December 23, 1960

electronics

Photoelectric servo system keeps instruments in nose cone of research sounding rocket continually aimed at sun, p 43

Microcircuit binary full adder uses unipolar transistors, p 48

A McGraw-Hill Publication 75 Cents

W5MT3A

new

METERED VARIAC®
CONTINUOUSLY ADJUSTABLE
A-C SUPPLIES

- ★ Ideal for measuring power consumption.
- ★ Convenient means for determining the effects of reduced or increased line voltage on a-c operated equipment; for example, locating cutoff points of voltage-regulator circuits.
- ★ Useful for tracking down circuit troubles that are intermittent with normal line voltage, but which can be made to occur more frequently or fail altogether at either low or high line voltage.

W5MT3AW

W5MT3W

These Metered Variacs are everyday tools needed in laboratory test setups and engineering work areas. Each model consists of a Variac with patented Duratrak* brush contact surface, a current transformer, the necessary switches and meters. Meters are magnetically shielded to yield an over-all accuracy of 3%. A double-pole off-on switch disconnects the instrument from both sides of the line. The output circuit has two fuses mounted on the front panel to protect both the Variac and its meters from overload.

*U.S. Patent No. 2,949,592

5 MODELS — 0 to 135 volts at currents to 10 amperes

	Type	Current Ranges	Wattage Ranges	Price
5-Amp Models	W5MT3A	0-1, 0-5	—	$89
	W5MT3W	—	0-150 0-750	$112
	W5MT3AW	0-1 0-5	0-150 0-750	$150
10-Amp Models	W10MT3A	0-2 0-10	—	$110
	W10MT3W	—	0-300 0-1500	$138

Write For Complete Information

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

The Best Instruments In Electronics

NEW YORK, WOrth 4-2722 · NEW JERSEY, Ridgefield, WHitney 3-3140 · CHICAGO Oak Park Village 8-9400 · PHILADELPHIA Abington HAncock 4-7419 · WASHINGTON, D.C. Silver Spring JUniper 5-1088 · SAN FRANCISCO Los Altos WHitecliff 8-8233 · LOS ANGELES Los Angeles HOllywood 9-6201 · IN CANADA Toronto CHerry 6-2171

December 23, 1960

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

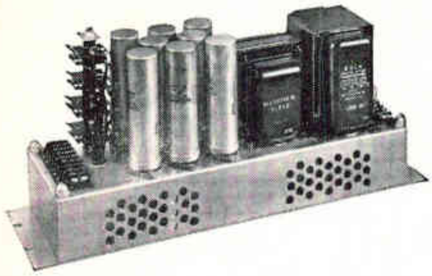
BUSINESS

ENGINEERING

DEPARTMENTS

HELPFUL FACTS ABOUT REGULATED A-C AND D-C POWER SOURCES

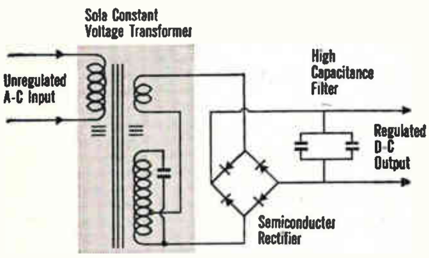
Sola will build regulated d-c power supplies to fit your mechanical requirements



Sola designs and produces hundreds of special regulated d-c power supply ratings to meet widely varying electrical and mechanical requirements of equipment manufacturers. We also produce complete power-supply systems to customer specifications.

Sola d-c power supplies easily handle intermittent, variable, or pulse loads and are widely used as components in equipment with relays, solenoids, or high-amperage requirements.

The combination of just three, reliable components — a Sola Constant Voltage Transformer, semi-coductor rectifier, and high-capacitance filter —

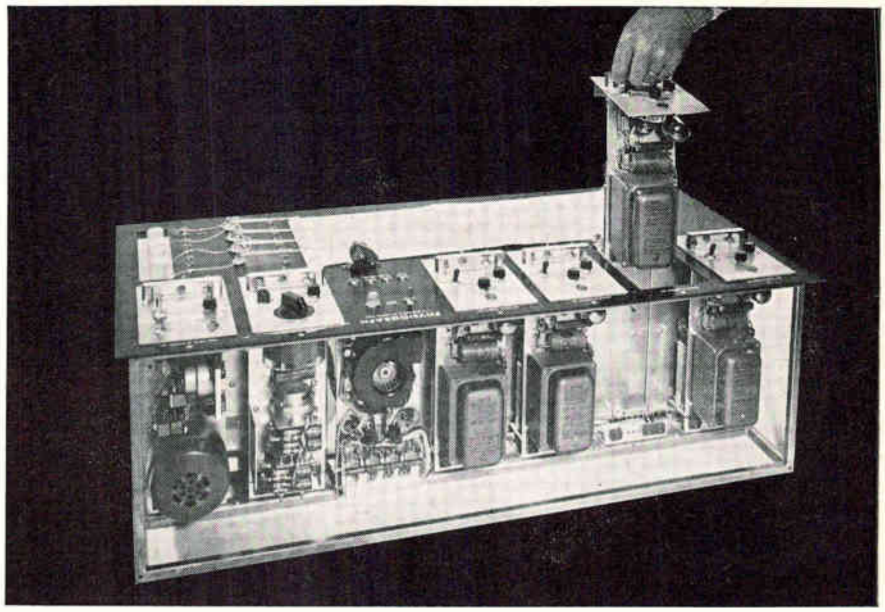


makes up a d-c power supply that's rugged and dependable, compact and lightweight. In addition, it gives you:

1. *Output regulation of ±1% with ±10% line voltage variations.*
2. *Minimum output voltage change even with wide, rapid load changes.*
3. *Low input power with resultant good efficiency.*
4. *Protection for itself and related components against high, short-time overloads.*
5. *Ripple voltage of approximately 1% (rms) or less.*
6. *High overall economy through elimination of unnecessary overload capacity in some applications.*
7. *Low ratio of size and weight to power output.*
8. *Freedom from routine adjustment and maintenance.*
9. *Exceedingly low output impedance.*

In addition to custom design and production service, Sola currently stocks six fixed-output models ranging from 24 volts at six amps to 250 volts at one amp. Six adjustable-output models are also stocked. Your nearby Sola sales engineer can supply all the facts.

Write for Bulletin DC



"Physiograph" uses Sola-regulated voltages for accuracy in recording physiological events

The Physiograph, engineered and manufactured by the E & M Instrument Co., Inc., Houston 21, Texas, is a multi-channel, electronic data-recording system used to make synchronized graphs of such phenomena as heart rates and sounds, blood pressure, respiration patterns, conduction velocities of nerves and muscles, and gland secretions.

The Physiograph is finding worldwide acceptance in educational and research institutions as a complete system of instrumentation for many investigations in the biological sciences. Its operating principle is similar to that of other data recording equipment. First the event is converted to a proportional electrical signal by a transducer. Then the signal is increased in intensity by an amplifier. Finally, the amplified signal energizes the appropriate type of reproducer, usually a direct-inking recording pen, which plots the event on a chart.

Because the physiological responses measured by the Physiograph are often almost infinitesimal, any variations in power supply voltage must be corrected if these responses are to be measured accurately.

The Physiograph's built-in power supply consists of several Sola Constant Voltage Plate-Filament Transformers which perform a dual function: (1) they supply plate and filament voltages just as an ordinary power supply transformer would do; (2) they regulate these supply voltages within ±3% even when the line voltage varies over a 100- to 130-volt range.

Besides providing this exceptionally close regulation, the Sola transformer protects tubes and components from cold inrush current and from fault currents.

This simple, reliable component costs little more than ordinary non-regulating transformers. And it is less costly than other types of regulating circuitry often used with conventional power transformers.

Write for Bulletin CVP

Sola Type CVS Constant Voltage Transformers provide regulated, sinusoidal output at moderate cost

Sola Standard Sinusoidal Constant Voltage Transformers regulate voltage within ±1% despite input voltage variations as great as ±15%. Their response time is fast — 1.5 cycles or less. Their output voltage wave has less than 3% total rms harmonic content, making them suitable for use with rectifiers and other harmonics-sensitive components. Nine stock ratings; special designs available in production quantities.

Write for Bulletin CVS

SOLA
A DIVISION OF BASIC PRODUCTS CORPORATION
BP C

Sola Electric Co., Busse Rd. at Lunt, Elk Grove, Ill.

electronics
Dec. 23, 1960 Volume 33 Number 52

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

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

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

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

Subscriptions are solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on orders. Subscription rates: United States and Possessions, $6.00 one year; $9.00 two years; $12.00 three years. Canada, $10.00 one year. All other countries $20.00 one year. Single Copies, United States and Possessions and Canada 75¢; Buyers' Guide $3.00; Single Copies all other countries $1.50; Buyers' Guide $10.00.

The Publisher, upon written request from any subscriber to our New York Office, agrees to refund that part of the subscription price applying to copies not yet mailed.

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

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

Audited Paid Circulation

CROSSTALK

CHRISTMAS 1960. *Outside Kabul, capital of Afghanistan, a tiny caravan (reminding us very much of paintings we've seen of the Three Wise Men) passes a Siemens & Halske transmitter*

ELECTRONICS IN EUROPE. Last February we published a special report revealing so many fascinating new research and development projects underway around the world in the field of electronics that it was difficult to edit. W. W. MacDonald, despite his affinity for a blue pencil, found it hard to behave like a blasé professional and persisted in reading and re-reading while the presses waited.

Fortunately, what happened to our editor also happened to many of our subscribers, who turned out to be at least as much interested in what went on abroad in sophisticated technical circles, and said so. This led to a trip assignment to the Far East for one of our top associate editors and, in May, a special report covering electronics in Japan. This too was widely read and widely praised.

So now we are planning a special report about electronics in Europe for our issue of June 9, 1961. Editorial representatives stationed abroad are already laying the groundwork and MacDonald will be over there personally gathering material from sources in government, education, research and, particularly, manufacturing circles during January, February and early March. Already on his travel schedule, in this order, are England, France, the Netherlands, Sweden, West Germany, Switzerland and Italy. Correspondents in other countries of Europe are also gathering material and their knowledge, too, will constitute part of the report. We even hope to include information from Eastern Europe.

Interesting to us will be any exchange of information about the size of the electronics industry and its character, exports and imports, the operation of overseas plants and other long-range affiliations, the manpower situation and even finance. More particularly, because our audience is heavy on engineering, we will be interested in exposure to new European research, imaginative products, advanced production methods.

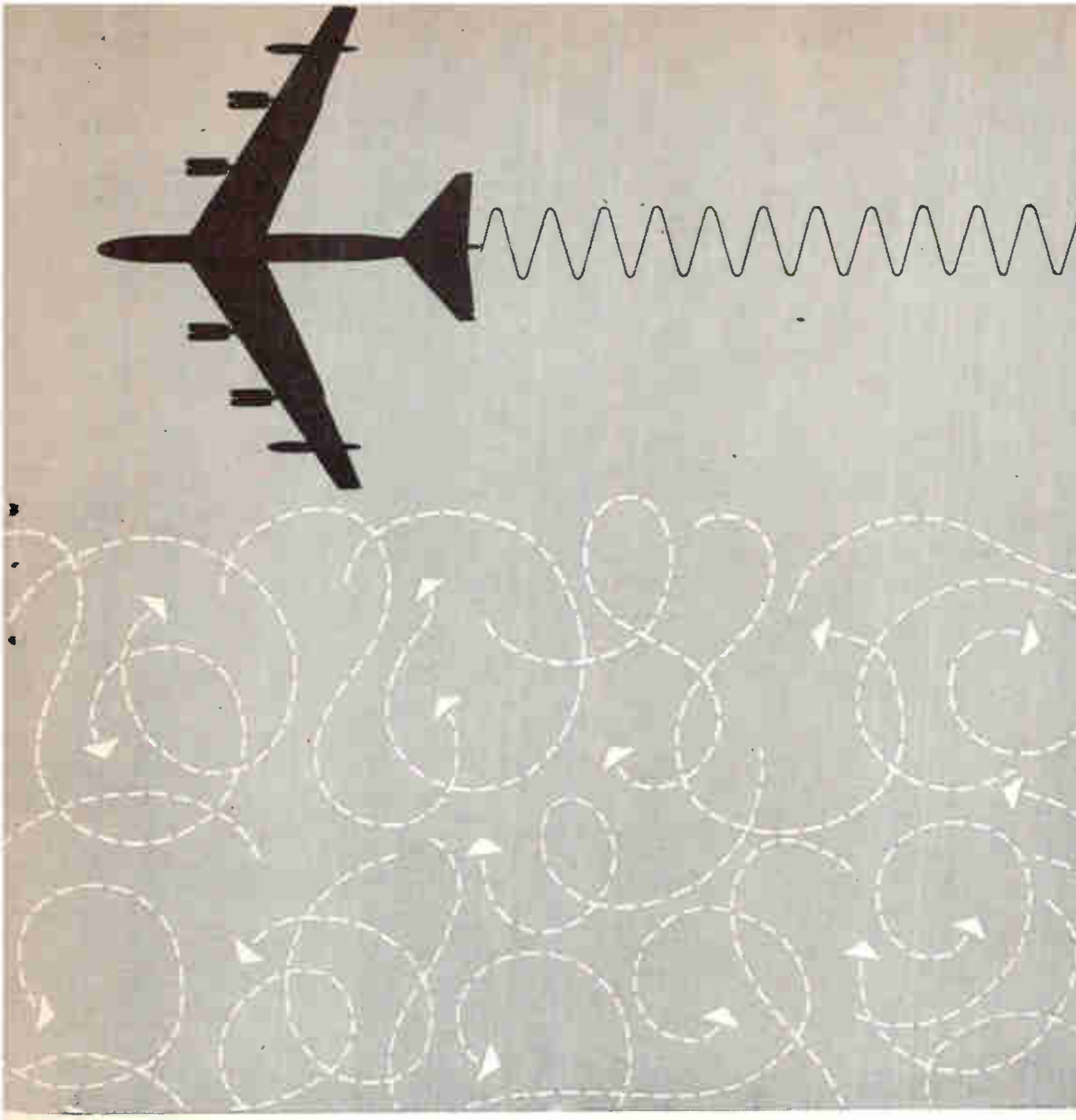
You should have little difficulty recognizing Editor MacDonald, should he cross your orbit in your own country early next year. Page 1 of the December 9th issue of ELECTRONICS carries his passport picture.

Coming In Our January 6 Issue

OUR MARKETS TODAY AND TOMORROW. Sales for the electronics industry will hit a new high in 1961 and continue upward for a decade. That's the forecast made in the special report on our markets for the next 10 years.

Prepared by Edward DeJongh, market research, this comprehensive report analyzes the military, industrial-commercial and consumer markets on the basis of information furnished by more than 100 market planners in our industry. Sections by top electronics industry executives discuss distribution, market planning, geographical breakdown and international trade, with charts and graphs to help you digest it all.

CIRCLE 5 ON READER SERVICE CARD→



Raytheon Subminiature Tubes Help Deliver The Message for Hughes Project Tattletale

Enemy atomic attack can scramble the ionosphere disrupting vital communications. The Air Force provides a solution in the form of Project Tattletale. A high altitude rocket containing a taped message and transmitting equipment is shot 300 miles up to provide a straight-line transmission requiring no ionospheric bounce.

PROBLEM: How to assure maximum reliability during transmission.

SOLUTION: Hughes Aircraft Company, contractor, chose Raytheon 5702WA, 5703WA, and 6021 Reliable Subminiature Tubes.

If your designs require tubes featuring reliable operation, long life, and stable performance under severe conditions of high temperature and mechanical shock or vibration, Raytheon Reliable Subminiature Tubes can offer an immediate solution. For complete technical data, please write to Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

For Small Order or Prototype Requirements See Your Local Franchised Raytheon Distributor.

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

COMMENT

Technical Abstracts

The Office of Technical Services of the U. S. Department of Commerce is attempting to analyze the public demand for English abstracts of selected articles appearing in the technical journals of the Soviet bloc countries and mainland China. This new series would replace the recently discontinued OTS service of providing abstracts of all articles appearing in each issue of certain USSR technical journals. This service was discontinued because of the lack of public demand, and the new service will not be offered unless demand is sufficient to justify the publication program.

The new series of abstracts would be disseminated once a month on an experimental six-month subscription basis, to begin about January 15. The time schedule for preparing, publishing and making these abstracts available to the public would approximate 70 to 120 days from date of nontranslated journal in which the articles appeared.

Anyone interested in this selected abstract service should communicate with Office of Technical Services, U. S. Department of Commerce. Washington 25, D. C. Abstracts have in the past contained information on USSR developments in automation, telemechanical systems, test apparatus, industrial instrumentation, computers and other areas of instrumentation.

THOMAS W. DELAHANTY
U. S. DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

Microwave Effects

In your Newsletter (p 9, Dec. 2) you discussed behavioral effects of microwave energy and other r-f fields on human beings. Coincidentally, I read in the public press an article on the new stapes operation for the hard of hearing.

There appears to be little connection between these items until one considers the possibility of serious physical injury to the middle and inner ear should metal be used in the stapes replacement instead of the miniscule plastic element currently employed.

Granted that the metal link may be only in the order of one-eighth inch in length, it might very well act as a resonant antenna to various r-f waves, or functions thereof, and dissipate the absorbed energy into the highly sensitive inner-ear complex.

May I suggest that this matter be called to the attention of the GE group exploring these r-f effects. Perhaps they may wish to discuss it with the medical profession.

C. F. ANDREWS
WEST SPRINGFIELD, MASS.

GE researchers at Ithaca, please note.

L-C Filter Design

On looking over the article "Charts Simplify Passive L-C Filter Design," published in ELECTRONICS of Dec. 1 '57 (p 160) and the ELECTRONICS Buyers Guide of June 1958. I find a number of errors. both editorial and typographical.

In Fig. 3G, a coil is missing, but the value is indicated by $R(L - M_{12} - M_{23})$. Also in Fig. 3, M_{12} is given as $(1/\omega_0)\sqrt{C_1/L_1}$, whereas it should read $M_{12} = (C_1/\omega_0)\sqrt{1/C_1L_2} = (1/\omega_0)\sqrt{C_1/L_2}$.

In p 162. col. 3. there are transposed lines in the second and third paragraphs of the section headed *Prototpyes*. The text should read:

"The total number of stages required to realize the specified skirt selectivity is found in Fig. 1A to be about 2.7. Three stages will be used since only integers are possible. Figure 2 shows that the expected insertion loss for this three-stage filter would be 2.5 db based on Q_L/Q_u ratio of 0.10 or $D = 0.2$.

"Using the bandpass protoype of Fig. 3A and Table II, the element values are . . ." etc.

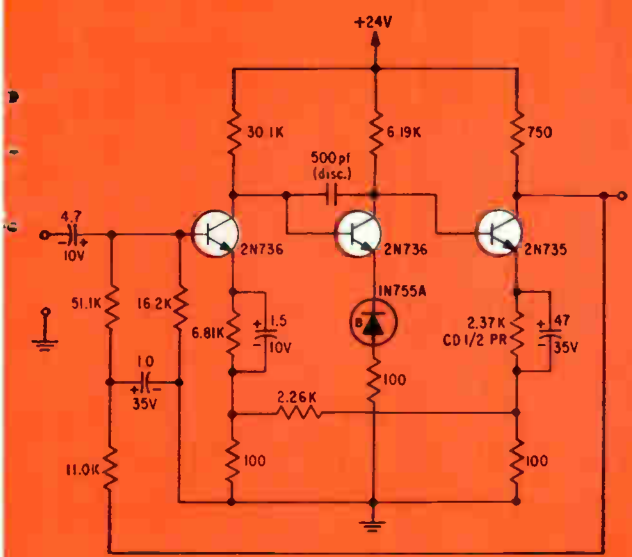
Just below this is a listing of the element values and the equations from which the values are evolved. In this list, C_1' should be evolved: $C_1' = C_3' = C_1/BR = 0.16$ μf; L_1' should be evolved $L_1' = L_3' = R/C_1Q_L\omega_0 = 16$ μh; and L_2' should be evolved $L_2' = RL_2/B = 3.2$ mh.

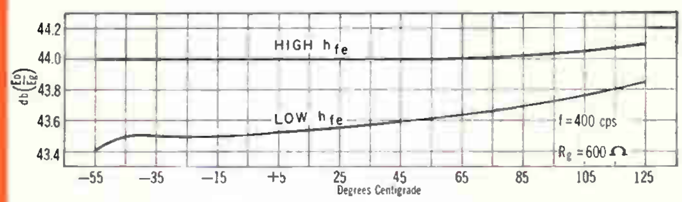
On p 163, the first paragraph under *Selectivity* should end with ". . . The desired impedance level is 300 ohms" (not 50 ohms, as printed).

DONALD R. J. WHITE
FREDERICK RESEARCH CORP.
WHEATON, MD.

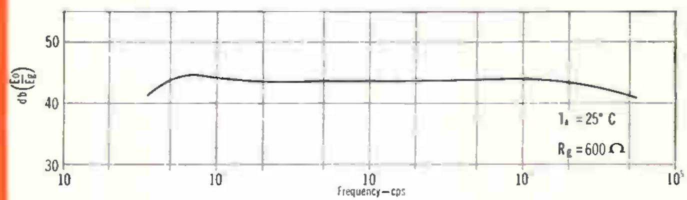
HOW TO GET FLAT FREQUENCY RESPONSE

FROM 37 CYCLES TO 45 KC





Voltage Amplification vs. Ambient Temperature



Frequency Response of Typical 2N735-2N736 Transistors

Specify TI 2N734 Series Silicon Transistors for Your Amplifiers!

For your audio/servo amplifiers, power supplies and medium-speed switches, design in TI 2N734 Series Silicon Transistors. Obtain a flat frequency response of ±1.5 db from 37 cycles to 45 kc . . . guaranteed beta at 25°C (1 ma at 1 kc) (5 ma at 1 kc) (5 ma at 30 mc) and at −55°C (5 ma at 1 kc) . . . guaranteed 500-mw free-air dissipation . . . reduced equipment size and weight with TO-18 package.

For even greater power dissipation, investigate the design flexibility of the equivalent TO-5 packaged 600-mw TI 2N1564 Series Silicon Transistors.

Write for complete specifications on 2N734 and 2N1564 Series Today!

SPECIFY TI FOR ALL YOUR SILICON TRANSISTOR REQUIREMENTS • Small Signal • Switchers • Medium Power • Power • Order TODAY from your local TI Sales Office or TI Distributor.

GUARANTEED MINIMUM BETAS

Symbol	Parameter	Test Conditions	2N734	2N735	2N736
h_{fe}	A-C Common-Emitter Forward Current Transfer Ratio	V_{CE} = 5v I_E = 5ma f = 1 kc T_A = 25°C	20	40	80
h_{fe}	A-C Common-Emitter Forward Current Transfer Ratio	V_{CE} = 5v I_E = 1 ma f = 1 kc T_A = 25°C	15	30	60
h_{fe}	A-C Common-Emitter Forward Current Transfer Ratio	V_{CE} = 5v T_A = −55°C I_E = −5 ma f = 1 kc	12	20	40
$\|h_{fe}\|$	A-C Common-Emitter Forward Current Transfer Ratio	V_{CE} = 5v I_E = 5 ma f = 30 mc T_A = 25°C	1	2	2

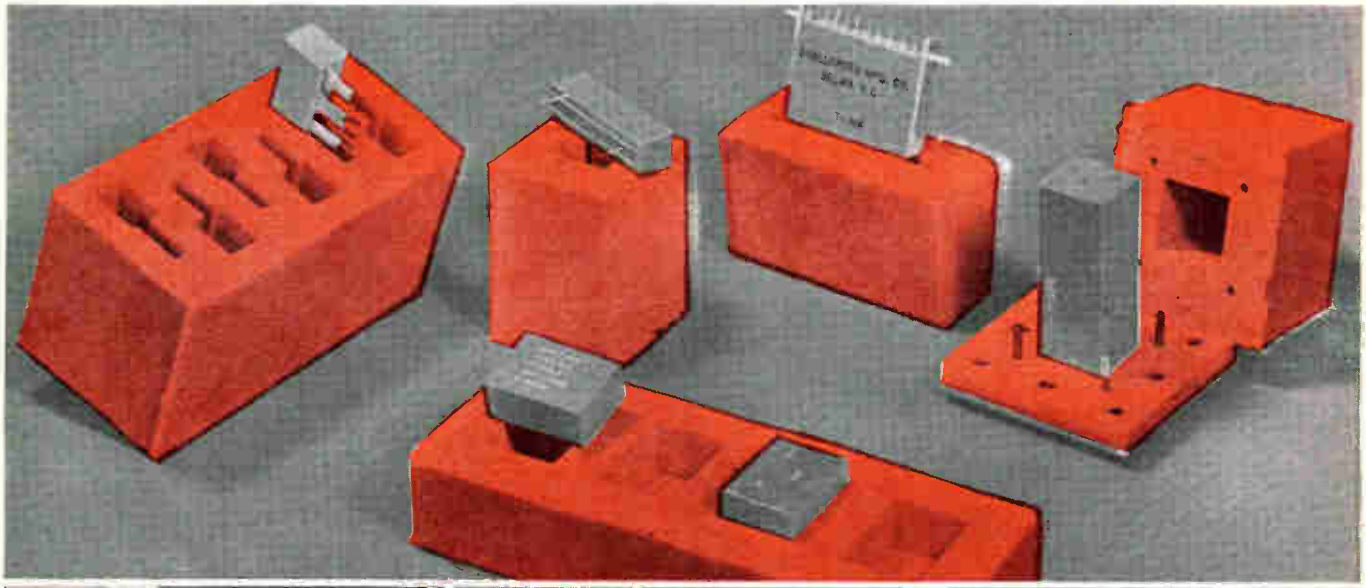
IN TI DISTRIBUTOR STOCKS 3D DEPTH • DELIVERY • DEPENDABILITY

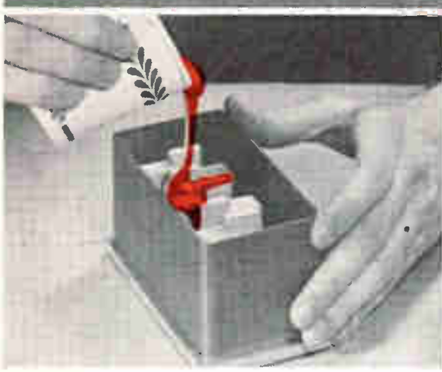
TEXAS LIMITED
DALLAS ROAD • BEDFORD, ENGLAND

SEMICONDUCTOR-COMPONENTS DIVISION
TEXAS INSTRUMENTS INCORPORATED
13500 NORTH CENTRAL EXPRESSWAY • DALLAS, TEXAS

SILICONE NEWS from Dow Corning

To Speed Production





Make Flexible, Durable Molds With Easy-to-use Silastic RTV

For production short-cuts and economies, look to Dow Corning Silicones. Here's just one example: Shallcross Manufacturing Company, Selma, N. C., makes molds for encapsulating electronic components with epoxies —they are made from Silastic® RTV, Dow Corning fluid silicone rubber.

Shallcross has found that it's easier to make molds with Silastic RTV because it sets up quickly and cures without heat. The previous mold making material required a 300 F cure and distorted on aging. Per cavity cost is substantially less with molds made of Silastic RTV.

Shallcross engineers also found Silastic RTV molds are easier to handle . . . have 400% longer production life . . . don't distort, shrink or alter their shape during storage . . . give finer detail. Flexible, multiple cavity molds are used for a variety of electronic components including delay lines, precision resistance networks, and shunts — like those pictured above.

Here's the simple procedure Shallcross follows:

Step one: Make the mold. Silastic RTV is poured over the mold forms . . . flows smoothly around the form. Result: a void-free flexible mold that withstands temperatures to 500 F . . . doesn't shrink or distort on aging.

Step two: Components to be encapsulated are placed in the mold and the encapsulating material is poured over the component. After the encapsulant sets up, parts are ready for removal.

Step three: Parts release quickly and cleanly from the flexible Silastic RTV multiple cavity form. The form is clean — ready for next use.

CIRCLE 289 ON READER SERVICE CARD

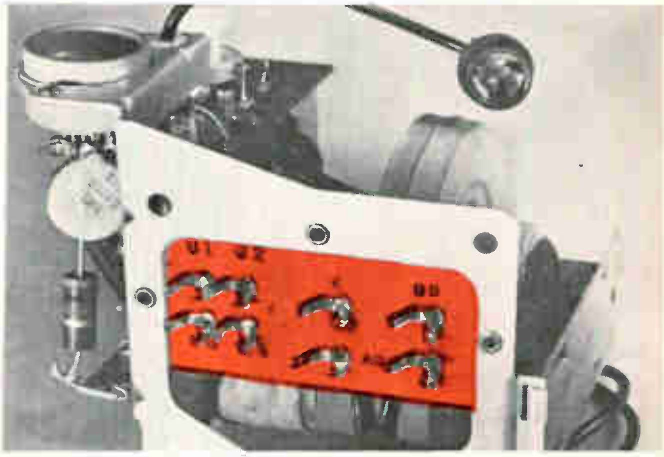
For 12-page manual
"Silicones for the Electronic Engineer"
Write Dept. 3512.

first in silicones

Dow Corning

. . . Specify Silicones

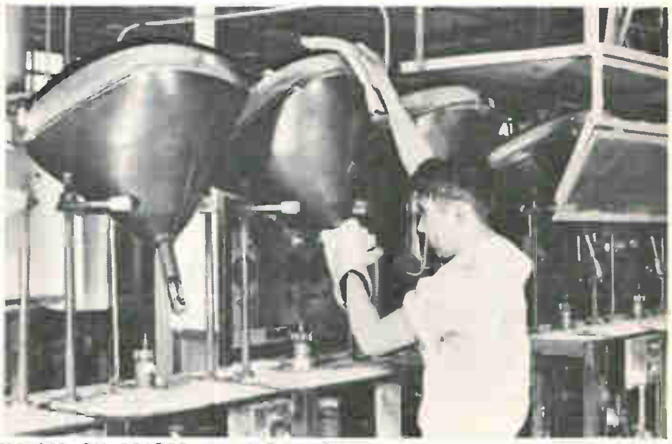
Heat Loosened Terminals No Problem



CIRCLE 290 ON READER SERVICE CARD

Production of flyback transformers for RCA "Living Color" TV sets is expedited by the use of terminal boards made from silicone-glass laminates. Bonded with a Dow Corning silicone resin, these laminates easily withstand 250 C continuously . . . much higher temperatures for shorter times. Soldering heat doesn't loosen terminals or slow production. Good electric and physical properties, ease of fabrication, and resistance to creep-under pressure of terminal fasteners add up to a top quality high voltage laminate that lends itself to mass production techniques.

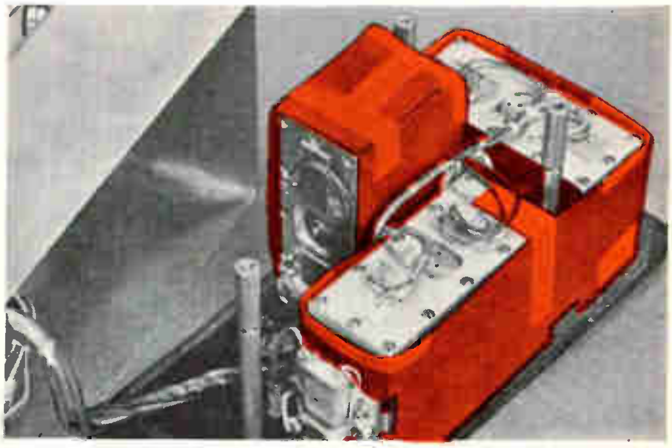
Faster Pump Down, More Cycles



CIRCLE 291 ON READER SERVICE CARD

Dow Corning silicone diffusion pump fluids offer a combination of properties that add up to high production rates and long runs without maintenance. These properties provide heat stability. low vapor pressure. high vacua in the range of 10^{-5} to 10^{-7} mm of Hg. rapid recovery, quick pump down, inertness to air and metals and resistance to gamma radiation. Silicone diffusion pump fluids are nontoxic and chemically inert . . . pump vacuum can be released without first cooling the boiler . . . decomposition does not occur when hot fluid is exposed to air.

Tape-On Heater Where It's Needed



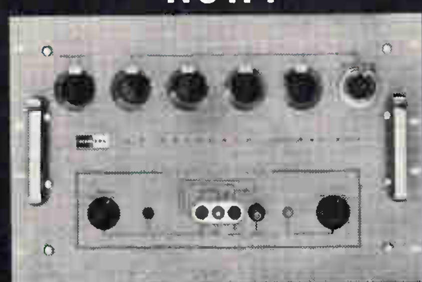
CIRCLE 292 ON READER SERVICE CARD

A new. easy-to-install, flexible strip heater developed by Electro-Flex Heat of Hartford, Conn., consists mainly of a spread-out coil of resistance wire sandwiched between layers of Silastic®, the Dow Corning silicone rubber. Only 0.04″ thick and very flexible, the unit can be taped to any shape and will pinpoint controlled heat to any desired location. Silastic brand silicone rubber was chosen because the heater elements are completely sealed against moisture and current leakage. Silastic also withstands temperatures as high as 260 C without loss of insulating efficiency or flexibility.

CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

NOW!



A 0.1% ACCURACY AC SOURCE!

KIN TEL's New AC Voltage Standard is Ideal For Use in Calibrating AC Instruments... Evaluating Magnetic Properties... Designing Servo and Gyro Equipment

The KIN TEL Model 601A is an exceptionally stable and accurate source of AC voltage. It needs no external oscillator, contains no electromagnetic servos. Simply dial the desired frequency — 60, 400, or 1000 cps — and adjust the RMS output in tenth-volt steps between 1 and 501 volts. Use a multi-turn control to set the voltage between steps to a resolution of 100 microvolts.

You can draw up to 25 watts from the output at any voltage between 5 and 501 — up to 5 amperes below 5 volts — without distortion or loss of accuracy. Short term stability is within ±0.01%, and the effective output impedance is on the order of 0.001 ohm. The output is completely guarded, floating, and isolated from the AC line and chassis ground. Write for detailed literature or demonstration. Representatives in all major cities.

OUTPUT VOLTAGE	1 to 501 volts RMS, adjustable in 0.1 volt steps and by multi-turn potentiometer to resolution of 100 μv
OUTPUT FREQUENCY	60, 400, or 1000 cps within 1%
VOLTAGE ACCURACY	Within ±0.005 volt or 0.1% of dial reading
VOLTAGE STABILITY	0.01%
WAVEFORM DISTORTION	<0.3%
OUTPUT CAPABILITY	5 amperes up to 5 volts, 25 watts above 5 volts
OUTPUT IMPEDANCE	On the order of 0.001 ohm (with constant load)
PRICE	$4500.

5725 Kearny Villa Road
San Diego 11, California
Phone: BRowning 7-6700

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.

ELECTRONICS NEWSLETTER

New Computer Systems Use Thin Magnetic Films

EASTERN JOINT COMPUTER CONFERENCE in snowbound New York last week saw the announcement of a dozen or so new data-processing systems, but the spotlight was taken by novel circuit developments.

Remington Rand Univac announced a system which uses magnetic thin-film planes for a control memory. The thin-film planes are made from nickel-cobalt alloy (in 81-19 ratio to minimize magnetostrictive effects). The material is deposited in an evacuated chamber across which a strong magnetic field is set up. The film dots are single-domain magnets which resist reversal strongly; but the field can be rotated in nanoseconds. The film planes can be easily made with nondestructive-readout properties.

At the same time, IBM announced that it had successfully fabricated a cryogenic thin-film memory plane the size of a postage stamp, and developed automatic control techniques capable of reproducing it. The plane consists of 135-cryotron devices built up in 19 layers of material, was fabricated at IBM's federal systems division. In the device, three cryotrons form a memory cell which combines storage and logic functions. Automatic controls place and remove 17 masks through which the thin layers of metal and insulating material are deposited; the masks are changed automatically inside the high-vacuum chamber in much the same manner as records are changed in a jukebox.

