-C to 900Mc

ANNOUNCED by Filmohm Corp., 48 W. 25th St., New York 10, N. Y., the wide range r-f micropotentiometer is good between d-c and 900 Mc and is suitable for use as a relative or absolute voltage standard. The unit has two separable components; a shielded heavy aluminum body assembly housing a conservatively rated thermoelement, and a type N interchangeable, concentric disc, thin-film resistor offering minimum reactance. No soldering is necessary when changing resistors. A set between 1 and $10^5$ $\mu$v consists of 5 resistor assemblies and 4 body assemblies. As shown in the sketch, input current passes through a thermoelement and heats a fine resistance wire. The temperature the wire reaches is indicated by a thermocouple whose output is brought out through a connector. The thermoelement is calibrated at d-c and is used to 900 Mc with the application of calibration factors at the highest frequencies. Current flows through the thin film resistor to provide an accurate output voltage. **(302)**

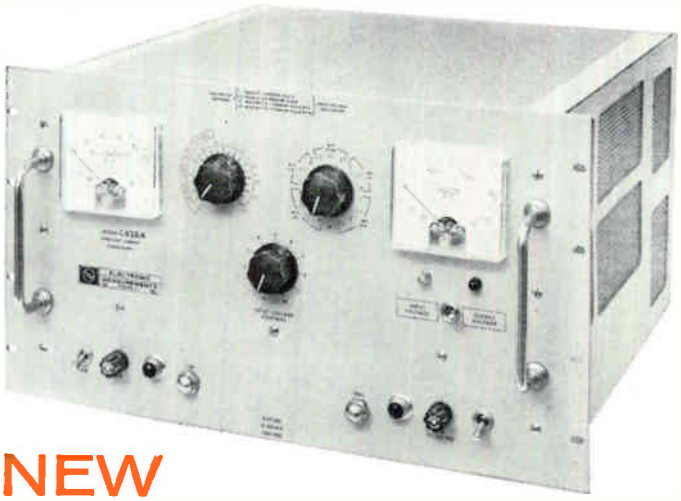



## Two Ounce Accelerometer Has 0.1% Accuracy

NEW on the market from Larson Aero Development, P. O. Box 135, Concord, California, the linear servo accelerometer comes with ranges as low as $\pm$0.001 g and as high as $\pm$500 g. The 2 oz hermetic sealed package has natural frequency from 100 to 500 cps depending on g-range although they are available from 2 to 2,000 cps. Standard ranges have $\pm$7.5 v output across 5,000-ohm load with current output optional. Linearity is within 0.05 percent, hysteresis is 0.02 percent, repeatability is within 0.01 percent and resolution is 0.0001 percent or better. Temperature stability is 0.01 percent per degree F and electronic damping

# only ELECTRONIC MEASUREMENTS



## NEW CONSTANT-CURRENT POWER SUPPLIES

*offer all these exclusive features:**

1. **Constant-current from less than 0.5 microampere up to 3 A.**
2. **Models to 1500 V DC compliance.**
3. **Voltage-limiting control to limit compliance.**
4. **Remotely programmable.**
5. **Modulation input . . . power supply can also be used as general purpose or operational amplifier.**

Electronic Measurements Constant-Current Power Supplies were designed specifically for constant-current output. In this respect, they offer advantages in the field of semiconductor work that can't be matched by conversions of constant-voltage (voltage-regulated) power supplies . . .
Ask for Specification Sheet 3072C for all the facts.

*BRIEF SPECIFICATIONS

| MODEL | CURRENT RANGE | | †VOLTAGE COMPLIANCE AT | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. I | MAX. I |
| C612A | 1 μa | 100 ma. | 260 V | 100 V |
| C631A | 1 μa | 100 ma. | 420 V | 300 V |
| *C638A | 0.5 μa | 100 ma. | 2100 V | 1500 V |
| C624A | 2.2 μa | 220 ma. | 260 V | 100 V |
| C632A | 2.2 μa | 220 ma. | 420 V | 300 V |
| *C636A | 2.2 μa | 220 ma. | 735 V | 600 V |
| C629A | 2.2 μa | 300 ma. | 205 V | 150 V |
| C633A | 2.2 μa | 300 ma. | 420 V | 300 V |
| C620A | 5 μa | 500 ma. | 110 V | 50 V |
| C621A | 5 μa | 500 ma. | 160 V | 100 V |
| C613A | 10 μa | 1 AMP | 115 V | 50 V |
| C614A | 10 μa | 1 AMP | 170 V | 100 V |
| *C628A | 10 μa | 1 AMP | 215 V | 150 V |
| *C630A | 10 μa | 1 AMP | 280 V | 200 V |
| *C625A | 22 μa | 2 AMP | 150 V | 75 V |
| *C626A | 22 μa | 2 AMP | 190 V | 100 V |
| *C615A | 22 μa | 3 AMP | 125 V | 50 V |
| *C618A | 22 μa | 3 AMP | 170 V | 100 V |

* Voltage limiting control standard. Optional on all other models.
† For current vs. voltage compliance curves, request Specification Sheet 3072C.

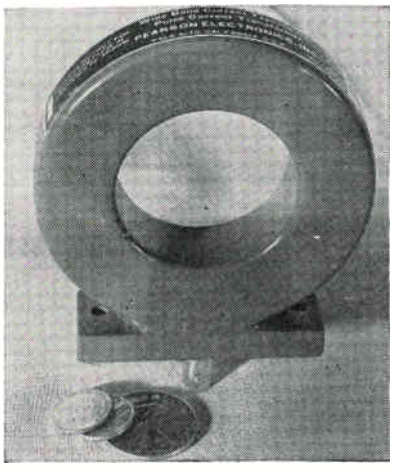
**ELECTRONIC MEASUREMENTS COMPANY, INCORPORATED**
EATONTOWN • NEW JERSEY

ratios are between 0.4 to critical, easily altered in field. The seismic system consists of a torque motor coupled to a calibrated pendulum (sketch p 66) with a servo system keeping the pendulous proof mass in a constant state of force balance during acceleration. Current required to do this is directly proportional to acceleration. When in servo, maximum deflection of pendulum is less than 1 mil. Damping is electronic and independent of temperature variations.

CIRCLE 303, READER SERVICE CARD

## Miniature Constant Time Delay Filter

RECENTLY announced by Magnatrol Avionics, 7929 Hayvenhurst Ave., Van Nuys, California, are a series of miniature constant time delay transient data filters encapsulated within 0.125 cubic inch. These filters are for use in discriminator and pulse applications where fidelity of pulse reproduction is of importance. Time delay variation is less than 1.0 percent from d-c to 90 percent of the cutoff frequency (3 db point). Input and output impedance is 10,000 ohms. Approximate attenuation at $f_c$ is 3 db, at $2f_c$ = 12 db, at $3f_c$ = 25 db and at $4f_c$ = 34 db. Frequency of cutoff is 400 cps through 100 Kc. The filter has many variations in either Gaussian (Bessel Polynomial), Thompson, Tchebycheff or Butterworth lines. **(304)**



## Current Transformer Covers Wide Band

PEARSON ELECTRONICS, INC., 707 Urban Lane, Palo Alto, Calif. The WBCT-110, with a frequency response of 1 cycle to 35 Mc, is used for precision measurement of audio, video, r-f and pulse currents in conductors at low or very high voltages or in a beam of charged particles. It has 0.1 v per amp output, 20 nsec risetime, 0.0005 percent droop per $\mu$sec, and it is rated at 30 Kv flashover in air and hundreds of Kv in oil. Unit is plugged into an oscilloscope using 52 ohm cable. Price is $235. **(305)**

