electronics

A McGraw-Hill Publication 75 Cents February 8, 1963

READY FOR SKY HOOK

Three-ton telescope will dangle fifteen miles up, p 47

(photo right)

PHASE-LOCKING DEMODULATOR

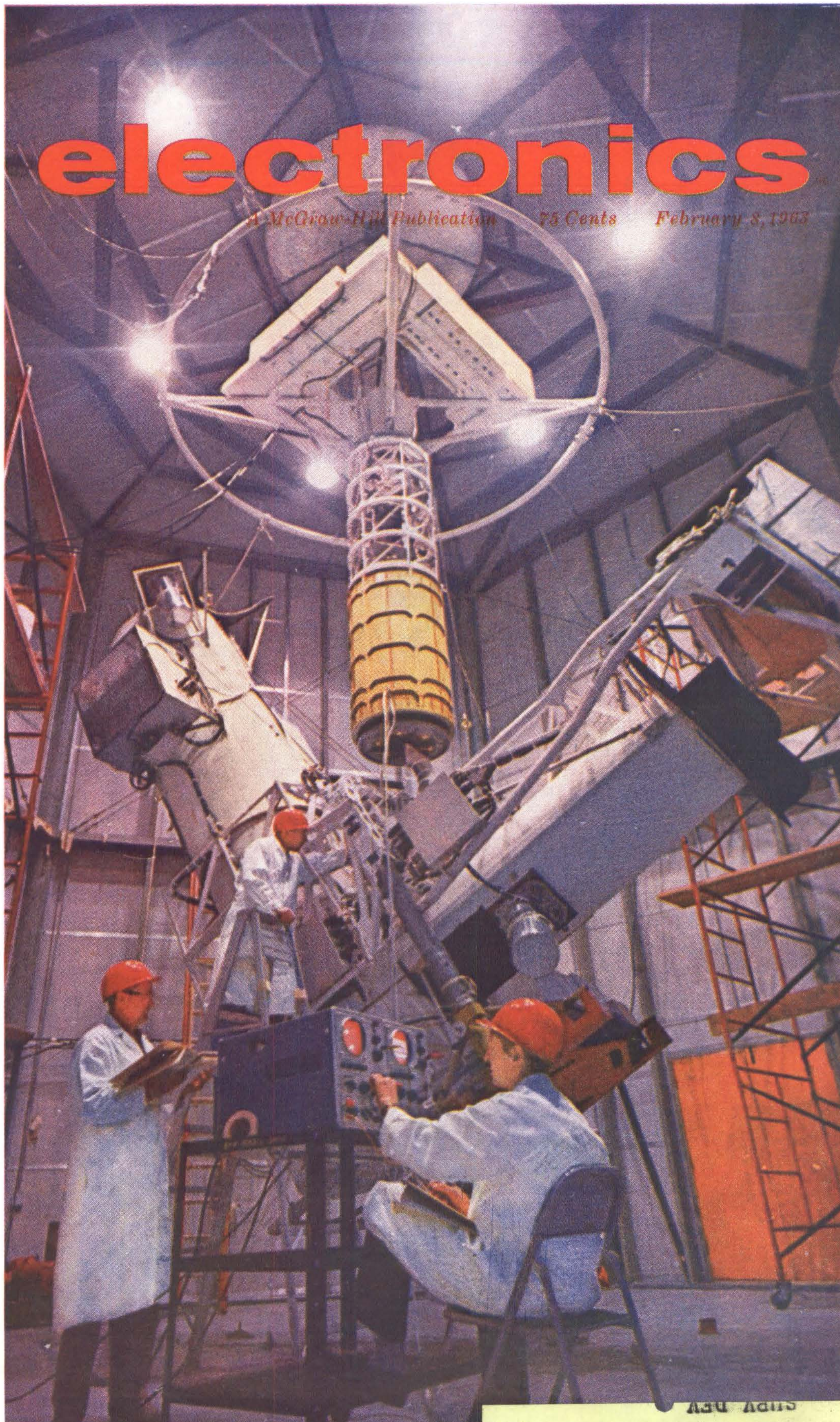
Telemetry unit rejects sidebands, p 52

BACK DIODE HELPS TUNNEL

Circuit reduces storage-time delays, p 56

CIRCULAR SLIDE RULE

Cutout device for noise calculations, p 64



Identical to 5243L except counts DIRECT TO 50 MC - $3,250.00

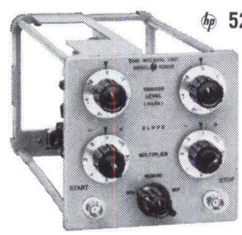
- Display storage for continuous readout
- Automatic decimal and units indication
- Frequency extender and time interval plug-ins
- BCD outputs
- 8 standard output frequencies
- Modular design—rack, stack or carry

NEW PLUG-INS INCREASE VERSATILITY AND PERFORMANCE OF BASIC COUNTER

hp 5253A 512 MC Frequency Converter

hp 5251A 100 MC Frequency Converter

These frequency converters increase the range of the 5243L Counter and retain counter accuracy. They plug in directly and are extremely easy to operate. The stability and accuracy of the basic counter is retained because the converters use a multiple of the 10 MC signal from the electronic counter to beat with the signal measured. So simple to use even non-technical personnel can make frequency measurements quickly and accurately. hp 5253A 512 MC Frequency Converter, $500.00; hp 5251A 100 MC Frequency Converter, $300.00.



hp 5262A Time Interval Unit

Converts the 5243L Counter into an accurate time interval counter with a resolution of 0.1 microsecond. Also can measure pulse length, pulse spacing and time between electrical events. Time is read directly on the counter with the units and decimal indicated. Also can be used as an amplitude discriminator for the counter. hp 5262A, $300.00.

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

SPECIFICATIONS

Registration: 8 digits in-line with rectangular Nixie tubes and display storage. Automatic decimal and units indication

Input Sensitivity: 100 mv rms, minimum

FREQUENCY MEASUREMENTS

Range: 0 to 20 MC (100 to 512 MC with 5253A plug-in; 20 to 100 MC with 5251A plug-in)

Gate Time: 0.1 μsec to 10 seconds in decade steps

Reads-in: KC or MC with positioned decimal point

Accuracy: ±1 count ± time base accuracy

PERIOD AVERAGE MEASUREMENTS

Range: Single period, 0 to 1 MC; multiple period, 0 to 300 KC

Reads-in: Sec, msec, μsec, with positioned decimal point

Accuracy: ±1 count ± time base accuracy ± trigger error/periods averaged

RATIO MEASUREMENTS

Displays: (f_1/f_2) times period multiplier

Range: f_1, 0 to 20 MC; f_2, 0 to 1 MC in single period, 0 to 300 KC in multiple period; periods averaged 1 to 10^5 in decade steps

Accuracy: ±1 count of f_1 ± trigger error of f_2 divided by number of periods averaged

Scaling: Factor, by decades up to 10^8, 0 to 20 MC, switch selected on rear panel

Time Base: Internal time base frequency, 1 MC

Stability, aging rate less than ±2 parts in 10^8/week. Less than ±3 parts in 10^9/day

As a function of temperature, less than ±2 parts in 10^{10} per °C from —20°C to +55°C

As a function of line voltage, less than ±5 parts in 10^{10} for ±10% change in line voltage from 115 v rms

Short term, less than ±5 parts in 10^{10} peak-to-peak with measurement averaging time of one second under constant environmental and line voltage conditions

Output Frequencies: 0.1 cps to 10 MC in decade steps, switch selectable at rear panel

Operating Temperature Range: —20°C to +65°C

Size: 16¾" wide x 5¼" high x 16½" deep

Weight: Less than 40 lbs.

Price: $2,950.00

hp

HEWLETT-PACKARD COMPANY

1501 Page Mill Road, Palo Alto, California, Area Code 415, DA 6-7000
Sales and service representatives in all principal areas;
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Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand Street, Montreal

CIRCLE 900 ON READER SERVICE CARD

Makes more measurements with greater accuracy than any other counter available today. New *hp* 5243L Electronic Counter

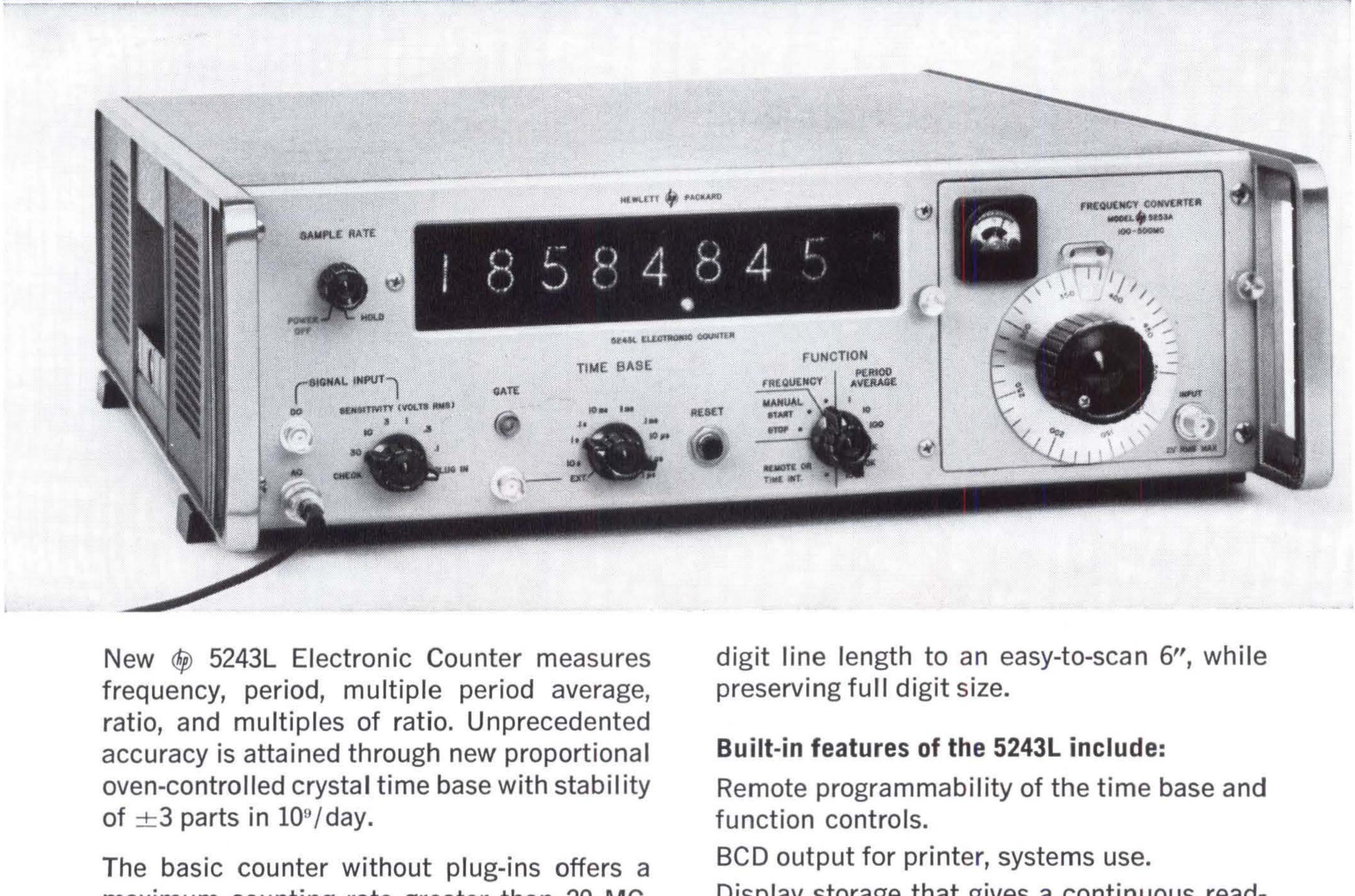
Actual size

- Measures frequency, time interval, period, multiple period average, ratio, multiple ratio, scales by decades
- Stability: 3 parts in 10^9/day; 5 parts in 10^{10}/short term
- Measures to 500 MC with plug-in, to 20 MC directly
- Solid state, just 5¼″ high including plug-ins
- Full storage display on easy-reading, close-spaced Nixies

TURN PAGE FOR DETAILS

NEW 5245L MODEL ALSO AVAILABLE!

- All solid state
- Just 5¼″ high with plug-ins
- $\pm 3/10^9$/day, $\pm 5/10^{10}$/short term stability
- 0.1 v sensitivity
- —20°C to +65°C operating range
- Remote programming



New ⓗⓟ 5243L Electronic Counter measures frequency, period, multiple period average, ratio, and multiples of ratio. Unprecedented accuracy is attained through new proportional oven-controlled crystal time base with stability of ± 3 parts in 10^9/day.

The basic counter without plug-ins offers a maximum counting rate greater than 20 MC, with 8 digit resolution. Plug-in units insert directly into the 5¼″ high modular cabinet and extend frequency measurements to greater than 500 MC. Completely solid state, the counter weighs less than 40 pounds with plug-in and can be carried easily in one hand.

Full display storage permits a continuous display of the most recent measured quantity, even while counting. The display changes only if the measured count changes thus permitting faster sample rates. Sample rate is adjustable and is independent of gate time. New, close-spaced rectangular Nixies reduce the 8 digit line length to an easy-to-scan 6″, while preserving full digit size.

Built-in features of the 5243L include:

Remote programmability of the time base and function controls.

BCD output for printer, systems use.

Display storage that gives a continuous readout and allows faster sampling.

Multiple period average to 10^5 periods for highly accurate low frequency measurements.

Operating temperature range from -20°C to $+65$°C for high accuracy under mobile, remote, or extreme environmental conditions.

Signal scaling 0 to 20 MC by decade factors up to 10^8.

8 switch-controlled standard outputs with time base stability, for local standard applications.

Space-saving modular design that racks in 5¼″, stacks on your bench, gives full access to removable etched circuit boards,

February 8, 1963

electronics

A McGraw-Hill Publication *75 Cents*

Contents Continued

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DEPARTMENTS

How to Improve Testing

THERE ARE FEW INDUSTRIES that do more testing and evaluation than the electronics industry. And there are few industries that waste so much time and money in these activities. An important reason is that electronics engineers generally have yet to appreciate fully the value of statistical techniques in setting up and evaluating experiments.

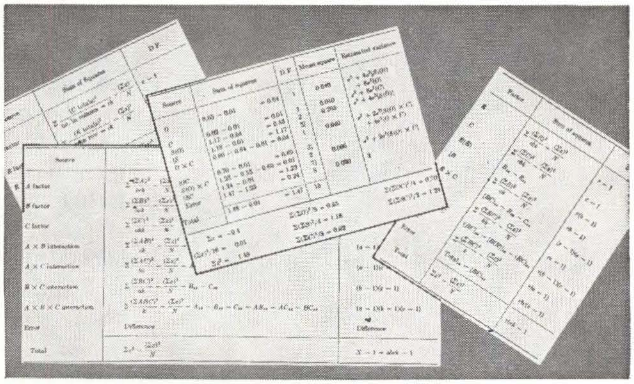
Although electronics engineers working in information theory or applications of quantum physics are indeed well versed in statistics, the average engineer has little appreciation of these very useful methods for coping with the inherent contrariness of nature. Thus some engineers will work out their circuits, carefully take readings with their trusty vtvms and then wonder why the circuits don't work next time they plug them in. Many circuits are not designed to cope with even slight changes in operating conditions.

More than forty years ago agricultural experiment stations began using statistically designed experiments to determine the effects of applying certain fertilizers, plowing to different depths or both. These and many other experiments have contributed in no small measure to our present-day agricultural-product surpluses that are the wonder of the rest of the world. At least twenty years ago, chemical engineers started to use statistical techniques with similar success in plastics and petrochemicals. Life scientists also have made good use of statistically designed experiments in developing new vaccines.

Many of the more vexing problems of the electronics industry—reliability of equipment and components, manufacture of microcircuits with uniformly high performance and good yield, more dependable communications—might be solved by intelligent application of modern statistical techniques.

Parameter-point estimation, tests of hypotheses, confidence limits, analysis of variance, correlation and regression, factorial designs, response surfaces and even nonparametric techniques are all powerful tools that belong in the electronics engineer's bag of tricks.

We are no longer fiddling around breadboarding relatively inexpensive equipment items. In the missile and space business particularly, experiments such as launching interplanetary probes or building huge and complex antenna systems are far too expensive for us not to get all the useful information possible out of every test.



TABLES *are from "Applied Statistics for Engineers," by William Volk (McGraw-Hill Book Co.)*

MINIATURIZATION has been a continuing goal of electronics engineers since the earliest days of our industry. As we all know, however, with the growth of solid-state technology the trend has accelerated in recent years so that now we are faced with a whole new technology of microelectronics.

We ran the first comprehensive technical report on this new art in our issue of November 25, 1960, and have since carried many articles on important developments in microelectronics.

Next week, we take another broad look at the field. We think you will find, as we did, that remarkable progress has been made. For one thing, some people didn't expect microelectronics to show up so soon in major equipments. Furthermore we found a wide awareness that success in this field will call for some new thinking by management and working engineers. For example, the device physicist and the circuit designer will no longer be able to remain separate.

On the technical front we found many significant trends, such as the stress on field-effect devices and phenomena. Next week's article highlights the new techniques, applications, design problems and research trends. We think you will find it "must" reading.

COMMENT

Electronics Markets

I want to congratulate you and your associates on the splendid wrap-up of the electronics industry's outlook for 1963 (Electronics Markets, p 43, Jan. 4).

The succinct yet complete analysis of the industry's prospects will, I am sure, prove most helpful to all those who look to ELECTRONICS magazine for assistance in their planning and projections.

JACK GALUB
Robert Mullen, Inc.
New York, New York

How To Win Students?

In reference to your Dec. 14, 1962, *Crosstalk* editorial (p 3), I agree the engineering curriculum is tough, but my biggest problem has been classroom semantics.

I've yet to get an instructor who knows how to put himself across to the students (E.E. classes at a local university). I'm impressed by their brilliance but certainly not by their grasp of basic teaching and psychological principles.

We need smaller, shorter classes and instructors versed in Dale Carnegie, or, at least, with some personality.

LARRY OSTERMAN
South Milwaukee, Wisconsin

Cameras Over Cuba

I read with interest your article, Electronically-Controlled Cameras Watch Cuba (p 20, Nov. 30, 1962). Unfortunately there was no discussion of the camera's electronic controls, the stabilized camera mounts that allowed the cameras to make extremely sharp photographs while flying at treetop level.

These mounts are installed in every major reconnaissance aircraft, including the U-2 and the RF-101 Voodoo, which are most probably the aircraft used in the reconnaissance missions recently flown over Communist Cuba.

The function of these mounts is to maintain the camera absolutely steady while the photographs are being taken. Vertical gyros and Schuler tuned earth's-rate pendulums provide position reference and sensitive servo systems maintain camera steadiness in roll, pitch and yaw.

The LS-19 Schuler tuned vertical reference, made by Aeroflex Laboratories Inc., senses verticality to within ± 1.5 minutes of arc rms, with a slow 84-minute period of oscillation. During camera exposure, this error causes a camera motion of only one or two seconds of arc, barely enough to disturb even the best photographic resolution.

IRVING A. GREENFIELD
Groody Avertising Co.
New York, New York

Sunflower Optics

In the article, Sunflower Optics: A New Concept in Color TV Display (p 33, Dec. 14, 1962), a theoretical illustration was given (p 36, top) of the fact that the luminance of a projection color display can be greater than that of an equivalent direct-viewed display. The following corrections should be made:

Delete π in Eq. 1 and 3.

Multiply the right side of Eq. 2 by Q and of Eq. 3 by $1/Q$.

In place of "The ratio of luminances . . . projection" (following Eq. 3), substitute:

"Typical approximate luminance ratios follow from Eq. 3. For a single-gun color display, $Q = 0.163$. This Q is the product of losses in luminance due to back-excitation of the phosphor (0.65), the duty ratio of the phosphor strips (0.5), and the lowered phosphor efficiency (0.5) necessary to achieve white balance. The ratio of projection to direct-viewed luminance is then 3.0 in favor of color projection. For aperture mask color displays, $Q = 0.11$. This Q is the product of aperture mask transmission (0.17) and back excitation (0.65). The luminance ratio is then 4.4 in favor of color projection. For monochrome, $Q = 0.65$ and represents the loss in luminance due to back-excitation."

In the second paragraph of column 2 of the box, delete "same" in "The same result . . ." and delete S in Eq. 4.

On p 37, under Luminance, change "1.5" to "3 to 4."

On p 38, first column, change "2,000" and "18.5 watts" to "5,200" and "42 watts" for a 23.6-inch diagonal screen. The mean wattages are 3 to 5 watts.

J. H. OWEN HARRIES
Harries Electronics Corp., Ltd.
Devonshire, Bermuda

MODEL CFI TRANSISTORIZED CALIBRATED MICROWAVE FIELD-INTENSITY (RI/FI) METER —1,000 to 10,000 MC.

Category A Air-Force Approval For MIL-I-26600 and MIL-I-6181. Transistorized, portable, compact, ruggedized.

Combines an impulse calibrator, field-intensity meter, and calibrated antenna system. Provides accurate measurements of the frequency and the absolute power level of conducted or radiated microwave energy. Choice of 12V battery or line-power operation.

FEATURES: UNIDIAL® tuning; Direct-reading digital frequency dial; ±1% frequency accuracy; Choice of 3 impulse bandwidths — 1 MC, 5 MC, wide band; Direct reading output level, microvolts, db above 1 microvolt and db above 1 microvolt per MC; Image and spurious response rejection better than 60 db; Max. RF input, 3 volts. Audio, video, recorder outputs. AM, FM, CW, and Pulse Reception Capability. Four interchangeable plug-in tuning units cover 1,000 - 2,040; 1,900 - 4,340; 4,200 - 7,740; and 7,300 - 10,000 MC.

MODEL FIM-2 CALIBRATED MICROWAVE FIELD-INTENSITY (RI/FI) METER —1,000 to 10,000 MC (Extension to 21,000 MC nearing completion)

Category A Air-Force Final Approval For MIL-I-26600 and MIL-I-6181. Widest frequency range ever offered in a microwave RI/FI meter!

Combines internal CW signal generator, field-intensity meter, and calibrated antenna system. Provides accurate absolute power level and frequency measurements. The signal level indication is in microvolts, db above 1 microvolt, and db above 1 microvolt per MC.

- Only microwave Field Intensity Receiver with self-contained CW signal generator which calibrates entire system under test at any level.
- First single microwave test system to determine radiated r-f interference and susceptibility.
- Front-panel meter directly reads average, peak, slide-back peak or quasi-peak value of r-f signals.
- Six interchangeable tuning heads cover 1,000 to 21,000 mc.
- Outputs for video, audio and recorder.
- Single UNIDIAL® tuning control simultaneously tunes the receiver and signal generator.
- Calibrated antenna system includes an omni-directional broadband antenna and separate directional antennas to match each tuning unit.
- Frequency Dial Accuracy: ±1%.
- Maximum RF Input: 3 volts
- Sensitivity: −81 dbm minimum
- Impulse Bandwidth: 5 mc
- Image and Spurious Response Rejection: Better than 60 db
- Attenuation: 0 to 80 db in steps of 1 db

HAVE YOU MADE RESERVATIONS YET?

Polarad's new "Project Mohammed" will be bringing the "Mountain" (our new Mobile Microwave Calibration Laboratory) to "Mohammed" (your microwave instruments) starting next month. 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!

How To Select An RI/FI Meter

In noise-and-field-intensity measurement, Polarad has three major competitors. They are all competent. They build good equipment. Give or take an adjective, they describe and rate their equipment accurately. We respect their designs, their equipment, and their integrity as manufacturers. We believe they return that respect.

As an engineer, you know that no two design groups ever produce exactly the same instrument for a specific purpose. Experience and backgrounds differ. Approaches differ. Even basic concepts differ. Then, too, each group has its own view of the needs of the user. In a complex design, one approach will favor sensitivity over bandwidth, or, perhaps, cost over durability. We all must draw the line somewhere, in reaching each design decision. In an RI/FI meter, there are dozens of such decisions. The final "mix" of characteristics is, at best, an intelligent compromise . . . never the ultimate.

We believe that the two instruments described on this page represent by far the best "mix" of performance, economy, and versatility for the majority of applications.

You don't buy an RI/FI meter every day. Once you buy it, however, you may use it every day, for many years. Therefore, we urge you to consider the "mix" carefully. Limited range or restricted utility may seem tolerable now, but what about next month, or next year? Initial cost may dominate your thinking now, but how much does an extra man-hour a day (or one questionable result a week) cost . . . over five years?

Consider the "mix". We think you'll choose Polarad.

We can't resist listing the outstanding features of our "mixes", below — but don't decide until you have the complete technical data in front of you.

Call your Polarad Field Engineer.

CFI "mix"

- Portable, Rugged, Compact
- Battery and AC Operation
- Direct Reading without Charts
- Directly Calibrated Long-Life Impulse Calibrator
- Digital Frequency Display
- —85 dbm Minimum Sensitivity
- 70 db Dynamic Range
- Standard Calibrated Horn Antennas
- Air Force Approved

FIM-2 "mix"

- Integral CW Generator for Accurate Calibration & Direct Substitution Measurements
- Separate Generator Output for Susceptibility Measurements
- Direct Reading without Charts
- —81 dbm Minimum Sensitivity
- Standard Calibrated Horn Antennas
- Air Force Approved

Which one is just right for you?

POLARAD

POLARAD
ELECTRONIC INSTRUMENTS
A Division of Polarad Electronics Corporation
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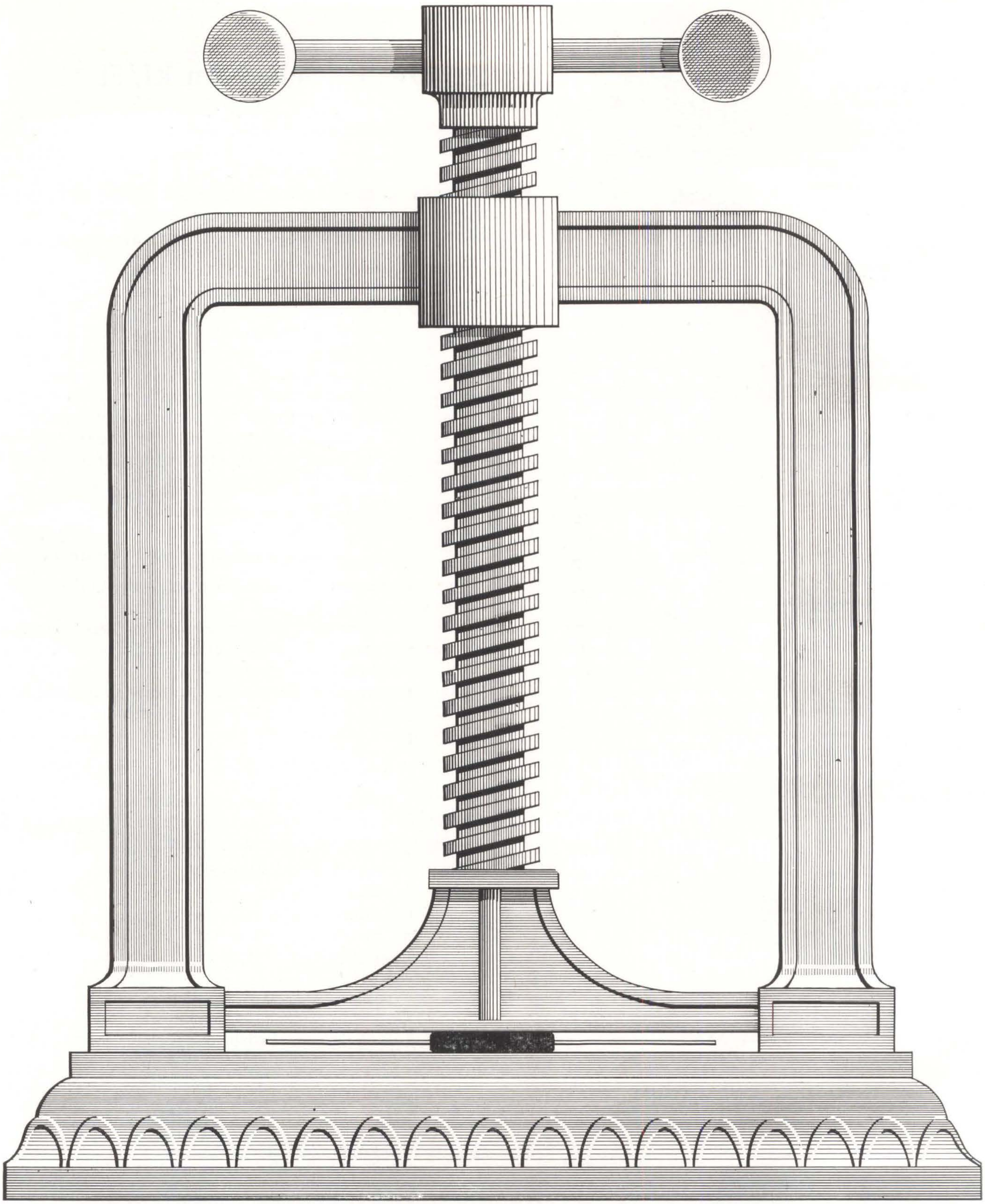

ffft There goes the air out of a Corning capacitor. It's pure enough to breathe, but in a capacitor it's a possible contaminant. We put the squeeze on this last measurable impurity when we fuse glass, foil, and leads together. Superimpose techniques like this on our ability to control the makeup of raw materials down to 0.00006 and you see why Corning capacitors give you superior stability and reliability. Ask your Corning distributor, or write us, for technical data sheets.

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ELECTRONICS
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3901 ELECTRONICS DRIVE, RALEIGH, N. C.

Stalemate Strategy May Level DOD Budgets

WASHINGTON—Defense Secretary McNamara last week underscored a shift in U.S. strategic thinking—that a state of mutual or stable deterrence is emerging. This could mean a leveling off new defense contracts in the near future.

He told Congress that "even if we were to double or triple" the size of U.S. strategic forces it could not "ensure the destruction of any very large portion" of Soviet nuclear striking power.

McNamara said military spending has reached a point of "diminishing returns"—another tip-off that some Pentagon officials see at least a plateau, perhaps even a downslide in new defense business in two years or so.

Military electronics procurement is leveling off in fiscal 1964 (p 18, Jan. 25), primarily because of the phasing out of bombers and completion of the Atlas and Titan missile programs and the early-warning radar lines.

The new strategy is reflected in decisions not to produce any more manned bombers, to cancel Skybolt and not to expand Polaris and Minuteman production beyond last year's goals. Contracts to complete the 41-vessel Polaris force will be awarded in fiscal 1964. Final Minuteman production is scheduled for fiscal 1965—150 more will be made in fiscal 1964.

The big question marks in the military electronics outlook are decisions still to be made on anti-ICBM's, antisubmarine warfare, military space, Army modernization and the Navy's ship modernization program.

If funds saved by trimming strategic retaliatory forces are diverted to these programs, the rapid rise in military electronics contracting will be resumed.

The new budget, McNamara explained last week, places a new emphasis on anti-ICBM development with a push for the Nike X system (see p 12), expands ASW efforts (funds are provided for a prototype of a new class of ASW destroyer escorts), and acceleration of Army modernization.

However, military space R&D continues at what Air Force considers to be very low gear and Navy's ship modernization program is deferred again.

Laser May Find New Role in Navigation

NEW TYPE of laser, apparently suitable for gyro applications, was to be demonstrated yesterday by Sperry Rand scientists. It is reportedly a radically new "closed-circuit" laser in which counter-rotating light beams are used to measure rate and degree of rotation of a vehicle. The Sperry group is predicting that the laser will provide a new method for stabilizing and navigating aircraft and space vehicles, missiles and ships.

Sensor Problems Sent Midas Back into R&D

WASHINGTON — Technical difficulties with infrared sensors were what forced the Air Force to revert its Midas early-alert satellite system back to the research stage (p 7, Feb. 1).

The sensors are to pick up blast-off heat signals from Soviet missiles to give the U.S. a 30-minute alert. The sensors are supposed to scan a wide sector of the ground as the satellite orbits across Soviet territory, locking on to any "hot spots" detected, according to sources close to the project. The sensors occasionally picked up the "hot spots," but have not locked on.

Air Force's Midas budget for fiscal 1964 is cut to some $30 million for further sensor research. The service is not expected to spend all of the $100 million appropriated for fiscal 1963.

Tracking Ship Troubles Delay Syncom Launching

DELAYS in checking out electronic equipment aboard the new tracking ship *USNS Kingsport* have postponed for one week the launching of Syncom I (p 28, Oct. 27, 1961; p 30, Aug. 17, 1962). It is now set to go up by Feb. 13 at the earliest.

Syncom, developed by Hughes, will mark the first U.S. attempt to place a satellite into 22,300-mile-high synchronous orbit. Unlike later models, the satellite will not appear to hover over one spot on the earth but will move in an elongated figure-8 pattern about 30 degrees north and south of the equator.

Syncom is designed for two-way voice, teleprinter and facsimile transmissions. Starting about five

Optical Computer Slated for Command Systems?

MILITARY command and control systems may be the first large-scale applications for computers using lasers and optical fibers. Command and control systems must handle large quantities of data rapidly. Extremely high speeds have been predicted for optical computers (p 7, Dec. 7, and p 30, Nov. 9, 1962).

Scientists and engineers working on laser computers stress that principles and effects are under study now, that hardware is still in the future. Much of this work is being done for Air Force.

Conventional lasers are being used in the feasibility studies, but injection diode lasers will be considered for systems because of their small size and low power requirements days after launch, Army personnel will attempt to use Syncom—to relay messages between the *Kingsport*, anchored at Lagos, Nigeria, and Lakehurst, N.J.

System Will Tune Out Telemetry Interference

CHICAGO—Self-adapting communications system being tested at Purdue University promises to tune distortion and interference out of telemetry channels.

Purdue's 7090 computer will be used to break up and process composite signal from a transmitter at Collins Radio, 290 miles away at Cedar Rapids, Iowa. The computer measurements will automatically tune the campus receiver to near-optimum reception. Purdue's transmitter will report channel distortions and interference back to Collins' receiver. Collins' transmitter will modify its subsignal patterns to compensate for the distortion or interference and this will trigger a new cycle of even finer adaptive tuning. The system operates at 900 to 1,000 Mc.

The team, headed by John Hancock, which developed the composite signal theory is also working on anti-jamming techniques.

Switch Reportedly Uses Dielectric Semiconductor

LONDON—Switching device said to employ a new dielectric-semiconductor material was unveiled here last week by Energy Conversion Laboratories, Detroit, and its British and Canadian licensees. Its properties closely resemble those of conventional back-to-back SCR's and *pnpn* switches.

Intended primarily for a-c power switching, the experimental unit is reportedly capable of switching up to 150 watts in microseconds. It can be triggered at a fixed threshold by an external triggering source, or in series with its load, by a rise in the a-c voltage. Resistance is said to be 100,000 megohms in the nonconducting state and 1 ohm in the conducting state.

At the press conference, little or no details were given on its construction (a wafer of the material between conducting plates), threshold levels, what prevents it from switching off during each cycle when the a-c voltage falls below the threshold, the dielectric switching action, nor the hysteresis characteristic.

British solid-state experts expressed surprise at claims made for the device. One said that field emission effects could account for the change in state, but that more facts are required for assessment.

Ikara ASW Missile Eyed by U. S. Navy

MELBOURNE—An unofficial source here says that the new antisubmarine missile, the Ikara, will compete with Asroc (p 28, July 8, 1960) for U. S. Navy use. It's adoption as a standard weapon by the British and U. S. navies is likely, he said. Range is reportedly 15 miles.

Officially, the Australian Defence Ministry has said the U. S. contributed $4 million to Ikara's development, that Ikara could deliver the U. S. Mark 44 torpedo and have twice the range of any known similar weapon.

The missile is guided by radar in helicopters, surface ships and submarines. Ikara will go on 3 new Australian destroyers. Ikara has passed its land tests and will be sea-tested within six months.

Stable Plasma Raises Fusion Reactor Hopes

NEW YORK—Stable plasma has been achieved at Oak Ridge National Laboratory, raising hopes for controlled fusion reactors. However, the other necessary condition, raising plasma temperature to about 100 million deg C, still requires much more work, Arthur H. Snell reported at the first meeting of the IEEE last week.

In the experiment, headed by R. A. Dandl, a foot-long copper cavity was placed between two mirror coils (p 47, July 14, 1961) and 5 Kw of power at 10 Gc was fed in through a waveguide. A visible ball of plasma was seen after deuterium gas was bled in a 10^{-5} torr. X-ray and 8-mm noise measurements gave evidence of plasma stability.

In Brief . . .

AIR FORCE is inviting industry proposals on medium-altitude communications satellite system development. A number of identical satellites would be placed in polar orbits. Proposals are due March 11.

TWO NEW COMPUTERS were introduced last week, the GE-215, a general purpose computer that can use programs of the larger GE-225, and the Minneapolis-Honeywell 1400, a business and scientific system. Monthly rentals are from $2,390 for the GE-225 and from $10,000 for the 1400.

TAIWAN will start exporting transistor radios this year, chiefly to Southeast Asia.

RICE UNIVERSITY has established a department of space science.

COMMUNICATIONS SATELLITE CORP. received its certificate of incorporation last week.

ALLIED RESEARCH ASSOCIATES and Baird-Atomic are planning to merge. Two subsidiaries of Allied Research are Aracon Laboratories and Mark Systems.

STANDARD KOLLSMAN has acquired The Grigsby Company.

NATIONAL SEMICONDUCTOR and Clark Semiconductor Corps. plan to merge.

BRAZIL'S RCA Victor has begun exports to Latin America Free Trade Area countries with a shipment of 20,680 tubes to Mexico.

MEMBERSHIP of the IEEE's Electronic Computer Group has reached 10,000. Group sees 20,000 membership by 1970.

IMPROVED Ship's Inertial Navigation Systems (SINS) will be put aboard 6 more Polaris submarines by Autonetics.

NASA'S Deep Space Network is getting a new 210-foot-diameter antenna that will permit communications with future Voyager spacecraft to the edge of the solar system, a factor-of-10 improvement in the net's capability. Rohr will install the antenna at Goldstone, Calif., for $12 million.

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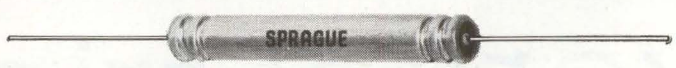
SOLID TANTALUM CAPACITORS
Meet Minuteman Goal April, 1962

...*AND NOW* HYREL® FT
FOIL TANTALUM CAPACITORS
NOVEMBER, 1962

SPRAGUE HYREL® FT FOIL TANTALUM CAPACITORS *SURPASS* MINUTEMAN PROJECT GOAL!



SPRAGUE successfully meets 2nd of two Minuteman targets, having previously achieved solid tantalum capacitor goal

Failure Rate Goal of .001%/1000 hrs.* has been bettered by wide margin!

Sprague HYREL FT Foil Tantalum Capacitors have exceeded Minuteman's component development objective, attaining a use condition failure rate of .00045% per 1000 hours in recently completed tests. Sprague's qualification to the Minuteman Foil Tantalum Capacitor Specification, like its earlier qualification to the Minuteman Solid Tantalum Capacitor Specification, is unrestricted and "across-the-board."

Backing this performance is Sprague's record of pioneering in highly reliable capacitors, which earned the opportunity to participate in the Air Force's Minuteman Component Development Program at Autonetics, a division of North American Aviation, Inc.

All of the special processes and quality control procedures that make HYREL FT Foil Tantalum Capacitors so reliable can now help improve the dependability of your military and aerospace electronic equipment. A tantalum capacitor engineer will be glad to discuss the application of these capacitors to your projects. For engineering assistance without obligation, write to Mr. C. G. Killen, Vice-President, Industrial and Military Sales, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

**at 60% confidence level by accelerated qualification tests.*

SPRAGUE COMPONENTS

CAPACITORS	INTERFERENCE FILTERS	HIGH TEMPERATURE MAGNET WIRE
TRANSISTORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
MAGNETIC COMPONENTS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	FUNCTIONAL DIGITAL CIRCUITS
MICROCIRCUITS	TOROIDAL INDUCTORS	ELECTRIC WAVE FILTERS

48C-483

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THE MARK OF RELIABILITY

CIRCLE 9 ON READER SERVICE CARD

HF oscilloscope GM 5600

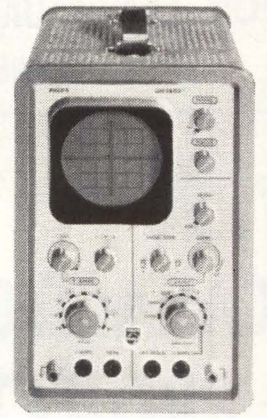
Y amp: DC to 5 Mc/s, sensitivity 50mV$_{pp}$/cm to 20V$_{pp}$/cm, acc 4%, rise time 70ns; attenuator probe 10:1 (10M Ω//8pF).
Time base: sweep speeds 0.5 μs/cm to 180ms/cm.
X amp: 5c/s to 2Mc/s, sensitivity 3V$_{pp}$/cm.
C.R.T.: 7cm tube, 1.6kV accelerating voltage.
Dimensions: 250 x 160 x 340mm.

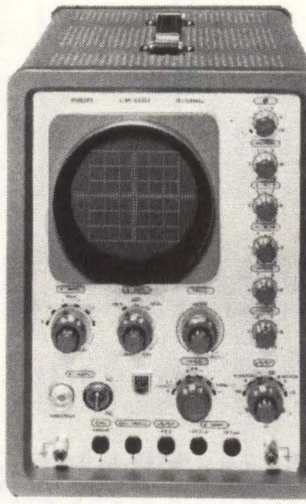
HF oscilloscope GM 5601

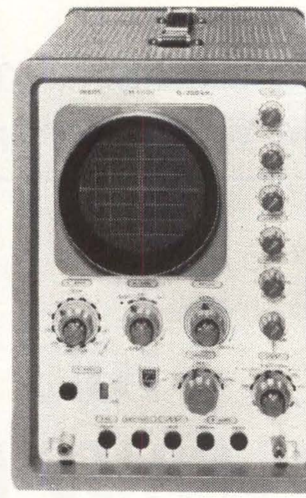
Y amp: DC to 5Mc/s, sensitivity 100mV$_{pp}$/cm, to 5V$_{pp}$/cm, acc 3%, rise time 70 ns; attenuator probe 10:1 (10M Ω//6pF).
Time base: sweep speeds 0.5μs/cm to 200ms/cm, acc 3%, magnification 5 x.
X amp: DC to 300kc/s, sensitivity 1V$_{pp}$/cm.
C.R.T.: 10cm tube, 3kV accelerating voltage.
Dimensions: 300 x 215 x 400mm.

LF oscilloscope GM 5606

Y amp: DC to 200 kc/s, sensitivity 100mV$_{pp}$/cm to 50V $_{pp}$/cm, acc 3%.
Time base: sweep speeds 2.5μs/cm to 1s/cm, acc 3%, magnification 5 x.
X amp: DC to 300 kc/s, sensitivity 1V$_{pp}$/cm.
C.R.T.: 10cm tube, 3kV accelerating voltage.
Dimensions: 300 x 215 x 400mm.







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XY oscilloscope GM 5639

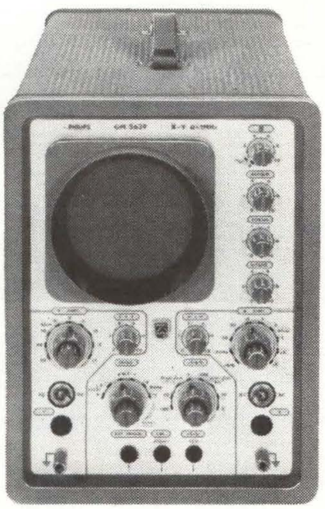
X and Y amp (identical): DC to 1Mc/s, sensitivity vert $100mV_{pp}$/cm, hor $200mV_{pp}$/cm, acc 3%, relative phase shift 2°.
Time base: sweep speeds 2μs/cm to 0.5 s/cm.
C.R.T.: 10cm tube, 2kV accelerating voltage.
Dimensions: 300 x 215 x 450mm.

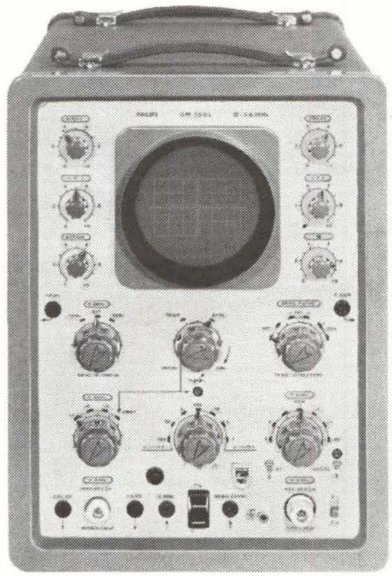
Wide band oscilloscope GM 5602

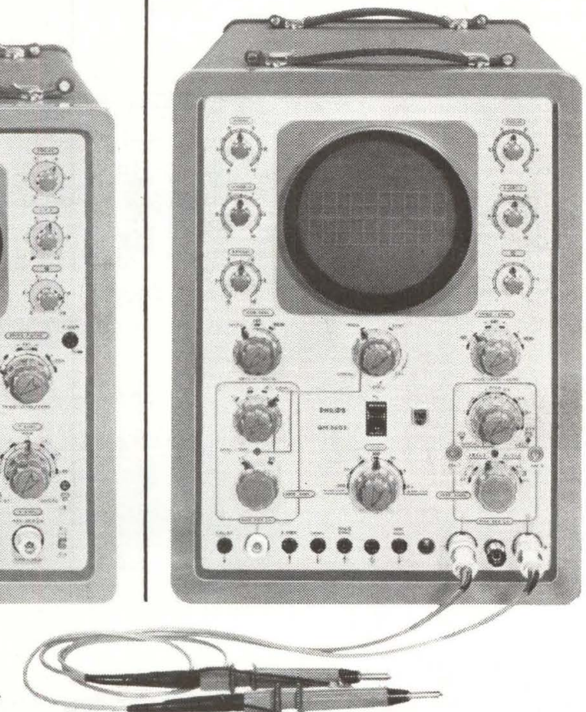
Y amp: DC to 14Mc/s, sensitivity $50mV_{pp}$/cm to $5V_{pp}$/cm, acc 3%, rise time 25ns, signal delay 300ns; attenuator probe 10:1 (10MΩ//8pF) DC coupled cathode follower probe 0.5M Ω // 6pF.
Time base: sweep speeds 0.2μs/cm to 1s/cm, magnification 2x, 5x.
X amp: DC to 1.8Mc/s, sensitivity $1V_{pp}$/cm.
C.R.T.: 10cm tube, 4kV accelerating voltage.
Dimensions: 370 x 270 x 530mm.

Wide band oscilloscope GM 5603

with differential input
Y amp: DC to 14Mc/s, sensitivity $50mV_{pp}$/cm to $5V_{pp}$/cm, acc 3%, rise time 25ns, signal delay 300ns, rejection 300x; 2 att. probes 10:1 (10M Ω//8pF); 2 DC coupled cathode follower probes 0.5M Ω//6pF.
Time base: sweep speeds 0.2μs/cm to 1s/cm, magnification 2x, 5x.
X amp: DC to 1.8Mc/s, sensitivity 1V $_{pp}$/cm.
C.R.T.: 13cm tube, 10kV accelerating voltage.
Dimensions: 400 x 300 x 600mm.







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The trigger performance of every Philips oscilloscope is of such high stability that it ensures a completely jitter free trace for any signal within its design specification.

Trigger facilities in the various models range from auto-triggering to very high stability circuits, requiring no external stability controls.

instruments: quality ***tools*** for industry and research

PHILIPS

WASHINGTON THIS WEEK

NIKE X AND SPRINT NOW RUSH-RUSH PROJECTS

HERE IS THE BACKGROUND on the Pentagon's decision to push development of the Nike X anti-ICBM system:

The Office of the Director of Defense Research & Engineering found that four major improvements could be made in the Nike Zeus system within the state of the art: (1) using Zeus discrimination radar as a high-volume, lower-accuracy target tracker; (2) modifying the Zeus missile to reduce the minimum intercept altitude; (3) developing a new higher-acceleration missile, Sprint (ELECTRONICS, p 12, Dec. 21, 1962), to increase available discrimination time, and (4) developing a new advanced radar to simultaneously acquire, evaluate and track numerous objects.

These major alternatives were considered: (1) continue development and test of the present Nike Zeus system and do limited development of the new radar, or (2) proceed with all four major improvements and deploy a system initially incorporating only the first two improvements. Both plans were scrapped. It was decided to skip the first two improvements and proceed on an "urgent basis" with development of Nike X—incorporating Sprint and advanced radars—and again deferring decisions to deploy the system and begin component production.

DO THEY HAVE A POLARIS?

NEW DEFENSE BUDGET allots funds for what Defense Secretary McNamara cryptically describes as "enhancing our detection and tracking capability against submarine-launched missiles." So far, Pentagon officials are mum about details.

LONG-TERM PROCUREMENT AWARDS TO CUT COSTS

MILITARY PROCUREMENT officials will soon be authorized to use a new "multiple-year buy" procedure. Purpose is to assure contractors of long production runs, so they can quote lower unit prices.

It will apply to fixed-price hardware (such as communications and electronic end items) bought competitively and produced essentially in contractor-owned facilities. It will not apply normally to spare parts procurement or when, for strategic reasons, the military wants multiple sources of supply.

Potential suppliers will be asked to submit two prices—based on a one-year production run and on a three-year run. The latter bid will include "maximum ceiling charges"—that is, termination payments for cancellation of production after one or two years.

The Pentagon assumes that the long-term unit prices would be lower since the contractor could amortize his tooling and other investment over three years without fear that a competitor would be selected after the first year for follow-on buys.

PENTAGON WILL BUILD THOSE UNDERGROUND COMMAND POSTS

DEFENSE DEPARTMENT has decided to go ahead with construction of an underground "post-attack command and control center" at an undisclosed site. Staffed by top-echelon officials and crammed with communications and computer equipment the center would function if a nuclear attack on the U. S. knocked out major military command and control installations. It would augment the airborne post-attack command and control system, KC-135 command aircraft and B-47's equipped as communications relay planes.

How Sylvania produced a 100-watt TWT in a PPM package...in only 4 months

Our microwave engineers pride themselves on being able to redesign an existing traveling-wave tube in a short time to meet new specifications of a customer. "Quick reaction," they call it.

In the case of our 100-watt CW X-band tube, the reaction took only four months—something of a record for a power increase of such magnitude. They started with a pulsed Sylvania tube of 10 watts average power, modified the internal structure, and incorporated a new helix design. The result is a whopping 100-watt CW output that system designers have been needing for ECM, long-range space communications, and special equipment for testing high-power components.

"Quick reaction" means being able to come up with fast solutions and render on-the-spot engineering assistance. And it requires production lines that can handle either long runs of standards or small runs of special-purpose tubes. That's exactly the way we are set up—a result of our work on the B-58 "Hustler" tube program.

Care to give us a try on your traveling-wave tube requirements?

Write to Microwave Device Division, Sylvania Electric Products Inc., P.O. Box 87, Buffalo, New York.

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A battery-operated rotating "whisk-er"? To replace the ever present whisk broom of the plate umpire? Hardly. It's part of the time-honored ritual of the game—to relax while the ump meticulously whisks every corner. That makes the elimination somewhat improbable.

Our point is this—your present design problem may seem just as improbable, just as the drill, shaver, mixer and other cordless products did a few years ago. But Gould-National research engineers developed a package of concentrated power using NICAD® Hermetically Sealed Rechargeable cells that helped to make these products a reality.

Have a design problem that could be solved with NICAD portable power? Write us, we may be able to help you solve your problem.

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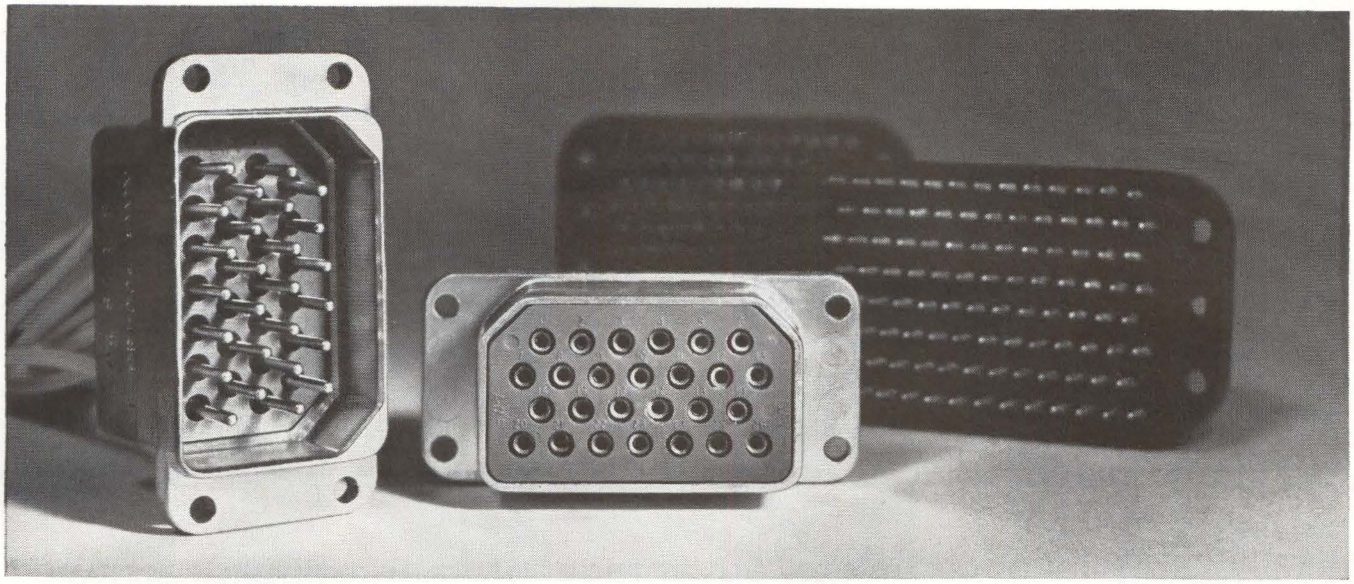
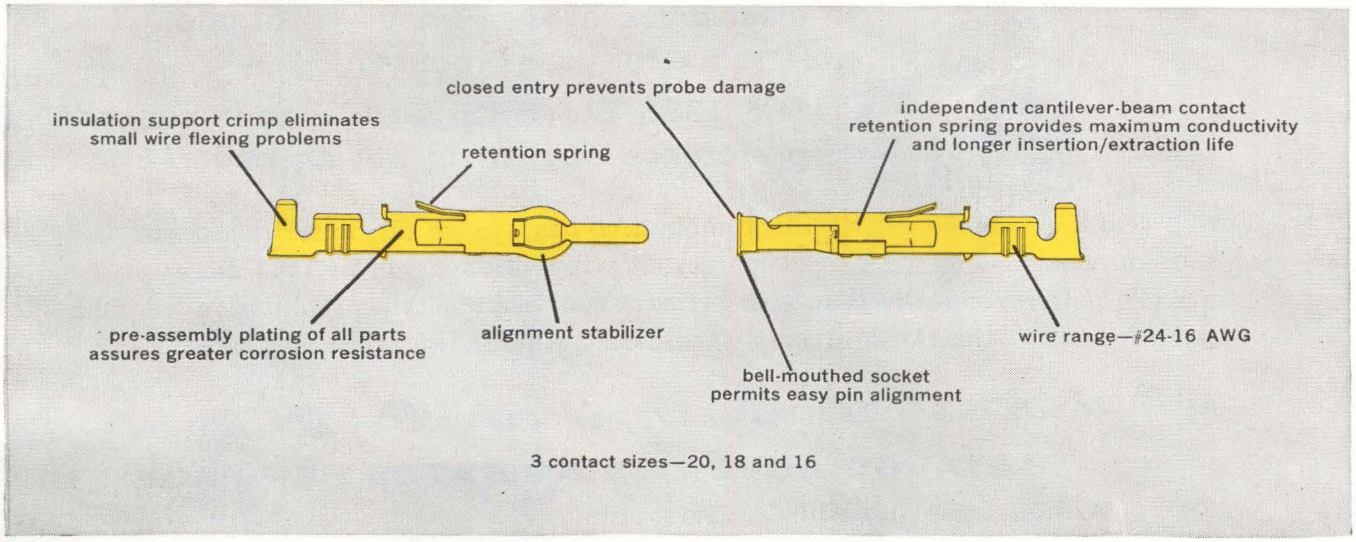


What's unique about these connectors?