Forty bits of information are stored in 120 cryotrons; 10 additional cryotrons permit access to the stored bits; the other 5 are for switching information from one memory plane to another.

Multiple-Lens Satellites Proposed for Communications

AIR FORCE is developing a satellite system studded with radio-frequency lenses mounted over spherical reflectors for use as a communications relay. The design, reported at the American Rocket Society meeting last week, will negate the effects of tumbling, permit strong transmissions between ground stations 6,000 miles apart no matter what the satellite's attitude.

Lenses would focus r-f energy onto a reflector for reception, spread the beam out to encompass the earth. First model will be 10 ft in diameter, will be tested suspended from a high-altitude balloon. The satellite is being developed at Air Research & Development Command's Wright Air Development Division.

New Optical Masers Use Doped Calcium Fluoride

DEVELOPMENT of new types of optical maser (or laser) which can be used in c-w operation was announced by IBM last week.

Two young IBM scientists jointly developed a pair of laser devices using calcium fluoride, doped in one case with trivalent uranium and in another with bivalent samarium. Previous lasers used chromium-doped ruby elements.

Use of uranium and samarium overcomes the limitations of the ruby laser for c-w operation. Pumping power required to achieve the necessary population inversion of energy states in ruby is prohibitively high. Uranium- and samarium-doped crystals of calcium fluoride achieve stimulated emission with 1/500 to 1/1,000 the pumping power needed for ruby lasers.

Coherent infrared output of the uranium laser is at 2.5 microns; the samarium laser produced emission at 7,082 angstroms in the visible spectrum.

Earth-Link Communications To Control Minuteman

USE OF UNDERGROUND RADIO to provide a jamproof sabotage-proof launch control for the Minuteman ICBM was discussed in Seattle, Wash., last week by USAF General B. A. Schriever. The development, reported previously in ELECTRONICS Newsletter p 11, Aug. 5, and p 49, Oct. 14, is devised for the silo sites of the solid-fueled Minuteman, but Schriever said "there appears to be no technological reason why a similar system would not be just as practical for Minuteman railroad cars."

Besides being deployed in deep-dug permanent sites, the solid-fueled ICBM will be deployed on 150 railroad mounts shuttling constantly around the nation.

Schriever said the radio-launch system, by eliminating control cabling, would save about $300,000 per missile. The system would consist of a network of antennas buried near each control tower. R-f energy transmitted from the antennas travels to the surface, where it bends and then travels along the ground to receiving antennas buried at the silos or dragged alongside the railroad car. Air Force has been developing the system for two years.

Navy Department Studying High-Temperature Magnetrons

NAVY'S Bureau of Ships is reported to have contracted with a leading tube manufacturer for research studies in high-temperature operation of magnetrons. The program is scheduled for final report this summer, aims to discover how to make magnetrons operate reliably and with reasonably long life at temperatures above 350 C. ELECTRONICS learns from Navy sources that new materials and novel design and fabrication are among the approaches being undertaken. The same sources indicate that 10-Gc units have already been successfully operated in the required ambient.

Trans- U. S. Microwave Link To Quadruple Capacity

FIRST 500-MILE LINK in $11-million microwave relay chain which eventually will span the U. S. has been checked out and is now in service over the Rockies between Denver and Salt Lake City.

Carrier for the new system is in the 5,925 Mc-6,425 Mc range, compared with 3,700 Mc-4,200 Mc for the existing system. Capacity is increased 400 percent, according to AT&T. New system's 16 channels can carry more than 11,000 simultaneous voice conversations; four channels reserved for maintenance and standby are automatically switched into use when needed.

Overcrowding of existing long distance and tv channels caused AT&T's long lines department to begin the project 19 months ago. The Denver-Salt Lake route was chosen because of its growing traffic volume, and because the variety of terrain features provides excellent conditions for experimental testing. Without interfering with the existing coast-to-coast relay, AT&T is installing complex new electronic equipment, replacing square-faced horn antennas with new cornucopia horns, building new relay sites or expanding the capacity of existing sites.

Plan Educational Tv Net For Upper Midwest

MIDWESTERN EDUCATIONAL TELEVISION Corp. was formed in St. Paul last weekend to advance plans for setting up a six-state educational network serving tv stations in Iowa, Minnesota, Nebraska, North and South Dakota and Wisconsin.

Loring Staples, Minneapolis attorney and one-time president of Twin Cities station KTCA-Tv, was elected president of the new group. The corporation aims to implement recommendations of a recent survey which pointed out advantages to be gained from exchanging educational programs, pooling facilities, and otherwise cooperating in education projects.

Inductance Coil Stores Megajoule Energies

MAGNETIC FIELD of an 18-ft coil is being used to accumulate and store energy for hypersonic wind-tunnel research at Air Force's Arnold Engineering Development Center, Tullahoma, Tenn. Air Force officers indicate that the inductive store cost about $7 million less than conventional capacitive storage systems.

University of Michigan engineers proposed the use of the big inductance coil to store spark energies for triggering gases to produce hypersonic flow needed for research on models of space vehicle probes. Proposal was considered so revolutionary at first that Michigan engineers had to build a prototype to demonstrate economics of coil storage of energy. Team also developed special switch-fuse interruptor combination to divert 100 megajoules into a test chamber without creating huge arcs that could do extensive damage. Present tunnel cost $2.5 million, permits tests on elaborate models of space vehicles.

Test Inflatable Collector For Solar Energy

INFLATABLE solar energy collector is being tested by developer G. T. Schjeldahl Co., Northfield, Minn. The metalized plastic device is meant to be tucked into a canister the size of a coffee cup and lofted into space; once aloft, it inflates to a conical reflector configuration seven feet in diameter at the base.

Company figures that future models may serve as power sources for space satellites, collecting solar energy to run electrical and mechanical devices.

Radio Command Network Speeds Restaurant Service

ELECTRONICS has stepped in to speed up service for customers of a restaurant at Chicago's O'Hare airport. A dozen hostesses and busboys are equipped with transistor receivers and earphones supplied by Transvox, N. Y. Similar networks are in use at Denver and St. Louis branches of the restaurant.

L-C Filters Control Artificial Stereo System

"POOR MAN'S STEREO" adapter costing less than $25 has been developed by Gibbs Electronics of Arcadia, Calif. The adapter uses broadband L-C filters to separate the elements of monaural audio and direct the separated portions to two loudspeakers placed six or eight feet apart. Filters in the bridge network have flat response, and cutoffs are low. Whole audio spectrum is distributed between the two loudspeakers.

Foresee Ion Rocket In Five Years

ROCKET PIONEER Ernst Stuhlinger said last week that ion rockets will be in operation in 1966 or 1967.

The German-born scientist, now on the staff of the Marshall Space Flight Center at Huntsville, Ala., added that an experimental model of an ion rocket should be launched in 1962. Plans call for a one or two-hour spaceflight.

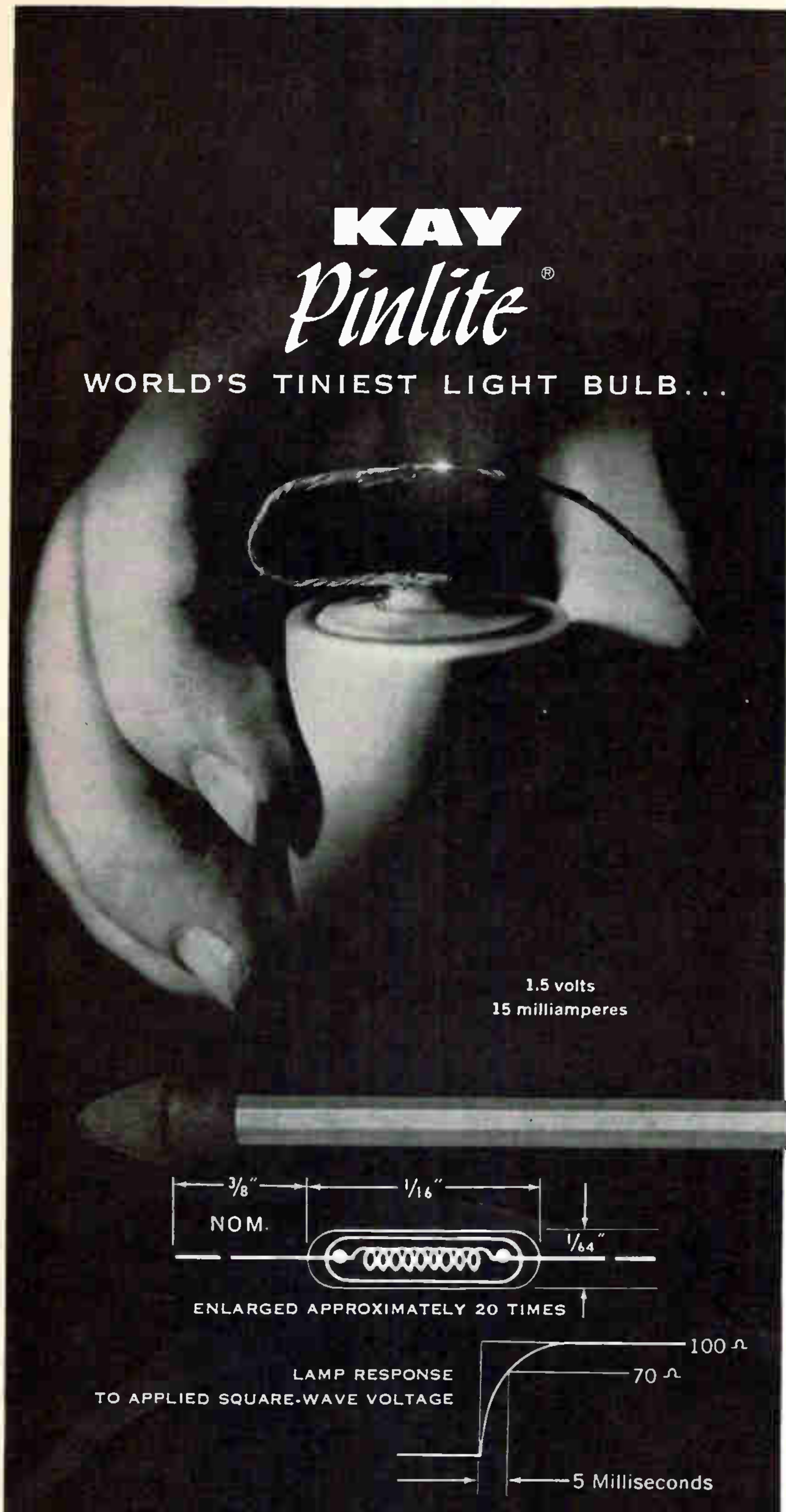
Airframe Company to Use More Automatic Tools

TAPE-OPERATED machine tools worth $3 million will be added to the inventory of automatic tools now used by Republic Aviation on the production line for the all-weather F-105D fighter-bomber. Expansion is part of a program stimulated by the Air Force to hold machining time, tooling costs, lead time and equipment investment to a minimum. Three of the new machines will be capable of drilling, boring, milling, changing heads and positioning the work part, all automatically.

Blind Student Builds Audible Voltmeter

AUDIBLE OUTPUT which he built into his voltmeter is helping Guy Clawson, 21-year-old student of Denver's Emily Griffith Opportunity School, get the electronics education he wants, despite the handicap of blindness.

Clawson was blinded by glaucoma at 13, has built and operated his own ham radio station, is now one of top students in electricity course learning to repair and make radio and tv sets and other electronic equipment. One of his friends renders blueprints and circuit drawings into Braille by tracing them onto Pliofilm, then punching holes along the outlines. Another big help has been $150 Braille slide rule, built for Clawson and given to him free by Chicago manufacturer Keuffel & Esser.



TENTATIVE DESIGN SPECIFICATIONS

ELECTRICAL DATA:
Operating voltage—1.5 volts dc • Operating current—15 milliamperes • Resistance (cold)—15 ohms • Resistance (hot)—100 ohms • Fil. Temp. (Brightness)—1900° C @ 1.5v, 15ma. • Light output—60 millilumens @ 1.5 vdc. • Pulse frequency—Audio frequencies • Life expectancy*—In excess of 1000 hrs. @ 1900° C filament temp.

PHYSICAL DATA:
Diameter—1/64″ • Length—1/16″ • Lead length—3/8″ • Lead material—Platinum • Lead diameter—3 mils. • Lamp weight—2.5 milligrams (dependent on lead length).

AVAILABILITY:
Sampling quantities @ $4.75 each, F.O.B. Factory. Delivery—Immediate.

**Complete life specifications not yet established.*

Pinlite

Unique, New Microminiature Lamp Offers Engineers Wide Range of Applications

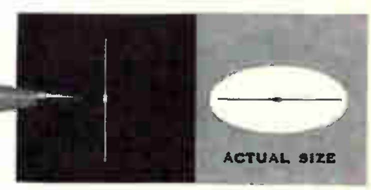
This startling new development from Kay Electric Company fills the need for a low voltage, low current microminiature incandescent lamp. Development engineers have visualized numerous practical developments for Kay Pinlites... the world's tiniest light bulbs... in a wide variety of applications. They have already been extensively employed in original circuit designs and circuit redesign.

Smallest Size • Lowest Power Consumption

Kay Pinlites are only 1/64″ in diameter by 1/16″ long, excluding the axial leads, which are cut to a nominal 3/8″ length. A d-c potential of 1.5 volts at 15 ma. will produce approximately 60 millilumens at 1900° C filament temperature, providing a point source of light.

Fastest Response Time

Kay Pinlites exhibit excellent response to pulsed operation at audio frequencies and may be pulsed to full brightness, depending on the pulse repetition rate. Life expectancy at 1900° C is in excess of 1000 hours, and at reduced voltage the operating life is extremely long.



Pinlites Offer Unlimited Uses

Practical considerations dictated the design of these microminiature lamps. Because of their small size and low voltage, Kay Pinlites are ideally adaptable to portable equipment. Other present and anticipated uses include: computer read-out, performance indicators in transistorized circuits, as meter pointer visual aids, and use in conjunction with photo diodes and multiplier phototubes.

Lowest Series "L" and Shunt "C"

The small inductance, low impedance, low shunt capacitance and axial lead construction suggests many more important high frequency applications, such as: microwave power indicating device, a bolometer, a thermally variable resistance element. Many new uses for Kay Pinlites will emerge as engineers delve deeper into the field of microminiaturization.

Write For Complete Catalog Information.

KAY ELECTRIC COMPANY
Dept. E-12, Old Bloomfield Ave., Pine Brook, N. J. CApital 6-4000

CIRCLE 13 ON READER SERVICE CARD

WASHINGTON OUTLOOK

ELECTRONIC SUPPLIERS exhibit mixed reactions to the plan presented to President-elect Kennedy for the revamping of the Defense Department. How the Pentagon does business with contractors is sure to be hotly debated in Congress this coming year.

Behind the disagreement is the report prepared by a six-man committee headed by Sen. Stuart Symington (D., Mo.). Changes implicit in the Symington plan would reduce the authority of the individual services, strengthen the central authority of the Defense Secretary, and abolish offices of 15 service undersecretaries and assistant secretaries and 7 assistant defense secretaries. The office of assistant secretary of defense for supply and logistics is one that would be eliminated.

A large segment of the industry fears that the proposed changes would concentrate procurement among fewer companies. All defense contractors endorse any move that will cut decisionmaking time and red tape from military contracting, but few are pleased at the prospect of a single centralized Pentagon buying office.

The Army and Navy see the move as one to strengthen the Air Force at their expense. The two services point out that Symington and his team are strong partisans of the junior service, and that the Air Force alone of the services is strongly behind the Symington plan. Kennedy—as an ex-Navy man—may not be too quick to accept the more sweeping generalizations of the Symington report, and the conservatives in Congress will no doubt force the matter to extensive debate.

OWNERS OF TV AND RADIO STATIONS have been put on notice that the Federal Communications Commission is taking a tougher line in policing them. Item: the Commission for the first time has renewed a station owner's license for less than three years; also, it is considering a regulation which would require a formal hearing if a licensee who has held his license less than three years applies for permission to sell or transfer it.

Present law allows the Commission to renew station licenses for periods up to three years. The commissioners have always said that the vagueness of the language of the law casts some doubt on the FCC's authority to license an applicant for less than three years. In the aftermath of the "payola" scandals, however, Congress made it clear that the Commission may issue licenses for less than the upper legal limit.

Licenses for five stations controlled by Richard Eaton—in Richmond, Va., Washington, D. C., Rockville, Md., Manchester, N. H., and Baltimore, Md.—were recently renewed for about 15 months. The commission said it would take another look at Eaton's operations in March, 1962, to see about renewal beyond that date.

The Commission is concerned about speculations in broadcast stations, points out that over a three-year period an annual average of 555 applications were filed for ownership changes, more than half of which involved stations held for less than three years.

PROGRESS IN SPACE RESEARCH within the past year was evident at the annual meeting of the American Rocket Society held here last week. Many astronautical engineers stressed the wisdom of setting up orbiting space stations, supply depots, and rocket-powered ferries. The stations would bridge the gap to the moon, providing low-gravity launching points for payloads capable of setting up and supporting a lunar base.

Scientists say they have licked the theoretical problems involved in mid-space rendezvous and are now working on equipment to steer ships. Test flights will be made in 1964-65 *looking towards a manned mission to the moon by* 1970.

Rocket designer H. L. Thackwell Jr. of Grand Central Rocket told the Society that the U. S. could have a man on the moon in 1967 if it adopted a building-block type of solid-fueled spacecraft instead of the present Saturn and Nova plans that use liquid-fueled rocket engines.

Audio, telemetry and low frequency oscillators

Pictured here are six of the most widely used oscillators in electronics. All employ the highly stable, dependable, accurate resistance-capacity circuit. They require no zero setting. Output is constant, distortion is low and frequency range is wide. Scales are logarithmic for easy reading; all are compact, rugged and broadly useful basic instruments. Brief specifications are given below; call your hp rep for demonstration or write direct for complete data on any instrument.

Model	Frequency Range	Cali-bration Accuracy	Output to 600 ohms	Recom-mended Load	Maximum Distortion	Max. Hum & Noise ¶	Input Power	Price
200AB	20 cps to 40KC (4 bands)	±2%	1 watt (24.5 v)	600 ohms	1% 20 cps to 20 KC 2% 20 KC to 40 KC	0.05%	70 watts	$150.00
200CD	5 cps to 600 KC (5 bands)	±2%	160 mw 10 volts	600 ohms*	0.5% below 500 KC 1% 500 KC and above	0.1%	75 watts	$170.00
200J	6 cps to 6 KC (6 bands)	±1%†	160 mw 10 volts	600 ohms*	0.5%	0.1%	110 watts	$300.00
200T	250 cps to 100 KC (5 bands)	±1%†	160 mw 10 volts	600 ohms*	0.5%	0.03%	160 watts	$450.00
201C	20 cps to 20 KC (3 bands)	±1%†	3 watts (42.5 v)	600 ohms**	0.5%‡	0.03%	75 watts	$225.00
202C	1 cps to 100 KC (5 bands)	±2%	160 mw 10 volts	600 ohms*	0.5%§	0.1%	75 watts	$300.00

*Internal impedance is 600 ohms. Frequency and distortion unaffected by load resistance. Balanced output with amplitude control at 100. Use line matching transformer for other control settings. **Internal impedance approximately 600 ohms with output attenuator at 10 db or more. Approximately 75 ohms below 5000 cps with attenuator at zero. †Internal, non-operating controls permit precise calibration of each band. ‡0.5%, 50 cps to 20 KC at 1 watt output. 1.0% over full range at 3 watts output. §0.5%, 10 cps to 100 KC. 1.0%, 5 to 10 cps. 2.0% at 2 cps. 3.0% at 1 cps. ¶Measured with respect to full rated output.

HEWLETT-PACKARD COMPANY

1015A Page Mill Road • Palo Alto, California, U.S.A.

Cable "HEWPACK" • DAvenport 5-4451

Hewlett-Packard S.A., Rue du Vieux Billard No. 1, Geneva, Switzerland

Cable "HEWPACKSA" • Tel. No. (022) 26. 43. 36

Field representatives in all principal areas

6036

hp 200AB
Audio Oscillator

hp 200CD
Wide Range Oscillator

hp 200J
Interpolation Oscillator

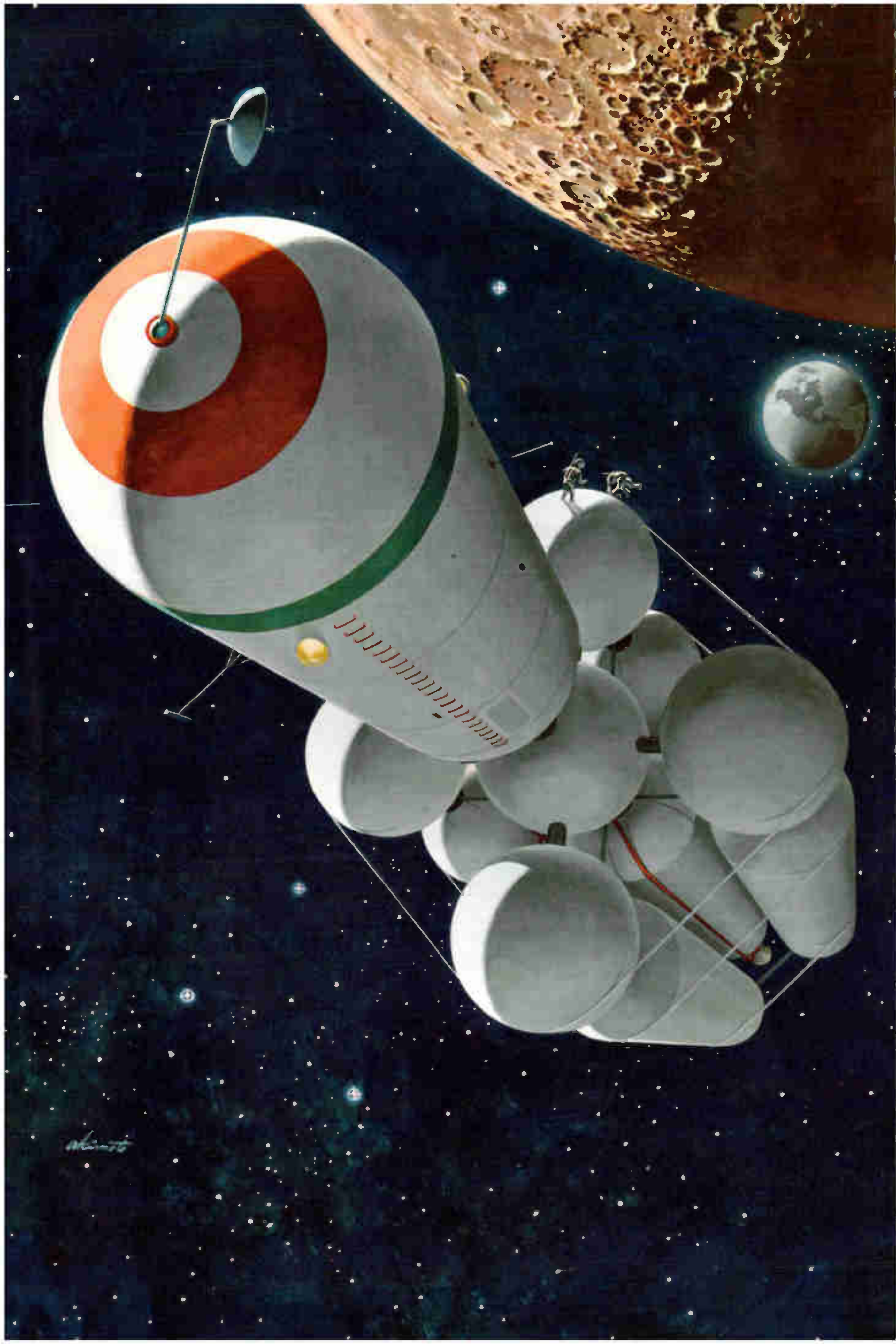
hp 200T
Telemetry Oscillator

hp 201C
Audio Oscillator

hp 202C
Low Frequency Oscillator

hp pioneered the world-famous resistance-capacity oscillator circuit

CIRCLE 17 ON READER SERVICE CARD→



SILICON MICRO-ELECTRONIC COMPONENTS

New! Micro Mesa Silicon Diodes

ULTRA FAST LOW CAPACITANCE

PSI TYPE	Equiv.	Forward Current @ 1 VDC (mA)	Breakdown Voltage @ 100 μa (volts)	Capacity @ 0 VDC (pf)	Inverse Current 25°C (μa)	Inverse Current 150°C (μa)	Rev. Recov.** (nanosec.)
PD301		10	50	4	.025 (−20V)	50 (−20V)	4
PD302	1N906	10	50	4	.1 (−20V)	10 (−20V)*	4
PD303	1N907	10	50	4	.1 (−30V)	10 (−30V)*	4
PD304	1N908	10	50	4	.1 (−40V)	10 (−40V)*	4
PD305	1N914	10	100	4	.025 (−20V) 5.0 (−75V)	50 (−20V)	4
PD306		10	50	2	.025 (−20V)	50 (−20V)	4
PD307	1N905	10	50	2	.1 (−20V)	10 (−20V)*	4
PD308	1N904	10	50	2	.1 (−30V)	10 (−30V)*	4
PD309	1N903	10	50	2	.1 (−40V)	10 (−40V)*	4
PD310	1N916	10	100	2	.025 (−20V) 5.0 (−75V)	50 (−20V)	4
PD311	FD100	10	75 @ 5μa	2	.1 (−50V)	100 (−50V)	2

*At 100°C.
**Switching 10 mA to −6 volts recovery to 1 mA.

General Purpose Computer Micro-Diodes

EIA EQUIV.	TYPES		BV (volt) 100 μa	I_F (mA) @ 1V	I_R (μa) −10V & 25°C	I_R (μa) @ 25°C	I_R (μa) −10V & 100°C	I_R (μa) @ 100°C	Recovery Time	(2) Res
		PD-101	50	5	1		25		1 μsec	100K
	1N897		50	5	.025	.1 @ − 40	5	20 @ − 40	1 μsec	100K
		PD-102	50	20	.5		25		.3 μsec	100K
		PD-103	50	100	.5		25		.3 μsec	100K
	1N898		50	100	.025	.5 @ − 40	5	20 @ − 40	.3 μsec	100K
1N457			70	20		.025 @ − 60		5 @ − 60 (1)		
		PD-104	100	5	.5		25		.3 μsec	100K
	1N899		100	5	.025	.1 @ − 80	5	20 @ − 80	.3 μsec	100K
1N662			100	10	1	20 @ − 50	20	100 @ − 50	.5 μsec	100K
		PD-105	100	20	.5		25		.3 μsec	100K
		PD-106	100	50	.5		25		.3 μsec	100K
	1N900		100	50	.025	.1 @ − 80	5	20 @ − 80	.3 μsec	100K
1N663			100	100		5 @ − 75		50 @ − 75	.5 μsec	200K
		PD-107	100	100	.5		25		.3 μsec	100K
	1N901		100	100	.025	.5 @ − 80	5	20 @ − 80	.3 μsec	100K
1N658			120	100		.05 @ − 50		25 @ − 50 (1)	.3 μsec	80K
1N458			150	7		.025 @ −125		5 @ −125 (1)		
1N459			200	3		.025 @ −175		5 @ −175 (1)		
		PD-108	200	10	.5	5 @ −100	25		.3 μsec	200K
		PD-109	200	10	.025	1 @ −100	5		.3 μsec	200K
1N643	1N902		200	10	.025	1 @ −100	5	15 @ −100	.3 μsec	200K

1. @ 150°C.
2. JAN 256 5mA to −40V.
   typical capacity at −10V = 2 pf.

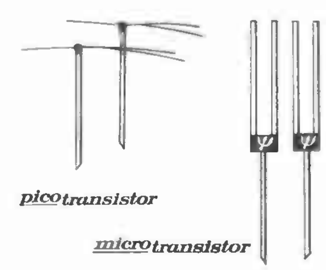
RATINGS

Maximum power dissipation 250 mw @ 25°C.
Maximum temperature range −65°C to + 150°C.
Peak pulse current 2 amperes; 1 μsec 170 duty cycle.
Typical inverse capacity = 2pf @ −10V.
Meets all environmental specifications of Mil-S-19500B

PHYSICAL CHARACTERISTICS:

HERMETICALLY SEALED—Bonded Surface films.
TERMINALS—.004x.019 gold plated leads. Lead length ½ inch minimum.
MARKING—Type number designated by color of body and color of stripes on pointed (cathode) lead.
ALL DIMENSIONS SHOWN IN INCHES.

Silicon Pico-Transistors



*TYPE	BV_{CBO}	I_{CBO}	V_{EBO}	h_{FE} (min)	h_{FE} (20mc)
PMT 011	30V	10μa (20V)	4V	15 (150mA, 10V)	3.1
PMT 012	30V	10μa (20V)	4V	30 (150mA, 10V)	3.5
PMT 013	60V	1μa (30V)	5V	20 (150mA, 10V)	2
PMT 014	60V	1μa (30V)	5V	40 (150mA, 10V)	2.5
PMT 019	40V	1μa (10V)	5V	30 (5mA, 5V)	2.5

Total Dissipation 25°C. 100 mw
*Available in both Micro and Pico configurations. Type numbers above indicate Pico configuration. For Micro configuration add 100 to type number. Thus, Pico transistor PMT 011 is designated PMT 111 in Micro version.

LOOK INSIDE FOR LATEST INFORMATION AND SPECIFICATIONS ON PSI SILICON DIODES, ZENERS AND RECTIFIERS

Silicon General Purpose Diodes

EIA TYPE NUMBER	Minimum Saturation Voltage @ 100 µa @ 25°C (volts)	Maximum Forward Voltage DC @ 25°C (volts) @ 100 mA	Maximum Inverse Current at Maximum DC Operating Voltage (µa @ volts) @ 25°C	@ 150°C	Maximum Average Rectified Current (mA) @ 25°C	@ 150°C
1N488A	420	1.0	.100 @ – 380v	25	200	70
1N488	420	1.1	.250 @ – 380v	50	125	50
1N487A	330	1.0	.100 @ – 300v	25	200	70
1N487	330	1.1	.250 @ – 300v	50	125	50
1N486B	250	1.0	.050 @ – 225v	10	200	70
1N486A	250	1.0	.050 @ – 225v	25	200	70
1N486	250	1.1	.250 @ – 225v	50	125	50
1N485B	200	1.0	.025 @ – 175v	5	200	70
1N485A	200	1.0	.025 @ – 175v	15	200	70
1N485	200	1.1	.250 @ – 175v	30	125	50
1N484B	150	1.0	.025 @ – 125v	5	200	70
1N484A	150	1.0	.025 @ – 125v	15	200	70
1N484	150	1.1	.250 @ – 125v	30	125	50
1N483B	80	1.0	.025 @ – 60v	5	200	[illegible]
1N483A	80	1.0	.025 @ – 60v	15	200	70
1N483	80	1.1	.250 @ – 60v	30	125	50
1N482B	40	1.0	.025 @ – 30v	5	200	70
1N482A	40	1.0	.025 @ – 30v	15	200	70
1N482	40	1.1	.250 @ – 30v	30	125	50

Silicon Diffusion Computer Diodes

The Broadest Line in the Industry...

Choose from military approved, low capacitance, high conductance, low leakage, high voltage types with assurance of unsurpassed reliability.

EIA TYPE NUMBER	Minimum Saturation Voltage @ 100 µa @ 25°C (volts)	Minimum Forward Current @ +1.0 VDC @ 25°C (mA)	Maximum Inverse Current at Maximum DC Operating Voltage (µa @ volts) @ 25°C	@ 150°C	Maximum Average Rectified Current (mA) @ 25°C	@ 150°C
1N464A	150	100	.5 @ 125	30 @ 125	200	70
1N464	150	3	.5 @ 125	30 @ 125	40	
1N463A	200	100	.5 @ 175	30 @ 175	200	70
1N463	200	1	.5 @ 175	30 @ 175	30	
1N462A	70	100	.5 @ 60	30 @ 60	200	70
1N462	70	5	.5 @ 60	30 @ 60	50	
1N461A	30	100	.5 @ 25	30 @ 25	200	70
1N461	30	15	.5 @ 25	30 @ 25	60	
1N459A	200	100	.025 @ 175	5 @ 175	200	70
*1N459	200	3	.025 @ 175	5 @ 175	40	
1N458A	150	100	.025 @ 125	5 @ 125	200	70
*1N458	150	7	.025 @ 125	5 @ 125	55	
1N457A	70	100	.025 @ 60	5 @ 60	200	70
*1N457	70	20	.025 @ 60	5 @ 60	75	
1N456A	30	100	.025 @ 25	5 @ 25	200	70
1N456	30	40	.025 @ 25	5 @ 25	90	

* JAN Types

Fast Recovery Types

MILITARY TYPES

EIA TYPE NUMBER	Minimum Saturation Voltage * @ 100 µa (volts)	Minimum Forward Current @ + 1.0 volt (mA)	Maximum Reverse Current (µa) 25°C	100°C	Reverse Recovery Characteristics: Reverse Resistance (ohms)	Maximum Recovery Time (µs)
1N663•	100	100	5 (75v)	50 (75v)	200K	0.5
1N662‡	100	10	1 (10v) 20 (50v)	20 (10v) 100 (50v)	100K	0.5
1N658•	120	100	.05 (50v)	**25 (50v)	80K	0.3
1N643†	200	10	.025 (10v) 1 (100v)	5 (10v) 15 (100v)	200K	0.3
1N663A	100	100	1 (75v)	15 (75v)	200K	0.3
1N662A	100	100	1 (10v) 20 (50v)	20 (10v) 100 (50v)	100K	0.5
1N643A	200	100	.025 (10v) 1 (100v)	5 (10v) 15 (100v)	200K	0.3
1N789	30	10	1 (20v)	30 (20v)	200K	0.5
1N790	30	10	5 (20v)	30 (20v)	200K	0.25
1N791	30	50	5 (20v)	30 (20v)	200K	0.5
1N792	30	100	5 (20v)	30 (20v)	100K	0.5
1N793	60	10	1 (50v)	30 (50v)	200K	0.5
1N794	60	10	5 (50v)	30 (50v)	200K	0.25
1N795	60	50	5 (50v)	30 (50v)	200K	0.5
1N796	60	100	5 (50v)	30 (50v)	100K	0.5
1N797	120	10	1 (100v)	30 (100v)	200K	0.5
1N798	120	10	5 (100v)	30 (100v)	200K	0.25
1N799	120	50	5 (100v)	30 (100v)	200K	0.5
1N800	120	100	5 (100v)	30 (100v)	100K	0.5
1N801	150	10	1 (125v)	30 (125v)	200K	0.5
1N802	150	50	5 (125v)	50 (125v)	200K	0.5
1N803	200	10	5 (175v)	50 (175v)	200K	0.5
1N804	200	50	10 (175v)	50 (175v)	200K	0.5
1N659	60	6	5 (50v)	25 (50v)	400K	0.3
1N660	120	6	5 (100v)	50 (100v)	400K	0.3
1N661	240	6	10 (200v)	100 (200v)	400K	0.3
1N625	30	4 @ 1.5v	1 (20v)	30 (20v)	400K	1 µsec
1N626	50	4 @ 1.5v	1 (35v)	30 (35v)	400K	1 µsec
1N627	100	4 @ 1.5v	1 (75v)	30 (75v)	400K	1 µsec
1N628	150	4 @ 1.5v	1 (125v)	30 (125v)	400K	1 µsec
1N629	200	4 @ 1.5v	1 (175v)	30 (175v)	400K	1 µsec

*Maximum DC working inverse voltage is 85% of minimum saturation voltage.

†Mil-E-1/1171 (SigC) ‡Mil-E-1/1139 (SigC) •Mil-E-1/1140 (SigC) •Mil-E-1/1160 (SigC)

**Max. Reverse Current at 150°C.

OTHER SPECIFICATIONS: Peak Pulse Current, 1 µsec, 1% duty cycle: 3.0 Amps. Storage and Operating Temperature Range: –65°C to 200°C.