## Linear Transformer

JOHN OSTER MFG. CO., 1 Main St., Racine, Wisc. Type No. 4292-00 size 8 linear transformer, designed to meet an accuracy requirement of ±7 minutes through an excursion of ±55 deg, is available in input voltage ranges of 12 through 26 v. **(306)**

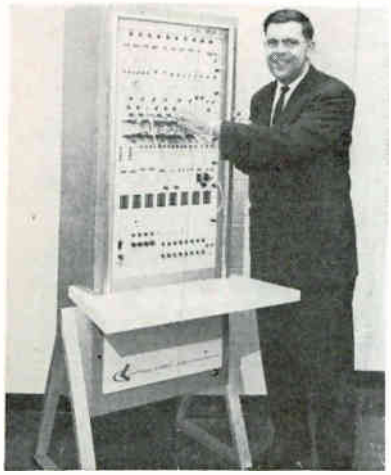
## Crystal Can Relay Withstands 50 G Shock

LEACH CORP., 18435 Susana Road, Compton, Calif. The C-200 series crystal can relay was designed for 10 amp, 2 pdt switching applications, where reliability is required and size and weight are important. It is 0.885 in. high and 0.458 cu in. volume. Its low silhouette gives it greater resistance to shock. Relay has 0.20 in. grid terminal spacing and is available in a variety of mounting and terminal configurations. **(307)**

## SCR Gater

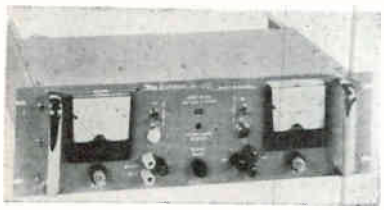
ELECTRO-SEAL CORP., 938 North Ave., Des Plaines, Ill. Model 1248-

E10-1 SCR Gater, providing complete control circuits for silicon controlled rectifiers rated to 235 amperes, employs a combination of magnetic and solid state components hermetically sealed in silicon oil. **(308)**



## Digital Trainer Offers Program Control

CONTROL LOGIC INC., Natick, Mass. The PE1-10 logic training console is a single cabinet of programmable circuit panels for demonstrating the design and operation of complete logic functions. It contains a comprehensive selection of individual circuits, associated pulse networks and toggle switch registers for data insertion and program control. This trainer may be operated at push button rates to visually demonstrate operating sequences or at frequencies up to 2 Mc, using oscilloscopic wave forms to illustrate functions. **(309)**

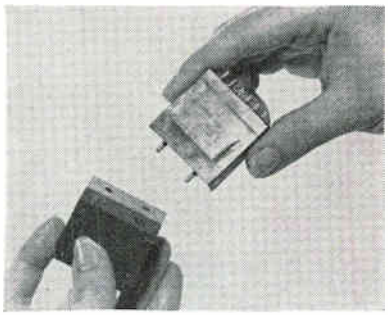


## Power Supply Provides 300-500 V D-C

BURTON MFG. CO., 8910 Winnetka Ave., Northridge, Calif. Precision-regulated voltages for circuitry mockups in the engineering lab are provided by the 500 ma model 550 power supply. It is designed for application also as a systems component in original equipment. Out-

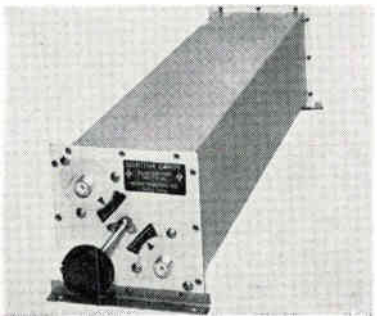
put is continuously variable from 300 to 500 v d-c. Load regulation is 0.03 percent; line regulation, 0.02 percent. Max ripple and noise is 1.5 mv, rms. Output impedance is 1.5 ohms. Filament output is 6.3 v at 15 amp. Transient response is less than 25 μsec.

CIRCLE 310, READER SERVICE CARD



## Stepping Switch Uses Hard Contacts

FISHER-AKIN CO., 1005 Sepulveda Blvd., Manhattan Beach, Calif. The Fast Acting Commutator is basically a pulse-driven, high-speed solid-state stepping switch utilizing hard contacts as the switching element. Use of hard contacts permits the highest degree of insulation between the driving circuit and the circuit selected. Because of its modular construction and high speed capability it offers a new flexibility in applications requiring selective switching. (311)



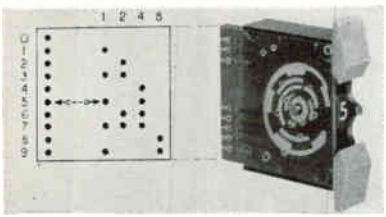
## Cavity Filters Made of Silver Plated Copper

DECIBEL PRODUCTS, INC., 3184 Quebec, Dallas 7, Texas. Cavities feature adjustable coupling loops that permit the user to obtain the optimum combination of selectivity and insertion loss for a particular problem. The loops are continuously adjustable from ½ db to 3 db. The cavities are constructed of silver plated copper to maximize per-

formance and minimize corrosion. Designated the DB-4001 series for the 150 Mc band and the DB-4021 for 450 Mc band, units come in single cavity modules or in combinations of two or three. (312)

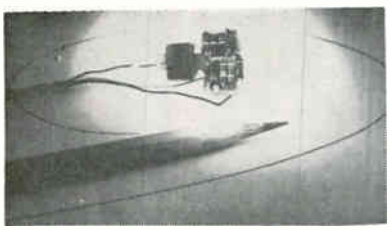
## Dry Circuit Tester Offers Visual Readout

SHASTA ELECTRONIC CO., P.O. Box 316, Palo Alto, Calif. Max cycling rate for relays under test with the model R-5 test set is 20 cps. Additional features include MISS and MASTER six digit counters (to 999999), sensitivity to 300 ohms at 1 $\mu$a, transient protection and adjustable sensitivity. (313)



## Single Switch Module Provides Dual Output

THE DIGITRAN CO., 855 South Arroyo Parkway, Pasadena, Calif. The Digiswitch model 334 provides both a binary-coded-decimal output and a simple 10 position-decimal output from a standard switch module. It is only ½ in. in width and can be installed interchangeably with other Digiswitch models. Any number of modules may be ganged for back or front mounting. (314)

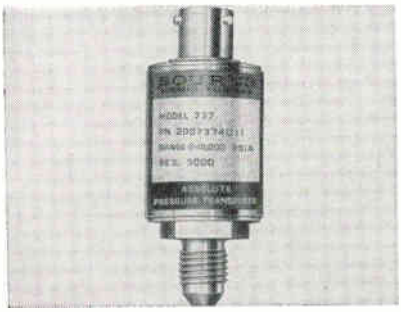


## Timing Device Withstands Severe Shock

GENERAL TIME CORP., 355 Lexington Ave., New York 17, N. Y. The Mu-Chron is a timing device based on magnetic property of a material. Used as an oscillator, frequency divider and analog-to-digital converter, it can be potted to withstand the severest type of shock

and vibration. As a frequency divider, it is particularly useful since it has achieved stable and reliable frequency division as high as 500:1.