This stamped and formed contact!

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

- performance characteristics conform to all dimensional and mechanical requirements of MIL-C-8384A.
- contacts are crimp, snap-in type for assured uniformity and quick, easy connector assembly.
- strip-mounted, reel-fed termination with our automatic crimping machine provides rates of 1,600 uniformly crimped contacts per hour.
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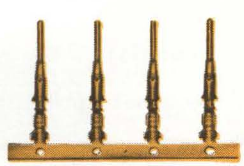
Put an end to solder-pot uncertainties, hit-or-miss connections, production slow-ups due to time-consuming inspection steps. Get consistently reliable connectors and at the lowest applied costs in the industry. Specify AMPin-cert TYPE III contacts. There is no equivalent! Write today for more information.



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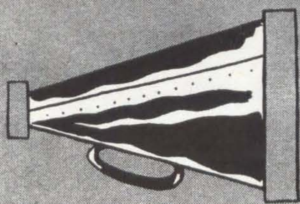
CIRCLE 15 ON READER SERVICE CARD



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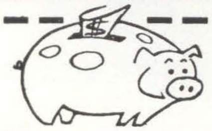

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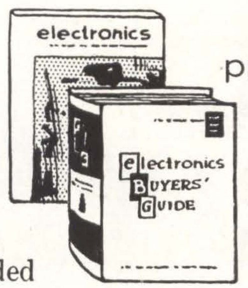

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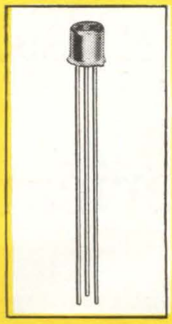

■ Operation to 150°C Ambient

■ 300 Nanosecond Turn-on Time

■ High Gate Sensitivity

NEW SILICON PLANAR CONTROLLED SWITCHES

Transitron announces a new series of low current silicon planar controlled switches in the TO-18 package with specifications and ratings exceeding anything now available. The stepped-up performance of these premium devices makes possible many new applications for controlled switches, especially where temperature and switching speeds are critical.

Now in full production, this series, 2N2679-2N2682, features 150°C ambient temperature operation with no voltage derating; 300 nanoseconds total turn-on time; extremely high gate sensitivity; plus the added feature of having all key parameters specified @ —65°C and 150°C wherever applicable.

Furthermore, the planar construction features extremely low leakage — 100 nanoamperes @ 25°C, 100 microamperes @ 150°C — thereby offering increased reliability. These new switches also offer increased current-carrying ability of 350 mA @ 55°C ambient and 75 mA @ 130°C ambient.

For further information, write for Transitron's "planar switch" bulletins.

CIRCLE 17 ON READER SERVICE CARD

2N2682 — 200 Volt Type[1]

Specification	Symbol	Min.	Max.	Units
Forward Breakover Voltage @ 150°C[2]	V_{BO}	200	—	volts
Reverse Voltage @ 150°C	V_R	200	—	volts
Forward and Reverse Currents @ 25°C[2] @ Rated Voltage @ 150°C[2]	I_S, I_R	— —	0.1 100	μA μA
Gate Current to Fire @ 25°C @ —65°C	I_{GF}	— —	20 100	μA μA
Gate Voltage to Fire @ 25°C @ —65°C @ 150°C	V_{GF}	— — 0.2	0.7 0.9 —	volt volt volt
Holding Current @ 25°C[2] @ —65°C[2]	I_H	— —	0.5 2.0	mA mA
Forward Voltage @ 200mA @ 25°C	V_F	—	1.25	volts
Turn-On Time @ 25°C	$t_d + t_r$	—	300[3]	nanosecs

1 30, 60, and 100 volt types are also available as the 2N2679, 2N2680 and 2N2681 respectively.

2 With 10K ohm bias resistance between gate and cathode.

3 For maximum limit of 300 nanoseconds, add suffix /A to type designation. For example 2N2682/A.

Transitron
electronic corporation
wakefield, melrose, boston, mass.

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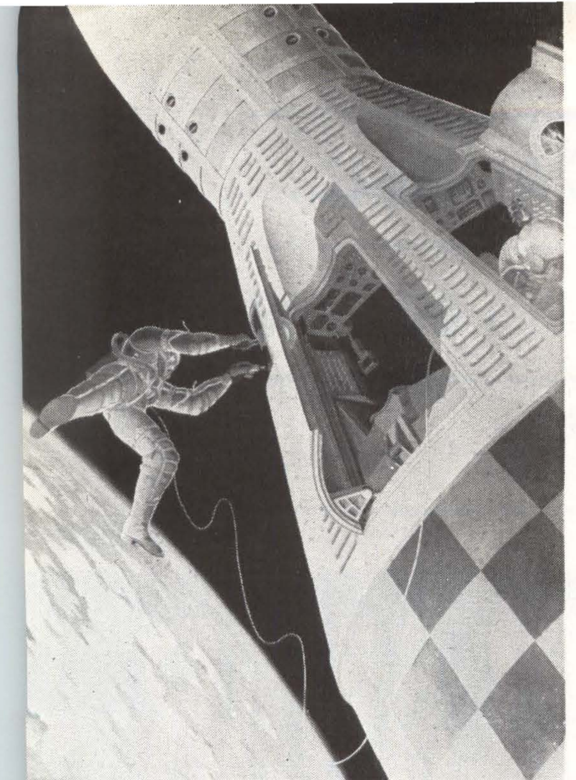
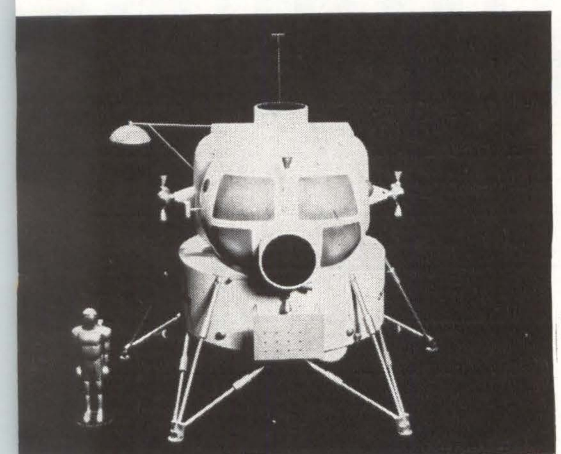
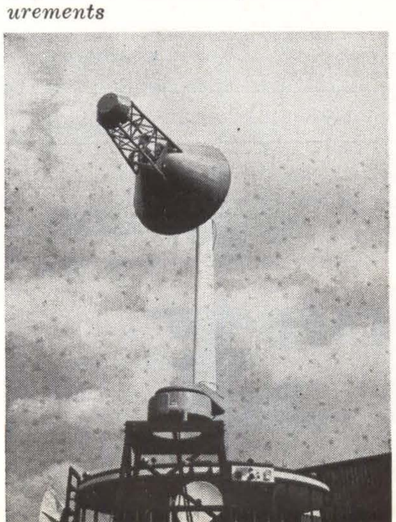


GEMINI SPACECRAFT *will provide a training ground for the astronauts. In this artist's conception, a crewman makes equipment repairs*



LUNAR *excursion module (LEM) is nicknamed "the bug." This model shows why*

SCALE MODEL *of Apollo on range rotator used by Collins Radio to facilitate antenna pattern measurements*



PROJECT APOLLO'S MISSION:

Get Two Americans to

Here are the latest details on electronic equipment to be used

By MARVIN REID
McGraw-Hill World News

HOUSTON—As early as 1967 or 1968, a huge Saturn rocket will lift off its launch pad at Cape Canaveral, Fla. Riding on the tip of this fireball, in an 80,000-lb spacecraft, will be three astronauts off on the most hazardous and expensive space journey ever undertaken by Americans. Their mission will be to go to the moon, make a landing and return home.

Here at the National Aeronautics and Space Administration's Manned Spacecraft Center (MSC), the success of this manned lunar excursion is the single major goal.

Electronics will play a major role, both in preliminary flights and in the big one.

There are two major programs leading to manned lunar flight: Project Gemini will test theories, systems and hardware; Project Apollo will conduct more tests, then make the big shot.

LUNAR MISSION—For the manned lunar mission, a lunar orbit rendezvous (LOR) technique is planned (ELECTRONICS, p 22, Aug. 3, 1962). A three-element spacecraft will first orbit the earth, then go to near the moon and orbit 100 miles above the lunar surface.

The spacecraft will consist of a lunar excursion module (LEM), propulsion module and command module. The astronauts will make the trip to lunar orbit in the command module. Two astronauts will land on the moon in the LEM while one continues in orbit in the mother craft. The two astronauts will explore the moon for one to four days, then relaunch the LEM, rendezvous with the main vehicle, and rejoin the third astronaut for the trip home.

Before such a mission is undertaken, much must be learned about rendezvous and docking, deep-space navigation and communications.

Experience in these requirements will be gained in Gemini flights, scheduled to start early next year. Equipment and other requirements for Gemini have been established, but some equipment decisions for Apollo are still not made.

Gemini, operating on a $700-million budget, is the intermediate step between Mercury and Apollo. One MSC official says: "If Gemini equipment will do the job for Apollo, much of it will be used."

Plans call for 12 flights of the two-man Gemini spacecraft, mostly in 1964 and 1965. The first will be unmanned to check out equipment. Others will be manned. Flights will range from 2 to 14 days.

For rendezvous and docking, an Agena D target vehicle will be launched separately into earth orbit.

ENVIRONMENT—Gemini spacecraft will resemble Mercury capsules, but will be twice as heavy and 20 percent larger.

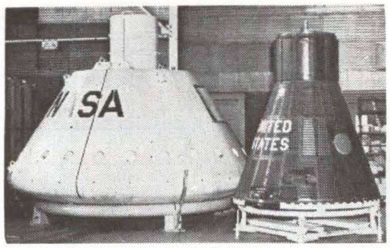
Most instrument packages will be housed in space between the crew compartment and the external surface. There will be more electronic gear on board to do more jobs than in Mercury, but not the complete redundancy of Mercury gear.

"We learned with Mercury," says Scott Simpkinson, technical advisor to the Gemini project manager, "that electronic systems are reliable if properly checked out."

Gemini astronauts will have much greater control of the flights. There will be less automatic control because Mercury proved man can

Gemini will have a fuel cell to function normally in space flights.

the Moon



COMMAND MODULE *of Apollo spacecraft will carry three men. Mercury capsule, at right, held one*

supply power, a guidance system, computer, radar unit, and a sophisticated communications system. The fuel cell, to be supplied by GE, can lose half its power and still supply the spacecraft's needs.

Cooling will have to be provided for the fuel cell and all electronic equipment will have to be mounted on cold plates. Gemini will also carry a 1.5-orbit-capability storage battery to supply power to get the craft home if the fuel cell fails.

COMPUTER—Another innovation will be an automatically programmed electronic computer that can be fed manually if necessary.

This 65-lb, general-purpose, binary, serial, fixed-point computer, being developed by IBM, can be programmed with 159,744 bits of information. It will have a 500-Kc clock rate, 250-Kc memory cycle, take about 1 cu ft of space outside the crew compartment, and will function on less than 100 watts.

The computer is primarily for rendezvous missions, but it can also determine at any time a reentry impact point and what flight corrections are needed to land at a desired point.

During rendezvous and docking the computer will figure the amount, direction and timing of thrust needed to automatically or manually guide the spacecraft toward the Agena D target vehicle.

After retro-firing during reentry, an external sensor will feed data so the computer can supply landing site information. The computer will be preprogrammed to continually work out retro-fire and landing data. However, variables can be fed into it manually through a keyboard.

RADAR—Gemini radar will have a range of up to 250 miles.

This 2-cu-ft, 60-lb, 100-watt unit will be used in rendezvous and docking. Locking onto the Agena's radar transponder, it will give bearing, range, distance closing rate and directional data until the two vehicles are 50 to 20 miles apart. Then, optical tracking will be employed.

GUIDANCE—Another Gemini system is a four-gimbaled inertial guidance platform similar to those aboard many military vehicles.

It can retain attitude reference in the event of spacecraft tumbling. The system will also serve for navigation during rendezvous, reentry and possible paraglider landing. It will operate with the general-purpose digital computer.

The inertial measuring unit which contains the platform is about 10 in. long, 8 in. wide, weighs about 130 lb, and requires 250 watts. It will be outside the crew compartment.

Other equipment on Gemini will include:

• Horizon sensors. Infrared-solid-state devices, they will provide pitch and roll information to the control system. Two will be needed, each a 10-lb, 250-cu-in., 7-watt unit.

• An automatic solid-state control system will fire attitude jets on orders from the computer. It will measure 600 cu in., weigh 20 lb and consume 10 watts.

• Also, an attitude and control interval electronics system (115 cu in., 5 lb, 15 w); a solid-state power inverter (110 cu in., 10 lb, 15 w); two rate gyros (80 cu in., 5 lb, 15 w each); and a solid-state timer (300 cu in., 10 lb, 5 w) accurate to ±1 sec a week. Mercury had a mechanical timer.

RADIO—One of the big jobs of the digital r-f command link will be to update the computer memory with digital information from the ground computer.

Telemetry will differ from Mercury, providing one-orbit storage capacity and playback, Simpkinson says. It will be a pulse-code-modulation system accurate to 0.4 percent, able to handle 300 parameters and with greater range than telemetry used on Mercury.

Collins Radio was a communications contractor for Mercury, also has Gemini and Apollo contracts.

CHECKOUT — A computer controlled check-out system for equipment and systems will be all new.

Simpkinson says this will be semiautomatic with an operator in control. The system will have 900 test parameters, and will "tell what part or what black box is bad."

A video cable will hook-up the capsule to the computer check-out system. The computer complex will be 10 miles away. Actual checkout will be done from a blockhouse viewing room. The system will have a 20-crt display system.

MSC says Gemini check-outs should require a little over 2½ months. Mercury often took 6 or 7 months.

The computer control check-out system will carry over into the Apollo program. Apollo check-out tests will start in the factory.

APOLLO—Apollo will draw heavily on Gemini flight experience, but will be a much bigger and more complex program. Equipment delivery will begin around mid-1965.

MSC officials, such as David W. Gilbert, chief of guidance and control for Apollo, say they are remaining flexible at this stage to take advantage of any breakthroughs.

Deep-space navigation, Gilbert says, "is the only thing we will have to do on Apollo that hasn't been done before," in guidance and control.

Astronauts on the lunar mission will have to make navigational measurements in flight, then feed the information into their computer so it can automatically make mid-course guidance correction maneuvers.

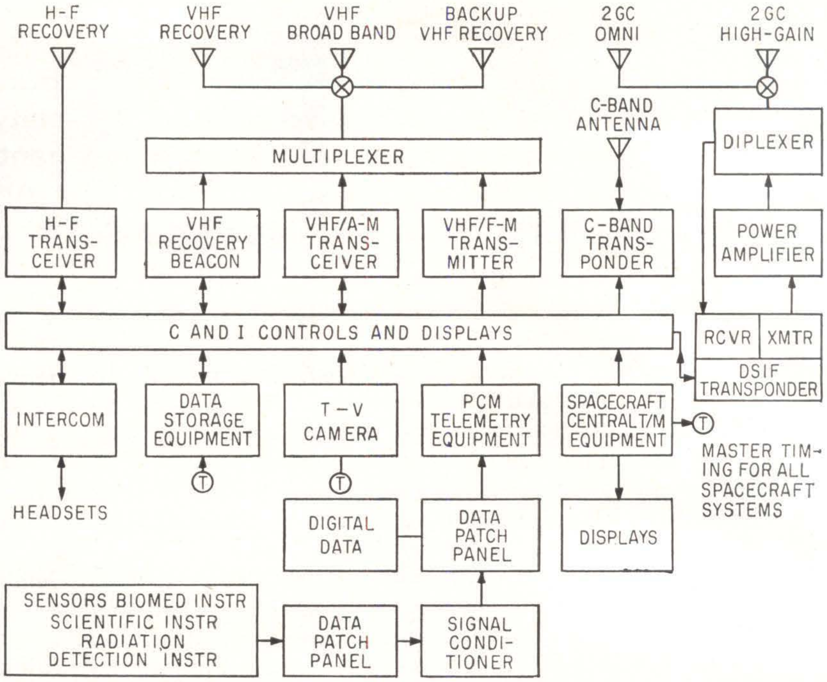
Apollo's optical instruments, such as space sextants and telescopes will be servo driven, but can also be operated manually.

Gemini equipment scheduled for Apollo includes the fuel cell, airborne computer, inertial guidance platform and radar. Most will be in both the command module and the LEM.

Apollo capsules will have more system redundancy than Gemini, although Gilbert says the number of spares is not yet determined.

Nor has it been decided just how much ground control will be provided Apollo missions. Chances are considerable ground control backup will be provided, but mission success will still depend substantially on functioning of on-board systems.

There will be an evolutionary series of tests on Apollo before its big mission—including both unmanned and manned rendezvous and docking practice with the LEM while in earth orbit.



COMMUNICATIONS *and instrumentation system hookups for Apollo, as proposed by North American Aviation*

PROCUREMENT: $20 BILLION-PLUS

HOUSTON—Putting two Americans on the moon will cost $20 billion to $40 billion. The Procurement Section at MSC, headed by D. W. Lang, handles the major contracts—most of which will have been placed by 1964.

There are six major buying groups: Apollo, Mercury/Gemini, Control Systems, General Research, Center Facilities and Construction, and Support.

The latest major contract is the $30-million one now being negotiated with Philco to develop and equip the $50-million mission control center. IBM is providing the computer complex, presently funded at $3 million.

Major Apollo contracts include: MIT, navigation and guidance; AC Sparkplug-GMC, ground support equipment, inertial guidance unit and integrating gyro, power servo assembly, and systems assembly and test; Raytheon, computer; Sperry Gyro, plus integrating pendulum for guidance, and Kollsman Instruments, optics. Fiscal 1963 funding for these contracts totals about $18 million. These are contracts handled at MSC.

Prime contracts for spacecraft are: McDonnell Aircraft, Gemini; North American Aviation, Apollo command and propulsion modules, and Grumman Aircraft, the LEM. Total funding for fiscal 1963 is $334 million

CIRCLE 21 ON READER SERVICE CARD→

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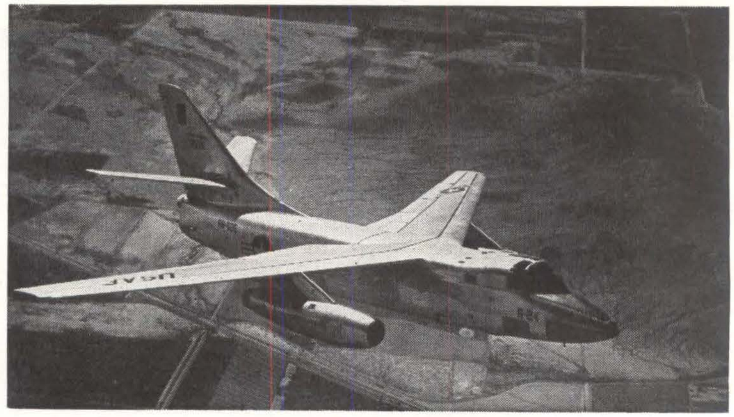


RB-66 DESTROYER. *This type of twin-engine reconnaissance jet was flown over Cuba by the Tactical Air Command*

Countermeasures Equipment Eyes Cuba

Atlantic Missile Range and Air Force planes hunt for missile sites

ELECTRONICS learned last week that electromagnetic analysis and countermeasures equipment used in Atlantic Missile Range operations and by the Air Force's Tactical Air Command (TAC) definitely were used for electronic surveillance of Cuba during the crisis last fall.

The information bears out previous indications (ELECTRONICS, p 20, Nov. 30, 1962) that data developed through electronic reconnaissance helped pinpoint the missile sites in Cuba for the camera planes.

Although a security lid has been placed over present operations, indications are that electromagnetic surveillance of that troubled—and troubling island—is still being continued and more equipment is being moved into the area.

Officials decline to comment on present operations. However, at his press conference two weeks ago, President Kennedy indicated that "daily" intelligence checks of Cuba are being made.

Missile range and TAC spokesmen have revealed to ELECTRONICS the standard ecm and analysis equipment that they use. More sophisticated equipment is in the works and is presumably being put to use as surveillance continues.

CAPE CANAVERAL — This sprawling test site and the whole Atlantic Missile Range (AMR) played an important but heretofore unsung part in the electronic reconnaissance and monitoring of Cuba.

Just how big a part AMR played is unknown, since officials are bound by security regulations.

AMR operations in such reconnaissance is headed by the Frequency Control and Analysis (FC&A) Branch, which monitors the r-f spectrum to detect any emissions which might interfere with missile testing at the Cape and along the 6,000-mile range.

Equipment operated by FC&A in normal missions is the same type of instrumentation used in electronic reconnaissance.

EQUIPMENT — This equipment includes the APR-9 electronic countermeasures receiver, capable of monitoring the electromagnetic spectrum from 1 to 10 Gc, and a companion unit, the APR-14, which covers 30 to 1,000 Mc.

Pulse analyzers are also used on the range. Although specific types were not revealed, there is a strong indication that the APA-74 pulse analyzer, a confidential piece of equipment, is in use by FC&A. The ALA-6 direction finder is also part of FC&A's operating gear.

There are two roving vans and one fixed station in operation at Cape Canaveral. The only downrange equipment admittedly in operation is a van at Antigua containing equipment "like" the APR-14 and APR-9.

When asked what "like" meant, an AMR official said: "Well, it's classified ecm equipment and all I can say is 'like' the APR-14 and APR-9."

The Antigua receiver goes to 10.7 Gc. Some of the equipment has been modified by the use of traveling-wave tubes in the front end and with parametric amplifiers. All equipment operates within about 4 to 6 db.

In addition to the ground stations, FC&A has five range aircraft at its disposal that are outfitted with the same equipment as the ground stations. Some of the latest passive ecm equipment is being used on the range.

DATA GATHERED—The type of information derived from incoming signals by the pulse analyzers probably includes: bandwidth, signal-to-noise ratio, antenna polarization and beamwidth, and modulation type as well as percent amplitude modulation, f-m derivation, duty cycle, analog determination of pulse repetition frequency, number of frequency multiplex channels, pulse width, pulse repetition frequency, pulse intermodulation and pulse group count.

As one range official put it: "You can practically see the equipment transmitting the signal."

AIR RECONNAISSANCE—Tactical Air Command uses a number of the equipments employed by AMR. Confirmation that TAC aircraft also participated in the Cuban reconnaissance operation was received last week, but TAC will discuss present operations only in general terms.

The Douglas-built RB-66C Destroyer is the workhorse of TAC's 9th Tactical Reconnaissance Squadron electronic reconnaissance missions. Other versions of the plane are also used for photo and weather missions.

The RB-66C carries four electronic warfare officers (EWO) in addition to the basic three-man crew. Each EWO monitors a specific frequency band. EWO's are generally navigators with added, intensive training in electronic detection.

Their primary mission is to monitor, ferret and pinpoint the location of hostile radar and other electronic systems.

Ferreting equipment on RB-66C's includes the APR-14, APR-9, ALA-6, APA-74, and the ALA-5 pulse analyzer and the ANH-2 wire recorder.

With the equipment, such information as type of radar, frequency, range and use can be obtained. Analyzed and plotted on map overlays, the information becomes the basic source of intelligence for establishing and maintaining an up-to-date hostile electronic order of battle.

AIRLIFT — During the Cuban crisis Rome Air Development Center airlifted electronic equipment to the crisis area. RADC aircrew and maintenance personnel remained on the alert during the Cuban quarantine and made many additional flights to crisis areas.

Rechargeable Batteries Power New Appliance

CHICAGO—Flameless lighters and portable mixers, as well as cordless electric shavers, were the newest consumer products powered by nickel-cadmium batteries at the Chicago housewares show.

The lighter, introduced by Gulton, is said to light 3 packs of cigarettes on one charge. Similar batteries will power an a-m—f-m transistor radio the company plans to introduce this summer.

A battery pack built into Sunbeam's portable Mixmaster is reported to be rechargeable for the normal life of the appliance.

Air Force Revamps Computer Procurement

Selection of edp systems centralized in new office

BEDFORD, MASS.—The computer industry's biggest single customer —USAF—is revamping its shopping habits.

From now on, choosing computers to fill Air Force needs, domestic and foreign, will be centralized at the new EDP Equipment Office, Hanscom Field.

Expected to be operational in March, the office will have a staff of 46. Computer manufacturers will be briefed on the office February 27.

The new operation is headed by Col. Edward McCloy, formerly chief of data system planning in the Logistics Command at USAF Headquarters. He will direct selection procedures for computers costing a total of $125 million a year.

Air Force now rents most of its "off-the-shelf" computers, but this is expected to be changed by a recent Bureau of the Budget edict.

Manufacturers can be expected to set up liaison offices in the Boston-Bedford area, in some cases shifting the emphasis from user command areas.

BUYING POLICIES—Assignment of the EDP Equipment Office to Hanscom Field means that the Electronics Systems Division (ESD) becomes the focal point for virtually all Air Force procurement for edp equipment above the punched-card, accounting-machine level.

ESD, development center for command-control systems, already had supervision over scientific and control type systems.

The office will follow standard procurement policies on announcement of system specs and invitations to bid. Awards will be made by a source selection board headed by McCloy. Exceptionally large contracts may be awarded by a USAF Headquarters board acting on a recommendation from Bedford.

The edp office will not negotiate price. Prices for "off-the-shelf" computers sold or rented to a government agency are negotiated by the General Services Administration. USAF Headquarters will still decide if a user command should have a computer.

OTHER GOALS—Goals of the new selection system include:

- Standardizing management-type edp systems within the Air Force
- Objective evaluation and selection by an experienced staff
- Providing industry with a single point of contact in the Air Force
- Developing an in-house staff familiar with state-of-the-art and able to project long-term needs of user commands.

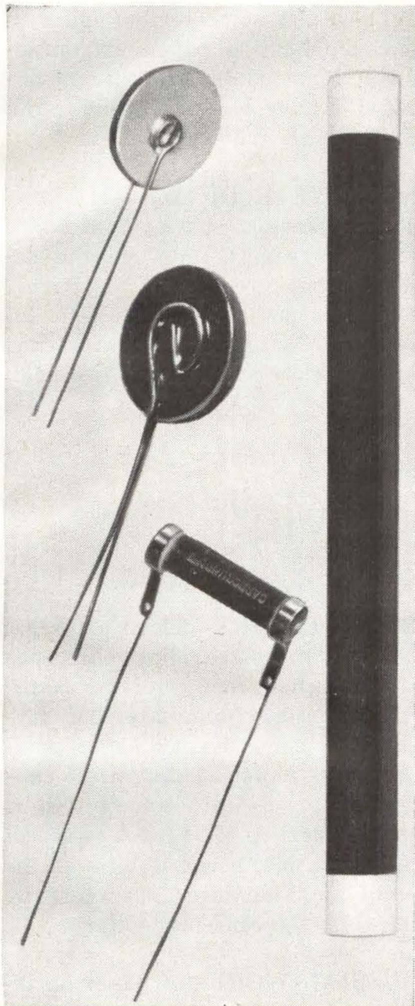
The edp office will periodically brief computer designers and makers on present needs of user commands, future Air Force requirements and directions in which R&D should move. It will probably be a computer information center.

Tracking Twins

TRANSMITTING *and receiving dishes for Goddard Range and Range Rate System that Motorola is building for NASA are set up for tests. System, also including vhf array, is for space tracking*

ELECTRONIC PRODUCTS NEWS BY CARBORUNDUM

NEWS



New $1½ million electronic facility marks spectacular Carborundum development program

Almost doubling the size of the original plant, a new addition to Carborundum's electronic product manufacturing facilities is now in operation at Niagara Falls.

The new facility provides for greatly increased production of the line of non-metallic resistors, thermistors and varistors. It will also allow for greater diversification resulting from new products developed out of Carborundum's extensive research in solid-state materials, particularly for high temperature applications. Several significant developments in this field are expected to be announced shortly.

Modern manufacturing facilities provide for improved quality control, aimed at precise reproducibility of physical and electrical characteristics of all electronic products. Expanded technical services will be available to assist in the solution of industry problems.

If your product could benefit from application of symmetrical varistors, positive or negative temperature coefficient thermistors, or high temperature ceramic resistors, write for technical data to Dept. ED-12G, Electronics Division, Carborundum Company, P. O. Box 339, Niagara Falls, New York. For evaluation or quotations covering your particular application, please include the necessary particulars.

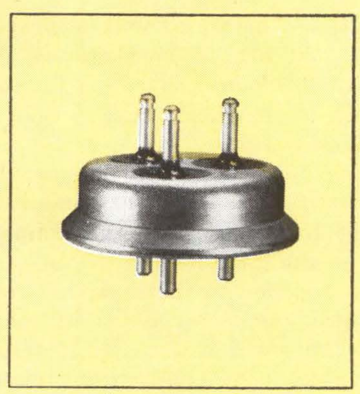
Heavy duty glass-to-metal seals pass stringent tests . . . 2½ million without rejects!

The heavy duty seal illustrated is one of hundreds of types manufactured by Carborundum's Latrobe Plant, for use in electrical and electronic components. This particular example is a refrigerator seal. It must withstand wide swings in temperature and seal against refrigerant leakage.

Quality control checks include cyclic testing for thermal shock resistance from freezing to 500F., resistance to gas leakage at 350 psi and a flash-over test at 2500 volts. Despite these requirements, 2½ million have been supplied to the refrigerator industry without a single reject. Automated production equipment keeps costs of these seals exceptionally low.

Typical of other critical hermetic sealing applications solved with Carborundum's metal-bonded ceramic-to-metal assemblies and metal-bonded ceramics are those involving space capsules and guided missiles, pressure vessels, canned nuclear pumps, thermopile lead-thrus, nuclear reactors, and housings for silicon and germanium rectifiers.

Carborundum's Latrobe plant specializes in all types of glass-to-



metal and ceramic-to-metal seals. For helpful suggestions in solving a variety of difficult sealing problems, contact Dept. ED-12S, Electronics Division, Latrobe Plant, The Carborundum Company, Latrobe, Pennsylvania.

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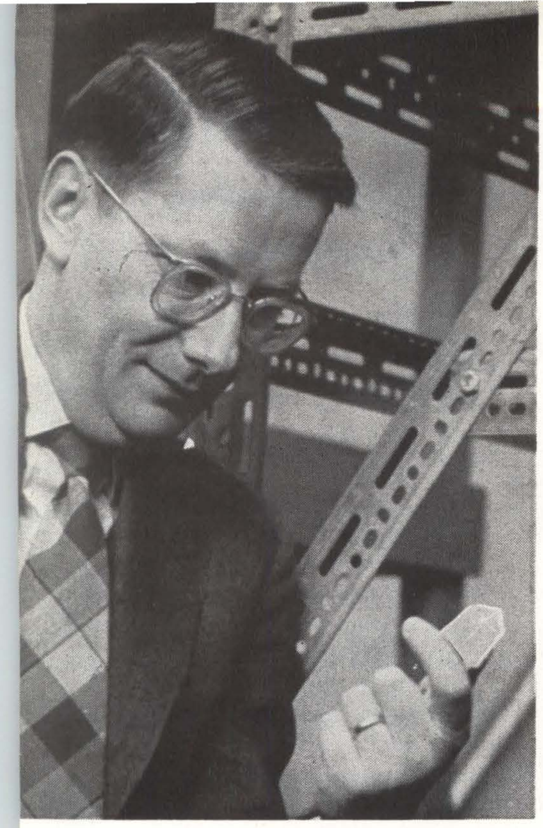


Optical Techniques Will

Scientific program chairman comments on conference's new look

BOSTON—That major emphasis in quantum electronics has moved into the optical region will be driven home next week at the Third International Conference on Quantum Electronics, in Paris.

MAN AND CRYSTAL. *One of the pioneers in the solid-state maser, Prof. Nicolaas Bloembergen is now investigating the properties and behavior of crystals in maser beams*

"This shift to the optical area is the most significant feature of the 1963 program," Prof. Nicolaas Bloembergen, chairman of the scientific program, told ELECTRONICS.

There are some review and systems application papers on microwave, reported the Harvard physicist, but microwave "is really in the realm of technical operations."

NONLINEAR OPTICS—The only double session at the conference (for program details see the accompanying report from Paris) will be on nonlinear optics. The advent of coherent light sources has focused more attention on this field.

Are Masers Going Out of Style?

Here's a quick preview of Quantum Electronics Conference highlights

PARIS—The maser will be practically old hat to speakers at the Third Quantum Electronics Conference, to be held next week at UNESCO House here.

The 150-odd papers screened by the conference scientific committee point to an overwhelming emphasis on the laser.

In addition to these papers, conference goers—estimated at more than 700—will hear nearly 50 state-of-the-art lectures by world-ranking experts. They will sum up quantum electronics theory as it stands today, plus potential applications. Two lectures on phonon masers, the coherent-sound branch of the maser-laser family, should attract considerable attention.

LASERS—Much of the work to be reported is directed at developing practical radar and communications hardware using the laser. This accounts for a strong accent on nonlinear optics, key to demodulation of coherent light.

Among demodulation techniques that conference goers will hear about are second-harmonic and third-harmonic generators based on crystals such as calcite and cadmium sulfide.

One paper, for example, describes third harmonic generation in calcite from 0.2-joule/30-nanosecond output pulses from a ruby laser. Still another paper reports the development of f-m/a-m optical frequency converters with traveling-wave phototubes as key components.

RECEIVERS — Several reports cover superheterodyne optical receivers. Underlying principle—mix modulated coherent light with a local laser oscillator to get a microwave beat frequency suitable for a conventional microwave receiver. Beat techniques have also made possible single far-infrared (160-micron wavelength) pulses from a laser, a British paper indicates.

Along with modulation and demodulation, methods for propagating coherent light will come in for a lot of attention. A variety of light pipes will be described.

DIODE LASERS—Third principal field of interest at the conference is research in new laser materials.

Here, theory dominates but nevertheless some devices using semiconductor materials for direct conversion of d-c into coherent light should turn up. A French research team, for one, hopes to have an indium arsenide laser operating by the time the conference starts.

RUSSIAN WORK—A paper on inverted population in semiconductors has been invited from Russia. Researchers at the Academy of Sciences in Moscow, have also reported advanced work with gallium arsenide, but apparently had not yet achieved laser action.

One of the contributed-paper slots, on Friday, is reserved for post-deadline papers of exceptional interest. It should provide the setting for some late announcements on gallium arsenide and other semiconductor lasers, since the first successes with these in U. S. labs came after the conference paper deadline.

Immediately after this session, the conference will close with a summing up, by C. H. Townes, of MIT.

Star at Paris

Bloembergen emphasizes the possibilities of developing nonlinear optical devices that run the gamut of r-f and microwave devices.

"How many of these devices will be practical and useful is another matter," Bloembergen said. "But the general theory supports the existence of nonlinear processes in the optical as well as other parts of the spectrum."

"Modulators, demodulators, harmonic generators, subharmonic generators, parametric amplifiers of all kinds—these can be built in the light region."

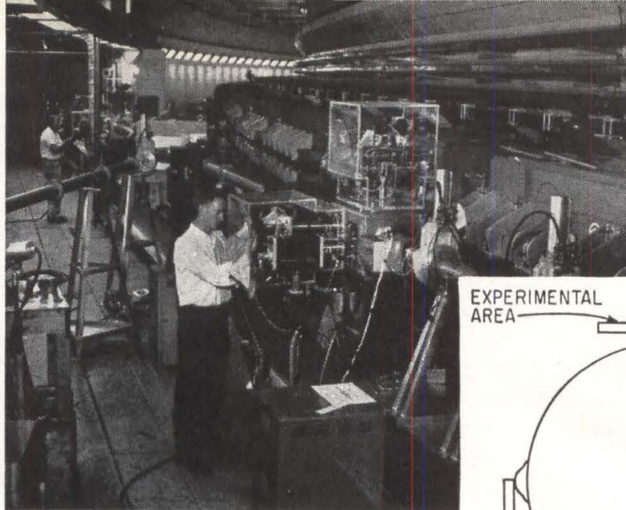
If light waves are to be used for communications, nonlinear elements will have to be engineered and the propagation of light waves in various media explored, he pointed out.

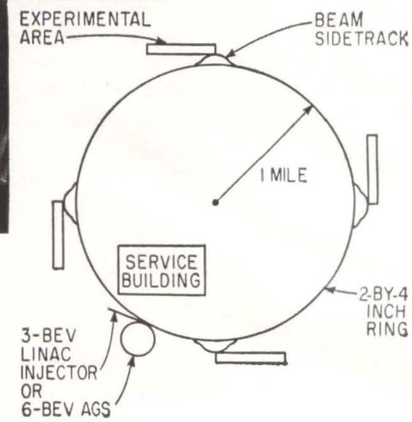
Exploring the nonlinearity of light waves is also important scientifically, he adds. His special area now involves the properties and behavior of crystals in the intense light fields produced by optical maser beams.

Bloembergen will be speaking at the Paris conference on the interaction between light waves in nonlinear media.

Guarding Against Flats

TRUCK DRIVER *locates low tire with indicator by Magnavox. Indicator is used after transistor radio transmitters on wheels signal cab when pressure is low, as determined by valve pressure switch*





BROOKHAVEN *National Laboratory is proposing a 300 to 1,000-Bev alternating gradient synchrotron (sketch). It would be a scaled-up version of the lab's 33-Bev synchrotron, part of which is seen in the photo*

More Atom-Smashers Wanted

Three more big accelerators are being considered

NEW YORK—Growing research in nuclear physics is generating demand for a variety of high-energy particle accelerators.

Throughout the world, there are about 20 accelerators with energies of 1 billion electron volts (Bev), or greater, in use or under construction. Their requirements for advanced components and circuit design are expected to stimulate advances in electronics.

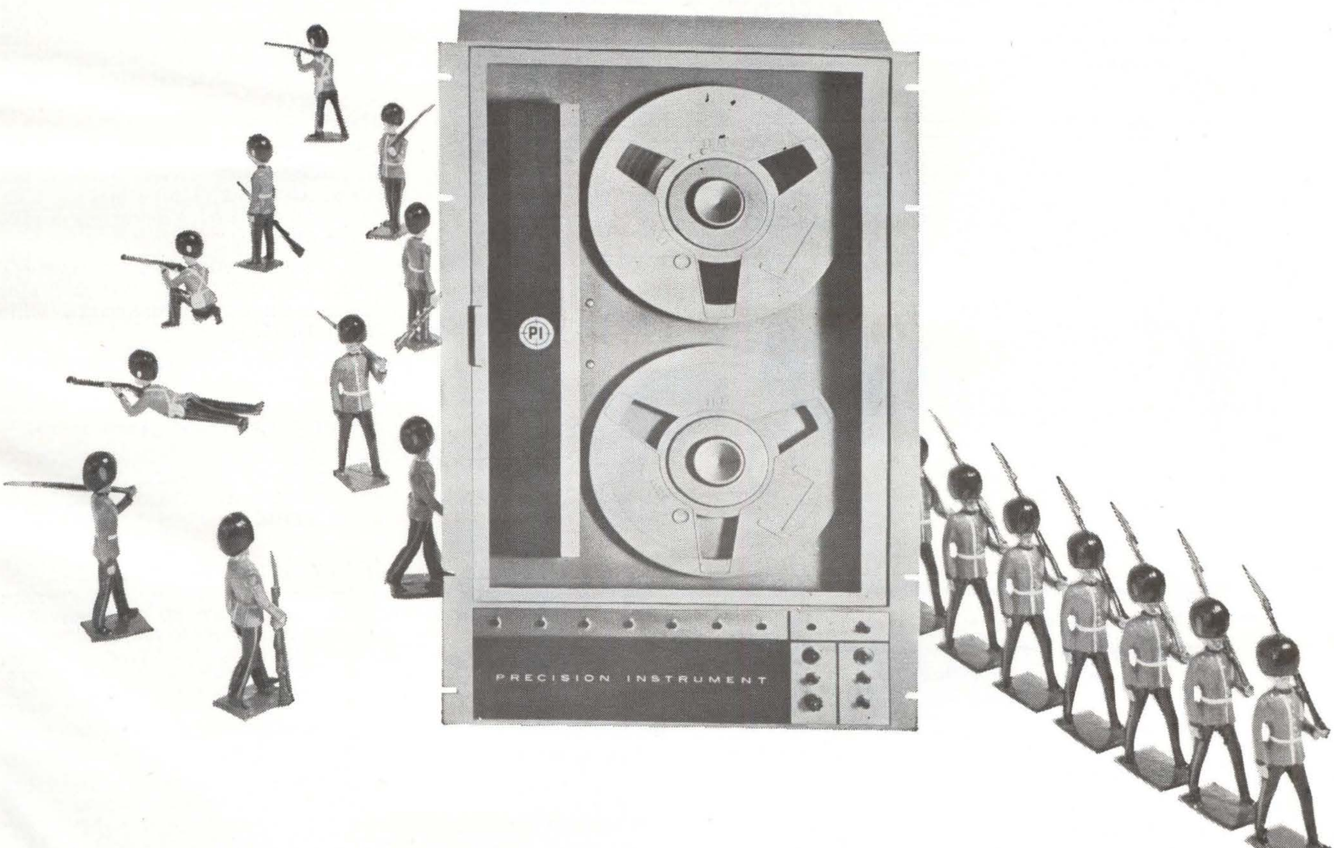
The biggest to date is Stanford University's two-mile, $114-million, 20-Bev linear accelerator, scheduled for operation in 1966. Excavation is underway, reported R. B. Neal at the American Physical Society meeting here, and component installation should start in about 14 months. It will have 240 klystrons, each with average power of 22 Kw and peak power of 24 Mw. Going to 960 klystrons would double beam energy.

J. P. Blewett, of Brookhaven National Laboratory, described a design study for a 300-Bev to 1,000-Bev proton accelerator, scaled up from the 33-Bev alternating gradient synchrotron at Brookhaven. Estimated cost is about $1 million per Bev—about 20 percent of which would be for the electronics. A typical 600-Bev accelerator (see sketch) would require rapid-tuning, high-power transmission tubes, isolators capable of handling several megawatts and other 200-Mc parts.

FUNDS ASKED—An AEC and President's Scientific Advisory Committee panel is reviewing Brookhaven's request. Requests by University of California and Midwestern Universities Research Association, for 100-Bev and 10-Bev machines, are also under study.

National Science Foundation is calling for a doubling of federal support of low-energy nuclear structure research in the next five years. Federal support of unclassified basic research in nuclear structure physics has risen to $40 million in the past five years.

NSF asks for a stepup in development of electrostatic accelerators with energies variable to 36 Mev, in installation of commercially available 20-Mev tandem Van de Graaff machines, and in design and construction of cyclic particle accelerators above 40 Mev.



PRECISION INSTRUMENT

MEETINGS AHEAD

ELECTRONIC COMPONENTS INTERNATIONAL EXHIBITION, Fédération Nationale des Industries Électroniques; Unesco House, Paris, France, **Feb. 8-12.**

ELECTRONIC MARKETING CONFERENCE, Electronic Sales—Marketing Association; Americana Hotel, New York City. **Feb. 11-13.**

QUANTUM ELECTRONICS INTERNATIONAL SYMPOSIUM, IRE, SFER, ONR; Unesco Building and Parc de Exposition, Paris, France, **Feb. 11-15.**

INFORMATION STORAGE AND RETRIEVAL SYMPOSIUM, American University; International Inn., Washington, D. C., **Feb. 11-15.**

ELECTRICAL & ELECTRONIC EQUIPMENT EXHIBIT, ERA, FRC; Denver Hilton Hotel, Denver, Colo., **Feb. 18-19.**

ELECTRICAL-ELECTRONIC TRADE SHOW, Electrical Representatives Club and Electronic Representatives Assn.; Hilton Hotel, Denver, Colo., **Feb. 18-19.**

SOLID STATE CIRCUITS INTERNATIONAL CONFERENCE, IRE-PGCT, AIEE, University of Pennsylvania; Sheraton Hotel and U. of P., Philadelphia, Pa., **Feb. 20-22.**

PACIFIC COMPUTER CONFERENCE, AIEE; California Institute of Technology, Pasadena, Calif., **March 15-16.**

BIONICS SYMPOSIUM, United States Air Force; Biltmore Hotel, Dayton, Ohio, **March 18-21.**

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

ENGINEERING ASPECTS OF MAGNETO-HYDRODYNAMICS SYMPOSIUM, IRE-PGNS, AIEE, IAS, University of California; UCLA, Beverly, Calif., **April 10-11.**

OHIO VALLEY INSTRUMENT-AUTOMATION SYMPOSIUM, ISA, et al; Cincinnati Gardens, Cincinnati, Ohio, **April 16-17.**

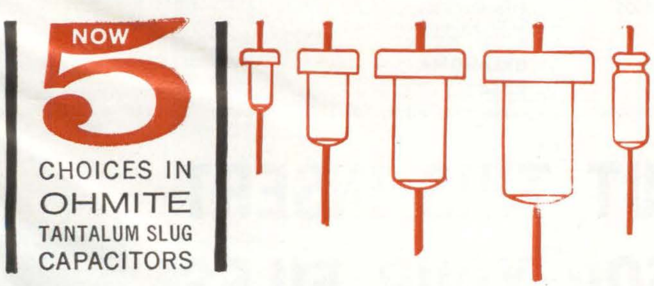
CLEVELAND ELECTRONICS CONFERENCE, IRE, AIEE, Case Institute, Western Reserve University, ISA; Hotel Sheraton Cleveland, **April 16-18.**

INTERNATIONAL NONLINEAR MAGNETICS CONFERENCE, IRE-PGEC, PGIE, AIEE; Shorham Hotel, Washington, D. C., **April 17-19.**

ADVANCE REPORT

CIRCUIT THEORY SYMPOSIUM, *University of Wisconsin, U of W, Madison, Wis., May 6-7. March 15 is the deadline for submitting papers to: T. J. Higgens, Chairman, Arrangements Committee, Sixth Midwest Symposium on Circuit Theory, Department of Electrical Engineering, University of Wisconsin, Madison 6, Wisconsin.*

AUTOMATIC PRODUCTION IN ELECTRICAL AND ELECTRONIC ENGINEERING SYMPOSIUM, *Science and General Division of the Institution of Electrical Engineers; IEE, Savoy Place, London, England, October 24-25. March 31 is the deadline for submitting suggested title and outline of less than 200 words to: Secretary, The Institution of Electrical Engineers, Savoy Place, London W. C. 2., Covent Garden 1871, England.*



■ Size Y is the tiniest hat-shaped capacitor ever developed. Its case measures only 19/64″ long with a flange diameter of 13/64″ and body diameter of 1/8″. Yet this miniature unit offers characteristics equal to any of the larger sizes. Size Y meets all requirements of MIL-C-3965B.

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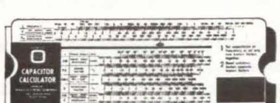

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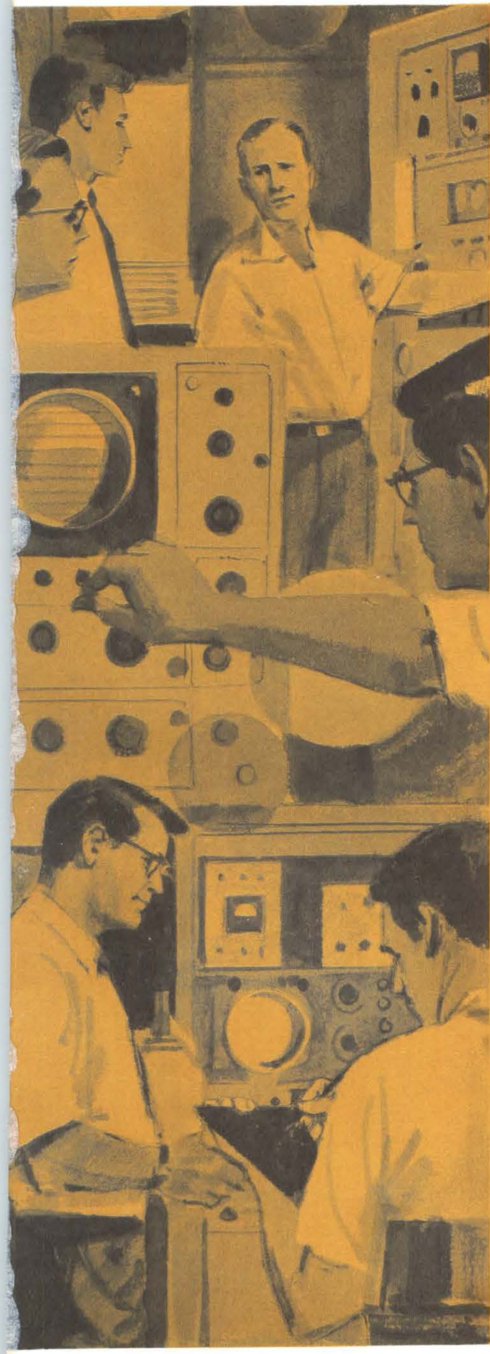
CIRCLE 31 ON READER SERVICE CARD

PRECISION POTENTIOMETER SUMMARY BROCHURE NO. 1 / *JANUARY 1963*



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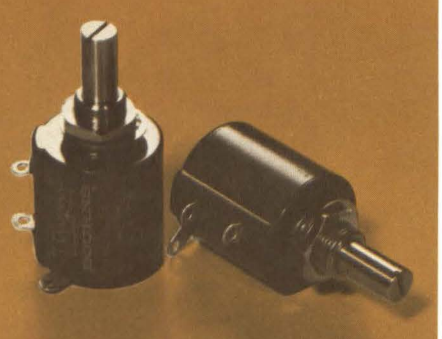
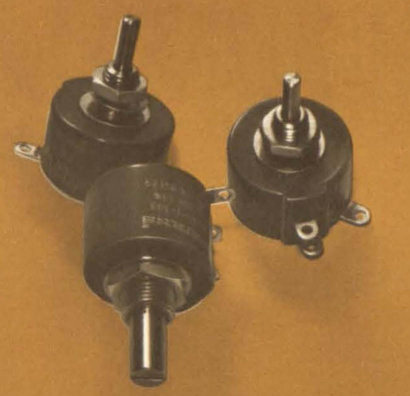


Model 3500 – ten turn

Resistance Values	500 to 125K ohms
Resistance Tolerance	±3% standard, closer tolerances available
Linearity (Independent)	±0.2% standard
Electrical & Mechanical Rotation	3600° (+10°; —0°)
Power Rating (70°C)	2.0 watt
Operating Temperature Range	—65 to 125°C
Humidity	Standard - MIL-STD-202, Method 103 (Steady State). Optional Feature - MIL-STD-202, Method 106 (Cycling)
Vibration	MIL-STD-202, Method 204, 20G
Shock	MIL-STD-202B, Method 202, 100G
Mechanical Life	100,000 cycles (2,000,000 shaft revolutions)
Size	⅞" diameter; 1" case length
Weight	Approximately 1.0 ounce

PRICES:

Model	1-9	10-24	25-99	100-249
3500	11.99	11.39	10.79	9.59



Model 3510 – three turn
Model 3520 – five turn

Resistance Values	200 to 50K ohms (3510) 200 to 75K ohms (3520)
Resistance Tolerance	±3% standard, closer tolerances available
Electrical and Mechanical Rotation	1080° (3510) 1800° (3520)
Linearity (Independent)	±0.30% standard
Power Rating (70°C)	1.0 watt (3510) 1.5 watt (3520)
Operating Temperature Range	—65 to 125°C
Humidity	Standard - MIL-STD-202, Method 103 (Steady State) Opitonal Feature - MIL-STD-202, Method 106 (Cycling)
Vibration	MIL-STD-202B, Method 204, 20G
Shock	MIL-STD-202B, Method 202, 100G
Mechanical Life	100,000 cycles (2,000,000 shaft revolutions)
Size	Diameter ⅞"; 0.549" case length (3510) Diameter ⅞"; 0.678" case length (3520)

PRICES:

Model	1-9	10-24	25-99	100-249
3510	14.99	14.24	13.49	12.74

Model	1-9	10-24	25-99	100-249
3520	13.50	13.10	12.30	11.10

Standard Resistance Range	500 to 100K ohms
Resistance Tolerance	±5% standard, closer tolerances available
Linearity (Independent)	±0.25% standard
Electrical & Mechanical Rotation	3600° (+10°; —0°)
Power Rating (70°C)	1.0 watt
Operating Temperature Range	—65 to 125°C
Humidity	Standard - MIL-STD-202B, Method 103 (Steady State) Optional Feature - MIL-STD-202B, Method 106 (Cycling)
Vibration	MIL-STD-202B, Method 204, 20G
Shock	Exceeds MIL-STD-202B, Method 202, 100G
Mechanical Life	50,000 cycles (1,000,000 shaft revolutions)
Size	½" diameter; 1" case length

PRICES:

Model	1-9	10-24	25-99	100-249
3700	24.50	23.28	22.05	19.60

½ INCH DIAMETER PRECISIO
POTENTIOMETER. TEN-TUR
TYPE. The Model 3700 combines u
usually high performance with miniatu
size. Measure only ½ inch in diamet
by 1 inch long, the Model 3700 featur
independent linearity of 0.25%, pow
rating of 1 watt at 70°C, and 125°
maximum operating temperature rang
Standard model exceeds steady sta
humidity requirements, and as an o
tional feature, meets the stringent d
mands of MIL-STD-202B, Method 10

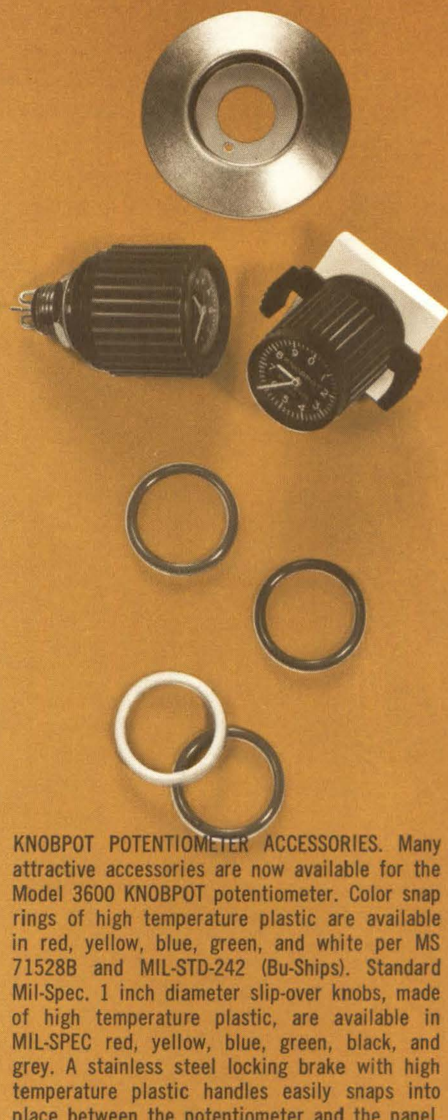
PRECISION POTENTIOMETER READ-OUT DIALS. These attractive, easy-to-read dials are available in anodized black or clear finishes for all Bourns 3, 5, and 10-turn precision potentiometers. Dials require only 1 inch of panel space and can be easily read to four places. Settings can be estimated to a fraction of a thousandth. Dials are easily mounted; no extra holes in the panel are required. Knobs screwed directly to pot shaft eliminate backlash. An optional locking device permits positive locking without shifting dial reading. These sturdy dials have been tested for 250,000 cycles with no sign of appreciable wear.