Zener Diodes 500 mW Power Dissipation

Also available at 750 mW in Configuration "B".

EIA TYPE NUMBER	Zener (Breakdown) Voltage @ 5 mA: E_z Min. (v)	E_z Max. (v)	Maximum Inverse Current: I_b @ 25°C (µA)	I_b @ 100°C (µA)	At Inverse Voltage (v)	Maximum Dynamic Resistance (ohms) 1
1N702	2.0	3.2	75	100	–1	60
1N703	3.0	3.9	50	100	–1	55
1N704	3.7	4.5	5	100	–1	45
1N705	4.3	5.4	5	100	–1.5	35
1N706	5.2	6.4	5	100	–1.5	20
1N707	6.2	8.0	5	50	–3.5	10

1. Measured at 10 mA DC Zener current with 1 mA RMS signal superposed.

Also Available 1N708-1N723 covering 5.6v to 24v Zener Voltages.

PSI TYPE NUMBER	Elect. Equiv.	Zener Voltage @ 200 µA @ 25°C: E_z Min. (v)	E_z Max. (v)	Maximum Inverse Current: I_b@ 25°C (µA)	I_b @ 100°C (µA)	At Inverse Voltage (v)
PS6313	1N1313	7.5	10	.5	5	6.8
PS6314	1N1314	9	12	.5	5	8.2
PS6315	1N1315	11	14.5	.5	5	10.0
PS6316	1N1316	13.5	18	.5	5	12.0
PS6317	1N1317	17	21	.5	5	15.0
PS6318	1N1318	20	27	.1	10	18.0

LOW VOLTAGE PRECISION REGULATOR DIODES

PSI NUMBER	E_R ±5% @ 25°C @ 20 mA (Volts)	Max. Dynamic Impedance @ 20 mA (ohms) (1)	Max. Rev. Current @ 25°C µa.	Typical Temperature Coefficient mv/°C
PS1171	1.50	9	20 @ 0.5V	–3.5
PS1172	1.60	12	20 @ 0.5V	–3.5
PS1173	1.80	18	20 @ 0.5V	–3.5
PS1174	2.20	12	20 @ 1.0V	–4.8
PS1175	2.40	18	20 @ 1.0V	–4.8
PS1176	2.70	27	20 @ 1.0V	–4.8
PS1177	3.00	18	20 @ 1.0V	–6.4

For 2% Types specify PS1171A - PS1177A

(1) Measured with 1 mA (RMS) superposed on 20 mA D.C.

DIMENSION NOTE: Regulator diodes maximum diameter .405", maximum length .53".

Also available 1421 thru 1426 extending regulating voltage to 5.2 volts.

Voltage Reference Diodes

EIA TYPE NUMBER	REFERENCE VOLTAGE @ 7.5 mA @ 25°C. (volts) Min.	Avg.	Max.	Max. Voltage change from 25°C Reference Voltage (volts) –55°C to +100°C	Max. Dynamic[1] Resistance (ohms)
1N2765	6.46	6.80	7.14	±0.050	20
1N2766	12.92	13.60	14.28	±0.100	40
1N2767	19.38	20.40	21.42	±0.150	60
1N2768	25.84	27.20	28.56	±0.200	80
1N2769	32.30	34.00	35.70	±0.250	100
1N2770	38.76	40.80	42.84	±0.300	120

1. Measured with 1 mA AC superposed on 7.5 mA DC
Max. Operating Temp. @ Iz = 7.5 mA: –65°C to +175°C.

NEW! Military Types Zener Diodes (MIL-E-1/1258)

EIA TYPE NUMBER	Zener Voltage E_z(Volts)[2]	Max. Inverse Current E_B = – 1V µa 25°C	150°C	Max. Dynamic Resistance I_z = 20mA I_{AC} = 1 mA (Ohms) (Max.)
1N746A	3.3	10	30	28
1N747A	3.6	10	30	[illegible]
1N748A	3.9	10	30	22
1N749A	4.3	2	30	23
1N750A	4.7	2	30	19
1N751A	5.1	[illegible]	20	17
1N752A	5.6	[illegible]	20	11
1N753A	6.2	0.1	20	7
1N754A	6.8	0.1	20	5
1N755A	7.5	0.1	20	6
1N756A	8.2	0.1	20	8
1N757A	9.1	0.1	20	10
1N758A	10.0	0.1	20	17
1N759A	12	0.1	20	30

1. "A" versions ±5% Zener Voltage Tolerance.
2. E_z measured at Test Current I_z = 20mA
All of the above types can be supplied in ±10% Tolerance of center Zener Voltage Value. (Omit suffix "A" for these units.)

Fast Switching Low Capacitance Types

EIA TYPE NO.	MIN. SAT. VOLTAGE @ 100 µa (volts)	MIN. FWD. CUR. @ 1.0 volt (mA)	MAXIMUM REVERSE CURRENT (µa) 25°C	100°C	REVERSE RECOVERY CHARACTERISTICS: REVERSE RESIST. (Ohms)	MAX. RECOV. TIME* (µs)	TYPICAL RECOV. TIME** (Mµs)	MAX. CAP. @ ZERO VOLTS (µµf)
1N925	40	5	1.0 (10v)	20 (10v)	20K	0.15	5.0	4.0
1N926	40	5	0.1 (10v)	10 (10v)	20K	0.15	5.0	4.0
1N927	65	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15	5.0	4.0
1N928	120	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15	5.0	4.0

*Switching from 5mA to –10 volts (R_L = 1K, C_L –10µµf)
**Switching from 5mA to –10 volts (R_{LOOP} = 100 ohms, C_L = 8µµf including diode capacitance)

PSI

ADVANCED SILICON MESA TRANSISTORS
FOR ADVANCED CIRCUIT DESIGN

BRAND NEW! 2N1837

...outperforms 2N697!

COMPARE THESE OUTSTANDING DIFFERENCES!

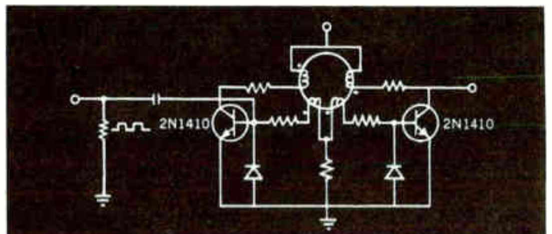
MAXIMUM RATINGS					
Parameter	2N697	2N1837	Unit	Test Condition	% Improvement
V_{CER}	40.	50.	Volts	$R_{BE} = 10\Omega$	25% Higher
V_{CBO}	60.	80.	Volts	$I_{CBO} = 100\ \mu A$	33% Higher
V_{EBO}	5.	8.	Volts	$I_{EBO} = 100\ \mu A$	60% Higher
Power Dissipation	2.0	2.0	Watts	25°C Case Temp	—
Power Dissipation	0.6	0.6	Watts	25°C Ambient Temp	—
I_{CBO}	1.0 100	0.5 50.	μA μA	$V_{CB} = 30V$, $T = 25°C$ $V_{CB} = 30V$, $T = 150°C$	50% Decrease
$V_{BE}(SAT)$	1.3	1.3	Volts	$I_C = 150mA$, $I_B = 15mA$	
$V_{CE}(SAT)$	1.5	0.8	Volts	$I_C = 150mA$, $I_B = 15mA$	47% Decrease
h_{FE}	40-120	40-120		$V_{CE} = 10V$, $I_C = 150mA$	
h_{fe}	2.5 min	7.0 min		$V_{CE} = 10V$, $I_C = 50mA$ $f = 20$ mc	280% Increase
Cob	35.	18.	μμf	$V_{CB} = 10V$, $I_E = 0$ $f = 140$ kc	48% Decrease

Only half the collector to emitter voltage drop... nearly three times the small signal beta... half the collector capacitance ...half the leakage current!

PSI is also in large volume production of many standard switching transistors including 2N696, 2N697, 2N699, 2N1420 and 2N706.

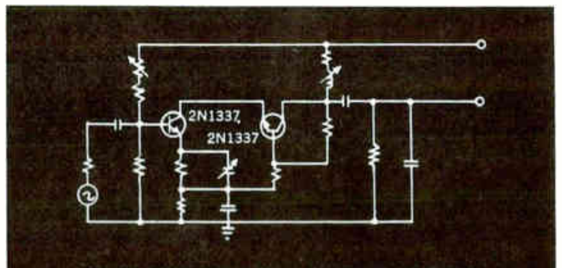
High Speed Switch Types—2N1409-2N1410

Typical switching speed of 52 nanosec turn-on time and 130 nanosec turn-off . . . saturation resistance of only 5 ohms and power ratings of 2.8 watts (25°C case temp.) For use in low current logic or high current core-driver circuitry.



TRANSISTOR CORE FLIP-FLOP

High Versatility Types—2N1335 thru 2N1341



TEN MC BANDWIDTH, HIGH VOLTAGE VIDEO AMPLIFIER

The higher power dissipation, faster rise time and lower collector capacitance of the 2N1337, for example, makes this transistor an unusually fine performer in advanced video amplifier circuits.

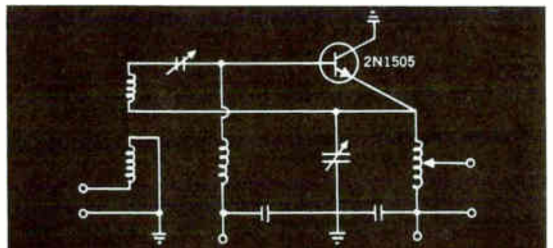
These 2.8 watt, 120 volt VHF transistors are well suited to IF and DC amplifiers, RF power amplifiers and oscillators and to high voltage switching applications.

Communication Types—2N1505-2N1506

This series of silicon mesa transistors provides high power output at Very High Frequencies. Typical power outputs are one-half watt at 200 mc with 3 db gain or one watt at 70 mc with 12 db power gain operating from 28V source.

A power output of 2.5 watts at 250 mc. may be obtained by using these transistors with a High-Q Varicap® frequency multiplier.

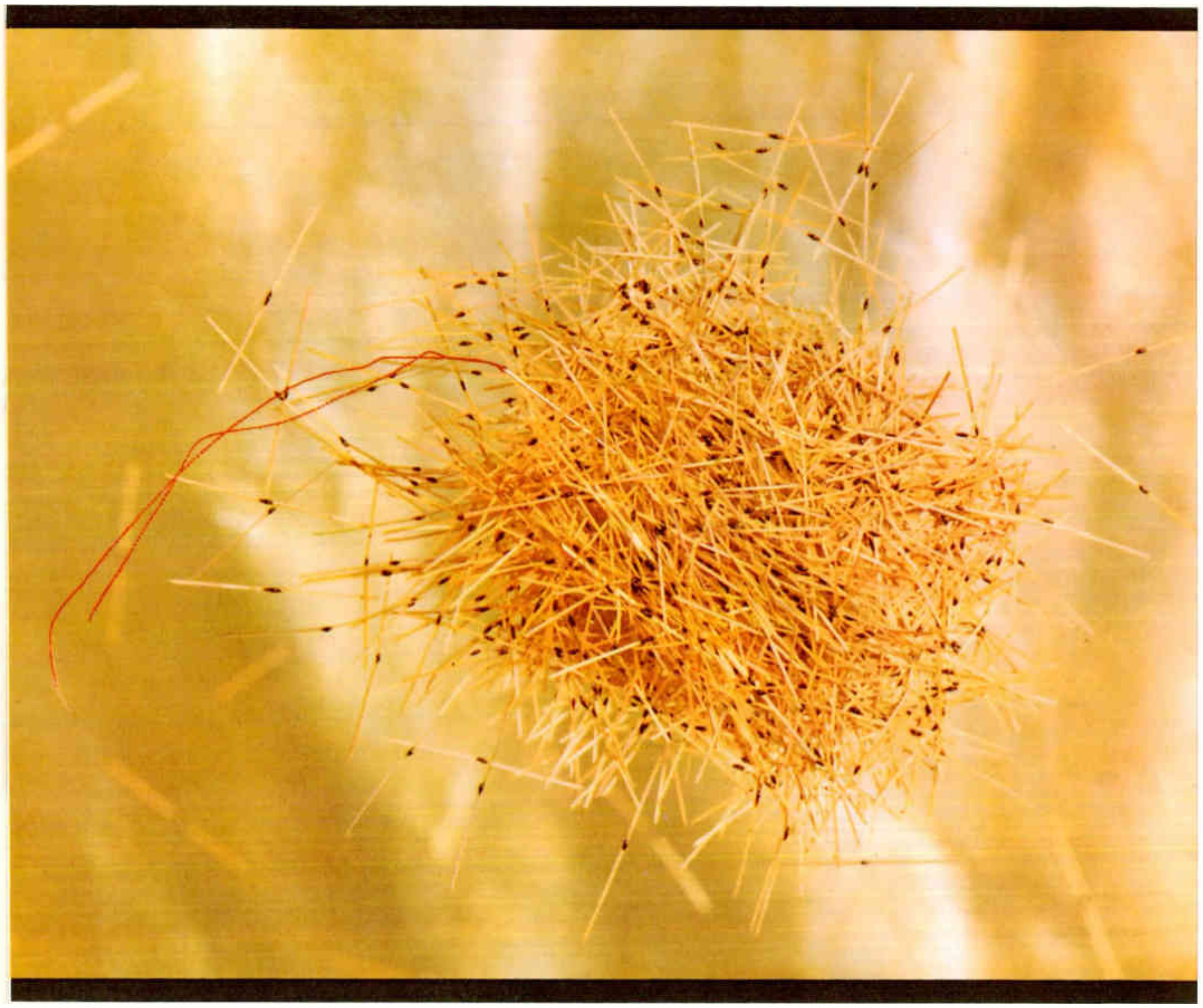
"VARICAP" is the registered trade-mark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.



GROUNDED COLLECTOR COMMON EMITTER RF AMPLIFIER PROVIDES UNIQUE COMBINATION OF HIGH GAIN AND HIGH POWER.

AVAILABLE NOW! PT530—5 watt 30 mc Power Amplifier
PT901—High Frequency High Power Transistor

RELIABILITY
Comes in All Sizes



Here's reliability so big you can barely see it. A needle and red thread almost concealed among thousands of silicon diodes demonstrate the super-miniaturization of PSI Micro-Diodes. These are the smallest known semiconductor devices, with reliability equal to or greater than conventional diodes.

At Pacific Semiconductors, Inc. reliability comes in all sizes—in a broad product line ranging from tiny Micro-Diodes and Pico-Transistors to large 30,000-volt cartridge rectifiers.

But size is only part of the story. At PSI, reliability begins at the conceptual stage of a device. It is as essential as the ability to manufacture in large production quantities. Reliability is as basic as original thinking.

PSI®
Pacific Semiconductors, Inc.
A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE, INC.
CORPORATE HEADQUARTERS: 14520 South Aviation Boulevard, Lawndale, California
General Sales Offices: 12955 Chadron Avenue, Hawthorne, California

LITHO IN U.S.A.

Very High Voltage Silicon Rectifiers

- Many values...1,000 to 30,000 Volts
- No voltage derating over entire temperature range of —55°C to 150°C
- Extremely rugged
- Non metallic "cold" case
- Wire-in leads...easy to mount
- Use in printed circuit board applications

EIA TYPE NUMBER	Peak Inverse Voltage (volts)	Maximum Average Rectified Current (mA) @ 25°C	Maximum Average Rectified Current (mA) @ 100°C	MAX RMS Input Voltage* (volts)	MAX DC Fwd Voltage Drop @ 100 mA DC 25°C	Dimensions (Inches) L.	Dimensions (Inches) Dia.
1N1730	1000	200	100	700	5	.5	.375
1N1731	1500	200	100	1050	5	.5	.375
1N1732	2000	200	100	1400	9	1.0	.375
1N1733	3000	150	75	2100	12	1.0	.375
1N1734	5000	100	50	3500	18	1.0	.5
1N2382	4000	150	75	2800	18	1.0	.5
1N2383	6000	100	50	4200	27	1.5	.5
1N2384	8000	70	35	5600	27	1.5	.5
1N2385	10000	70	35	7000	39	2.0	.5

*Resistive or Inductive Load
Maximum DC Reverse Current @ Rated PIV 10 μA @ 25°C, 100 μA @ 100°C.
Maximum Surge Current (8msec.): 2.5 Amps.
Continuous DC Voltage same as PIV.
Operating Temperature Range —55°C to 150°C.

EIA TYPE NUMBER (Fuse Clip Types)	Length Inches	Absolute Max. Rtgs. H/W Res. Load at 75°C Ambient: Peak Inverse Voltage Volts	Absolute Max. Rtgs. H/W Res. Load at 75°C Ambient: Max. Rectified DC Output Current mA	Electrical Characteristics at 25°C Ambient: Forward DC Volt Drop at Rated DC Current Volts	Electrical Characteristics at 25°C Ambient: Reverse DC Current at Rated PIV mA
IN1139	4 5/16	3600	65	27.0	.025
IN1140	2½	3600	65	18.0	.025
IN1141	4 5/16	4800	60	36.0	.025
IN1142	2½	4800	50	24.0	.025
IN1143	4 5/16	6000	50	45.0	.025
IN1143A	4 5/16	6000	65	30.0	.025
IN1144	6 1/16	7200	50	54.0	.025
IN1145	4 5/16	7200	60	36.0	.025
IN1146	6 1/16	8000	45	60.0	.025
IN1147	6 1/16	12000	45	60.0	.025
IN1148	6 1/16	14000	50	52.0	.025
IN1149	6 1/16	16000	45	60.0	.025

Storage and Operating Temperature Range —55°C to 150°C

MAXIMUM RATINGS

EIA TYPE NUMBER	Peak and Continuous Inverse DC Voltage —55°C to 175°C (Vdc)	Equivalent RMS Voltage (Vdc)	Forward Drop at 100 mA dc at 25°C (Vdc)	Average Rectified Current* (mAdc) 25°C	Average Rectified Current* (mAdc) 100°C
1N3052	12,000	8,450	70	100	50
1N3053	14,000	9,900	75	100	50
1N3054	16,000	11,300	80	100	50
1N3055	18,000	12,700	85	100	50
1N3056	20,000	14,150	90	100	50
1N3057	22,000	15,500	95	100	50
1N3058	24,000	17,000	100	100	50
1N3059	26,000	18,350	105	100	50
1N3060	28,000	19,750	120	100	50
1N3061	30,000	21,150	125	100	50

Operating Temperature Range: —55°C to 175°C.

PSI® High-Q Varicap®

VARICAP TYPE NUMBER	Capacitance* @ 4 VDC 50MC (μμf)	Quality Factor Min. (Q) @ 4VDC 50MC	Max. Working Voltage (VDC)	Minimum Saturation Voltage @ 100 μADC (VDC)	Maximum Inverse Current (μADC)	Capacitance Change (Ratio)
PC-112-10	10	50	80	90	0.5**	from 2VDC to 80VDC, 4.0 to 1 Min.
PC-113-22	22	50	80	90	0.5**	
PC-114-47	47	50	80	90	0.5**	
PC-115-10	10	100	100	110	0.5†	from 2VDC to 100VDC, 5.2 to 1 Min.
PC-116-22	22	100	100	110	0.5†	
PC-117-47	47	100	100	110	0.5†	
PC-122-47	47	75	100	110	0.5†	
PC-132-10	10	50	25	30	0.5‡	from 1VDC to 25VDC, 3.0 to 1 Min.
PC-133-22	22	50	25	30	0.5‡	
PC-134-47	47	50	25	30	0.5‡	
PC-135-10	10	150	50	60	0.5#	from 1VDC to 50 VDC, 4.0 to 1 Min.
PC-136-22	22	125	50	60	0.5#	
PC-137-47	47	100	50	60	0.5#	

*All capacitance values are ± 20% All values at 25°C
**Measured @ 50VDC †Measured @ 75VDC ‡Measured @ 10VDC #Measured @ 30VDC
"VARICAP" is the registered trade-mark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.

PSI TYPE NO.	MAXIMUM RATINGS: Recurrent Peak Inv. Voltage at 150°C (Volts)	MAXIMUM RATINGS: RMS Voltage at 150°C (Volts)	MAXIMUM RATINGS: Avg. Forward[1] Current I_O (mA) at 25°C	MAXIMUM RATINGS: Avg. Forward[1] Current I_O (mA) at 150°C	ELECTRICAL CHARACTERISTICS: Min. E_S at 100 μa at 25°C (Volts)	ELECTRICAL CHARACTERISTICS: Max. E_f at 500 mA at 25°C (Volts)	ELECTRICAL CHARACTERISTICS: Max. I_R (μa) Recurrent Peak Inv. Voltage at 25°C	ELECTRICAL CHARACTERISTICS: Max. I_R (μa) Recurrent Peak Inv. Voltage at 100°C	ELECTRICAL CHARACTERISTICS: Max. Avg. Inverse Current[2] at 150°C (μa)
PS405	50	35	400	150	75	1.5	5	50	500
PS410	100	70	400	150	130	1.5	5	50	500
PS415	150	105	400	150	180	1.5	5	50	500
PS420	200	140	400	150	240	1.5	5	50	500
PS425	250	175	400	150	285	1.5	5	50	500
PS430	300	210	400	150	340	1.5	5	50	500
PS435	350	245	400	150	400	1.5	15	75	500
PS440	400	280	400	150	450	1.5	15	75	500
PS450	500	350	400	150	560	1.5	15	75	500
PS460	600	420	400	150	675	1.5	15	75	500

PSI TYPE NO.	MAXIMUM RATINGS: Recurrent Peak Inverse Voltage (Volts) @ 100°C	MAXIMUM RATINGS: RMS Voltage @ 100°C (Volts)	MAXIMUM RATINGS: Avg. Forward Current I_O (mA)[1] @ 25°C	MAXIMUM RATINGS: Avg. Forward Current I_O (mA)[1] @ 100°C	ELECTRICAL CHARACTERISTICS: Min. E_S @ 100 μa @ 25°C (Volts)	ELECTRICAL CHARACTERISTICS: Min. I_f @ 1.0V E_f @ 25°C (mA)	ELECTRICAL CHARACTERISTICS: Max. I_R (μa) @ Recurrent Peak Inv. Voltage @ 25°C	ELECTRICAL CHARACTERISTICS: Max. I_R (μa) @ Recurrent Peak Inv. Voltage @ 100°C	ELECTRICAL CHARACTERISTICS: Max. Avg.[2] Inverse Current @ 100°C (μa)
PS005	50	35	250	140	75	100	10	75	100
PS010	100	70	250	140	130	100	10	75	100
PS015	150	105	250	140	180	100	10	75	100
PS020	200	140	250	140	240	100	10	75	100
PS025	250	175	250	140	285	100	10	75	100
PS030	300	210	250	140	340	100	30	100	100
PS035	350	245	250	140	400	100	30	100	100
PS040	400	280	250	140	450	100	30	100	100
PS050	500	350	250	140	560	100	30	100	100
PS060	600	420	250	140	675	100	30	100	100

1. Resistive or Inductive Load.
2. Average over one cycle for half wave resistive or choke input circuit with rectifier operating at full rated current and maximum RMS input.

Silicon Subminiature Rectifiers

MEDIUM POWER - Military Types

EIA TYPE NUMBER	MAXIMUM RATINGS: Peak Inv. Voltage (v)	MAXIMUM RATINGS: Maximum Avg. Rectified Current (mA)[1] @ 25°C	MAXIMUM RATINGS: Maximum Avg. Rectified Current (mA)[1] @ 150°C	ELECTRICAL CHARACTERISTICS: Minimum Saturation Voltage @ 100°C	ELECTRICAL CHARACTERISTICS: Maximum Reverse Current @ PIV (μA) @ 25°C	ELECTRICAL CHARACTERISTICS: Maximum Reverse Current @ PIV (μA) @ 100°C	ELECTRICAL CHARACTERISTICS: Max. Avg. Voltage Drop @ I_O =400 mA @ 25°C (v)
AF1N645	225	400	150	275	0.2	15	1.0
AF1N646	300	400	150	360	0.2	15	1.0
AF1N647	400	400	150	480	0.2	20	1.0
AF1N648	500	400	150	600	0.2	20	1.0
AF1N649	600	400	150	720	0.2	25	1.0

Mil-E-1/1143 (USAF)
1. Resistive or Inductive Load
Maximum Storage and Operating Temperature Range —65°C to 150°C

NEW!

MICRO-MINIATURE
BRIDGE RECTIFIERS
PS2411 thru PS2419

MICRO-MINIATURE
HIGH VOLTAGE RECTIFIERS
PS2422 thru PS2430

Please Note: All specifications and information contained herein are current as of *November 15, 1960*

This catalog contains only highlights of the complete PSI line of semi-conductor devices. For current information on PSI, save this and other inserts which appear periodically in leading electronic publications.

NEW! High Voltage-High Current Cartridge Rectifiers
1,500 to 20,000 Volts @ 200 to 500 mA

PSI®

Pacific Semiconductors, Inc.

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE, INC.
GENERAL SALES OFFICE: 12955 Chadron Avenue, Hawthorne, California

REGIONAL AND DISTRICT SALES OFFICES

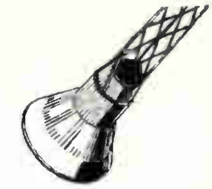
NEW YORK—870 Broadway, Newark 4, New Jersey • Humboldt 4-5616 • TWX: NK 1010
Boston—471 Washington Street, Wellesley 81, Mass. • CEdar 5-0171
Syracuse—4455 E. Genesee Street, DeWitt, New York • GIbson 6-4600
PENNSYLVANIA—320 Huntingdon Pike, Rockledge, Philadelphia 11, Pa. • Pilgrim 2-8089 TWX: Rockledge PA 1064
Baltimore—1811 North Rolling Road, Baltimore 7, Maryland • WIndsor 4-3622
ILLINOIS—6957 West North Avenue, Oak Park, Illinois Village 8-9750 • TWX: OKP 1547
Dallas—P.O. 6067, Dallas, Texas • RIverside 7-1258
Detroit—1204 North Woodward Avenue, Royal Oak, Michigan • LIncoln 8-4722
St. Paul—2664 Caltier, St. Paul 17, Minnesota • MIdway 6-2471
CALIFORNIA—8271 Melrose Avenue, Los Angeles 46, Calif. • OLive 3-7850
San Diego—5022 Field, San Diego, California • BRowning 6-2261
Palo Alto—701 Welch Road—Suite 305, Palo Alto, Calif. DAvenport 1-2240

DISTRIBUTORS IN MAJOR ELECTRONIC CENTERS COAST-TO-COAST

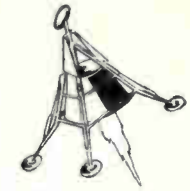
NASA program-highlights

NEXT DECADE IN SPACE

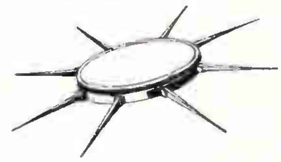
Year 4 to 14 of the Space Age



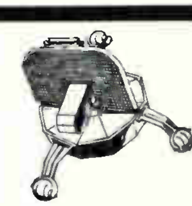
Project Mercury—U. S.'s first manned satellite.



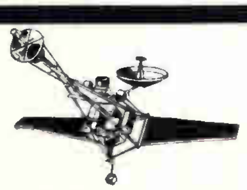
Project Surveyor—First soft landing on moon. Conduct observations from stationary position.



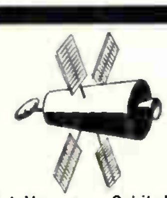
Project Prospector—Soft landing on moon and exploration of area within 50 miles of landing point.



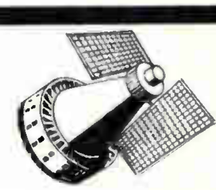
Solar Observatory—350 lb. Large flywheel and extended arms rotate to stabilize. Under construction.



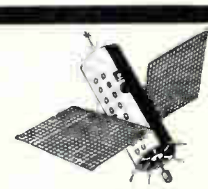
Project Mariner—600 to 1200 lbs. First U. S. Planetary missions to Venus and Mars. Modified craft for hard landings on moon.



Project Voyager—Orbit Mars and Venus and eject instrumented capsule for atmospheric entry and perhaps landing.



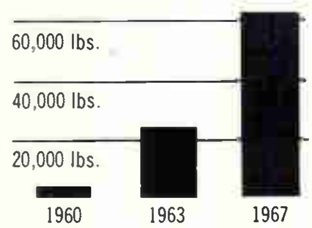
Nimbus—600 to 700 lb. meteorological satellite series. Stabilization system will keep cameras pointed earthward.



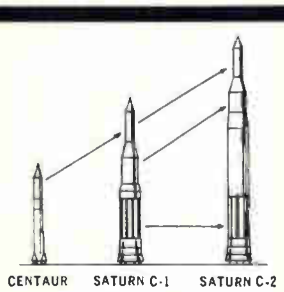
Orbiting Geophysical Observatory—1000 lb. geophysical research satellite designed for a near earth circular polar orbit or an inclined highly elliptical orbit.

Project Aeros—24-hour stationary weather satellite. Launched in equatorial orbit. Three satellites could permit continuous observation of most of earth's surface.

Orbiting Astronomical Observatory—Standardized, 3500 lb. satellite, for several experiments with different scientific sensors and specialized devices.



Anticipated Growth of NASA Spacecraft in terms of weight of individual near earth satellites.



Launch Vehicles—New and more powerful launch vehicles; chemical, electrical, nuclear propulsion.

These programs facing the scientists and engineers of NASA comprise the most challenging assignment ever given a group of Americans.

You are invited to work alongside the many distinguished and dedicated members of our technical staff. For details about outstanding professional opportunities, address your inquiry to the Personnel Director of any of these NASA Research and Space Flight Centers—

NASA Ames Research Center • Mountain View, California

NASA Flight Research Center • P.O. Box 273, Edwards, California

NASA Goddard Space Flight Center • Greenbelt, Maryland

NASA Langley Research Center • Hampton, Virginia

NASA Lewis Research Center • Cleveland 35, Ohio

NASA Marshall Space Flight Center • Huntsville, Alabama

NASA Wallops Station • Wallops Island, Virginia

National Aeronautics and Space Administration

NASA

FINANCIAL ROUNDUP

New Merger Plans Announced

YEAR-END MERGERS and acquisitions are continuing at the same brisk pace that has characterized much of this year's financial activity.

Two Los Angeles companies with a combined annual sales figure of $40 million have announced merger plans. **American Electronics** and **Electronic Specialty Company** plan to form a new corporate entity under which shareholders in American will receive one share of new stock for each share they now hold, and stockowners of Electronic Specialty will receive 1¼ shares. Plans are for the consolidation to be completed in February of 1961 subject to shareholder approval to be solicited at early January meetings. Combined plant area of the two companies is more than 550,000 sq ft. Both firms manfacture controls and systems with both military and commercial applications.

Ling Temco Electronics, Dallas, Tex., has completed negotiations to acquire the remaining minority stock interest in a subsidiary company, **Fenske, Fedrick & Miller.** The subsidiary's sales, standing at about $100,000 in 1958 climbed to $600,000 in 1959, and are forecast to top $6 million this year. Basic product of FF&M is a system called Iconorama that visually displays the paths of moving vehicles in the air or on the surface. Company officials say it has a potential market in air-traffic control and ship-movement control. Installations have been made in the Pentagon, for the North American Air Defense Command and for the Strategic Air Command. A system is also in use in the BMEWS network.

Houston Fearless Corp., Los Angeles, announces purchase of **Mastertite Industries**, Inglewood, Calif., manufacturer of printed circuit connectors, electronic contacts. The transaction was negotiated for an undisclosed amount of cash. Present annual sales for the newly acquired firm have been approximately $1 million. No changes in personnel are anticipated.

U. S. Systems, Inc., Los Angeles, reports acquisition of all capital stock of **Dyna-Matics Corp.**, Sun Valley, Calif., making it a wholly owned subsidiary. This is the fourth acquisition the Los Angeles company has made within the past year, bringing its combined annual sales to over $2 million a year. The Sun Valley company manufactures valves, pumps and control systems. Founded in the early part of this year, its sales were about $500,000.

Edo Corporation, College Point, L. I., reports unaudited earnings of 65 cents a share for the first nine months of 1960. In the same period of 1959, this figure was 18 cents. Company officials also report that stockholders have voted approval for the reclassification of previously authorized Class A and Class B stock into a single classification of common stock. They have also voted an increase in capital stock from 807,435 to 1,200,000 shares. The company recently issued 100,000 shares of previously authorized stock for the acquisition of all outstanding capital stock of **Electric Indicator Co.** of Stamford, Conn.

Television-Electronics Fund, Chicago, mutual fund specializing in electronics investments, reports total net assets of $339.4 million as of Oct. 31 this year as compared with $308.1 million a year ago. Sales of shares during the past fiscal year were $67.7 million compared with $64.3 million in the 1959 fiscal year. Net per-share value dipped to $7.41 this year as compared with $7.94 the year before, a decline of 2.7 percent.

Perkin-Elmer Corp., Norwalk, Conn., announces net sales of $5.4 million and earnings of $138,710 for the first three months of the fiscal year, this period ending Oct. 31, 1960. Net sales for the interval compared with $3.2 million for the first three months of last year. Earnings were $55,550 for the same period a year ago. Per-share earnings on common stock were 11 cents this period, five cents for the same period a year ago.

Lear, Inc., reports record net operating earnings of about $2,800,000 on sales of more than $90 million, equal to $1.01 a share as the forecast for 1960. In 1959, the company had net earnings of $2,407,000, equal to 91 cents per share on sales of $87,002,000. The company expects to realize a nonrecurring gain of about 29 cents a share from sales of assets, bringing the total 1960 earnings to about $1.30 a share.

Microwave Associates, Burlington, Mass., announces a net profit of $633,800 for the fiscal year ended Sept. 30 this year, an increase of 65 percent over last year's $384,500. Sales increased 30 percent in 1960 to $8,691,500 from 1959 sales of $6,670,500. Earnings per share were equal to 64 cents this year as compared with 43 cents in 1959.

25 MOST ACTIVE STOCKS

WEEK ENDING DECEMBER 9, 1960

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Sperry Rand	2,784	23⅛	18⅝	23⅛
Ampex Corp.	1,402	25½	22¾	23⅝
Gen Tel & Elec	1,139	26¾	25	26⅝
Lockheed Aircraft	974	28	25⅜	27¾
Univ Control	869	15¾	14⅛	15½
Int'l Tel & Tel	843	44½	42⅛	44½
Standard Kollsman	673	25⅞	22⅛	24¾
Gen Elec Co	661	77¾	74⅜	77¾
Western Elec	629	52	48½	52
Nuclear Corp Amer	594	4¼	3½	4
RCA	567	55⅜	53½	54⅝
Telectro Ind	557	15⅞	13⅛	14⅛
Philco Corp	555	18⅜	15⅞	15⅞
Transitron	548	36¾	35⅜	36⅜
Raytheon Co	532	35¼	32¼	34¾
Avco Corp	509	14¼	13¾	14¼
Clary Corp	495	10¾	9⅜	9¾
Loral Elec	456	34⅜	30⅛	33¼
Burroughs Corp	455	28⅜	26¼	28⅜
Gen Inst Corp	427	41½	38⅝	40⅛
Gen Dynamics Corp	397	41⅞	38¼	41¾
Elec & Mus Ind	378	6	5⅝	5⅞
Polarad	346	25⅜	22¼	22⅞
Audio Devices Inc	311	25¾	23⅜	25⅛
Martin Co	304	60⅜	58⅝	60

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

Report to Cover Military Components

Col. Horace W. Lanford, Jr.

ELECTRONIC Production Resources Agency announced plans this week to regularly supply our industry with expected requirements for military components for periods five years in the future.

Announcement culminated several years' effort by Col. Horace W. Lanford, Jr., director of EPRA, to obtain necessary data from Department of Defense officials needed to supply this information to the electronics industry.