CIRCLE 315, READER SERVICE CARD

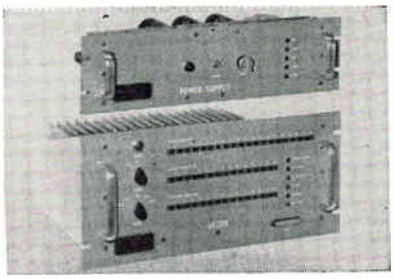


## Transducer Extends Pressure Ranges

BOURNS, INC., 1200 Columbia Ave., Riverside, Calif. Model 737 transducer now permits precision measurement of absolute pressures over an extended 0-500 to 0-10,000 psia range. It measures only 1 in. in diameter and 1.5 in. in overall length, excluding standard connectors and pressure fittings. Temperature limits are — 100 to + 200 F; vibration, 35 g; shock, 50 g; weight, about 4 oz. (316)

## D-C Amplifier

REDCOR CORP., 7760 Deering Ave., Canoga Park, Calif. Model 371 low level d-c amplifier features: fast recovery from differential and common mode overload of 80 μsec, wide band common mode rejection, band width unaffected by gain change, high cmr with wide band width of 50 Kc. (317)

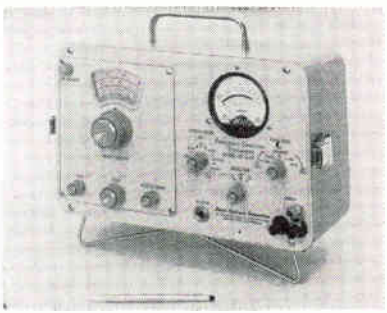


## Data Format Converter Can Sample and Store

METRIC SYSTEMS CORP., Fort Walton Beach, Fla. The Decon is a digital data format converter designed to accept information from five shaft encoders in parallel gray code and provide, as an output, the same information in serial straight binary code. Unit is constructed for standard, 19-in. rack mounting and is all solid state except for indicator lamps. It can sample and store and can freeze the encoder reading upon receipt of internal or external sample commands. (318)

## Piezoelectric Ceramic

CENTRALAB, 900 E. Keefe Ave., Milwaukee 1, Wisc. KD-13, a piezoelectric ceramic with a minimum curie temperature of 125 C is designed for a wide range of military and commercial appplications, including sonar, accelerometers, hydrophones, frequency control devices and ultrasonic cleaning equipment. (319)



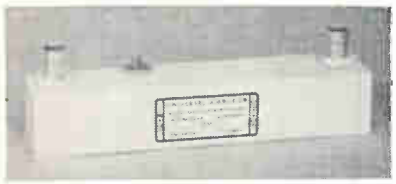
## Voltmeter-Wave Analyzer Covers 2 to 350 Kc

SIERRA ELECTRONIC DIV., Philco Corp., 3885 Bohannon Dr., Menlo Park, Calif. Model 127A-CR is a solid state, carrier reinsertion frequency selective voltmeter-wave analyzer. It covers a range of 2 to 350 Kc with a 250 cycle bandwidth and provides a front panel audio monitoring output through a 2.5 Kc band pass filter. Input sensitivity is — 80 dbm to + 22 dbm in 5 db steps; measuring accuracy, ± 1 db (— 70 to + 22 dbm); frequency accuracy, ± 1 Kc over complete range. (320)

## Receiver/Decoder

ADVANCED COMMUNICATIONS, INC., 7225 Alabama Ave., Canoga Park, Calif. Model R-420 uhf command receiver/decoder is a crystal-controlled, solid state, fixed tuned, f-m

receiver which operates in the 406 to 550 Mc range and complies with the rfi requirements of MIL-I-26600. (321)

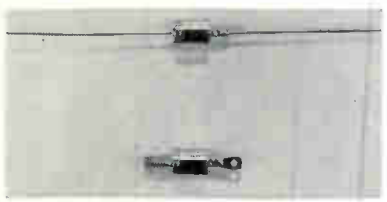


## Universal Amplifiers Packaged in Compact Case

INTERNATIONAL MICROWAVE CORP., 1 Seneca Place, Greenwich, Conn., offers a series of wide band, solid state amplifiers covering bands of 3-80 Mc and 10-100 Mc with manual or automatic gain control circuits. Gain control flatness is maintained over these wide bands to ± 0.5 db for gain variations of 25 db. The agc circuits will maintain output constant to ± 1.5 db for a 25 db variation in input signal. (322)

## Waveguide Switch

QUANTATRON, INC., 2520 Colorado Ave., Santa Monica, Calif. Model WS-02R12, a high speed microwave device for H-plane switching of a single WR-28 waveguide input to either of two similar waveguide outputs, has a switching speed of less than 100 millisec, with 50 db isolation between channels. (323)



## Zener Diodes Offer Close Tolerance

U. S. SEMCOR, 3540 W. Osborne Road, Phoenix 19, Ariz., announces production of new 1 percent Zener diodes. Any Zener voltage tolerance between 1 percent and 5 percent is now available. A test circuit is specified for exact correlation. Available in two package designs, 7 w (PZ) and 1 w (LPZ), these close tolerance Zeners are available with nominal voltage between 8 and 100 v. (324)

## PRODUCT BRIEFS

REPEAT CYCLE TIMERS are subminiature, hermetically sealed. They are designed for aircraft, missile and rocket applications. A. W. Haydon Co., 232 N. Elm St., Waterbury 20, Conn.
CIRCLE 325, READER SERVICE CARD

SLIDING TERMINATION with a vswr of 1.05 including the connector. Frequency range is 2,000 to 12,000 Mc. Astrolab Inc., 120 Morris Ave., Springfield, N. J. (326)

PCM TELEMETERING SIMULATOR speeds satellite ground station check out. Basic price is $15,000. Correlated Data Systems Corp., 1007 Air Way, Glendale, Calif. (327)

POTENTIOMETRIC TRANSDUCERS offer life to 3,000,000 cycles. Unit depth is only $1\frac{3}{32}$ in. Computer Instruments Corp., 92 Madison Ave., Hempstead, L.I., N.Y. (328)

MOLDED METAL FILM RESISTORS with low temperature coefficients. They are available in MIL sizes RN60 to RN80 inclusive. American Components, Inc., 8th Ave. and Harry St., Conshohocken, Pa. (329)

DIGITAL VOLTMETER meets all MIL specs. Features include all solid-state circuitry and 200-million operation reed relays. Cubic Corp., 5575 Kearny Villa Road, San Diego 11, Calif. (330)

TIME DELAY MODULE is $\frac{1}{2}$ crystal can type. It is rated for 10,000 hr life minimum. Wheaton Engineering Div., Hurletron, Inc., 920 Manchester Road, Wheaton, Ill. (331)

SOLID STATE D-C AMPLIFIER is low in cost. Bandwidth is from d-c to 100 Kc. Astrodata, Inc., 240 E. Palais Road, Anaheim, Calif. (332)

SLIP RING AND BRUSH ASSEMBLY for missile launching applications. It passes 2,000 hr life test. Electro-Miniatures Corp., 600 Huyler St., S. Hackensack, N.J. (333)

POLYCRYSTALLINE FERRITE MATERIALS for microwave applications. Eleven different formulations are offered. Airtron, a division of Litton Industries, 200 E. Hanover Ave., Morris Plains, N. J. (334)

VHF F-M TRANSMITTER is a solid-state 3-w unit. It meets operational specs for aerospace uses. Electronic Communications, Inc., Box 12248, St. Petersburg 33, Fla. (335)