Part No. Black	Part No. Clear	Description	1-9	10-24	25-99	100-199
H412	H462	1/4" Brake	8.95	8.50	8.06	7.61
H411	H461	1/4" No Brake	7.75	7.36	6.98	6.59
H432	H482	3/32" Brake	9.30	8.84	8.37	7.91
H431	H481	3/32" No Brake	8.10	7.70	7.29	6.89
H422	H472	1/8" Brake	8.95	8.50	8.06	7.61
H421	H471	1/8" No Brake	7.75	7.36	6.98	6.59

Resistance Values	1K to 100K ohms
Resistance Tolerance	±5% standard, closer tolerances available
Electrical & Mechanical Rotation	3600° (+10°; —0°)
Dial Accuracy (Including Linearity)	±0.5% standard
Repeatability of Dial Reading	0.1% voltage ratio
Power Rating (25°C)	1.50 watts
Operating Temperature Range	—65 to 125°C
Humidity	MIL-STD-202B, Method 103
Vibration	MIL-STD-202B, Method 204, 10G
Shock	MIL-STD-202B, Method 202, 50G
Mechanical Life	10,000 cycles
Size	3/4" diameter; 1" case length
Weight	0.62 ounce

Model	1-4	5-9	10-24	25-49	50-99	100-249
3600	20.52	20.52	19.00	17.10	16.22	15.20

3/4" DIAMETER KNOBPOT® POTENTIOMETER, READOUT DIAL, KNOB – ALL IN FRONT OF PANEL. The Model 3600 KNOBPOT potentiometer – an exclusive Bourns design – introduces a new component concept in precision potentiometer-dial applications. A 10-turn precision potentiometer, readout dial, and knob in a single compact package measuring only 3/4" in diameter by 1 inch long. The potentiometer mechanism, built inside the knob, occupies no space behind the panel. The easy to read, integrated 3/4" clock dial eliminates assembly and phasing during mounting.



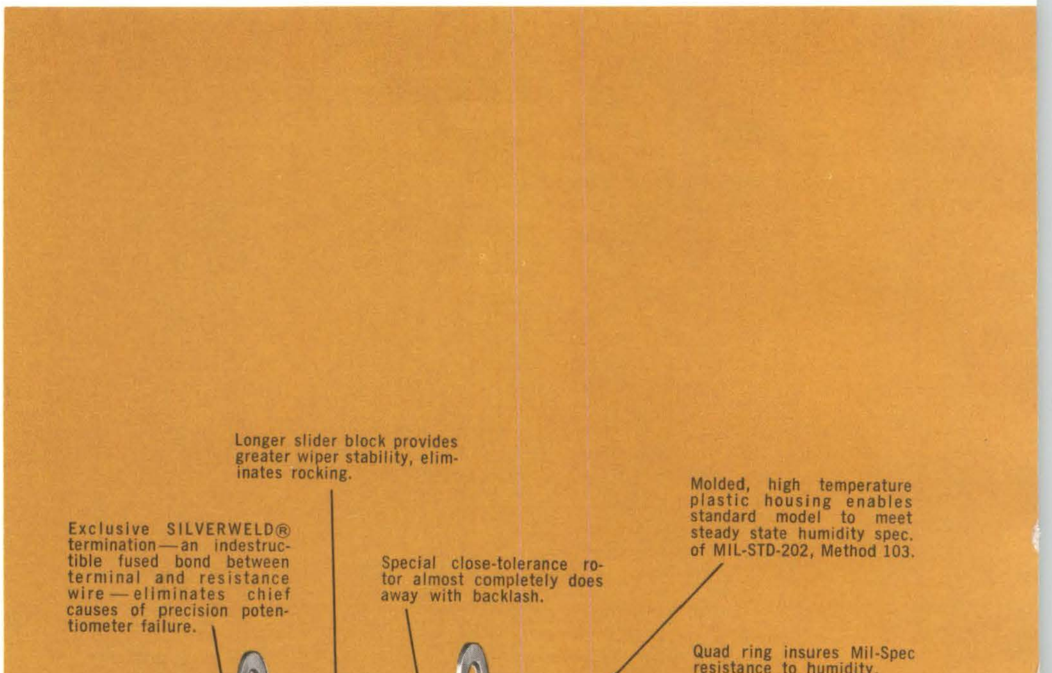
KNOBPOT POTENTIOMETER ACCESSORIES. Many attractive accessories are now available for the Model 3600 KNOBPOT potentiometer. Color snap rings of high temperature plastic are available in red, yellow, blue, green, and white per MS 71528B and MIL-STD-242 (Bu-Ships). Standard Mil-Spec. 1 inch diameter slip-over knobs, made of high temperature plastic, are available in MIL-SPEC red, yellow, blue, green, black, and grey. A stainless steel locking brake with high temperature plastic handles easily snaps into place between the potentiometer and the panel. Stainless steel skirts provide a finishing touch of high-polish glamour.

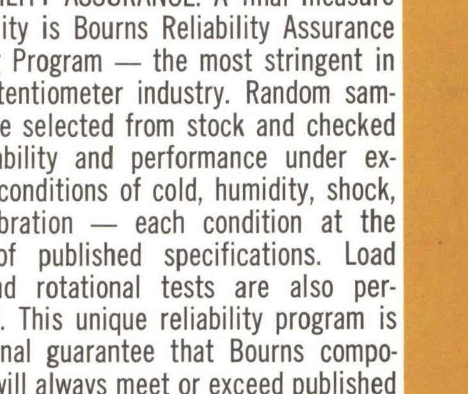
Part No.	Description	1-24	25-99	100-499
H93	Colored Snap-Ring	.35	.30	.25
H94	Slip-Over Knob	1.25	1.07	.97
H95	Stainless Steel Skirt	1.50	1.25	1.00
H96	Locking Device (Brake)	1.25	1.07	.97

QUALITY DESIGN. The construction details shown in the cut-a-way drawings of the Model 3500 are not necessarily descriptive of all models, but are typical of the design features found in Bourns precision potentiometers. These high-reliability features have evolved through Bourns long experience in the potentiometer field — specifically through the Company's capability in producing quality miniature parts, precision plastic moldings, and dependable seals.

QUALITY CONTROL. All units are individually inspected to guarantee full conformance to all key physical and electrical specifications. One hundred percent inspection for contact pressure (wiper and both collector ring pickoffs) also assures low noise levels and reliable performance for a minimum of 100,000 cycles or 2 million shaft rotations.

RELIABILITY ASSURANCE. A final measure of quality is Bourns Reliability Assurance Testing Program — the most stringent in the potentiometer industry. Random samples are selected from stock and checked for stability and performance under extreme conditions of cold, humidity, shock, and vibration — each condition at the limit of published specifications. Load life and rotational tests are also performed. This unique reliability program is your final guarantee that Bourns components will always meet or exceed published standards of performance and reliability. In addition to precision potentiometers, Bourns manufactures a complete line of leadscrew actuated adjustment potentiometers and relays. Write for the TRIMPOT Summary Brochure or contact your nearest Bourns sales representative or distributor for price and delivery information.





Bourns, Inc. owns the following United States Letters Patent relating to certain of its precision potentiometers: 3,069,646. Other patents pending.

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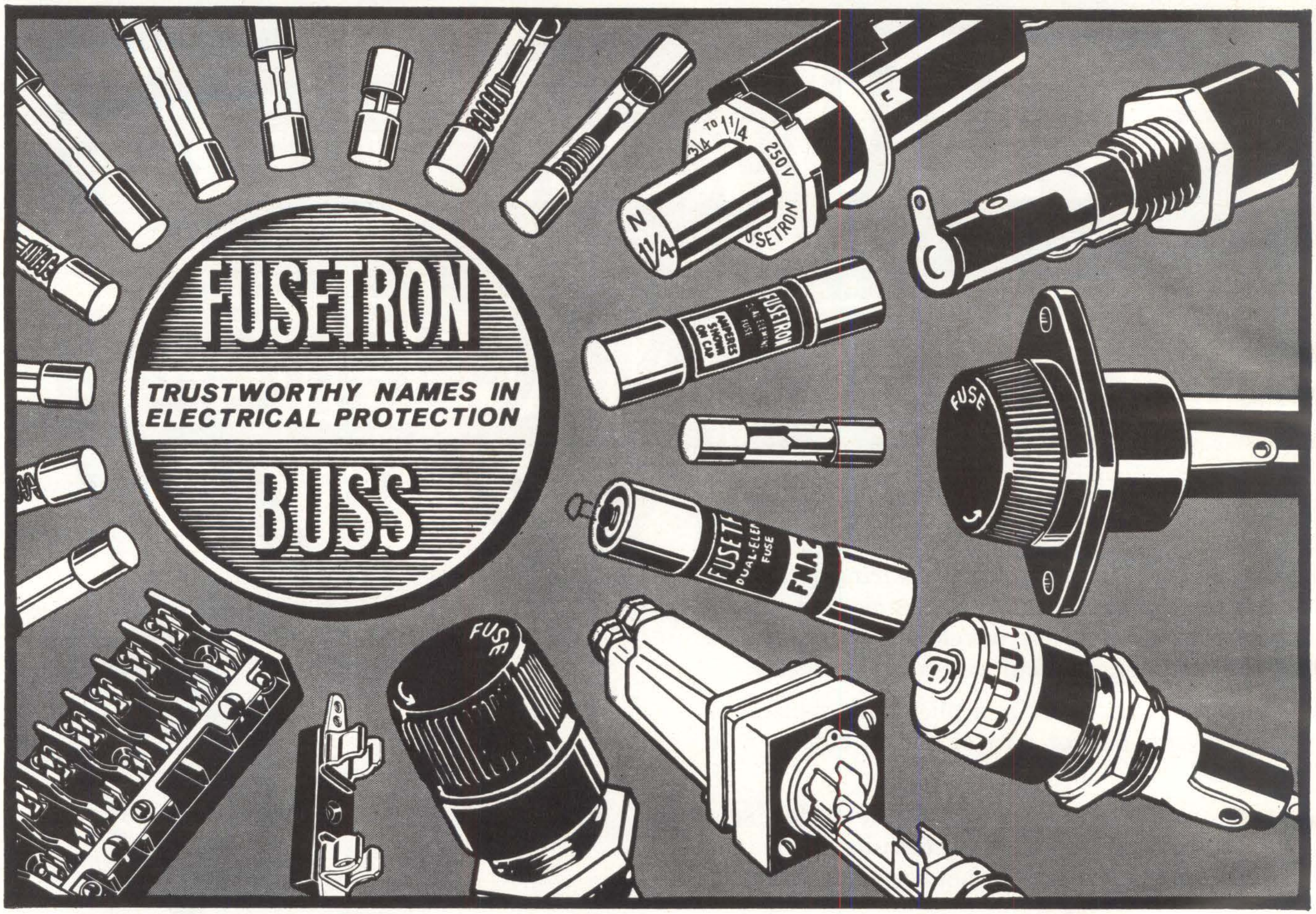


Save Time and Trouble by standardizing on BUSS Fuses–You'll find the right fuse every time... in the Complete BUSS Line!

By using BUSS as your source for fuses, you can quickly find the type and size fuse you need. The complete BUSS line of fuses includes: dual-element "slow-blowing", single-element "quick-acting", and signal or visual indicating types . . . in sizes from 1/500 amp. up—plus a companion line of fuse clips, blocks and holders.

BUSS Trademark Is Your Assurance Of Fuses Of Unquestioned High Quality

For almost half a century, millions upon millions of BUSS fuses have operated properly under all service conditions.

To make sure this high standard of dependability is maintained... BUSS fuses are tested in a sensitive electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

Should You Have A Special Problem in Electrical Protection . . . BUSS fuse engineers are at your service—and in many cases can save you engineering time by helping you choose the right fuse for the job. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be serviced easily.

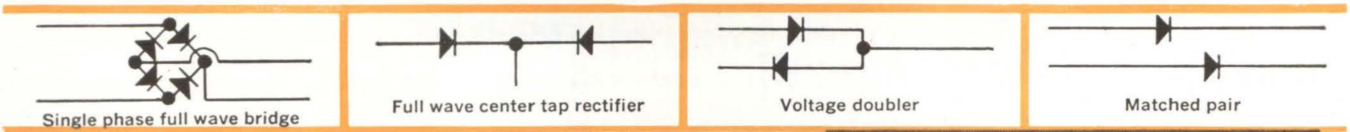
For more information on the complete line of BUSS and FUSETRON Small Dimension Fuses and Fuseholders, write for BUSS bulletin SFB.

BUSS

BUSSMANN MFG. DIVISION

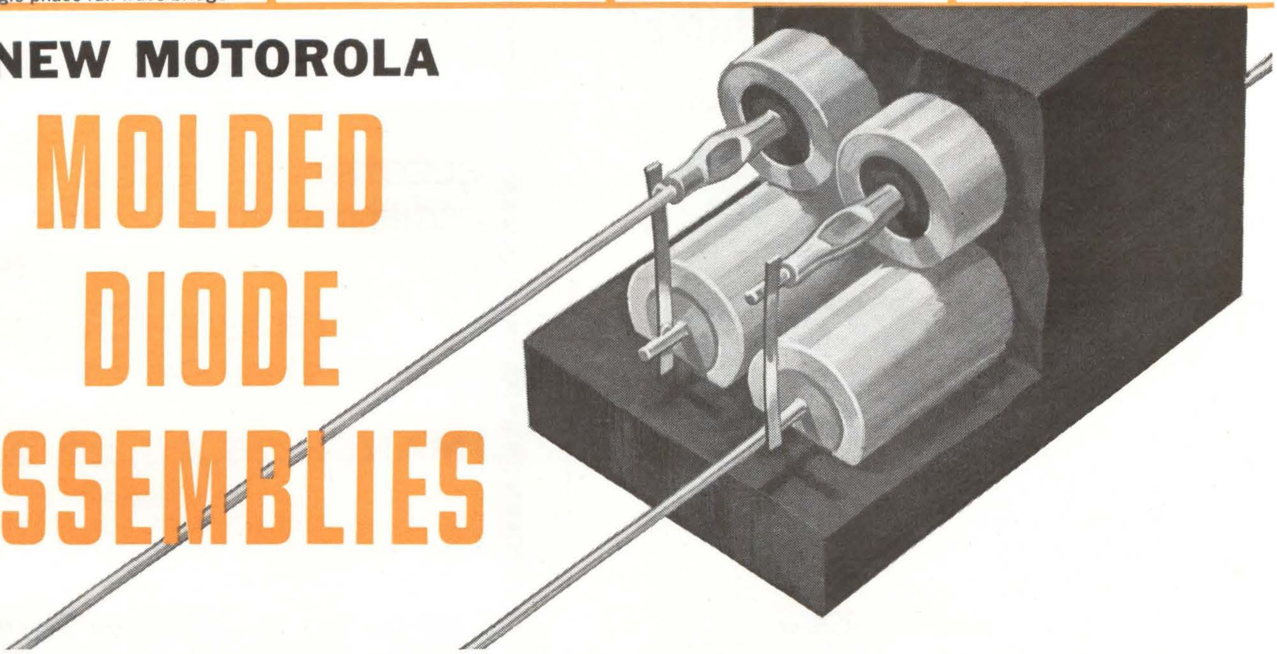
MAKERS OF THE COMPLETE LINE OF FUSES OF UNQUESTIONED HIGH QUALITY

McGraw-Edison Co. • St. Louis 7, Mo.



NEW MOTOROLA

MOLDED DIODE ASSEMBLIES



Custom-built or EIA space-saving circuits feature welded connections, transfer-molding encapsulation, and three-stage testing

From more than 630 standard Motorola zener diodes and rectifiers, you can now custom design your own circuit and have the components factory-assembled and encapsulated into a compact package ready for soldering into conventional or printed circuits. Series strings, full wave bridges and zener clippers . . . these are only a few of the circuits possible. These assemblies also offer you a reliable source for extended component values such as 10,000-volt rectifiers and 50-volt temperature-compensated reference diodes.

Reliability of Motorola molded diodes assemblies is insured by:

- **Strong, welded-lead connections**
- **High-pressure, void-free transfer molding**
- **Three-stage quality control testing**

Motorola factory welding, with its extremely short duration of heating, yields strong bonds while preventing heat damage to the components.

Motorola's high-pressure, transfer-molding process prevents the formation of voids that occur with ordinary open mold casting and produces a package of exceptionally high mechanical strength that is highly resistant to the absorption and collection of moisture.

In Motorola's three-stage quality control testing, not only are the components individually tested, but the welded circuits are tested *before* and *after* encapsulation to insure desired performance.

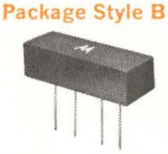
For further information, write for this new 6-page brochure describing Motorola's line of EIA assemblies as well as providing complete instructions for ordering your own custom circuits.

MOTOROLA MOLDED DIODE PACKAGE STYLES

Package Style A

Package Style Prefix	Max. No. of glass diodes	Max. No. of metal pkgs.	Max. L inches	Max. D inches
2A	up to 2	—	.900	.150
4A	up to 4	—	.500	.313
10A	up to 10 or	2	1.00	.313
18A	up to 18 or	4	.625	.625
36A	up to 36 or	8	1.200	.625

Package Style B



Package Style Prefix	Max. No. of glass diodes	Max. No. of metal pkgs.	Max. L inches	Max. W inches	Max. H inches
19B	up to 19 or	4	1.00	.300	.600
38B	up to 38 or	8	2.00	.300	.600

Package Style C

Package Style Prefix	Max. No. of glass diodes	Max. No. of metal pkgs.	Max. L inches	Max. W inches	Max. H inches
16C	up to 16 or	4	.600	.600	.625

Package Style D

Package Style Prefix	Max. No. of glass diodes	Max. No. of metal pkgs.	Max. L inches	Max. W inches	Max. H inches
6D	up to 6	0	.550	.550	.275
12D	up to 12 or	2	.750	.550	.275

Motorola molded diode assemblies are available in many standard package styles similar to those above . . . for either single-ended or axial lead connection. Custom packaging can be designed to fit your exact space requirements.

MOTOROLA

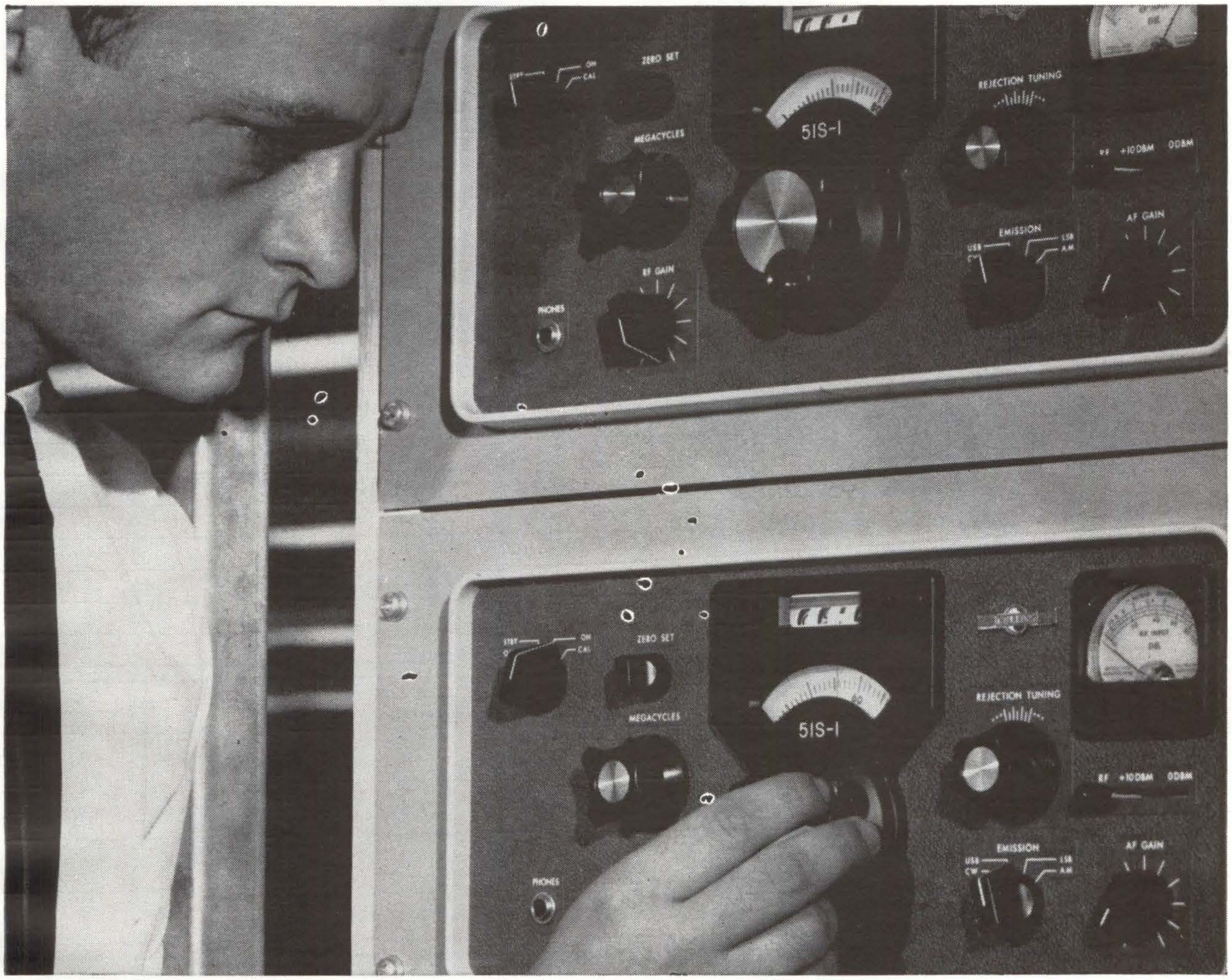
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA INC.

D-13-013

5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

now get
SSB with optimum performance
over the entire HF spectrum



Continuous tuning with extreme accuracy — that's what you get with Collins' 51S-1 HF receiver.

Most advanced in a famous series of general coverage receivers, this SSB/CW/AM unit delivers: visual dial setting *within* 1 kc throughout the range • *high frequency stability,* 70 cycles per week, ideal for pre-assigned frequencies • *sharpest selectivity,* from Collins Mechanical Filters • *highest sensitivity* for difficult monitoring assignments.

Features like these, packaged into a compact unit specifically designed for commercial application, make this receiver ideal for both general communication and lab uses. Contact Collins today for complete information. COLLINS RADIO COMPANY • Cedar Rapids • Dallas • Los Angeles • New York • International Division, Dallas

See Collins display at the New York IEEE Show March 25-28.

COLLINS

HITACHI TRANSISTORS

SPECIFY "MESA" TYPE TRANSISTORS FOR HIGH FREQUENCY USE

2SA233, 2SA234, 2SA235

Hitachi PNP germanium diffused "Mesa" type transistors provide outstanding high frequency characteristics compared with conventional alloy junction or drift transistors.

Exclusive "Mesa" type transistors are indispensable for FM receivers used in tuner circuits and intermediate frequency amplifiers and also in TV receivers in intermediate frequency amplifiers. They can be used effectively in short-wave converters, medium wave converters and all high frequency applications.

For superior performance, specify Hitachi "Mesa" type transistors . . . another engineering achievement from one of the world leaders in electronics.

Maximum Ratings (Ta=25°C)

Items	Symbol	Unit	2SA233	2SA234	2SA235
Collector Voltage	V_{CBO}	V	−20	−20	−20
Emitter Voltage	V_{EBO}	V	− 0.5	− 0.5	− 0.5
Collector Current	I_C	mA	−10	−10	−10
Emitter Current	I_E	mA	10	10	10
Junction Temperature	T_j	°C	85	85	85
Collector Dissipation	P_C	mW	80	80	80
Ambient Temperature	T_A	°C	60	60	60

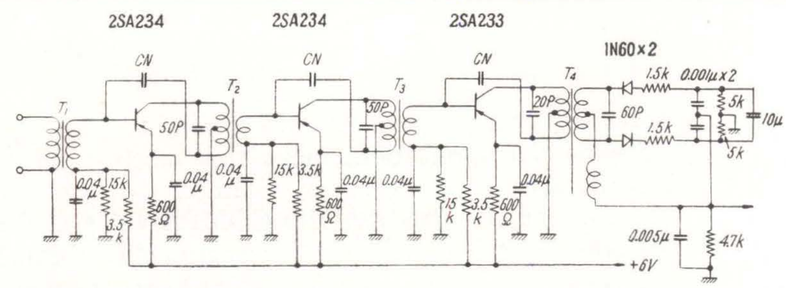
Characteristics (Ta=25°C)

Items	Symbol	Conditions for measurement	Unit	2SA233	2SA234	2SA235
Max. Collector Cut-off-Current	I_{CBO}	$V_C=-20V$ $I_E=0$	μA	−30	−30	−30
Max. Emitter Cut-off-Current	I_{EBO}	$V_E=-0.5V$ $I_C=0$	μA	−50	−50	−50
Current Amplification Factor	h_{fe}	$V_C=-6V$ $I_E=1mA$		50	60	80
Alpha Cut-off Frequency	$f_{\alpha b}$	$V_C=-6V$ $I_E=1mA$	Mc	90	110	125

Typical Operation (Ta=25°C)

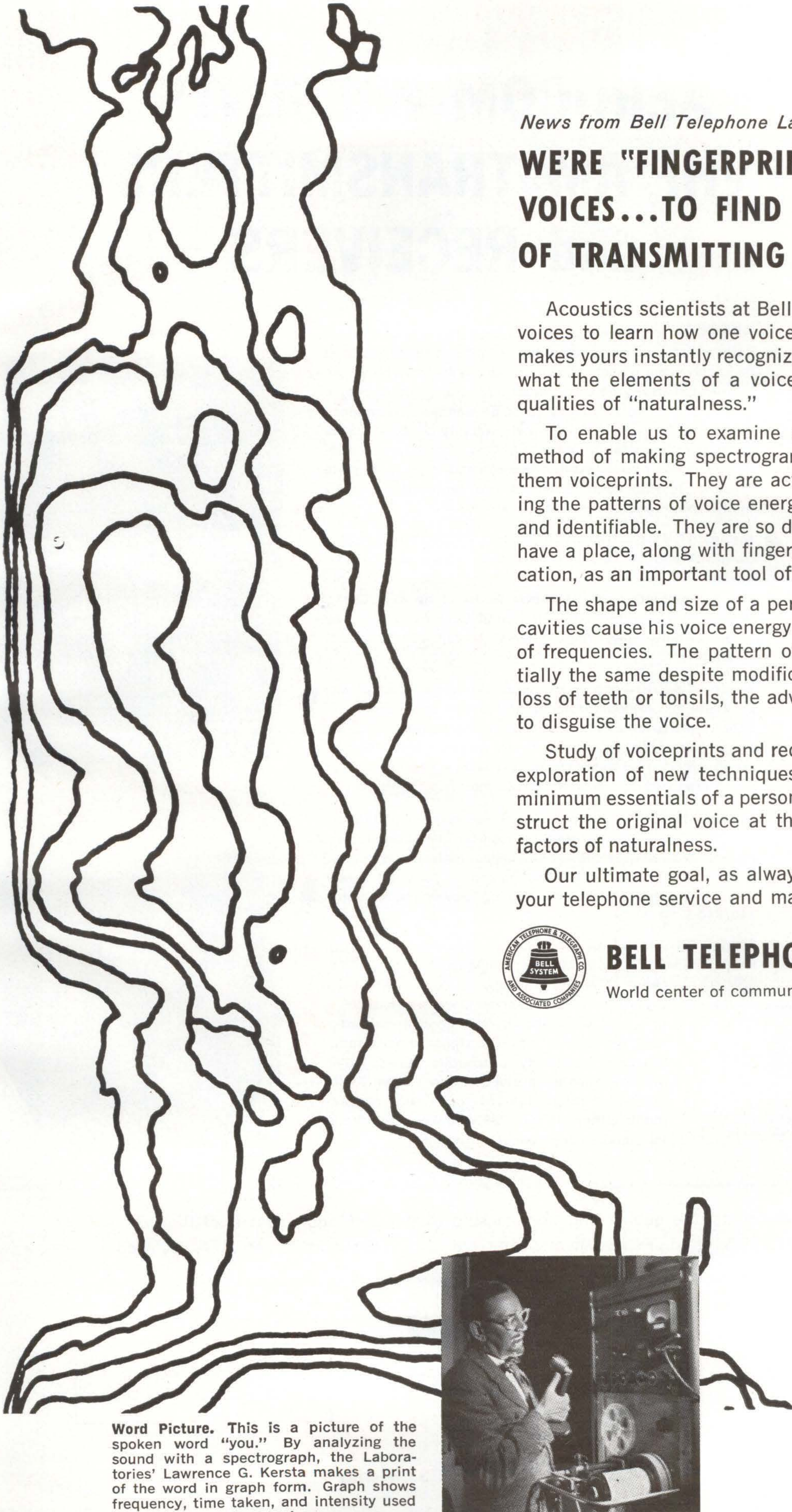
Items	Conditions for Measurement	Unit	2SA233	2SA234	2SA235
Power Gain at FM Radio Frequency	$V_C=-6V$ $I_E=1mA$; $f_S=100Mc/s$; $R_g=75\Omega$ $R_L=2k\Omega$	db	—	—	12
Mixer Gain at FM Radio Frequency	$V_C=-6V$ $I_E=1mA$; $f_S=100Mc/s$ $f_{osc}=110.7Mc$; $R_g=3k\Omega$ $R_L=15k\Omega$	db	—	—	13

10.7 Mc Intermediate Frequency Amplifier Circuit



Hitachi New York, Ltd.
501, 5th Avenue, New York 17, N.Y., U.S.A.
Sole Agent:
International Importer Inc.
2242 South Western Avenue, Chicago 8, Illinois, U.S.A.

Hitachi, Ltd.
Tokyo Japan



News from Bell Telephone Laboratories

WE'RE "FINGERPRINTING" VOICES...TO FIND BETTER WAYS OF TRANSMITTING THEM

Acoustics scientists at Bell Telephone Laboratories study voices to learn how one voice differs from all others, what makes yours instantly recognizable to friends and family, and what the elements of a voice are that give it the elusive qualities of "naturalness."

To enable us to examine speech closely, we devised a method of making spectrograms of spoken words. We call them voiceprints. They are actual pictures of sound, revealing the patterns of voice energy. Each pattern is distinctive and identifiable. They are so distinctive that voiceprints may have a place, along with fingerprint and handwriting identification, as an important tool of law enforcement.

The shape and size of a person's mouth, throat and nasal cavities cause his voice energy to be concentrated into bands of frequencies. The pattern of these bands remains essentially the same despite modifications which may result from loss of teeth or tonsils, the advancement of age, or attempts to disguise the voice.

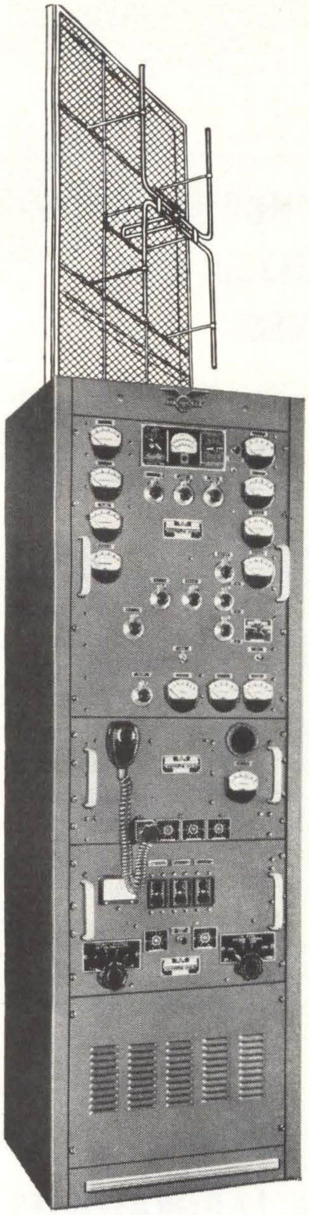
Study of voiceprints and recognition factors is part of our exploration of new techniques to extract and transmit the minimum essentials of a person's voice and from these reconstruct the original voice at the receiving end, retaining its factors of naturalness.

Our ultimate goal, as always, is to learn how to improve your telephone service and make it a better value.

BELL TELEPHONE LABORATORIES

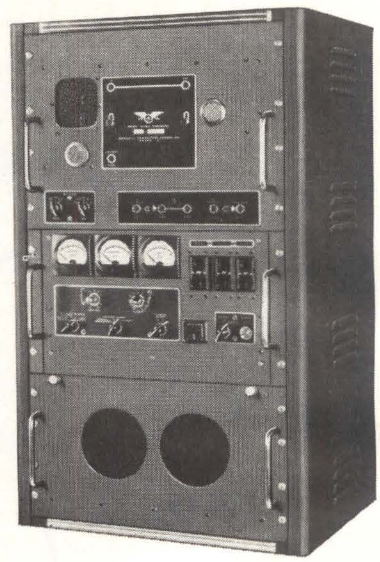
World center of communications research and development

Word Picture. This is a picture of the spoken word "you." By analyzing the sound with a spectrograph, the Laboratories' Lawrence G. Kersta makes a print of the word in graph form. Graph shows frequency, time taken, and intensity used in making speech sound.



AEROCOM PRESENTS VHF AM TRANSMITTERS and RECEIVERS

AEROCOM communications equipment is designed with both performance and reliability in mind, and is produced by experienced personnel using high-quality materials. The following features are found in all three transmitters: Single crystal controlled frequency (plus an additional frequency ½% away from main frequency): stability ± .003% or ± .001% over temperature range of 0° C to + 55° C, any humidity up to 95%; audio system incorporates high level plate modulation, with compression; forced ventilation with air filter is employed. Welded steel cabinets.

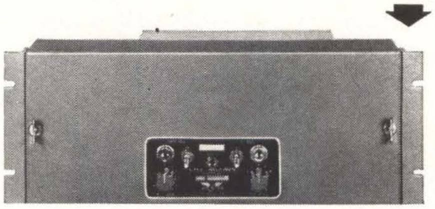


Model 10V1-A—1000 Watts output—Successfully being used in Troposcat service for communications with aircraft beyond the optical horizon. Frequency range 118-153 mc. Can be completely remote controlled by using AEROCOM's remote control equipment. All tuning from front panel by means of dials. Power requirements 210-250 V 50/60 cycles, single phase.

Model VH-200—200 Watts output in range 118-132 mc. Excellent for both point-to-point and ground-to-air communications. Press-to-talk and audio input may be remoted using single pair of telephone lines. Power requirements 105-120V 50/60 cycles. Also available for use above 132 mc; output drops gradually to 150 watts at 165 mc.

Model VH-50—50 Watts output. Frequency range 118-153 mc. Outstanding low power transmitter for ground-to-air service. With remote control provisions; main power control with front panel switch. Convection cooling for press-to-talk service—otherwise forced air cooling. Power requirements 115/230 V 50/60 cycles.

Model 85 VHF Receiver. A high performance, low noise, single channel crystal controlled, single conversion VHF receiver. Stability normally ± .001% (with oven crystal ± .0005%) over temperature range 0° C to + 55° C. Sensitivity ½ microvolt or better for 1 watt output with 6 db signal to noise ratio. Standard selectivity bandwidth 30 kc; other widths available. Spurious response down 90 db. Frequency range 118-154 mc. Power requirements either 115 V or 230 V 50/60 cycles. Made for standard rack panel mounting.



As in all AEROCOM products, the quality and workmanship of this VHF equipment is of the highest. All components are conservatively rated. Replacements parts are always available for all AEROCOM equipment.

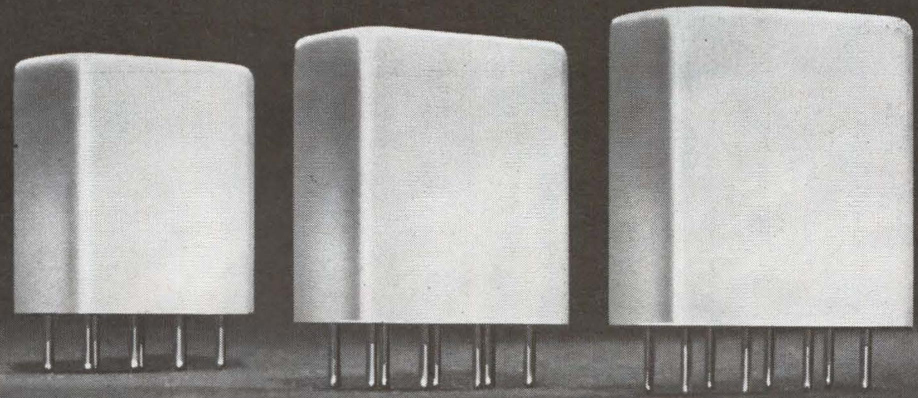
Complete technical data available on request

AER-O-COM

FCC Type Accepted for Aviation Service

3090 S. W. 37th Avenue — Miami 33, Florida

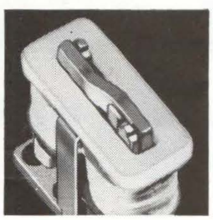
PERSPECTIVE ON RELIABILITY



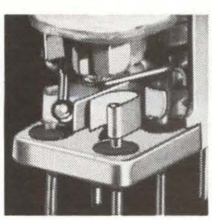
.1% FAILURE RATE in 10,000 operations with 90% confidence factor	**.01% FAILURE RATE** in 10,000 operations with 90% confidence factor	**.001% FAILURE RATE** in 10,000 operations with 90% confidence factor

DESIGN FEATURES OF BABCOCK RELIABILITY-RATED RELAYS

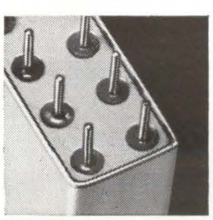
Vycor activated getter. Exclusive to Babcock, this porous glass getter prevents contact contamination by adsorbing all outgassed organic substances, following production degassing at 200°C under less than 5 microns vacuum.



Self-wiping, gold-plated contacts. Contacts of AgMgNi alloy with specially-designed configuration assure miss-free performance under load and minimize low level contact resistance.



Welded-header construction. Automatic sealing process gives stronger header-case bond and prevents solder flux contamination. Leakage rate is less than 10^{-8} c.c. per sec. by mass spectrometer.



Not all relay applications demand "millions of miss-free operation." Yet for every level of reliability, one requirement is mandatory—consistent performance within predictable limits of accuracy.

Babcock's pioneering work on relay reliability has evolved a statistical test procedure which verifies reliability by combining Darnell Report methods with proprietary testing techniques. Result: the design engineer can obtain any desired level of relay reliability with assurance of uniform predictable operation **at a cost no greater than the need justifies.**

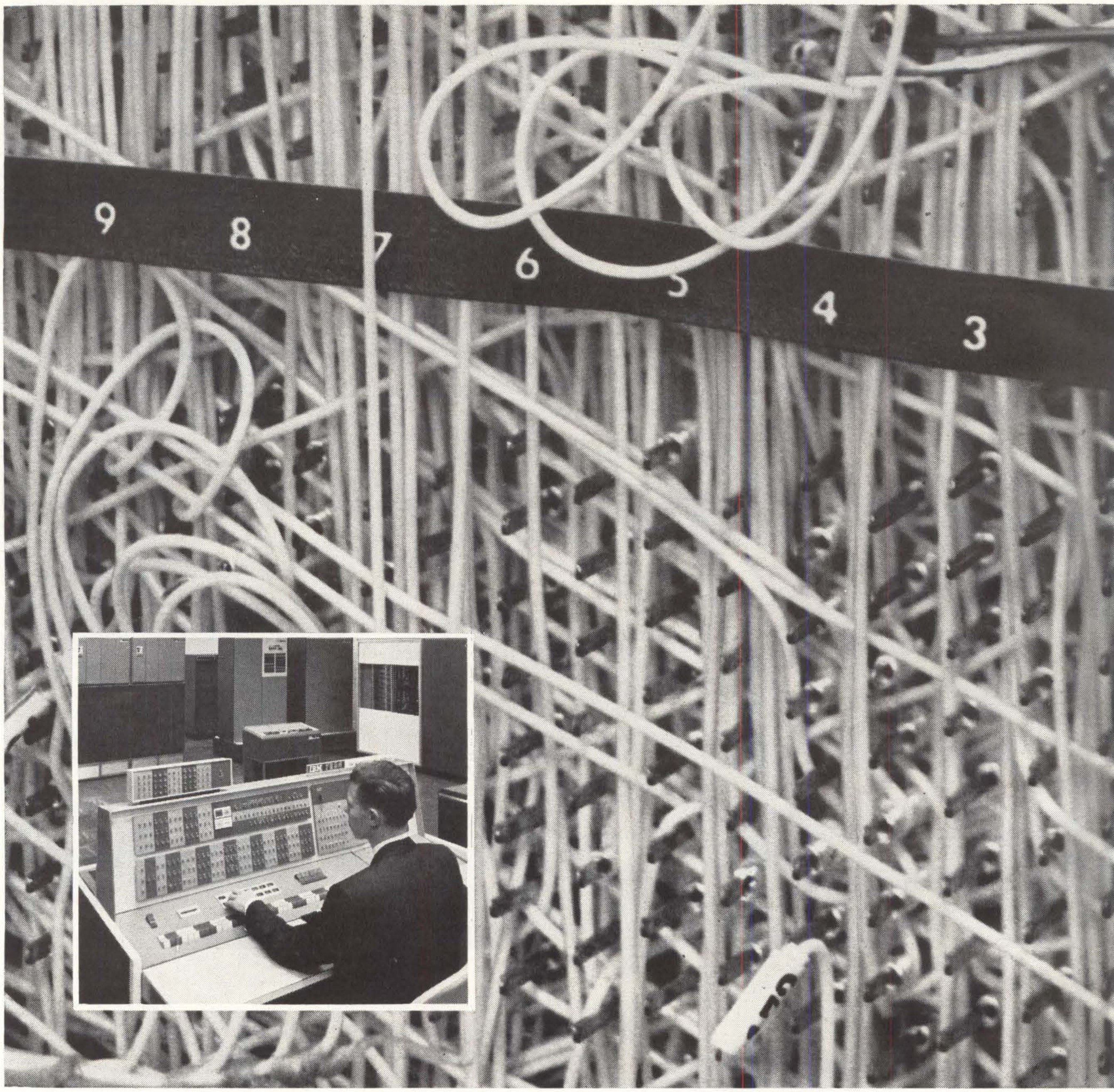
In classifying relay reliability by failure rate level, Babcock provides the user with a universal yardstick for specifying and evaluating requirements. High reliability units are presently testing to failure rates under .01% in 10,000 operations with a 90% confidence factor.

Babcock reliability verification procedures offer other benefits, too. With testing carried on continuously, ratings are based on cumulative data, preventing any possibility of quality deterioration. In addition, the use of uniform reliability test standards enables the user to eliminate costly evaluation testing . . . each rated relay is shipped with a certificate documenting reliability test results.

General catalog BR-6200, describing the complete line of Babcock Relays, is available upon request. For reliability information pertaining to specific applications, please write directly, outlining requirements.

BABCOCK RELAYS
A Division of Babcock Electronics Corporation
3501 Harbor Boulevard, Costa Mesa, California

CIRCLE 45 ON READER SERVICE CARD



IBM computers get 5½ miles of wiring reliability with insulation of Du Pont TEFLON®

A typical large-scale IBM data-processing system, like that shown here, uses 1,200 feet of hookup wire in each of twenty-four back panels—a total of roughly 5½ miles of wiring. One of the ways in which IBM builds the highest possible reliability into its systems is by using Du Pont TEFLON fluorocarbon resins—the most reliable of all insulating materials—on all back-panel hookup wire.

TEFLON resins provide the unvarying insulating characteristics needed in high-speed circuits, mechanical toughness to minimize the danger of cut-through and short circuiting, and unexcelled resistance to unfavorable environments. Most significantly, insulation of TEFLON maintains its desirable properties through year after year of operation. This is not merely the hopeful projection of short-term laboratory tests—this is *reliability in use*, which TEFLON resins have demonstrated in thousands of demanding applications ranging from computers to missile wiring.

That's why you're likely to find insulation of TEFLON in electronic equipment specifically designed for long-term, trouble-free service.

E. I. du Pont de Nemours & Co. (Inc.), Div. E-2-8-63TE, Room 2526 Nemours Bldg., Wilmington 98, Del. In Canada: Du Pont of Canada Ltd., P. O. Box 660, Montreal, Quebec.

TEFLON®
FLUOROCARBON RESINS

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

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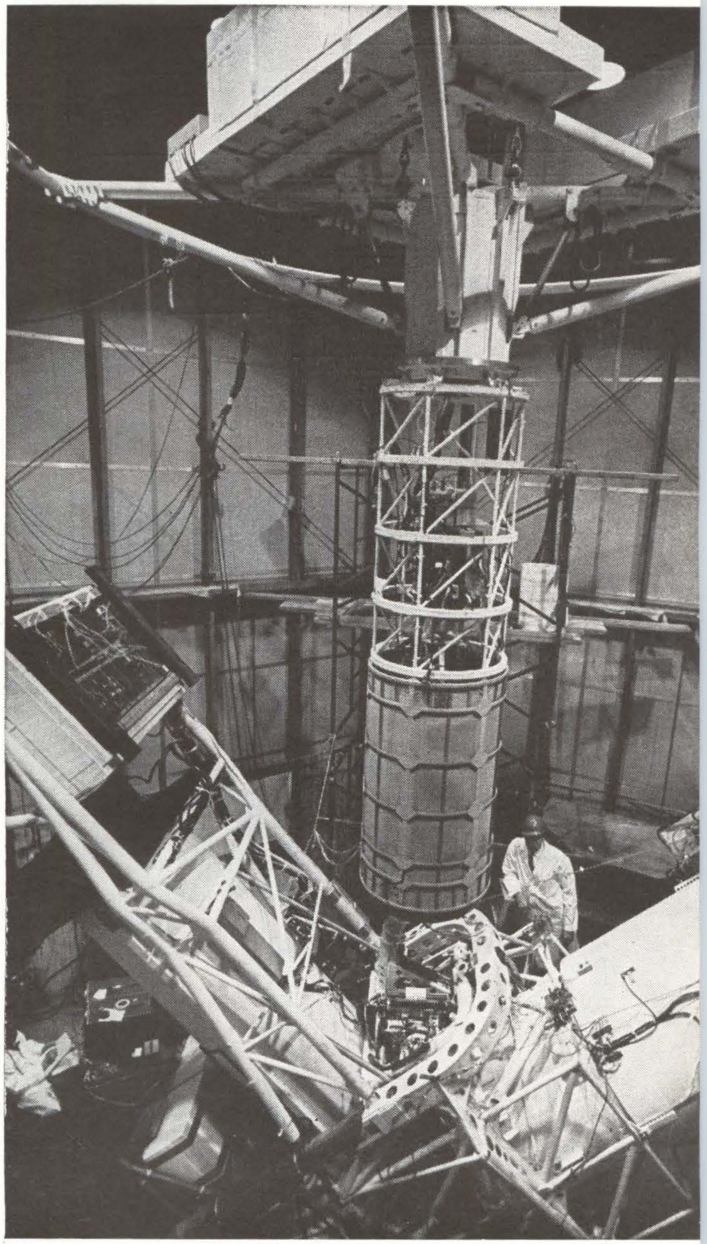
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

electronics

February 8, 1963

Aiming a 3-Ton Telescope Hanging From Balloon

Servo system responds to ground signals and points telescope at chosen stars; resolution of resulting photographs approaches theoretical limit. Night temperatures make operating environment more severe than an earth satellite's

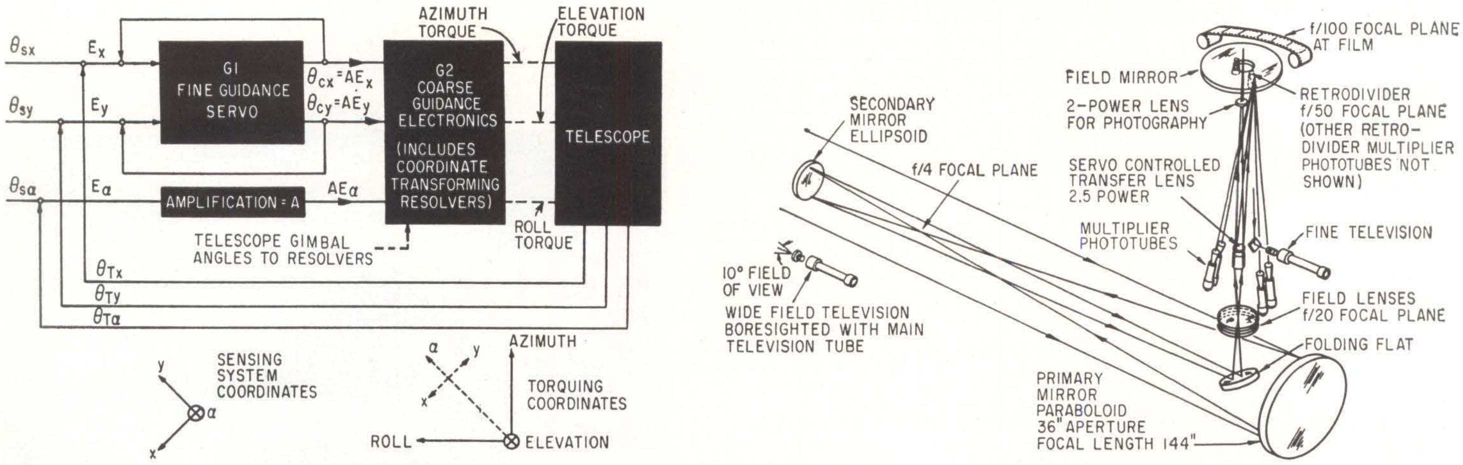


LIGHT *entering telescope traverses a right-angle before reaching photographic plate; the optics cause telescope unit to have an L-shaped configuration*

By E. R. SCHLESINGER
Senior Staff Engineer,
Perkin-Elmer Corp.,
Norwalk, Conn.

ONE of the most serious limitations to astronomical research has been the earth's atmosphere, which limits the astronomer in several ways, including (1) the atmospheric transmission loss, which is a function of wavelength and contains relatively narrow spectral windows; (2) air turbulence, which limits the resolution obtainable with even the best of equipment.

One of the first major steps in overcoming these problems was the construction of Stratoscope I, an unmanned balloon-borne 12-inch-diameter solar telescope, built under the direction of Professor Martin Schwarzschild of Princeton University. This telescope was flown at an altitude of 80,000 feet (above approximately 96 percent of the earth's atmosphere) in 1957 and provided photographs of the sun with record detail. The success of this and subsequent flights led to the construction of Stratoscope II, an unmanned balloon-borne 36-inch-diameter astronomical tele-



CONTROL SYSTEM *has conventional appearance but produces extreme precision (left), multiplier phototubes within optics package detect when telescope is correctly aimed, generate error signals to correct any misalignment (right)—Fig. 1*

scope, scheduled to be flown from Palestine, Texas this month.

This new telescope, which weighs over three tons and together with its flight train towers over 650 feet high, is designed to provide consistent 0.1 sec arc resolution photographs for exposure times up to one hour.

Features of the design include stellar guidance stabilization with a two speed servo control system, means for inflight optical focusing, provision for inflight programming of the optical and electrical system that selects different targets, and highly versatile command and telemetry links.

EQUIPMENT—The airborne portion of Stratoscope II consists of a dual balloon, an electronic package containing the command and telemetry equipment for balloon navigation, emergency recovery parachutes, shroud lines in which an antenna unit is hung, and finally, the scientific package. The scientific package in turn consists of an inertia ring on which are mounted batteries, an azimuth frame housing all transmitters and receivers, an azimuth floatation bearing with slip-ring assembly, a four-axis suspension gimbaling system, and finally, the gimbal-supported L-shaped telescope with electronics containers.

The ground equipment, housing all operator controls, is mounted in a control truck, support truck and two trailers containing engine-driven 60-cycle generators.

GUIDANCE SUBSYSTEM — The guidance subsystem has a capability of stabilizing the target image on the photographic film within 0.02 second of arc rms equivalent. This accuracy has been achieved with a three-axis control system as shown by the system block diagram of Fig. 1 (left).

Two of the three components of telescope pointing error (E_x, E_y, E_α) are fed to the fine guidance servo, which produces amplified output signals (θ_{cx} *and* θ_{cy}) proportional to the input signals. The telescope roll error signal, E_α, is amplified and fed (together with θ_{cx} and θ_{cy}) to the coarse guidance electronics, G_2. The G_2 electronics contains more amplification, error-rate stabilization networks, resolvers for transformation of the signals (from the telescope to the driven axes coordinate system), and three d-c output driver amplifiers.

These driver amplifiers with their torquers provide up to four foot pounds of correction torque about each of the three axes during target tracking. The system is conventional but has E_x and E_y errors that greatly exceed the photographic requirements. The reason for this is that large image motions are produced by x and y telescope motions as compared to the image motions produced by tele-

HOW'S THE VIEW?

Although we wouldn't get along too well without the earth's atmosphere, astronomers don't regard it in the same benevolent light because it upsets their observations of the universe. To have an unobscured look at the stars, the observatory must be hoisted above the earth's atmosphere, or at least above 90 percent of it. Using a balloon to lift a three-ton telescope and its control equipment aloft is no mean task, especially when the telescope must be kept on-target within 0.1 second of arc throughout photographic exposure. Since observations are made at night, all equipment experiences extreme cold unrelieved by the "nights" and "days" which enable an earth satellite to warm up periodically scope a motions. The fine guidance servo, however, keeps these excessive E_x and E_y errors from degrading photographic quality. The method used is explained by Fig. 1 (right), an optical diagram of the telescope. Light enters the main tube from the left, strikes the primary mirror and is reflected toward the secondary mirror, directed by the secondary mirror towards the following flat, passes through the field lens and is brought to a focus at the f/50 focal plane by the transfer lens. When the telescope is correctly pointed at the target, an image of the target is formed on the optical axis of the instrument. Outside the target area (approximately 2 min × 2 min arc) and within the 50-minute diameter field of view, will be the images of stars, two of which are used for stellar guidance. One of the two star images strikes the apex of a four-way reflective beam splitter (or retrodivider). The light division is such that the energy reflected to each of four multiplier photo tubes is equal indicating correct telescope pointing. If the telescope develops an X or Y pointing error, the light division becomes unequal. The four multiplier phototube output signals are processed to derive electrical error signals proportional to the mispointing. Such signals drive the transfer lens off axis in a direction to return the star image to the apex of the retrodivider. This action fixes the image of the guide star with respect to the retrodividers in spite of E_x and E_y errors. Several other advantages are provided by this guidance scheme.

The transfer lens, being relatively low in mass, allows a high frequency capability (20 cps) without the huge expenditure of power required to similarly move the whole telescope.

AQUISITION—Without the fine guidance servo, multiplier phototube sensed errors would be proportional to pointing errors over a range of approximately ±0.1 second of arc. The acquisition problem would be extremely difficult since error rate damping would not be highly effective. The fine guidance servo, however, can rapidly move the transfer lens off axis to capture the star image and track it over a range of ±1 minute of arc. Signals proportional to off-axis distances (or pointing error) allow damping over a range approximately 600 times larger. Although the star image could be defocused to similarly increase the linear sensing zone, signal to noise ratio would be reduced.

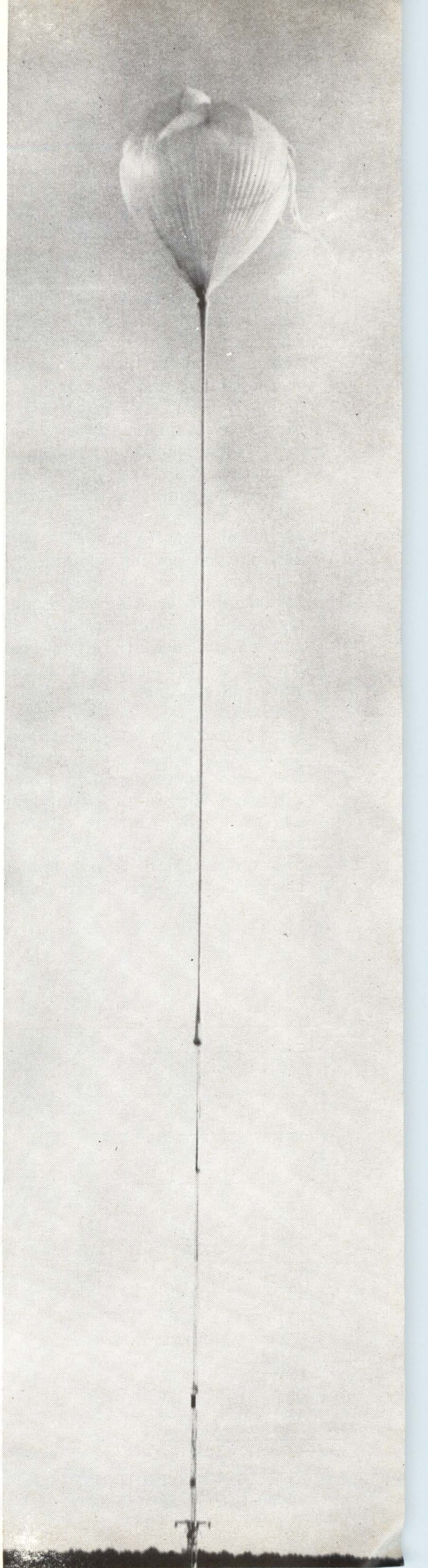
Optical focus quality can be checked by introducing a small fixed amplitude dither signal to the servo amplifier. At best focus, the star image is of minimum diameter and the sensed transfer lens excursions (or rates) will become minimum as the secondary mirror is axially moved to the correct focus position.