Information represents a major market data break-through for our industry. It will enable manufacturers of military components to guide their activities and tie in with future DOD needs. The five-year look-ahead at military needs is expected to make its bow about next July. Components in the requirement forecast will include many of the items listed in the Joint Survey of Component Shipments by Manufacturers, regularly issued by Business and Defense Administration's Electronics Division, and EPRA.

Like all five year forecasts, information to be supplied will represent best thinking of DOD officials as of this time. The future, as always is subject to change, and manufacturers using this data should regularly review successive five year forecasts to check on changing requirements and needs.

Working with Don Parris, director of BDSA's, of Electronics Div., Lanford has also played an important role in coordinating the electronic market gathering efforts of the Departments of Defense and Commerce.

At present, information obtained from Joint Survey of Shipments is made public to all. At one time, information was supplied only to manufacturers who participated in specific components surveys, and EPRA and BDSA issued differing figures.

Another example of how BDSA and EPRA have worked together has been the recent transfer by BDSA to EPRA of its mandatory authority, under the Defense Production Act, requiring manufacturers to cooperate in a joint survey by supplying sales information requested.

For the future, Lanford plans to develop estimated expenditures for military systems and hardware (equipment). He had EPRA personnel develop a military product classification system and at present has them working on a trial run of their equipment gathering abilities and facilities.

Though much of the credit of the marketing aids which have been developed for the electronics industry goes to Col. Lanford, and to Don Parris in those areas where they jointly function, Lanford has not done the job alone.

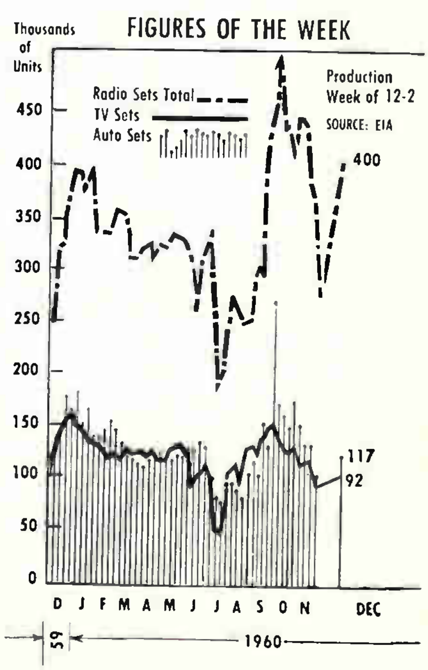
He has been assisted in his efforts by a staff including Tom Harris, chief, resources and logistics; Jack Branham, components manager, and Frank Cunningham, manager of semiconductors.

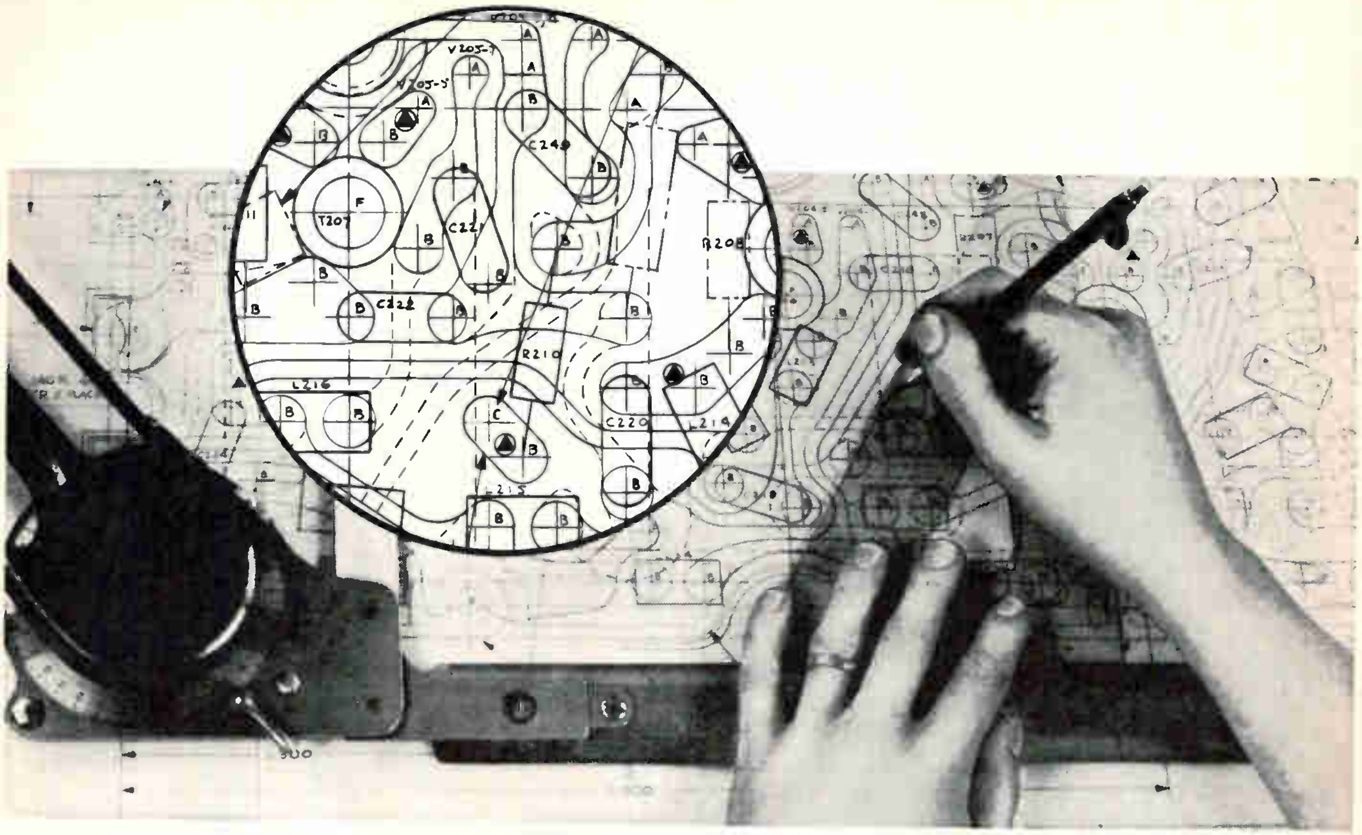
Optimistic view of the future of the electronics industry was presented at the winter conference of Electronic Industries Association by L. Berkley Davis, president of EIA and a vice president of General Electric. The meeting, attended by approximately 200 EIA members, was held recently in San Francisco.

Davis said that the rosy glow exuded by the electronics industry may eventually work to its detriment, however, as the federal government ignores the undermining effect of certain islands of foreign competition.

On the positive side, Davis, who is general manager of GE's Electronic Components division at Owensboro, Ky., said that when the 1960 tallies are in they will show an overall increase of six percent in sales over 1959. This will break down into a five percent rise in consumer products and a nine percent rise in industrial sales. The growth of data processing and industrial communication equipment was pointed out by Davis as prime reason for the industrial sales increases. Television sales, unusually high during the first nine months of the year, accounted largely for the consumer increases.

The picture for 1961 will show sales "up at least six percent again" with increased military and space needs providing the biggest single impetus, said Davis. And he predicted that the industry will double in size, to $20 billion in sales, within ten years to become the largest industry in the U. S.





Designer drafts master layout of printed circuit design on dimensionally stable CRONAFLEX. Inset shows detail: solid lines indicate circuitry on component side of board; broken lines, circuitry on reverse side.

At Bendix-Pacific . . .

CRONAFLEX® *CUTS COSTS,* *SPEEDS PREPARATION OF PRINTED CIRCUITS*

Versatile CRONAFLEX Engineering Reproduction and Drafting Films have made possible a new, simplified method of preparing printed circuits at Bendix Corporation's Bendix-Pacific Division. Not only has it proven much more efficient and economical, it also assures uniform quality of finished boards and steps up the entire production cycle.

Commenting on the procedure, Edward E. Benjamin, Methods and Design Standards Engineer, says: "CRONAFLEX lets us do a better, faster job, at lower cost, all along the line. For master layouts, where basic design begins, CRONAFLEX Drafting Film is ideal. It holds its size under varying temperature and humidity conditions, takes erasures and handling without damage, and has a far superior matte surface.

"From the master layout we make our master transparency, machine board drawing and assembly board drawing, using CRONAFLEX Direct Positive. Here again results are phenomenal. In the assembly drawing alone, for example, we've cut drafting time from 3-5 days to 4-8 *hours!* Add to this elimination of the negative step, fast printback and excellent halftone quality, and you'll see why we're sold on CRONAFLEX!"

For a FREE booklet that describes this new method in detail, plus information on the many ways CRONAFLEX can help *your* firm cut costs and increase efficiency, clip and mail this handy coupon *now.*

E. I. du Pont de Nemours & Co. (Inc.)
Photo Products Department E-12
Wilmington 98, Delaware

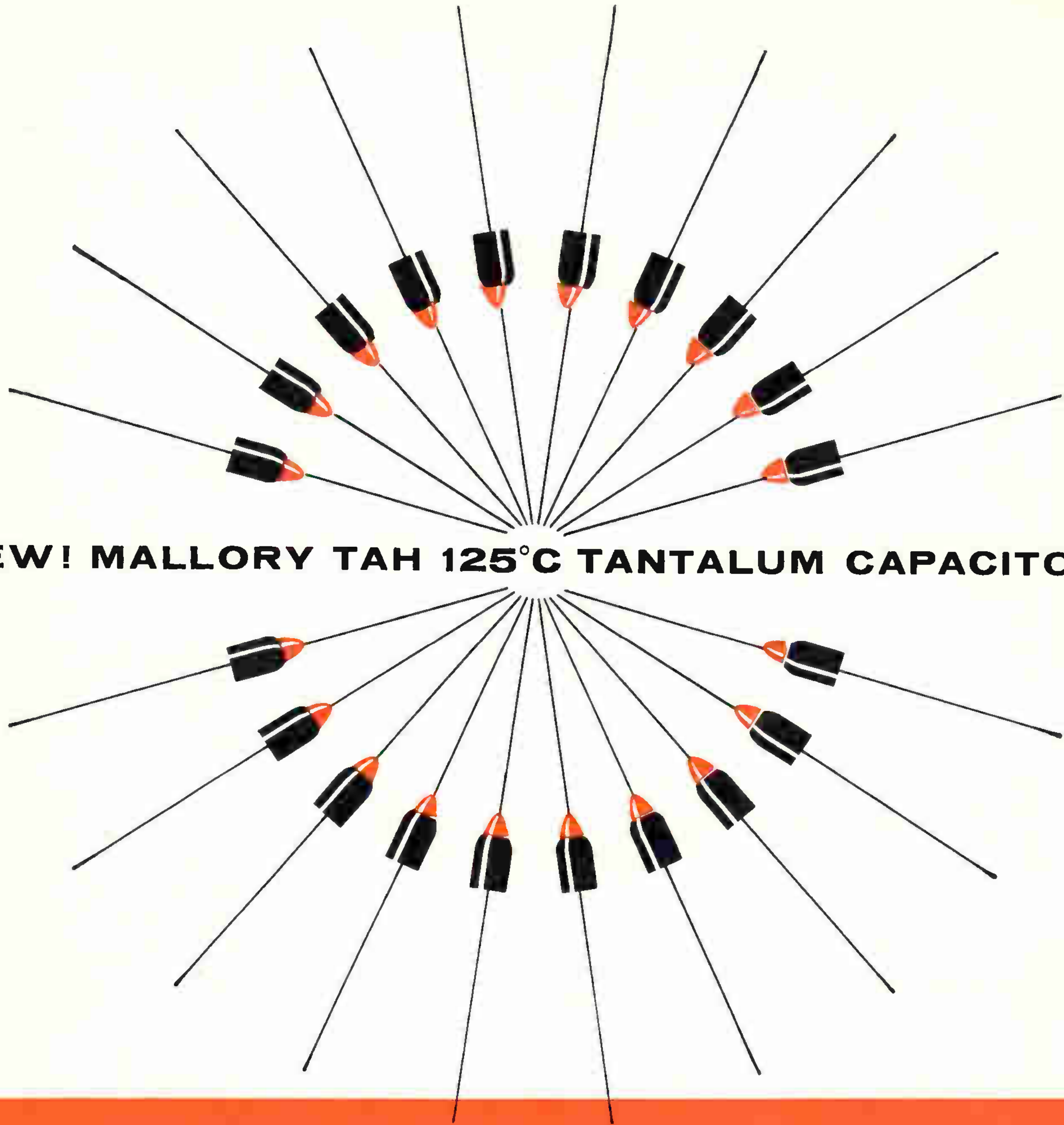
Please send me without obligation:

- ☐ Free booklet, "A Photographic Method for Preparing Printed Circuits."
- ☐ Information on the Full Line of CRONAFLEX Engineering Reproduction and Drafting Films.

Name____________________
Firm____________________
Address____________________
City__________ Zone____ State________

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

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



NEW! MALLORY TAH 125°C TANTALUM CAPACITORS

New! A miniature 125°C tantalum capacitor—the Mallory TAH. The largest capacity per volt per cubic inch of any high temperature tantalum capacitor. Available in three case sizes and in 30 ratings from 2 mfd/60WVDC to 330 mfd/4WVDC. Same sintered pellet anode construction made famous by Mallory for reliability under extreme environmental conditions. High temperature seal and superior welded lead construction.

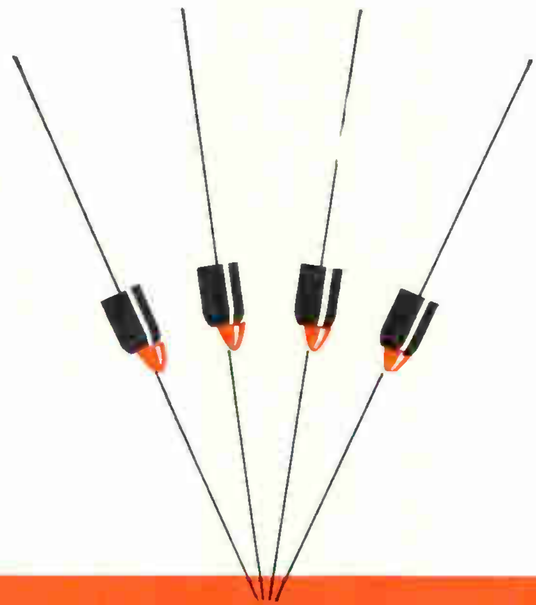
The Mallory TAH is specifically designed for medium voltage, low impedance transistorized circuits requiring small size, stability and long life characteristics.

FROM THE INDUSTRY'S WIDEST SELECTION

... seven high temperature sintered anode tantalum electrolytic capacitors

Type	Capacity Range mfd	W. Volts DC at 85° C	Temp. Range ° C	Body Length	Body Diameter	Bulletin Number
TAH	2-330	90-6	—55 to +125	.500 to .875"	.238"	4-57
MTF	11-140	90-6	—55 to +150	.500"	.287" (Body) .484" (Flange)	4-41
XTK	2-70	340-8	—55 to +175	.438 to 1.313"	.650"	4-49
XTM	4-140	340-8	—55 to +175	.566 to 1.800"	.650"	4-49
XTL	3.5-120	630-18	—55 to +200	.500 to 2.595"	.875"	4-31
XTH	7-240	630-18	—55 to +200	.688 to 4.065"	.875"	4-31
XTV	18-1300	630-30	—55 to +175	.563 to 2.750"	1.125"	4-39

HIGH RATINGS-SMALL CASE SIZES



. . . *and six other types* . . . HAT, TNT, & TAP sintered anode liquid electrolyte; TAM & TAS sintered anode solid electrolyte; and 110 TAF foil ratings . . . Metal case and encapsulated, from micro-miniature size upward. All produced in our new manufacturing facilities, the first in the industry specially designed for tantalum capacitor production.

Easier than ever to order. New 13-digit catalog numbering system lets you specify the exact Mallory tantalum capacitor you want, without writing out long, detailed specifications.

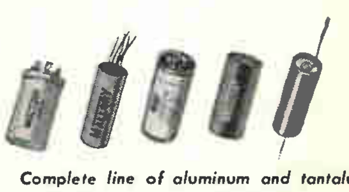
Write for complete technical data. For expert consultation on your circuit requirements, see a Mallory capacitor specialist.

Mallory Capacitor Co.
Indianapolis 6, Ind.
a division of

P. R. MALLORY & CO. Inc.
MALLORY

Mallory Tantalum Capacitors Stocked by these distributors

Baltimore, Md.
Radio Electric Service
Binghamton, N.Y.
Stack Electronics
Boston, Mass.
Cramer Electronics, Inc.
DeMambro Radio Supply Co.
Lafayette Radio
Bridgeport, Conn.
Westconn Electronics
Buffalo, N.Y.
Wehle Electronics
Camden, N.J.
General Radio Supply Co.
Chicago, Ill.
Allied Radio Corp.
Newark Electronics Corp.
Cincinnati, Ohio
United Radio
Cleveland, Ohio
Pioneer Electronics
Dallas, Texas
Engineering Supply Co.
Dayton, Ohio
Allied Supply Co.
Denver, Colo.
Denver Electronics
Houston, Texas
Harrison Equipment Co., Inc.
Lenert Company
Indianapolis, Ind.
Graham Electronics
Los Angeles, Calif.
California Electronics
Kierulff Electronics, Inc.
Radio Product Sales
Minneapolis, Minn.
Northwest Radio
Montreal, Que.
Canadian Electrical Supply Co.
Mountainside, N.J.
Federated Purchaser, Inc.
Nashville, Tenn.
Electra Dist. Co.
Newark, N.J.
Lafayette Radio
New York, N.Y.
Harrison Radio Corp.
Harvey Radio Co., Inc.
Hudson Radio & TV Corp.
Lafayette Radio
Terminal Electronics
Oakland, Calif.
Elmar Electronics, Inc.
Zack Electronics
Orlando, Fla.
East Coast Radio
Ottawa, Ont.
Wackid Radio-TV Lab.
Palo Alto, Calif.
Zack Electronics
Pasadena, Calif.
Electronic Supply Corp.
Perth Amboy, N.J.
Atlas Electronics
Philadelphia, Pa.
Herbach & Rademan
Philadelphia Electronics
Pittsburgh, Pa.
Radio Parts Co.
St. Louis, Mo.
Olive Electronics
Seattle, Wash.
F. B. Connelly Co.
Tampa, Florida
Thurow Distributors, Inc.
Toronto, Ont.
Alpha Aracon Radio Co.
Electro Sonic Supply
Wholesale Radio & Electronics
Tucson, Ariz.
Standard Radio Parts
Tulsa, Okla.
Engineering Supply Co.
Washington, D.C.
Electronic Industrial Sales
White Plains, N.Y.
Westchester Electric
Winston-Salem, N.C.
Dalton-Hege Radio



Complete line of aluminum and tantalum electrolytics, motor start and run capacitors

ORCE-FEEDING BRINGS RAPID GROWTH

ELECTRONICS IN COMMUNIST

' JOHN YAMAGUCHI
Graw-Hill World News

KYO—SECOND FIVE-YEAR program the Chinese People's Republic set target in 1958 to push the Chim technology up to world standds by 1962-63. The electronics lustry, as it is developing in inland China, may reach that al.

The groundwork was laid during first five-year program on Rusn, Hungarian and East German hnological foundations. Mateils and parts were imported from ier Soviet-bloc nations. The govnment's official program of vault; over present technological iges—dubbed the "big leap for-rd" by Peking planners—takes it can get from wherever it's ailable, plows in research effort the frontier areas of the various hnologies.

Informed Japanese observers told ECTRONICS last week that China's ctronics industry can now match rld standards in long-distance rrier systems and mobile radio. crowave communications have en installed in some parts of the intry, and high-speed computer hnology is being pushed rapidly. e Japanese observers predict that Chicom technology will catch to Japanese electronics "about time when the third five-year in begins in 1963."

"It is dangerous," one visitor to mainland warns, "to underestiite the growth potential of the inese electronics industry. Rearchers in China's Military Scice Institute at Peking, for innce, are inexperienced compared th their Russian equivalents, but ey are young and aggressive."

The 12-year science development ogram of the Science Institute Peking, made public in 1956, is master plan for technological velopment on the mainland. Top iority in this program is developnt of carrier communications stems to cover the vast territory China.

In November 1956, the Scientific stitute established research units in precision machinery, semiconductors, computers, and control engineering. At the same time, the Communist regime opened a Science Intelligence & Research Institute in Peking, collecting about 6,000 European, American and Japanese books and magazines on the electronics technology.

As early as 1951, the Chinese had begun working in semiconductors and copper-oxide rectifiers. Single-crystal germanium was grown in 1956, and production of diodes and transistors began the same year. In 1956-57, Chicom scientists made a thermoelectric generator using bimetallic semiconductors with oil lamps as a heat source. Photoelectric units of cadmium sulfate were developed for automatic controls and measuring instruments.

By 1958, the Chinese claimed success in manufacturing magnetic cores, silicon steel, and ferrites for computer memories and uhf systems.

Status of the Chicom electronics industry is spotty at present, as is inevitable when a technology is force-fed. Production figures are nonexistent in most cases: orientals are traditionally disinterested in exact production figures; Communist governments are—equally traditionally—unwilling to disclose them. The combination militates against a precise measure of Communist China's electronics.

In the area of long-distance carrier communications, postal telegraph research units across the nation began competing with one another in laying 1-, 3-, and 12-channel carrier systems in 1958; crossbar system capable of doubling the efficiency of the 12-channel carrier network was added in 1959. The central government in Peking can now call each of 24 provinces and three autonomous regions for telephone conferences. The 27 trunk lines were installed at a cost of some $4.1 million; the Chinese say importing the systems would have involved costs in excess of $16.5-million. The 27-trunk conference calls seem to have become the mainstay of government planning and liaison.

Commercial production of teleprinters began in Shanghai in 1956. In 1958, the Chinese were able to send 100 Chinese characters a minute instead of fudge-coding ideograms as numerals, as was traditional prior to 1950. A radiophoto circuit was set up between Peking and Tientsin in 1958, has now been extended to cover 11 cities. Facsimile systems to transmit newspapers are being developed. A "manual telegraph exchanger" developed in 1958 now connects Peking and Moscow.

A 4-channel single-sideband telephone system with peak output of 2 Kw was produced in 1958. Now in development are over-horizon communications systems and multichannel microwave equipment.

Mass production of automatic transistor switchboards began in 195?. The Chinese hope to put all major city telephone service on automatic dial exchanges soon. As of September 1958. 98 percent of the total 26,425 communes were served by at least one telephone, according to last June's (Chinese) *Telecommunications Service Journal.*

Production of uhf communications was undertaken as part of the first five-year program, which also produced 120-Kw transmission gear and a generous assortment of electron tubes, capacitors, resistors, loudspeakers and high-frequency ceramics. In 1958, the Chinese were able to produce 1,140,-000 radio receivers, as compared with 6,000 in 1959 and 350,000 in 1957.

The People's Hall—equivalent to the Congressional chambers in the U. S.—is now being equipped with a 10-channel transmitter and a headphone system to translate deliberations simultaneously into 12 languages.

First television broadcast station was opened in Peking in 1958. National network now comprises more than 20 stations in Shanghai, Canton, Harbin, and other major population centers. Color-tv equipment

CHINA

was imported from Britain last fall.

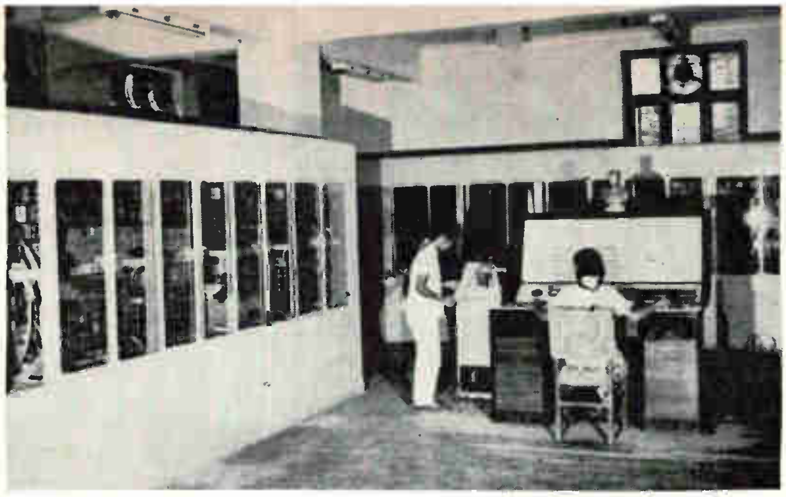
First small analog computer was manufactured in 1958 with technical assistance from the Russians. In 1959, the Chinese completed a large high-speed analog computer with the help of Soviet technology, also built a combination digital-analog computer to measure output of a power station.

In October 1959, the Chinese came out with a high-speed general-purpose computer (pictured) containing 4,200 tubes, 4,000 diodes and some 40,000 capacitors, and using 100,000 magnetic cores. The system has two memory drums with a total capacity of 6,000 bits, an add-subtract speed of between 65 and 178 microseconds; it consumes 180 Kw. Peking Radio recently commented that the computer is being used to determine water flow in the Sanmen Gorge in north central China, and to plan a dam construction on the Yellow River.

Pulse-frequency-modulation telemetry was developed in 1954; the equipment has been put to work to analyze power utility systems in Northeast China, Nanking, and a few other places.

The Chinese began researching magnetic telemetry systems in 1958, succeeded in putting one out for a test run at a Peking transformer station. Chinese engineers say this is the most important development in control engineering they've made thus far.

Information on those aspects of the technology related to the Chinese war machine exists, of course, only in the realm of speculation. Judging from Peking statements illuminated by limited on-the-spot observation, the radar, aircraft navigation, gun-laying and missile portions of the electronics technology are almost entirely copied from Soviet models. Peking is apparently willing—almost eager—to let Moscow carry the burden of war research, meanwhile pushing the areas of industrial and consumer electronics, components, and communications.



High-speed digital computer completed last year (above) was built in 18 months on Russian model; below, the controls of Peking's transformer station

In Shanghai, 100,000-power electron microscope was built last year; lab that built it stresses precision machinery, machine tools, automatic controls

SONAR and RADAR

TO HELP DRILL

THROUGH EARTH'S CRUST

By HAROLD C. HOOD
Pacific Coast Editor

THE SUCCESS of Project Mohole, calling for a bottom-of-the-ocean hole drilled into the Mohorovicic discontinuity (called the Moho by scientists) between the earth's crust and the underlying mantle, will depend to a considerable extent on electronics.

Sponsored jointly by the National Science Foundation and the National Academy of Science, Mohole is expected to provide priceless evidence on the earth's history and internal constitution.

Ultimate plan is to operate from a floating drilling platform anchored in water three miles deep and pierce the earth's crust to a depth of 18,000 ft. This calls for a drill string two miles longer than that used for the deepest hole yet drilled.

Phase 1, evaluation of techniques and equipment, gets under way next month when Global Marine Exploration Co. of Los Angeles will drill three 2,000-ft holes between Guadalupe and Cedros islands off the Mexican coast. Operating from its 260-ft, 3,000-ton drilling barge *Cuss I* in 12,000 ft of water, GME will depend primarily on sonar for accurate positioning over the holes, with a secondary radar system for backup.

Transistorized Bendix sonar transducers will be attached to four gasoline-filled aluminum buoys, moored 200 feet beneath the Pacific's surface, with taut, low-drag piano wire. These transducers will, in effect, frame the drilling barge. The transducers are battery-equipped; they will operate for approximately 60 days.

Aboard the barge, a modified Bendix depth recorder will pick up signals from the four transducers. In the wheelhouse of *Cuss I* the pilot will watch a ppi screen, and control by a single joy stick both the thrust and the direction of thrust of four 235-hp diesel outboard motors mounted on the sides and ends of the barge.

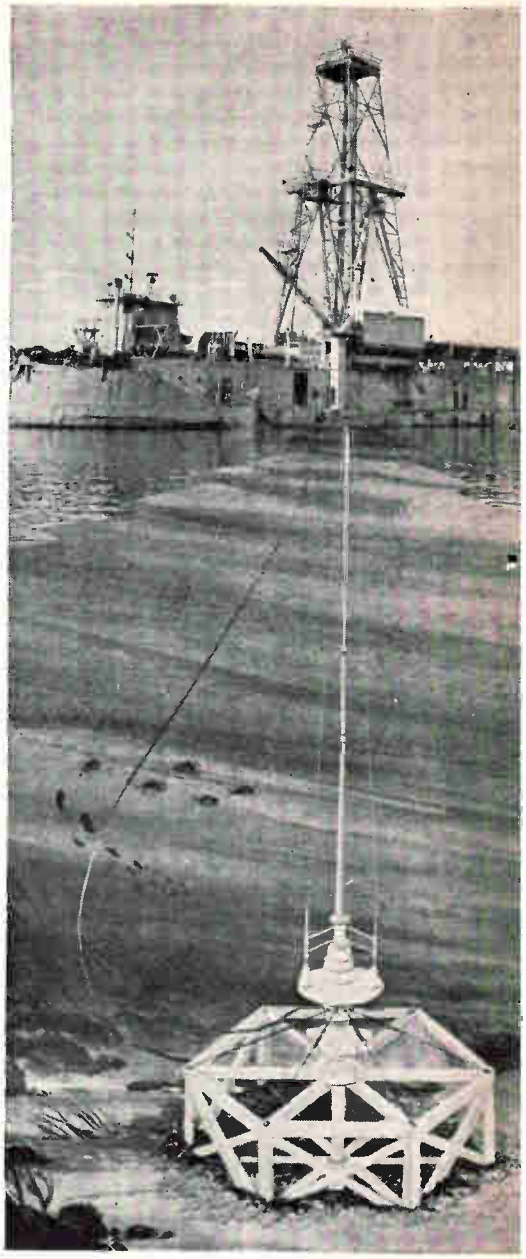
Backup radar system will use an additional four buoys, floating on the surface of the water and supporting radar reflectors. A second ppi screen in the wheelhouse will indicate the position of the barge in relation to these reflectors. GME officials feel that the sonar-equipped hours will be less affected by wave motion, tides and ocean currents than the radar buoys, and believe that accurate positioning of the barge will result from a combination of both systems.

Robert Taggart & Associates, of Falls Church, Va. is developing the electronic console containing servomechanisms connected to 400-cycle reversing motors on the outboards. Feedback amplifiers ensure correct speed of outboards to within 1 rpm.

GME officials report that, if present evaluation progresses as expected, positioning of *Cuss I* for subsequent holes will be completely automatic, with a closed-loop feedback system eliminating all manual control.

Responsibility for development of accelerometer systems measuring the barge's response to ocean waves and longitudinal vibration in the drill string itself has been given to the Naval Civil Engineering Laboratory at Pt. Hueneme, Calif.

By continuous coring of one of the Phase I holes, studies will be made on conductivity, formation and heat balance of material encountered. The second hole will be electronically logged with conventional oil-field equipment for measurement of resistivity, spontaneous potential and detection of gamma rays. It is anticipated that the actual Mohole will be instrumented with much more sophisticated electronics, the exact nature of which has not been determined.



Drilling rig for Mohole project

The reason for going to the trouble of drilling from a floating platform on the ocean rather than using dry-land techniques is explained by geologists and geophysicists as follows: The thickness of the earth's crust appears to be proportional to the mass of the land it supports. To reach the Moho from the surface of a continent, some 100,000 ft would have to be drilled. From an oceanic island, this distance would be reduced to about 50,000 ft. But to reach it from a deep ocean surface, only 32,000 ft must be negotiated, 14,000 ft of which is water.

Space Use Triggers Spectrum Squabble

Telephone company requests a piece of the spectrum above 890 Mc; many private-microwave users are against it

WASHINGTON—SHARP DISPUTE is developing over allocation of microwave bands for commercial space communications experiments, with Federal Communications Commission stuck in the middle. American Telephone & Telegraph is forcing the issue. The company wants FCC to approve its use of the 6,425 to 6,925-Mc band for the experimental communications satellite AT&T wants to loft next year to link the U. S., England, and Western Europe.

These frequencies fall into a block of the microwave spectrum that was allocated for private microwave by the Commission on Sept. 28. At that time, the Commission overruled opposition by communications common-carriers and threw open microwave frequencies in the bands above 890 Mc for use by private companies.

On Oct. 21, AT&T asked the Commission to set aside a large chunk of this spectrum for space communications. The action immediately touched off a round of protests from private organizations.

The National Association of Manufacturer's committee on manufacturers' radio use, and American Trucking Association, blasted out sharply at the move. They told FCC "it appears to us that the primary purpose of the AT&T petition is not to conduct experimentation . . . but to undermine the Commission's recent microwave decision . . . with the ultimate view of preempting the private microwave spectrum space and, in this manner, obtaining by indirection what the Commission refused to grant directly—namely, the use of all microwave space for common-carrier public correspondence."

They are joined in opposing the AT&T petition by American Petroleum Institute's central committee on communications facilities and the National Committee for Utilities Radio.

AT&T not only wants to use certain frequencies set aside by the FCC for private microwave, but also wants FCC to take a large chunk of the spectrum above 890 Mc and reallocate it for internal fixed public radio service.

The experimental communications satellite AT&T wants to launch within the next year is to provide space communications on a test basis between North America and Western Europe, with specific tests of telephone, data, and television transmission. The utility plans to transmit to the satellite on 6,775 to 6,875 Mc; the satellite will shift the incoming frequency by 350 Mc and transmit to earth on 6,425 to 6,525 Mc.

Each of the two 100-Mc bands will be divided into two parts to provide four frequency assignments of 50 Mc each. The plans call for England and Western Europe to transmit in the low half of the 6,775 to 6,875-Mc band; the U. S. terminal will transmit on the upper half. The satellite will beam to the U. K. and Western Europe on the upper portion of the 6,425 to 6,525-Mc band, and to the U. S. on the lower portion.

Eventually, AT&T proposes to use four 100-Mc bands which, with the necessary guard bands, will extend from 6,425 Mc to 6,925 Mc. This would provide two-way tv operations or 600 telephone circuits.

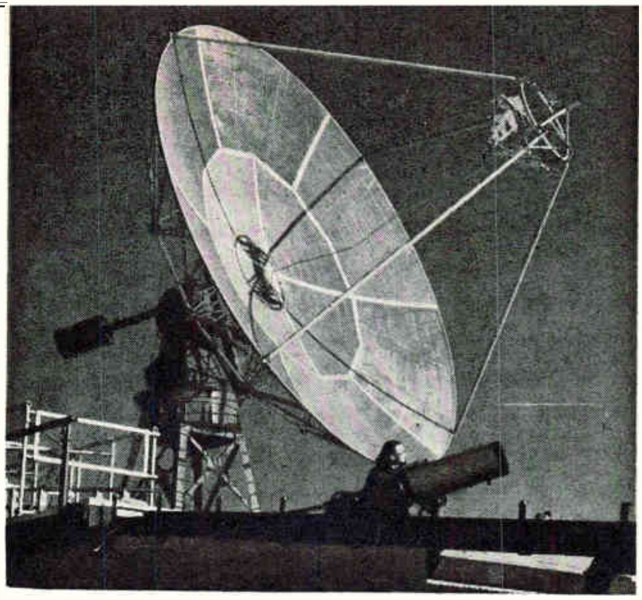
AT&T's statement says "We believe the requirements for overseas services by the year 1980 justify provision of a minimum of four blocks of frequencies each 500 Mc wide, or alternatively 16 bands of about 125 Mc. It is anticipated that the assignment of additional frequencies will be requested in later petitions."

AT&T says it selected frequencies around 6,500 Mc because such frequencies permit use of presently available traveling-wave tubes in the satellite. The full bandwidth from 6,425 Mc to 6,925 Mc is considered to be "the one within the operating range of existing devices and technology that will permit the most active coordination of operations with the aim of avoiding interference."

API and other opponents of AT&T's petition challenge this position. API wants to know why AT&T cannot conduct its satellite experiments in portions of the spectrum now allocated for common carriers. "In view of the obvious adequacy of existing microwave spectrum already available to common carrier services," the Institute claims, "the central committee is at a complete loss to understand why AT&T insists on utilizing on a shared basis the operational fixed microwave frequencies. The central committee is aware of no evidence of common carrier congestion in the 6,000-megacycle portion of the spectrum."