WAVEGUIDE ISOLATORS for K- and V-band. They can be supplied with standard round or rectangular flanges. Sperry Microwave Electronics Co., P. O. Box 1828, Clearwater, Fla. (336)

RESISTANCE CALIBRATOR is designed for rapid calibration of bridges in high ranges. It is priced from $290 to $800 depending on range and con-

struction. Angstrohm Precision Inc., 1136 N. LaBrea Ave., Hollywood, Calif. (337)

SIZE 23 MOTOR offers high torque-to-inertia ratio. It can have stall torque up to 9 in. oz. Kearfott Div., General Precision Inc., McBride Ave., Little Falls, N. J. (338)

DIODE DETECTOR with 100 db dynamic range. It is designed for use in the 100 Mc to 11 Gc range. Cascade Research, 5245 San Fernando Road, Los Angeles 39, Calif. (339)

DELAY LINE offers precision delay adjustments. It is particularly suitable for printed board mounting. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J. (340)

AIR-INSULATED CABLE looks like linked miniature balloons. Application is for carrying information electronically, whether words, pictures or symbols. Simplex Wire & Cable Co., Cambridge, Mass. (341)

SILICON ZENER VOLTAGE REGULATOR DIODES have 50-w power dissipation. They are hermetically sealed. Fansteel Metallurgical Corp., North Chicago, Ill. (342)

TRANSISTOR AND TUNNEL DIODE ANALYZER reads both $I_{cbo}$ and $I_{ceo}$ leakage currents. Transistors can be tested in or out of circuit. Seco Electronics, Inc., 1201 S. Clover Drive, Minneapolis 20, Minn. (343)

SILICON ZENER REGULATORS with 10 w dissipation up to 75 C case temperature. Voltage ranges are 6.3 through 200 v. Diodes, Inc., 7703 Canoga Ave., Canoga Park, Calif. (344)

SILK SCREEN KIT for printing production quantities of etched circuit boards or instrument panels. No dark room is required for processing. Keil Engineering Products, Inc., 6833 Manchester Ave., St. Louis 10, Mo. (345)

FAST MULTIPLEXER is compact unit. It samples up to one hundred, 10 v inputs at a 50 Kc rate. Texas Instruments Inc., 3609 Buffalo Speedway, Houston, Texas. (346)

TURNS-COUNTING DIAL with digital readout. Simplified construction eliminates need for auxiliary mounting hardware. Spectrol Electronics Corp., 1704 South Del Mar Ave., San Gabriel, Calif. (347)

PRESET COUNTER CONTROLLER is 100 Kc unit. It is available in two through six decade models. Computer Measurements Co., Bradley Ave., San Fernando, Calif. (348)

SERVO AMPLIFIER is transistorized. It features 30 w power output and external gain setting. Melcor Electronics Corp., 110 Central Ave., Farmingdale, L. I., N. Y. (349)

PLASTIC CLIP for holding round components. It is made of rigid vinyl, strong but flexible. Richco Plastic Co., 3722 W. North Ave., Chicago 47, Ill. (350)

# Literature of the Week

ANALOG COMPUTER features removable patch panel. Modular construction permits expansion to 24-amplifier capacity. Applied Dynamics, Inc., 2275 Platt Road, Ann Arbor, Mich. CIRCLE 351, READER SERVICE CARD

CATHODE FOLLOWERS Columbia Research Laboratories, MacDade Blvd. & Bullens Lane, Woodlyn, Pa. Data sheet T-120 describes cathode followers used in vibration, shock and pressure studies. (352)

METAL FILM RESISTORS Daven Division of General Mills, Inc., Livingston, N.J., has issued its latest status report on the reliability of metal film resistors. (353)

CLAMPS, FLANGES & SCREWS DeMornay-Bonardi, 780 S. Arroyo Parkway, Pasadena, Calif. Two-page data bulletin describes clamps, flanges and screws covering the range 50.0 to 140.0 Gc. (354)

TRIMMERS AND INDUCTORS Corning Electronics Components, Raleigh, N.C. A 16-page booklet covers metallized glass trimmer capacitors and inductors with high Q and low temperature coefficients. (355)

DELAY LINES ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N.J. Electromagnetic delay lines for industrial and military applications are described in catalog No. 9. (356)

TRANSISTOR CAN RELAYS Babcock Relays, 3501 Harbor Blvd., Costa Mesa, Calif. Bulletin CBR-621 describes the CBR-500 series transistor can size, low cost, high performance relays. (357)

UHF TRANSMITTER General Electronic Laboratories, Inc., 8440 Second Ave., Silver Spring, Md. Engineering bulletin covers a series of telemetry transmitters meeting the critical requirements of all commonly used uhf telemetry and data transmission bands. (358)

ULTRA-HIGH VACUUM EVAPORATOR General Vacuum Corp., 82 Hicks Ave., Medford 55, Mass. Bulletin 1444721 covers features and design details of a new ultra-high vacuum evaporator. (359)

LOSSY DIELECTRIC CERAMIC National Beryllia Corp., First & Haskell Ave., Haskell, N.J. Superior h-f energy absorption without thermal damage is offered by a new lossy dielectric ceramic described in a 4-page data sheet. (360)

MEMORY SYSTEMS Radio Corp. of America, Semiconductor and Materials Division, Somerville, N.J., has prepared a brochure describing its MS series memory system in detail. (361)

TRANSFORMERS & INDUCTORS Cohu Electronics, Inc., KinTel division, Box 623, San Diego 12, Calif., has published data sheet 23-3 listing

descriptions of its transformer and inductor line. (362)

MARKER BEACON RECEIVER Aircraft Radio Corp., Boonton, N.J. Bulletin describes and illustrates the 502A tiny, lightweight, low cost marker beacon receiver. (363)

EPOXY CASTING RESIN Emerson & Cuming, Inc., Canton, Mass. Technical bulletin 7-2-10 B covers Stycast 2651-40 low viscosity general purpose epoxy casting resin. (364)

POLYESTER SPLICING TAPE Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Bulletin 1639-5 contains characteristics of a polyester splicing tape for use with type 23-109B oscillogram processor. (365)

DIGITIZING CHART RECORDS Disc Instruments, Inc., 3014-B So. Halladay St., Santa Ana, Calif., has released a 6-page brochure covering operation and applications of series 200 chart integrator. (366)

INSTRUMENTS Houston Instrument Corp., P.O. Box 22234, Houston 27, Texas. A 16-page catalog describes precision recording, measuring and conversion instruments for laboratory and industrial use. (367)

TANTALUM SLUG CAPACITOR Ohmite Mfg. Co., 3630 Howard St., Skokie, Ill., has published a bulletin supplement on the case size Y, its smallest hat-shape, tantalum slug, electrolytic capacitor. (368)

C-W KLYSTRONS Sperry Electronic Tube Division, Sperry Rand Corp., Gainesville, Fla. Brochure gives design and performance data on high power c-w klystrons. (369)

LEAD ANODES Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J. Bulletin 621 covers standard and special virgin metal lead anodes for efficient chromium plating. (370)