Figure 3 is a single axis block diagram of the fine servo system. The nonlinearities provide a constant high slewing speed when large errors exist and a high static gain with good damping around null. The servo thus displays rapid star image acquisition followed by good tracking performance.

The other guide star is used in similar fashion to sense rotation errors E_a but the electrical error signal is simply amplified and fed to the coarse guidance servo.

The guidance electronics is transistorized except for the eight multiplier photo tubes, and contains many interesting circuits. Noteworthy among these are the multiplier phototube preamps, and the error-rate compensation amplifiers.

The multiplier phototube circuit Fig. 2 (left) uses a conventional bleeder string arrangement modified to include a static modulator circuit (connected to pin 14). Capacitor C_1 and resistor R_{18} phase-correct the incoming 26-v, 400-cps signal applied to the primary step-up transformer T_1. The secondary of T_1 feeds the zener diode D_1 (110 v) through C_2. These latter two elements clamp the dynode voltage during alternate half cycles, to the normal voltage determined by the bleeder string elements. On the other half cycles, the dynode voltage is driven by the trapezoidal



AUXILIARY BALLOON *hoists assembly aloft preparatory to takeoff. Once aloft, gas in auxiliary balloon inflates main balloon (hanging limply below it) carrying instrumentation package to 80,000 feet* modulator voltage to the voltage existing at one of the adjacent dynodes. This causes the gain of the multiplier phototube to be varied in square-wave fashion between nominal gain and approximately 1 percent of nominal gain. Signal conversion to a-c is thus accomplished without the use of optical chopping mechanisms whose vibration might shake the telescope and cause photographic degradation.

The preamplifier receives the a-c signal from the multiplier phototube V_1 and amplifies it by a factor between 0.2 and 1.2 $\times$ 10^6 volts/ampere, depending upon the setting of R_1. The gain is set to achieve an overall transfer factor of 0.6 $\times$ 10^9 volts rms per input lumen. The 3-db passband of the amplifier, 130 to 800 cps, reduces the output noise caused by the multiplier-phototube shot effect and by the higher harmonics of the otherwise square-wave output signal.

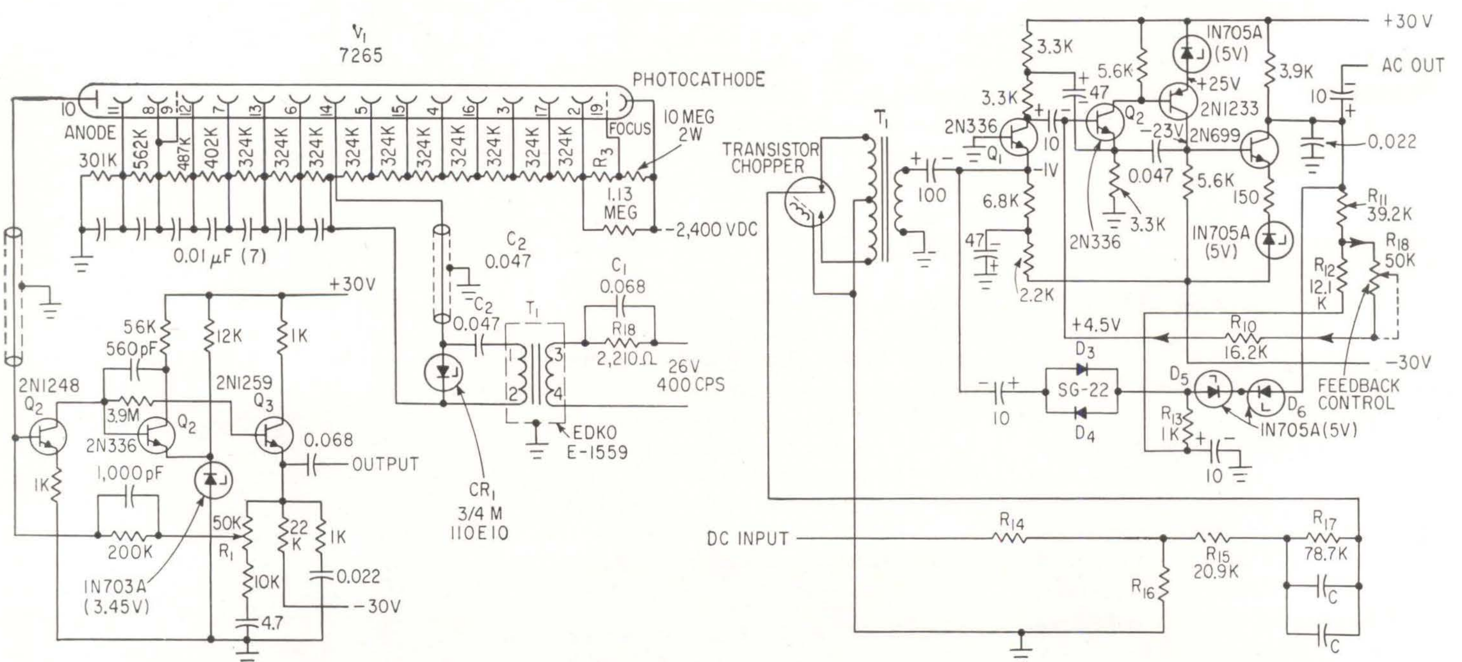
Transistor Q_1 is operated with a low collector voltage, approximately 4 volts, and a collector current in the microampere region to achieve a preamplifier noise contribution negligible when tracking dimmest stars (ninth magnitude). The d-c collector voltage of Q_3 is nominally at signal ground to allow the large output signals which prevail when tracking the brightest stars (fifth magnitude).

The error rate compensation amplifier, Fig. 2 (left), contains the lead-lag compensation network for servo-system stabilization, plus components for manual and inflight adjustment of gain. The signal output is restrained by nonlinear feedback from exceeding 5 v peak; a requirement dictated by servo performance considerations. Resistors R_{14}, R_{15} and R_{16} give the desired nominal gain while presenting equal input and output impedances of 10,000 ohms. The load on the preceding 400-cps demodulator filter combination is thus constant while the 10,000-ohm output impedance is used as part of the lead lag network that follows. This network provides the chopper modulator with a d-c signal that is 3.5:1 lead corrected with C_{10} and C_{11}.

The chopper output to transformer T_1 provides a signal modulation prior to subsequent amplification. Transistor Q_1 receives the T_1 output and furnishes it at high impedance level to the base of Q_2. The base of Q_2 acts as the amplifier summing point and also receives the feedback signal. A motor driven potentiometer, R_{18}, allows in-flight gain adjustment over a range of $\pm\sqrt{3}$ about the nominal gain setting. A maximum nominal gain of 2.73 v. rms per volt d-c is achieved with less than 5 percent gain variation over the temperature range of -65 C to $+50$ C. Components D_5, D_6 and R_{13} provide the feedback to accomplish 5 v clamping, while D_3 and D_4 block the small feedback signal through the capacitance of D_5 and D_6 prior to zener conduction.

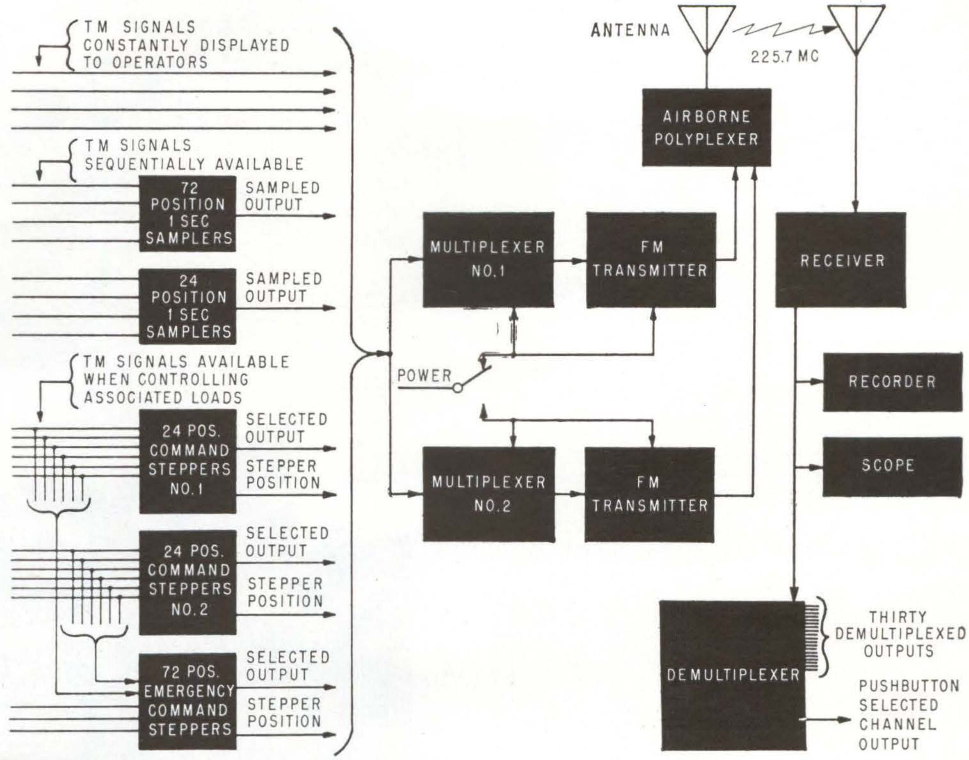
COMMAND SUBSYSTEM — Remote control of the various portions of the telescope is accomplished by two normally operative parallel command *rf* links and associated equipment. The subsystem receives on-off commands from operator-controlled switches, and produces corresponding airborne relay closures. The relays provide d-c bipolar on-off signals to the decoder, which routes these signals to the loads. Complete control of the telescope, with added burden on the ground operator, is also possible with only one *rf* link operative.

TELEMETRY SUBSYSTEM — This subsystem provides the ground operator information on telescope reactions to the transmitted on-off commands and other data such as



MULTIPLIER PHOTOTUBE *has gain switched between maximum and one percent values by 400-cycle modulating input (left), error-rate compensating amplifier (right) uses zeners D_5 and D_6 to anchor output within 5-volt peaks—Fig. 2* temperatures and battery voltages. Telemetry input signals, in proportional voltage form and between ±2 v d-c in amplitude, can be reproduced on the ground with accuracy and frequency response of approximately one percent and ten cycles respectively. Two sixty-four channel multiplexers simultaneously receive up to 60 input signals from the sources directly, from each of two sequentially sampling stepping switches, and from the three command stepper pairs.

Each multiplexer is a solid-state scanning commutator operating at a clock rate of 4,000 cps to achieve a 62.5 cps sampling frequency for each input channel. The input signals are sequentially sampled to obtain the composite PAM signal required to frequency-modulate the transmitter. The transmitter is a precision multivibrator forced to deviate in frequency by the PAM input signal, followed by frequency multiplier and power output stages. The transmitter output signal is routed to the antenna through the polyplexer.



AIRBORNE TELEMETRY *system accommodates 64 transmitted instruction and feedback channels; tape recorder permits reenactment of flight activity, assists fault diagnosis—Fig. 3*

RECEIVER—The Nems Clarke receiver high sensitivity-crystal controlled unit, receives the transmitted signal and produces an output PAM signal proportional to the multiplexer output signal. A tape recording of this signal during flight allows later playback to reenact the flight history with reduced accuracy. The oscilloscope displays the PAM signal directly in bar graph form for display of the less critical data transmitted on channels 33 through 64. Provided on the scope is a photographic negative mask through which the bar presentation is viewed and upon which appear the individual bar identifications. Since certain of these bars represent known reference voltages, the scope gain controls can be used to calibrate the display.

The demultiplexer, also receiving the PAM signal, synchronizes its internal clock frequency on a 2.5-v reference pulse transmitted over channel 1 and adjusts its internal scale factor and clamps the composite signal at the d-c reference level by data transmitted on three other channels.

The composite signal, so processed and amplified, is used to drive thirty-one box-car detectors, each provided with gating pulses time referenced to the synchronizing pulse. Thirty of the demodulated output lines are equal to given transmitted signals and are primarily used to drive associated meters calibrated in terms of the original quantities. The other demodulated output is derived from a box car whose input gate is pushbutton selectable and so can provide, in demultiplexed form, any one of the 64 original input signals.

The sequential data, derived through the one-second airborne steppers, is normally recorded on paper tape by a strip-chart recorder. Each of these two steppers generates an easily recognized signal pattern, when passing over several consecutive known positions, to form a decoding reference. In addition, a ground command has been provided with which stepping can be halted at any position for closer inspection of a desired signal.

CONCLUSION — The scientific package has been modified, for the first flight, to perform the nonphotographic mission of measuring the infrared spectra from the planet Mars and possibly Venus with similar measurements of the Moon spectra planned as controls for the Martian observations. Later flights will be devoted to photographic missions with Venus, Jupiter, Saturn, gaseous nebulae of our galaxy, globular clusters, and the center of the Andromeda galaxy representing a few of the many possible targets.

The scientific package and the other portions of Stratoscope II, were developed under the direction of Professor Martin Schwarzschild of Princeton University and sponsored by NSF, ONR and NASA.

The author would like to express his appreciation for the assistance of J. R. Pascucci and D. Hoeffner, in the preparation of this article.

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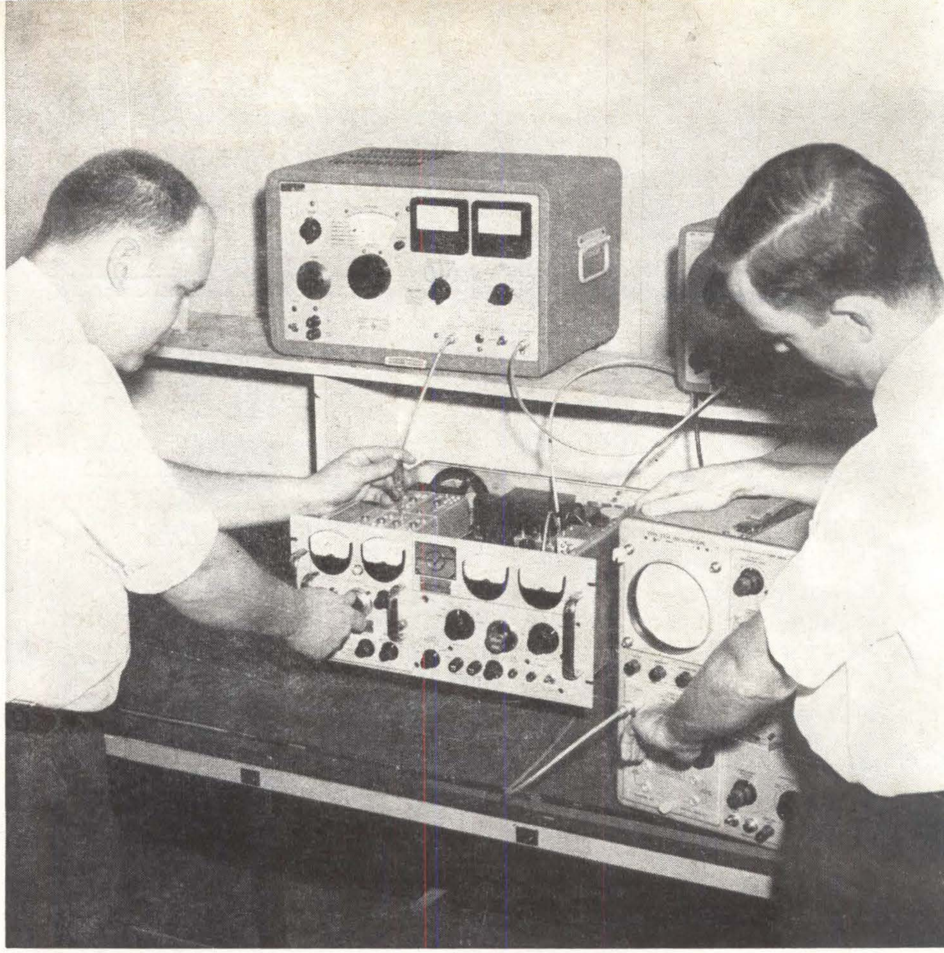
AUTHORS' *Casson (left) and Hall adjust the phase-tracking module mounted in a telemetry receiver*



TO LOCK OR NOT TO LOCK

When receiving phase-modulated signals, as in telemetry, demodulators having acquisition thresholds less than —150 dbm often lock on to first and higher order sidebands. It is usually impossible to assure carrier lock until the signal level exceeds the information channel threshold when the extreme distortion-attending sideband lock is apparent. By using f-m discriminator type techniques in an a-m detector, it becomes possible to cancel the effects of the sidebands until necessary for use

New Phase-Tracking Demodulator Will Not Lock on Sidebands

While the tracking loop is automatically searching for signals around the i-f frequency, an antisideband circuit rejects sideband locking. After signal acquisition, the device provides both p-m and a-m demodulation

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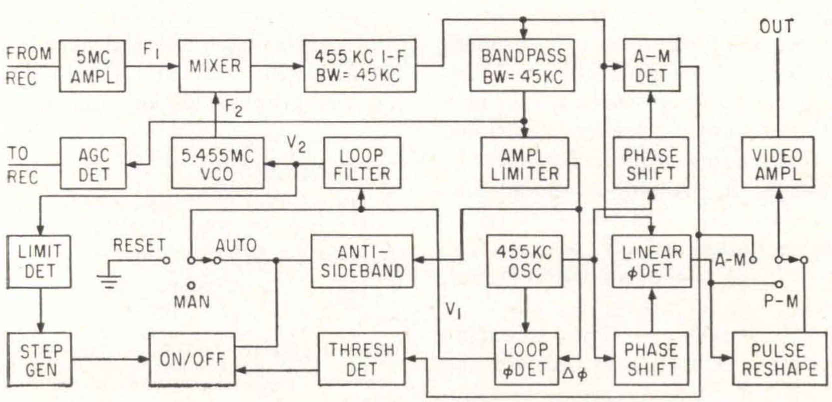


OUTPUT *of a telemetry receiver is fed to the phase-tracking demodulator that scans the i-f frequency for a signal. The antisideband circuit prevents locking on any associated sidebands—Fig. 1*

IN RECENT YEARS, a number of tracking filters and demodulators using phase-lock techniques have been developed for use with telemetry and related signals. Although sophisticated in design, these devices suffered from difficult or time-consuming changing of carrier frequency with associated narrow frequency range, inability to distinguish between a carrier and associated sidebands and the necessity of separate receivers of other auxiliary equipment.

CIRCUIT—To minimize incidental phase jitter, the receiver first and second local oscillators must be crystal controlled.

As shown in Fig. 1, receiver 5-Mc output is applied to a double-tuned, 5-Mc amplifier having 100-Kc bandwidth. Besides increasing signal amplitude, it also provides additional agc and at least 60-db attenuation of image frequency.

TRACKING LOOP—The tracking loop is also supplied with a 455-Kc, crystal-controlled reference frequency.

The phase detector is a balanced or multiplying type that generates an error voltage proportional to the cosine of the phase difference between the 455-Kc reference signal and a locked received signal ($E_d = K \cos \Delta\phi$). At $\Delta\phi = 90$ degrees, the error voltage is zero and at phase angles near 90 degrees the detector output is approximated by $E_d = K (90 - \Delta\phi)$. In the unlocked condition, the output of the phase detector consists of the beat frequency between the received signal and the reference signal and contains no d-c component.

The error voltage output of the loop-phase detector is applied to the loop filter. This is an active circuit using a highly-stable, solid-state operational amplifier with open loop gain in excess of 20,000. Feedback circuits give the loop the overall transfer function $H(S) = \phi_{out}/\phi_{in} = 1 + (\sqrt{2}/\omega_o)\, S/1 + (\sqrt{2}/\omega_o)\, S + (1/\omega_o)\, S^2$ where $\omega_o = 2\pi f_o$ = loop natural frequency, $2B_{LO} = 1.06\, \omega_o$ = loop bandwidth at threshold and

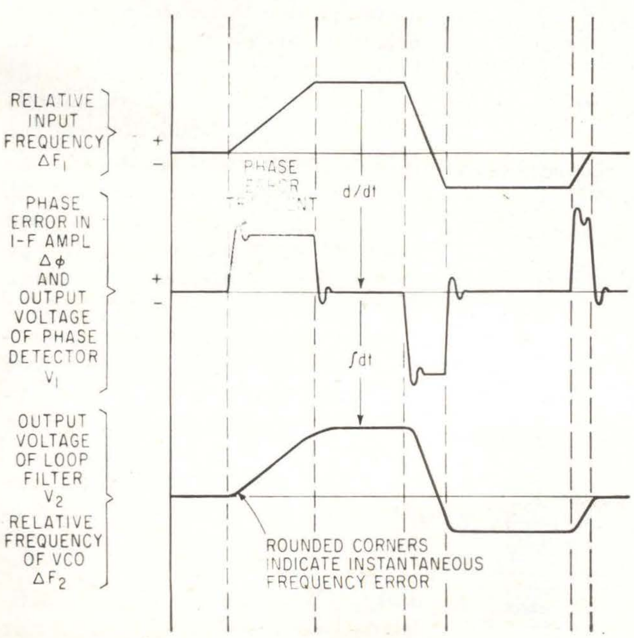
$$\frac{1}{2\pi j} \int_{-j\infty}^{+j\infty} |H(S)|^2 \, ds =$$

equivalent noise bandwidth.

The d-c output of the loop filter is applied to a voltage-variable capacitor in the frequency determining elements of the vco. When the loop is phase-locked on a received signal, the frequency of the vco, determined by capacitor voltage, is such that the frequency difference between the received signal and the vco input to the mixer equals the frequency of the 455-Kc reference oscillator. In addition, if other than a 90-degree phase difference exists between the received signal applied to the phase detector and the reference signal, the error voltage will drive the output voltage of the loop filter in a direction to reduce phase error. This operation is shown in Fig. 2. With a constant frequency shift with respect to center frequency, the phase error and the error voltage from the phase detector will be zero and the output of the loop filter will be constant. Also, a constant rate-of-change of frequency will produce a constant phase error, error voltage and a linearly changing output.

Thus, the phase-lock loop performs a double integration on phase-error voltage, the first integration taking place in the vco and the second in the loop filter. Phase tracking loops have been designed using a third-order loop transfer function that is three integrations. However, a second-order loop is the best compromise between acquisition of a signal in the presence of noise and maintaining lock on a weak signal.

The voltage-controlled oscillator incorporates a second voltage-variable capacitor controlled by a 10-turn potentiometer to vary the center frequency of the vco approximately ±15 Kc with respect to the nominal frequency of 5.455 Mc. This range is sufficient to compensate for accumulated tolerance in the transmitter and receiver crystals. A vernier adjustment is the manual sweep control.



GRAPHICAL *representation of operation of the phase-tracking loop—Fig. 2*

SWEEP CIRCUITS — When the unit is switched to the automatic sweep mode and before a signal is acquired, vco frequency is continuously swept ±5 Kc with respect to the center frequency. Sweep is accomplished by applying a step function to the input to the loop filter (integrator). The output of the integrator will be a linear ramp function applied to the loop voltage-variable capacitor in the vco. This voltage is also sampled by a limit detector which reverses the polarity and changes the amplitude of the step function when a voltage corresponding to the high- or low-frequency limit is reached. The sweep rate is determined by the amplitude of the step function. The band is swept from the high-to the low-frequency end at three selectable sweep rates, 75, 250 and 500 cps per second. Sweep retrace is approximately 5,000 cps per second.

As the unit is about to acquire a signal in the search band, a d-c voltage is produced by an a-m synchronous detector and applied to a threshold detector. This circuit removes sweep voltage from the input to the loop filter and allows the loop to lock on the signal. A panel light is also energized. If the signal drops below the locking threshold, the sweep function will be resumed after a delay of approximately three seconds.

DEMODULATORS — The modulated signal from the i-f amplifier is applied to both the a-m and p-m synchronous demodulators. The 455 Kc reference signal is applied to each demodulator through an adjustable phase-shifting network. The a-m demodulator consists of a balanced phase detector to which the received signal and the reference signal are applied in phase, producing an output proportional to the product of the two signals. This type of a-m demodulation is free from threshold effects associated with envelope detectors.

AGC—The agc voltage for the 5 Mc amplifier and earlier stages of the receiver is obtained from a diode detector and stablized d-c amplifier connected to the output of the 4-Kc filter to reduce the agc threshold considerably below that of the information channel. This assures agc control on all usable demodulated signals. Control range is from −130 dbm to −40 dbm with a-m and −20 dbm with p-m. The time constant was made as small as possible consistent with the lowest modulating frequencies.

ANTISIDEBAND CIRCUIT—This circuit prevents the tracking loop from locking on to sidebands of the modulated signal. With 90-degrees peak-phase deviation, a phase-modulated signal has fourth-order sidebands less than 34 decibels below the carrier. With acquisition thresholds of less than −150 dbm, locking on to first and higher order sidebands has been a constant problem with previously designed equipment, particularly in automatic-search operation. It is usually impossible to assure carrier lock until the signal level exceeds the information channel threshold when the extreme distortion attending sideband lock is apparent.

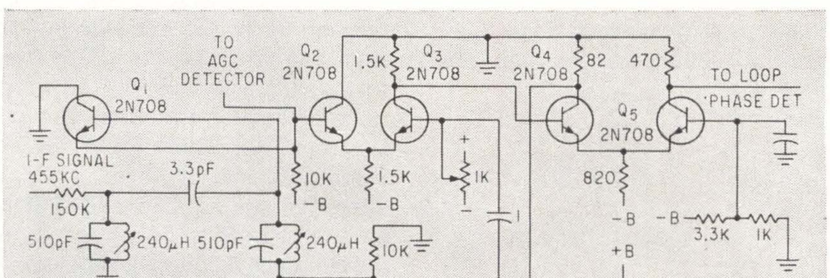
The circuit consists of a narrow-band frequency discriminator tuned for zero output at 455 Kc. When locked on a carrier, the spectral output of the i-f amplifier consists of the carrier, heterodyned to 455 Kc (actually equal to the reference oscillator frequency), surrounded symmetrically by the information sidebands. Under these conditions, the output of the discriminator will be zero. However, in sideband lock, the sideband will be translated to 455 Kc and the carrier will be displaced by some multiple of the modulating frequency, depending on the order of the sideband. For example, if the loop locks on the third lower sideband of a pcm signal with a switching rate of 1 Kc, the translated carrier frequency will equal 458 Kc ($455 + 3 \times 1$ Kc). The asymmetrical spectrum applied to the discriminator generates an error signal which overrides the loop phase detector voltage and continues the search sweep voltage.

The output signal from the 455 Kc i-f amplifier is applied through a 4-Kc double-tuned band-pass filter to emitter follower Q_1 as shown in Fig. 3. The filter lowers the threshold level of the discriminator (as well as the agc detector) well below that of the information channel, thus assuring carrier lock at the information threshold. The emitter follower drives the first limiter Q_2 and Q_3. The output of this stage is applied to the second limiter Q_4 and Q_5 which in turn supplies signal to the discrimnator and loop-phase detector. Two stages of limiting are necessary for satisfactory operation with a-m signals.

The discriminator consists of emitter followers Q_6 and Q_7, each driving a series-tuned circuit and diode detector. The tuned circuit resonant frequencies are 5 Kc above and below 455 Kc. The d-c output of the two detectors are opposite in polarity and the circuit is tuned so the two voltages cancel at the base of emitter follower Q_8 when the input frequency is 455 Kc. For off-tune frequencies, the resulting difference voltage is applied to a logic circuit that produces a constant positive output voltage whenever the positive or negative voltage at the emitter of Q_8 exceeds the breakdown voltage of the base-emitter junction of Q_9 or Q_{10} in series with diodes D_1 and D_2. This antisideband error signal is applied to the loop filter input.

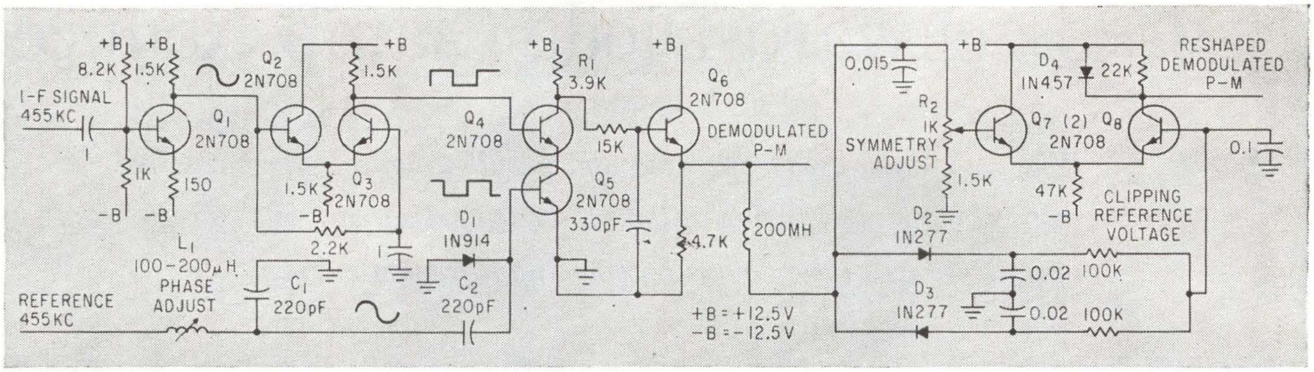
The discriminator also generates a voltage due to the off-center signal, as a carrier is approached and before lock takes place.

The output of the logic circuit will add to the sweep voltage at the loop filter input and greatly accelerate sweep rate. The diodes in Q_9 and Q_{10} emitters provide a dead space of approximately ±300 cps around the center frequency where the discriminator error voltage is insufficient to produce the accelerating voltage. Thus, the sweep rate is greatly accelerated until the carrier is within 300 cps of lock, then the sweep is reduced to the normal rate. The result is that acquisition times are greatly reduced for useful signal strengths.



ANTISIDEBAND *circuit uses two detectors, tuned 5 Kc above and below the i-f, so that sideband signals associated with the carrier are rejected. D-c output of both diode detectors cancel at 455 Kc—Fig. 3*

PM DEMODULATOR AND RESHAPING CIRCUIT—This circuit



PHASE DEMODULATOR *has high degree of linearity with deviations as large as 85 degrees. The reshaping circuit makes output symmetrical—Fig. 4*

exhibits a high degree of linearity with phase deviations as high as ±85 degrees without using transformers or tuned circuits.

The basic elements of the system are symmetrical clipping of both the received signal and reference voltages, the application of two signals 90-degrees out of phase to a coincidence circuit and the integration of the output pulses of the coincidence circuit to obtain the information.

The 453 Kc phase modulated signal from the i-f amplifier is fed to a linear amplifier Q_1 (see Fig. 4) where the level is increased approximately 20 db. The sine-wave output is applied to the symmetrical clipper Q_2 and Q_3. The same d-c bias is applied to both transistors, but the base of Q_3 is at ground potential for signal voltage. A positive signal voltage applied to the base of Q_2 will raise the emitter voltage of both transistors and cut off Q_3. However, the fixed bias on the base of Q_3 will prevent the emitter voltage from dropping below the steady-state value and, thus, a negative voltage on the base of Q_2 will cut it off. The result is that with peak signal voltage in excess of about ±0.5 v applied to the base of Q_2, one or the other transistor will be cut off and the collector current of Q_3 will switch between zero and some steady value. With a 10-v peak-to-peak signal applied to the circuit, a symmetrical square-wave signal is obtained at Q_3 collector.

The 455-Kc reference signal is passed through an adjustable phase-shift network, L_1 and C_1, and then is clipped to a square wave by silicon diode D_1 and the base-emitter junction of Q_5, with C_2 providing the necessary series impedance.

Phase demodulation takes place in coincidence circuit Q_4 and Q_5. The modulated signal, after being squared by the clipping circuit, is applied to the base of Q_4. The reference signal, also squared, is applied to the base of Q_5 and the phase-shift circuit adjusted to obtain a 90-degree phase difference between the two signals. For current to flow in the series circuit consisting of Q_4, Q_5 and load resistor R_1, a positive saturating voltage must be applied simultaneously to the bases of both transistors. Thus, with exactly a 90-degree phase difference between the two signals, current will flow through R_1 for $\frac{1}{4}$ cycle or 90 degrees. If the phase difference is 180 degrees, current never flows and if the signals are in phase, the current will flow for $\frac{1}{2}$ cycle or 180 degrees. As the relative phase between the reference voltage and the received signal is varied (as during modulation) from 0 to 180 degrees or 90 ± 90 degrees, the length of the voltage pulse produced at the collector of Q_4 will be linearly proportional to the phase difference, varying between 180 degrees and zero. The pulses from the coincidence circuit are applied to the integrating network where the modulation is separated from the i-f frequency components.

The reshaping circuit consists of a low-pass filter, a symmetrical clipper and a symmetry-sensing circuit. The output of the p-m demodulator is first passed through a low-pass filter with a cutoff frequency of 4 Kc. The filter improves the signal-to-noise ratio, and the attending loss in pulse rise time is restored in the following clipper.

Clipping circuit Q_7 and Q_8 functions similarly to the symmetrical clipper Q_2 and Q_3. However, in this circuit the base voltage of Q_8 instead of being equal to that of Q_7 is derived from the symmetry-sensing circuit D_2 and D_3. This circuit consists of two peak detectors, one for positive pulses and one for negative pulses, the polarity with respect to the d-c level at the circuit input. The network is connected so the voltage applied to the base of Q_8 is equal to the difference between the output of the two detectors superimposed on the d-c level at the input to the circuit. This voltage determines a reference about which clipping takes place. This maintains the clipping level symmetrically between the positive and negative peaks of the input signal independent of signal amplitude, pulse length or d-c level.

For example, if the input signal contains positive pulses twice the amplitude of the negative pulses with respect to the d-c level, the voltage applied to the base of Q_8 will equal the d-c level at the base of Q_7 plus a positive error voltage equal to the difference between the positive and negative pulses. The result is that reshaped pulse width is maintained equal to the width of the input signal at one-half the peak-to-peak amplitude and a maximum amount of noise is sliced off the information.

Application for patent is in process.

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Backward-Diode Clamp Reduces

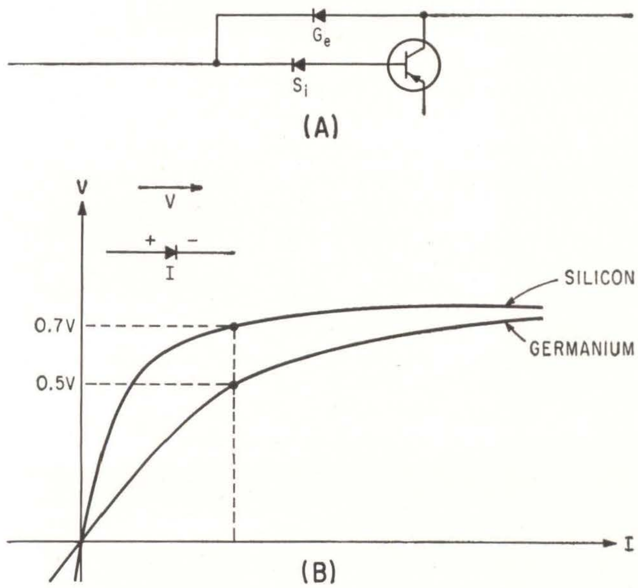
When a tunnel diode operates above valley-voltage the principal current flow is diffusion rather than tunneling current. This clamp circuit reduces time delays by limiting diffusion current

TUNNEL DIODES have three different types of current flowing throughout their *I-V* curves.[1] When the tunnel diode operates above valley-voltage, the principal current flow is diffusion rather than tunneling current. This creates a problem in switching the tunnel diode to and from the high-current, high-voltage state. At high current levels, a fast increase in diffusion current is opposed by an inertial inductance, while a fast decrease in diffusion current is opposed by diffusion capacitance. The switching time is a function of the *R-C* prouct, where *R* is the negative resistance of the tunnel diode and *C* is the capacitance measured at the valley point of the diode current-voltage characteristic. When the total switching time of a tunnel diode circuit is much greater than *R-C*, time delays due to inertial inductance and diffusion-capacitance can be neglected; however, when the switching time approaches *R-C*, reactances account for a significant portion of total switching time.

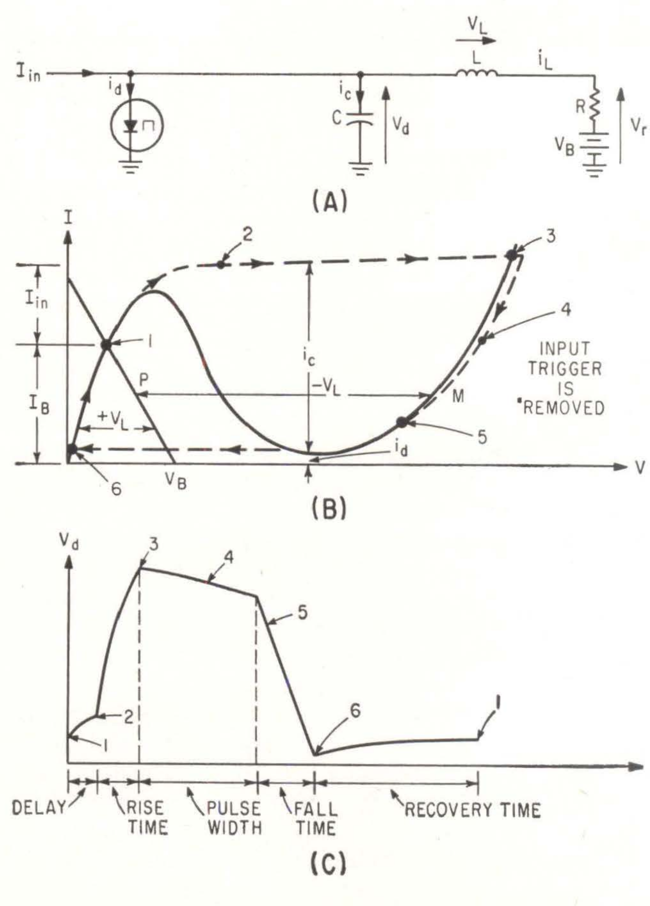
CLAMP—To prevent minority carrier-storage in the base region of transistors, Baker[2] used a clamp as show in in Fig. 1A. The operation of this clamp depends upon the difference in forward drops between silicon and germanium diodes as shown in Fig. 1B. This method however, cannot be used for nsec speeds because of diffusion current storage in the clamp diodes.

BACKWARD DIODE CLAMP—A circuit that provides the desired clamping action[3] is shown in Fig. 3A. The clamp has no effect until the tunnel-diode voltage rises to the clamp voltage V_c. The backward diode conducts above the clamp voltage and has no storage-time effects, since appreciable minority carriers are not permitted to flow. The composite load line on the tunnel diode I-V characteristic curve, is determined by R_L and the backward-diode characteristics. An inductance *L* is connected in series with the backward diode to prevent it from capacitively loading the diode. The inductance must be large enough to prevent loading the tunnel diode and small enough to permit the clamp to function.

I_p/I_v RATIO—Since all backward diodes have a degenerate tunnel-



CLAMP *operation depends upon the difference in forward-voltage drops in silicon and germanium diodes (A) and voltage curves for the two diodes (B)—Fig. 1*



NORMAL *monostable gate (A), I-V operating trajectory (B) and output-voltage waveform (C)—Fig. 2*

Tunnel-Diode Delays

By W. T. Rhoades
Staff Engineer,
Hughes Aircraft Co., Fullerton, Calif.

diode characteristic in the reverse direction, this current may be used to increase the effective I_p/I_v ratio of a tunnel diode. By placing the backward diode reverse current hump at the same forward voltage as the valley voltage of the tunnel diode, the overall I_p/I_v ratio can be made as high as 50 to 1. This represents an improvement of ten to one. There is no increase in speed with the increased I_p/I_v ratio, but larger fan-out can be obtained from tunnel diode gates[4].

DIFFUSION CURRENT INCREASES TIME DELAYS

When principal tunnel-diode current flow is diffusion instead of tunneling current, a problem arises that makes switching the diode to and from the high-current, high-voltage state difficult.

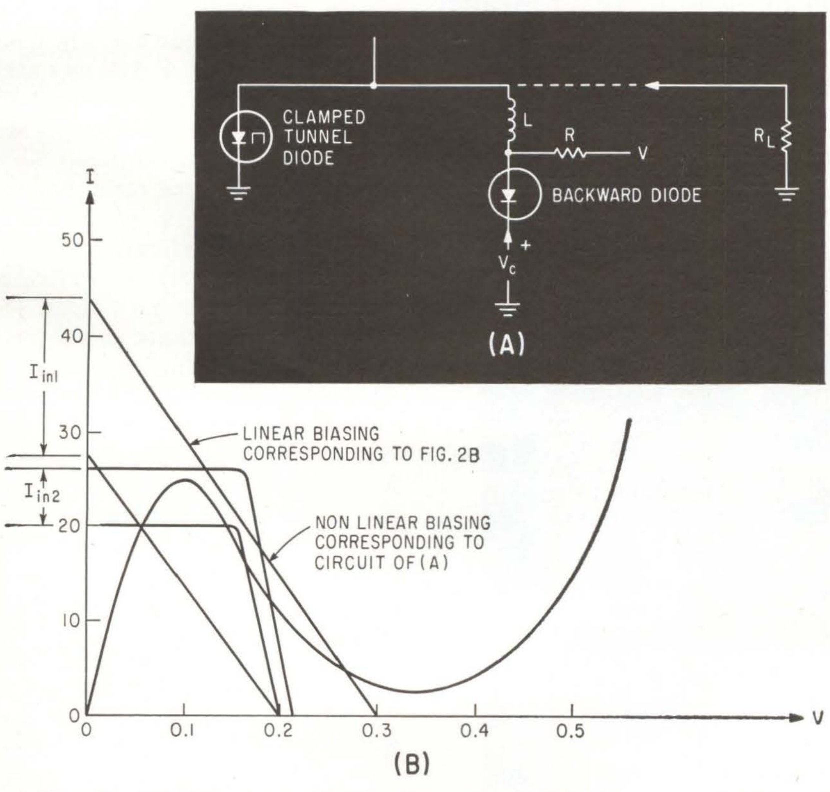
Switching time is a function of the R-C product. When the total switching time exceeds R-C, time delays from inertial inductance and diffusion capacitance are negligible. When switching time approaches R-C, however, reactances account for a considerable portion of the total delay.

This clamp circuit reduces switching time by limiting diffusion current flow.

OPERATION—The advantages of using the clamp for this gate are reduced fall time, increased fan-out, constant high-voltage level and reduced overshoot.

For monstable operation, another advantage is obtained with this clamp. The normal monostable gate[5] is shown in Fig. 2A, the I-V operating project trajectory in Fig. 2B, and output voltage waveform in Fig. 2C. A serious disadvantage of this mode is long minimum pulse width and recovery period. The speed from point 4 to point 5 in Fig. 2B depends upon how quickly the current in the inductance can change. This instantaneous rate of current change in the inductance L depends on the voltage V_L across the inductance, divided by L. The difference V_L between the biasing network voltage V_r defined in Fig. 2A and the tunnel-diode voltage V_d is represented by the distance PM in Fig. 2B. Since this distance, for a fixed bias network, has an upper limit determined by the tunnel diode I-V curve, the pulse width can be decreased only if the inductance is decreased. The same applies between the points 5, 6, and 1 in Fig. 2B and 2C where the V_L is positive. To obtain a 5-nsec total cycle time for tunnel diodes having I_p/C of 5 ma/pf, the inductance has to be made so small (5 nanohenries) that it no longer blocks the trigger current I_{in} from being partially diverted through R of Fig. 2A. This effect is shown in Fig. 3B; note the large trigger current I_{in1}. The trigger current I_{in1} is now about 2 to 3 times I_p-I_B, and the end result is a low current gain.

By using the clamp circuit shown in Fig. 3A, this situation is corrected. The relative magnitudes of I_{in} with linear and nonlinear biasing are shown in Fig. 3B. Thus, the clamp circuit provides efficient switching and fast recovery.



TUNNEL DIODE *clamp circuit that reduces diffusion current (A) and relative magnitudes of input current with linear and nonlinear biasing (B)—Fig. 3*

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High-Speed Servo Positioner

Assembling mesa transistors requires attaching a gold lead to an extremely small metalized contact assembly. This can present a serious problem in mass production. An optically controlled servo positioner and associated logic is used to control automatic thermocompression bonding

TO AUTOMATICALLY ATTACH lead wires to the stripes of a mesa transistor, the bond location was fixed in reference to the frame of the machine and the stripes of all incoming units were referenced to this location. The positioning mechanism determines the location of the stripes and moves the semiconductor in the appropriate direction until the stripes are in position to be bonded. For high speed and simplicity, a repetitive optical scan was chosen to locate the stripes.

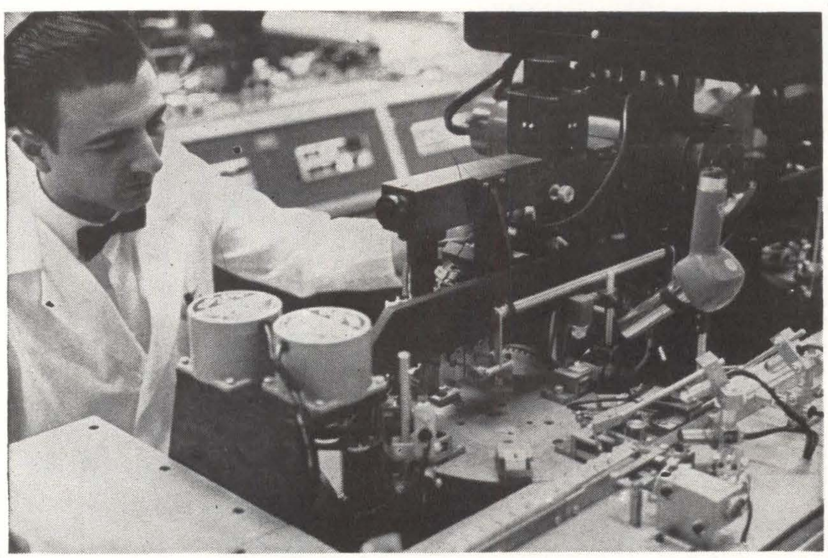
Maximum amount of luminous contrast between the stripes and their surroundings is obtained when the unit is illuminated from an angle approximately 45 degrees from the vertical as shown in Fig. 1. Since the unit is viewed from the vertical, the polished, specular surface of the semiconductor material appears black, while the matte surface of the stripes reflects light diffusely. Some of the light is reflected in the vertical direction and makes the stripes appear brighter than the background.

To gather as much light as possible and reduce the effects of minor imperfections, scanning spot area is made large as possible. Dimensions of the scanning spot are limited in the direction of scan by the small positioning tolerance ($\pm$0.00015 in.) and the requirement that the space between the two stripes be distinguished. To satisfy these conditions, a scanning spot 0.0002-in. in width is used. The height of the scanning spot is set at 0.002-in., limited primarily by the loss of discrimination resulting from image skew.

The characteristic pattern of variations in light intensity derived from a scan of the mesa transistor is shown in Fig. 2A. Figures 2B, 2C and 2D show variation in the pattern caused by vertically displacing the image. Between the displacements shown in Fig. 2C and 2D, the pattern caused by the mesa and stripes disappears. Two such scans, if separated by 0.002-in. as in Fig. 3A, will result in a condition where displacement of the image either up or down will cause the characteristic pattern to appear in either one or the other of the scans. When the image is correctly centered, as in Fig. 3A, the pattern will occur in both sweeps, or neither, depending on the actual length and reflectivity of the stripes. Since displacement of the image either up or down will result in the characteristic pattern occurring in one or the other of the scans, an indication of error and the direction of error can be obtained by determining which scan reveals the pattern.

Positioning in the horizontal (X) axis is accomplished by a third center scan, shown in Fig. 3B. When positioning in the Y axis is nearly complete, the characteristic pattern caused by the mesa and stripes will appear in this center scan. Since the scan proceeds in serial fashion, the light intensity pattern may be checked for conformity to a preprogrammed pattern indicative of a scan of the mesa and stripes. The pattern requirements have been fulfilled by the time the scanning slot has passed over the edge of the mesa and the emitter stripe and exposes the edge of the base stripe. At the instant of exposure of the edge of the base a recognition signal is generated. The location of the scanning slot when this recognition signal occurs thus represents the location of the base stripe.

The direction of scan is assumed as left to right in Fig. 3D and E. The desired location of the base stripe (point A) is defined by a zero timing signal occurring at the time the scanning slot is viewing point A.



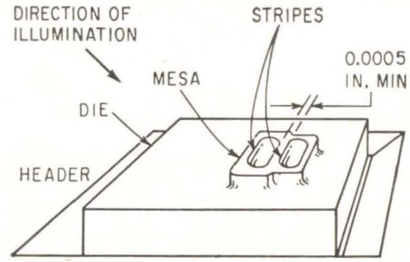
ATTACHING *contact leads to active elements of a mesa transistor is difficult when contact areas are 0.002 $\times$ 0.003 inches, separated by 0.0005 inch*

Bonds Mesa Transistors

By ROBERT L. MOORE
IBM Components Div.,
Poughkeepsie, New York

A FLEA ON A FLEA ON A FLEA . . .

High-speed assembly of physically small items can become mechanically difficult. When such small items are further complicated because they have even smaller parts to be attached, the process can become a mechanical nightmare. To preserve sanity, electronics and a servo positioner can be used to sort out the parts, position them properly and stick 'em together



ILLUMINATING *45-degrees off vertical produces maximum contrast—Fig. 1*

To determine positioning error and direction in the horizontal axis, the time of occurrence of the recognition signal can be compared with the time of occurrence of the zero signal. Recognition after the zero signal indicates that the image is displaced to the right of center (Fig. 3D) while recognition before the zero signal indicates that the image is displaced to the left of center (Fig. 3E).

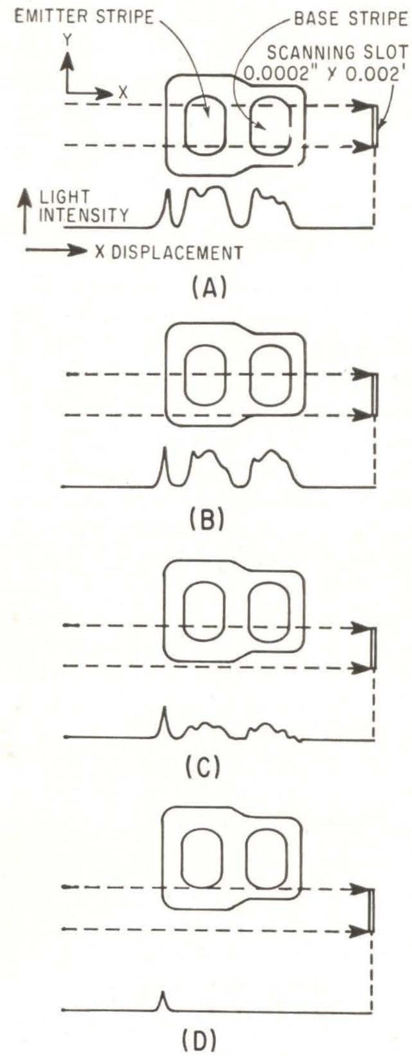
SCANNING MECHANISM — The method of positioning determines design of the scanning mechanism. Scanner requirements are: an optical system to form an enlarged, real image of the transistor; a scanning mechanism to sample the light intensity across the image; a means of converting variations in light intensity to variations in an electrical signal; and a timing system to determine the location of the scanning spot.

The optical system selected consists of commercially available microscope elements. A 2× microscope objective was chosen to permit sufficient working distance between the lens and transistor. A linear magnification of 50 was chosen to prevent the positioning accuracy from being overpowered by normal mechanical tolerances. The combination of a 25× eyepiece and a projection distance of 10 inches provides the required magnification, while holding the length of the system to a reasonable dimension.

The real image formed by the lens system is limited to a 1-inch square by an aperture plate and is focused on the surface of a hollow, rotating drum. Slots cut through the surface of this drum perform the scanning function by allowing light from progressive portions of the image to pass through the drum where it is collected by a multiplier phototube as shown in Fig. 3C. The output of the multiplier phototube is the equivalent of that shown in Fig. 2A, with the light intensity axis changed to electrical current and the displacement axis changed to time. To preserve the equivalence of time and displacement, the scanning drum is driven by a synchronous motor at 1,800 rpm.

The surface of the scanning drum, shown in Fig. 4, contains eight slots equally spaced around its periphery. The slots are staggered axially along the drum in the order; center, top, center, bottom. The drum is of sufficient diameter so that only one of the slots can be within the 1-inch image area at any time.

The scanner of Fig. 4, illustrates the method of obtaining required timing information. Center slot (*C*-1) is ready to begin its traverse of the image. At this same instant, a corresponding center slot (*C*-3) 180-degrees away exposes a photodiode to the light from an incandescent lamp. The photodiode, under the stimulus of this light, emits a signal which identifies the following scan as being through the center of the image. Continued rotation of the drum brings slot *C*-1 to the center of the image. At this instant, another center slot (*C*-4) 90 degrees away exposes a photodiode to the sharply focused light from another incandescent lamp. The output signal from this photodiode defines the desired location

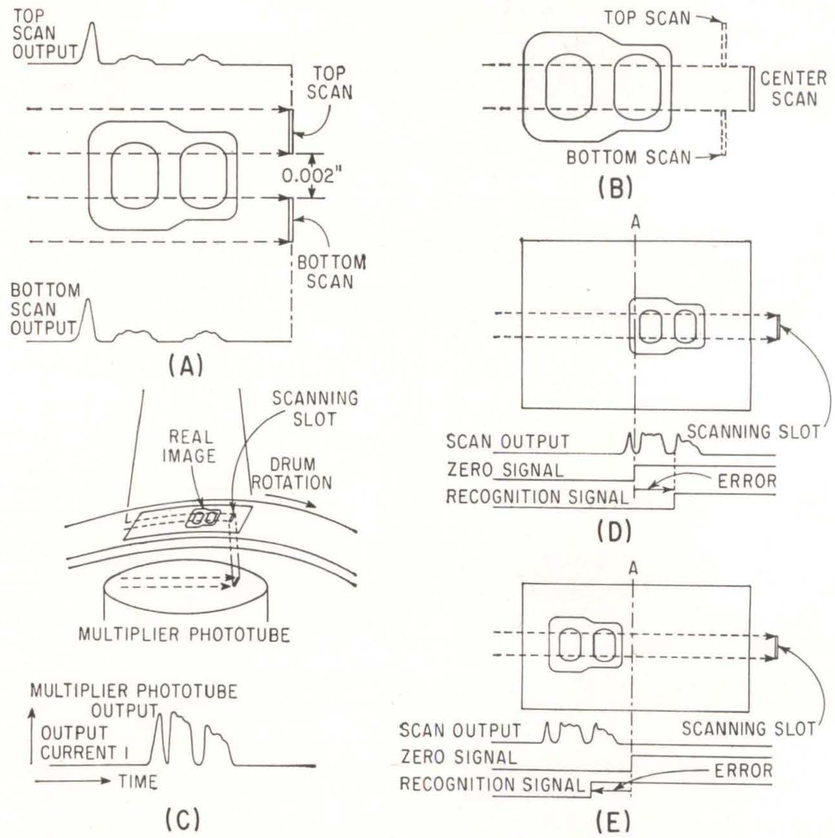


VARIATION *in light pattern output caused by vertical displacement of the scanning slot—Fig. 2*

of the base stripe in the *X* direction. Since reproducibility of the timing of this signal is essential for accurate positioning in the *X* axis, the light is sharply focused on the drum surface. This results in a fast-rising signal whose timing is only slightly affected by aging of the lamp and variations in gain.