API also told the Commission it "does not understand why the same traveling-wave tubes cannot be used in the frequency bands currently allocated for common-carrier use in the 6,000-Mc bands. Certainly, traveling-wave tubes are available on a commercial basis for use in this portion of the frequency spectrum as well as the portion requested by AT&T in its petition."

As the matter now stands, the FCC is expected to decide within the next few weeks what course of action it will take on the petitions. It can approve the AT&T petition outright, or with modifications; deny the petition; or throw the issue up for public hearings. Best guess is that the Commission will not go into hearings. This would run into months of delay in getting into commercial space communications experimentation, and would probably draw the ire of Congress and the National Aeronautics & Space Administration. A modified approval seems the likely outcome.



Tunable Paramp Permits New Space Studies

Space communications antenna with log periodic feed (left) and telescope of electrooptical system (right) at GE

SCHENECTADY, N. Y.—A recently installed tunable parametric amplifier is making it easier for engineers of GE's General Engineering Laboratory to track satellites now in orbit and to study moon-bounce communications at the combined radio optical observatory here. The optical system uses television, helps keep the radio antenna system on target especially when the target is passing directly overhead.

Tracking satellites and deep-space probes has occupied an important portion of the facility's time, but there is a big emphasis today on radio communication studies that will pay off quickly.

For example, GE is working with the Air Force Cambridge Research Center to determine the practicality of moon-bounce communications.

The Air Force is illuminating the moon with wideband signals. Now it looks like reflected signals lack the coherency of phase and amplitude in the sidebands for digital data transmission, although voice communication may indeed be feasible despite distortion.

Changing frequencies is one of the troublesome aspect of space communication work, said Roy E. Anderson, head of the space communications group. To eliminate the time-consuming problem of changing the antenna feed, a log periodic feed usable without adjustment over a frequency range of 108 to 1,200 Inc was designed by George Swenson of the University of Illinois. The linearly polarized feed has a motorized mounting that turns it on the antenna axis for changing polarization of return signals.

A tunable parametric amplifier also reduces the frequency changing problem. Designed and developed within the last year, this low-noise device yields a system noise figure of 2 db or better over a frequency range of 375 to 2,000 Mc. The amplifier is of the negative resistance type in which the output is taken at the signal frequency. A fixed-frequency pump signal is set at 10 Gc. Because of its wide frequency range, the amplifier is normally required to operate without circulators.

However, it can easily be adapted for use in limited frequency bands. As with any frequency nonconverting amplifier, three resonant circuits are required: signal, pump frequency and idler, or difference, frequency circuits. All of these circuits are tightly coupled to a varactor diode.

Frequency selective filters independently tune each circuit. The filters are arranged around the diode so as to avoid spurious resonances and interaction between tuning controls. A waveguide H-plane cross houses the pump and idler circuits. There are four waveguide filters, one in each arm of the cross. The diode is at the center of the cross.

Mounted directly on the cross assembly is a resonant coaxial cavity forming the tunable signal circuit, which is a modified ¼ or ¾-wavelength shorted line capacitively loaded by the diodes.

The circuit includes a coaxial low-pass filter to keep out X-band frequencies.

Operation of the amplifier over wide frequencies has been in close agreement with theory. Reception of signals from space vehicles such as Pioneer IV at 960 Mc and Pioneer V at 375 Mc have shown that an amplifier of this type can be used for successful continuous reception of signals providing that care is taken with power supply, voltage stability and temperature control.

Optical methods, it is said, can perform navigation of manned space flight more advantageously than radar because of the real-time problem—reflected radar waves may take untold years to return from a space fix, while light waves are already available.

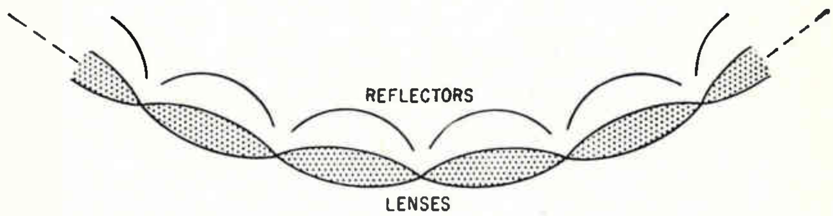
The optical system using the Z5294 GE's image orthicon camera to collect and amplify light locates stars to within ½ second of arc. (One second of arc would be represented by the diameters of two dimes subtending an arc at a radial distance of one mile.) Sensitivity of the system was demonstrated by snapshots taken during the Shotput Tests. Here the National and Aeronautic Space Administration fired 100-foot metallized plastic baloons into ballistic trajectories from Wallops Island, Virginia.

Despite thin cloud cover, the photos taken from the system's picture screen clearly revealed the balloons. Such real-time photos make possible accurate determination of trajectories. The television-equipped optical system is said to be at least a thousand times more sensitive than fast photographic film.

Light-wave communication using losers and other advanced studies are being made at the station.

CIRCLE 37 ON READER SERVICE CARD→

Passive Satellite Relay Stations



Proposed directional spherical reflector, called a "more sophisticated Echo satellite," gives high directivity, great versatility in reflection patterns

BOSTON—Air Force R&D efforts on global communications are concentrating on passive satellite relay stations, it was evident here at the 7th annual science and engineering symposium of ARDC.

Said an AF researcher: "The reliability problem being what it is today, and with the high parts-count in repeater-type satellites, it makes a lot of sense to put up passive satellites. Once they're in orbit, little can happen to them."

Early next year, first tests are expected to be made of the orbiting belts of the tuned dipoles suggested by W. E. Morrow Jr. of Lincoln Laboratory (ELECTRONICS, p 43, Sept. 30). Transceivers linked to 120-ft dishes at Tyngsboro, Mass., and Camp Parks, Calif., will be used.

Plane reflectors, commonly known as flat plates, are being studied at AF Cambridge Research Laboratories as a type of passive satellite for communications.

And under investigation at Wright Air Development Division is a more sophisticated Echo satellite, a directional spherical reflector using lenses combined with reflecting surfaces for high directivity and great versatility in reflection patterns.

Development of these directive nonoriented reflectors was proposed at the ARDC symposium by Y. E. Stahler and Lt. L. A. Johnson of WADD.

They said that, while global belts consisting of thousands of orbiting dipoles would facilitate tracking, they would also scatter the energy in all directions and might interfere with radioastronomy. Plane reflectors, they pointed out, have high directivity but they must be oriented in position and attitude with respect to ground sites by some electronic and mechanical means.

They characterized as most desirable an orbiting reflector with high directivity but independent of position and attitude, a modified spherical reflector.

By optical reflection and backscattering tests, they found that the lens-reflector arrangement on the spherical surface is more advantageous than application of corner reflectors, conically shaped reflecting elements, or a sphere of dipoles over the reflecting surface.

Solution, they point out, combines high directivity of a plane reflector with the nonorientation requirement and beam-spreading feature of a sphere, thus achieving a reflector that may rotate or tumble along its orbit, but still would send much of the incident energy back to the earth.

To exploit the lens-reflector idea, the surface of the sphere would consist of many reflecting elements as sketched. A considerable amount of the surface would act as a flat plate reflecting the entire impinging energy to the transmitting source.

Meanwhile, AF researchers continue to investigate transoceanic radio ducts and their usefulness for communications. Russell W. Corkum of Cambridge Research Laboratories reported to the ARDC

Stressed

symposium on Project Tradewinds, which proved that this anomalous propagation mode does exist.

In certain areas of the world and under certain meteorological conditions, these elevated atmospheric layers trap radio energy and propagate it abnormally large distances. Ultrahigh-frequency radio energy has been trapped and transmitted over distances greater than 1,400 miles. The signals can be transmitted at low-loss in the duct, and fading characteristics indicate a wide-band capability.

The phenomenon explains a World War II mystery involving abnormally long radar ranges in the Arabian Sea area. A 200-mc radar with a normal range of 20 miles located ships at ranges of 700 miles in the Arabian Sea, and was able to see the coast of Arabia 1,700 miles away.

The Arabian Sea duct occurred during the monsoon season when relatively hot dry air moved down from the Asian continent overlying cooler moist air above the Arabian Sea, producing a temperature inversion and creating a strong elevated duct.

Experiments have proved the existence of a persistent duct between Recife, Brazil and Ascension Island, as predicted. Meteorological studies predict that the duct extends all the way from Brazil to West Africa. The same studies predict a similar duct system in the northerly trade winds belt between Puerto Rico and Dakar.

Corkum's group at AFCRL will investigate these predicted ducts and also determine if any coupling exists between the two Atlantic duct systems.

Air-to-Air propagation was employed in the preliminary experiments. Ground-to-air experiments will come next. And a separate program in the ideal mode, ground-to-ground through duct, will be conducted between Ascension and Brazil.

MEETINGS AHEAD

Dec. 27: Lunar Flight Symposium, Annual, American Astronautical Society; Biltmore Hotel, New York City.

Jan. 8-12: Thermoelectric Energy Conversion, Dept. of Defense, Joint Technical Society; Statler-Hilton Hotel, Dallas.

Jan. 9-10: Plasma Dynamics; Southern Methodist Univ., Dept. of Mech. Engineering, Dallas.

Jan. 9-11: Reliability & Quality Control, ASQC, AIEE, EIA, PGRQC of IRE; Bellevue-Stratford Hotel, Phila.

Jan. 12-13: Reliability of Semiconductor Devices, Working Group on Electron Tubes; Western Union Auditorium, New York City.

Jan. 17-19: Instrument Automation Conf. & Exhibit, ISA; Sheraton-Jefferson Hotel, Kiel Auditorium, St. Louis, Mo.

Jan. 31-Feb. 2: Cleveland Electronics Conference; Engineering & Scientific Center, Cleveland.

Feb. 1-3: Military Electronics, PGMIL of IRE; Biltmore Hotel, Los Angeles.

Feb. 1-4: Electronic Representatives Assoc., Annual Convention; Ambassador Hotel, Los Angeles.

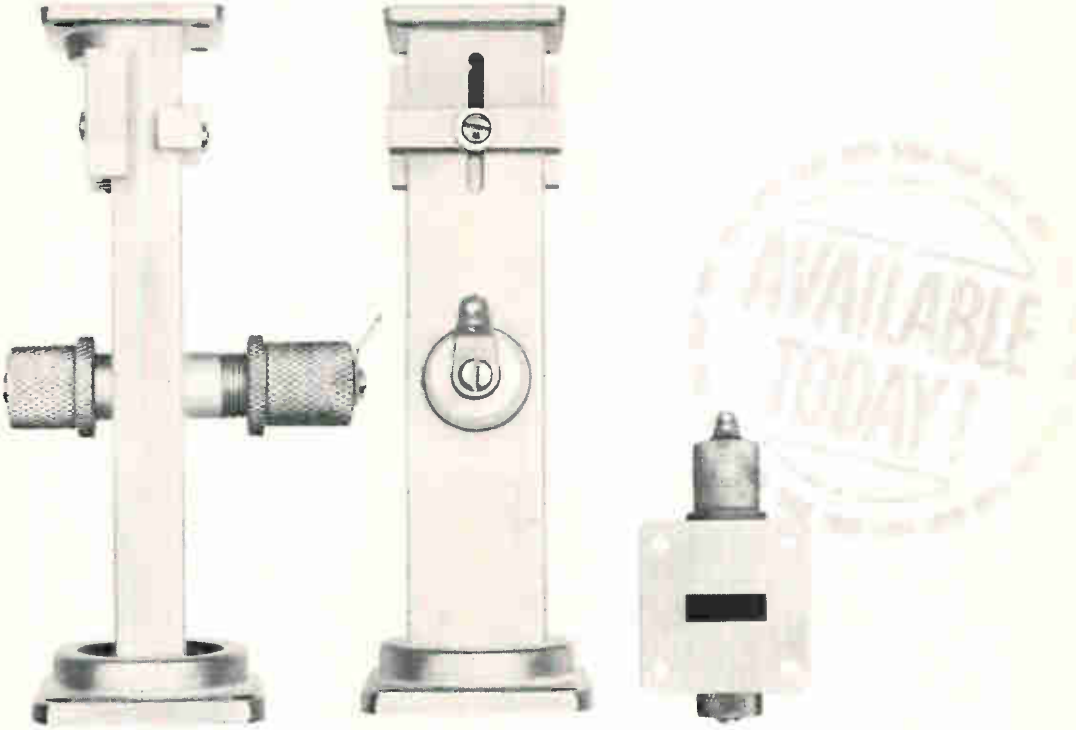
Feb. 7-9: Electrical Manufacturers Assoc.; Veteran's Memorial, Columbus, O.

Feb. 14-16: Nondestructive Testing of Aircraft & Missile Components, Southwest Research Institute, South Texas Section of the Society for Nondestructive Testing Inc.; Gunter Hotel, San Antonio, Tex.

Feb. 15-17: Solid State Circuit Conf. International, PGCT of IRE, AIEE; Univ. of Penn. & Sheraton Hotel, Philadelphia.

Mar. 9-10: Engineering Aspects of Magnetohydrodynamics, PGNS of IRE, AIEE, IAS; University of Penn., Philadelphia.

Mar. 20-23: Institute of Radio Engineers, International Convention, All PG's; Coliseum & Waldorf-Astoria Hotel, New York City.



X-Band parametric amplifiers

Pioneers in parametric amplification, Hughes offers "systems proven models" for frequency ranges at L-Band, S-Band, C-Band...and now, X-Band systems. ■ Hughes parametric amplifiers are now in operation at Patrick Air Force Base; Marine Corps Station, San Diego, California; Naval Research Laboratory, Washington, D.C.; Eglin Air Force Base, Florida; Rome Air Development Center; North Bay, Canada; and elsewhere outside the Continental United States. ■ Whatever your parametric amplifier needs, Hughes is most qualified to serve you.

For information or to order the Hughes Model 1019-A parametric amplifier, write, teletype or call collect: Marketing Operations, Hughes Components Division, Building 20, Room 1372, Culver City, Calif. TWX—HAC SMON 7396-U; Phone—UPton 0-7111, Ext. 4190.

HUGHES

HUGHES AIRCRAFT COMPANY
COMPONENTS DIVISION

Hughes offers you X-Band parametric amplifiers with these advantages:

- **More decibels reduction in noise figure per dollar**
- **Light weight (less than five pounds)**
- **Low pump power—50 milliwatts**
- **Uses inexpensive air cooled klystron**
- **Utilizes commercially available varactor diodes**

Specifications for X-Band Model 1019-A Parametric Amplifier.

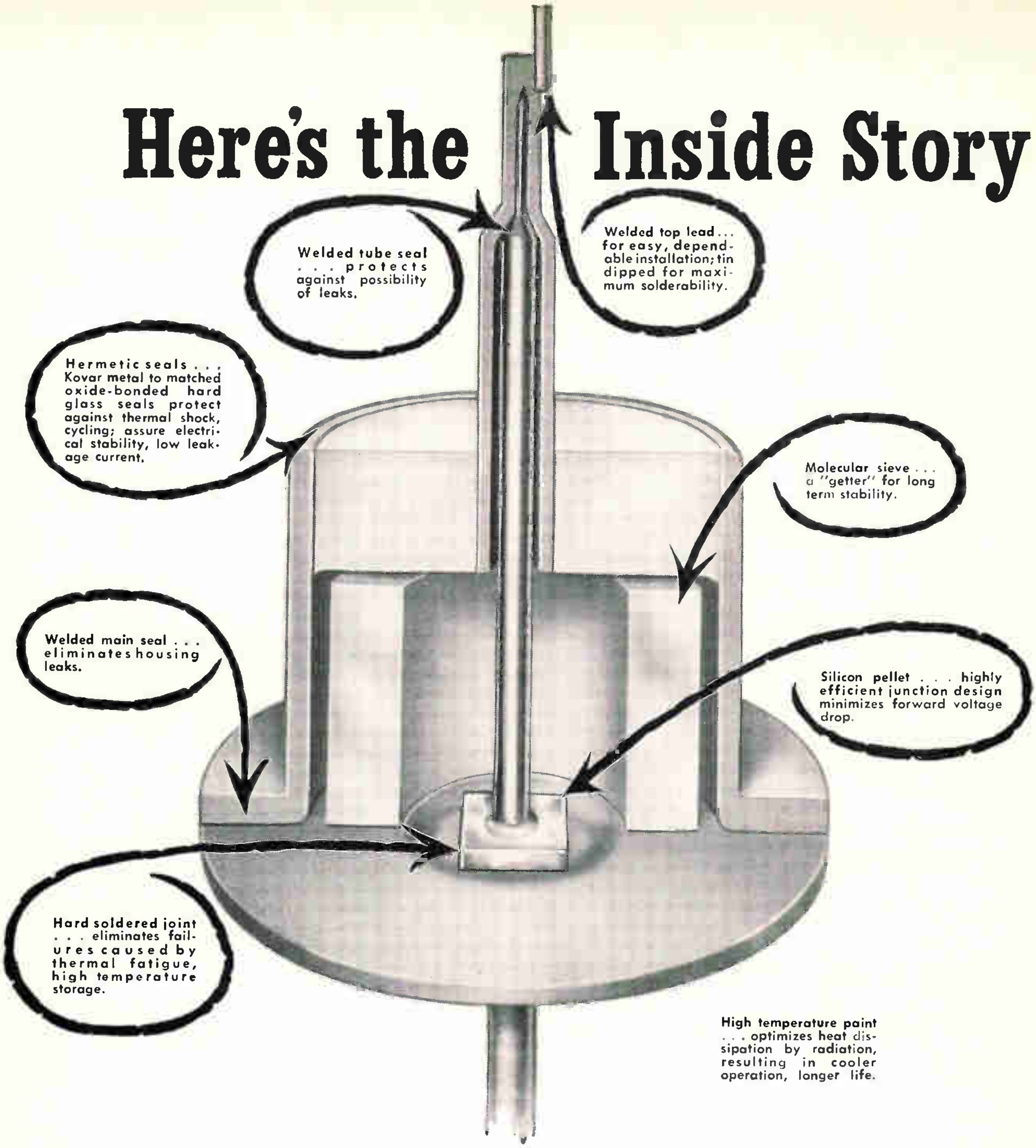
Frequency Range	8600 to 9300 mc (tunable)
Bandwidth	30 mc
Gain (minimum)	17 db
Single Channel Radar Noise Figure	5.0 db including circulator
Pump Frequency	17,400 to 18,400 mc
Pump Power	25 to 50 milliwatts
Type of Operation	Quasi—degenerate
Weight	Less than 5 pounds
Size	190 cubic inches
*Unit Price	$6,998.00 each (less in quantity)
Delivery	90 days after receipt of order

*Price quoted above includes basic amplifier body, varactor diode, circulator, and klystron.

Specifications, price and delivery subject to change without notice.

CIRCLE 46 ON READER SERVICE CARD

Here's the Inside Story



99% SURVIVAL AT 10,000 HOURS! General Electric low current silicon rectifier type 1N538 has gone through torturous life test studies over a period of 10,000 hours at maximum temperature, current, and PRV with a truly amazing survival percentage. But this performance is typical of all General Electric low current silicon rectifiers because reliability is built into every device in the line. Every unit is painted to provide cool operation even at high temperatures. Hard soldered joints and the Kovar metal-to-glass hermetic seals are but two further examples of careful step by step controls that have earned G-E rectifiers an unequalled reputation for reliability. An average of 16 separate life, electrical, mechanical and environmental tests on every manufacturing lot prove out the quality that has been built in. It's no accident that General Electric low current silicon rectifiers *better* all known existing MIL specs.

Survival Data from Operating and Elevated Storage Tests

Type of Unit	PRV	Current (ma)	Operating Temp. (ambient)	Type of Test	No. of Units	*Percent Survival
1N538 Silicon	200V	250	150°C	Operating at full load and at elevated storage temperature of 175°C ambient	83	99 @ 10,000 hrs.

*Percent survival = No. of good units x 100 / total no. tested

# of General Electric's

Low Current Silicon Rectifiers

WITH THESE ADDED FEATURES

Transient PRV ratings provide safer applications. You get the continuous rating you need with protection against occasional transients up to 1200 PRV . . . at no extra cost.

Maximum forward conductance at high operating temperatures. High current loads are carried without external heat sinks.

Very low leakage makes these devices exceptionally well suited for magnetic amplifier applications.

Minimum forward voltage drop combined with outstanding efficiency of hermetic seal provides unsurpassed reliability.

Conservative ratings — In a recent study G-E devices had the highest resistance to thermal runaway at maximum full load operating temperatures of the products tested.

G-E stud mounted low current silicon rectifiers and the new subminiature silicon glass rectifiers feature the same built-in reliability and performance. Take advantage of the research, advanced development and product design that makes survival rates of 100% a common occurrence, call your G-E Semiconductor Sales Representative today. For additional technical data write Section **S25120A,** Rectifier Components Dept., General Electric Company, Electronics Park, Syracuse, N. Y. In Canada: Canadian General Electric Company, 189 Dufferin St., Toronto, Ontario. Export: International General Electric Company, 150 E. 42nd Street, New York, New York.

Low Current Silicon Rectifier Cells (Lead Mounted)

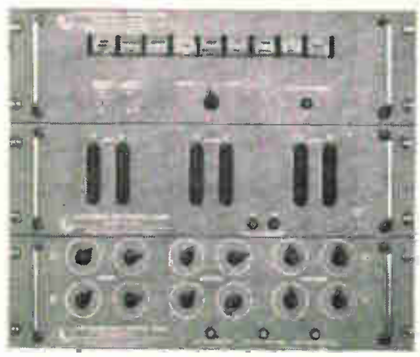
JEDEC & GE Type Number	PRV	Max. I_{DC} @ T°C Amb.	Max. Rev. Cur. (Full Cycle Av.)	Max. Full Load Voltage Drop (Full Cycle Av.)	Max. Oper. °C
		@ 50°C	@ 25°C	@ 25°C	
1N440	100	300 ma	.3 μa	.65V	150°
1N441	200	300 ma	.75 μa	.65V	150°
1N442	300	300 ma	1.0 μa	.65V	150°
1N443	400	300 ma	1.5 μa	.65V	150°
1N444	500	300 ma	1.75 μa	.65V	150°
1N445	600	300 ma	2.0 μa	.65V	150°
		@ 25°C		@ 200 ma	
1N599	50	600 ma	1.0 μa	.65V	150°
1N599A	50	600 ma	1.0 μa	.65V	150°
1N600	100	600 ma	1.0 μa	.65V	150°
1N600A	100	600 ma	1.0 μa	.65V	150°
1N601	150	600 ma	1.0 μa	.65V	150°
1N601A	150	600 ma	1.0 μa	.65V	150°
1N602	200	600 ma	1.0 μa	.65V	150°
1N602A	200	600 ma	1.0 μa	.65V	150°
1N603	300	600 ma	1.0 μa	.65V	150°
1N603A	300	600 ma	1.0 μa	.65V	150°
1N604	400	600 ma	1.5 μa	.65V	150°
1N604A	400	600 ma	1.5 μa	.65V	150°
1N605	500	600 ma	2.0 μa	.65V	150°
1N605A	500	600 ma	2.0 μa	.65V	150°
1N606	600	600 ma	2.5 μa	.65V	150°
1N606A	600	600 ma	2.5 ma	.65V	150°
		@ 30°C	@ 150°C	@ 150°C	
1N560	800	600 ma	.3 ma	0.5V	150°
1N561	1000	600 ma	.3 ma	0.5V	150°
		@ 50°C	@ 100°C	@ 100°C	
1N1692	100	600 ma	.5 ma	0.6V	115°
1N1693	200	600 ma	.5 ma	0.6V	115°
1N1694	300	600 ma	.5 ma	0.6V	115°
1N1695	400	600 ma	.5 ma	0.6V	115°
1N1696	500	600 ma	.5 ma	0.6V	115°
1N1697	600	600 ma	.5 ma	0.6V	115°
			@ 25°C	@ 25°C	
1N444B	500	650 ma	1.75 ma	.65V	150°
1N445B	600	650 ma	2.0 ma	.65V	150°
1N440B	100	750 ma	0.3 ma	.65V	165°
1N441B	200	750 ma	0.75 ma	.65V	165°
1N442B	300	750 ma	1.0 ma	.65V	165°
1N443B	400	750 ma	1.5 ma	.65V	165°
			@ 150°C		
1N1100	100	750 ma	.3 ma	.65V	165°
1N1101	200	750 ma	.3 ma	.65V	165°
1N1102	300	750 ma	.3 ma	.65V	165°
1N1103	400	750 ma	.3 ma	.65V	165°
		@ 25°C	@ 125°C	@ 125°C	
1N1487	100	750 ma	.4 ma	.55V	140°
1N1488	200	750 ma	.3 ma	.55V	140°
1N1489	300	750 ma	.3 ma	.55V	140°
1N1490	400	750 ma	.3 ma	.55V	140°
1N1491	500	750 ma	.3 ma	.55V	125°
1N1492	600	750 ma	.3 ma	.55V	120°
		@ 50°C	@ 150°C	@ 150°C	
1N536	50	750 ma	.4 ma	.5V	165°
1N537	100	750 ma	.4 ma	.5V	165°
1N538	200	750 ma	.3 ma	.5V	165°
(Meets MIL-E-1/1089 (USAF); MIL-E-1/1084A (JAN))					
1N539	300	750 ma	.3 ma	.5V	165°
1N540	400	750 ma	.3 ma	.5V	165°
(Meets MIL-E-1/1089 (USAF); MIL-E-1/1085A (JAN))					
1N1095	500	750 ma	.3 ma	.5V	150°
1N1096	600	750 ma	.3 ma	.5V	150°
1N547	600	750 ma	.3 ma	.5V	165°
(Meets MIL-E-1/1089 (USAF); MIL-E-1/1083A (JAN))					

FOR FACTORY-LOW PRICES IN QUANTITIES UP TO 999, SEE YOUR LOCAL G-E DISTRIBUTOR

Progress Is Our Most Important Product

GENERAL ELECTRIC

HANDS OFF



NO MANUAL SWITCHING FOR SPEED CHANGES WITH EECO'S NEW TIME-CODED MAGNETIC TAPE SEARCH AND CONTROL SYSTEM

Responsible for flight test instrumentation? Quick-look data readout? Check out this addition to the distinguished EECo line of timing system equipment. You'll find no other gives you all of the ZA-821's important benefits:

NO MANUAL SWITCHING or plug-changing is needed to compensate for speed changes.

DATA REFERENCED BY TIME CODE, so correct locating never depends on tape speed. Locates data interval between two time addresses.

CONTINUOUS DECIMAL DISPLAY OF TIME CODE, so user always knows exactly where he is on the tape.

SPEED WITH FLEXIBILITY. With typical tape transport, ZA-821 searches 1200 feet of tape in 90 seconds. Permits search-to-recording speed ratios up to 64 to 1.

FULLY AUTOMATIC. Choice of automatic or manual search. Permits automatic recycling of located data.

COMPACT. All solid-state. Entire ZA-821 unit including power supplies mounts in only 15¾" of rack space.

COMPATIBLE. Can be used with most continuous-motion tape transports including Ampex FR 100, FR 100A, FR 100B, FR600; Honeywell M-3170, M-3171, M-3172; CEC 5-752; Mincom C-100. Uses 24-bit BCD Time code supplied by EECo ZA-801 Time Code Generator. Can be modified for use with any time code.

ECONOMICAL. High utility. Beats in-house fabrication. Plug-in circuits keep maintenance cost down. Only $10,200.

For data sheet ZA-821 write:

Electronic Engineering Company *of California*

1601 East Chestnut Ave., Santa Ana, Calif. Phone Kimberly 7-5501. TWX: S ANA 5263

MISSILE & AIRCRAFT RANGE INSTRUMENTATION • DIGITAL DATA PROCESSING SYSTEMS

EE 0-10 COMPUTER LANGUAGE TRANSLATORS • SPECIAL ELECTRONIC EQUIPMENT

CIRCLE 47 ON READER SERVICE CARD

FOREMOST in UNDERWATER DETECTION SYSTEMS

EDO CORPORATION

College Point, L.I., N.Y.

Since 1925

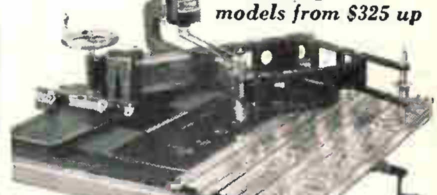
CIRCLE 207 ON READER SERVICE CARD

any size panels

engraved in your own plant

- **Engrave 1-inch nameplates or 6-foot panels by unskilled labor.**
- **Spindle covers 18¼" x 6" in one set-up — more than any other machine of its kind.**
- **Bench type model I-R — $685.**

Send for complete catalog ZR-4, illustrating other models from $325 up



new hermes

ENGRAVING MACHINE CORP.

154 WEST 14TH STREET NEW YORK 11, N. Y.

IN CANADA: 359 St. James Street West, Montreal, P. Q.

CIRCLE 209 ON READER SERVICE CARD

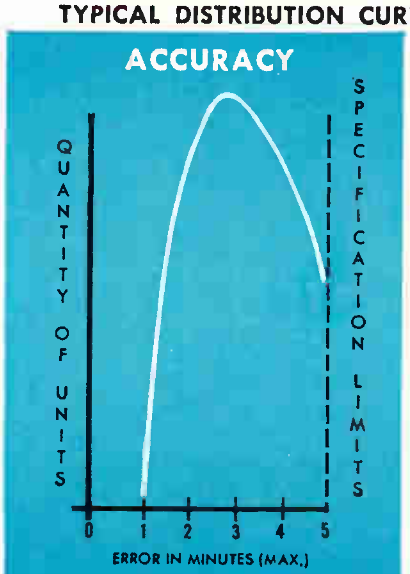
CLIFTON PRECISION OFFERS
SIZE 8 SYNCHROS
OF GUARANTEED
5′ (MAX. ERROR) ACCURACY

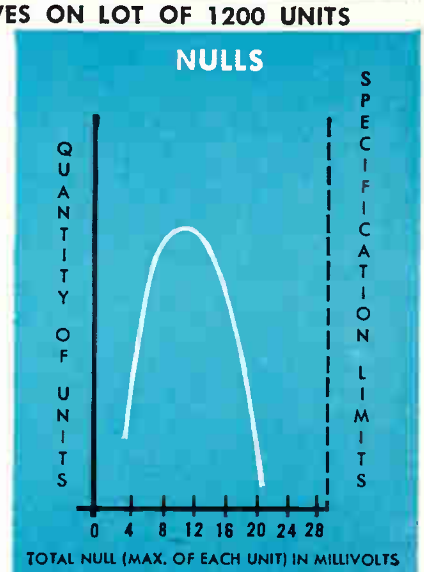
Extreme uniformity and thermal stability are maintained in these premium synchros in all electrical characteristics—and especially accuracy.

They are high temperature resistant units and retain their stable characteristics over a temperature range of —55°C to +125°C. Exposure to +150°C is feasible for short periods of time.

These are production line units—not selected. Delivery is in 45 days; prototype quantities immediately.

TYPICAL DISTRIBUTION CURVES ON LOT OF 1200 UNITS





ELECTRICAL CHARACTERISTICS

		ROTOR AS PRIMARY						STATOR AS PRIMARY						D.C. RESISTANCE		IMPEDANCE				ACCURACY
SYNCHRO FUNCTION	CPPC TYPE	Input Voltage (400~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	Input Voltage (400~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	Rotor (Ohms)	Stator (Ohms)	Zro (Ohms)	Zso (Ohms)	Zrss (Ohms)	Max. Null Voltage (MV)	Max. Error (Min.)
Torque Transmitter	HGC-8-A-010	26	.120	.66	11.8	206	10.0	—	—	—	—	—	—	37	12	46+j210	11+j36.5	81.5+j24	30	5
Control Transformer	HTC-8-A-010	—	—	—	—	—	—	11.8	.039	.092	22.5	393	10.5	365	64	400+j1420	60+j254	590+j176	30	5

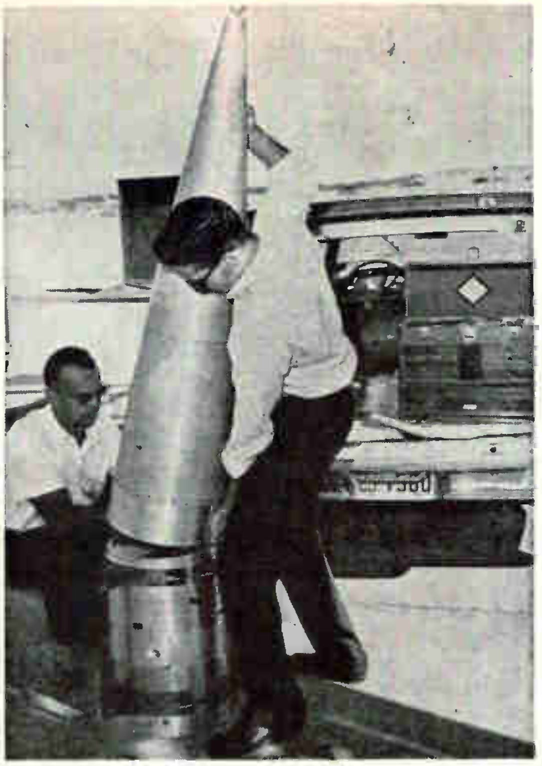
For additional information, call or write our Sales Department, 5050 State Road, Drexel Hill, Pennsylvania, MAdison 2-1000, TWX LNSDWN, PA. 1122(U)—or our Representatives.

CLIFTON PRECISION PRODUCTS CO., INC.

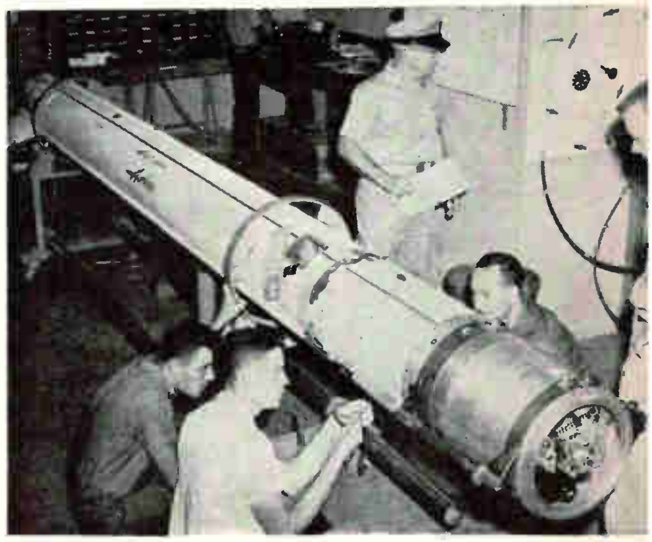
Clifton Heights, Pennsylvania

ENGINEERS—Join a pioneer in the rotary components field. Write David D. Brown, Director of Personnel.

electronics
December 23, 1960



Assembling nose cone section prior to mating to rocket body



Main rocket body is checked out before assembly

Orientation of Solar Instruments in Space

By CHARLES H. REYNOLDS,
Chief, Research Probe Instrumentation Branch, Geophysics Research Directorate, AFCRL

MERLE REISBECK,
Chief, Rocket Systems Division, Ball Brothers Research Corp., Boulder, Colorado

R. E. HATHAWAY,
Project Director, Rocket Systems Division, Ball Brothers Research Corp., Boulder, Colorado

Nose cone being raised up tower for mating with main rocket body

ROCKETS used for research soundings must be simple and inexpensive. In most cases they are fin-stabilized and do not have control or guidance systems to correct pitch, yaw and roll. In solar study, it is important to retain a fixed orientation of the solar measuring instrument with respect to the sun. Due to the large mass of the rocket vehicle, its orientation would require a great deal of complex and heavy equipment. A simpler solution is to make corrections only to the scientific payload housing the solar measuring instrument as shown in Fig. 1.