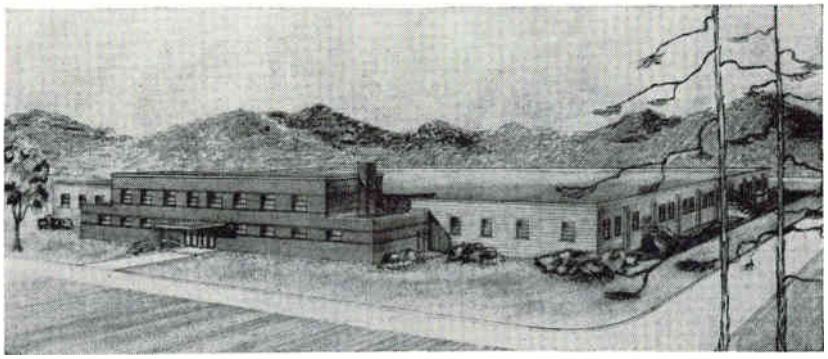
VACUUM DIFFUSION PUMP NRC Equipment Corp., 160 Charlemont St., Newton 61, Mass., has available an illustrated 8-page brochure on vacuum diffusion pumps. (371)

RETAINING RINGS Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N.Y. A 128-page technical manual contains engineering dimensions and specifications for the entire line of Truarc retaining rings and assembly tools. (372)

PRODUCT GUIDE P. R. Mallory & Co. Inc., Indianapolis 6, Ind. A 28-page product guide illustrates and gives brief description of electrical and electronic components, dry battery systems, special materials and metals. (373)

JUNCTION TRANSISTORS Burroughs Corp., Detroit 32, Mich. Technical bulletin discusses charge-step derived transfer functions for the junction transistor. (374)

D-C CHOPPER AMPLIFIER Dynatron Laboratories, 553-E Dawson Drive, Camarillo, Calif. Data bulletin describes model DA4510 low level d-c chopper amplifier. (375)



## Elco Corporation Opens New Plant

ELCO CORP., Philadelphia, recently opened its 52,000-square-foot manufacturing plant in Huntingdon, Pa. The plant, one of two new Elco manufacturing facilities, joins a production network that includes plants in Pennsylvania, New Jersey and California, and manufacturing subsidiaries and licensees in seven foreign countries.

The single story building, constructed at an estimated cost of $350,000, will be used to manufacture hermaphroditic connectors and Varicon connectors, proprietary products used in many industries, including space, aircraft and computer applications.

Huntingdon Scientifics, Inc., and Oak Engineering Co., Inc., the two Elco subsidiaries housed in the new structure, are engaged in filling civilian and government contracts, part of Elco's current $8-million order backlog.

The Huntingdon plant has 45,000 square feet of production area with 7,000 square feet for administrative offices, conference rooms, executive and employee lounges and an employee cafeteria. There is ample provision for future expansion with the plant located on a 20 acre tract.

Now headquartered in Philadelphia, Elco is preparing to move to a new $1.25-million, 115,000 square-foot structure nearing completion in Willow Grove, Pa. This will serve as the firm's principal manufacturing installation and as its headquarters.

### Phinizy Moves Up At IMC Magnetics

ROBERT B. PHINIZY has been promoted to the position of president and manager of the Western division of IMC Magnetics Corp., Westbury, N.Y. He was previously vice president in charge of engineering for the division, located in Maywood, Calif.

Phinizy succeeds David Menken who left the company but will continue as a director and as a consultant in many product areas.

The Western division of IMC Magnetics Corp. manufactures solenoids, synchro and pulse-driven step-servo motors and systems for missiles, aircraft and space uses.

### Epsco Pacific Hires Development Director

ROBERT H. OKADA has been appointed director of development for the newly formed Epsco Pacific, Menlo Park, Calif., an affiliate of Epsco, Inc., Cambridge, Mass.

Epsco Pacific is involved primarily with serving governmental agencies and prime contractors on the West Coast that are involved in key missile and satellite programs. The organization specializes in the areas of research and development, circuit design, micro power and special instrumentation systems for data processing and telemetry.

Okada was formerly a senior staff member with Arthur D. Little, Inc.

### Hycon Names Barnes V-P, Engineering

JOHN C. BARNES has been appointed vice president of engineering for the Hycon Mfg. Co. of Monrovia, Calif. He has been with the company for a year as a vice president in charge of long range planning with additional assignments to several special projects. He will continue in some of these activities.

Prior to joining Hycon, Barnes was assistant to the chief scientist and acting director of the laboratories for North American Aviation's Space and Information Systems division.

### Three Engineers Join Antenna Systems

ANTENNA SYSTEMS, INC., Hingham, Mass., announces the appointment of Augustine R. Stratoti, Robert J. Benson and Walter F. Spear to its growing engineering staff.

Stratoti comes to ASI from the Gabriel Electronics division. He will head up r-f engineering responsible for microwave components development.

Benson was formerly an engineering representative for the Boeing Co. At ASI he will be ad-

ministrative assistant to the engineering manager.

Spear joins ASI as an electrical engineer in the production department. He was formerly associated with Northeastern Engineering, Inc., as a project manager for the Army Security Agency.

## Magenheim Advances At Paradynamics

APPOINTMENT of Bertram Magenheim to the post of director of engineering has been announced by Paradynamics, Inc., Huntington Station, N.Y.

Formerly chief engineer of the firm, Magenheim held a corresponding position with Control Electronics Co., Inc., at the time of its merger with Paradynamics in January of this year.

## Portchester Instrument Appoints Lamb

JOHN M. LAMB, former president of the Electro Magnetic Transmission Co. and E.M.T. Corp. of Newton, N.J., has been named director of the new flexible waveguide and microwave antenna manufacturing division of Portchester Instrument Corp., Port Chester, N. Y.

The company, specialist in manufacturing microwave link system components, is acquiring 15,000 square feet of additional space in Port Chester for the new division.

Lamb is the inventor of the balanced seam flexible waveguide and the null point seam flexible waveguide.

## J. E. Tennis Becomes Chief Engineer at REL

JOSEPH E. TENNIS, senior staff engineer, has been appointed to the post of chief engineer at Radio Engineering Laboratories, Inc., Long Island City, N.Y. REL is the communications subsidiary of Dynamics Corp. of America.

With REL since 1947, Tennis was appointed assistant to the vice president of engineering in 1959.

## Levine Elected an Assistant V-P

SAMUEL LEVINE has been elected assistant vice president-advanced systems development of The Teleregister Corp., Stamford, Conn.

He joined the company in 1955 as systems engineer, and has been manager of systems and design engineering, and manager of systems engineering since that time.

## International Electric Promotes Hachigian

APPOINTMENT of Paul M. Hachigian as director of engineering has been announced by Martin H. Dubilier,

president of International Electric Corp., Paramus, N.J., a subsidiary of ITT Corp.

Hachigian will be responsible for the management, direction and coordination of all IEC system designs, such as Project 465L, the new command control system now being produced by IEC for the Strategic Air Command.

With the ITT System since 1951, Hachigian came to IEC in 1959. Prior to his new appointment, he was deputy director of the aerospace division.

## PEOPLE IN BRIEF

**Viktor W. Pleil** moves up to senior development engineer for x-ray tubes at The Machlett Laboratories. **Arnold S. Cherdak**, formerly with Gulton Industries, joins Kaiser Electronics, Inc. as senior electrical engineer. **Donald S. Jones**, advances to g-m of the Scintilla div. of The Bendix Corp. **William S. Boone, Jr.**, promoted to exec v-p of Scope Inc. **William H. Russell**, previously with Beckman Instruments, elected exec v-p of Technical Measurement Corp. **Ralph W. Jones** leaves Remington Rand Univac to become mgr. of manufacturing for Advanced Scientific Instruments, Inc. **Jack Cassidy** elevated from v-p to president of Absoca Industries. North American Aviation ups **David P. Chandler** and **George A. Kachickas** to asst. chief engineers in the inertial navigation product div. of Autonetics. **John E. Galione** advances to v-p in charge of operations at The Technical Materiel Corp. **Robert R. Shreve**, an engineer previously with Sperry Gyroscope Co., appointed sales and advertising mgr. for Philamon Laboratories Inc. **Cornelius P. McNamara**, ex-Cardion Electronics, Inc., named v-p of the Emerson Research Laboratories div. of Emertron, Inc. **Matthew L. Stephens** and **Wayne B. Johnson** promoted to engineering section mgr.'s in commercial products engineering at Lenkurt Electric Co., Inc. Fairchild Semiconductor ups **Fred Bialek** to mgr. of its San Rafael diode plant.