Since positioning in the X axis is accomplished only with the center sweep, no zero signal is required during the top and bottom sweeps. However, an indication of when these sweeps begin is necessary.

Therefore, at this time a signal is required just preceding the start of either of the top sweeps and another signal just preceding either of the bottom sweeps. These signals are obtained from the top and bottom photodiodes. When the first top slot T is ready to start its scan of the image, drum slot B' uncovers the top photodiode. When the second top slot T' is ready to start its scan, drum slot B uncovers the top photodiode, resulting in an output signal from this photodiode preceding each of the top scans. A similar action occurs with bottom photodiode preceding each sweep.

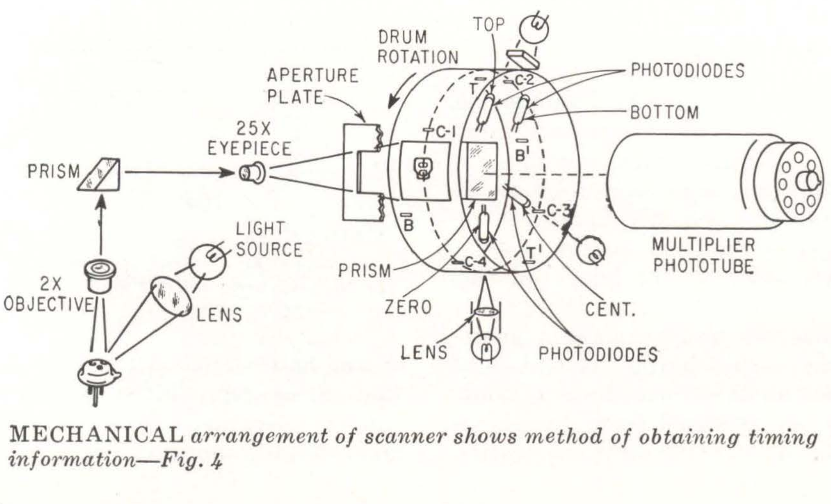


LIGHT *pattern output when correctly centered (A), center scan placement (B), basic mechanical assembly (C), image displaced right of center (D) and left of center (E)—Fig. 3*

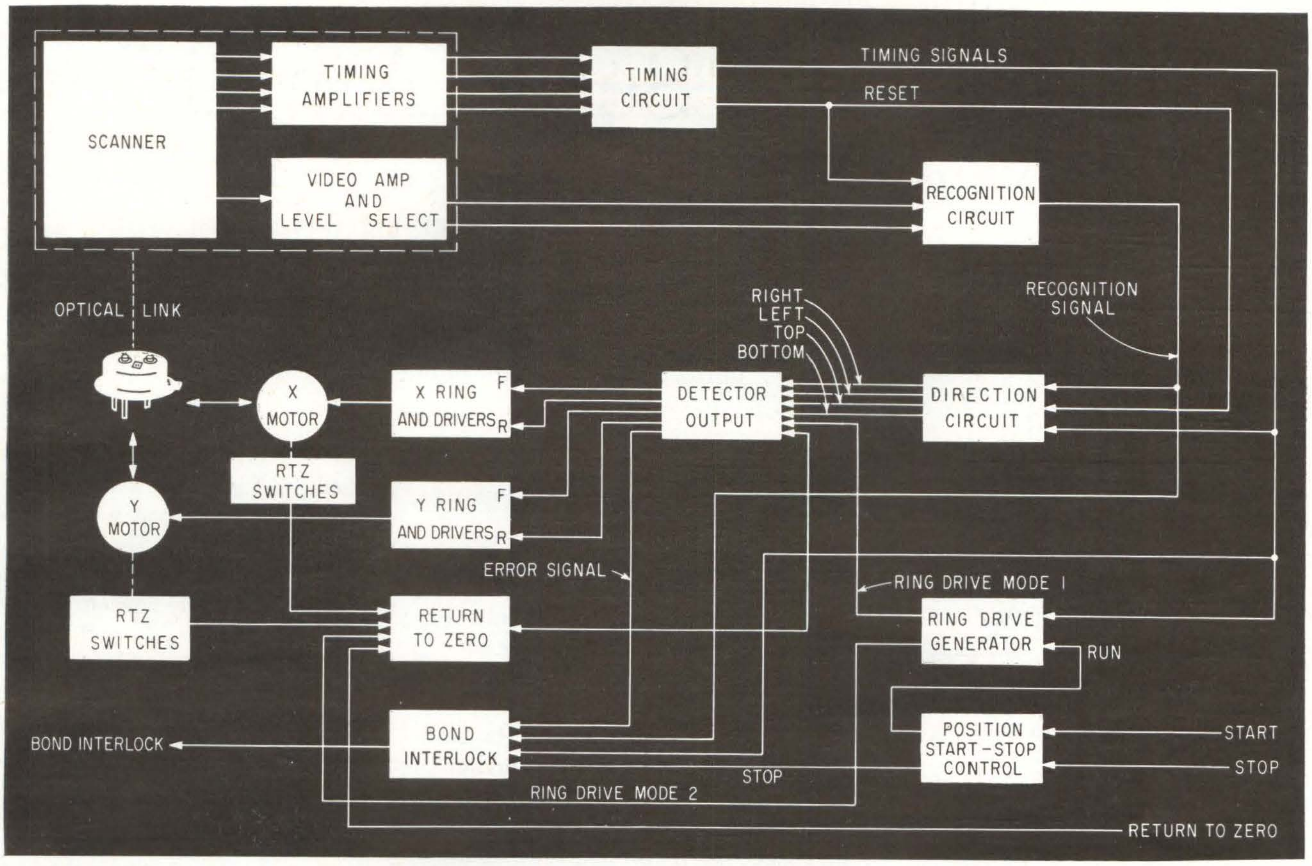
FUNCTIONAL ORGANIZATION —The functional organization of the positioner is shown in Fig. 5 The output of the multiplier phototube is amplified and converted to signals representing two different levels of light intensity. These two signals are directed to a recognition circuit where they are examined for conformance to the preset recognition pattern. The output of this circuit consists of a single pulse beginning at the instant a drum slot exposes the edge of the base stripe and ending at the start of the next scan. This pulse is compared with the timing signals in a direction circuit. This direction circuit provides four outputs that correspond to the four possible directions of error. The top output is activated when the recognition signal occurs during the top sweep and not during the previous bottom sweep. The bottom output is energized when the recognition signal occurs during the bottom sweep and not during the previous top sweep. The left output is activated when the recognition signal occurs during the center sweep and before the zero signal. The right output is present when the recognition signal occurs during the center sweep but after the zero signal.

To prevent continual hunting in the X axis, the recognition signal is compared with a null signal generated from the zero signal. A recognition signal occurring within the time period of the null does not result in an error signal either right or left. The null represents a dead area within which X axis positioning requirements have been satisfied. The duration of the null signal is adjusted to be the equivalent of 0.0002 in. on the transistor. The above and below outputs of the direction circuit are directed to the Y-drive ring. The left and right direction outputs are applied to the X-drive ring. These rings generate the sequence of pulses that determines the direction of rotation of the drive motors. The outputs of these rings are amplified by the motor drives to provide power to the windings of the Slo-syn stepping motors.

Through a lever and cam linkage,



MECHANICAL *arrangement of scanner shows method of obtaining timing information—Fig. 4*



FUNCTIONAL *organization of positioner showing logic circuits. Loop is closed through optical link between mesa transistor and scanner input. At the conclusion of the positioning cycle, a stop signal prevents further stepping and initiates a check on positioner performance—Fig. 5*

rotation of the stepping motors is converted to linear motion of the transistor in the two mutually perpendicular axes of positioning. The linkage is designed so that one step of the motors (1.8 degrees) results in a transistor motion of approximately 0.0001 inch.

TIMING—The timing circuit is straightforward. The three timing signals (top, bottom, and center) are used to set the appropriate storage triggers. Reset for the top and bottom triggers is accomplished by the center signal and reset for the center trigger is obtained by ORing the top and bottom signals.

To allow fine adjustments in the X-axis positioning, the zero signal initiates an adjustable length delay. At the conclusion of the delay the zero trigger is turned on. By varying the length of this delay, the zero location can be varied according to the equivalence 13.25 μs equals 0.0001 inch. The zero trigger is reset by the top or bottom signal.

RECOGNITION—This circuit provides a standard to which scan signals are compared. The preprogram is essentially a logic train corresponding to the major features of the scan output of the mesa and stripes. Adjustment is provided in the form of delay circuits to allow for changes in the dimensions of the units. Scan outputs corresponding to the program pass through this logic train and energize a recognition trigger when the edge of the base stripe is exposed.

DIRECTION—The direction circuit gates the output of the recognition trigger to the appropriate direction trigger under control of the timing signals. A recognition signal occurring during the top sweep turns on the above direction trigger. Recognition during the bottom sweep turns on the below direction trigger. Similarly, recognition during the center sweep is compared with the null signal. If the recognition signal occurs before the null, the left direction trigger is turned on; if the signal occurs after the null, the right direction trigger is turned on. The direction triggers retain their information until a common transfer time at the conclusion of the sweep then the information in the direction triggers is transferred to four storage triggers. These triggers hold this location data until contradictory information is received.

DETECTOR OUTPUT—Storage trigger outputs are sampled by a ring-drive pulse generated from the timing signals and occuring every 8⅓ ms, slightly after the end of each center sweep. The logic of the sampling system is constructed such that an above output is present only if the above trigger is on and the below trigger is off. Similarly, a below signal occurs if the below trigger is on and the above trigger is off. The same rules are applied to the right and left outputs.

RETURN TO ZERO—At the conclusion of the bonding operation, the stepping motors are returned to home position to prevent accumulation of error tolerances. This operation is performed under control of cam-operated switches driven by the stepping motors.

Designing Servo Amplifiers

Besides having higher efficiency than conventional class-B, push-pull types, these servo amplifiers eliminate the output transformer and require no centertap on the servo-motor control winding

By JOSEPH A. WALSTON
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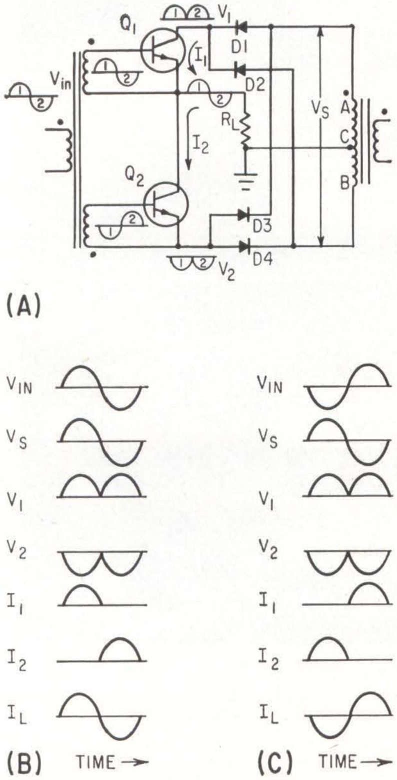
Dallas, Texas



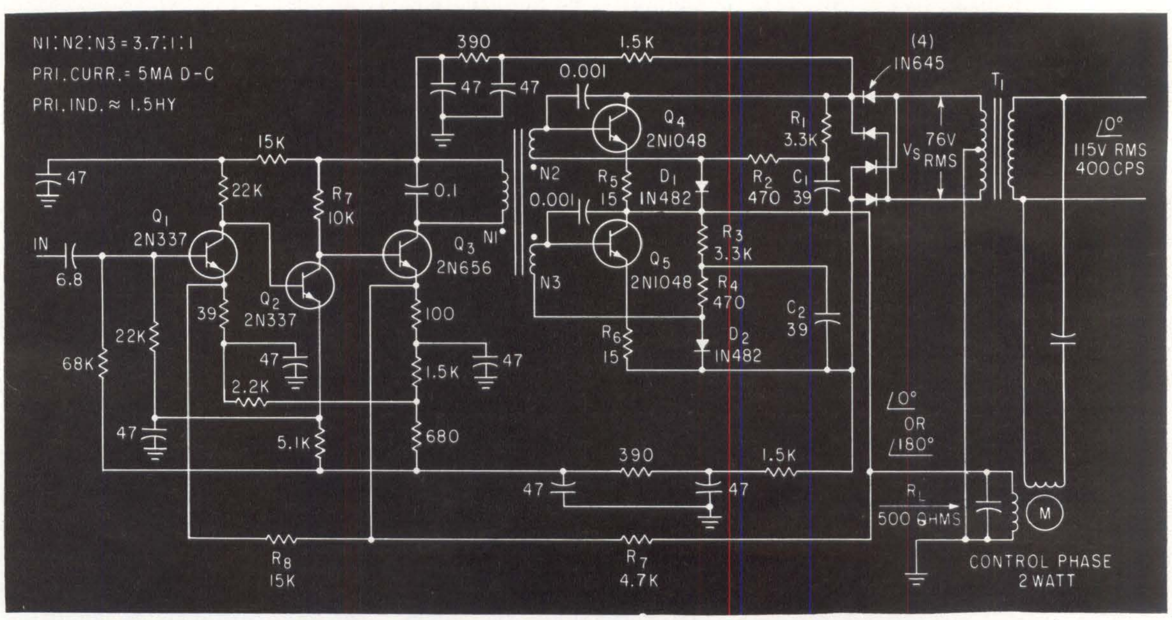
OPERATION *of unconventional output stage (A) when* V_{in} *is in phase with* V_s *(B) and 180-degrees out of phase (C)—Fig. 1*

SERVO AMPLIFIERS using unfiltered, rectified a-c for the collector supply voltage have higher collector efficiency than conventional class-B push-pull amplifiers.[1]

The higher efficiency results in greater transistor reliability, smaller heat sinks or higher ambient temperatures. An additional advantage is the absence of distortion that would be caused by overdriving the amplifier. The type of clipping that occurs in conventional push-pull amplifiers when overdriven, will not occur in this amplifier and the output remains sinusoidal even if driver output is many times that required to produce full output.

OUTPUT STAGE—The unconventional output stage operation is explained in Fig. 1A. Assume input signal V_{in} is in phase with supply voltage V_s. During the first half cycle, transistor Q_1 is turned on and Q_2 is off. Half-cycle current I_1 flows from A through D_1, Q_1 and R_L back to C. During the next half cycle, Q_1 is off and Q_2 is on. Half-cycle current I_2 flows from C through R_L, Q_2 and D_3 back to A. Figure 1B shows the voltage and current waveforms versus time when V_{in} is in-phase with V_s, while Fig. 1C shows voltage and current waveforms versus time when V_{in} is 180-degrees out-of-phase with V_s. In both cases, load current is in phase with V_{in} which should be either in phase or 180-degrees out of phase with V_s.

2 WATT AMPLIFIER—The circuit of Fig. 2 provides 2 w output for ambient temperatures between



AT OUTPUT *power of 2 w, change of gain due to temperature variations between —55 and +125 C is less than 3 db. Output distortion is about 7 percent when input is 30 db greater than that required to produce full power—Fig. 2*

For High Efficiency

−55 and +125C with output stage operation the same as for Fig. 1. To minimize crossover distortion, filter and divider network R_1, R_2, C_1 and D_1 provides d-c base bias for transistor Q_4 while R_3, R_4, C_2 and D_2 provide a similar bias for Q_5. Temperature coefficients of D_1 and D_2 match those of Q_4 and Q_5 so that correct bias is provided over the entire temperature range. Emitter resistors R_5 and R_6 provide temperature stabilization and distortion reduction.

Preamplifier and driver stages are direct coupled and use d-c feedback to ensure stability of bias conditions. Both positive and negative voltages (20 v) are obtained from fullwave rectifiers.

Negative feedback is applied to emitter of Q_3 through R_7 and to emitter of Q_1 from emitter of Q_3 through R_8.

Voltage gain of the amplifier with feedback loop closed is approximately 10,000. Input impedance is 10,000 ohms and output impedance is about 150 ohms. At 2-w output, change in gain due to temperature variations is less than 3 db. Maximum power output decreases slightly with increasing temperature due to positive temperature coefficient of the saturation resistance of the output transistors. Output distortion is only 7 percent when input voltage is 30 db greater than that required to produce full power output. At rated output, efficiency is greater than 50 percent.

6 WATT AMPLIFIER—Figure 3 shows a six-watt amplifier using the same circuit concept as the previous amplifier. Here, overall efficiency is 55 percent.

DESIGN INFORMATION — Maximum power output is given by

$$P_o(\text{max}) = [(0.5\ V_s)/(R_L+R_{cs}+R_e)]^2 R_L \quad (1)$$

where R_L is the load resistance presented by the control winding of the servo motor, V_S is the rms value of the full secondary voltage from T_1 (see Fig. 2), R_{cs} is the collector-emitter saturation resistance of Q_4 and Q_5, and R_e is the emitter circuit resistance of Q_4 and Q_5.

In Eq. 1, voltage drop across the rectifiers is neglected, and the peak value of supply voltage ($\sqrt{2}\ V_s$) should not exceed transistor maximum collector-emitter voltage ratings. Peak collector current of each transistor is given by

$$I_c(\text{max}) = (0.707\ V_s)/(R_L+R_{cs}+R_e) \quad (2)$$

The value of R_{cs} used in both equations should be the maximum value encountered in a production spread of the transistor type used over the temperature range for which the amplifier is designed to operate.

Peak base current to be supplied by the driver transformer is

$$I_B(\text{max}) = I_c(\text{max})/h_{FE} \quad (3)$$

The driver transformer must provide the peak base voltage necessary to produce peak collector current given in Eq. 2. Collector current versus base voltage characteristics are usually given on the transistor data sheets.

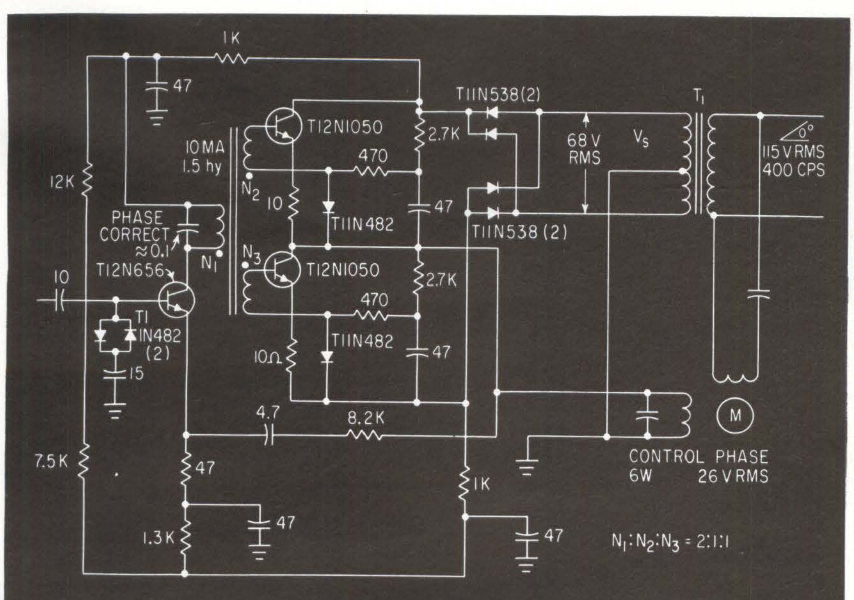
Peak driver transformer output voltage is given by

$$V_d\ (\text{max}) = V_{BE}\ (\text{max}) - V_{BE} + (1 + h_{FE})\ I_B\ (\text{max})\ R_E \quad (4)$$

where V_B is the zero signal bias voltage developed across diode D_1. Since signal current through D_1 is in the opposite direction to the bias current supplied through D_1, bias must be at least equal to I_B (max) given in Eq. 3. The same is true for D_2.

REFERENCES

(1) B. M. Benton, Servo Amplifiers Use Power Transistors, ELECTRONICS, p 153, Sept. 1956.



THIS *6-watt circuit uses the same general circuit concept as the 2-w unit shown in Fig. 2. In this 6-w amplifier, the overall efficiency is about 55 percent—Fig. 3*

A PEEK INTO THE FUTURE

The McGraw-Hill Book Company has just published "Transistor Circuit Design" written by the engineering staff of Texas Instruments, Transistor Products Division. We have already given our readers one glimpse into this useful book (**Electronics**, Aug. 17, 1962, p 46) and now present extracts from the section on the design of high-efficiency servo amplifiers. The book itself should be of great interest and utility to all engineers concerned with the design of transistor circuits

GET YOUR SCISSORS READY

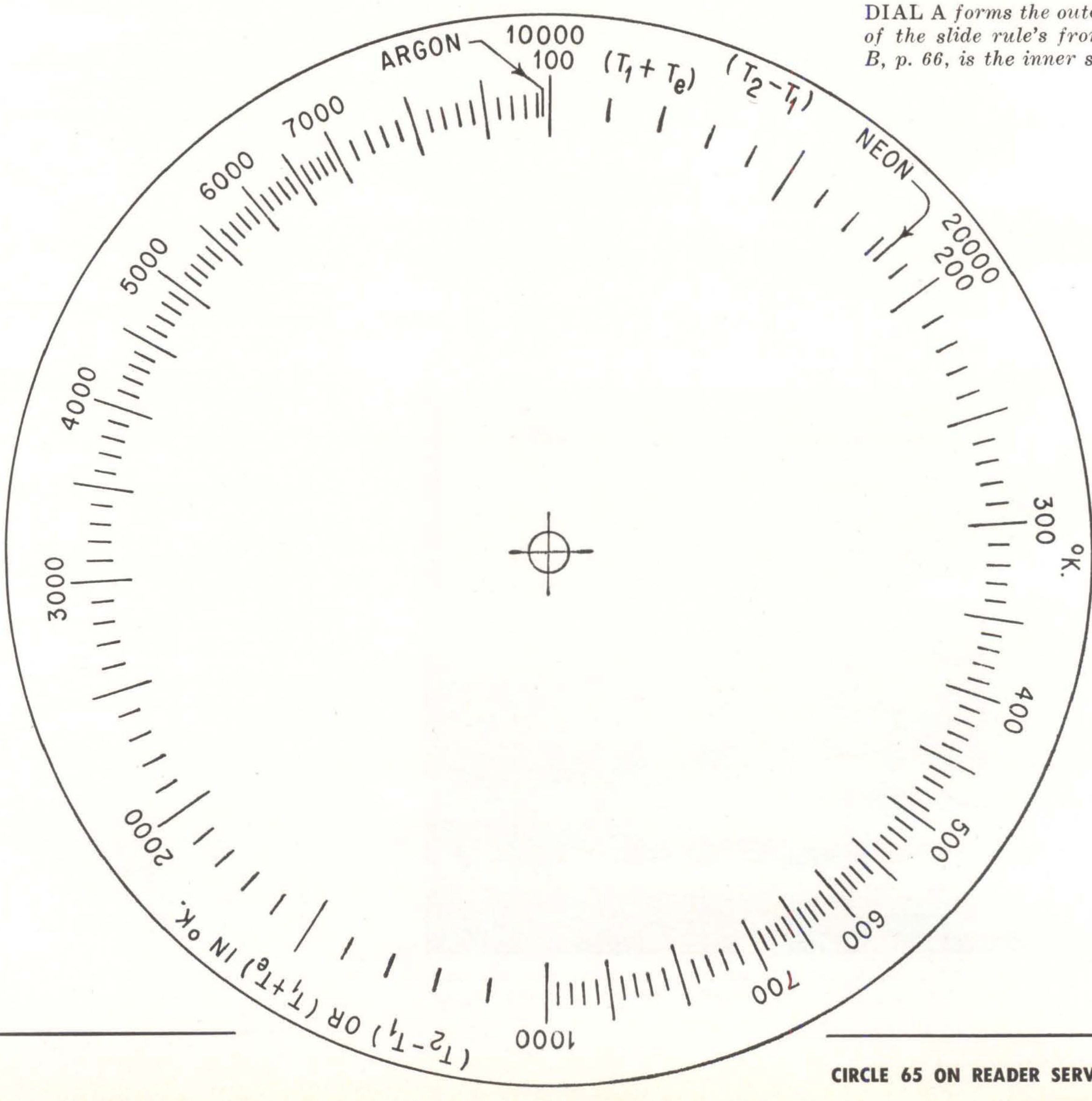
These **electronics** pages you cut out, you don't tear out. Dials A and B can be pasted on to cardboard stiffeners to form the front scales of the slide rule. Dial C fits back-to-back with Dial A completing the rule's reverse side. The two front scales give noise temperature values, the back scale converts the readings to noise figure in decibels

CUT-OUT SLIDE RULE
Simplifies Noise Calculations

By R. LAROSA, T. CAFARELLA and C. E. DEAN
Hazeltine Research Corporation, Little Neck, New York

THE NOISE FIGURE of a receiver or amplifier can be obtained by measuring its power output when connected successively to two sources of different temperature, as shown in the illustration p. 66, and making calculations with this slide rule.

The noise figure is obtained in

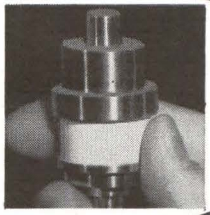


DIAL A *forms the outer scale of the slide rule's front, dial B, p. 66, is the inner scale*

CIRCLE 65 ON READER SERVICE CARD→

KNOW OF A
SMALL, RUGGED
METAL-CERAMIC TRIODE
WITH **HIGH P_o**
THROUGH 1600 MCS?

HAVEN'T YOU
HEARD?-



COME ON. YOU CAN'T **HEAR** PICTURES

THIS ONE IS **WORTH LISTENING TO.** IT'S GENERAL ELECTRIC'S **NEW** ZP-1026, a triode amplifier with the highest known power-handling capability of any tube its size through 1600 mc. Its peak power capabilities include 2 KW at 0.02 duty, and 750 watts at 0.03 duty.

This G-E triode was designed for use in applications such as TACAN, IFF, steerable arrays, Doppler radar and altimeters, and is only one of a complete line of metal-ceramic tubes General Electric has for a variety of military applications. Its features include long pulse and high duty capabilities, long life, small size and heat-sink cooling.

HERE ARE SOME CHARACTERISTICS OF OTHER TYPICAL G-E TUBES . . .

	ZP-1030 METAL-CERAMIC TETRODE	ZP-1016B METAL-CERAMIC TRIODE	ZP-1029 METAL-CERAMIC DIODE
TYPICAL APPLICATION	AM and CW Communications, SSB, Satellite Communications, Tropo-Scatter	Series Regulator	RF Switching
BRIEF DESCRIPTION	100 W carrier linear amplifier @ 225-400 mc; 300 W CW @ 225-400 mc; 200 W CW @ 900 mc.	$E_b = 10$ KVdc; $\mu = 10$; $P_p = 300$ W.	Heat-sink cooled; $I_b = 0.300$ Adc; PIV = 5500 v.

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GENERAL ELECTRIC
POWER TUBE DEPARTMENT

265-23

two steps, the first step giving the excess noise temperature contribution T_e of the receiver, a quantity widely used to describe the quality of ultra-low-noise equipment. The second step, if desired, is to convert the value of T_e into the equivalent noise figure, the quantity generally used for expressing the performance of medium-low-noise equipment.

NOISE TEMPERATURE — Since in each of the two power measurements the power is proportional to the sum of the source and the receiver temperatures, the observed power ratio is

$$Y = \frac{T_2 + T_e}{T_1 + T_e} \qquad (1)$$

Adding and subtracting T_1 in the numerator

$$Y = \frac{T_2 - T_1}{T_1 + T_e} + 1$$

or

$$T_1 + T_e = \frac{T_2 - T_1}{Y - 1} \qquad (2)$$

The front side of the slide rule, outer dial A, inner B, is arranged to give the value of T_e from this formula as follows

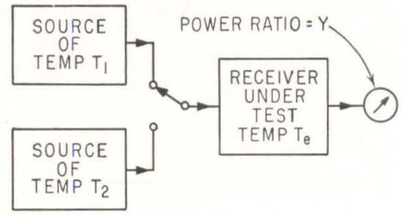
(1) Locate the known difference of source temperatures $(T_2 - T_1)$ on the outer scale, dial A.

(2) Set the inner scale, dial B, to bring the known value of Y (in decibels) to the particular $(T_2 - T_1)$ point.

(3) Read-off $(T_1 + T_e)$ on the outer scale, dial A, at the point on dial B designated "read $T_1 + T_e$ here".

(4) Subtract the known value of T_1 leaving the desired temperature T_e.

NOISE FIGURE—The receiver temperature is converted to noise figure by the scales on the back of the slide rule, dial C. Locate the particular value of T_e on the

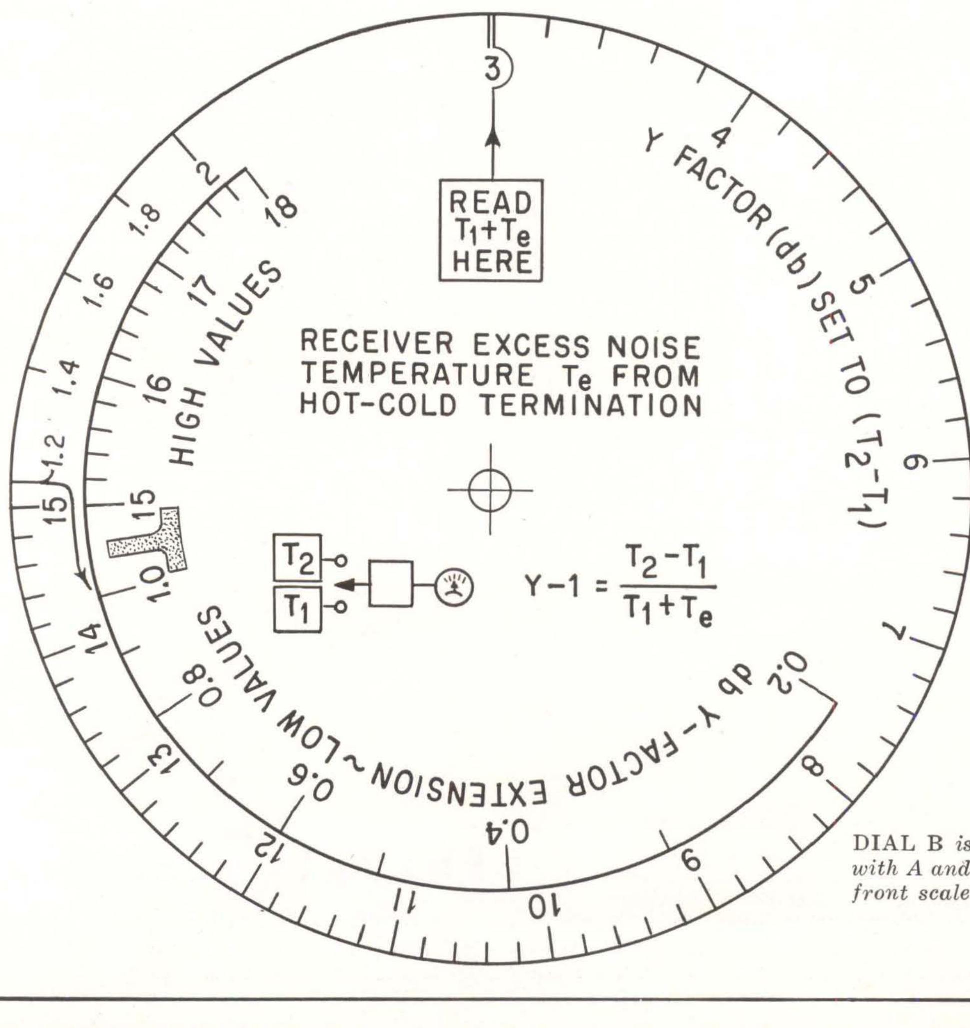


BASIC *receiver information leading to noise figures is obtained by connecting receiver successively to two different and known sources of noise*

inner scale of dial C and read the corresponding noise figure in decibels at the same point on the outer scale. This is the noise figure and is a solution of

$$F_{db} = 10 \log (1 + T_e/290) \qquad (3)$$

EXTREME VALUES— To obtain good accuracy, the Y scale, extending around the entire 360 degrees, has been devoted to values from approximately 1.2 db



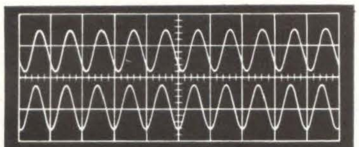
DIAL B *is mounted concentrically with A and provides the rule's inner front scale*

✯ DC-TO-80 MC *at 10 mv/cm*
✯ DC-TO-85 MC *at 100 mv/cm*

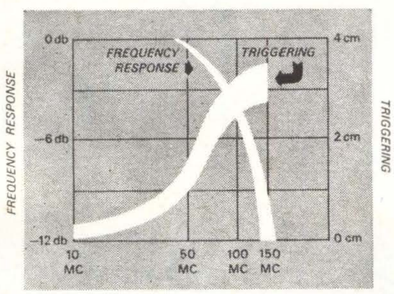
with a new

DUAL-TRACE

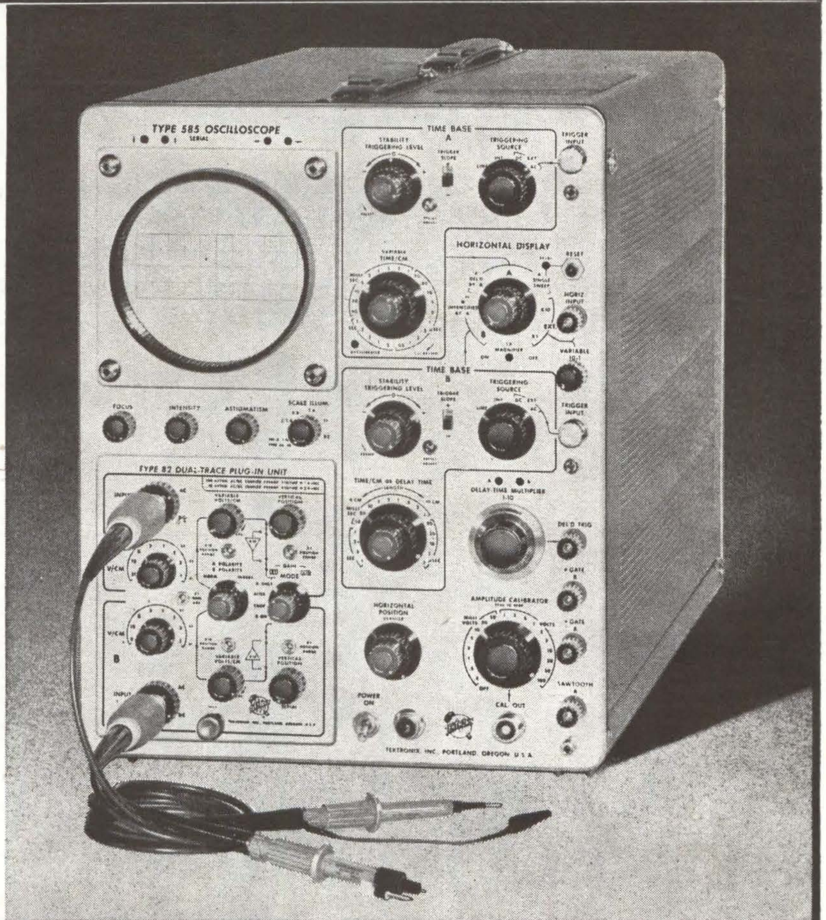
Tektronix Type 82 Plug-In Unit in a Type 581/585 Oscilloscope



Dual-trace display of 100 Mc sine waves at 10 nsec/cm. Phase difference is approximately 55 degrees. Phase comparison and similar measurements are possible with the stable high-frequency triggering system of the Type 585.



Typical frequency response and triggering characteristics of 580/82 combination—showing minimum number of centimeters necessary for triggering.



Supplied small size passive probes provide high input impedance characteristics. Probes increase input R to 10 megohms and decrease input C to approximately 7 pf.

Risetime (of supplied probe, plug-in unit, oscilloscope) at overall sensitivity of 0.1 v/cm is approximately 5¼ nsec.

OTHER CHARACTERISTICS of plug-in and oscilloscope

- RISETIME — nominally 4.3 nsec at 10 mv/cm and 4.0 nsec at 100 mv/cm.
- CALIBRATED STEP ATTENUATION—variable between steps.
- 4 OPERATING MODES—with independent controls for each channel for individual attenuation, positioning, inversion, and ac or dc coupling as desired.
- INTERNAL AND EXTERNAL TRIGGERING—to beyond 100 Mc.
- WIDE SWEEP RANGE—10 nsec/cm to 2 sec/cm.
- SINGLE-SWEEP PHOTOGRAPHY—at 10 nsec/cm for recording fast transients.
- CONVENTIONAL PASSIVE PROBES—for measurement convenience.
- COMPATIBILITY WITH 17 LETTER-SERIES PLUG-INS—to permit differential, multi-trace, sampling, other laboratory applications — when used with Type 81 Adapter.
- BRIGHT, HIGH RESOLUTION DISPLAY—with small spot size.

Call your Tektronix Field Engineer for a demonstration of the new dual-trace unit in a Type 581/585 Oscilloscope.

Type 82 Dual-Trace Unit . . . . . $ 650
(includes 2 low capacitance passive probes)

Type 581 Oscilloscope (without plug-in) $1425

Type 585 Oscilloscope (without plug-in) $1725

Type 585 Oscilloscope has 2 modes of calibrated sweep delay—either triggered or conventional—ranging from 1 μsec to 10 seconds.

TYPE 81 ADAPTER enhances versatility of the oscilloscope

The Type 81 Adapter allows insertion of Tektronix letter-series plug-ins. Bandwidth (up to 30 Mc) and Sensitivity depend upon plug-in used.

Type 81 Plug-In Adapter . . . . . $ 135

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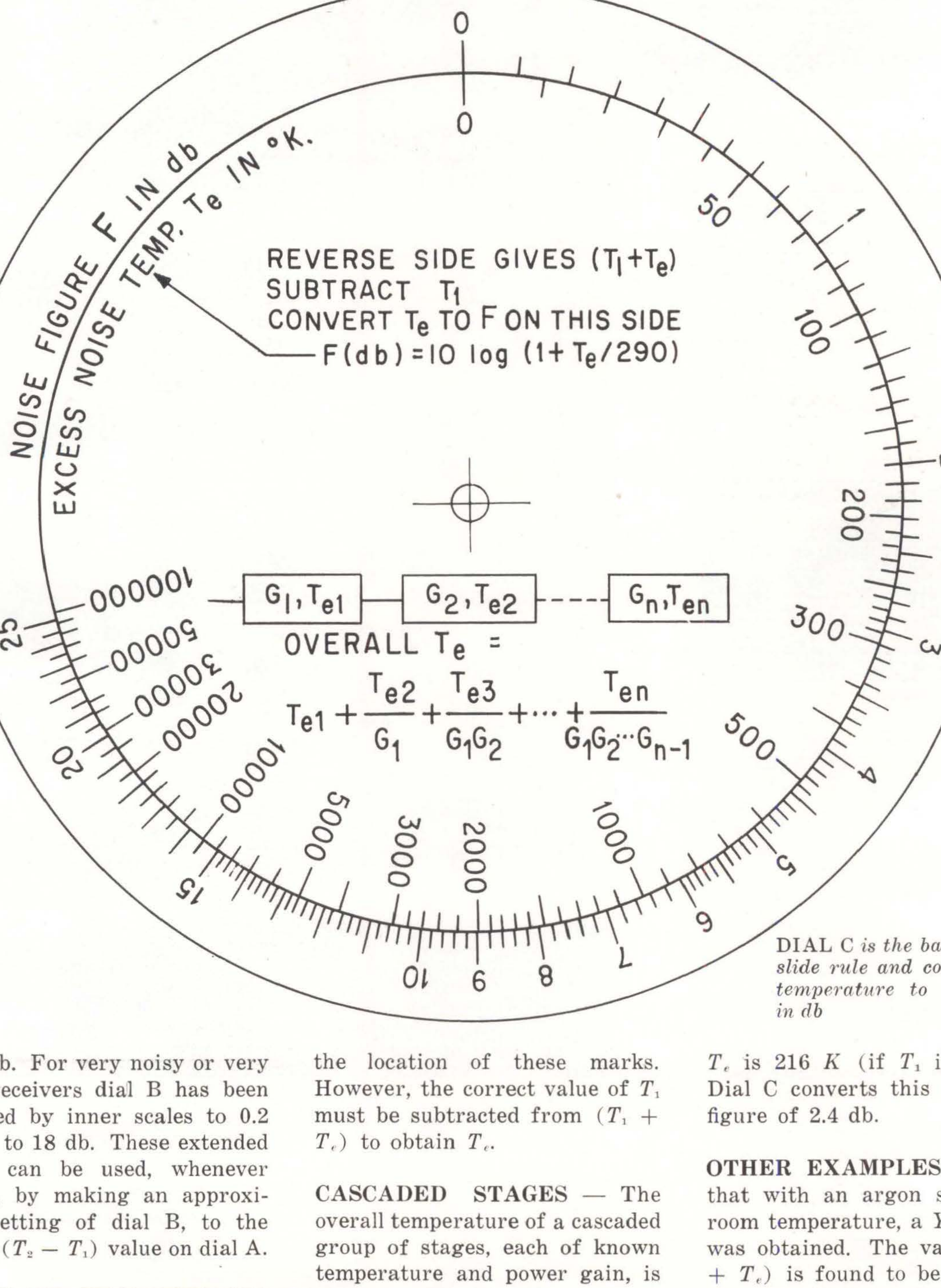


DIAL C is the back of the slide rule and converts noise temperature to noise figure in db

to 15 db. For very noisy or very quiet receivers dial B has been extended by inner scales to 0.2 db and to 18 db. These extended values can be used, whenever needed, by making an approximate setting of dial B, to the known ($T_2 - T_1$) value on dial A.

ARGON AND NEON SOURCES—A frequent case is where the T_2 source is an argon or neon bulb and T_1 is room temperature. The corresponding values of ($T_2 - T_1$), which are 10,100 − 300 = 9,800 degrees and 18,600 − 300 = 18,300 degrees respectively, are marked on the outer scale for convenient use. Small variations of T_1 have no effect on the location of these marks. However, the correct value of T_1 must be subtracted from ($T_1 + T_e$) to obtain T_e.

CASCADED STAGES — The overall temperature of a cascaded group of stages, each of known temperature and power gain, is

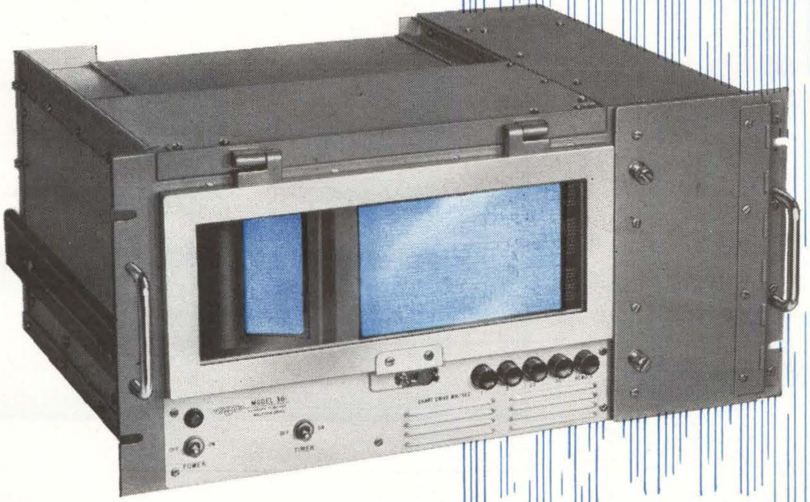
$$T_e = T_{e1} + \frac{T_{e2}}{G_1} + \frac{T_{e3}}{G_1G_2} + - - - - + \frac{T_{en}}{G_1 - - - G_{n-1}}. \quad (4)$$

QUIET EXAMPLE — Suppose that testing with an argon source and room temperature gives a Y of 13 db. Dials A and B show ($T_1 + T_e$) to be 516 K, whence T_e is 216 K (if T_1 is 300 K). Dial C converts this to a noise figure of 2.4 db.

OTHER EXAMPLES—Suppose that with an argon source and room temperature, a Y of 2.0 db was obtained. The value of ($T_1 + T_e$) is found to be 16,800 K, therefore T_e is 16,500 K. On dial C this is found to be a noise figure of 17.7 db.

For measurement equipment having T_2 = 373 K and T_1 = 77 K, the difference ($T_2 - T_1$) is 296 K. Suppose that Y is 1.4 db. Dials A and B give ($T_1 + T_e$) as 780 K, whence T_e is 703 K. Dial C gives 5.4 db as the noise figure.

New SANBORN 30-channel EVENT RECORDER



only 8¾" high, with solid-state plug-in writing control: $2050 complete

- Compact portable case or rack mounts in 8¾" of panel space
- Meets MIL-I-26600/2 Class 1B RFI Spec.
- Choice of 6 solid-state plug-in Writing Controls
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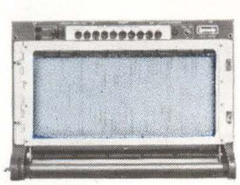
- 4 pushbutton-selected chart speeds, 1 to 100 mm/sec.; remote controlled chart speeds available on special order
- Signal return isolated from chassis (1 megohm min.)

This economical new 30-channel operations monitor provides immediate, permanent recording of on-off events on dry, electrosensitive charts — using "pulsed writing" for maximum clarity, stylus life and economy of power. Six different *interchangeable*, plug-in 10-channel *solid-state* Writing Control cards are available to match your signal voltage and recording requirements. Included are types which operate with logic levels between +6 and +40 volts or −6 and −40 volts. Also, "precision types" for monitoring low level signals are available with adjustable threshold or balanced input (with respect to signal return). Model 361 system, for rack mounting or portable case, is 8¾" x 19" wide x 14½" deep, weighs approx. 50 lbs. Complete 30-channel system, with either +6 v to +40 v or −6 v to −40 v Writing Control, is $2050 F.O.B. Waltham, Mass. Prices with other Writing Controls on request.

FOR UP TO 120 CHANNELS of on-off recording, Model 360 uses 16" wide, 450-foot charts; has 9 standard and 9 optional additional speeds; takes only 14" of panel space complete with integral cooling system. Solid-state plug-in Writing Control cards described above are optional. Model 360 120-channel Recorder alone, $3900; prices with various Writing Controls on request.



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CIRCLE 69 ON READER SERVICE CARD

Cubic announces first low-cost militarized digital voltmeter

Cubic Corporation has designed and is producing the first low-cost digital voltmeter based on military specifications. This new Model V-72 is now in continuous production and is available for all applications requiring a militarized instrument. It features all-solid-state plug-in circuitry. The virtually lifetime reed relays used for bridge switching are good for more than 200 million operations. The package is compact, rugged and lightweight, weighing only 22.5 lbs. A special snap-out replacement readout insures minimum down-time, should maintenance be required. The V-72 sells for approximately $3,400 and quotations on special configurations are available upon request. For additional information, write to Department B-112.

SPECIFICATIONS

Absolute Accuracy .01% of reading, ±1 digit

Sensitivity 1 mv

Reference Stability .005% for 1 month; .01%, 1 year

Bridge Linearity .003%

Temperature Range
Non-operational: −50°C to +72°C
Operational: 0°C to +55°C

Input Specs (Floating)
Z = 10 megs at balance

CMR AC 80 db @ 400
100 db @ 60 cps
DC 120 db

Range & Polarity 0.001 VDC to 999.9 VDC, completely automatic

Average Balance Time 400 msec; worst case, 800 msec

Calibration Cycle 6 months

Input Power 115 VAC 400 cps

Dimensions 16" wide, 5.25" high, 9.75" deep
Weight – 22.5 pounds

Special Configurations Quoted upon request

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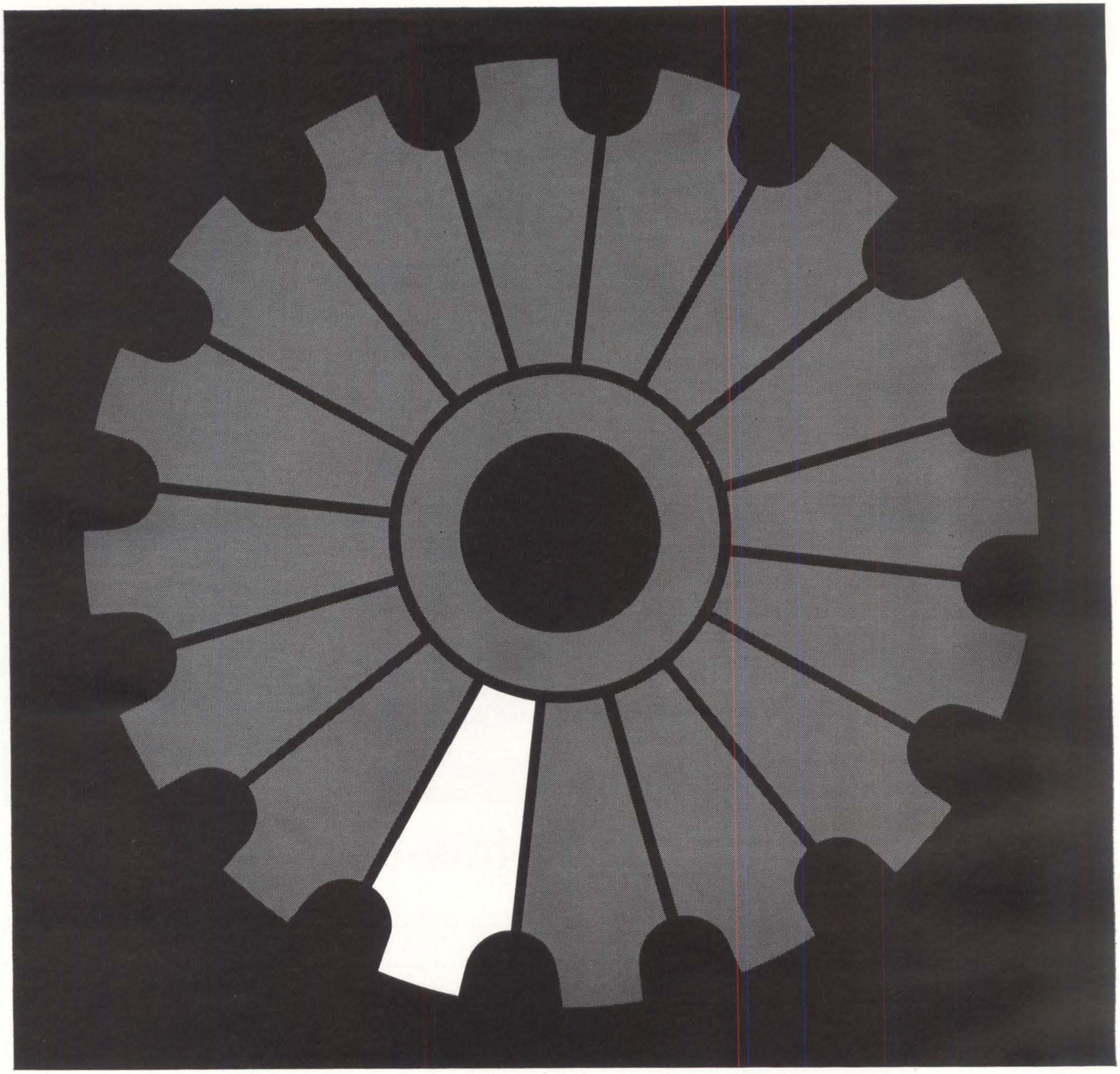

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These three Micropot® potentiometers illustrate how you can pack as much trimmer into just about as small a space as you'll ever require.

The middle trimmer (our 1.25 x .32 x .19″ 2750 series) gives you 47% more density than the one on the left (1.25 x .28 x .36″ 2800 series); the trimmer on the right (1 x .32 x .19″ 2700 series) offers 86% more density than the one on the left.

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However you look at trimmers—from component density, environment, reliability, delivery, or price—the Micropot line is a good bet to meet your requirements. And if you need specials, take advantage of our *Quick Reaction Facility*. You can get prototypes built to your own specifications almost as fast as you can ask for them.

Save time, money, and embarrassing trimmer failures by contacting your nearby Borg representative or distributor. Or a note to R. K. Johnson, Sales Manager, will bring you complete information by return mail.

Series	Miniature	High Temperature	Humidity Proof	Wirewound	Carbon
2700	X	X	X	X	
2750		X	X	X	
2800		X	X	X	
990		X		X	
992				X	
993					X
994			X	X	
995			X		X

CIRCLE 73 ON READER SERVICE CARD

BORG

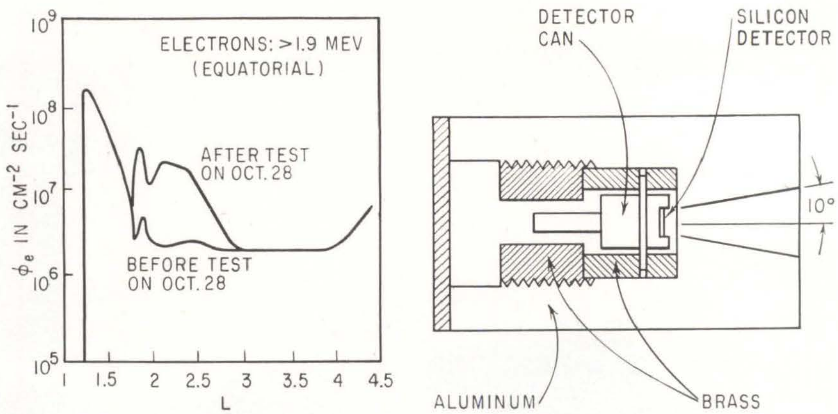
BORG EQUIPMENT

A Division of Amphenol-Borg Electronics Corporation

Janesville, Wisconsin

Nuclear Blast Effects on Communications

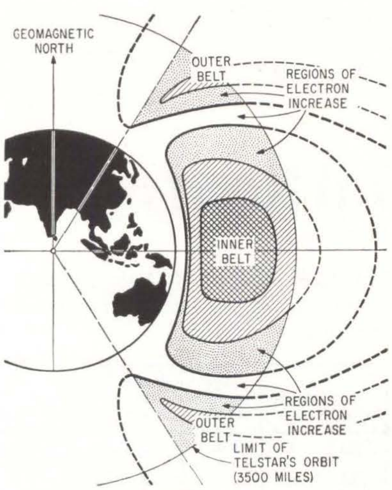
Scientists interpret satellite observations of radiation effects



FLUX DENSITY *before and after nuclear test, limited to particles above 1.9 Mev in equatorial region, left; detector carried aboard satellite, right, uses diffused silicon p-n junction 0.4 mm thick, 2 mm in diameter—Fig. 2*

EFFECTS OF NUCLEAR explosions on radio communications, on satellite functioning, and on radiation fields surrounding the earth were reported in several papers at the New York meeting of the American Institute of Physics.

Nuclear effects on the Van Allen radiation belts, as detected by Telstar and Explorer XIV and XV satellites, were described by W. L. Brown of Bell Telephone Laboratories. The normal Van Allen belts, shown in Fig. 1, exhibit a natural gap between the inner and outer belts, in which little radiation is normally encountered; the reason for the existence of the gap is not known. Immediately following the Russian nuclear explosions on October 22 and 28, 1962, satellite instruments detected a 1,000-fold increase in the flux of high-energy particles in the slot, thus "filling the slot" nearly to the same intensity as the two belts; there was less of an increase of electrons in the belts themselves, see Fig. 2.



VAN ALLEN *belt prior to Russian high-altitude nuclear test. Telstar orbital limit is 3,500 miles. Density in shaded inner region was 800 million per square centimeter per second, last July. After nuclear tests many high-energy particles appeared in slot between belts and in areas marked "regions of electron increase"—Fig. 1*

RADIATION DECAY — Within several days following the Russian explosions, the slot was again cleared of electrons; decay time constant was calculated as two days for these explosions. The U.S. nuclear shot in space, Starfish, on July 9, apparently had a similar effect on the radiation slot, with a much longer decay time; however, since no data are available prior to July 9 it is controversial how much of the radiation increase was due to natural variations rather than the Starfish blast.