The solar pointing control to be described will keep a rocket-borne solar instrument payload oriented towards the sun regardless of the attitude of the rocket. This system has been used in studies of the ultraviolet, infrared and x-ray spectrum of the sun using rockets.

A spectrograph, aimed by a pre-

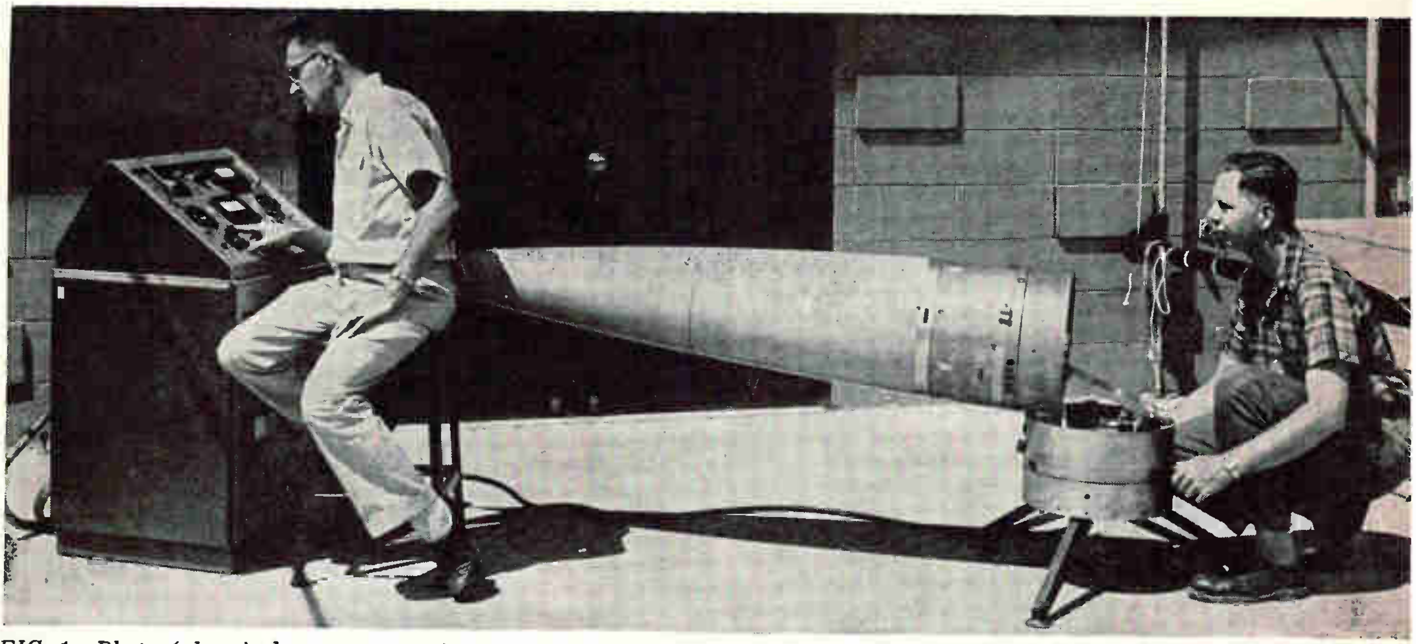


FIG. 1—Photo (above) shows an operation system check in progress. Sketch at right shows basic physical operation of

vious model of the pointing control (ELECTRONICS, Jan. 1954), made the first known observation of the Lyman-alpha hydrogen line at a wavelength of 1,216 angstroms.

In early designs, the spectrograph was housed in an arm that was programmed to extend from the rocket nose cone after the vehicle had reached the thin atmosphere about 50 to 60 miles above the surface of the earth. The arm was positioned into and out of the nose cone to make elevation corrections and the nose cone was rotated about its longitiudinal axis to make azimuth corrections. Several disadvantages and limitations became apparent with this system. The solar instrument was limited by the size and shape of the extended arm. The arm was exposed by removing doors from the nose cone by explosive bolts. The doors were not replaced, leaving large gaping slots in the nose cone when reentering the atmosphere.

The present design houses the optics and solar instruments in the forward 65 inches of nose cone. After reaching rarified atmosphere, this portion of the nose cone is bent at an angle of ninety degrees to the rocket main body and locked. Azimuth corrections are made by rotating about the missile axis. Elevation corrections are made by rotating the upper cone portion (now bent 90 degrees from the main body) about its longitudinal axis. One disadvantage of this system is that the optical axis is now the diameter (about 15 inches) of the nose cone.

This disadvantage is not important if folded optics can be tolerated. Before reentry, the upper portion of the nose cone is returned to its normal position. This facilitates reentry since the nose cone now presents a smooth, clean configuration.

A block diagram of the pointing control and timer sequence is shown in Fig. 2. Since the sole purpose of the instrument is to maintain orientation with respect to the sun, the major components are the azimuth and elevation drive mechanisms and their servo systems.

The azimuth system must track the target (sun) at rocket spin rates between 120 and 180 rpm and overcome the forcing functions exerted by the rocket to keep the instrument pointed to the sun with an accuracy of within a few minutes of arc.

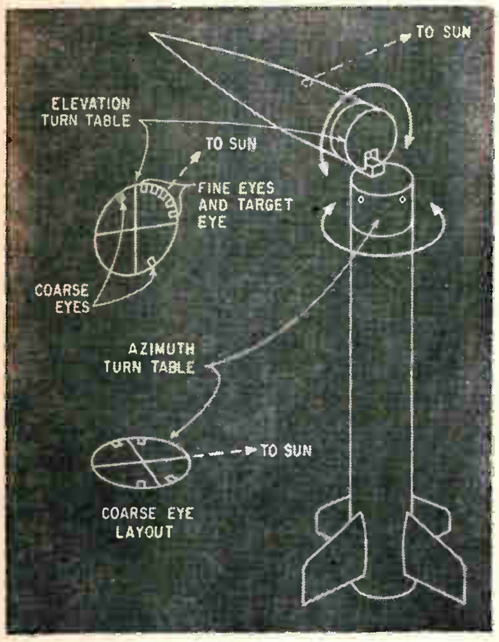
The azimuth servo system is composed of two separate input systems: the eye system (an array of photodetectors) and the rate gyro. The output of either system may be applied to the servo amplifier by the programming relay. The amplifier provides a signal to operate the magnetic clutch. The magnetic clutch is composed of two elements driven differentially by a continuously rotating motor with the outputs coupled to a common bull gear.

The amplifier drives one or the other elements of the magnetic clutch. Activation of one element causes a torque to be imparted to the output shaft in one direction, while activation of the other element provides a torque in the opposite direction.

The eye system shown in Fig. 3 consists of two pairs of coarse eyes and a pair of fine eyes that provide electrical signals proportional to the error angle. The coarse eyes have a wide angle of view and provide signals to acquire the target initially. The fine eyes have high static gain to satisfy the final pointing requirement.

The coarse eyes have two functions: one is to stop the rotation of the turntable, the other is to point the solar axis of the pointing control to within the cone of vision of the fine eyes. This is accomplished by several programmed steps and is performed by switching integrator capacitor C_2 (Fig. 3).

While the pointing control is catching the sun, the integrator hinders the operation due to charging effects and C_2 is therefore out of the coarse-eye circuit. After the pointing control has caught the sun,



rocket instrument nose cone

the fine eyes come into operation.

The response network is a simple lead-lag circuit, shown along with the eye circuit in Fig. 3. The lead elements are R_2C_1 and R_3C_3, which act to frequency-compensate the system for stability and good transient response. Lag circuits consisting of R_1C_2 and R_4C_2 provide high d-c and low-frequency gain to correct static errors and to follow the low-frequency forcing functions.

Initial acquisition of the target at high spin rates presented a difficult problem. Proper placement of the coarse eyes produces a characteristic that will enhance catching. An array of four coarse eyes is used as shown in Fig. 1. The use of a differentiator also helps in catching. The limiting spin rate is about 1.5 rps. To handle rocket spin rates up to 3 rps, a rate gyro is used. This gyro delivers a d-c signal proportional to the spin rate to the azimuth amplifier. The rate gyro is programmed into the azimuth system several seconds before pointing is needed. The rate gyro then reduces azimuth turntable spin to about 0.2 rps at which time the eye system is programmed in. Catching operation takes place before bending to take advantage of the smaller moment of inertia in the unbent configuration.

The elevation servo system re-

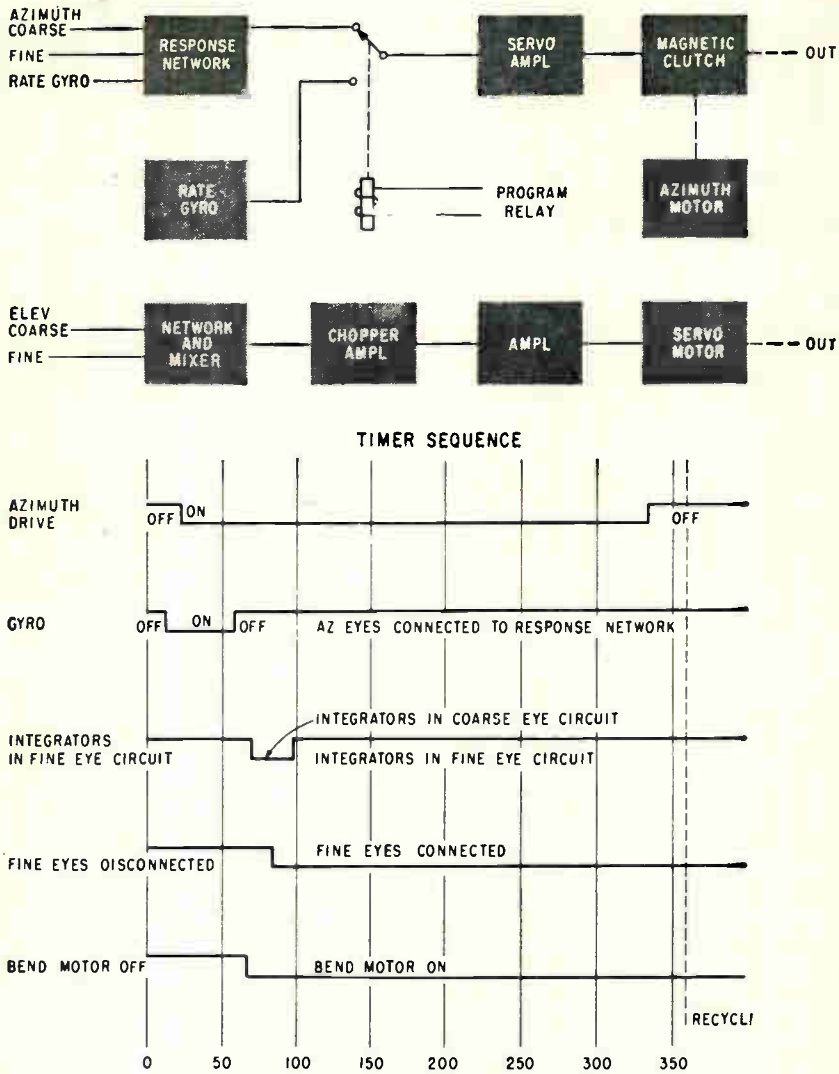


FIG. 2—Servo systems accept photodetector inputs to physically position nose cone. Timing operation is shown for one cycle

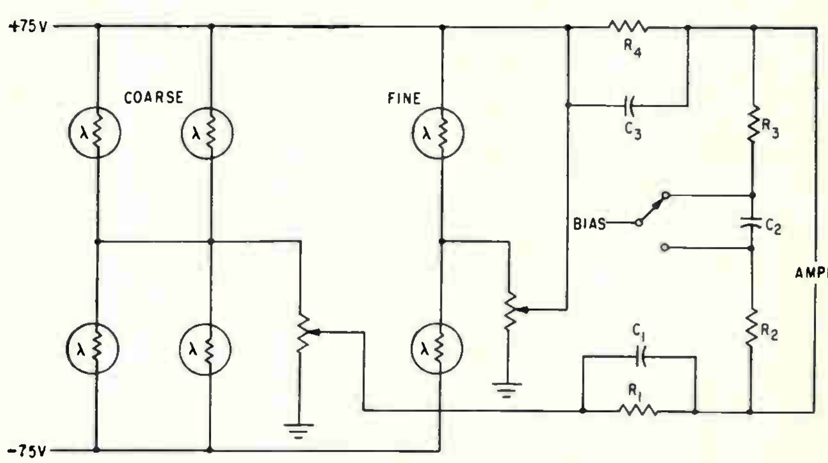


FIG. 3—Each eye system uses two pair of coarse and one pair of fine eyes to provide electrical signal proportional to error angle

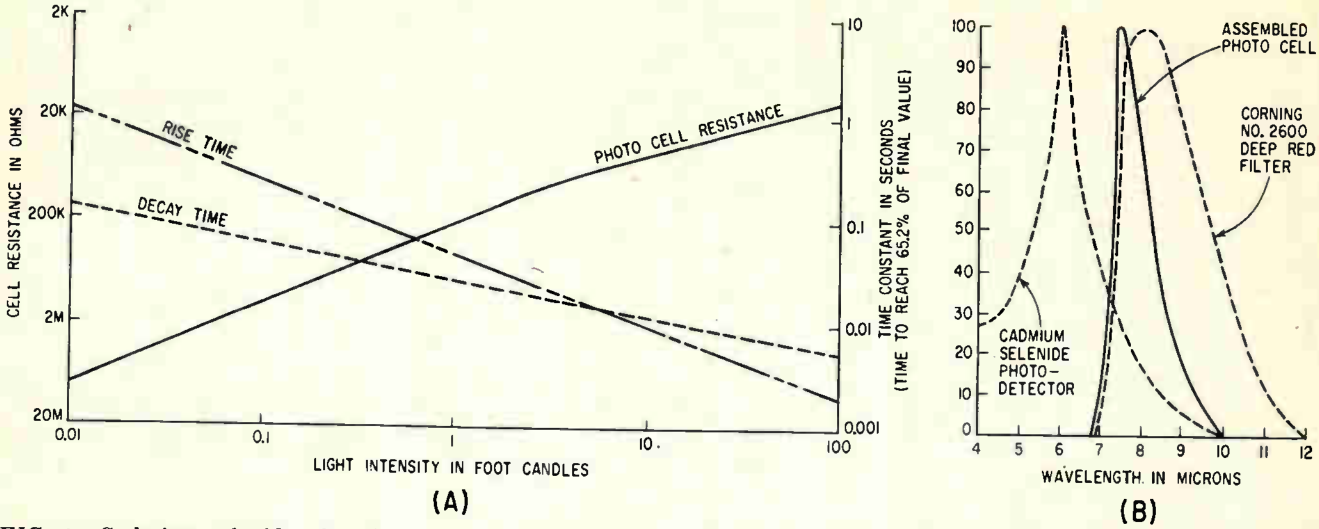


FIG. 4—Cadmium-selenide photodetector light characteristics shown in (A) while (B) shows spectral response of entire cell designed to cut off at 7,000 A because atmospheric absorption and scattering disturbs ground tests

quirements are simpler, having to correct only for the pitch and yaw of the rocket. This system is shown in Fig. 2. Servo system requirements are identical with those of the azimuth servo system with the exception of catching and acquisition requirements.

The eye system consists of a pair of coarse and a pair of fine eyes. The eye signals are summed by a mixer that provides a single-ended low-impedance output. The signal is then chopped at 400 cps and amplified to drive a servo motor. The eye and response network configurations are similar to those shown in Fig. 3.

As with the azimuth servo, the loop is closed by the mechanical coupling between the output shaft and the angular error sensors (eyes).

The error-sensing systems for a solar pointing control must be capable of generating electrical signals to the servo amplifiers to satisfy certain conditions: high gain at null to reduce required amplifier gain; broad angular characteristics to permit initial acquisition of the target; linearity near null to facilitate the use of straightforward compensation networks for stability and damping; short time constant to reduce lag at forcing function frequencies; low drift to reduce errors due to long time effects and temperature variations; and peak spectral response in a region of minimum atmospheric absorption to permit easy calculation of error signals outside the atmosphere.

Various photodetectors were evaluated for this application. The germanium phototransistor has a low light-to-dark current ratio and presents a difficult drift problem. Silicon phototransistors have a higher light-to-dark current ratio but sensitivity is low. Frequency response of both silicon and germanium detectors are satisfactory. The cadmium selenide photoconductor has a high light-to-dark current ratio and high sensitivity and therefore was chosen for this operation.

The stability of the cadmium selenide photodetector as received from the manufacturer is not ideal. A sensitizing effect was observed in which the cell exhibits higher sensitivity after storage in a dark condition. This effect is referred to as dark memory and may be as high as 25 percent. The effect was reduced by exposing the cells to 10 ft-candles of ambient light at 85 C for 28 hours. This aging reduced the dark memory by one half. Gain characteristics of the cadmium selenide photodetector are shown in Fig. 4A and the overall detector spectral characteristic is shown in Fig. 4B.

There are advantages in operating the cadmium selenide cells at high light intensity. The time constant of the cell is a distinct function of light intensity and a higher response speed is obtained at the higher light levels. Much can be gained by operating at the low cell resistance found at higher light levels. The lower cell resistance reduces noise pickup and presents a more desirable source resistance to the servo compensation networks.

The spectral response of the photodetector must be insensitive to wavelengths below 6,000 A. Considerable atmospheric absorption and scattering appears in the region below 6,000 A that makes the signal from the photodetectors dependent on atmospheric conditions and sun angle during ground tests. To avoid this, a deep-red filter was used to produce a spectral characteristic with a peak at 7,500 A and a cutoff at 7,000 A.

Various optical configurations will satisfy the requirements of the error sensing. Considering reliability, simplicity and physical size, the configuration used on previous pointing controls was used.

Two separate detector arrays (called eyes) are used in the system. Characteristics are shown in Figs. 5A, B and C. The coarse eye provides a wide angular characteristic for initial acquisition. The configuration of the coarse eye is such that the flush glass surface provides a characteristic that approximates the cosine of the angle of incidence. Flashed opal diffuses the light over the area seen by the sensitive portion of the cell. A deep-red filter provides the desired spectral response and a neutral density filter normalizes sensitivity.

The fine eye provides the high-gain characteristic that enables the servo to deliver the required accuracy. The fine eye obtains its high gain characteristic by focusing the solar image on a knife-edge reticle. As the image moves across the knife edge, the signal from the photocell changes from zero to maximum ideally in 32 minutes of arc (solar diameter).

Another requirement of the fine eye is to have a limited angle of vision. The reason for this being that after the target has been acquired and the fine eyes are operating, it is desirable to limit the sensitivity of the coarse eyes to reduce the effect of stray light. This is accomplished by programming a reduction in the gain of the coarse eyes.

To limit the fine-eye angle of vision, an aperture in front of the knife-edge reticle masks out the solar image beyond 12 degrees. The construction of the fine eye is an objective lens (planoconvex), front aperture for limited angle of vision, knife-edge reticle for sharp front characteristics, deep-red filter for spectral response, opal filter for uniform cell illumination and a neutral density filter for sensitivity normalization.

The fine and coarse eyes are used in pairs, and the signals from the two eye arrays are summed to obtain the desired characteristic. By opposing two fine eyes electrically, and sighting them along the same optical axis, a nonlinear characteristic is obtained through null. By overlapping the two optical axes by approximately 7 minutes, the nonlinearity will cancel out producing a linear characteristic shown in Fig. 5D.

The coarse eyes are overlapped in a similar manner. The linearity about zero is not as critical as the fine eyes. The basic requirement is that a dead zone not exist at the null. The coarse eyes are overlapped about 5 degrees.

The output of the fine eye pair is summed with the output of a coarse eye pair to provide a composite eye characteristic that satisfies the basic requirements of high gain around zero and a wide angle of view for initial acquisition, as shown by Fig. 5E.

In the elevation servo where the travel is limited to less than 180 degrees, one coarse eye pair is sufficient.

In the azimuth servo where the travel is 360 degrees, two coarse eye pairs are necessary. The solar pointing control has been successfully flown in an Aerobee rocket and is planned in future experiments.

Presently, a hybrid system is being designed that retains the advantages of the long optical axis of the original design and incorporates the best features of the new design discussed in this article.

Appreciation is expressed to William Frank for his efforts in coordinating the field effort.

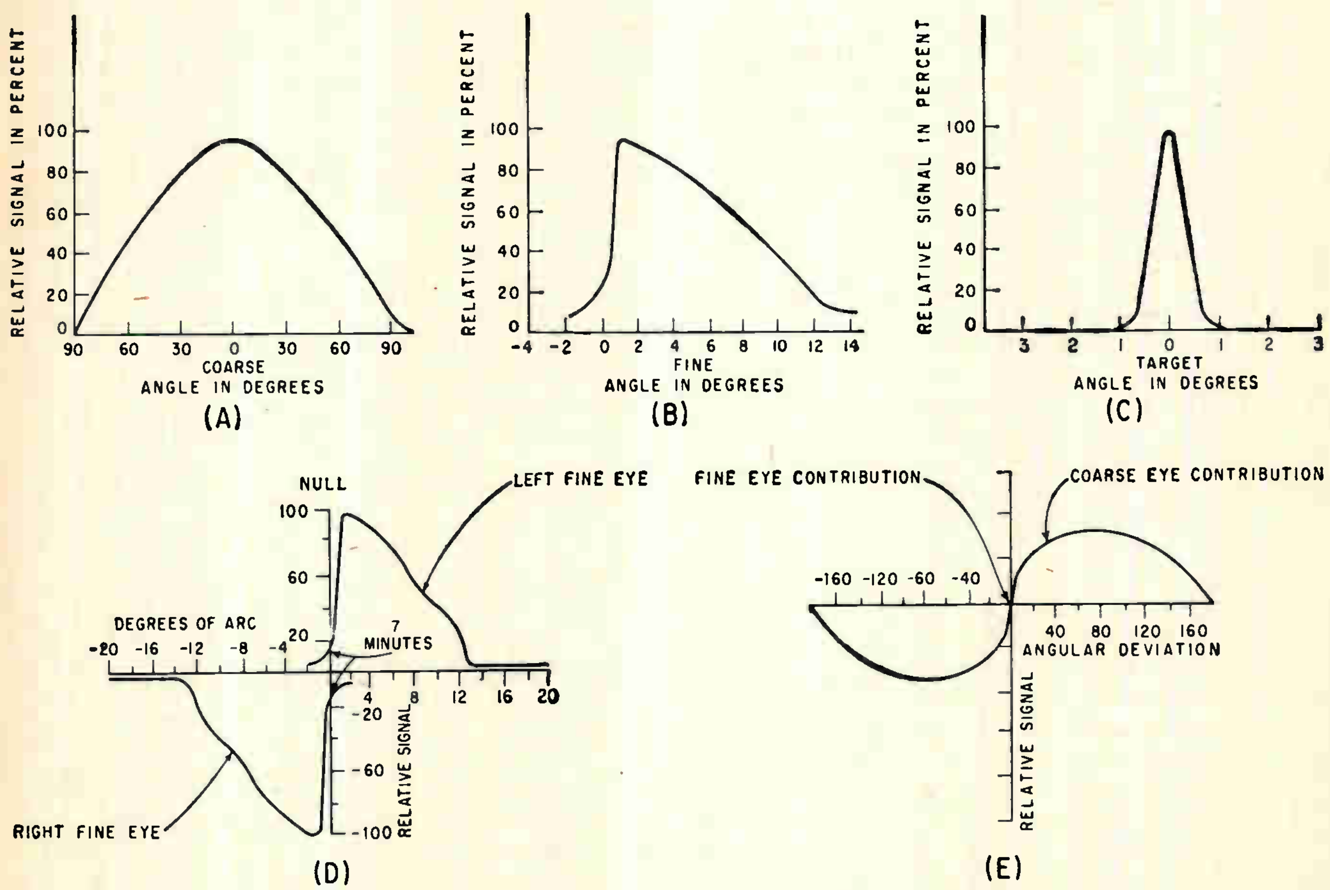
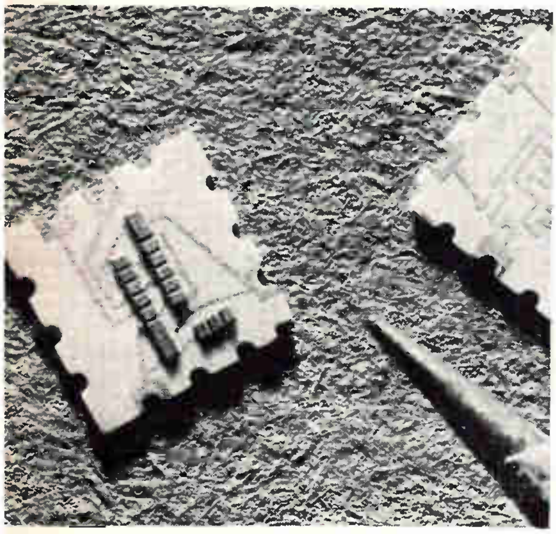


FIG. 5—Characteristics of coarse (A), fine (B) and target (C) eyes with typical azimuth system (D) and composite characteristics (E). Coarse eye provides wide angular characteristic for initial acquisition

Microcircuit Binary Full Adder

By M. E. SZEKELY, J. T. WALLMARK, RCA, Princeton, N. J. and S. M. MARCUS, RCA, Camden, N. J.



Experimental binary full adder on ceramic micromodule wafer carrying printed circuit for interconnections

THIS ARTICLE describes a microcircuit binary full adder that uses unipolar field-effect transistors as its active and passive elements.[1] A binary full adder is a computer circuit that adds three binary digits, namely X, Y and a carry C from a previous stage, and produces two outputs, one for the sum and one for the carry to the next stage. Each of these binary digits may be 0 or 1, corresponding to eight possible combinations as shown by the eight columns of the truth table.

The active element used throughout the adder is the unipolar field-effect transistor (UT), the operation of which is described in the box. The only passive elements are resistors, which are also unipolar transistors. The logic is direct-coupled unipolar transistor logic (DCUTL).

The Boolean expressions for a binary full adder are shown in the truth table. These expressions state in a shorthand form the conditions for a sum output and a carry output. Two forms are given. Equations 1A and 1B are the most general, but all the input variables and their complements are needed.

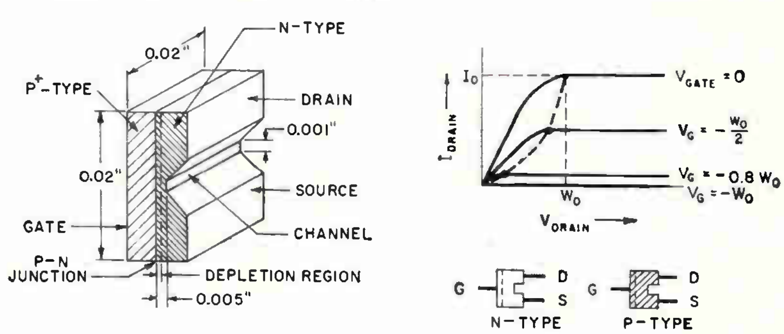
When this equation is put in circuit form it employs more elements than necessary. Equations 1A and 1B may be transformed by Boolean algebra into equivalent Eq. 2A and 2B. These are more concise and when put in circuit form appear as shown in block diagram (A) and in UT circuit (B). The circuit of (B) contains only 16 elements, 13 active and 3 passive, all UT's. The binary digits X, Y and C are each fed into three or four common inputs, although the connecting wires are not shown. The cross-hatched units in the inverter are of complementary symmetry having p-type channel and n-type gate while the other UT's have n-type channels and p-type gates. The binary number 0 is represented by a voltage level of -15 volts, which is equal to the pinch-off voltage of the UT. Therefore when 0 is fed into a gate, the UT is pinched off and represents an open circuit between source and drain. The binary number 1 is represented by a voltage level of -5 volts. This means that when 1 is fed into a gate, that UT represents a moderately low resistance between source and drain.

In (B) of the figure are indicated the four elements that are different from the rest, two p-type units and two load resistors. Their equivalent resistance values are given in terms of the channel resistance R_o of the regular units without bias. For the load resistors this means that, considering their nonlinear behavior, their channels are 4.5 times as long as the channels of the regular units. As can be appreciated from the values shown in (B) the power dissipated in the circuit is extremely small.

The next step is integration of the circuit shown in (B) into integral semiconductor packages. First the load resistors are replaced by properly dimensioned UT's. The topology of the circuit is such that a continuous path exists through the channels of all the n-type units. This continuous path is indicated by the broken line in (B), consequently the UT's can be arranged in one row as shown in (C). Thereafter the metallic connections between adjacent units are replaced by semiconductor bridges. The same is done with the p-type units. The circuit now appears as shown in (D) where the long n-type stick has been divided into two for use with micromodule[5] wafers.

In this form there are still some connections between elements that

UNIPOLAR FIELD-EFFECT TRANSISTOR



The unipolar transistor[2,3,4] one version of which is shown, operates as follows: when a reverse bias is applied to the gate contact, the depletion layer of the p-n junction grows and encroaches on the channel region, making it narrower until the resistance from the source to drain increases to about 10- to 100-megohms. When the reverse bias is reduced, the depletion layer retreats from the channel region and the resistance from source to drain reduces to about 5,000 ohms. At the same time, the gate is insulated from the source-drain by a reverse-biased junction constituting a high resistance, which in silicon is about 100 megohms. The unipolar transistor can be made not only in the p⁺-n version described above, but also in an n⁺-p version. For distinction this latter version is crosshatched in the schematics

Uses Unipolar Transistors

Binary Addition Truth Table

X	0	1	0	0	1	1	0	1	INPUTS
Y	0	0	1	0	1	0	1	1	
C	0	0	0	1	0	1	1	1	
SUM	0	1	1	1	0	0	0	1	OUTPUTS
CARRY (C_{OUT})	0	0	0	0	1	1	1	1	

BOOLEAN EXPRESSIONS FOR ADDITION:

$$SUM = X\bar{Y}\bar{C} + \bar{X}Y\bar{C} + \bar{X}\bar{Y}C + XYC \quad (1A)$$

$$CARRY = XY\bar{C} + X\bar{Y}C + \bar{X}YC + XYC \quad (1B)$$

$$SUM = (X+Y+C)\overline{C_{OUT}} + XYC \quad (2C)$$

$$CARRY = XY + (X+Y)C \quad (2D)$$

are not adjacent, and the art of integration is the finding of a circuit layout where these connections are as short and direct as possible. These connections are made by printed circuits on ceramic micromodule wafers, and the semiconductor sticks are soldered directly to these printed circuits. The photo shows an experimental integrated full adder.

In this form the integrated full adder occupies a volume of 1/400 cubic inch. The power dissipation of 20 mw is readily conducted away by the ceramic wafer and by the riser wires that interconnect the adder with other wafers.

The clock rate of the breadboard model was about 40 Kc and was limited by the large channel resistance of the experimental units, which had a channel length of about 0.006 inch. With improved units the speed is expected to increase by at least a factor of ten.

This work was supported by Air Force Research Division, Air Research and Development Command, under contract AF19(604)-5561.

The assistance of J. A. Briggs and R. R. Vannozzi in fabricating the devices and S. R. Hofstein in measurements is gratefully acknowledged.

REFERENCES

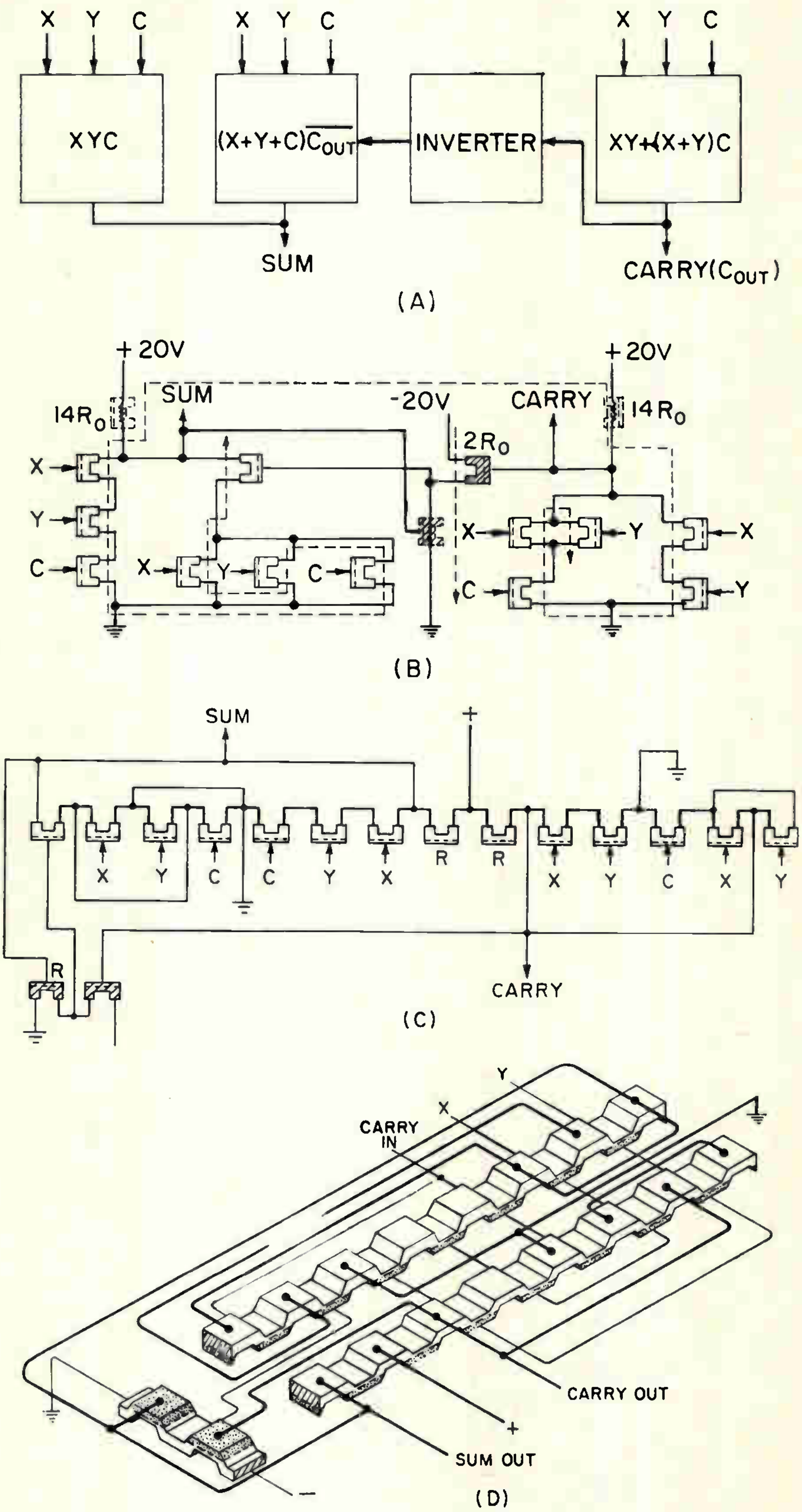
(1) M. E. Szekely, S. M. Marcus, and J. T. Wallmark, An Integrated Binary Adder, Paper No. 60-960, AIEE Summer General Meeting, June 19-24, 1960.

(2) W. Shockley, Unipolar Field-Effect Transistor, *Proc IRE*, 40, p 1365, 1959.

(3) G. C. Dacey and I. M. Ross, The Field-Effect Transistor, *BSTJ*, 34, p 1149, 1955.

(4) J. T. Wallmark and S. M. Marcus, Semiconductor Devices for Microminiaturization, ELECTRONICS, 32, p 35, June 26, 1959.

(5) S. F. Danko, W. L. Dorey and J. P. McNaut, The Micromodule: A Logical Approach to Microminiaturization, *Proc IRE*, 47, p 894, 1959.