EMPLOYMENT OPPORTUNITIES

# electronics

## WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

### ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

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

### STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

### WHAT TO DO

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

| COMPANY | SEE PAGE | KEY # |
|---|---|---|
| ATOMIC PERSONNEL INC. Philadelphia, Penna. | 98* | 1 |
| BELL AEROSYSTEMS COMPANY Div., of Bell Aerospace Corp., A Textron Company Buffalo, N.Y. | 84 | 2 |
| BRISTOL COMPANY Waterbury, Conn. | 84 | 3 |
| CURTISS WRIGHT CORPORATION Electronics Div. E. Paterson, N.J. | 86, 87* | 4 |
| DOUGLAS AIRCRAFT CO. Missile and Space Systems Division Santa Monica, Calif. | 53 | 5 |
| GENERAL DYNAMICS/ASTRONAUTICS San Diego, California | 41, 42, 43, 44* | 6 |
| HIGH VOLTAGE ENGINEERING CORPORATION Burlington, Massachusetts | 79 | 7 |
| JET PROPULSION LABORATORY California Institute of Technology Pasadena, California | 98* | 8 |
| NATIONAL CASH REGISTER CO. Dayton, Ohio | 85 | 9 |
| PHILCO WESTERN DEVELOPMENT Sub. of Ford Motor Co. Palo Alto, California | 83 | 10 |
| REPUBLIC AVIATION CORPORATION Farmingdale, L.I., New York | 84 | 11 |
| SCOPE PROFESSIONAL PLACEMENT CENTER Waltham, Mass. | 98* | 12 |

* These advertisements appeared in the October 26th issue.

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

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

### Personal Background

NAME .....

HOME ADDRESS .....

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

HOME TELEPHONE .....

### Education

PROFESSIONAL DEGREE(S) .....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

### FIELDS OF EXPERIENCE (Please Check)

11262

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

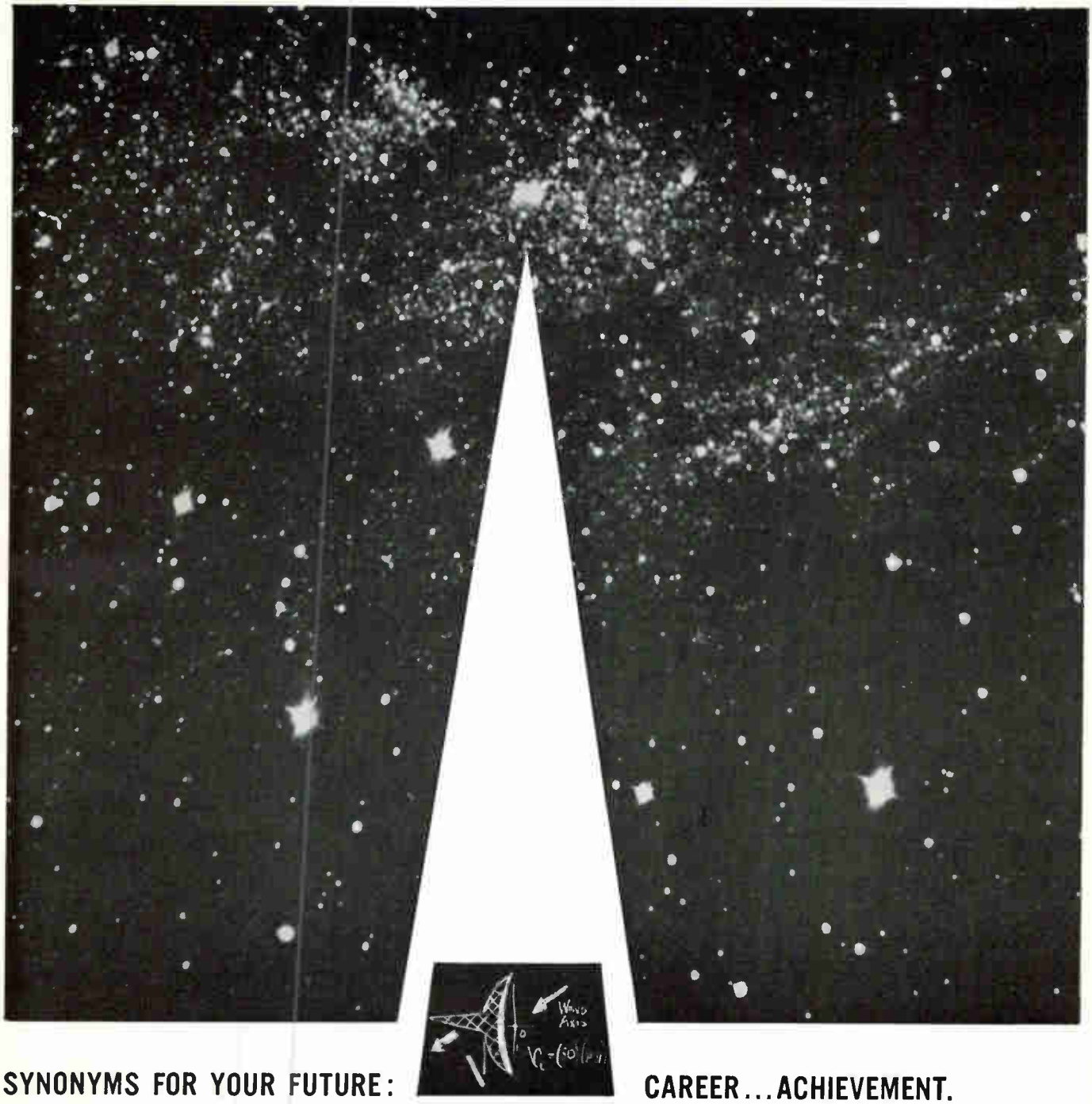
### CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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





## SYNONYMS FOR YOUR FUTURE: CAREER...ACHIEVEMENT.

Working at Philco Western Development Laboratories is synonymous with playing an important role in development of communications and control systems for the nation's frontiers of space. Philco WDL designed and produced the complete satellite package for the Courier Communications Satellite program; other important U. S. satellite programs benefited, too, from advanced technology, research, prototype and fabrication from WDL. This adventure . . . complete program-oriented evolution of tomorrow's answers to tomorrow's space age challenges... is yours, if you want a career that is measured in terms of achievement. Achievement is WDL's history . . . and future.

Write in confidence for information on how you can find your career at Philco WDL, with the additional rewards of ideal living on the San Francisco Peninsula and professional and monetary advancement commensurate with your own ability. Requirements include B.S. or advanced degree (electronics, mathematics, physics), U. S. Citizenship or current transferable D.O.D. clearance. Address Mr. Patrick Manning, Department E-11.