Telstar, which passes through portions of both radiation belts, has telemetered radiation data from its sensors (see Fig. 2). A circuit failure on November 23 was due to radiation damage, possibly caused partially by the cumulative effect of the nuclear explosions. High-energy electrons penetrating Telstar's skin caused a radiation level inside about 100 times as great as had been anticipated.

Brown suggested several ways in which a communications satellite can be made immune to radiation damage of this kind. One

---

INTERPRETING SATELLITE DATA

To date, Telstar has returned to earth about two million radiation measurements. Quantities of similar data stream in daily from other orbiting instruments; interpreting all these, relating them to each other and plotting them in a three-dimensional, continually changing sea of radiation belts is a massive scientific project.

The papers described here present some of the first coherent conclusions drawn from satellite measurements relating to the effects of recent nuclear blasts on our communications and on space itself

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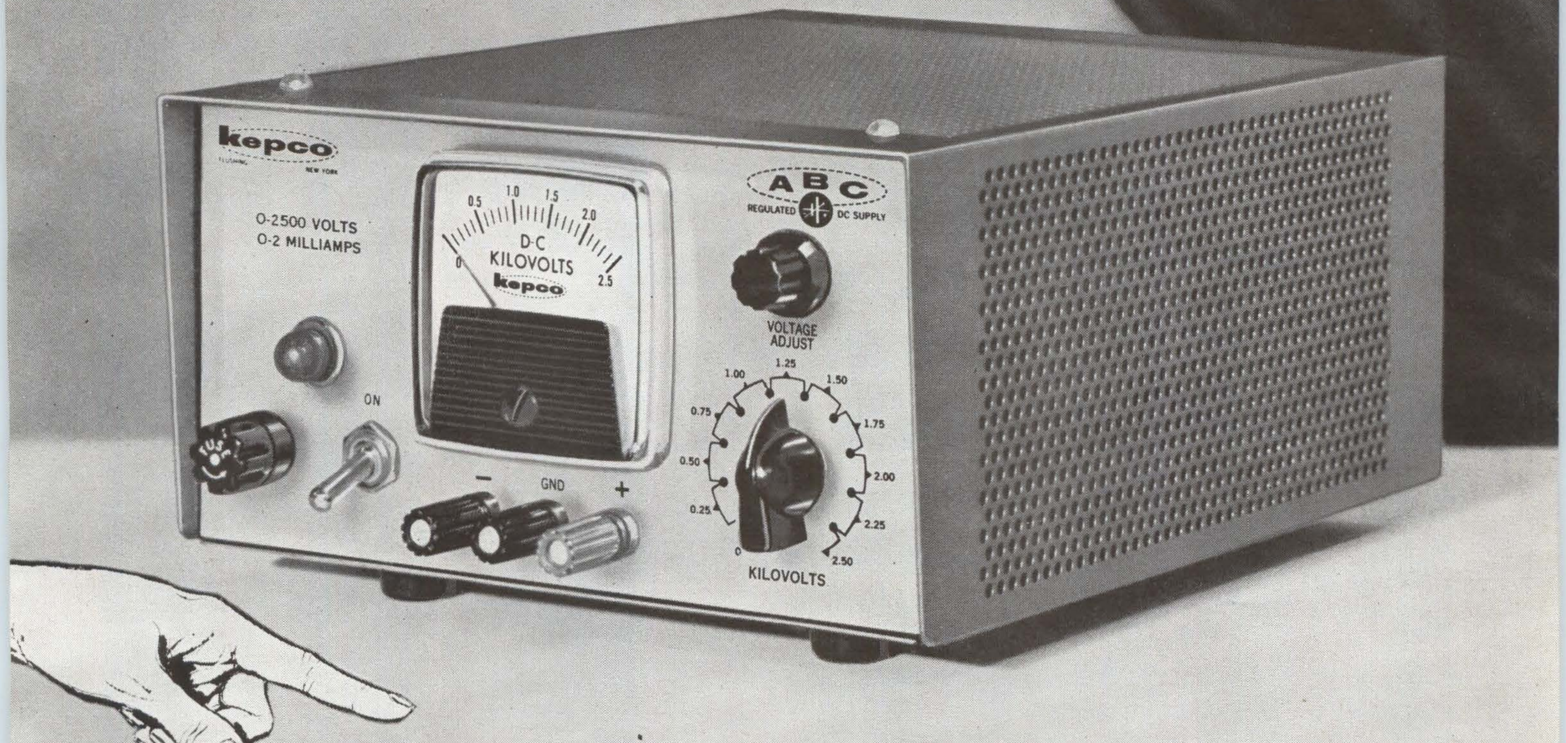

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STABILITY: Less than 0.05% or 3 mv, whichever is greater, over a period of 8 hours at constant ambient temperature.

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TEMPERATURE COEFFICIENT: Output voltage changes less than 0.05% per °C.

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0.05% REGULATION and STABILITY

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ABC 7.5–2M	0–7.5	0–2	0.5	0.002	0.01	0.05+0.5	$159
ABC 15–1M	0–15	0–1	0.5	0.008	0.01	0.02+0.2	$159
ABC 30–0.3M	0–30	0–0.3	0.3	0.05	0.02	0.1 +1	$119
ABC 40–0.5M	0–40	0–0.5	0.5	0.04	0.02	0.04+0.2	$159

HYBRID MODELS

MODEL	DC OUTPUT RANGE VOLTS	DC OUTPUT RANGE MA	INPUT AMPS (MAX.)	OUTPUT IMPEDANCE OHMS MAX. DC to 100 CPS	100 CPS to 1 KC	1 KC-100 KC (+ μhy)*	PRICE
ABC 200M	0–200	0–100	0.5	1	0.5	2+1	$199
ABC 425M	0–425	0–50	0.5	4	1	2+1	$199
ABC 1000M	0–1000	0–20	0.5	25	2	2+1	$274
ABC 1500M	0–1500	0–5	0.3	150	2	2+1	$274
ABC 2500M	0–2500	0–2	0.3	625	2	2+1	$334

*Effective series inductance.

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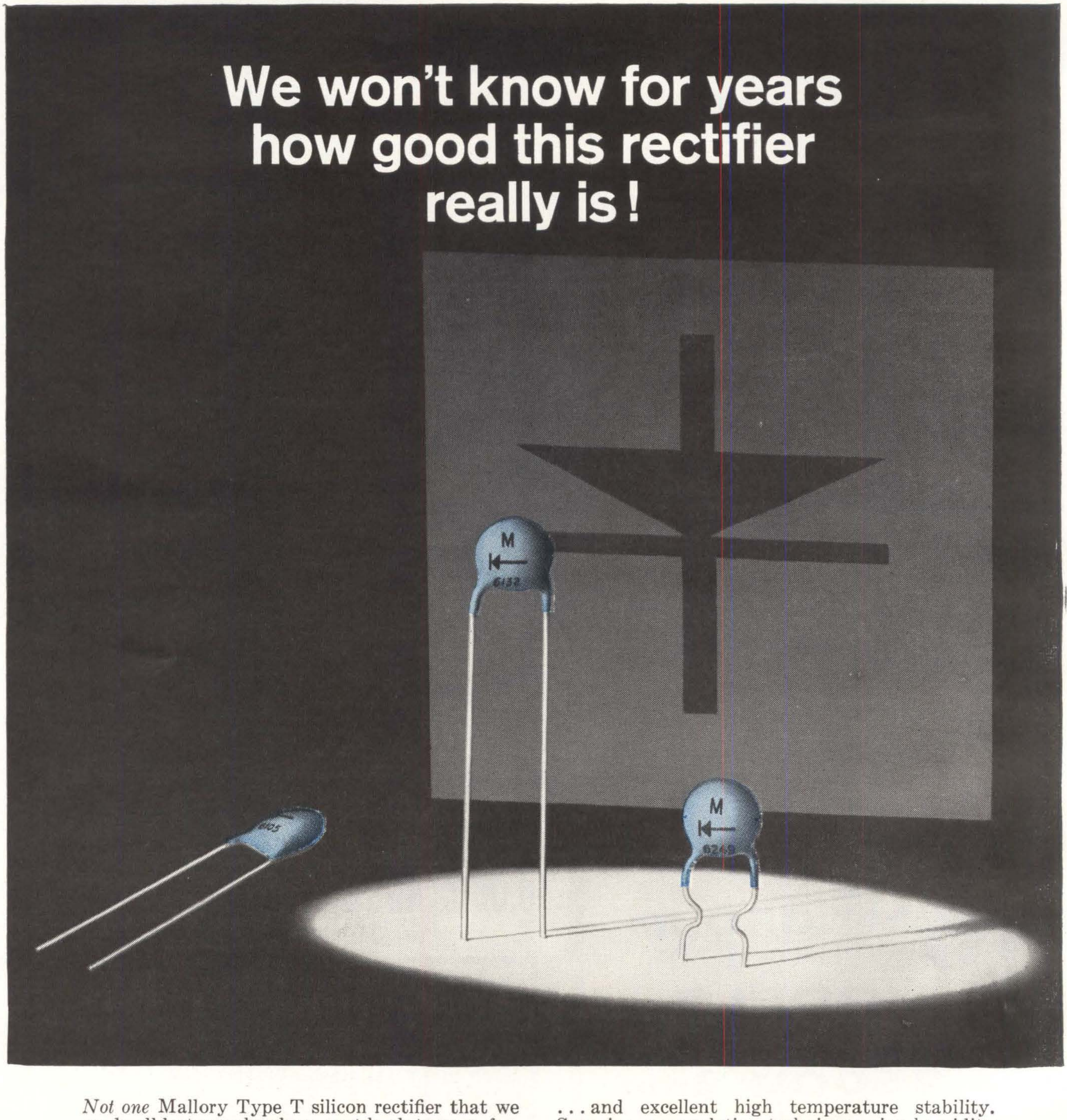

Not one Mallory Type T silicon rectifier that we made all last year has been sent back to us so far, because of electrical failure. So we'll have to wait until one finally fails until we can tell you how long they'll last. We think this is a remarkable record. But this happens to be a remarkable rectifier . . . exceptionally high in reliability and performance, yet competitively priced.

One reason for its success is the unique method we have developed for manufacturing the silicon cell. This construction results in unusually low forward voltage drop (maximum 0.5 volt full cycle average at full load) . . . low leakage current (maximum 0.1 microamperes full cycle average) . . . and excellent high temperature stability. Superior encapsulation techniques give humidity protection comparable to hermetic seal.

Another reason is the extreme care we take in pretesting rectifiers at every stage of construction. As part of this procedure, for example, *each rectifier* is given complete electrical tests at 85°C under full load—not once, but three separate times!

The Type T is available in PRV values from 50 to 600 volts, rated 0.5 amperes at 85°C, and operable up to 100°C. JEDEC types are 1N2090 to 1N2096. Get complete data by writing for Bulletin 11-7.

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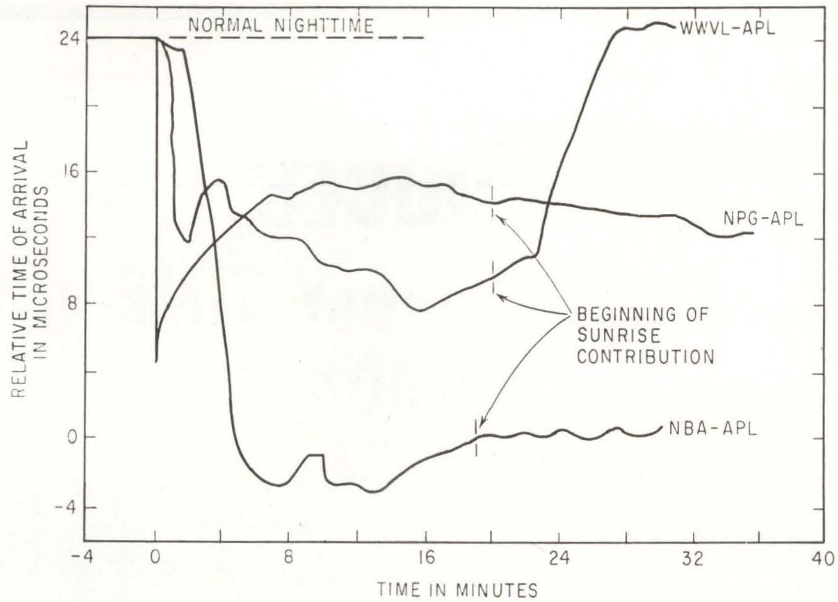


DISRUPTION *of communications over three vlf paths indicates immediate effect of high altitude blast; amount of disruption depends on location of paths—Fig. 3*

is to choose an orbit avoiding the high-radiation regions, such as an orbit within the slot. Another is shielding of the entire satellite; this would produce a resistance increase of about 10; the third is to develop components that are intrinsically radiation-proof. The Syncom satellites, operating at a 22,000-mile height, will be beyond the high radiation region of the Van Allen belts.

VLF LINKS DISTURBED—John Hopkins Applied Physics Laboratory scientists A. J. Zmuda, B. W. Shaw and C. R. Haave reported on the effects of nuclear explosions above 50 kilometers on vlf (3 to 30-Kc) radio communication channels. A perturbation in the velocity of propagation of a vlf signal is a result of changes in the ionosphere stemming from the nuclear burst. Measurements were made on three different vlf paths following the July 9, 1962 explosion over Johnston Island.

The lower ionosphere normally acts, with the earth's surface, as a waveguide for long-distance vlf radio; effective ionosphere height varies between 70 kilometers in daytime and 90 km at night. A daily change in propagation time results, of the order of microseconds, which is characteristic of a given vlf path. Perturbations may be superimposed by solar flares or ionospheric irregularities due to magnetic disturbances.

Ionizing agents such as x-rays, gamma rays and high-energy electrons and protons are formed in the radioactive decay of neutrons and fission fragments due to a nuclear explosion. These particles will ionize atoms at D-layer altitude, and thus disrupt any vlf path directly exposed to the high-altitude nuclear blast; this effect is almost simultaneous with the explosion. Also, a simultaneous disturbance occurs on any vlf paths that are themselves shielded from the blast by the earth's curvature, but are on the terminations of geomagnetic field lines passing through the location of the burst; in this case charged particles are channeled into the vlf path geomagnetically.

DELAYED DISTURBANCES—A third kind of disturbance caused by a high-altitude blast is a delayed perturbation, observed by John Hopkins Labs on vlf paths far enough removed from the burst that the entire path and the geomagnetic field lines terminating over the path are shielded by the earth and the atmosphere from direct radiation. These perturbations are caused by a slow drifting, from the burst to the vlf path, of particles formed in radioactive decay of neutrons and fission fragments, trapped in the earths' magnetic field. The particles spiral around the magnetic field lines, are then reflected back along the field lines at some altitude above the earth (the magnetic mirror point) and so oscillate back and forth between mirror points in the northern and southern hemispheres. Due to magnetic field inhomogeneity and centrifugal force, the trapped particles also drift in magnetic longitude, westward for protons and eastward for electrons.

MIRRORING EFFECT — Those particles that mirror at high altitudes remain trapped and form a relatively stable radiation belt; those that penetrate deeply into the atmosphere lose energy by collisions and do not remain trapped, but cause ionization at low enough altitudes to affect the vlf transmission as they drift over the vlf channel. As the trapped particles drift azimuthally from the burst point, an energy separation takes place, since the higher energy particles have the higher drift rate; also, particles of equal energies drift more rapidly at higher geomagnetic latitudes. A 1-Mev electron, mirroring at 80 km altitude, has a drift rate from 6 degrees a minute at a geomagnetic latitude of 20 deg N to about 100 deg a minute at an 80 deg N geomagnetic latitude.

A test vlf path between Balboa, Panama (NBA, 18 kc) and APL/ JHU, forms a well-defined north-south boundary for marking the passage of the drifting particles. Perturbation on this path began 1½ minutes after the high-altitude explosion on July 9, and peak deviation was reached between 7 and 8 minutes after the burst. John Hopkins Lab scientists attribute the onset to the arrival of electrons with energies exceeding 10 Mev, but relatively low total energy; the maximum is correlated with the arrival of 3-Mev electrons, representative of the peak in the spectrum of the total overhead energy.

Perturbations at the time of the explosion over three different vlf paths are illustrated in Fig. 3.

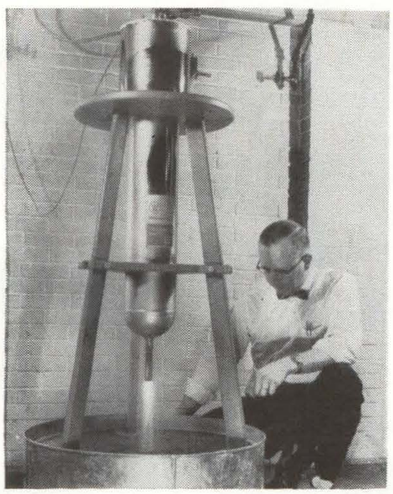
Radiant Cage May Smooth Heart Patients' Slumber

CHICAGO—A radiant cage, coupling r-f energy to an implanted coil, may allow patients with artificial heart stimulators to shed their battery packs for sounder slumber, J. Schuder, University of Missouri, told the Conference on Engineering in Medicine and Biology.

Efficiencies of a few percent have already been achieved, using mutually orthogonal coils measuring 2 meters on a side and centering the 9-cm-radius receiving coil within a 1-cubic meter area inside the cage, where the patient's chest is.

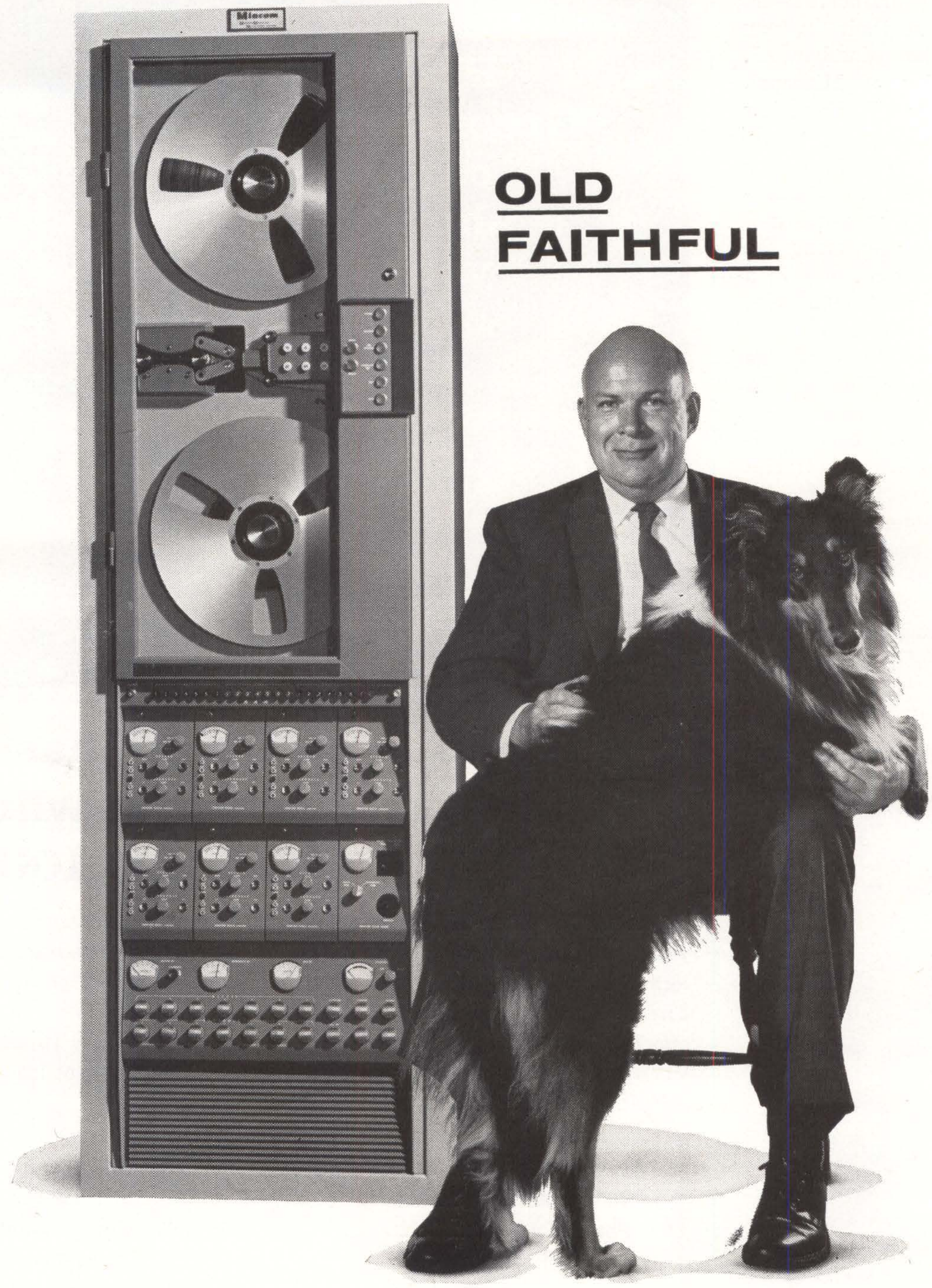
Simultaneous excitation of the external coils with 1 Kw at 422, 425 and 428 Kc transported 25 to 90 watts to monitor equipment loading the implanted coil. Artificial hearts would require 35 watts input or more, Schuder said. More than 50 watts have been transferred regularly inside one dog over the past 8 months, in experiments to evaluate tissue damage.

Superconducting Generator



MAGNETO - HYDRODYNAMIC *power generator, using a superconducting solenoid to produce the necessary magnetic field, was shown feasible by Westinghouse Research Laboratories. The niobium zirconium superconducting coil operates at —452 deg F, produces 30 kilogauss. In its 1-inch hollow core, thermally insulated by liquid nitrogen, ethylene and oxygen are passed at 4,500 deg F and interact with a small component of the magnetic field (swirling action). A voltage is developed between a center electrode and a wall electrode. This type of generator is said to open possibilities as a space vehicle propulsion unit; because superconducting magnets consume no power to produce a field, they will be more efficient than conventional MHD generators*

OLD FAITHFUL



MINCOM SERIES CM-100 RECORDER / REPRODUCER

Built-in reliability inspires confidence everywhere in this Mincom Wideband Instrumentation Recorder/Reproducer. CM-100's reputation for minimum downtime stems from its rugged simplicity—only twelve moving parts, four easy adjustments, dynamic braking. Plus, of course, overall electronic craftsmanship and the extreme precision achieved by Mincom's longitudinal recording with fixed heads. Versatile, too: Seven or fourteen tracks, 1.2 megacycles at 120 ips for analog data storage or simultaneous post- and predetection capabilities in FM/FM modulation, PCM, PCM/FM and other FM-type carrier systems. Write today for complete specifications.

Mincom Division 3M COMPANY

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Chances are you'll "plug-in" this power supply only once!

Forget all your old ideas about how long a precision power supply will last . . . how much abuse it can take and still stay accurate.

Once installed, you'll probably never ever touch a Con Avionics transistorized power supply again during the life of the equipment it operates.

Many of these power supplies have survived 20,000 hours under the worst possible conditions without the slightest sign of failure.

The reason? Con Avionics unique design principle "Worst Case" Analysis. It eliminates 90% of the causes for power supply failure. Increases the accurate life of a power supply substantially. Assures virtually failure-proof performance.

Learn how Con Avionics transistorized power supplies can give you extra protection against costly shutdowns, and substantially reduce your supply cost per operating hour. Write for bulletin on Con Avionics complete line of Transistorized Power Supplies. Or call your local Con Avionics representative.

New LR and XR MODULES for applications to 14 amps. 0.05% or 10 mv Regulation. Ripple: 2 mv. Stability: 0.1% for 8 hours. Operating temp: 45°C as specified, derated to 70°C. Send for bulletins 103 and 104 for details.

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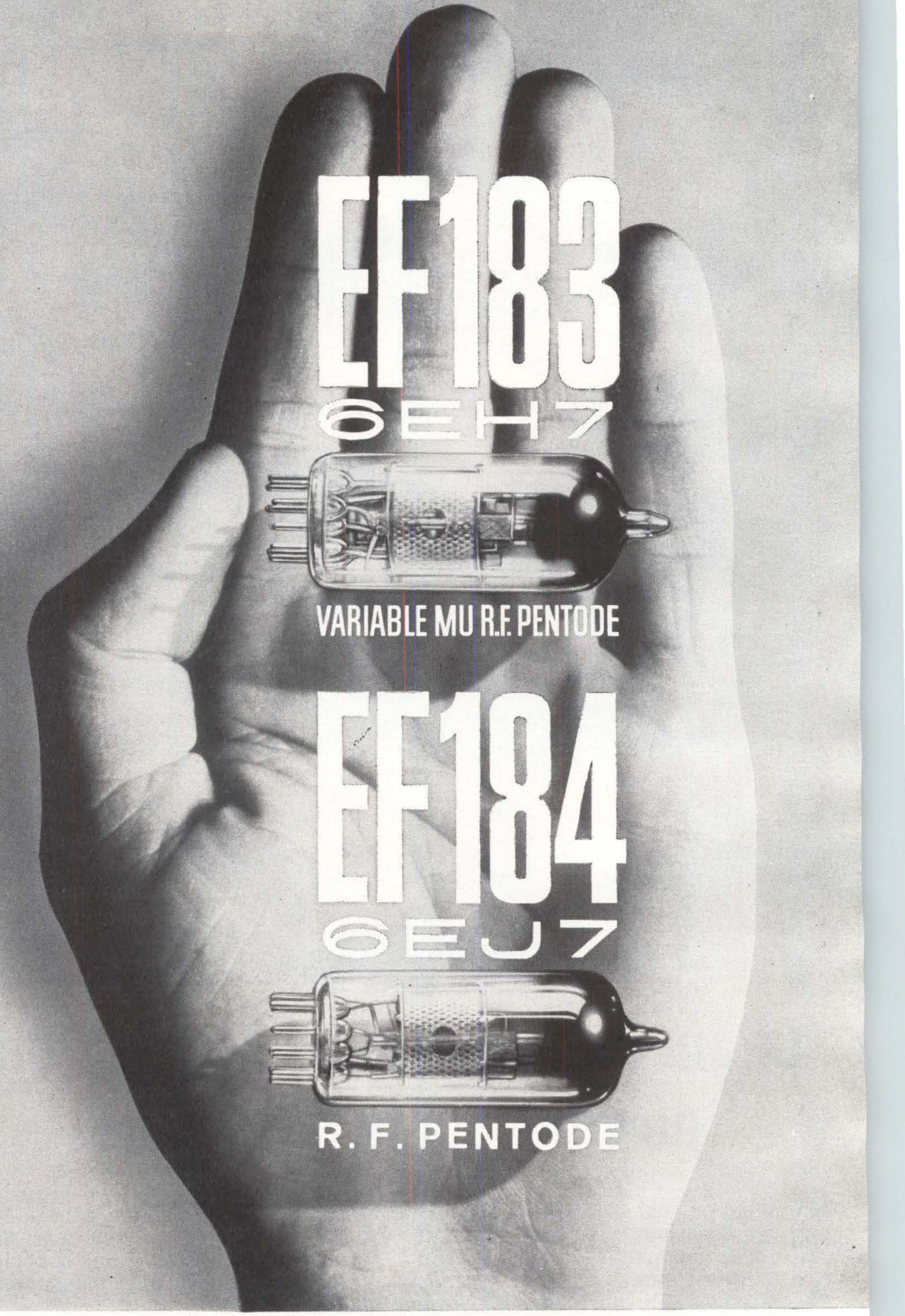
CON AVIONICS

CIRCLE 81 ON READER SERVICE CARD

MULLARD TUBES FOR TELEVISION I.F. STAGES



HIGH GAIN I.F. PENTODES

When improved i.f. performance is required, the first choice of television designers is the EF183, EF184 combination. In i.f. amplifier circuits the frame-grid construction of these two tubes gives outstanding advantages of reduced microphonics, uniformity, better controlled characteristics and high gain—twice the slope of conventional tubes.

Both tubes are available with 6·3V, 0·45A or 0·6A heater ratings.

For full technical data on the EF183 and EF184, write to the address below.

CHARACTERISTICS

EF183

gm	14	12·5	10·6	mA/V
E_b	170	200	230	V
E_{c2}	90	90	90	V
I_b	14	12	10·5	mA
E_{cl}	—1·8	—2·0	—2·1	V

EF184

gm	15·6	15	mA/V
E_b	170	200	V
E_{c2}	170	200	V
I_b	10	10	mA
E_{cl}	—2·0	—2·5	V

Full details on the Mullard range of tubes for television, stereo and high-fidelity available from:

INTERNATIONAL ELECTRONICS CORPORATION,
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CIRCLE 82 ON READER SERVICE CARD

Photoconductive chopper, all-transistor circuitry permit reliable low-level measurements with the wide-band, high-gain DY-2460A.

Here's a completely solid state high-gain DC amplifier for only $395. Exceptional reliability is achieved on low-level measurements with a specially designed photoconductive chopper and all-transistor circuitry.

The DY-2460A will supply an output of ±10 v peak at 10 ma. Zero drift is less than 1 μv per week, noise less than 4 μv peak to peak. Fast settling time (as little as 25 μs to 0.01%) and rapid overload recovery (only 20 μs, plus settling time) make the amplifier ideal for systems use.

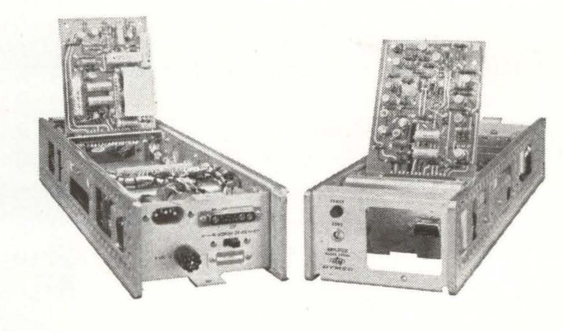
Long life is assured for the DY-2460A because of advanced solid state design. The photo chopper is unaffected by external vibration and is inherently a long-life device. Power consumption is only 4 watts, so that heat problems are non-existent.

Plug-in versatility is offered in the DY-2460A, with interchangeable plug-ins available for systems use (5 fixed gains, 10 to 1000); bench use (fixed gain in decade steps 1 through 1000); for special individual situations (patch panel brings input, output, summing point and feedback circuit to the front panel), and plus-one amplifier uses (input resistance greater than 10^{10} ohm, high gain accuracy).

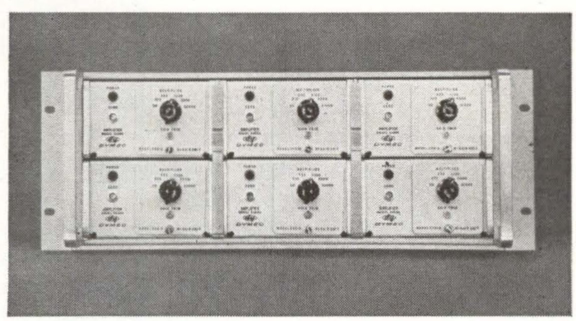
PRICE: DY-2460A Amplifier, $395.00. DY-2461A-M1 Data Systems Plug-in, $85.00. DY-2461A-M2 Bench-use Plug-in, $125.00. DY-2461A-M3 Patch Unit Plug-in, $75.00. DY-2461A-M4 Plus-one Gain Plug-in, $35.00.

Write or call today for complete details and specifications.

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



Major circuits of the DY-2460A are mounted on three plug-in etched circuit boards, which swing out for easy access. Sides, top and bottom are easily removed for servicing.



A combining case accommodates up to six amplfiers, can be used on the bench or mounted in standard rack with adapters furnished. Combining case C-146B-2, $200.00.

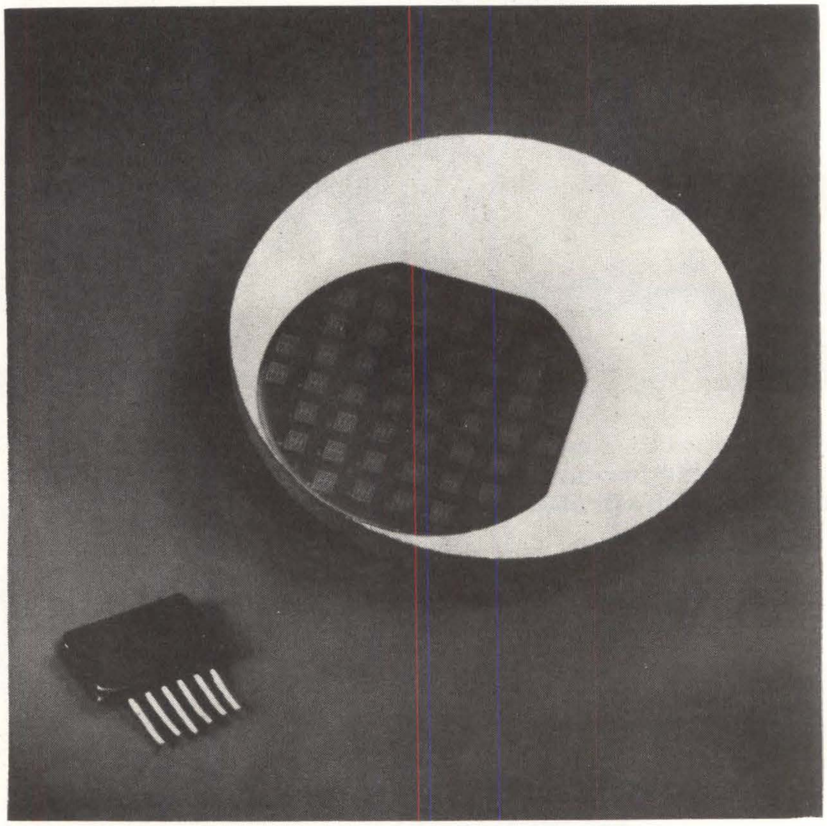
DYMEC

A Division of Hewlett-Packard Company

Dept. E-2, 395 Page Mill Road, Palo Alto, Calif. Tel. (415) 326-1755 • TWX, 415-492-9363

New 40-mm Silicon Crystals Permit Larger-Capacity Devices

Increased diameters promise higher ratings, lower cost for devices



LARGER *number of diffused junction devices can be produced from a given slice of silicon. Here the new 40-mm diameter silicon slice is compared with a slice of previously available material on which microelectronic circuits are diffused. More communication devices per slice should result in production economies for the device manufacturer company says*

HYPERPURE silicon has been used to make quality semiconductor devices for over six years. Improved methods for fabricating devices have greatly increased the uniformity, reliability and performance characteristics of devices. Silicon of increasing quality also contributed to improvement of semiconductor devices.

Development of new silicon production techniques have resulted in higher and more uniform purity, improving resistivity and lifetime of components. In addition, development of zone-refining techniques for silicon, pioneered by both Bell Telephone Laboratories and Siemens Schuckertwerke, have resulted in the availability of high purity crystals uniform from end to end and from center to surface.

NEW TECHNIQUE—Dow Corning now claims a major advance in silicon production with zone-refining techniques. Previously, high-quality zone-refined silicon crystals were available in maximum diameters of only about one inch or 26 mm. Now crystals can be grown routinely to diameters of 1$\frac{5}{8}$ inches or 40 mm, a practical limit for present methods for slicing silicon crystals.

This new zoning technique also improves the uniformity of resistivity and dislocations in the radial direction, from the crystal center to surface. This would not be expected by extrapolation of crystal properties from previous diameters up to 1$\frac{5}{8}$ inches.

One application that is forseen for the large-diameter crystals will be in manufacture of power diodes. At the *IEEE* meeting held in New York last week, discussion of a 50 megawatt silicon rectifier installation illustrated demand for higher current ratings. At present, these rectifier assemblies are usually made up from a group of silicon diodes with a 250 ampere rating. This is said to be the largest diode that is made in quantity. These rectifiers are made from float-zoned crystal with diameters of about $\frac{7}{8}$ inch. With the larger crystal diameters, development of power diodes with current ratings up to 1,000 amperes may be expected.

RECTIFIERS—Another application for large diameter crystals would be for the manufacture of silicon controlled rectifiers. These devices, basically solid-state switches, operate in microseconds, have potential application wherever a switch is found in an electrical circuit. Silicon controlled rectifiers are highly desirable since there are no moving parts, there is no arc when the switch is opened, no fire hazard and the devices are highly reliable. With large diameter silicon crystals, increases in current ratings for silicon controlled rectifiers are expected in the same order as for power diodes.

Dow Corning's C. G. Currin pointed out that high power devices are not usually made from Czochralski crystals, which are pres-

ently available in diameters up to 1½ inches. Power applications require greater uniformity of electrical and crystallographic properties than are normally obtained from Czochralski crystals. The important uniformity of these characteristics, now obtained by zone-refining, is improved by the advance made in forming large crystals.

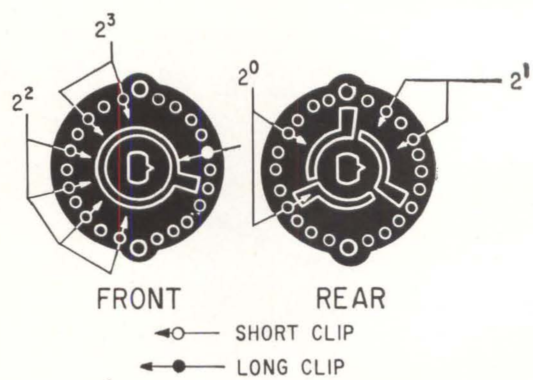
SIGNAL DEVICES—Competition among manufacturers of small signal devices—transistors and low-power diodes—require that they be mass produced at minimum prices. Thus, cost is extremely important. One of the major costs is in the diffusion process, by which most of these devices will be made. One major transistor manufacturer stated that savings in cost by using a 1⅜-in. slice from a Czochralski crystal was so great that ⅞-in. diameter float-zone crystal, supplied free of charge, could not be justified economically. Therefore, most manufacturers of these devices use large diameter Czochralski crystals instead of small-diameter float-zone crystals previously available. Using large float-zone crystals, now available, greater yield and greater uniformity can be obtained.

RESISTIVITY — Large diameter flat-zone crystals in most respects have properties quite similar to previous float-zone silicon crystals. Using phosphorus or boron, crystals are doped to resistivities between one and 200 ohm-cm. Resistivity is uniform, not only in axial or lengthwise direction, but also in the radial direction.

Previous experience indicates, according to Dow Corning spokesmen, that crystal perfection deteriorates as crystal diameter increases. Extrapolation of these data would indicate that a 1½-in. diameter crystal, if it could be developed, would be useless due to its poor crystal structure. However, the Dow Corning process is said to produce an entirely different crystal characteristic. A reasonable number of crystal imperfections are found for diameters as great as 1½ inches. The average dislocation density is approx-

Contact Arrangement Simplifies Design

DECIMAL	BIT 8	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1



SINGLE *wafer decimal-to-binary switch*

IDEA, devised by Robert B. Werden while working on a design for Atomic Energy of Canada, Ltd. saves space, cost and complexity problems over present switches which usually require two wafers.

Computer and data handling equipment often require manually-operated switches that are set on a decimal scale, 0 to 9, but which deliver the equivalent binary code, 0000 to 1001. A single wafer, illustrated above, can be used for this purpose. Standard 30 deg indexing switch has a 1 pole, 11 position contact arrangement on one side, and a 3 pole, 3 position contact arrangement on the other side. Drawing is viewed from knob end with switch in extreme counter-clockwise position. Rotor blades of the single-wafer design are through connected, and wafer is a Steatite miniature PA 2000 type.

The Honeywell Visicorder oscillograph & GUNPOWDER records forces in circuit breaker bushings

Wham! Forces imposed by the operation of oil-filled circuit breakers—especially during short-circuit interruption—are destructive enough to damage bushings. Engineers at the Ohio Brass Company have devised an ingenious method of simulating this explosive force in order to analyze bushing loads.

On a typical bushing, they mounted a dummy interrupter, in which they exploded gunpowder to propel from the interrupter fist-sized metal projectiles.

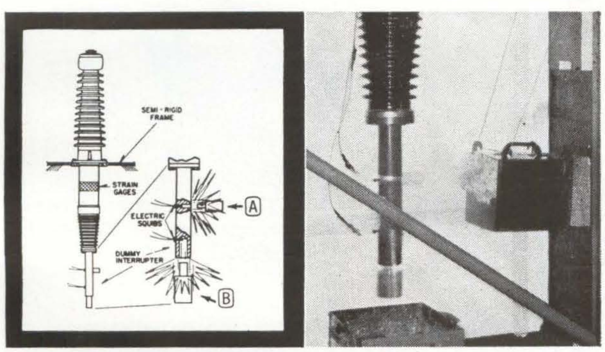
Strain gages, installed on the bushing ground sleeve, were connected to a Honeywell 119 Amplifier.

A Honeywell 906 Visicorder oscillograph was chosen to record the test data because of the extremely high speed and transient nature of the signals to be measured.

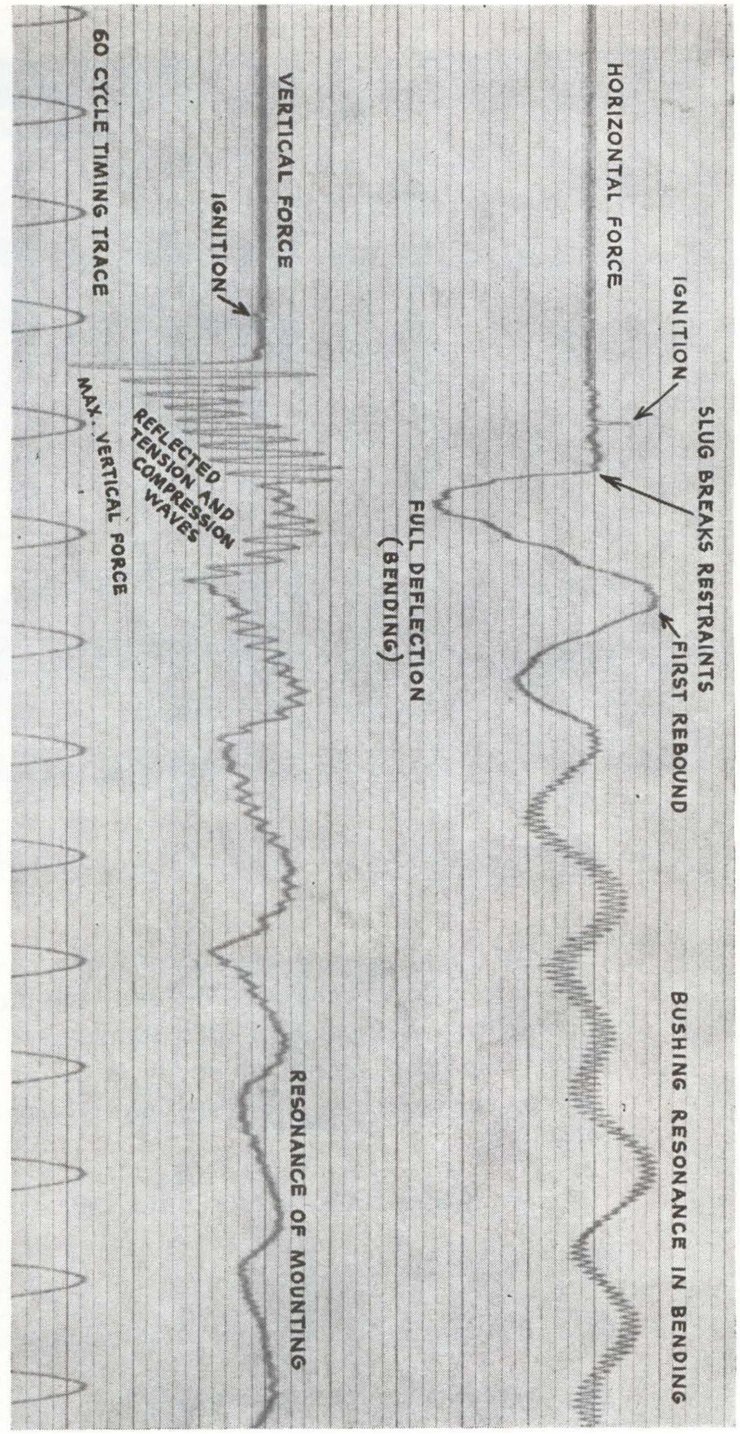
A typical record of this test, shown at right, was made at a record speed of 50"/second.

These Ohio Brass tests have opened the way to the development of standards for the mechanical performance of bushings (AIEE papers 62-153, 60-107).

This application is only one of thousands where the Visicorder is called upon daily as a basic research, test, and development tool. One of the six different Visicorder models should be a basic instrument in the management of your data acquisition.



Schematic at left diagrams method for duplicating bushing loads during short-circuit interruptions. Projectile (A) produces lateral forces at right angles to bushing axis; projectile (B) produces axial load on bushing terminal. At right, squibs have just detonated charges propelling projectiles from dummy interrupter. Below, Honeywell Model 906 Visicorder Oscillograph records circuit breaker bushing test for Ohio Brass.



For full details on all Visicorder Oscillographs, tape systems, and signal conditioning equipment, write to Honeywell, Heiland Division, Denver 10, Colo., or phone 303-794-4311.

DATA HANDLING SYSTEMS

Honeywell

The Honeywell Model 906 Visicorder Oscillograph—with a Honeywell Model 119 Amplifier—record circuit bushing tests for Ohio Brass.

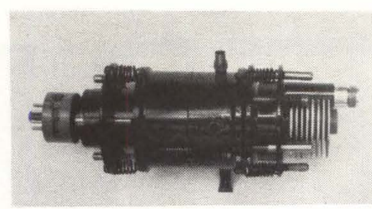
CIRCLE 87 ON READER SERVICE CARD

imately 30,000 per sq centimeter, which was typical of the zone-refined crystals supplied to device makers a few months ago.

SOLUTION—Key to the new zone-refining process centers around overcoming a surface tension problem that is normally encountered in formation of large diameter crystals. No loss of other vital semiconducting properties occur with the new technique. Currin estimates that about 250,000 dollars worth of silicon is now used in electronics. When Dow Corning entered the silicon market, about three years ago, there were about 12 suppliers of silicon. Since then there have been 7 dropouts. Still a large producer of silicones, Dow Corning now has set sights on the ever growing silicon market.

Microwave Oscillator Has High Efficiency

By RYOKAWA SAWADA,
Hitachi Central Research Laboratory
Tokyo, Japan

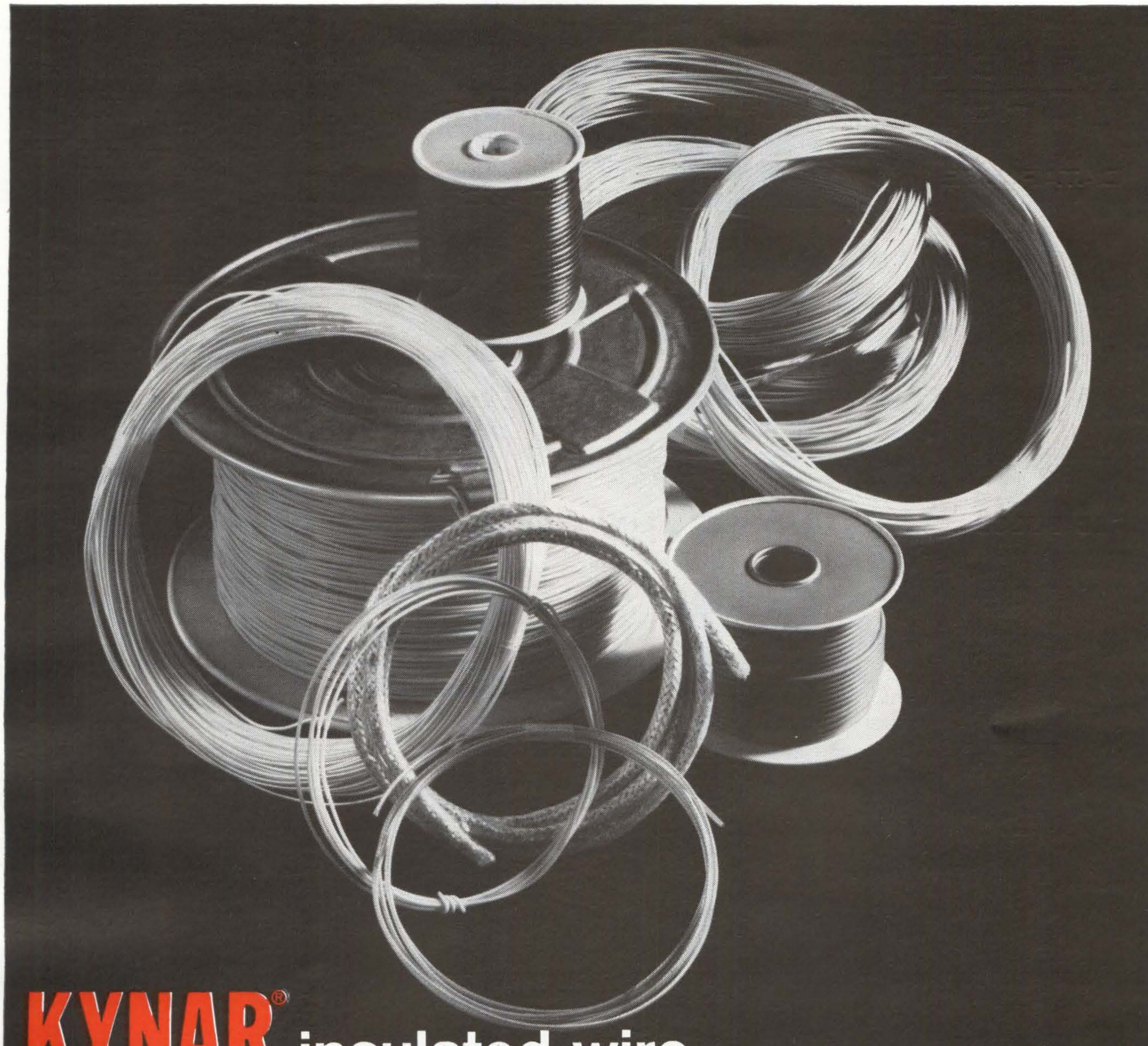


OUTPUT *power of experimental Duotron-amplifier is over 230 watts at 2.8 Gc—Fig. 1*

CALCULATIONS and experimental results of a novel microwave-oscillator tube, called Duotron, indicates promise as high-efficiency oscillator.

The important building blocks of the tube are gaps and cavities. The resonator is formed by mutually-coupled cavities, so that the r-f oscillator produces π-mode electric field in the resonator. At any instant, the two gap fields are opposite in phase.

An electron gun produces an electron beam which traverses, in succession, the first and the second gap. The resonator can oscillate powerfully and the maximum theoretical beam conversion efficiency is



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new standard in performance and production

Wire and cable insulated with Kynar—the new fluorocarbon resin from Pennsalt Chemicals—delivers premium performance in your product and on your production line. Kynar-insulated hook-up wire has high dielectric strength and resistivity . . . strips cleanly, won't tear or cut-through in automatic assembly equipment. Kynar has a useful temperature range of −80° to +300°F. and Kynar-insulated wire forms strong, tight seals with epoxy-base potting compounds. As a jacketing material, Kynar offers superior resistance to abrasion, corrosion, weathering, and radiation . . . extrudes readily over single or multi-strand constructions as well as vinyls, PTFE and metallic shields. It can be pigmented and striped to identify circuits. Typical properties of 10-mil Kynar insulation extruded over AWG 24 solid soft copper conductor:

Dielectric strength, volts	10,000
Insulation Resistance, meg-ohm/M	> 1,000
Cold bend, ½" dia., 1 lb. weight at −70°F, volts	8,000
Abrasion Resistance, Janco Tester grade 400 alumina, inches of tape	50
Cut through, anvil at 90°, 350 gm. hours at 270°F	> 500
Soldering test, flare back	None
Flammability	self extinguishing

Kynar-insulated wire is available from Surprenant Mfg. Co., Clinton, Mass.; Revere Corp. of America, Wallingford, Conn.; L. Frank Markel, Norristown, Pa.; Hitemp Wires Co., Westbury, L.I.; and Brand-Rex, Concord, Mass. Write to us for details. Plastics Department, PENNSALT CHEMICALS CORPORATION, 3 Penn Center, Phila. 2, Pa.

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about 22.5 percent.

One Duotron, built for 2.6 Gc operation, has a measured output of 8.6 watts, corresponding to a beam efficiency of 17.5 percent. The tube is suitable for millimeter wave oscillators, since the transient angle of the gap is much larger than that of a usual klystron.

Several modified configurations have been proposed. One version is a reflex type that is provided with a repeller electrode similar to the usual reflex klystron. Transit angle of one gap equals 3 radians and transient angle of the repeller space is 8.5 radians. Beam conductance of this tube is $-1.625\ G_o$ instead of $-0.6\ G_o$ of the reflex klystron. This value is useful in the millimeter wave region.

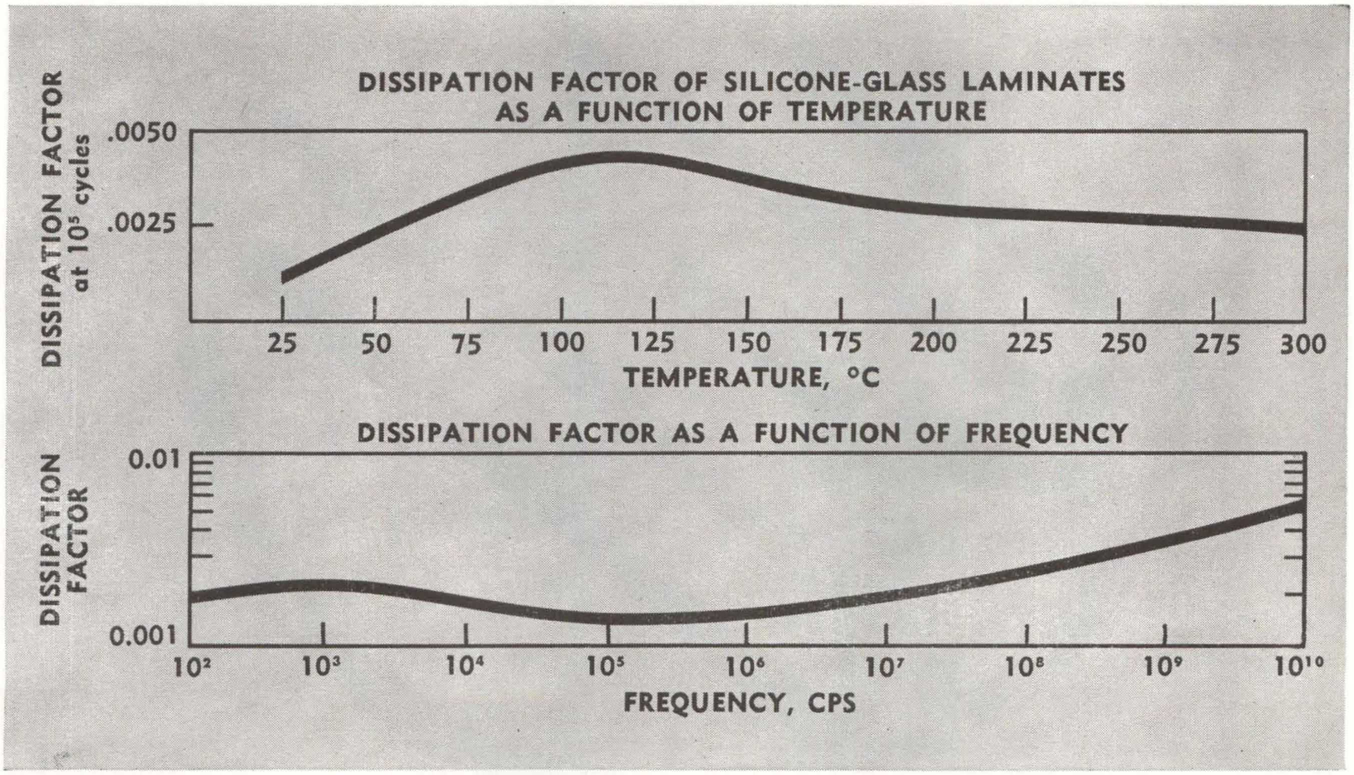
Another version of the tube is provided with an output cavity and is similar to the two-cavity klystron. The Duotron resonator is set as a klystron buncher, but does not need to be driven by a signal source, since it can oscillate by itself. The beam, passing through the resonator, has a highly density-modulated component and velocity-modulated component. Therefore high power is produced in the output cavity although beam passes through a short drift-distance.