Full adder in block diagram (A) and using unipolar transistors (B). The broken line forms a continuous path through the units to indicate the rearrangement for integration (C). The connections between adjacent elements are then replaced by semiconductor bridges (D). Three sticks of semiconductor are used rather than two, for convenience of fabrication

Designing Grounded-Grid Amplifiers

Grounded-grid triode amplifiers are suitable for automatic gaincontrol and

By J. W. RUSH
General Electric Co., Owensboro, Kentucky

MUCH AMPLIFICATION in electronic systems is done at intermediate frequencies. It is desirable to make the intermediate frequency high, to ensure sufficient bandwidth, to obtain good image rejection, and to reduce the effects of noise and radiation produced by the local oscillator. When a high intermediate frequency is coupled with low noise requirements, the triode becomes desirable because it has a better noise figure than the pentode. When stability and simplicity are desirable, the triode is best used in either cascode or grounded-grid circuits.

A six-stage, low-noise amplifier, shown in Fig. 1, was built to assess a high-performance triode as an i-f amplifier and to determine some of the problems in gain control.

A cascode circuit was chosen for the input stage because of its excellent low-noise performance in the vhf range. It has enough gain to determine the overall noise figure of the amplifier.

For subsequent stages the grounded-grid circuit was chosen because it is simple and stable. The six-stage amplifier has component values for operation at 60 Mc. The same circuit could be designed for operation at uhf frequencies.

A type 7462 microminiature ceramic triode is used in each stage because of its low noise properties, low interelectrode capacitances, low element-lead inductance and high transconductance (10,000 micromhos). The tube was also designed to solder into the printed-circuit board.

Amplifier tests gave the following performance data:

(1) Maximum over-all gain, 75 db

(2) Over-all noise figure, 1.7 db

(3) Over-all bandwidth, 6.5 Mc

Grounded-grid stages permit excellent isolation between input and output of each stage; this is important in view of the compact construction technique. Stability was improved by toroidal ferrite forms in all r-f chokes, which confine the fields about each choke and minimize stray coupling between chokes. Use of high-temperature, low temperature-coefficient coupling capacitors ensures constant bandwidth with temperature variations.

The grounded-grid configuration also permits simple interstage shields in the top cover. When the cover is installed, the shields mate with the grid terminals of the 7462 tubes in the five grounded-grid stages. All components were placed on the top side of the printed-circuit board, so that dip soldering could be used in assembly.

When designing grounded-grid amplifiers, several factors must be considered:

(1) Biasing systems

(2) Effect of biasing systems on tube characteristics

(3) Effect of controlling gain on characteristics of grounded-grid amplifiers

(4) Narrow-band case

(5) Broad-band case

Several biasing systems have been used with grounded-grid amplifiers. However, because of the minute spacing between tube elements, uniform characteristics are difficult to maintain in production. Therefore, the fixed bias, in combination with a well-regulated plate supply voltage, is generally not recommended since it provides the least control over plate current variations.

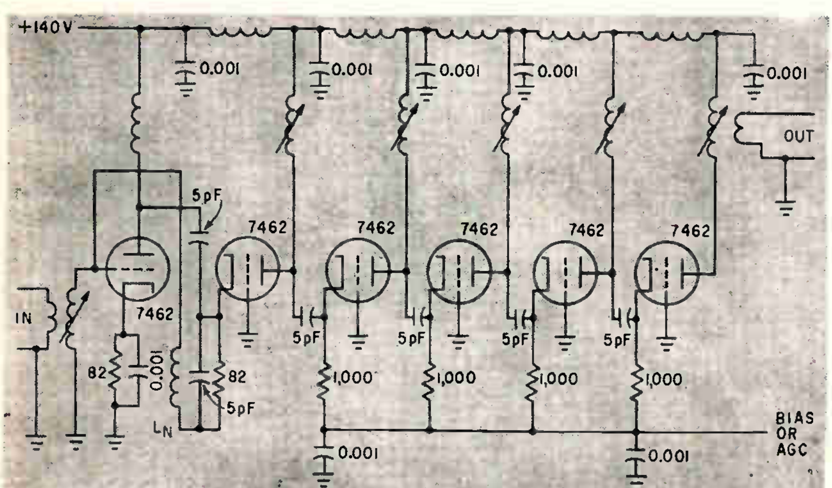


FIG. 1—*Six-stage, 60 megacycle i-f strip amplifier, using microminiature ceramic triodes. First stage is cascode, five subsequent stages are grounded-grid type*

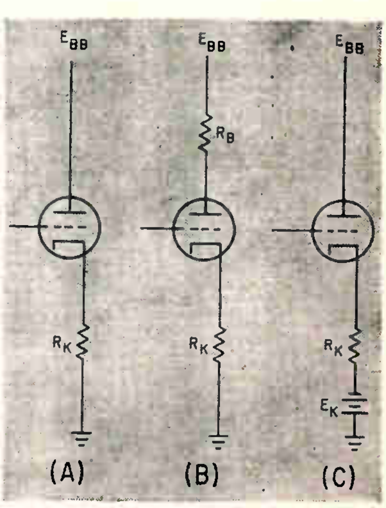


FIG. 2—*Typical biasing methods for triodes: cathode bias (A), plate resistor added (B), cathode resistor plus additional voltage (C)*

With Controlled Gain

intermediate frequency circuits

Author examines compact six-stage amplifier. All components are mounted on printed-circuit board. Cover has innerstage shields that mesh with triode connections

Cathode bias (Fig. 2A) improves plate current uniformity since it supplies more bias for high-current tubes, and less bias for low-current tubes. The amount of control depends on cathode resistor, but some circuits may need additional control not obtainable in this simple way.

Adding resistance in series with the plate supply voltage will increase uniformity of plate current flow (Fig. 2B). Plate voltage is thus increased in a low-current tube, and decreased in a high-current tube. The additional control is limited by the permissible increase in plate supply voltage to compensate for the drop across the resistor.

The third biasing system uses a larger cathode resistor and an additional voltage to return the bias voltage to the operating point. The grid can be connected to a positive voltage source rather than connecting the cathode to a negative source as shown in Fig. 2C, although at higher frequencies this would make it more difficult to obtain a good r-f ground for the grid. However, this arrangement needs a negative source of low resistance, capable of supplying the cathode current to the tube, and this may present a problem.

No capacitors are shown in the diagrams of Fig. 2, but they should be used, whenever appropriate, to bypass a cathode or plate resistor.

Invariably, the biasing system will affect the tube characteristics. The distributions of plate current, transconductance, grid-cathode voltage, and noise figure measured in circuits using each of the three biasing systems are illustrated in Fig. 3. The distributions in Fig. 3A were obtained with only a cathode resistor for bias. Those marked Fig. 3B were measured with a cathode resistor in the plate circuit, and Fig. 3C with a large cathode resistor plus a counteracting fixed bias.

Figure 3 indicates that an arrangement similar to Fig. 2C is preferable where tight control of plate current and gain (transconductance) is more important than noise figure. However, where noise figure is of greatest importance, the circuit of Fig. 2B is preferable. If circuit simplicity is most important, and greater variation in plate current and gain is permissible, the arrangement of Fig. 2A is best.

The tendency toward lower and more uniform noise figure in the circuit of Fig. 2B is a result of the much narrower distribution of grid-cathode voltage in this arrangement. A narrower distribution of bias also permits the choice of a low grid bias near optimum for noise figure.

Gain control may be achieved by varying the bias on the grounded-grid amplifier, either manually or automatically. To illustrate the effect of varying bias, two equivalent input circuits are shown.

Figure 4A shows the capacitances most often associated with the tube and its circuit. Cold grid-to-cathode, cold circuit, and dynamic input capacitances are plotted to show their dependence on grid bias. Miller effect capacitance (C_M) is not plotted, because in the grounded-grid stage Miller effect capacitance is much smaller than the other sources of capacitance.

The dynamic input capacitance (C_D) varies with grid bias because this additional capacitive component is due to the proximity of the space charge to the grid. This component is usually about half of the cold grid-to-cathode capacitance for conventional tubes. For the closest spaced triodes it may approach the cold grid-to-cathode value.

Figure 4B shows the equivalent resistive input to a grounded-grid stage and the variation of the various components with bias. The values of unbypassed cathode resistance (R_K) and cold circuit losses (R_{CK}) are not plotted and are assumed to be constant with tube bias. The value of transit-time loading (R_T) is shown to vary reciprocally with the tube transconductance at the respective bias levels. The values of dynamic input resistance (R_D) are not related to dynamic input capacitance but depend on the amplification factor and plate resistance of the tube and its plate load (R_L). In broad-band applications the value of plate load is usu-

TABLE I—SIMPLIFIED DESIGN EQUATIONS

Miller effect capacitance	$C_M = C_{KP}(1 - A \cos\phi)$	(1)
Dynamic grounded grid input resistance	$R_D = (R_P + R_L)/(\mu + 1)$	(2)
Transformed cathode resistance	$R'_{TK} = \left(\frac{C_C + C_{TK}}{C_C}\right)^2 R_{TK}$	(3)
Voltage and power gain	$= R_L(\mu + 1)/(R_P + R_L)$	(4)
Interstage bandwidth	$= 1/2\pi R_{TP} C_{TP}$	(5)
Center frequency	$= 1/2\pi\sqrt{C_{TP} L_P}$	(6)
Total plate circuit resistance	$R_{TP} = R_{CP} R'_{TK}/(R_{CP} + R'_{TK})$	(7)
Total plate circuit capacitance	$C_{TP} = C_{GP} + C_{CP} + \frac{C_C C_{TK}}{C_C + C_{TK}}$	(8)

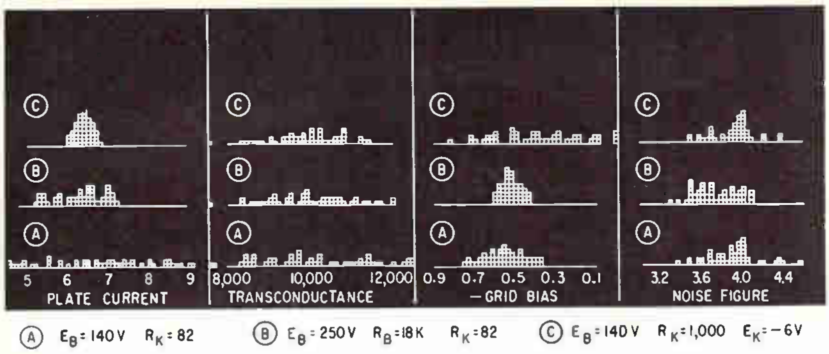


FIG. 3—Effects of the three bias methods on tube characteristics; tube to tube variations are shown as a function of the three methods in Fig. 2

ally much less than the tube's plate resistance and R_D varies as the reciprocal of the tube transconductance. In the narrow-band case the plate load may approach the value of tube plate resistance and the value of R_D varies as $2/G_M$. Since R_T and R_D are the principal input resistance parameters, the behavior of the grounded-grid stage would be expected to vary radically with grid bias, agc included.

To determine the behavior of the grounded-grid amplifier when biased, some form of interstage must be chosen. Figure 5 shows the equivalent circuit of a capacitively coupled, single-tuned interstage. With this interstage, the bandwidth is governed most by the value of coupling capacitor (C_C). Values of C_{TK} and R_{TK} have been previously defined. Inductance L_P resonates with the total interstage capacitance to determine the center frequency. Cold circuit and socket losses are represented by R_{CP}. Tube and plate circuit capacitances are represented by C_{GP} and C_{CP} respectively. Image resistance (R'_{TK}) of the total cathode resistance (R_{TK}) is defined in table I.

Simplified design expressions for voltage and power gain, interstage bandwith for a single tuned circuit, and center frequency of a grounded grid stage are shown in Table I. As bias or agc is applied, all three of these r-f performance equations change. The situation is made more complicated when two or more stages are connected in cascade and the interstage behavior depends on the behavior of its following stage. For this reason the exact expressions for gain, bandwidth and center frequency for the assumed interstage are complex.

In the narrow band case, R_L is assumed about equal to R_P of the tube. The voltage and power gain can be determined by Eq. 4 and equals approximately $\mu/2$. To determine the interstage bandwidth, a value for coupling capacitor (C_C) must be determined. Since R_L is assumed equal to R_P, the value of C_C in Eq. 3 must be chosen so that the ratio of R'_{TK} to R_{TK} is equal to $(\mu + 1)/2$. This assumption is based on R_{TK} being mainly composed of R_D, and is true if quality sockets and components are used, the tube is used at a frequency where transit time loading is small, and all cathode bias resistors are bypassed. The value of R_{TK} can be estimated from Eq. 2. The only unknown in Eq. 3 with the exception of C_C is C_{TK}, and this can be measured or estimated from published tube capacitances. Values of G_M, μ and R_P can be estimated from published tube data.

Using Eq. 8, C_{TP} can be determined since the values of C_{GP} and C_{CP} are published or can be measured. Assuming quality components in the plate circuits R_{TP} must be equal to R'_{TK} which has been established. Eq. 5 is used to calculate the interstage bandwidth. Using C_{TP} and Eq. 6, the value of plate inductance (L_P) can be determined for any chosen frequency.

Thus, the narrow-band, conjugate matched, grounded-grid interstage yields a maximum gain of approximately $\mu/2$ since most high performance triodes have μ much greater than one. Bandwidth of the assumed interstage circuit is independent of frequency if efficient elements are used. This bandwidth can be changed by changing one circuit component, C_C. To determine the gain, bandwidth, and center frequency at all levels of bias, a group of simultaneous equations must be used, or point-to-point calculations must be made using known changes in tube characteristics.

When these calculations are made it is found that gain varies principally with μ and this does not change rapidly with bias. The bandwidth does change rapidly with bias because it is controlled

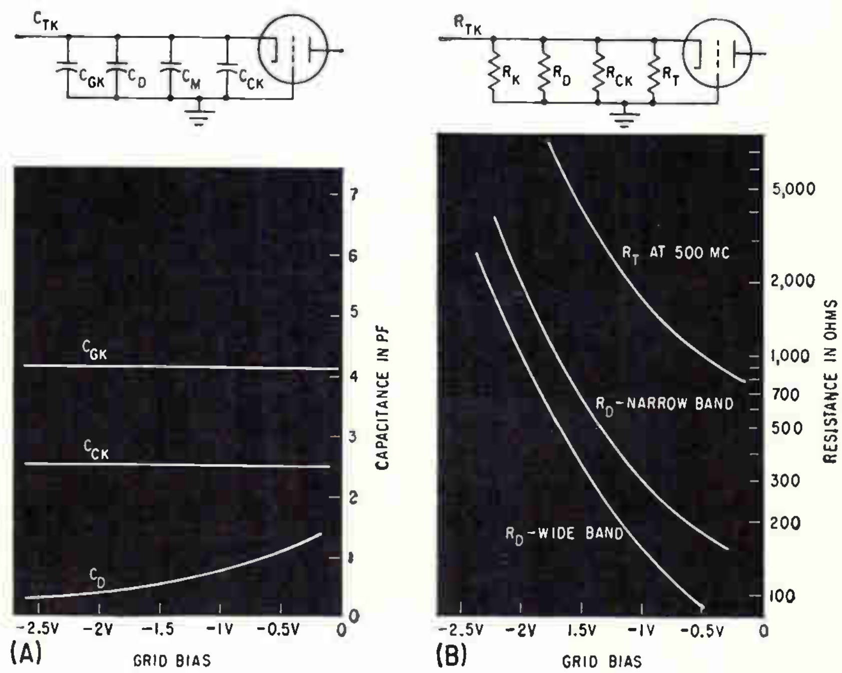


FIG. 4—Equivalent input circuits for the grounded-grid triode, considering capacitance components (A) and resistance components (B) and their variation plotted against effective grid bias

mainly by the transconductance, which changes more rapidly than μ.

In the broad-band case, R_L R'_{TK} is assumed to be much less than the plate resistance of the tube. With this assumption, Eq. 4 shows that gain is approximately equal to $G_M R_L$. Thus in the broadband case, variations in transconductance are more important than variations in μ. The ratio of R'_{TK} to R_{TK} approaches $G_M R_L$.

Since the interstage bandwidth is dependent on both C_c and R_L, the best design procedure is to assume a reasonable value of C_c and solve for C_{TP} using Eq. 8. The other capacitances in this equation have been previously established. Use Eq. 5 and the desired interstage bandwidth, to solve for R_{TP}. If quality components are used, R_{TP} should be equal to R'_{TK} (Eq. 7). This value of R'_{TK} is the desired R_L and the resulting stage gain can be calculated. If the calculated results are not acceptable, adjustments in the assumed values can be made to obtain the desired performance.

In the broadband grounded-grid stage, the change in gain with bias depends mainly on changes in transconductance. Change in bandwidth with bias also depends on transconductance. This means that the broad-band stage is more suited to the application of agc than the narrow-band stage, but changes in bandwidth must be tolerated.

Once the plate tuning inductance has been determined, center frequency will change with bias only with dynamic changes in C_{TP} (Eq. 6). The only active element is the capacitance C_D shown in Figure 4A. This shows that C_D is relatively small compared to the other components of C_{TP}. For this reason, changes in center frequency with bias should not be a problem. Since changes in dynamic input resistance with changes in bias cause the most trouble (Fig. 4B), these changes should be minimized. A varying R_D must be assumed, because it is inherent to the grounded-grid amplifier. If changes in interstage bandwidth cannot be tolerated, the effective dynamic changes must be reduced. One approach is the use of passive damping resistance in the form of an unbypassed cathode resistor. To retain most of the stage gain, this resistance must be somewhat larger than the normal input resistance of the stage. At the same time this resistance could be used for cathode d-c stabilization. In the 6-stage amplifier described, the 1,000-ohm shunt-feed cathode resistors clamp the input resistance to 1,000 ohms or less for all values of bias. This biasing arrangement also eliminates the need for a cathode choke and bypass capacitors.

Figure 6 shows the measured performance of the amplifier as a function of bias or agc. Figure 7 illustrates the effectiveness of the cathode stabilization system used.

In conclusion several facts are evident. The grounded-grid stage is not ideally suited for continuous attenuation with external bias over wide ranges. However, it is very well suited for gating-type agc systems.

Good circuit stability is inherent to the grounded-grid configurations; the low impedance of the grounded-grid stage permits the use of unbypassed cathode resistors for d-c stabilization; the control of input impedance, and circuit simplicity, good gain and low noise performance are available at high frequency.

TABLE II—SYMBOLS USED

C_{GP}	= *grid to plate capacitance*
C_{CP}	= *cold plate circuit-socket capacitance*
R_{CP}	= *cold plate circuit losses*
C_C	= *coupling capacitance*
C_{TK}	= *total cathode capacitance (total input capacitance)*
R_{TK}	= *total cathode resistance (total input resistance)*
R_K	= *unbypassed cathode resistance*
R_{CK}	= *cold circuit-socket resitsance*
C_{CK}	= *cold circuit-socket capacitance*
R_T	= *transit time resistance at operating frequency*
C_{GK}	= *cold input grid-to-cathode capacitance*
C_D	= *dynamic input capacitance due to space charge*
C_{KP}	= *cathode-plate capacitance*
R_P	= *pla e resistance*
R_L	= *plate load resistance*
L_P	= *plate inductance*

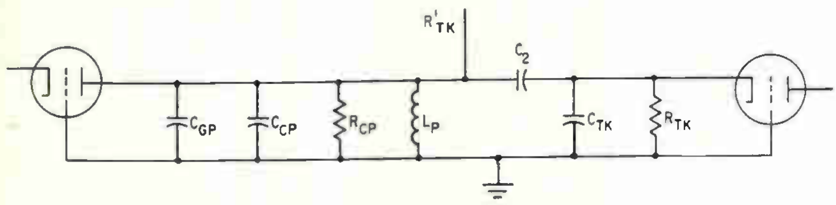


FIG. 5—Equivalent interstage circuit between two grounded-grid stages with capacitive coupling

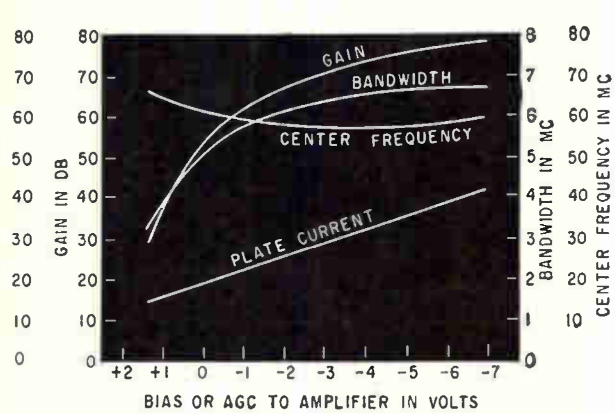


FIG. 6—Performance of i-f amplifier as a function of applied bias or automatic gain control: gain, bandwidth, plate current and center frequency plotted against bias voltage

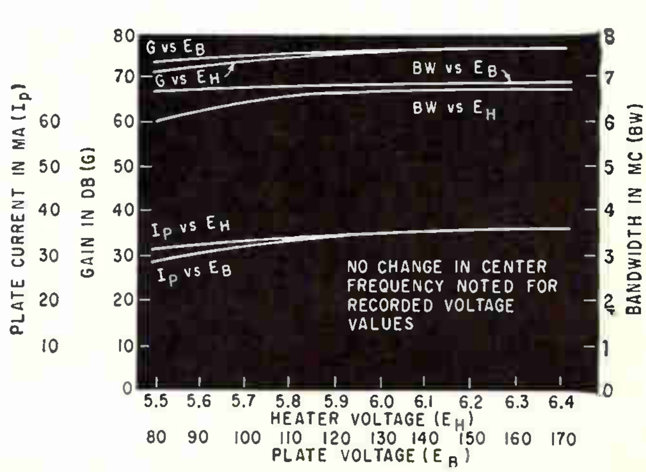


FIG. 7—Performance as a function of plate and heater voltages

Subject wears clip, transmitter, batteries and antenna. One box contains all electronic components, encapsulated in Plexiglass for strength; the other box contains batteries

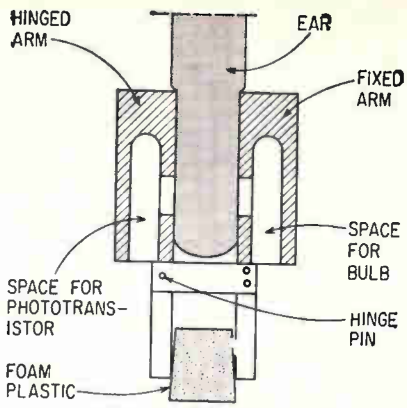


FIG. 1—Detail of ear clip. Phototransistor measures varying opacity of earlobe. Foam plastic serves as spring and as size adjustment

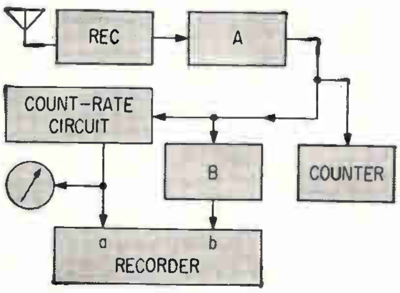


FIG. 2—Block diagram of receiving, monitoring and recording unit. For normal use the count-rate circuit is used and heartbeat is monitored on meter. For rapid heart rate changes, circuit B (see text) is used with graphic recorder

Radio Transmitter for Remote

Self-contained device worn by patient transmits his pulse to a radio

By G. A. HARTEN, Medical Service,
A. K. KORONCAI, Engineer,
Philips Research Laboratory,
Eindhoven, Netherlands

MEASURING HEARTBEAT RATE is an important way to estimate energy consumed by the human body, and helps to determine whether a person is under needless physical strain when working under adverse conditions. Other factors, such as nervous tension, smoking or excessive ambient temperature, affect the heart rate; nevertheless, it is a convenient yardstick for measuring a person's reactions to different physical tasks. Roughly, 70 to 80 beats a minute corresponds to light, sedentary work, 80-100 to moderately heavy work and 100-130 to heavy work.

It is often impossible to count the pulse in the usual way while a person is working. Heart rate changes rapidly after some physical task is completed, so that a count taken immediately after a task or exercise is not accurate.

This apparatus[1] measures the pulse rate continuously, without obstructing the subject's movement, and transmits it to a monitoring meter or recording instrument.

The subject wears the equipment shown in the photograph. Attached to one earlobe is a small clip, containing a lamp in one side and a phototransistor in the other side as shown in Fig. 1. Each heartbeat causes a variation in the blood stream and also slightly changes the volume of the earlobe. As a result, the amount of light transmitted through the earlobe changes, producing a pulse in the photocell.

After amplification (see Fig. 3) the pulse goes to a shaper circuit that generates a square-wave signal with every beat. This pulse triggers, through a transistor switch, a fixed-frequency oscillator (about 3 Kc) that amplitude-modulates the carrier frequency of a miniature transmitter (10 to 15 Mc). The transmitted signal can be picked up by a radio receiver.

The equipment worn by the subject weighs about 3 pounds. Its electronic circuit is powered by 18 small nickel-cadmium batteries, with useful life of 8 hours before recharging. An automobile radio antenna is used. To ensure ruggedness, all transmitter components are mounted in small Plexiglass blocks.

To reduce interference, the pulse amplifier passes frequencies between 1 and 3 cps, that is, 60 to 180

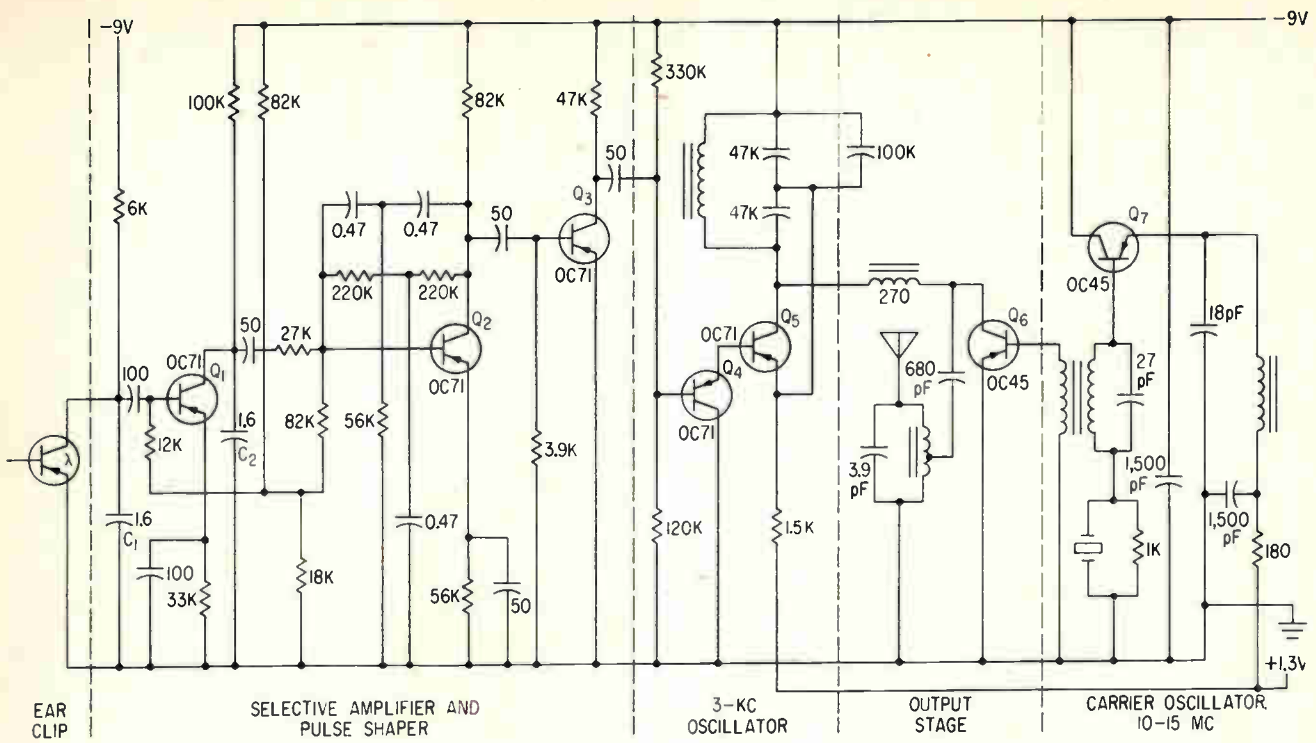


FIG. 3—Circuit of transmitter carried by subject. Required frequency response is obtained by double-T filter and capacitors C_1 and C_2 (1.6μf). Switching transistor Q_4 triggers 3-Kc oscillator Q_5. Phototransistor is fed separately

Heartbeat Measurements

receiver for remote monitoring or recording

heartbeats a minute. Chief causes of interference were a-c power lines (hum) and unduly sharp movements by the subject, which have a frequency on the order of 10 cps. The ear must be screened if a powerful infrared source is near, since the ear is transparent to infrared and the phototransistor will respond to radiation up to 1.5 μ.

Signals are heard as a succession of short, high-pitched notes; these can be counted by an observer. Counting is inconvenient for frequent or continuous measurements; thus a recording count-rate meter was added (see Fig. 3). The receiver gives a 3,000 cps signal for each beat. Block *A* contains a selective amplifier with a narrow passband at 3,000 cps and a rectangular pulse shaper. The count-rate circuit consists of a monostable flip-flop followed by a diode pump and an R-C network, incorporating the indicating meter. The R-C network has a time constant of about 5 seconds. This makes the meter indication, an average of the heart rate in the 5 or 10 seconds before the reading. The meter cannot follow rapid changes of heart rate, but is fast enough for most cases. If the R-C time constant is shortened, the needle drops appreciably between successive heart beats and becomes difficult to read. The meter scale covers a range from 1 to 3 cps, that is, 60 to 180 beats a minute. Output of the count-rate circuit is also recorded for some patients.

For following rapid variations of the heart rate, a circuit delivering sawtooth pulses whose amplitude is a measure of the time between two heartbeats is used; block *B* of Fig. 2. When these pulses are recorded, a line drawn through their peaks is similar to that obtained by a frequency meter with short indication time. A slightly modified metronome is used to calibrate the instrument.

If the subject does not have to shift from one place to another during his work, and need make no considerable movements, radio transmission is not necessary. The output from the pulse shaper that drives the 3,000 cps oscillator can then be applied directly to the measuring and recording instrument. The subject now carries no equipment other than the ear clip and leads, and radio interference is eliminated.

REFERENCES

(1) G. A. Harten and A. K. Koroncai, A Transistor Cardiotachometer for continuous measurements on working persons, *Philips Technical Review*, 21, p 304, 1959/60.

OVERLOAD PROTECTION FOR

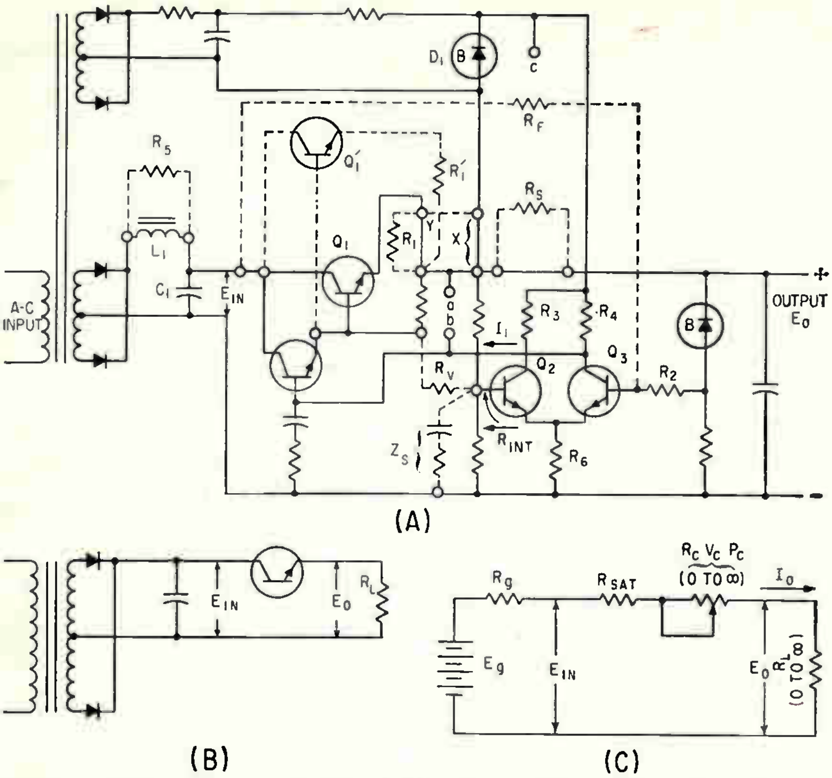


FIG. 1—Broken lines going into terminals of this regulator indicate refinements introduced at these points (A). Circuit of (B) is simplified version of (A), and (C) is equivalent of (B)

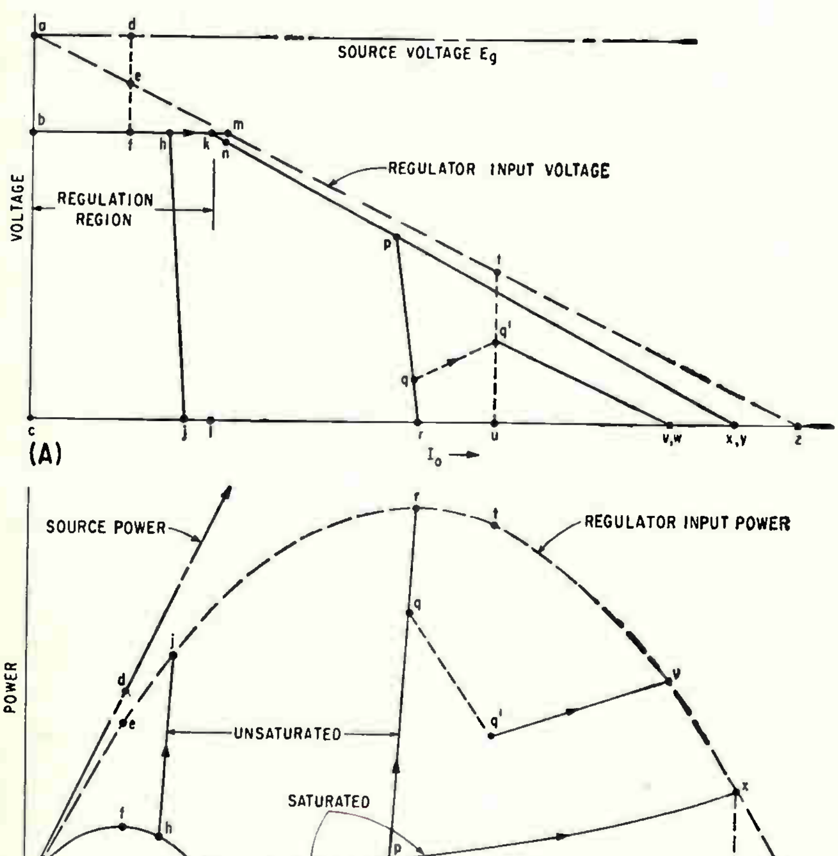


FIG. 2—Solid lines indicate regulator output voltage (A). In (B), solid lines indicate series-transistor dissipation

By ALLAN G. LLOYD,*

Staff Engr., The Daven Co., Livingston, N. J.

TRANSISTOR REGULATORS are being widely used in d-c power-supplies. However, they are fragile under overload conditions, especially over-voltage inputs, over-current or short-circuit outputs and over-temperature base-plate operation. A slipped screw driver or loose test lead can permanently short the series transistors in such a regulator. Fuses do not help, because the energy that a fuse will pass in clearing a fault is enough to destroy a power transistor, especially at the higher power levels.

Figure 1A is the circuit of a typical regulator. The terminal circles indicate points at which design changes, such as addition of components, are introduced; solid-line connections indicate the circuit before modification and broken lines indicate circuit changes that improve regulation and output impedance (editorial box). The power-handling part of this circuit is

* Now with Bread-Boards, Inc., Hanover, N. J.