**PHILCO** A SUBSIDIARY OF *Ford Motor Company*

***WESTERN DEVELOPMENT LABORATORIES***

3875 Fabian Way, Palo Alto, California

an equal opportunity employer

7757

# PHYSICISTS & ELECTRONIC SCIENTISTS

The Scientific Research Staff at Republic Aviation is conducting a wide range of theoretical and experimental programs in electronics and guidance research, including a significant advance in nuclear gyroscopics.

Shown above is a prototype model of Republic's new "proton" gyro concept. Discussing its basic performance formulas are Mr. Alex Grumet, designer of the initial feasibility demonstration model, and Mr. Joseph Skala, who designed the advanced model in photo. Fundamentally, the gyro is a water-filled sphere subjected to a magnetic field. The only moving parts are spinning electrons and protons. A long-term investigation was initiated in this area by Republic in 1959. Recently the company was awarded a contract by the Bureau of Naval Weapons for further research and development of a practical magnetic induction gyroscope. It is expected to have a lower drift rate than the best existing gyros and cost far less.

Opportunities exist on this program for interested Physicists with PhD and experimental or theoretical experience in magnetic resonance or related field.

The Scientific Research Staff is supported by the excellent facilities of Republic's Paul Moore Research & Development Center, the most sophisticated aerospace research complex in the East. Appointments to the Staff are also open in these other areas of

## ELECTRONICS & GUIDANCE RESEARCH

**ELECTROMAGNETIC THEORY & ANTENNAS.** Involves several aspects of electromagnetic theory and antenna research. At the theoretical and experimental level, investigations are exploring broadbanding phenomena. Related studies concern a miniature antenna concept with characteristics equivalent to much larger units. Other work relates to electro-optics, effects of plasma on communications, electromagnetic means of determining vehicle attitudes, as well as the initiation of new research studies. Requirement: PhD (or MS working toward PhD) and heavy research experience.

**COMMUNICATIONS & GUIDANCE.** Research is being expanded in the areas of communications theory, displays, guidance subsystems and computer theory. Requirements: PhD in Physics or EE, capable of initiating such research.

You are invited to write in confidence to Mr. George R. Hickman, Professional Employment Manager, Dept. 11L-1.

**REPUBLIC**
**AVIATION CORPORATION**

**FARMINGDALE, LONG ISLAND, NEW YORK**
An Equal Opportunity Employer

## Electronics Laboratory Engineer

To supervise activities in a data acquisition and electronic data processing laboratory, and to design electrical circuits for special applications. Requires BSEE with 5 years experience related to analog wave analysis, telemetering systems and data acquisition systems, including Beckman 210.

This is a highly responsible position due to the increased activity at Bell. The varied programs include development of a lunar landing research vehicle, advanced AGENA engines, a multiple restart engine, jet VTOL transports, advanced GEM vehicles, and investigation of new concepts in battlefield surveillance systems and air traffic control.

Your inquiries are invited. Please send resumes to Mr. T. C. Fritschi, Dept. G10.

**BELL AEROSYSTEMS COMPANY**
DIVISION OF BELL AEROSPACE CORPORATION—A textron COMPANY

**P. O. Box #1, Buffalo 5, N. Y.**
An Equal Opportunity Employer

Engineering or Science Graduates
to be trained as
**INSTRUMENT SALES ENGINEERS**
with
**The Bristol Company**

Leading manufacturer of automation equipment and control systems requires men, preferably 25 to 35 years old, to sell high quality, nationally accepted products to wide variety of industrial markets.
Openings in various areas of the country. Successful applicants take comprehensive three-months course at headquarters. Salary and expenses
All replies confidential; every inquiry answered.
Write: Charles F. Johnson, Mgr. of Sales Training

**The Bristol Company**
Waterbury 20, Conn.
*An equal opportunity employer*

### *SELLING OPPORTUNITY WANTED*

**Established Manufacturing Representatives** desire additional OEM electronic lines. Complete New York State coverage except New York City. Excellent component contacts. Buffalo office. RA-9974, Electronics, Classified Adv. Div., PO Box 12, New York 36, N. Y.

### EMPLOYMENT OPPORTUNITIES

The advertisements in this section include all employment opportunities — executive, management, technical, selling, office, skilled, manual, etc.

Look in the forward section of the magazine for additional Employment Opportunities advertising.

— RATES —

**DISPLAYED:** The advertising rate is $40.17 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

**UNDISPLAYED:** $2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line. Box numbers—count as 1 line.

**Discount of 10%** if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

# If your potential is not being recognized...

. . . consider the excellent growth environment at NCR. Extensive company backed R & D; new facilities—expanding laboratory space in 1963 and 1964; advanced programs encompassing major sciences integrated for practical results; excellent employee benefits; an aggressive management group; professional advancement encouraged through company sponsored programs.

We have openings at this time as listed below for Dayton, Ohio.

- ☐ Senior Circuit Designer: familiar with solid state circuitry; creative; desire to work at advanced development stage.*
- ☐ Thin Film: materials research; device development.*
- ☐ Chemists-Research: project leader capability; background in physical chemistry; polymers.
- ☐ Test Equipment Design Engineers: BS or MSEE with some experience.
- ☐ Mechanical Design Engineers: Small mechanism experience desired.
- ☐ Advanced Development Planning Specialists—Military R & D.*
- ☐ Operations Research—Commercial applications.*
- ☐ Integrated Electronics—Advanced concepts for Computer Development.*

*These positions are not limited to any special level. Ph. D. background is preferred for many, and some areas of responsibility involve Management or Technical Director potential.

Don't wonder what may be present for you. Drop us a line describing your background and interests. We'll contact you to arrange for more detailed discussion.

Send your personal letter to:
T. F. Wade, Technical Placement
The National Cash Register Company
Dayton 9, Ohio

NCR

an equal opportunity employer

## 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 ⅞ 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).



### Searchlight Equipment Locating Service

***No Charge or Obligation***

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used Electronic equipment not *currently* advertised. (This service is for USER-BUYERS only.)

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

***Searchlight Equipment Locating Service***
**c/o ELECTRONICS**
**P. O. Box 12, N. Y. 36, N. Y.**

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

---

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

.....

NAME .....

TITLE .....

COMPANY .....

STREET .....

CITY .....11/2/62

# INDEX TO ADVERTISERS

Audited Paid Circulation



■

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.



INDEX TO CLASSIFIED ADVERTISERS



■

• See advertisement in the July 25, 1962 issue of Electronics Buyers' Guide for complete line of products or services.