Power output of experimental Duotron-amplifier shown in Fig. 1 is more than 230 watts at frequency of 2.8 Gc. The tube acts as a self-excited frequency multiplier if output cavity is tuned to a higher harmonic component of modulated beam.

Receiving Tubes Utilize Rhenium Tungsten Heaters

ALTHOUGH tungsten is basic in the construction of tube heaters, incorporation of rhenium enhances strength and reliability during the heating and cooling that occurs during off-on cycling of electronic tubes, according to Sylvania. Company says 14 types of receiving tubes will use a rhenium-tungsten alloy in the future. Alloy is said to offer lower current density, more reliable high line operation and reduced damage to surge currents. Improved ductility helps prevent heater insulation cracking and reduced incidents of heater cathode shorts, according to company.

Laminates you can trust



Silicone resin laminates offer constant electrical properties

Dow Corning silicone resins help create a variety of laminated parts with a unique combination of electrical properties. Silicone-glass laminates are very low loss materials with low dielectric constant. More important, however, is the fact that both dissipation factor and dielectric constant stay low as a function of both temperature and frequency.

Moisture is no problem either. Silicone-glass laminates maintain their low loss characteristics under heat and moisture conditions. For example, silicone-glass laminate with a dissipation factor of 0.002 was aged for 200 hours at 250 C, then immersed in water for 24 hours. Tests showed no change in dissipation factor. Other outstanding electrical properties are: surface resistivity, electric strength and arc resistance.

Design engineers have found these *constant* low loss properties invaluable in modern electronic design. For regardless of environmental conditions, electrical parameters stay constant . . . equipment performs as designed.

Silicone-glass laminate sheet in a variety of thicknesses is immediately available from many fabricators. Some also offer help with special designs of finished laminated parts. Ask your present source about silicone-glass laminates made with Dow Corning Silicones.

ELECTRICAL PROPERTIES OF SILICONE-GLASS LAMINATES (1/8")

Dielectric constant 10^5 cycles	
Original	3.5
Condition D 24/25	3.6
After 200 hr. @ 250 C, aging	3.3
Condition D 24/25 after 200 hr. @ 250 C	3.3
Dissipation factor 10^5 cycles	
Original	0.002
Condition D 24/25	0.004
After 200 hr. @ 250 C, aging	0.001
Condition D 24/25 after 200 hr. @ 250 C	0.002
Surface resistivity, megohms	
Original	3.95×10^8
Condition C 96/25/96	1.0×10^7
Electric strength	
Perpend short time V/M	400
Parallel KV	55
Life 250 C, hrs. to drop below 180 V/M	8000
Arc resistance, sec.	180

Condition C 96/25/96, 96 hrs. at 25 C and 96% relative humidity

Condition D 24/25, water immersion 24 hrs. at 25 C

For list of fabricators of silicone-glass laminates write Dept. 3914, Engineering Products Division, Dow Corning Corporation, Midland, Michigan.

first in silicones **Dow Corning**

Said Pierre de Fermat:

"The optical length of an actual ray between any two points is shorter than the optical length of any other curve which joins these points and which lies in a certain regular neighborhood of it."

The continuing requirements of space exploration projects for larger and more accurate antennas have resulted in the construction of a number of enormous parabolic reflector antennas. Each costs many millions of dollars. This tremendous expense is due to the difficulty of maintaining reflector accuracy as the huge structures are moved and tilted, and as wind forces and temperature changes distort the surface.

Lockheed Missiles & Space Company's Electromagnetic organization is developing a far more economical and practical solution to the problem. A 120' reflector antenna working model now is being erected. Its shape is spherical instead of parabolic, and it is firmly mounted on the ground. *Only the feed is moved to change the beam angle.* This type of antenna design now is feasible, thanks to successful Lockheed research in spherical aberration correction. The concept should find applications in radar systems, satellite communication systems, and systems for data reception from deep space exploration probes.

Many comparable scientific break-throughs are being evolved at Lockheed because scientists and engineers find here the creative freedom needed to pursue and perfect original ideas. Lockheed Missiles & Space Company is located on the beautiful San Francisco Peninsula in Sunnyvale and Palo Alto. If you are interested in correlating your specialty to one of Lockheed's many challenging assignments, please write: Research & Development Staff, Dept. M-39A, 599 North Mathilda Avenue, Sunnyvale, California. Lockheed is an equal opportunity employer.

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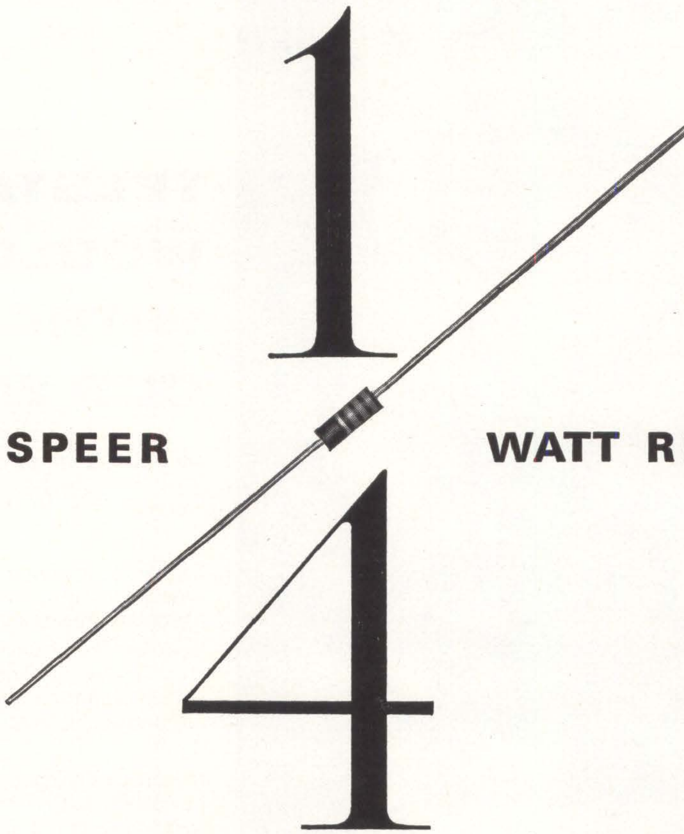
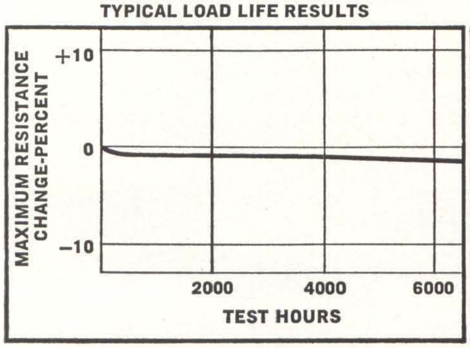
REALLY RELIABLE



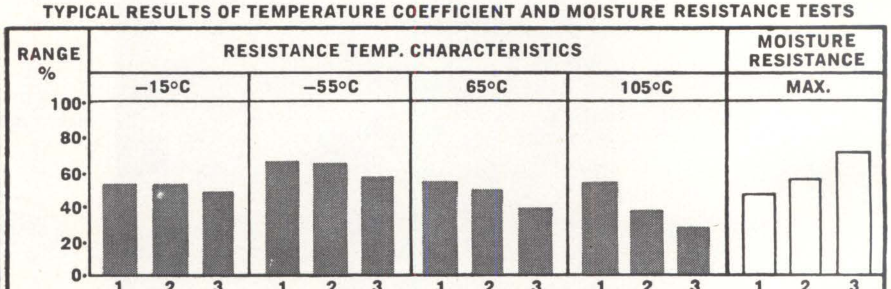
...THE SPEER 1/4 WATT RESISTOR

Speer's newly-developed RC 07 1/4 watt resistors—available in a range of values from 10 ohms and up—to meet or exceed all MIL-R-11D specifications. What's your chief concern—load life? Moisture resistance? Temperature coefficient?

TYPICAL LOAD LIFE RESULTS



TYPICAL RESULTS OF TEMPERATURE COEFFICIENT AND MOISTURE RESISTANCE TESTS



Graphs depict Maximum % changes on ten units. 100% represents Maximum allowable change per MIL-R-11D. **1.** 10 ohm **2.** 270K ohm **3.** 1 Megohm

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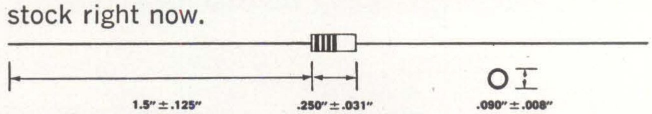

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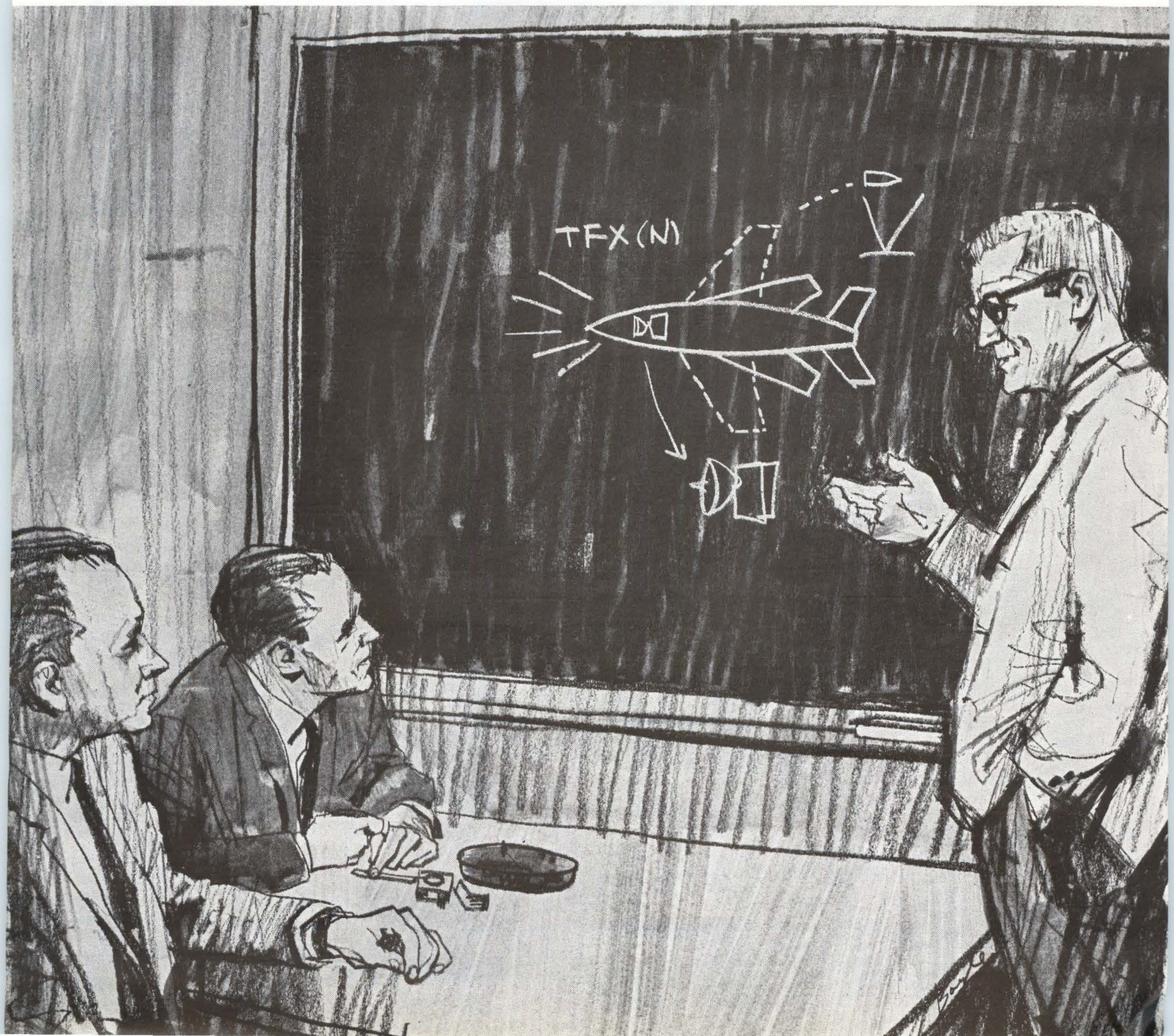
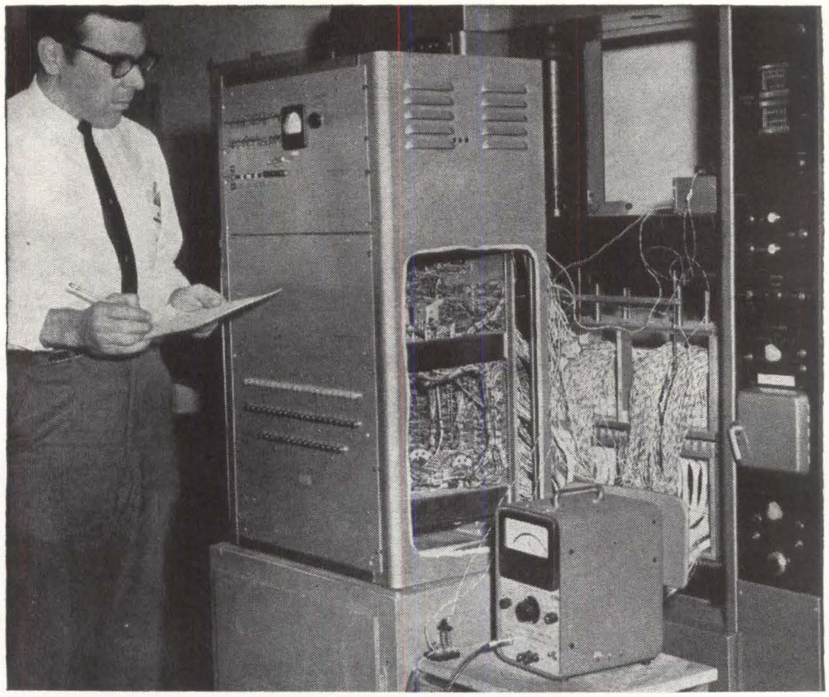


Checking Connector Production

Techniques and equipment improve statistical check-out tests

By W. F. BONWITT
T. SHAHNAZARIAN
Burndy Corporation
Norwalk, Conn.

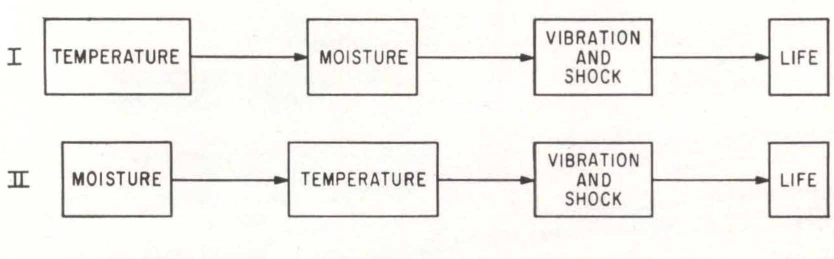


AUTOMATIC-STEPPING *switches in automatic potential-drop test equipment simultaneously hook-up 20 connectors. Panel lights indicate which connectors are under test*

CONNECTOR - RELIABILITY — measuring techniques and equipment have been developed to overcome problems generated by the sheer number of samples and measurements needed for statistical, or lot-to-lot, evaluation. Time and cost are significantly less than design-qualification testing. Deviation from qualification tests can be detected statistically.

Six test sequences (Fig. 1) are followed using three basic environments — temperature, moisture, vibration-shock. Before each sequence and after each environmental test, various connector characteristics are checked in the following order: contact retention, capacitance, probe damage, contact separation, connector separation, contact resistance, high potential, insulation resistance.

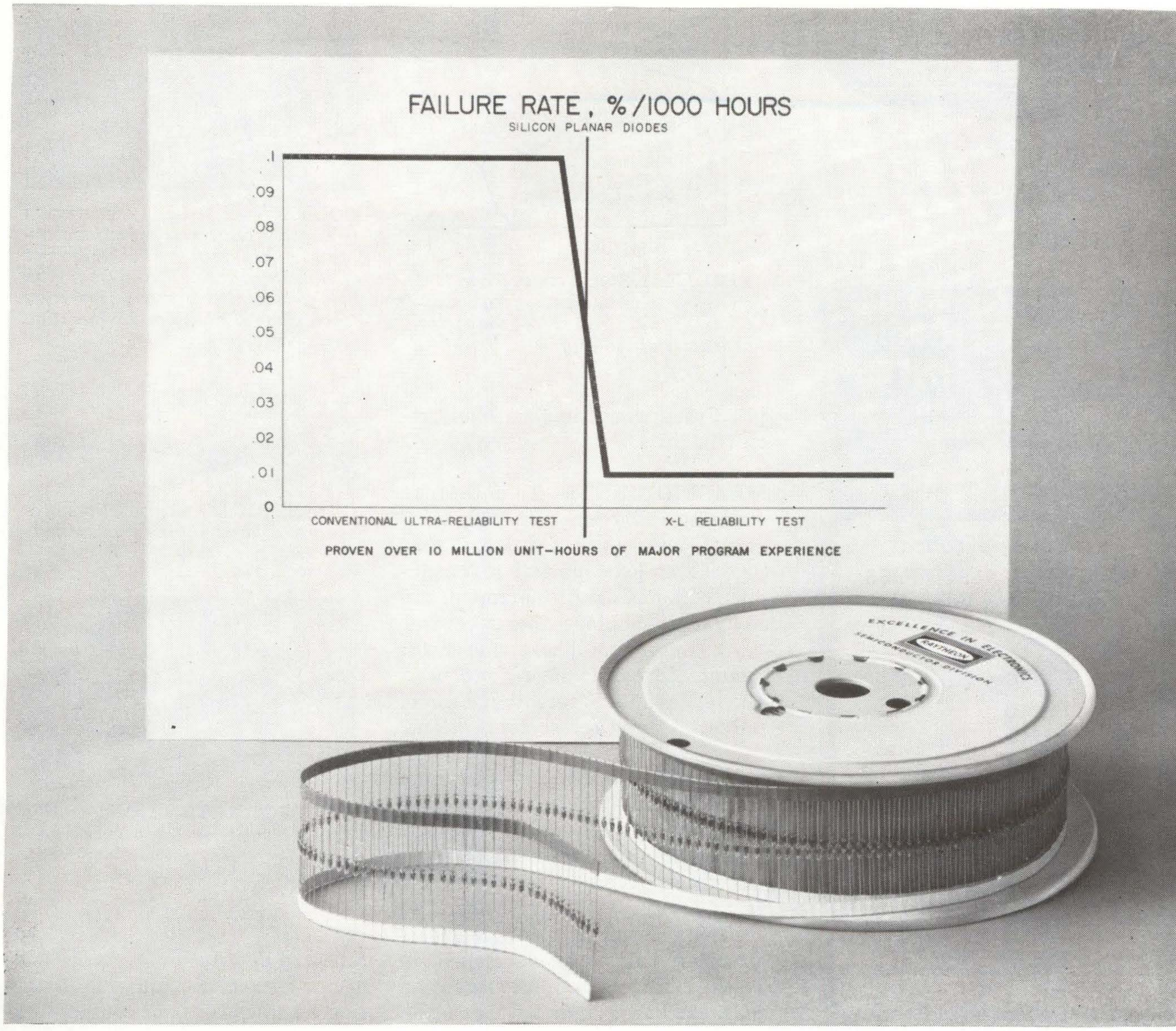
VARIATIONS — The aforegoing sequential environmental testing can be improved upon. For example, one might consider monitoring contact resistance through a minimum time period of temperature, moisture, or vibration and shock. Or, one might consider exposure to simultaneous environmental affects such as moisture and vibration for a given length of time. Continuous monitoring of these will show a variable distribution of results. An accompaning graph (Fig. 2) shows that although individually moisture and vibration tests would pass contact-resistance requirements, jointly ap-



SIX *test sequences check-out various connector characteristics measured after each environmental exposure—Fig. 1*

CONNECTOR ACCEPTANCE CHECKING

Connector manufacturers can perform stringent lot-to-lot tests to check whether high-volume production variables — material variations, operator variability, machine variability—have affected designed-for reliability. Testing program described here was formulated by Burndy and a major customer



How low-cost Raytheon X-L Reliability Program cuts "hidden" semiconductor failures by 10:1

Many transistors and diodes good enough to pass today's reliability tests can still drift out of spec limits and fail tomorrow. Now, for the first time, Raytheon's X-L reliability technique can detect these future drifters before they fail — at exceptionally low cost. Result: a reduction in failure rate of as much as 10:1 over conventional ultra-reliability levels — 100:1 over Military Specifications.

To qualify for X-L certification, devices must first pass the rugged requirements of the Raytheon MARK X and MARK XII reliability programs. Then, each semiconductor is carefully measured — electrically exercised for 100 hours — and measured again for changes in characteristics. A parameter change of as little as 2 nanoamps can cause rejection — *even though the device is still within initial spec limits.* Potential failures, which would have passed conventional electrical tests, are eliminated.

These low-cost, "tight yardstick" benefits of X-L certification are a direct result of proprietary techniques and specialized equipment developed at Raytheon and proven over 10 million unit-hours of major program experience.

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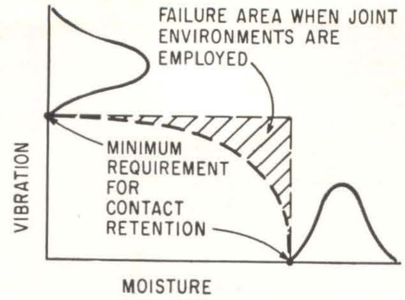


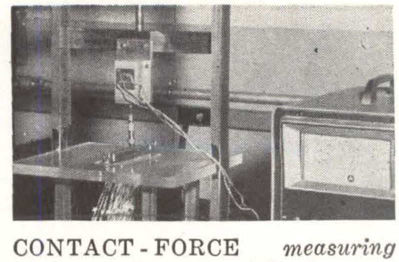
SIMULTANEOUS *exposure to two or more environments greatly increase failure rates of connector characteristics—Fig. 2*

plied they would in time likely result in failures.

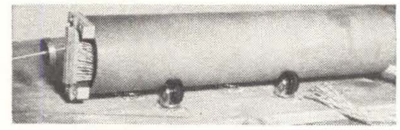
MEASUREMENTS—To date, four experimental connector-evaluation setups have been developed that provide at least partial independence of human skill, judgment and fatigue to achieve the necessary work speedup. These measure: contact force, damage done by a probe, contact retention force, potential drop across connection.

CONTACT FORCE — Optimum force holding pin to socket must exist so as to handle low-level signals and to permit easy disengagement. A two-step "pin-lift" test is the standard checking method. However, a single measurement has been developed to combine the check on the retention of a smaller weight by the socket and the check on its inability to lift a larger weight. A test pin is mounted over a socket in the connector assembly. Pin is part of a system (Fig. 3) having a screw drive to vertically move the pin into the socket and a calibrated strain gage connected to a bridge circuit for measuring insertion force. Screw drive rapidly inserts the pin to a predetermined socket depth and withdraws it at a slow, steady rate. Bridge circuit includes an alternating vacuum tube voltmeter with automatic voltage range selector within the range observed. As the pin is withdrawn, the maximum voltmeter value and range are observed. A calibration graph then provides conversion to force. This arrangement is preferred to mechanical spring gages.

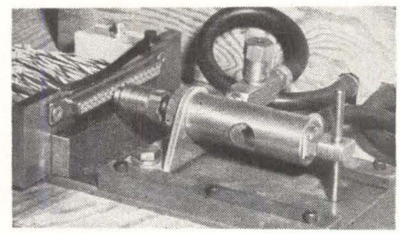
PROBE DAMAGE—Insertion of a weighted contact pin into a socket,



CONTACT-FORCE *measuring equipment has screw drive for moving test pin into connector socket a preset distance. Strain gage and bridge circuit measure insertion force exerted at different insertion levels—Fig. 3*



CYLINDRICAL *fixture eliminates awkward hand rotation in connector-distortion test—Fig. 4*



CONTACT-RETENTION *testing by automatic device assures adequate alignment and rate-of-force-increase control—Fig. 5*

followed by rotation, tests the connector-socket resistance to distortion by test probes of contact fingers and contact spring in preserving adequate contact force. Awkward rotation by hand lessens test reproducibility. To eliminate this factor and to increase test speed, a fixture of cylindrical shape was designed to mount the connector at one end at right angles to the rotation axis (Fig. 4). A weighted test pin is placed in one connector socket at a time and the cylinder rotated through 360 degrees.

CONTACT RETENTION — Contact-retention force is that force which can be resisted by the connector contacts before they are either pushed out or dislodged. In testing, a force is applied axially against the tip of the connector pin, or the entry of the socket, maintaining full load for a specified period. Doing this with a calibrated spring gage or in a tension tester is difficult because

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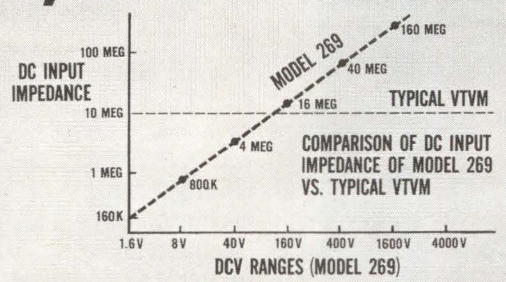

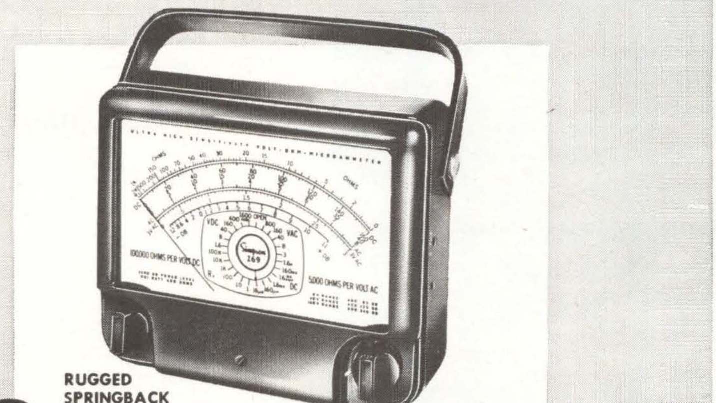

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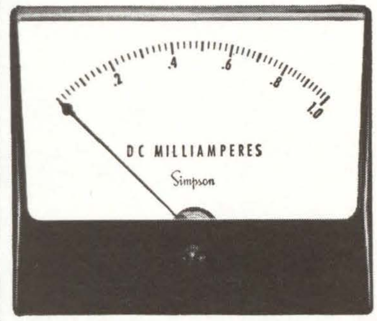

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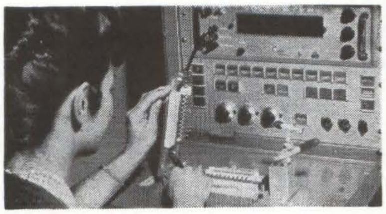
alignment and rate-of-force-increase control is inadequate. Fig. 5 illustrates an automatic device that meets the needed requirements and that also includes process reversal to unload test samples. An electrical-cycle control (timer) actuates a solenoid to let air enter at a predetermined pressure into a cylinder that provides the axial test force. When the maximum force is reached, it is maintained for a given period by a bleeder valve. At the end of this period, the timer cuts-off the solenoid valve so as to retract the cylinder's pushrod.

POTENTIAL DROP — Determining potential drop across connections has been completely automatized because of the many life-test measurements required. A transistorized test device was developed that includes eleven automatic stepping switches which provide for simultaneous hookup for 20 connectors, each with 35 connections and which can concurrently energize three connectors. Lights indicate which connectors are energized and which position is being measured. All 35 positions of each connector are wired in series through the test device. A direct current of 7.5 amperes is used with a potential drop of 45 millivolts. A mechanically programmed tensile tester engages and disengages the connectors with measurements made after every 50 such cycles. This life-cycling is continued to failure. An amplifier and a metering circuit having an indicating circuit and overvoltage trigger, measure potential drop. Set at 44.5 millivolts, the trigger circuit automatically stops the test when this level is exceeded, actuating a light and buzzer alarm. Meter is then read and test started again manually. Measurements begin after one minute of current flow when thermal stabilization is achieved. Measurement speed can be varied from ⅓ second to 5 seconds. This is advantageous: for example, assuming an average life of 10,000 test cycles, for 221 connectors with 35 connections each, measurements in excess of one million would be required.

Quality Specs Checked By Computer System

By E. F. THIBEAULT
Clevite Transistor Division
Clevite Corporation
Waltham, Mass.

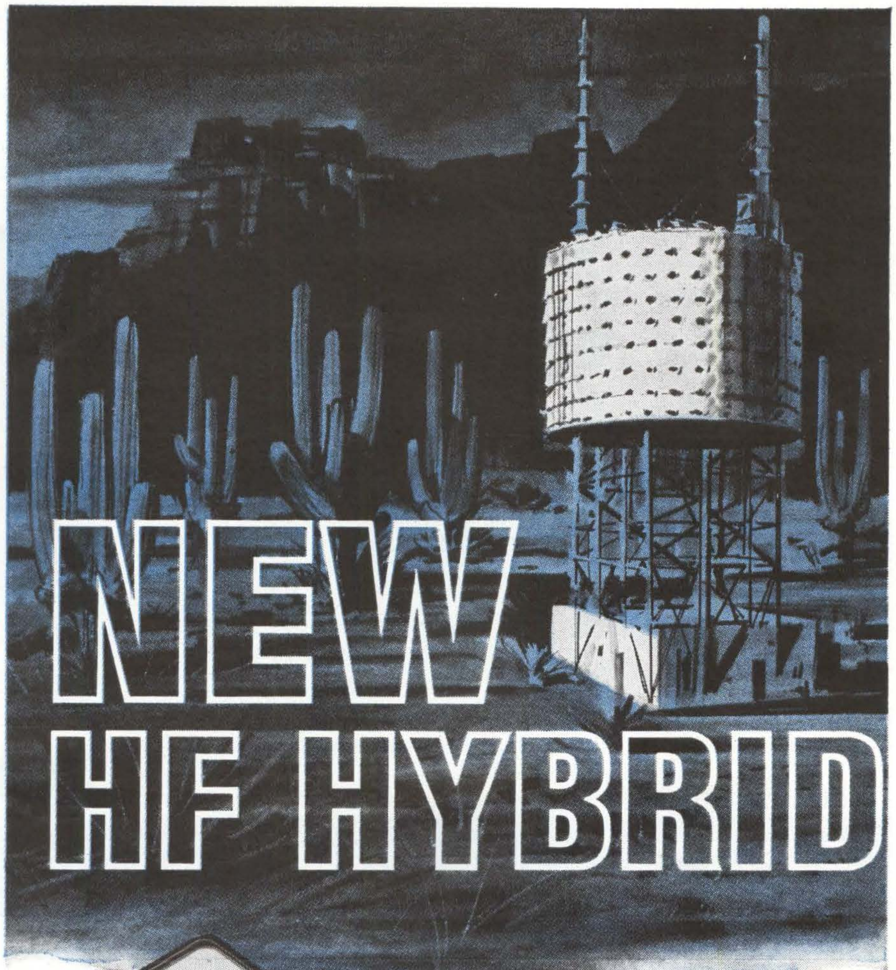


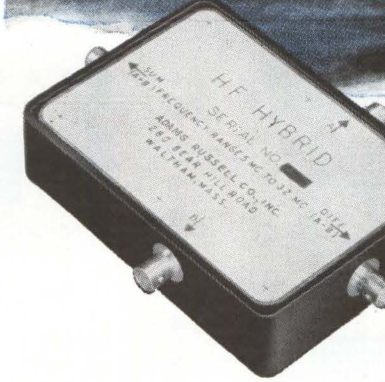
THREE *separate tests each are made of diodes' forward voltage and reverse current leakage by automatic equipment that records data on punched cards for computer evaluation. Testing rate is 1,300 diodes per hour*

RIGID SPECIFICATIONS on mass-tested silicon-alloy diodes—forward voltage less than 1 volt and reverse current leakage less than 100 millimicro amperes—have prompted the use of a Univac Step 80 Card System in Clevite's Waltham, Mass. plant. Diode checking requires that forward and reverse readings be taken over 3 time intervals during high-temperature and operational-life tests. Readings are recorded by automatic equipment on identifying punched cards. Computer uses cards to calculate whether difference between smallest and largest of forward-voltage readings exceeds 50 millivolts and whether the smallest-and-largest reverse-current difference exceeds 10 na.

This information is recorded on individual cards and used to tabulate histograms: For example, with forward voltage, a 0.50 to 1.00 volt range is divided into 20 intervals (.50, .51, etc.). Readings falling in different intervals are used to calculate arithmetic mean and variance of the three voltage-reading distributions.

Arithmetic mean and variance of all six distributions (forward voltage and reverse-current leakage) are used to determine significance of spread about the mean. Cards for those diodes not having readings representative of the total population are sorted into a separate output stacker on a high-speed reader.





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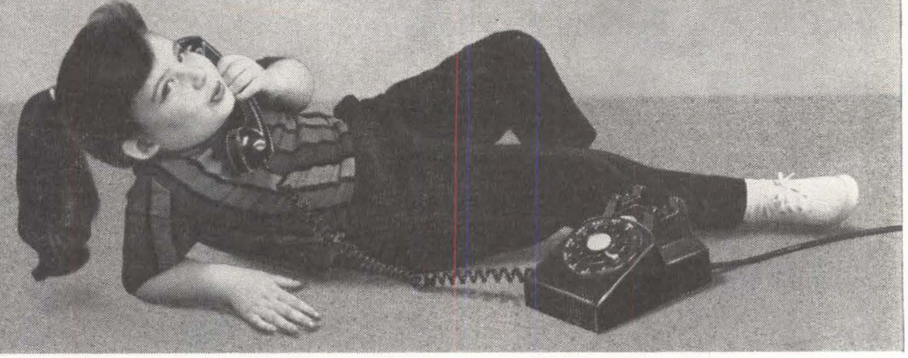

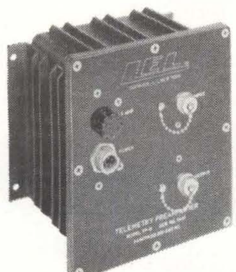

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TP-7-108	108-162 (Fixed Tunable)	6	<2
TP-7-160	160-225 (Fixed Tunable)	6	2-3
TP-7-225	225-400 (Fixed Tunable)	6	2.5-4.5
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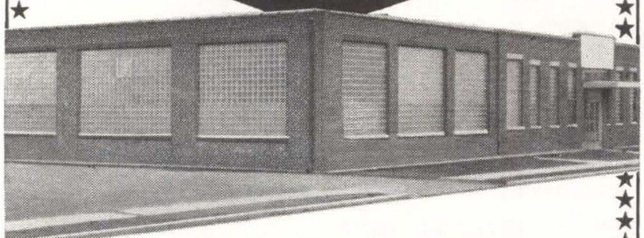

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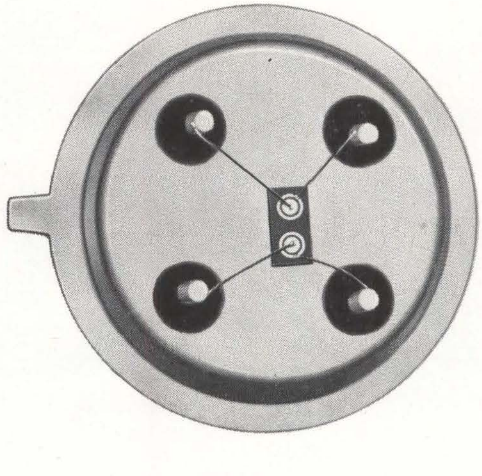

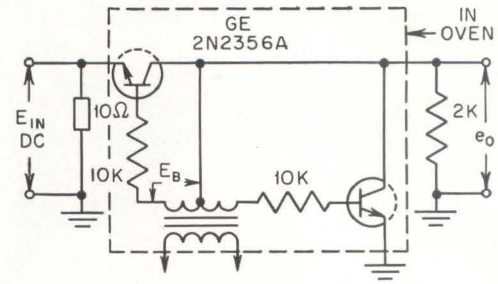

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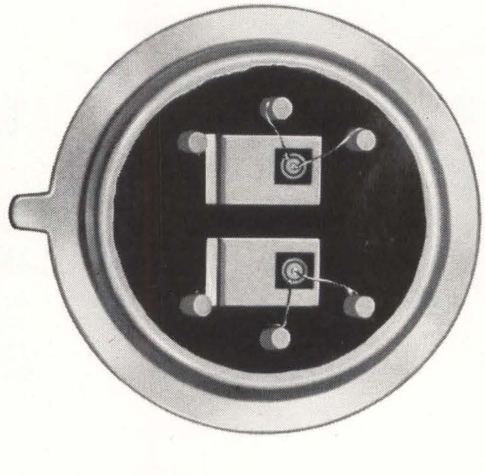

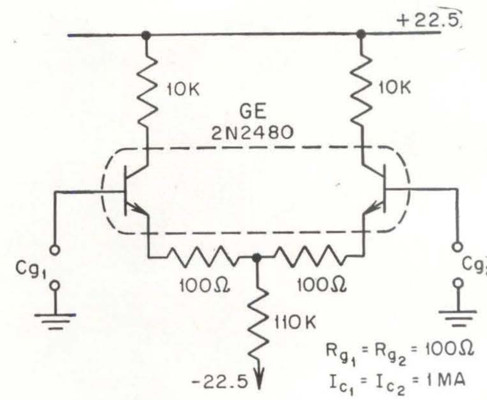

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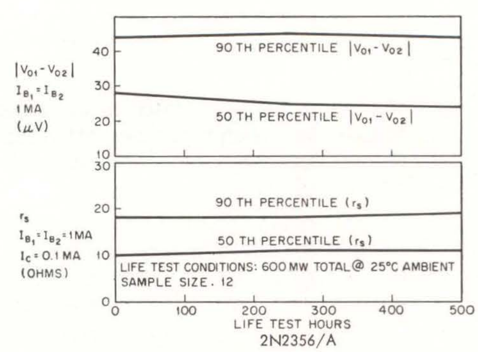

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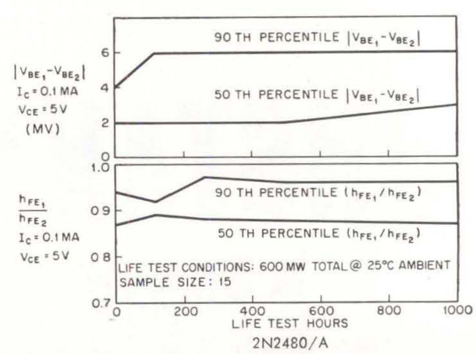

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2N2480	40	30 min	0.8-1.0	10
2N2480A	40	50-200	0.8-1.0	5
12A8	30	30 min	0.6-1.0	15

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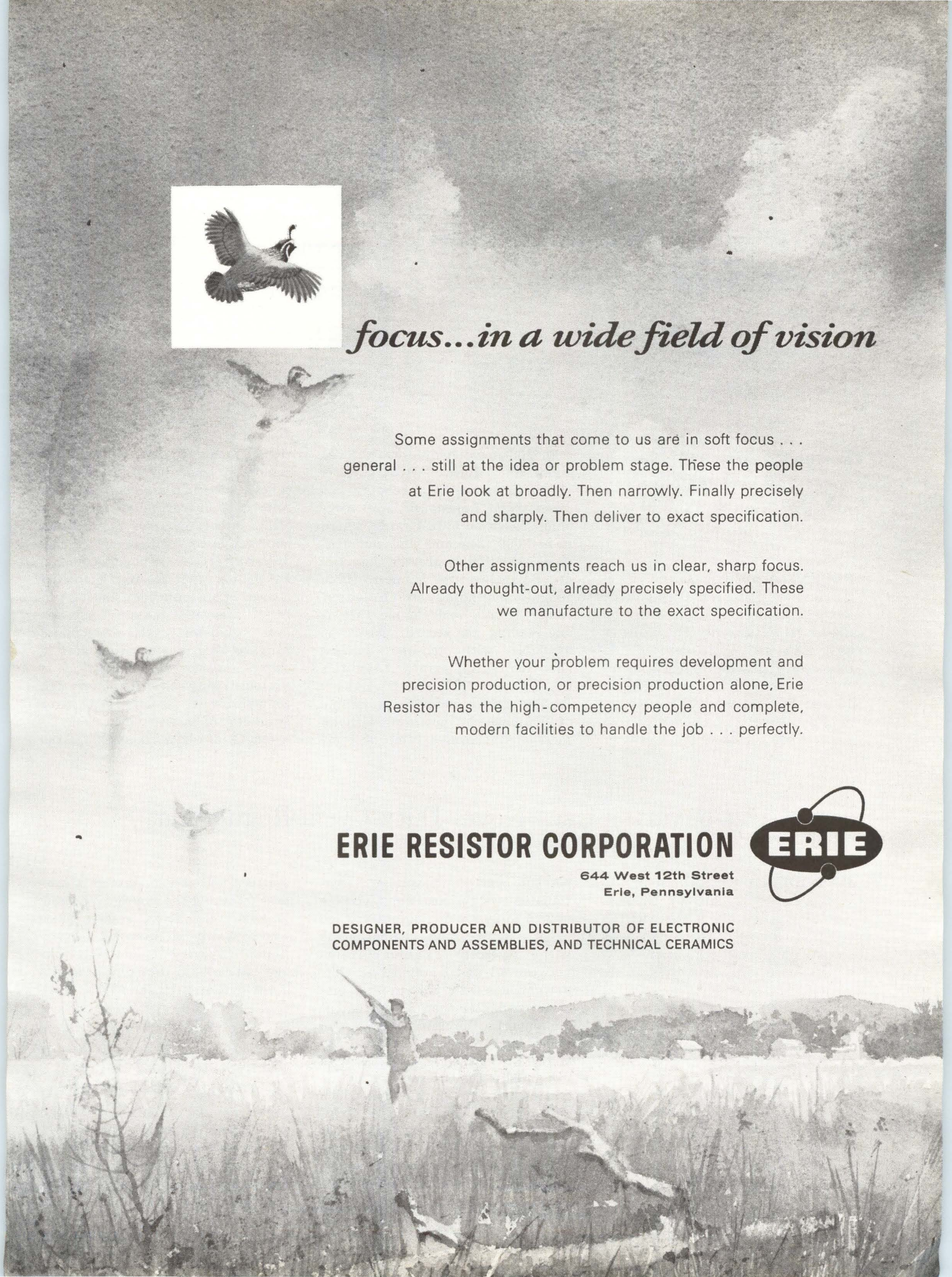
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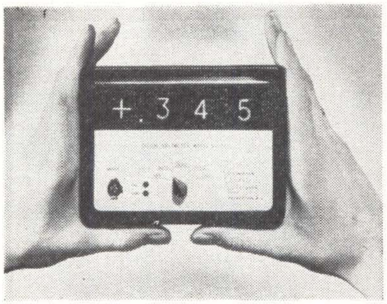
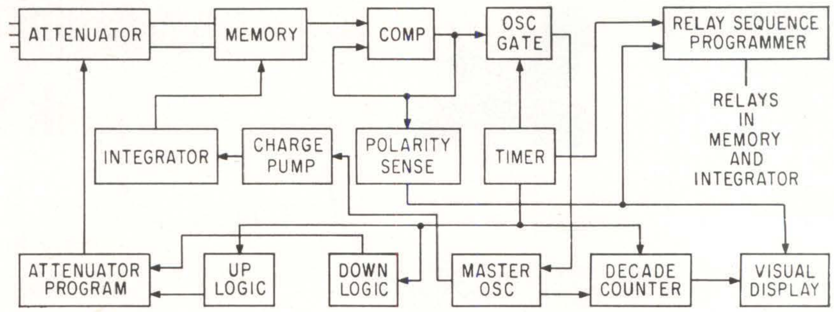




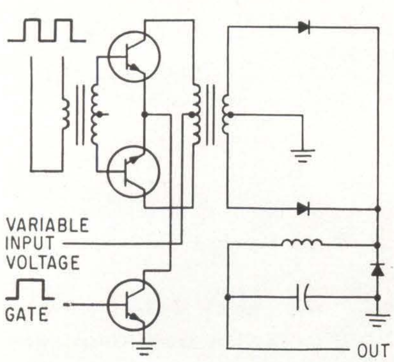
Portable instrument uses novel approach to reduce physical size

RECENTLY announced by Princeton Applied Research Corp., P. O. Box 565, Princeton, N. J., the model CS-3.1 miniature digital voltmeter uses both solid-state devices and reed relays, floating differential input, automatic polarity indication, automatic ranging and has no stepping switches. Range is d-c from 0.001 to 999 v with voltages greater than 100 mv displayed with three significant digits. Accuracy is within 0.1-percent of reading ±1 count, input impedance is 10 megohms except on lowest range where it is 1,000 megohms and common-mode rejection is greater than 100 db. Balancing time is one to three seconds depending on change of range desired and sample rate is one reading per second. Output is available with ten-line decimal code for digital print-out. Unit is $6\frac{1}{2} \times 5 \times 8$ inches and weighs 9 lb. The device compares a sample of unknown d-c potential with an internally-generated ramp of 1 mv steps, then displays accumulated ramp step count on in-line readout tubes. The ramp is generated by a solid-state charge pump feeding a Miller integrator. The charge pump is driven by an oscillator which also drives a three-digit decade counter. Integrator input receives quantized charge in amounts just sufficient to raise integrator output 1 mv for each oscillator cycle. Automatic ranging programs an attenuator to charge a memory capacitor which is switched between attenuator and comparator to isolate attenuator from rest of instrument.

CIRCLE **301** READER SERVICE CARD

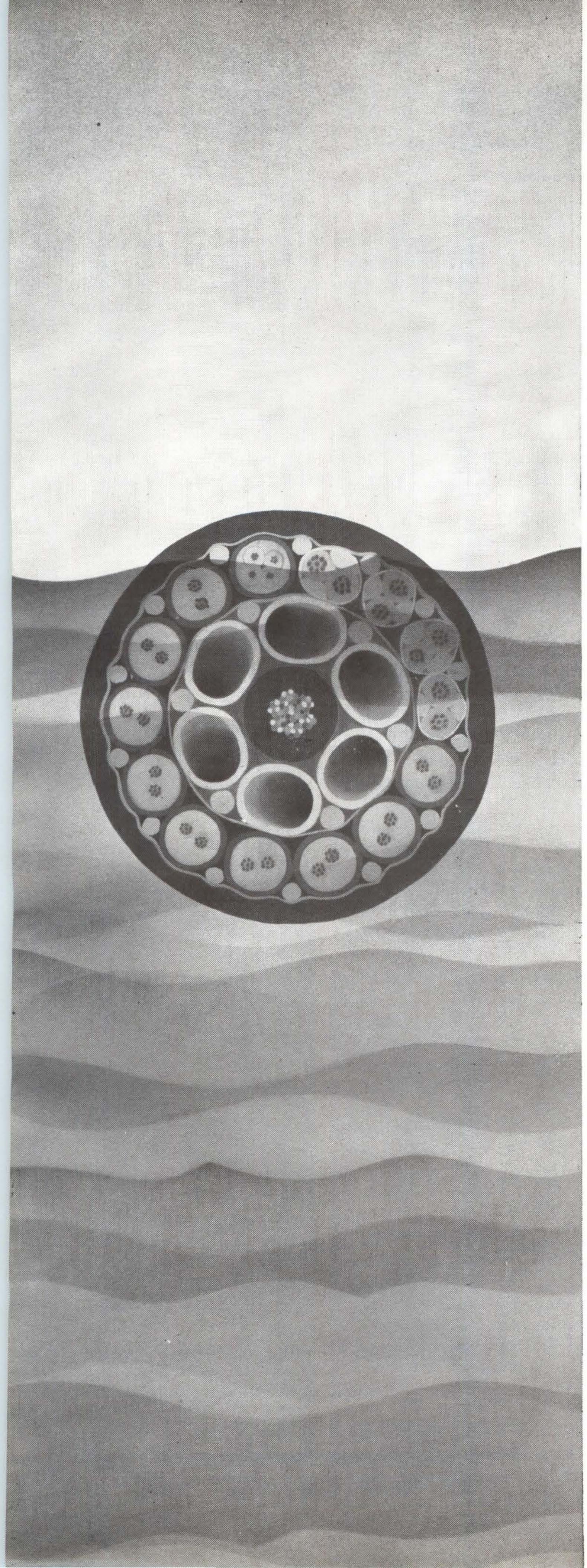
Converter Uses Novel Duty-Cycle Regulation

INTRODUCED by Astronetic Research, Inc., P. O. Box 397, Nashua, New Hampshire, the model ARI 168 constant-voltage power supply uses special duty-cycle regulation techniques to develop efficiencies of 85-percent over input voltage variations of two to one. Input voltage is 23.5 to 33.5 v d-c, output voltage is +28 v d-c and regulation is within $\frac{1}{4}$-percent at output currents between 0.1 and 1.5 amperes. Output ripple is 0.2 v peak-to-peak, efficiency is better than 80 percent at 1.5 amperes, the unit is $\frac{7}{8} \times 4 \times 6$ inches and weighs 12 ounces. As shown in the sketch, a square wave is applied to the bases of two switch transistors and a variable-width gate pulse is applied to a series emitter switch. The resulting signal across the transformer is a variable pulse-width a-c waveform whose frequency is that of the square-wave drive. The a-c waveform is rectified and passed through a low-pass filter and the average d-c value is recovered. Thus, a gate pulse whose width is inversely proportional to varying input supply voltage can be used to maintain a constant output voltage. **(302)**

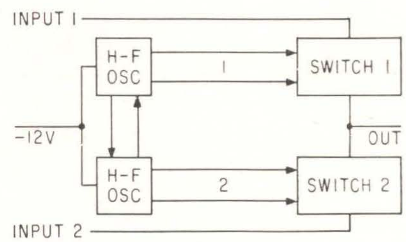


Solid-State Data Relay Operates Within 10 μsec

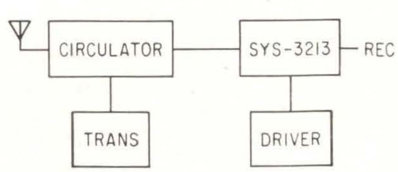
NEW from Data-tronix Corp., Penn and Archer Streets, Norristown, Pennsylvania, the model 5000 is a solid-state, high-impedance switch whose input is ±5 v at 100 μamp, resistance to ground is 5,000 meg-



ohms and power requirement is 12 v at 4 ma. Switching speed is d-c to 1 Kc, switching time is 10 μsec, load impedance is 50,000 ohms, contact resistance is 50 ohms maximum and output ripple is 5 mv. Operating linearity is 0.1 percent for a 5 v input and offset is within 2 mv. Maximum open-switch leakage current at 85 C is 25 nanoampere for a 6-v signal. Output level is equal to input less contact resistance drop ± offset voltage. Output impedance is equal to source impedance plus contact resistance. The spdt switch shown in the sketch consists of two separate oscillators coupled to two switches. When B+ is turned on, oscillator 1 output is rectified and applied to switch 1. The switch is an inverse-mode saturated transistor that exhibits offset voltage no greater than 300 μv. With trigger application, oscillator 1 is turned off and oscillator 2 turned on. Oscillator 2 activates switch 2. All B+ voltages are isolated from signal path and switch 2 is back-biased when switch 1 is activated and vice-versa.

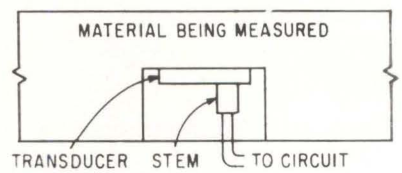


CIRCLE **303** READER SERVICE CARD



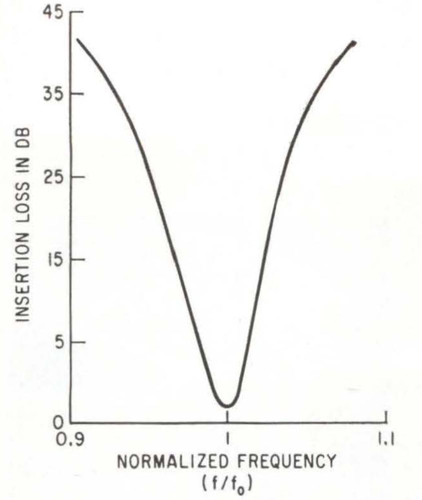
R-F Switch Combines Isolator and Diode

ANNOUNCED by Sylvania Electric Products, Inc., 1100 Main Street, Buffalo 9, N. Y., the SYS-3213 is a solid-state component for radar receiver protection in 13.26 to 13.36 Gc band doppler systems. It combines a ferrite isolator and a fast diode switch within a single unit. The diode switch prevents the pulse from entering the receiver and the isolator acts as an absorber so that the pulse is not reflected back to the transmitter. Minimum isolation is 40 db, maximum insertion loss is 1.5 db, vswr (on) is 1.5 and r-f power rating is 10 w peak and 1 w average. Switching time is 50 nsec. Power requirement is approximately 80 mw. The ferrite isolator prevents local oscillator signals from reaching the diode switch. Normally, this would not be a problem but due to high switching speed, signals of many frequencies are generated during switching cycle. If these are allowed to combine with the signal generated by local oscillator and returned to the receiver input, they would be amplified and displayed with the signal received at the antenna. **(304)**



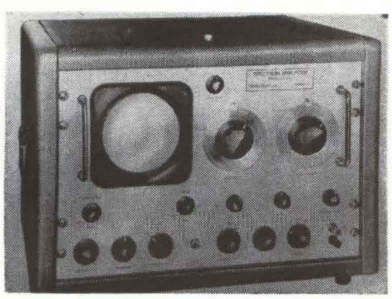
Transducer Measures Temperature to 1,200 F

MANUFACTURED by Trans-Sonics, Inc., P. O. Box 328, Lexington 73, Massachusetts, the T4151 alumina temperature transducer has an operating range of 0 to 1,200 F with brief transients to 1,500 F, accuracy within 2 percent, repeatability of 0.2-percent of range interval, operating current of 15 ma and a thermal time constant less than 500 milliseconds (63 percent of full range) when measured in agitated liquid. Insulation resistance is greater than 2 megohms at 100 v and room temperature, and a calibration card is supplied with each unit. The device consists of a platinum winding on an alumina card. The wire is flame-sprayed with aluminum oxide to provide a high-temperature insulation resistance. Composition of the sprayed coating may be varied to obtain thermal conductivity close to the material being measured. The unit is mounted as shown in the sketch. The transducer's stem is sufficiently removed from the internal winding to insure that the leads will not transmit heat to or from the platinum winding thus creating a false reading. Physical size is 0.47 × 0.34 × 0.035 inches, stem is ¼-in. long and the device weighs less than 0.25 ounce. **(305)**



UHF Bandpass Filter Uses Helical-Line Resonators

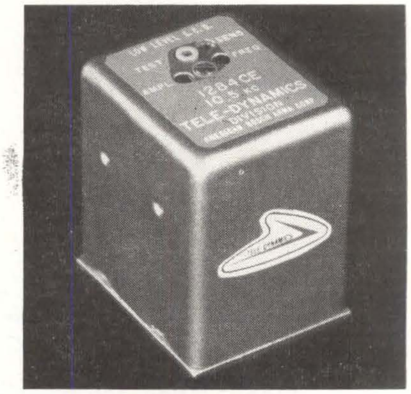
ON THE MARKET from Dorne and Margolin, Inc., 29 New York Ave., Westbury, New York, the DM F5 bandpass filter has a center frequency between 100 and 500 Mc, midband vswr of 1.30:1, impedance of 50 ohms and an insertion loss of 1 db. Bandwidth is 2 to 5 percent, rejection is 40 db at $f_o \pm 10$ percent, and no spurious responses up to 4 f_o. The device uses three coupled end-loaded helical line resonators. Units incorporating additional resonators and still higher selectivity can be furnished. Unit body length is 3.90 inches and connectors extend overall length to 6 inches. Height is 1⅞ inches, width is 1.31 inches and the device weighs 8 oz. **(306)**



Sonic Analyzer Spans 6 Cps to 23 Kc

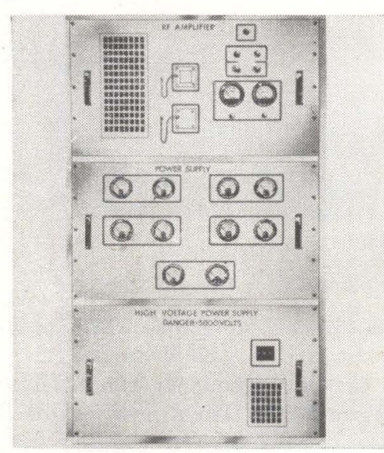
PROBESCOPE CO. INC., 211 Robbins Lane, Syosset, N. Y. Model SS-20L covers the frequency range from 6 cps to 23 Kc. Unit incorporates log sweep. This permits a quick analysis of all the information contained in the range of frequencies from 40 cps to 20 Kc. Incorporated in the log sweep function are three markers—60 cps, 1 Kc, 20 Kc—which permit calibration of the screen at all times. The SS-20L is valuable in the field of vibration and distortion analysis.

CIRCLE **307** READER SERVICE CARD



Subcarrier Oscillator For Space Vehicle Use

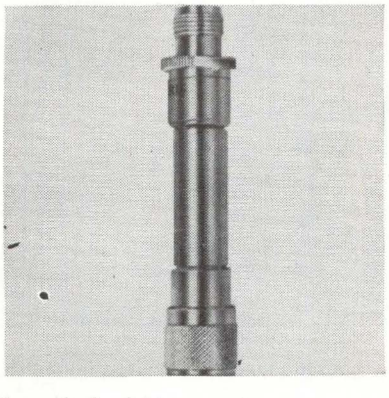
TELE-DYNAMICS DIVISION, American Bosch Arma Corp., Garden City, N. Y. Designed to operate with differential signals as low as ± 5 mv full scale, model 1284 subcarrier oscillator combines high common mode rejection with high input impedance. Its inherently high linearity and thermal stability are further enhanced by its extremely rugged mechanical construction capable of withstanding severe environments such as: random vibration of 30 g, 25 to 2,000 cps; shock of 150 g; acceleration of 150 g; unlimited altitude and temperatures from − 20 to + 85 C. It is available for all IRIG channels. **(308)**



R-F Transmitters From 200 to 1,000 Mc

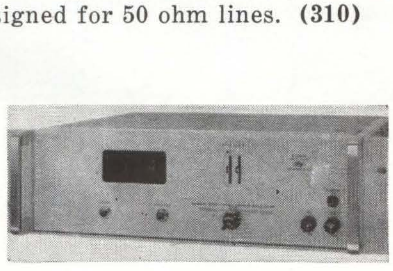
MICROWAVE CAVITY LABORATORIES, INC., 10 North Beach Ave., La

Grange, Ill. High power c-w r-f transmitters from 200 to 1,000 Mc are available on a custom basis. Power supplies and protective circuitry are common to all models while r-f racks are designed for particular frequency applications. Units have been life-tested and are extremely reliable. Coaxial cavities are used to generate power at maximum efficiency. **(309)**



Coaxial Attenuators Rated 2 W Average

RLC ELECTRONICS, INC., Port Chester, N.Y. Model A-10 miniature fixed coaxial attenuators are available with a range of attenuation values of 1 db to 60 db. They are power rated 2 w average, peak 2 Kw. Maximum vswr is 1.25 from d-c to 2,500 Mc. Attenuation accuracy from 1 to 5 db is ± ¼ db, 6 to 25 db ± ½ db, 30 to 60 db ± 1 db. Conservatively operated over a temperature range of − 55 C to + 125 C, units are fabricated from silver plated brass. They are designed for 50 ohm lines. **(310)**

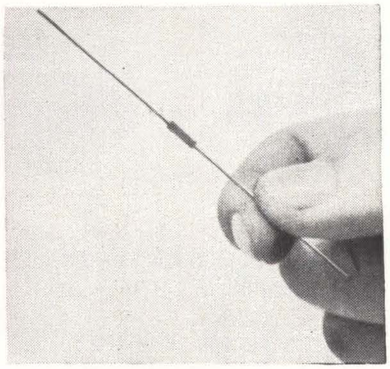


Input Scanner Has Limit Control

DYMEC, a division of Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. The DY-2900A input scanner sequentially transfers data from a group of external sources to one set of measuring and recording equipment. It permits up to 50 single-wire or 25 2-wire inputs to be scanned at speeds up to

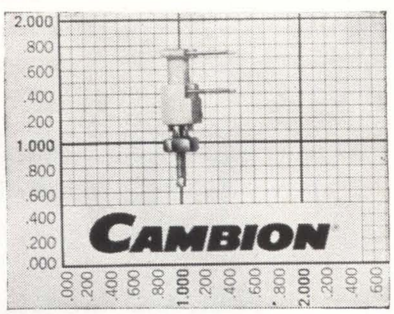
25 channels per sec. A scan limit control permits simple omission of unwanted input points. Unit can be externally programmed for a fixed delay time at each channel position before a read command is issued to the measuring device.

CIRCLE 311 READER SERVICE CARD



Ceramic Capacitor For P-C Use

HI-Q DIVISION, Aerovox Corp., Olean, N. Y. The MC-70 ultraminiature ceramic capacitor is available in a range from 10 μμf to 20,000 μμf in a single case size. It is ideally suited for automatic insertion in printed circuits, and is especially compatible for cordwood packaging. All units are rated for 100 v d-c at 85 C, except those between 10,000 and 20,000 μμf which are rated at 50 v d-c, derated 50% at 125 C. **(312)**



Tunable Coil Form Has Live P-C Leads

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., announces a molded diallyl phthalate printed circuit tunable coil form. It has live p-c leads, is mounted and tuned horizontally and, with its above board height of just 0.300 in. when mounted, is ideal for drawer-type installations. The new form mounts on a 0.250 in. by 0.500 in. p-c grid. **(313)**

Literature of the Week

GRAPHIC RECORDING CHARTS Esterline Angus Instrument Co., Inc., P.O. Box 596, Indianapolis 6, Ind. Catalog describes curvilinear, rectilinear, inkless event recorder and ink type event recorder charts.
CIRCLE 314 READER SERVICE CARD

MINIATURE CONNECTORS General RF Fittings, Inc., 702 Beacon St., Boston 15, Mass., has available an 8-page catalog describing miniature TPS connectors. (315)

DIGITAL VOLTOHMMETER Beckman Instruments, Inc., 2400 Harbor Blvd., Fullerton, Calif. Data sheet describes a digital voltohmmeter for airborne use. (316)

FRONT PLUG-IN READOUTS Industrial Electronic Engineers, Inc., 5528 Vineland Ave., North Hollywood, Calif. Technical bulletin describes series 220,000 front plug-in readouts. (317)

STRANDED WIRE International Wire Products Corp., Midland Park, N. J., has available a new survey report entitled "True Concentric vs Unilay Stranded Wire." (318)

INSULATED GLASS CAPACITORS Corning Electronic Components, Raleigh, N. C. Insulated glass-dielectric capacitors, made especially for printed circuits and point-to-point wiring, are described in data sheet CE-1.05. (319)

EPOXY-POLYESTER ALLOYS FMC Corp., 633 Third Ave., New York 17, N. Y., has published a 19-page technical booklet on new epoxy-polyester alloys. (320)

PRECISION MAGNET SYSTEMS Harvey-Wells Corp., Framingham, Mass. A 24-page catalog illustrates and describes a line of precision magnet systems. (321)

DIGITAL LOGIC MODULES Scientific Data Systems, 1649 17th St., Santa Monica, Calif. Catalog details a line of all-silicon semiconductor digital logic modules. (322)

COMPUTER TERMINOLOGY General Electric Co., Phoenix, Ariz. Brochure CPB-93BP is a 26-page glossary defining some 400 computer-language words and phrases. (323)

MEGAWATT KLYSTRONS Sperry Electronic Tube Division, Gainesville, Fla. Brochure describes super power klystrons spanning a four-band spectrum with megawatts of power output. (324)

TUBE SOCKETS Connector Corp., 6025 N. Keystone Ave., Chicago 46, Ill. Data sheet covers a h-v Compactron tube socket line. (325)

CAPACITOR TESTING Aerovox Corp., New Bedford, Mass., has issued bul-

letin 102C3 entitled "Testing Ac Industrial Application Capacitors."
CIRCLE **326** READER SERVICE CARD

CONTROL PANEL KEYBOARDS Korry Mfg. Co., 223 8th Ave. No., Seattle 9, Wash. Bulletin provides data on the 210 series control panel keyboards **(327)**

MODULAR POWER PACKS Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J., has available a catalog sheet describing an all-silicon line of high temperature modular power packs. **(328)**

TEFLON HOOK-UP WIRE Insulated Wire Co., Moorestown, N. J. Data sheet contains specifications for silver plated or nickel plated conductors with Teflon insulation for either 200 C or 260 C operation. **(329)**

MOLECULAR ELECTRONICS Westinghouse Molecular Electronics Division, P.O. Box 868, Pittsburgh 30, Pa. Booklet covers uses, manufacturing methods, and other aspects of molecular electronics. **(330)**

X-BAND MULTIPLIER Microwave Associates, Inc., Burlington, Mass. Preliminary data sheet P-7506 covers the MA-8107 X-band multiplier for 9.6 to 11.5 Gc. **(331)**

PRINTED CIRCUITRY Electralab Electronics Corp., Encinitas, Calif. Folder pictorially illustrates and explains the 14 basic steps in producing circuit boards. **(332)**

PHASE-SHIFTING MODULES Nilsen Mfg. Co., P.O. Box 127, Haines City, Fla. Data sheet describes characteristics of a series of phase-shifting modules which operate at r-f frequency specified by user. **(333)**

PRECISION METAL FILM RESISTORS Weston Instruments and Electronics Division, Daystrom, Inc., 514 Frelinghuysen Ave., Newark 14, N. J. Latest models and specifications of the Vamistor line are offered in folder 04-104. **(334)**

SILICON CARBIDE VARISTORS The Carborundum Co., P.O. Box 337, Niagara Falls, N. Y. Brochure illustrates and describes symmetrical nonlinear voltage sensitive varistors. **(335)**

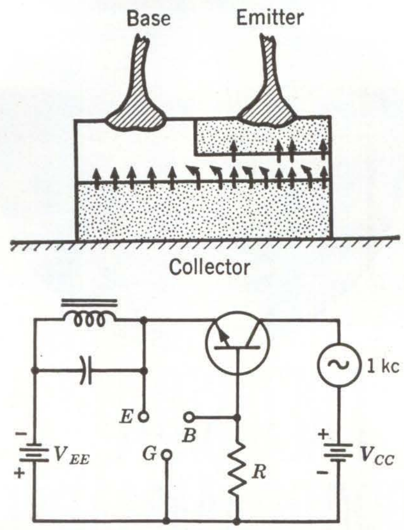
MICROELECTRONICS Instrument Division, Lear Siegler, Inc., 110 Ionia Ave., NW, Grand Rapids 2, Mich., has published a brochure describing its facilities and capabilities in the field of microelectronics. **(336)**

LASER MATERIALS Isomet Corp., 433 Commercial Ave., Palisades Park, N. J., offers a technical bulletin entitled "CT Lasers". **(337)**

SWITCHING TRANSISTOR Bendix Semiconductor Division, South St., Holmdel, N. J. Engineering data sheet covers the 2N1751 diffused alloy power high-current switching transistor. **(338)**

SHRINKABLE TUBING Alpha Wire Corp., 200 Varick St., New York 14, N. Y. Chart illustrates the range of wire and cable diameters covered by various types and sizes of the Fit line of heat shrinkable tubing. **(339)**

NEW BOOKS



DOUBLE-DIFFUSED *mesa transistor and a test circuit for measuring its r_B', from section on biasing*

Transistor Circuit Design

By the engineering staff of Texas Instruments Inc., Semiconductor Components Division

McGraw-Hill Book Company, Inc., New York, 1963, 523 *p*, $15.

THIS will be a valuable addition to the circuit designer's working library. It is a comprehensive collection of solutions to a wide range of basic circuit design procedures, compiled by thirty-two engineers.

Topics include a classification of all commercially available transistors, measurement of transistor parameters, and thermal effects on transistor circuits, as well as a very large number of practical circuit-design procedures ranging from amplifiers to digital servo systems. Each circuit is analyzed mathematically and described by step-by-step procedures; many tested circuit designs are included as illustrations.

An appendix dealing with field-effect transistors and their applications should gain added usefulness in the near future.—G.V.N.

Space Radio Communication

Edited by G. M. BROWN

American Elsevier Pub. Co., Inc., New York, 1962, 624 *p*, $25.

THIS book contains a bilingual (French and English) collection of technical papers that were presented at a symposium on space radio research held in Paris during September, 1961.

Subject matter includes data on launching, attitude control and tracking, frequency allocations, propagation problems, satellite equipment and instrumentation, modulation and specific communication systems.

The material is well supported by charts, drawings and graphs and includes some mathematical analysis where necessary. The bulk of material, however, tends to be more practical and deals with state-of-the-art techniques, though much information gathered since the symposium is, naturally, not included.

For one actively engaged in space research or allied fields, this volume will be a valuable addition to a reference library.—B.A.B.

Digital Computer Principles

By Staff of Technical Training Dept, Burroughs Corporation

McGraw-Hill Book Company, Inc., New York, 1963, 507 *p*, $10.95

A non-mathematical introduction to the modern digital computer, that attempts to evaluate the underlying concepts of computer logic and circuitry for an over-all understanding by the engineer, technical executive or programmer.

The three principal parts of the book deal with the physical fundamentals (components, Boolean algebra, number systems), with computer circuits (switching circuits, flip-flops, amplifiers, ferromagnetic cores), and with entire computer units and systems (registers, decoders, arithmetic units, input and output equipment and programming).

Appendices include a table of computer symbols, a general bibliography, and a good glossary of computer terms.—G.V.N.

Automatic Control Systems

By BENJAMIN C. KUO

Prentice-Hall, Inc., Englewood Cliffs, N. J., 1962, 504 *p*, $16

A comprehensive treatment of the principles and techniques involved in the use and design of feedback control systems. The book begins with basic mathematical concepts and feedback theory, then introduces the components of a feedback system and develops techniques for the analysis of a system's time response and frequency response. The Nyquist criterion and the generalized root-locus technique are next covered in considerable detail, followed by compensation of feedback control systems, z-transformations, sampled-data systems and a chapter on non-linear systems.

Some of the necessary mathematical foundations of control theory are briefly given in the appendix; a number of problems follows each chapter.

Environmental Testing Techniques For Electronics And Materials

By GEOFFREY W. A. DUMMER and NORMAN B. GRIFFIN

The Pergamon Press, New York, 1962, 443 *p*, $15.

A broad-level text covering most aspects of environmental test and evaluation procedures with emphasis on techniques. While the book is intended for a diversified audience, it is heavy on testing aspects applicable to the manufacture of military products, in particular those with space goals.

Chapters cover subjects such as planning, test methods and instrumentation, high-humidity environments, galvanic corrosion, high and low-temperature environments, mechanical hazards and effects, acoustical noise, transport and storage difficulties and environmental stresses and strains. The section on high-altitude and space environments is particularly detailed and discusses the aspects of arcing, corona effects, orbital simulations and the effects of nuclear and ultraviolet radiations, to mention a few.

The text is well appended with charts, tables and diagrams and has numerous graphs for reference.

The work ends with a well-stocked bibliography that will permit ready reference to works more detailed on specific points of interest.—B.A.B.

Western Electric Opens Research Center

WESTERN ELECTRIC'S new Engineering Research Center near Princeton, N.J., where some of the company's research scientists and engineers study telephone equipment manufacturing techniques, was recently officially opened.

Work at the Center involves research into machines, systems and processes for manufacturing Bell System communications equipment. Western Electric is the manufacturing and supply unit of the system.

The Research Center staff works closely with members of Bell Telephone Laboratories technical staff to develop manufacturing processes for new products designed by the Laboratories, and with engineers from the company's own plants to translate these designs into useful applications in the plants.

The Center's three-story main building, with the administrative offices and laboratories and a one-story building, containing heavy equipment laboratories, an auditorium, the power plant, and record storage facilities, provide a total of 138,000 square feet of floor space.

The Engineering Research Center was established in 1958 when the first staff arrived to set up offices and laboratories in a building formerly occupied by the Princeton Film Center. The building (shown in background) of 23,000-square foot floor space is currently used for the company's graduate engineering training program being conducted in cooperation with the Graduate School of Engineering of Lehigh University. This program leads to the Master's degree in either solid-state physics or operations research.

The present staff numbers more than 300, almost equally apportioned among scientists and engineers, technical support, and administrative support personnel.

Wright Appointed Astropower President

JOHN P. WRIGHT has been appointed president of Astropower, Inc., Newport Beach, Calif., a subsidiary of the Douglas Aircraft Co.

He had been executive vice president of Electra Manufacturing Co., Kansas City, Mo.

Packard Bell Names Wendell Sell

WENDELL B. SELL, group vice president and member of the board of directors of Packard Bell Electronics, Los Angeles, Calif., has been named to the newly created post of executive vice president.

As group vice president Sell directed three divisions of the company. In his new assignment he will be the chief operating executive supervising all line and staff managers of the company. The position of group vice president will be eliminated, according to Robert S. Bell, president.

Robert Wood Takes Additional Post

ROBERT M. WOOD, vice president and general manager of Keleket X-Ray, a division of Laboratory For Electronics, Inc., has also been named vice president and general manager for LFE's Tracerlab division in Waltham, Mass.

Wood will now be responsible for all engineering, quality control, manufacturing, technical products and marketing activities for Tracerlab's local operations, as well as continuing to perform a similar function for Keleket X-Ray.

Mellonics Announces Expansion Program

MELLONICS SYSTEMS DEVELOPMENT, INC., recently moved into new facilities in Sunnyvale, Calif.

As part of the expansion program, Frank Druding, president of Mellonics, announced the following appointments:

Jack Rose, who joined Mellonics shortly after it was organized, is promoted to vice president.

B. C. Dove, formerly manager of the Aerospace Corp. office at the

USAF Satellite Test Annex in Sunnyvale, has accepted the position of director of advanced planning. He has also been elected to the board of directors.

Ward Ellis has advanced to the post of director of engineering.

Donn Seeley, formerly general manager of Computer Technology Corp., has been appointed director of operations analysis.

Keith Pritchard has been appointed as secretary of the corporation.

Current Mellonics activities include performing system engineering for the U.S. Army Satellite Communications Agency for the SATCOM Ground System and Control Center. Mellonics is also participating in augmentation of the USAF Satellite Control Facility. In addition, work is being done on several commercial data processing applications.

General Precision Names Weiner

JAMES R. WEINER has been appointed director of advanced systems at General Precision's newly formed Information Systems Group. He will be responsible for the development of advanced computing, data-processing, and data-display systems for commercial and military applications.

Weiner's previous affiliations include Hughes Aircraft Co., Philco Corp., and Lockheed Missiles and Space Co., all in management capacities.

Litton Industries Advances Varnum

GORDON D. VARNUM has been named vice president, production, of Mc-

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The COLISEUM at Columbus Circle
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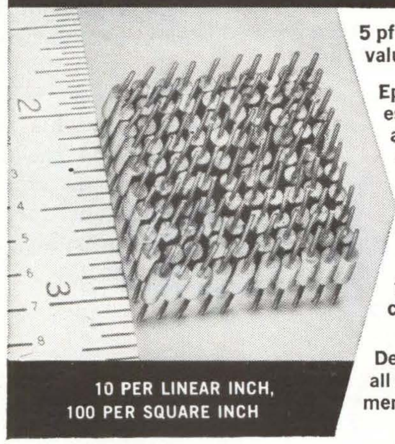
admission: MEMBERS $1.00; NON-MEMBERS $3.00
MINIMUM AGE: 18

SHOW

(formerly the IRE Show)

THE DECI-CAP

New Subminiature Ceramic Capacitor—0.100" Diameter by 0.250" Molded Envelope—24 Hour Delivery



5 pf to 470 pf in 19 values, 200 WVDC

Epoxy molded for highest reliability and performance—less than 7½% capacitance change from −55°C to +125°C

FEATURES:

Standardized size for high density cordwood packaging

Designed to meet all the requirements of MIL-C-11015

The DECI-CAP is the latest addition to Nytronics' DECI Series—a series that does consist of inductors, capacitors and resistors in a uniform envelope to facilitate point-to-point assembly in cordwood, printed circuit and other high density module assemblies.

For complete engineering data, write Dept. WL-60, or phone 201-464-9300.

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Tough competition *demands* that the electronics man be reached and *sold* wherever you find him: *Research, Design, Production, and Management.* Only advertising in **electronics** reaches all four... the same men your salesmen call on. Put your advertising where it works *hardest.....*

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Good parts work best!

Intermediate Frequency Transformer IFT

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The high standards of MITSUMI electronic components are insured by a fully-automated assembly system, and double-checked by rigid quality controls. Mitsumi Electric Company is Japan's largest manufacturer of components for radio, television and communications equipment.

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MITSUMI ELECTRIC CO., LTD.

Kiernan-Terry Corp., of Litton Industries, Radcom division. He assumes responsibility for the company's manufacturing operations at Harrison and Dover, N. J.

Varnum, who joined McKiernan-Terry in 1956 as a project engineer, had been assistant chief engineer prior to his recent promotion. He directed the Telstar horn antenna program which produced identical antennas for Bell Laboratories at Andover, Me., and Pleumeur-Bodou, France.

PEOPLE IN BRIEF

Daniel I. Pomerantz leaves Clevite Transistor to join the Laboratory for Physical Science of P. R. Mallory & Co. Inc. National Research Corp. promotes **Philip J. Clough** and **Norman Beecher** to asst. research directors. **Thomas J. Wortman** advances to asst. to v-p of marketing at Lenkurt Electric. **John Masse, Kenneth W. Brown** and **Alfred W. Brook,** formerly with Sperry Gyroscope, Philco and Federal Electric Corp., respectively, appointed principal engineers in the Systems Engineering dept., Government Products div. of Adler Electronics, Inc. Sylvania ups **Charles H. Miller** to mgr. of the Burlington, Iowa, receiving tube plant. **Endel Uiga** and **Wallace F. White** move up to v-p, engineering, and mgr. of R&D, respectively, at Ballantine Laboratories. **Edward D. Gray,** Potter Instrument v-p, assigned to organize and direct company's Computer Operation in Great Britain. **Michael Silver,** previously with Dorne & Margolin, appointed electronic engineer for General Microwave Corp. **Bernard Walley** of RCA appointed mgr., west coast microwave engineering operation, Electron Tube div. **David C. Scott,** ex-GE, now v-p and group exec at Fairbanks Whitney. **John C. Simons, Jr.,** recently resigned from National Research Corp., has established a consulting practice in vacuum science and technology in Weston, Mass.

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: Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

(Continued on page 126)

(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) 2863

☐ 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

LET'S TALK About the New Field of

AEROSPACE GROUND ELECTRONICS!

The rapidity with which we are reaching further and further into outer space . . . the many new and as yet completely unexplored related technologies . . . are giving birth to a vital new field—Aerospace Ground Electronics.

To be sure, ground support equipment, test equipment design and the like are involved. But the enormity of the tasks which lie ahead require different approaches than before and can only be described in new terms, and by the creation of a new master-field.

General Dynamics/Electronics is very active in Aerospace Ground Electronics and expects to become even more heavily involved. Our preliminary ideas in the field evolve from the disciplines listed below. If you have the required background, we would like to explore the possibilities of AGE with you.

SYSTEMS ENGINEERING

Broad knowledge of Aerospace Ground Electronics design. Will analyze aerospace electronic sub-systems for test requirements and determine test equipment needs. Experience in Air Force Shop or Naval Carrier Installations desirable, with emphasis on equipment layout, intercabling, work flow analysis, operational and calibration procedures.

PROJECT ENGINEERING

Project Engineers to supervise design and integration of test equipments and test stations. Should be familiar with all types of testing equipment and techniques in one or more of the following areas.

- **Flight Control Systems**
- **Radar**
- **HF-UHF Navigation & Communication Equipment**
- **Microwave Equipment**
- **Antenna Systems**
- **Electronic Countermeasures**

DESIGN ENGINEERING

MICROWAVE—Engineers experienced in the design of signal generators and receivers in the following frequency bands: L, S, C, T, Ku, Ka. Should also know techniques for remote control of frequency and signal amplitude.

LOW FREQUENCY—Experience in the design of audio and sweep signal generators and servo systems test equipment. Knowledge of remote control of audio generator frequency and output using digital techniques is desirable, or in cathode ray tube sweep circuits.

HF-UHF—Engineers with experience in the design of HF and UHF signal generators, using both transistorized and vacuum tube circuitry. Knowledge of techniques for digital selection of frequency, such as frequency synthesis, and remote control of signal amplitude required.

CIRCUIT DESIGN

Digital and Pulse engineers with experience in the design of transistorized logic circuits, pulse generators and other digitally controlled circuits such as numerical indicators.

Assignments Immediately Available in:

RELIABILITY SPACE NAVIGATION

ADVANCED DEVELOPMENT & ENGINEERING DESIGN OF DATA & RADIO COMMUNICATIONS

Send us your qualifications now. A discussion can be arranged. Address Mr. R. W. Holmes, Dept. 22.

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ENGINEERS/ELECTRICAL

FORMER TV EXPERIENCE NOT REQUIRED FOR

GENERAL ELECTRIC OPENINGS IN EXPANDING COMMERCIAL TV RECEIVER PROGRAM

Engineers with experience in advanced circuitry, digital techniques, radar and related technologies are invited to contribute to diverse approaches in:

DEFLECTION CIRCUIT DESIGN: (BS/MSEE)

Design deflection and convergence circuits for color T.V. Evaluate and approve vacuum tubes and other circuit components. Monitor pilot run and production run of completed designs. Achieve specified performance at minimum costs. EXPERIENCE: Color T.V. deflection and convergence circuit experience desired; experience in vacuum tube or transistor circuits, deflection circuits or closely related work, e. g., magnetic sweeps for T.V. cameras or radar flying spot scanners. Familiarity with and aptitude for product design work where cost is an important consideration; ability to cooperate with other engineers in integrating designs into complete receivers.

SWEEP CIRCUIT DEVELOPMENT (BS/MSEE)

Work in advanced development display systems group conceiving and developing novel sweep systems techniques and applying them to circuit development of TV receivers. EXPERIENCE: Practical experience with either digital circuits, computers, digital scopes and meters, encounters or deflection circuits — T.V., radar; or transistor circuits. An aptitude for circuit work and originality.

ELECTRICAL PRODUCT DESIGN: (BS/MSEE)

Conceive and design electrical circuits and components for mass production of monochrome or color T.V. receivers. EXPERIENCE: Familiarity with circuit design, IF, AGC, Pulse Circuits, AFC loops and video amplifier or applicable experience in radar design.

This is a compact engineering operation where each man can assume full responsibility for specific developments, designs or devices . . . where individual initiative and creativity become highly visible . . . where opportunities for growth and advancement are multiplied.

INQUIRIES ARE INVITED. *Your confidential resume will receive careful attention and a prompt reply. Write to Mr. Fred Piker, T.V. Receiver Department, General Electric Company, Div. 69-WJ, Electronics Park, Syracuse, New York.*

GENERAL ELECTRIC

An Equal Opportunity Employer

IBM asks basic questions in character recognition

How can we help computers read more?

U V W X Y Z , 2 3 4
5 6 7 8 9 a b c d e

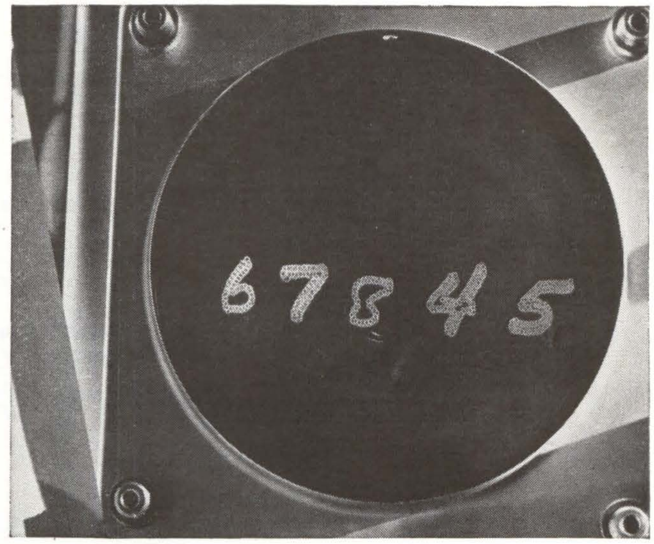
U V W X Y Z , 2 3 4
5 6 7 8 9 a b c d e

The experimental
system can also

настоящей· статьи

Первая серия проводи

Upper or lower case, typewritten or printed, good registration or bad, these letters are all recognizable to IBM's experimental multi-font reader.



Written in different styles, these numbers can be recognized by an experimental reader whose scanning beam detects line edges by traveling a circular path around the characters.

Transforming source information into machine codes is the slowest step in data processing. To make it possible to enter data directly, optical-scanning and magnetic character-sensing devices have been developed. However, most of these machines have been able to read only specially designed type faces. Now IBM has built experimental devices for optically reading a wide variety of printed and typewritten material—and even handwritten numbers.

The chief obstacle to automatic print reading is the variation in type styles found in printed and typewritten information. To overcome this obstacle, IBM scientists have developed an experimental character recognition system which can accept many different type fonts, sizes, and printing qualities in both the Cyrillic and the Latin alphabets. The system determines its own criteria for distinguishing among characters. As it identifies characters, it estimates the reliability of its recognition. After a few minutes it can read text in type styles for which it had not previously been adjusted.

The experimental character recognition system is a form of self-organizing machine. It works out its own methods of distinguishing one character from another in each alphabet it encounters by deriving 96 unique reference measurements which are used to identify each character. The computer programs which aided in the design of this machine represent an advance in character recognition research.

An equally important step toward more direct entry of data has been the development of an experimental system which recognizes handwritten numbers despite variations in individual writing styles. This system thus solves one of the most difficult problems in character recognition. It differs in its optical reading technique from the multi-font reader, making use of "recognition logic" derived from statistical summaries of the contours of sample handwritten characters. These samples were collected under uncontrolled writing conditions. The scanner in this experimental system generates voltage wave forms analogous to character outlines. The system analyzes these wave forms and records its identification on IBM cards. In a recent test at Tufts University, 200 people, after brief instruction on avoiding excessive distortion in their writing, submitted more than 100,000 numerals to the system. It recognized 98.5% of them correctly, indicating that it may possess the flexibility required to sense large volumes of handwritten numerals in computer systems of the future.

If you have been searching for an opportunity to make important contributions in character recognition, programming systems, space, or any of the other fields in which IBM scientists and engineers are finding answers to basic questions, please contact us. IBM is an Equal Opportunity Employer. Write to: Manager of Professional Employment, IBM Corporation, Dept. 554B2, 590 Madison Ave., N.Y. 22, N.Y.

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Positions Wanted	Selling Opportunities Wanted
Part Time Work	Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

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Box numbers—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

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electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from page 123)

* These advertisements appeared in the Feb. 1st issue.

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Electronic Technology

We need a versatile, creative, technically oriented writer to interpret and report on new product, market and growth developments. In one year we will have practically doubled our plant size (to 1 million square feet), introduced many exciting new developments in the semiconductor field (integrated circuits, field-effect transistors, SCR's and bi-stable switches), and opened up vast new applications in the automotive, consumer and controls field.
This is an excellent opportunity to contribute to a better understanding of these highly technical areas by initiating and generating all types of written material with particular emphasis on feature stories. This opening requires an excellent writing and electronics background with a desire to teach and communicate. If you consider yourself an expert in this area write to:

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LOcust 8-4330

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4 Gateway Center
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7751 Carondelet Avenue
PArkview 5-7285

SAN FRANCISCO, 11 J. A. Hartley
255 California Street
DOuglas 2-4600

SPECIAL PURPOSE TUBES

OA2	.80	4-125A	20.00	100TH	12.00	816	2.00	5836	50.00
OA2WA	1.50	4-250A	35.00	100TL	12.00	826	5.00	5837	50.00
OA3	.85	4-400A	35.00	FG-105	25.00	828	17.50	5840	2.50
OA5	5.75	4-1000A	95.00	FG-172	25.00	829B	10.00	5842	7.50
OB2	.70	4AP10	10.00	HF-200	15.00	832A	7.50	5845	6.00
OB2WA	1.50	4B31	15.00	212E	50.00	833A	37.50	5847	7.50
OB3	.75	4C35	12.50	242C	10.00	836	2.50	5852	5.00
OC3	.50	4CX250B	30.00	244A	3.50	837	1.50	5876	9.50
OD3	.50	4CX300A	40.00	249B	8.50	842	7.50	5879	1.15
C1A	7.50	4CX1000A	135.00	249C	6.50	845	12.50	5881	2.50
1AD4	1.75	4D32	15.00	250R	10.00	849	75.00	5886	3.50
1B24	7.50	4E27	10.00	250TH	25.00	851	50.00	5893	10.00
1B24A	17.50	4J32	100.00	251A	75.00	866A	2.00	5894	19.85
1B35A	3.50	4J34	100.00	259A	5.00	869B	75.00	5915	1.00
1B59/R1130B	10.00	4J50	100.00	262B	4.00	872A	5.00	5933	3.50
1B63A	10.00	4J52	35.00	267B	5.00	884	1.25	5948	150.00
1C/3B22	4.00	4J62	150.00	271A	10.00	885	1.00	5949	100.00
1D21/SN4	6.00	4J63	150.00	274A	3.50	889RA	150.00	5963	1.00
C1K	7.50	4J64	150.00	279A	200.00	891R	300.00	5964	.85
1P21	30.00	4PR60A	50.00	283A	3.50	892R	300.00	5965	.85
1P22	8.00	4X150A	12.50	287A	3.50	913	12.50	5976	50.00
1P25	10.00	4X150D	12.50	QK-288	200.00	927	2.00	5993	5.00
1P28	15.00	4X150F	20.00	HF-300	35.00	931A	5.00	5998	5.00
1Z2	2.50	4X150G	25.00	300B	5.00	1000T	100.00	6005	1.50
2-01C	12.50	4X250B	25.00	304TH	30.00	VC-1257	500.00	6012	4.00
2AP1A	8.50	4X250F	30.00	304TL	40.00	VC-1258	15.00	6021A	2.00
2B23	20.00	5ABP1	20.00	310A	3.50	K-1303	35.00	6028	2.75
2BP1	10.00	5AHP7A	25.00	311A	3.50	1500T	200.00	6032	50.00
2C36	22.50	5BP1A	9.50	313C	1.50	1603	3.50	6045	1.15
2C39	5.00	5C22	17.50	323A	6.00	1614	2.25	6072	1.25
2C39A	10.00	5CP1A	9.50	328A	4.50	1620	4.00	6073	1.50
2C39B	15.00	5J26	75.00	329A	4.50	1624	1.00	6074	1.50
2C40	7.50	5LP1A	20.00	336A	2.50	1625	.50	6080	3.35
2C42	4.00	5R4GY	1.25	337A	3.50	1629	.50	6080WA	5.00
2C43	7.50	5R4WGA	4.00	348A	4.50	1645A	4.00	6080WB	10.00
2C50	4.00	5R4WGB	6.00	349A	3.50	1846	50.00	6081	25.00
2C51	1.50	5R4WGY	2.00	350A	3.50	1850A	300.00	6082	3.35
2C53	7.50	5RP1A	35.00	350B	2.50	2000T	285.00	6087	2.50
2D21	.65	5UP1	12.50	352A	8.50	2050	1.35	6101	1.50
2D21W	1.25	5Y3WGT	1.25	354A	12.50	ZB-3200	150.00	6115A	65.00
2E22	3.00	6AC7W	1.00	355A	12.50	5516	7.50	6130	6.50
2E24	3.50	6AG5WA	1.50	393A	5.00	5528/C6L	3.50	6136	1.50
2E26	2.50	6AG7Y	1.00	394A	3.00	5545	25.00	6146	3.00
2J42	88.85	6AK5W	1.25	403B	3.00	5550	35.00	6159	3.50
2J51	50.00	6AL5W	.60	404A	7.50	5551/FG271	50.00	6161	50.00
2J55	100.00	6AN5	1.75	407A	3.75	5552/FG235	60.00	6163	15.00
2J66	200.00	6AN5WA	3.50	408A	2.75	5553/FG258	125.00	6164	45.00
2K22	25.00	6AQ5W	1.00	GL-414	80.00	5556/PJ8	20.00	6186	1.60
2K25	8.50	6AS7G	2.50	416B	20.00	5557/FG17	5.00	6189	1.60
2K26	35.00	6AU6WA	1.25	417A	7.50	5558/FG32	10.00	6197	1.75
2K28	25.00	6B4G	3.85	418A	7.50	5559/FG57	10.00	6199	35.00
2K29	25.00	6BA6W	.75	420A	5.00	5560/FG95	20.00	6201	1.75
2K30	50.00	6BF7W	2.00	421A	7.50	5561/FG104	40.00	6202	1.50
2K33A	175.00	6BL6	20.00	422A	10.00	5586	100.00	6211	.75
2K34	100.00	6BM6	20.00	423A	4.00	5590	1.00	6213	2.50
2K35	200.00	6BM6A	30.00	427A	4.00	5591	3.00	6216	3.00
2K39	125.00	6C4W	2.50	429A	6.50	5603	3.00	6236	125.00
2K41	35.00	6C21	25.00	432B	7.00	5608A	5.00	6263	9.00
2K42	150.00	6F4	5.00	GL-434A	10.00	5636	2.25	6279	17.50
2K43	175.00	C6J	10.00	450TH	50.00	5641	2.00	6280	20.00
2K44	125.00	6J4	1.75	450TL	40.00	5642	2.25	6291	35.00
2K45	20.00	6J4WA	2.50	QK-531	35.00	5647	3.50	6292	40.00
2K47	150.00	6J6W	.75	QK-532	35.00	5651	1.00	6293	4.50
2K48	60.00	6J6WA	1.00	QK-549	45.00	5654	1.50	6299	40.00
2K50	100.00	6L4	3.00	575A	15.00	5656	5.00	6303	65.00
2K54	15.00	6L6GAY	1.25	578	5.00	5665	40.00	6316	100.00
2K55	15.00	6L6WGA	1.50	NL-615	7.50	5667	125.00	6328	7.50
2K56	50.00	6L6WGB	2.00	NL-623	10.00	5670	1.00	6336	8.75
2X2A	1.25	6Q5G	2.50	631-P1	5.00	5672	1.35	6336A	12.75
3A5	1.00	6SJ7WGT	1.25	673	15.00	5675	9.50	6350	1.25
3AP1A	12.50	6SK7W	1.00	677	50.00	5678	1.50	6360	4.00
3B4	2.50	6SL7WGT	1.25	BL-696	35.00	5684	9.50	6363	90.00
3B24W	3.00	6SN7W	.75	701A	5.00	5685	15.00	6364	130.00
3B24WA	5.00	6SN7WGT	1.00	707B	2.50	5686	2.25	6385	10.00
3B25	2.50	6V6GTY	1.00	NL-710	10.00	5687	1.50	6390	125.00
3B26	3.50	6X4W	.75	715C	15.00	5691	5.00	6394	12.75
3B28	3.00	6X5WGT	1.00	719A	12.50	5692	3.50	6442	25.00
3B29	5.00	7MP7	22.50	721B	5.00	5693	3.50	6476	10.00
3BP1A	7.50	10KP7	15.00	723A/B	3.50	5696	1.00	6485	1.50
3C22	25.00	12AT7WA	1.25	725A	10.00	5718	1.50	6528	12.75
3C23	5.00	12AU7WA	1.50	726A	5.00	5721	100.00	6550	3.50
3C24/24G	5.00	12AX7W	1.35	726B	5.00	5725/6AS6W	1.50	6655	40.00
3C45	3.50	12AY7	1.00	726C	10.00	5726	.75	6807	25.00
3CX100A5	15.00	12GP7	25.00	750TL	112.50	5727	1.25	6816	40.00
3D21A	5.00	X-13	150.00	NL-760	25.00	5728/FG67	20.00	6877	12.50
3E29	7.50	C16J	25.00	BL-800	75.00	5734	15.00	6883	3.50
3GP1A	12.50	HK-24	5.00	802	7.50	5749	1.00	6888	2.00
C3J	7.50	25T	7.50	803	5.00	5750/6BE6W	1.75	6896	350.00
3J21	35.00	26Z5W	1.50	804	15.00	5751WA	1.50	7391	47.50
3J31	100.00	28D7W	3.50	805	7.50	5755	5.00	7521	100.00
3K21	125.00	FG-32	10.00	807	1.50	5763	1.75	7580	35.00
3K22	125.00	35T	7.50	807W	2.50	5777	150.00	8000	18.85
3K23	200.00	35TG	3.75	809	4.75	5778	150.00	8002R	35.00
3K27	150.00	FP-54	150.00	810	18.85	5783	2.25	8008	6.00
3K30	100.00	FG-57	10.00	811	3.00	5787	2.50	8013A	5.00
3KP1	9.75	RK-60/1641	1.50	811A	4.75	5800	7.50	8014A	25.00
3RP1	7.50	HY-69	3.00	812A	4.75	5803	5.00	8020	6.00
3WP1	12.50	75TL	18.85	813	12.50	5814A	1.35	8025A	5.00
3X2500A3	150.00	KU-99	12.50	814	4.50	5819	40.00	9003	2.00
4-65A	12.00	HF-100	10.00	815	3.50	5829	1.00	9005	3.50

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ELK GROVE, CALIFORNIA

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Prices FOB
Min order $10

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AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.
EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

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

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Send NEW ADS or inquiries to Classified Adv Div. of Electronics P. O. Box 12, N. Y. 36, N. Y.

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
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Please help us locate the following equipment components.

....

NAME ....

TITLE ....

COMPANY ....

STREET ....

CITY 2/8/63

ELECTRONIC

WAR TERMINATION INVENTORIES

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F.O.B. PASADENA, CALIFORNIA

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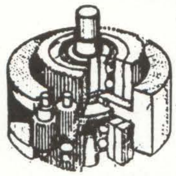
SIMPLE DIFFERENTIAL WITH BALL-BEARING SUN GEARS



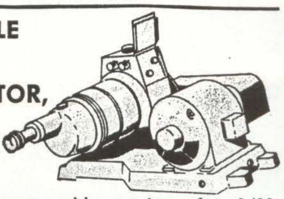
The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 11/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. 1/4" lg. 2-13/16" dia. is required to clear the body.
Stock no. A6-115 ....each $15.00

RCA 6032 IMAGE-CONVERTER TUBE

Combined with suitable optical systems, this 3-electrode tube permits viewing of scene with infrared radiation. Scene to be viewed is imaged by optical objective upon semi-transparent photocathode. Spectral resp., S-1; good response up to about 1200A. Max. ratings, absolute, grid #2, 20,000VDC or peak AC, grid #1,2700.
$9.95 ppd.

MINOR SWITCH 10-position, 3-pole, with stopper & reset coil 6-12 V. D.C. off-normal non-bridging wiper. wt.: 1 lb. $9.95

400-CYCLE MOTOR GENERATOR, PU-20



The generator assembly consists of a 1400-watt, 120-volt, 400-cycle inductor-alternator and a 400-watt, 27-volt D.C. generator. The alternator rotor and the D.C. generator armature are mounted on a common shaft, which is dual-belt-driven by a 3-H.P., 1750-R.P.M., 115/230-volt, single-phase 60-cycle electric motor. Weatherproof output box is mounted on top of the stator shell. It contains a rheostat, adjustable resistor, two pin jacks for plugging in an A.C. voltmeter. Size: 28" W., 33" L., 18" H. Weight, approx. 250 lbs.
Price $175.00

8-DAY ELAPSED-TIME SURPLUS AIRCRAFT CLOCK

Here's an accurate time-control center that'll help you win your next rallye. It not only tells you the date and time of day right to the second, it's a stop watch that gives you elapsed time in seconds, minutes, and hours! The 24-hour clock simplifies adding and subtracting elapsed time for your navigator. Manufactured by Elgin Watch Co. to exacting military specifications, it will remain accurate in spite of road bumps and vibrations. Uses no electrical connections. Does the job of high-cost equipment. Jeweled/Sweep Second Hand/Luminous Hands and Numerals/25-Hour Dial/Black Face and Plastic Case/3⅛" Mounting.
Cost the Government $185.00
Only $39.95 Postpaid

SPERRY VERTICAL GYRO

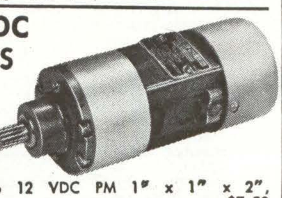
Part #673073, Motor 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch 85°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±½°. Weight 3½ lbs. Approx. dim. 5¾" L., 4½" W., 4½" H.
Price $35.00

VARIABLE SPEED BALL DISC INTEGRATORS (All Shafts Ball Bearing Supported)

No. 145 Forward & Reverse 2¼"-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. ⅜" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x ⅜" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾" $17.50

No. 146 Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long: Output shaft 15/64" dia x 9/16" long. Control shaf 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4". $18.50 ea.

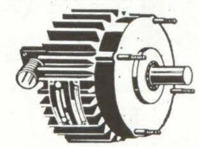
SMALL DC MOTORS



(approx. size over 3¾" x 1¼" dia.:

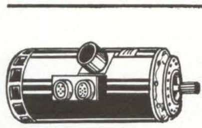
5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm. $7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled 15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm 12.50
#5069625 120 rpm, mfr. Delco, 27 VDC governor controlled $15.00
5069230 Delco PM 27.5 VDC 145 rpm 15.00
5068750 Delco 27.5 VDC 160 rpm w. brake 6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2") 5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled 15.00 ea.
#5069800 575 rpm, mfr. Delco, 27 VDC, PM reversible governor controlled, equipped with 27 VDC clutch $17.50
5072735 Delco 27 VDC 200 rpm governor controlled. 15.00
5BA10A118 GE 24 VDC 110 rpm 10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible 10.00
5BA10AJ52 27 VDC 145 rpm reversible 12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm 15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., 7 amp. contains brake 15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp 15.00

400 CYCLE PM GENERATOR



115/200 volts A.C. 1- or 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4¾" dia.; 3" long; ½" shaft, AN connector. $75.00

9KVA 400-CYCLE GENERATOR

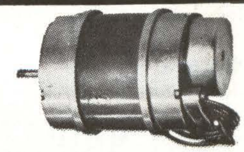


120/208 volts, 3-phase power factor 1.0 CCW rotation. Approx. 13½ lg. x 8" dia. 4000 rpm, mfg. Bendix Aviation P/N 1633-1A.
$150.00

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

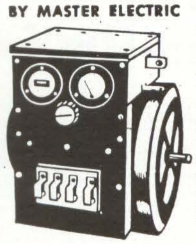
Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64.
Price $22.50

SELSYNS-SYNCHROS



1CT cont. Trans 90/55V 60 cy............$27.50
1DG Diff. Gen. 90/90V 60 cy............ 34.50
1F Syn. Mtr. 115/90V 60 cy.............. 34.50
1G Gen. 115V 60 cy..................... 34.50
1HDG 37.50
1HCT 37.50
1SF Syn. Mtr. 115/90V 400 cy........... 12.50
23TR4 torque receiver.................. 34.50
23TR6 torque receiver.................. 37.50
23CT6 control transformer.............. 37.50
23CX6 control transmitter.............. 37.50
23TX6 torque transmitter............... 37.50
7DG differential generator............. 37.50
2J1F1 Gen. 115/57.5V 400 cy............ 7.50
2J1F3 Gen. 115/57.5V 400 cy............ 10.00
2J1FA1 Gen. 115/57.5V 400 cy........... 7.50
2J1G1 57.5/57.5V 400 cy................ 5.00
2J1H1 Diff. Gen. 57.5V 400 cy.......... 7.50
2J5D1 Cont. Trans. 105/55V 60 cy....... 17.50
2J5F1 Cont. Trans. 105/55V 60 cy....... 17.50
2J5H1 Gen. 115/105V 60 cy.............. 17.50
2J15M1 Gen. 115/57.5V 400 cy........... 17.50
5CT Cont. Trans. 90/55V 60 cy.......... 34.50
5D Diff. Mtr. 90/90V 60 cy............. 34.50
5DG Diff. Gen. 90/90V 60 cy............ 34.50
5F Syn. Mtr. 115/90 VAC 60 cy.......... 34.50
5G Syn. Gen. 115/90VAC 60 cy........... 34.50
5HCT Cont. Trans. 90/55V 60 cy......... 37.50
5SDG Diff. Gen. 90/90V 400 cy.......... 12.50
6DG Diff. Gen. 90/90V 60 cy............ 25.00
6G Syn. Gen. 115/90VAC 60 cy........... 34.50
7G Syn. Gen. 115/90VAC 60 cy........... 42.50
C56701 Type 11-4 Rep. 115V 60 cy....... 20.00
C69405-2 Type 1-1 Transm. 115V 60 cy... 20.00
C69406 Syn. Transm. 115V 60 cy......... 20.00
C69406-1 Type 11-2 Rep. 115V 60 cy..... 20.00
C78248 Syn. Transm. 115V 60 cy......... 12.50
C78410 Repeater 115V 60 cy............. 20.00
FPE 49-7 Diehl servo motor, 115 volts, 60 cycle, 10 watts.................. 30.00

400 CYCLE, 3 PHASE GENERATOR BY MASTER ELECTRIC



Type AG, frame 364Y, 7.5 kw, 3428 rpm, pf .95 Star connected 120/208 3 phase, 22 amps. Delta connected 120 volt single phase 6 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long; overall dim. of unit: 21"6x18"x 20".
Price $395.00 each

SENSITIVE INTEGRATING GYROS

This is the famous HIG Gyro which is being used in missile guidance systems, radar stabilization and fine control systems. Government cost approximately $1500.
PRICE $50.00

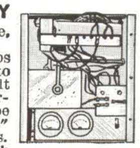
OIL CAPACITORS

1 MFD. 25,000 V. DC Westinghouse interteen type FP style 1313854.
$39.95 each
10 or more, $35.00 each.

HONEYWELL VERTICAL GYRO MODEL AG7044A17

115 volts, 400 cycles, single phase, 35 watts. Pitch and roll potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm ²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°; caging mechanism operates on 24 VDC.
$49.50

24 VOLT DC POWER SUPPLY



input: 115/440 volts A C, 60 cycle, single phase
Output: 24 volts D C at 25 amps tapped primary and secondary to vary voltage unit contains 0-30 volt D C meter and 0-30 amp meter, circuit breaker, filtered, selenium type rectifier approx. dim: 16" wide, 18" long 8½" high approx. wt.: 70 lbs.
PRICE ....$49.50 each

CIRCLE 959 ON READER SERVICE CARD

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■

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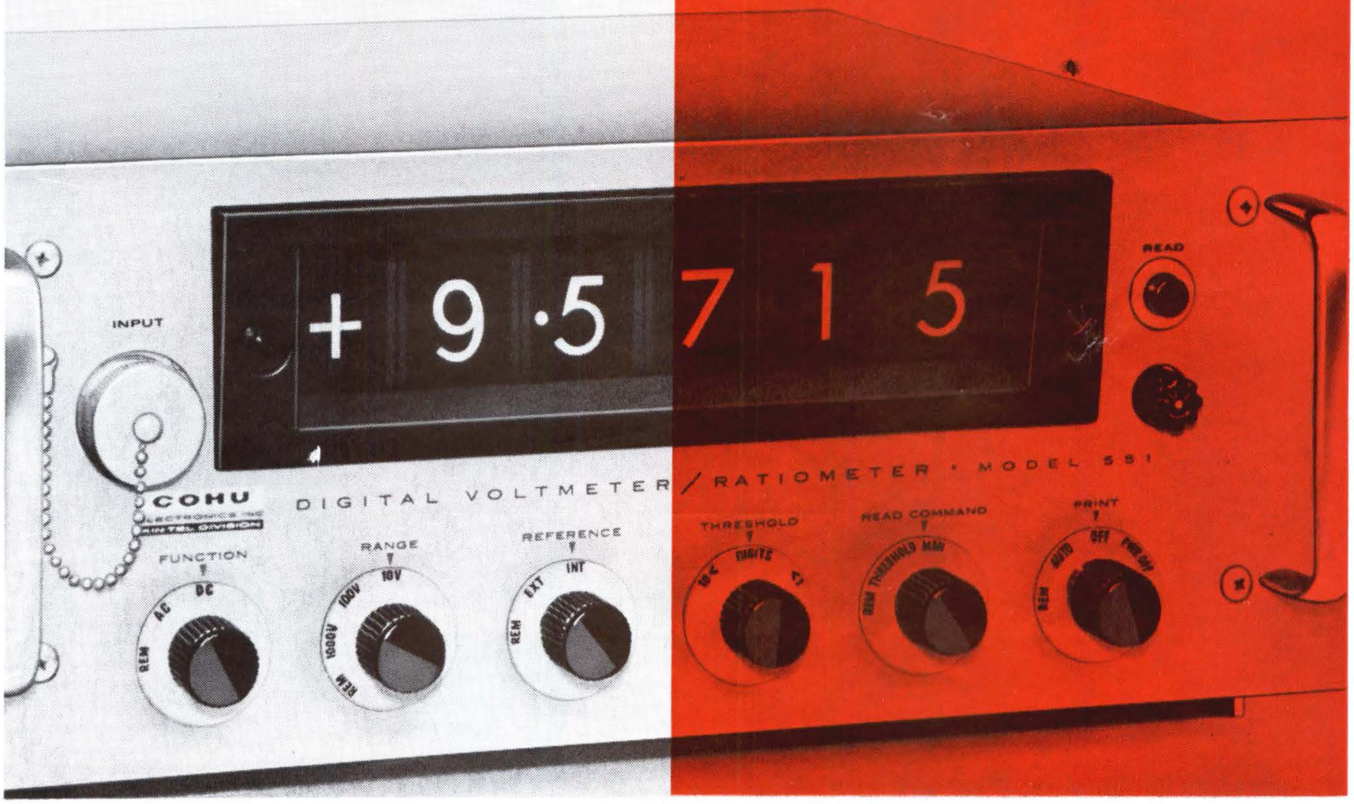
NEW AC/DC DIGITAL VOLTMETER/RATIOMETER!



FIRST TO BRING YOU 5 READINGS-PER-SECOND SPEED WITH MERCURY-WETTED RELAYS!

If you want accuracy *and* speed in a voltmeter/ratiometer, KIN TEL'S Model 551 is for you. It has *more than just sufficient speed* for most data logging and bench applications. In fact, it is the fastest, most accurate unit on the market with mercury-wetted relays and all-solid-state construction.

ACCURATE. DC measurements between 0.0000 and ±999.99 volts are accurate to within 0.005% of full scale +0.005% of reading. AC measurements from 30 to 10 kc between 0.0000 and 999.99 volts are accurate to within 0.05% of full scale +0.05% of reading. Ratio accuracy is 0.005% of full scale +0.001% of reading. All measurement circuits are fully isolated from the case, power line, and output devices. This exceptional accuracy makes the 551 ideal for laboratory use.

ADAPTABLE WITHOUT MODIFICATION to fit in a variety of digital data-logging systems. Printer output driver circuits provide electrical signals or contact closure in either binary-coded decimal or 10-line parallel form for virtually any type of digital recorder.

For complete technical information, or a demonstration without obligation, write direct. *Price* (without optional visual readout) for the basic 5-digit instrument with buffer register and auto/manual/command range: $4150. F.O.B. San Diego. Export charge 5%. Accessories include projection readout, BCD mercury-relay output, 10-line mercury-relay output, and AC converter.

Representatives in all major cities.

Visit booth 3601 at the IEEE Show, March 25-28.

COHU ELECTRONICS, INC
KIN TEL DIVISION

5725 Kearny Villa Road, San Diego 12, California • Phone 277-6700 (Area Code 714)

CIRCLE 901 ON READER SERVICE CARD

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. B-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.

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