# electronics

Audit Bureau of Circulations — Associated Business Publications

Audited Paid Circulation

**JAMES T. HAUPTLI**

**Advertising Sales Manager**

R. S. QUINT:
Assistant Publisher Buyers' Guide and Business Manager
FRED STEWART:
Promotion Manager
B. ANELLO:
Market Services Manager

RICHARD J. TOMLINSON:
Production Manager
GEORGE E. POMEROY:
Classified Manager
HUGH J. QUINN:
Circulation Manager

**ADVERTISING REPRESENTATIVES**

ATLANTA (9):
Michael H. Miller, Robert C. Johnson
1375 Peachtree St. N.E., Trinity 5-0523 (area code 404)

BOSTON (16):
William S. Hodgkinson, Donald R. Furth
McGraw-Hill Building, Copley Square, Congress 2-1160 (area code 617)

CHICAGO (11):
Harvey W. Wernecke, Robert M. Denmead
645 North Michigan Avenue, Mohawk 4-5800 (area code 312)

CLEVELAND (13):
Paul T. Fegley
55 Public Square, Superior 1-7000 (area code 216)

DALLAS (1):
Frank Le Beau
The Vaughn Bldg., 1712 Commerce St.
Riverside 7-9721 (area code 214)

DENVER (2):
J. W. Patten
Tower Bldg., 1700 Broadway,
Alpine 5-2981 (area code 303)

HOUSTON (25):
Joseph C. Page, Jr.
Prudential Bldg., Halcombe Blvd.,
Riverside 8-1280 (area code 713)

LOS ANGELES (17):
Peter S. Carberry, Ashley P. Hartman, W. C. Gries
1125 W. 6th St., Huntley 2-5450 (area code 213)

NEW YORK (36):
Donald H. Miller, Henry M. Shaw, George F. Werner
500 Fifth Avenue, LO-4-3000 (area code 212)

PHILADELPHIA (3):
Warren H. Gardner, William J. Boyle
6 Penn Center Plaza, LOcust 8-4330 (area code 215)

SAN FRANCISCO (11):
R. C. Alcorn
255 California Street, Douglas 2-4600 (area code 415)

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

FRANKFURT/Main:
Matthée Herfurth
85 Westendstrasse

GENEVA:
Michael R. Zeynel
2 Place du Port

***"Headquarters for Business Information"***

## McGraw-Hill Technical and Business Publications

American Machinist/Metalworking Manufacturing
Aviation Week and Space Technology
Business Week
Chemical Engineering
Chemical Week
Coal Age
Construction Methods and Equipment
Construction Daily
Control Engineering
Electrical Construction and Maintenance
Electrical Merchandising Week
Electrical Newsletter
Electrical West
Electrical Wholesaling
Electrical World
Electronics
Engineering Digest
Engineering and Mining Journal
E & MJ Metal and Mineral Markets
Engineering News-Record
Factory
Fleet Owner
Industrial Distribution
National Petroleum News
Nucleonics
Nucleonics Week
Platt's Oilgram News
Platt's Oilgram Price Service
Power
Product Engineering
Purchasing Week
Science Week
Textile World

Overseas only:
Automobile International (English, Spanish)
Ingenieria Internacional Construccion (Spanish)
International Management (English, Spanish Portuguese editions)
Metalworking Production (Great Britain)

Available by subscription only — to qualified persons actively engaged in the field of the publication. For subscription rates and information describing the editorial coverage of any of the above publications, write to: *Subscription Manager, Circulation Department, McGraw-Hill Publishing Company, 330 West 42nd Street, New York 36, N. Y.*

SPERRY microwave memo

# Sperry offers 60-day delivery on a low-cost K band reflex klystron

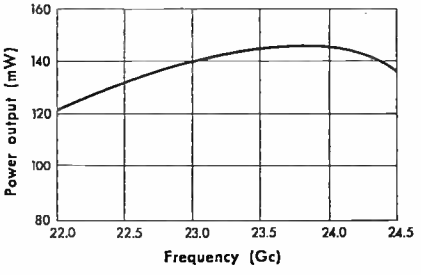
The SRK-291, a new low-cost K band reflex klystron oscillator offering dramatic cost savings in microwave systems, is now available from Sperry Electronic Tube Division within 60 days from receipt of your order! Sperry's new tube operates at frequencies ranging from 21 to 24.5 Gc. Within these frequency limits, it offers a 1½ Gc mechanical tuning range and a low temperature coefficient. The SRK-291 is priced at only $1495.

## PARAMETRIC PUMPING APPLICATIONS

The SRK-291 is specially suited to the requirements of parametric amplifier pumping, since its power output — 80 mW minimum — is more than adequate for parametric amplifier pumping demands. Its low price, wide bandwidth, and inherent stability remove the technical and economic limitations that formerly hindered the use of parametric amplifiers in many systems.

## OTHER APPLICATIONS

Sperry's versatile new tube also shows great desirability for application in short range communications systems, beacons, and microwave links. Extreme mechanical ruggedness, light weight (only 3½ oz.), and small size, make the tube ideal for airborne as well as ground-based installations.




SRK-291, typical P out vs. Freq.

## NEW, FREE BROCHURE

*A new, free brochure describes the capabilities of the SRK-291 in greater detail. For your copy, write to Sperry Electronic Tube Division, Sec. 147, Gainesville, Florida.*

Since the SRK-291 is available within 60 days, it represents an *immediate* solution to your present problems, whether you are designing a new system or concentrating on improved performance for an operational one. Cain & Co., which represents Sperry nationally, has a sales engineer near you. He'll be happy to help you work out specification details. Call him today.

SPERRY ELECTRONIC TUBE DIVISION

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

CIRCLE 901 READERS SERVICE CARD


## Now A Special New Industrial Nuvistor For Use With

# LOW-VOLTAGE POWER SUPPLIES

For the first time the proven advantages of the famous RCA nuvistor tubes are available in a type specifically designed for low-voltage operation. The new RCA-8056, designed to operate from a plate supply of between 12 and 50 volts, is suitable for a wide variety of industrial and military applications, including mobile and aircraft communications, employing low-voltage circuits.

The 8056 is recommended for use in low-noise rf and if amplifier circuits, control and multivibrator circuits, cathode-follower circuits, and in other special applications requiring a device having a high input impedance and capable of operating at low plate supply voltages. When used with a low-voltage power supply, the 8056 can provide high gain with low noise in small-signal amplifier applications at frequencies up to 350 Mc.

*Design advantages include:*

- Small size and light weight
- High input impedance to minimize impedance-matching problems
- Relatively high voltage gain (amplification factor = 11.5 in Class $A_1$ amplifier service)
- Low power drain
- Very high resistance to nuclear radiation fields
- Excellent stability
- Ability to withstand severe mechanical shock and vibration
- Exceptional uniformity of characteristics from tube to tube
- Stable operation over a wide thermal range
- Stable operation at any altitude

For full information on the 8056 nuvistor, talk to your RCA Field Representative or write: Commercial Engineering, Sec. K-19-DE-2, RCA Electron Tube Division, Harrison, N. J.

**TYPICAL OPERATING CHARACTERISTICS:**

| | | | |
|---|---|---|---|
| Plate-Supply Voltage | 12 | 24 | volts |
| Grid-Supply Voltage | 0 | −0.7 | volt |
| Grid Resistor | 33000 | — | ohms |
| Amplification Factor | 12.5 | 12.5 | |
| Plate Resistance (Approx.) | 1560 | 1560 | ohms |
| Transconductance | 8000 | 8000 | μmhos |
| Plate Current | 5.8 | 10 | ma |

**MAXIMUM CIRCUIT VALUES:**

| | |
|---|---|
| Grid-Circuit Resistance:[a] | |
| For fixed-bias operation | 10 max. megohms |
| For cathode-bias operation | 10 max. megohms |

[a] For operation at metal-shell temperatures up to 150°C.

**RCA ELECTRON TUBE DIVISION FIELD OFFICES**

**EAST:** 744 Broad Street, Newark 2, New Jersey
HUmboldt 5-3900

**MIDWEST:** Suite 1154, Merchandise Mart Plaza
Chicago 54, Illinois, WHitehall 4-2900

**WEST:** 6801 East Washington Boulevard
Los Angeles 22, California, RAymond 3-8361
1838 El Camino Real, Burlingame, California
OXford 7-1620

**The Most Trusted Name in Electronics**