CIRCUIT REFINEMENTS OF FIG. 1A

$R_t = R_{INT}$ for high temperature stability

R_F improves line regulation

Positive current-feedback resistor R_s and positive voltage-feedback resistor R_v reduce d-c output impedance

Lead network Z_s reduces h-f Z_o and usually improves loop stability

Q'_1 and $R'_1 = R_1$ add to current capability

If $R_1 > 0$, breaking circuit at X and connecting to Y improves current stability of I_1 for load variations and reduces output Z_o. This connection is not recommended for current-limiting circuit

Setting $R_3 \cong R_4$ and selecting R_6 properly results in equal dissipation in Q_2 and Q_3 for all current values. This reduces drift due to differential heating in Q_2 and Q_3 caused by load-current changes

---

TRANSISTOR VOLTAGE REGULATORS

shown simplified in Fig. 1B; Fig. 1C is the equivalent circuit of Fig. 1B.

Voltage and power equations for this circuit are tabulated in Tables I and II and are plotted in Fig. 2A and 2B. These curves cover the load-conductance range of open to short circuit and indicate what happens to the series element in a regulator for all possible load conditions. Note that curves *a-r-z* and *a-f-m* of Fig. 2B are both inverted parabolas with similar equations. Segment *f-k* shows that the series transistor power dissipation can decrease with increased loading. For current-limited regulators operating from low source impedance, point *h* may be to the left of *f* so that the peak point at *f* is never reached. Segment *k-x* is also parabolic with the apex at the origin. Segment *q'-v* extrapolates through the origin.

Brute force short circuit protection can be achieved by inserting a series resistor ahead of the series transistors. A compromise value is chosen such that the series transistor can safely handle this new value of short-circuit current and remain in saturation (I_x, Fig. 2B). The supply is fused so that this value of I_x blows the fuse. This scheme requires the extra resistor and also wastes power.

With the regulator series transistor connected between a capacitor source and capacitor load, as in Fig. 1A, high input line voltage can drive the collector-to-emitter voltage to Q_1 to breakdown voltage BV_{ce}. For transistors having a negative-resistance region at BV_{ce}, large values of intercapacitor charging current can flow between the input and output capacitors, resulting in transistor burn-out.

Load induced high-voltage transients can also be generated at the output of ripple filter L_1C_1 when the current demand on the regulator steps from a high value to a low value. This is due to the conversion of the stored magnetic energy of the choke, given by $(\frac{1}{2})LI_o^2$, to increased charge storage of C_1 as the choke current decays, resulting in a higher-than-normal capacitor

TABLE I—EXPLANATION OF FIG. 2A

Line Segment	Quantity described by 1st column	Equation
a–d	Source v	E_g = constant
a–z	Regulator input v	$E_{IN} = E_g - I_oR_g$
b–k	Regulator output v, reg region, $R_{sat} > 0$	E_o = constant
b–m	Regulator output v, reg region, $R_{sat} = 0$	E_o = constant
k–x	Regulator output v, unreg region, $Q_{1/sat}$	$E_o = E_g - I_o(R_g + R_{sat})$
p–r	Regulator output v, unreg, Q_1 unsat	$I_o \approx$ constant
h–j	Regulator output v, current limited at *h*	$I_o \approx$ constant
q–q' *q'–v*	Instantaneous jump due to second breakdown Regulator output v with Q_1 (fig. 1A) in second breakdown	V_{SERIES} = 20v V_{SERIES} = 20v $E_o = (E_g - 20v) - I_oR_g$

TABLE II—EXPLANATION OF FIG. 2B

Line Segment or point	Quantity described by 1st column	Equation
a–d	Power delivered by source	$P_g = I_oE_g$
a–r–z	Regulator input power	$P_{IN} = I_oE_g - I_o^2R_g$
a–f–m	Series transistor dissipation	$P_c = I_o(E_g - E_o) - I_o^2R_g$
r	Max available power from gen	$P_{max} = E_g^2/4R_g, \quad I_r = E_g/2R_g$ $E_{IN} = E_g/2$
z	Short circuit with $R_{sat} = 0$	$I_z = E_g/R_g, \quad R_{sat} = 0 \quad P_c = 0$
b–k	Series transistor diss, reg region	$P_c = I_o(E_g - E_o) - I_o^2R_g$ $(E_g - E_o)$ = constant
f	Max series trans diss, reg region	$I_f = (\frac{1}{2})(E_g - E_o)/R_g,$ $P_c = (E_g - E_o)^2/4R_g$ $(E_g - E_o)$ = constant
k	Reg end point for $R_{sat} > 0$	$I_k = \frac{(E_g - E_o)}{(R_g + R_{sat})}, \quad P_c = \frac{(E_g - E_o)^2R_{sat}}{(R_g + R_{sat})^2}$
m	Reg end point for $R_{sat} = 0$	$I_m = (E_g - E_o)/R_g; \quad P_c = 0$
k–x	Series trans diss, unreg region, Q_1 sat	$P_c = I_o^2R_{sat}$
x	Short-circuit end point for $R_{sat} > 0$	$I_x = \left(\frac{E_g}{R_g + R_{sat}}\right), \quad P_c = \left(\frac{E_g}{R_g + R_{sat}}\right)^2 R_{sat}$
p–r	Series-trans diss, unreg region. Q_1 shown coming out of sat under worse-case conditions	$P_c = I_o(E_g - E_o) - I_o^2R_g$ I_o = constant $P_c = P_{max} = E_g^2/4R_g$
q–v	Series-trans diss, Q_1 (fig. 1A) in second breakdown	$V_c = 20v, \quad P_c = (20v)I_v$ $I_v = (E_g - 20v)/R_g$
h–j	Series-trans diss, current-limiting circuits	$P_c \approx I_h(E_g - E_o) - I_h^2R_g$ I_h = arbitrary

voltage. Some manufacturers avoid this problem by using RC filtering, even for high current levels. This modification is indicated by resistor R_5 replacing L_1.

A simple form of over-voltage protection for the series transistors consists of connecting a Zener diode and resistor in series across the transistor. Since the Zener diode may cost as much or more than the transistor it protects, it may be cheaper to use two transistors in series. A workable procedure is to allow enough transistor-voltage rating, either as a single transistor or as a string of transistors in series, to accommodate the largest expected voltage transient.

Series-transistor drive circuits (I_f of Fig. 1A) usually have generous drive current capability to accommodate the lowest β transistors encountered at the lowest temperature. Thus, normal transistors at higher temperatures are capable of delivering output currents of two to ten times full load. If this current value does not damage the series transistor directly due to high current density at its junction, the temperature rise associated with points r or x of Fig. 2B may still deteriorate the junction by thermal action.

This problem in transistor overloading is related to the high ratio of electrical energy the transistor can control to the amount of thermal energy it can store or dissipate before destruction.

At some value of over-current, the series transistor may come out of saturation due to insufficient drive current for that value of load current (see point p, Fig. 2A and 2B). With increased loading, the output current stays nearly constant, and the voltage across the series-transistor circuit increases. As the output voltage drops to zero at point r, the series transistor power dissipation can increase in the worst case to the value $P_{max} = E_g^2/4R_g$, which may fuse the junction.

Unsaturated over-currents can also take the series transistor operating point into a region of second breakdown, point q', Fig. 2A and B. In this mode, the transistor has a constant voltage drop of about 20 volts, independent of collector current and base drive. Thyratron-like action of the transistor at this second breakdown between the source and load capacitors results in peak currents limited only by circuit impedance. Transistors driven into second breakdown are usually either altered drastically in their characteristics or destroyed.

Line h-j (Fig. 2A and 2B) illustrates the constant-current action of a circuit having an extra series transistor;[1] this circuit is not shown. Both the total dissipation at point j, Fig. 2B, and short-circuit current I_j can be made substantially smaller than the values associated with points r or x for the Fig. 1 circuit. However, the circuit with the extra series transistor doubles the number of series power elements.

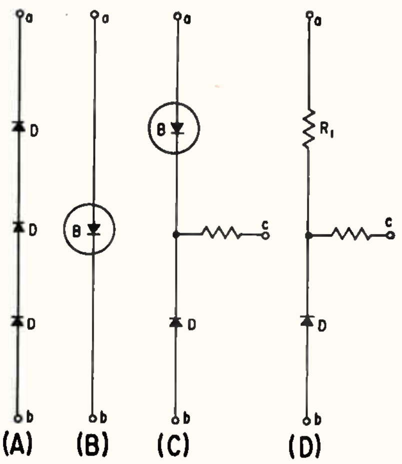


FIG. 3—These circuits are alternate forms for connection to points a, b and c of Fig. 1A. They provide current-limiting in series transistor

Figures 3A and 3D show the extra elements that can be incorporated into the Fig. 1 circuit[2] to achieve constant-current operation. With the regulator in its normal regulation region, this extra diode circuit in no way affects circuit operation. With Fig. 3A, each silicon diode allows a forward-voltage drop of about 0.6 v; with Fig. 3B, the Zener diode may be between 4 and 6 v; Fig. 3C provides sharp limiting action; in Fig. 3D, the Zener of Fig. 3C is replaced by the less-expensive resistor R_1, at some sacrifice in performance. Under output current overload, the increasing voltage drop across R_1 causes the D diode (or diodes) to conduct, limiting the base drive voltage of Q_1 (Fig. 1A), and hence the output current, to a selected value.

At point j, Fig. 2B, the dissipation is still higher than the dissipation at point f, which represents the maximum value of transistor dissipation with the regulator in its normal regulating region. Under continuing short circut conditions this increased value of dissipation within the power-supply package may cause severe over-heating of the entire supply. Therefore, means must be provided to cut back the average output current to a lower value so that average power dissipation within the supply remains low.

Figure 4 has an extra shut-off transistor, Q_3, that reduces output current to zero when the voltage across the series transistor rises above a selected value.[3] This occurs at current overloads that drive the regulator into its constant-current mode. Increased loading then reduces the output voltage below its normal value, and increases the drop across the series element in the regulator. Figure 4 shows several schemes for using this voltage drop. With switch S_1 connected to point a, the circuit includes Zener diode D_2 and R_2. When the voltage across Q_1 increases to the value that causes D_2 to conduct, Zener current flows through R_2 and into the base of Q_3, driving Q_3 into saturation. This shorts out the base drive to Q_2, and reduces the output current, hence the output voltage, to approximately zero. This means that if Q_3 is turned on, it remains on, and the output voltage is forced to stay at a low value. To restore the circuit to normal, either series switch S_1 must be opened or shunt switch S_2 closed. This removes the drive to Q_3 and allows the circuit to return to normal operation if normal load conditions prevail. If short-curcuit conditions still prevail the current-limited value of short-circuit current flows.

Resistors R_3 and R_4 form an alternate source of base drive for Q_3. These resistors are chosen so that the open-circuit value of E_1 is less than the output voltage E_o for all line conditions. Therefore with S_1 connected to b, Q_3 is normally held cut-off. Under conditions of overload or short circuit, E_o becomes less than E_1, causing Q_3 to conduct and hence reduce the output current to zero. This circuit also requires the momentary operation of switch S_1 or S_2 to restore it to normal. A more accurate source of voltage for E_1 may be achieved by replacing R_4 with Zener D_3 in which case it may be necessary to insert R_5 in series with the base of Q_3.

The restoring function of shunt switch S_2 can be duplicated and made automatic by replacing S_2 with an oscillatory circuit and diode.[3] Simple forms of relaxation oscillators are shown in Fig. 5A and 5B. Figure 5A shows a unijunction-transistor oscillator circuit and Fig. 5B uses a 4-layer diode. In each case the original circuit is broken at X and the discharge current of C_1 is used to shut off transistor Q_3 of Fig. 4. Figure 5C shows the voltage waveform for both circuits. Time t_1 is determined for the most part by R_1C_1 and is set for about 10 milliseconds. Time t_2 is determined by R_2C_1 and E_1, and is set for 100 milliseconds or more. This yields a duty cycle of 1 to 10 or more, and establishes the ratio of average short-circuit current to peak value for the fully protected regulator.

Figure 6 shows the schematic of a series regulator incorporating automatic pulsing-type short-circuit protection. In this circuit, diode D_1, divider R_2 and R_3 constitute the constant-current prelimiting circuit; no series resistance is required at R_1 because of the large base input voltage of silicon transistors Q_1 and Q_2. Transistor Q_4 is the shut-off transistor. The unijunction transistor circuit (Q_5) pulses continuously. Diode D_2 completes the discharge path of C_1 through R_4 when Q_5 fires. The forward drop across D_2 constitutes reverse bias for Q_4 which turns it off and allows current-limited output current to flow. The low duty cycle of this output current results in low average power dissipation within the supply. Thus, the supply is protected against all load conditions, including partial and complete, continuous short circuits.

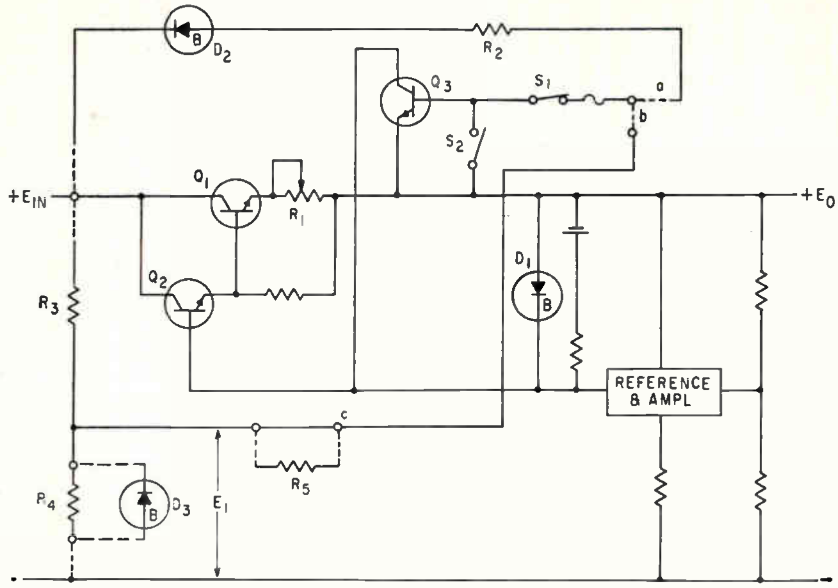


FIG. 4—Current-limited regulator with manually reset shut-off Q_3

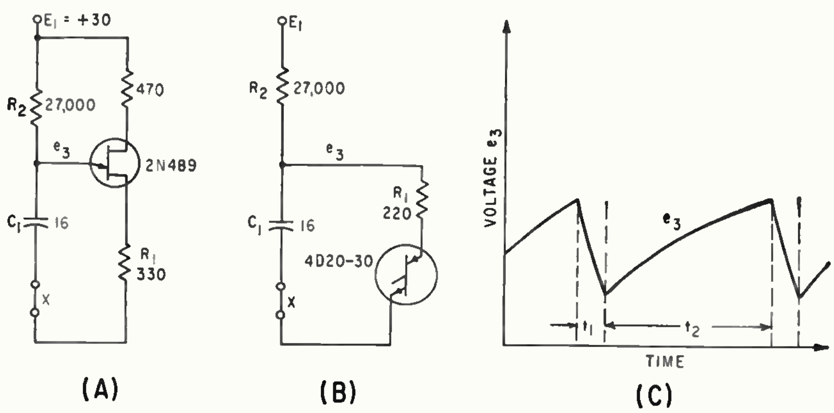


FIG. 5—A unijunction transistor oscillator (A) and a 4-layer-diode oscillator (B) have their e_3 waveshape(s) shown in (C)

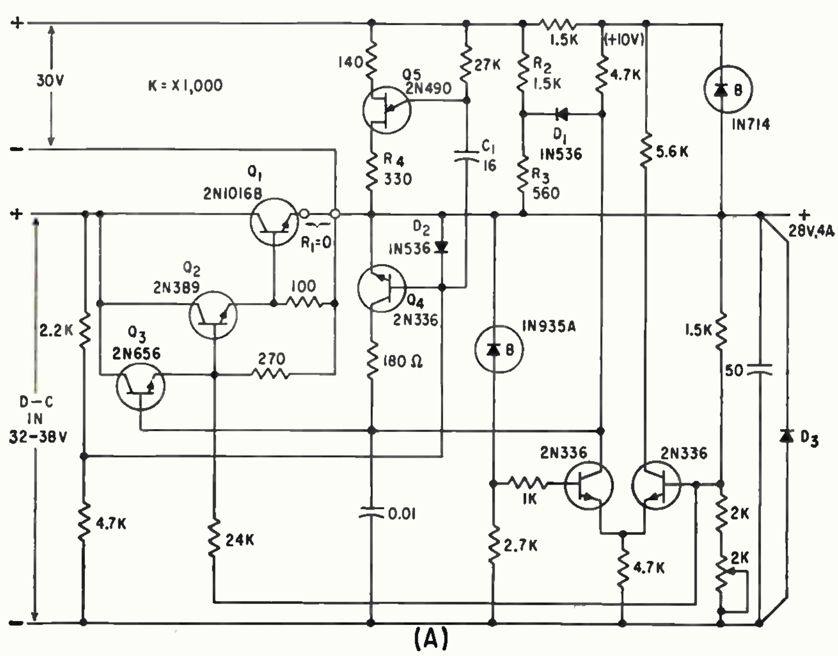


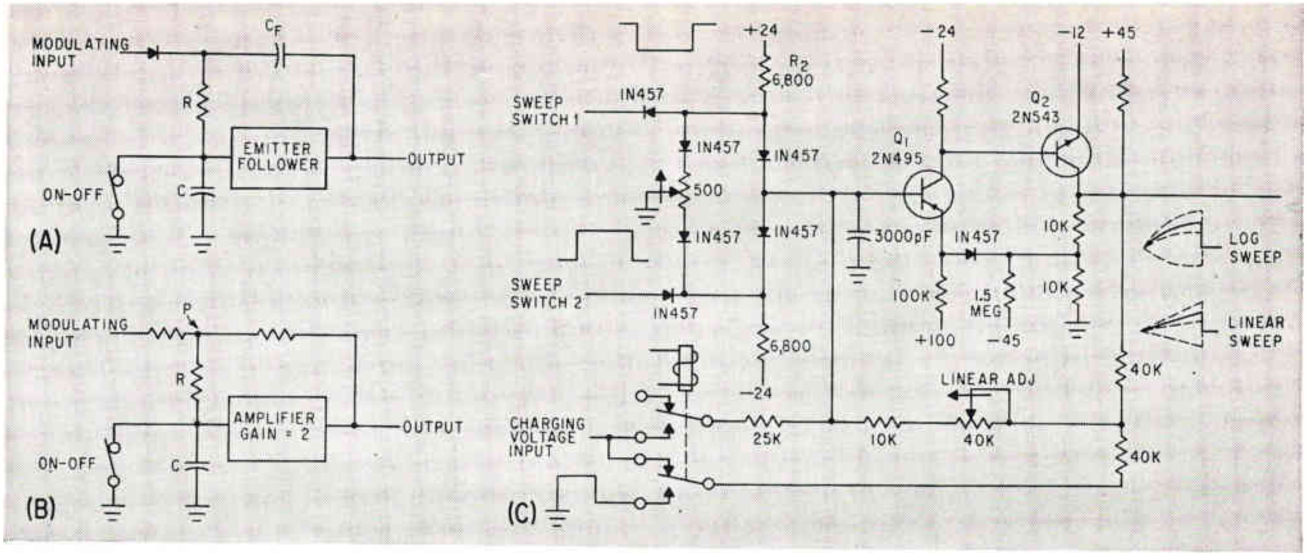
FIG. 6—This series regulator is current limited and has automatic pulsing-type short-circuit protection

REFERENCES

(1) H. D. Ervin, Transistor Power Supply has Overload Protection, ELECTRONICS, p 74, June 20, 1958.

(2) Earl Wilson, Designing Transistorized Voltage Regulators, ELECTRONICS, p 62, Sept 23, 1960.

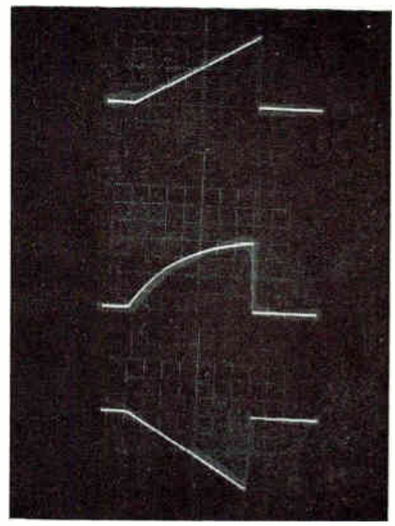
(3) Patent applied for.



Conventional bootstrap with capacitive feedback (A); resistance coupling increases linearity and permits versatile operation of circuit (B); final circuit with relay for switching between linear and logarithmic sweep (C)

Bootstrap Generates Logarithmic Sweeps

Resistance coupling in the feedback loop permits positive going as well as negative going waveforms, and in addition, enables the circuit output to be logarithmic, exponential or linear



Bootstrap traces: upper and second sweeps are positive going, bottom is negative going

By J. CURRY,
W. SANDER,
Tasker Instrument Corporation,
Hollywood, Calif.

BOOTSTRAP SWEEPS are relatively simple circuits except where a high degree of accuracy is desired. One limitation of the simple bootstrap is its inability to generate sweeps in both directions; however, the resistance-coupled bootstrap shows a high degree of accuracy without a marked increase in circuit complexity. It can sweep in positive or negative directions, generate triangular waveforms, and can easily generate exponential or logarithmic sweeps.

In the bootstrap sweep circuit Fig. (A) any variation in voltage across the charging capacitor is fed back to the top of the charging resistors by the gain-of-one amplifier (emitter follower) and the feedback capacitor. Deviation from linearity can occur if feedback capacitor charging takes place during the sweep.

In the resistance coupled bootstrap the emitter follower Fig. (B) has been replaced by an amplifier with a gain of two; the feedback circuit then consists of a voltage divider with two equal-valued resistors. The modulating voltage sets the potential of the terminal side of the voltage divider and thus the initial charging current through *R*. The gain-of-two amplifier has been designed with a large feedback factor to maintain a stable gain over wide operating limits.

Changes in voltage at the junction of *R* and *C* are amplified by the gain-of-two amplifier and divided by the voltage divider to reappear at junction *P*. Thus any variation in the voltage across *C* is added to the initial voltage across *R*, where it maintains a constant charging current in *C*.

The sweep rate is a function of the initial drop across *R* and is set by the modulating voltage. The direction of the sweep will depend upon the polarity of this modulating voltage. Variations in the modulating voltage during the sweep will cause a change in the charging current and therefore in the output waveform. Switching the modulating voltage between positive and negative values will generate a triangular waveform.

Exponential waveforms can be generated by using resistors of unequal values in the feedback path. The sign of the exponential will then depend upon which feedback resistor is the larger.

A MAJOR CAUSE OF FAILURE ELIMINATED BY BUILDING A TRANSISTOR INSIDE ITS OWN SHELL

Most transistor failure is not abrupt. It consists of surface changes causing a gradual shift in parameters. While the whole industry has sought answers, Fairchild has followed a research and development course of its own. We can now reveal a unique solution.

Called "PLANAR STRUCTURE," this Fairchild answer uses a passivated surface—a hard, passive coating of silicon oxide—not new in theory, but new in the way it is done. Fairchild oxidizes the surface first. Then the transistor's junctions are diffused **under the oxide.** Contaminants cannot reach them during process or after. Result: performance is unchanged by time, use, environment or even exposure to foreign matter.

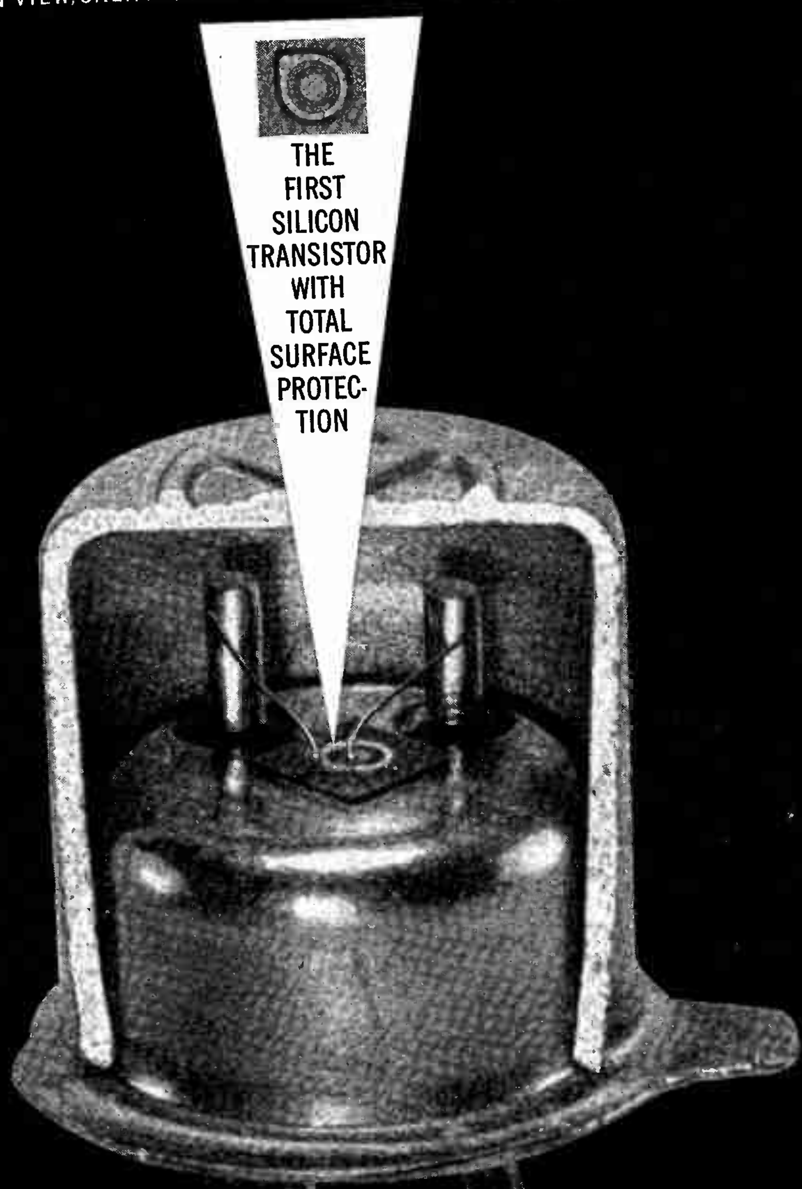
Planar is the answer: for system reliability where thousands of transistors must all be operative at an instant—for fast, simple circuits tightly packed in minimum space—for carefully matched pairs, triplets or quads that must stay exactly in balance—and for leakage reduction by a factor of one hundred. And planar is the answer even for simpler circuit requirements where high assurance has a value.

These advantages apply to planar diodes,too. Of course, Fairchild planar silicon transistors and diodes are available in production quantities. A new 12-page brochure explains the process and results more fully. May we send you a copy?

A wholly owned subsidiary of Fairchild Camera and Instrument Corp.

FAIRCHILD
SEMICONDUCTOR CORPORATION

545 WHISMAN RD. • MOUNTAIN VIEW, CALIF. • YOrkshire 8-8161



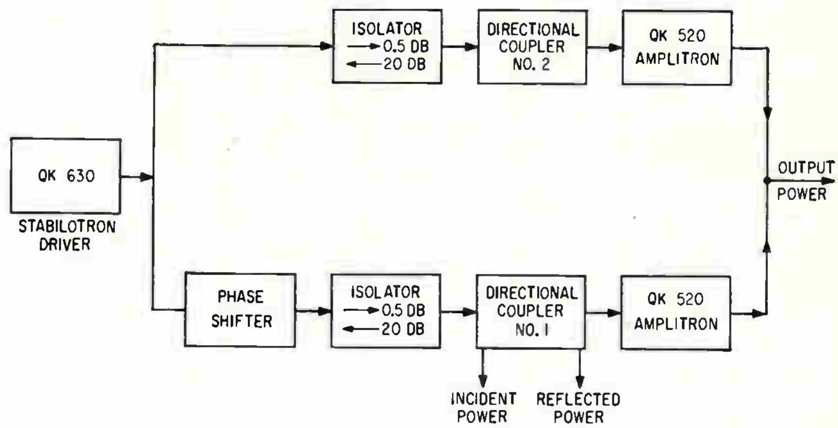
Paralleled Amplifiers Increase R-F Power

SEPARATE driving of two Amplitrons by a common driver source was demonstrated to be practical recently at the Washington meeting of the IRE Professional Group on Electron Devices. Also, the r-f power from both Amplitrons was combined in one terminal.

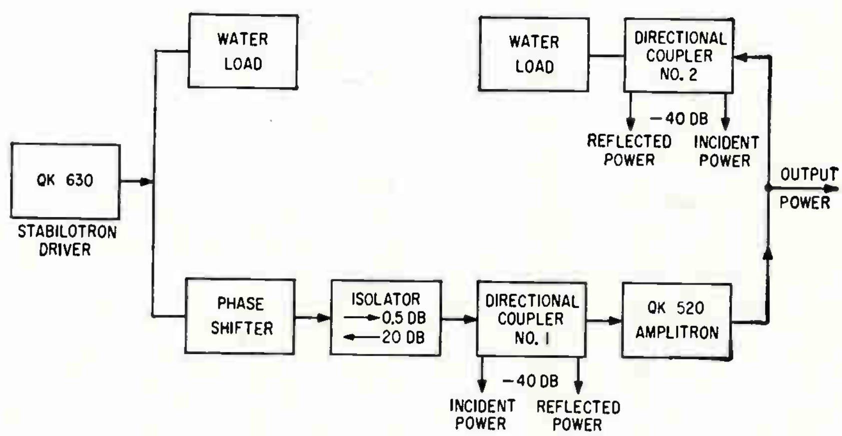
Raytheon company engineers C. Hellenbrand, C. McGeoch, and F. Zawada used a QK630 L-Band Stabiltron as the driver source. Its power was evenly split in a tee-section, each arm of which was connected through an isolator and directional coupler to the inputs of the QK520 Amplitrons. Connecting the Amplitron outputs to a common output load is a tee-section.

Simultaneous monitoring of incident and reflected powers is permitted by the directional couplers.

Equi-phased arrival of each output power at the tee-section is assured by a coaxial phase shifter in one of the input arms; thus, outputs add properly so that each of them does not return as reflected power through the other Amplitron. The phase shifter may be sensitively adjusted by monitoring the reflected power in the directional coupler.



Operation of two Amplitrons in parallel



Output r-f plumbing for experiments

Reflected power measured by the directional coupler was proved to be due entirely to mismatches in the r-f output plumbing. One arm of the Stabilotron driver was terminated in a matched water load. The Amplitron in that arm was removed so that the directional coupler and matched water load were connected directly to the output r-f plumbing. The r-f input power of 65 kilowatts was split into 30 kilowatts into the water load and 35 kilowatts driving the Amplitron. If there were no connection mismatches, 25% of the Amplitron output would be reflected and measured in directional coupler No. 1, and the transmitted power would be split two-thirds into the output load and one-third into the termination of directional coupler No. 2. Amplitron output power of 900 kilowatts actually resulted in 300 kilowatts of peak power measured in directional coupler No. 1, 450 kilowatts peak power into the output load, and 150 kilowatts peak power into coupler No. 2 terminating load. Thus, the 150 kilowatt difference between the directional couplers is due to connecting mismatches.

The above experiment was performed with input and output connections of equal electrical length to provide phase balance. Also, for a given drive and operating condition, the r-f power output of the two Amplitrons were equal in amplitude. Thus, conditions of phase balance and amplitude balance existed.

The effect of phase unbalance with amplitude of both Amplitrons balanced was also demonstrated. One leg of the parallel-fed Amplitron circuit was increased by insertion of a length of waveguide 50 electrical degrees long. The operating conditions were the same as before, and, as expected, the r-f power in the output load was reduced and the out-of-phase power, as measured in the E arm of the output hybrid T, was increased by the exact amount of lost r-f output power.

Another experiment involved phase balance and amplitude unbalance. Ratio of amplitude unbalance was 1.5 to 1, and reduced operating conditions existed. As expected, all but 4% of the r-f power ended up in the output load. Even if r-f outputs of the Two Amplitrons were a quarter wavelength out of phase, there would not be

VOLTAGE REGULATED DC POWER SUPPLIES KEPCO

TRANSISTORIZED DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
SC 32-0.5	0-32	0-0.5	0.01%
SC 32-1	0-32	0-1	
SC 32-1.5	0-32	0-1.5	
2SC 32-1.5	0-32	0-1.5	
Dual Output	0-32	0-1.5	
SC 32-2.5	0-32	0-2.5	
SC 32-5	0-32	0-5	
SC 32-10A	0-32	0-10	
SC 32-15A	0-32	0-15	
SC 60-2	0-60	0-2	
SC 60-5	0-60	0-5	
2SC 100-0.2	0-100	0-0.2	
Dual Output	0-100	0-0.2	
SC 150-1	0-150	0-1	
SC 300-1	0-300	0-1	
SC 18-0.5	0-18	0-0.5	0.1%
SC 18-1	0-18	0-1	
SC 18-2	0-18	0-2	
SC 18-4	0-18	0-4	
SC 36-0.5	0-36	0-0.5	
SC 36-1	0-36	0-1	
SC 36-2	0-36	0-2	
SC 3672-0.5	36-72	0-0.5	
SC 3672-1	36-72	0-1	
PSC 5-2	0-7.5	0-2	0.02%
PSC 10-2	7.5-12.5	0-2	
PSC 15-2	12.5-17.5	0-2	
PSC 20-2	17.5-22.5	0-2	
PSC 28-1	22.5-32.5	0-1	
PSC 38-1	32.5-42.5	0-1	
HB-2	0-325	0-200 ma.	0.1%*
HB-4	0-325	0-400 ma.	
HB-6	0-325	0-600 ma.	
HB-8	0-325	0-800 ma.	
SR 12-50	5-13	0-50	0.1%
SR 28-50	24-32	0-50	
SR 48-30	44-52	0-30	
SM 14-30	0-14	0-30	0.1%*
SM 36-15	0-36	0-15	
SM 75-8	0-75	0-8	
SM 160-4	0-160	0-4	
SM 325-2	0-325	0-2	
SM 14-15	0-14	0-15	
SM 36-10	0-36	0-10	
SM 75-5	0-75	0-5	
SM 160-2	0-160	0-2	
SM 325-1	0-325	0-1	
SM 14-7	0-14	0-7	
SM 36-5	0-36	0-5	
SM 75-2	0-75	0-2	
SM 160-1	0-160	0-1	
SM 325-0.5	0-325	0-0.5	

*0.01% REGULATION AVAILABLE

MAGNETIC DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
KM236-15A	0.1-36	0-15	0.5%
KM236-30	0.1-36	0-30	
KM236-50	0.1-36	0-50	
KM 251	2-14	30A or 240 W.	±1%
KM 252	5-35	12A or 240 W.	
KM 253	20-60	6A or 240 W.	
KM 254	30-90	4A or 240 W.	
KM 255	60-180	2A or 240 W.	

MODEL HB-6M

COMPACTNESS

TWO 4¼" SC UNITS MOUNTED IN RACK ADAPTER RA-2

WIDE VARIETY

MODEL 2SC32-1.5

VERSATILITY

MODEL 400B

FOR DETAILED SPECIFICATIONS ON MORE THAN 150 STANDARD MODEL POWER SUPPLIES SEND FOR KEPCO CATALOG

kepco inc.

131-48 SANFORD AVENUE
FLUSHING 52, N. Y.
IN 1-7000 • TWX #NY4-5196

VACUUM TUBE DESIGN GROUP

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.	REGULATION
800B	#1 0-600 #2 0-600 Parallel 1 & 2 0-600 Series 1 & 2 0-1200	0-200 ma. 0-200 ma. 0-400 ma. 0-200 ma.	TO 0.01%
430D	#1 0-450 #2 0-450 Parallel 1 & 2 0-450 Series 1 & 2 0-900	0-300 ma. 0-300 ma. 0-600 ma. 0-300 ma.	
2400B	#1 0-400 #2 0-400 #3 0-150 Bias Parallel 1 & 2 0-400 Series 1 & 2 0-800	0-150 ma. 0-150 ma. 0-5 ma. 0-300 ma. 0-150 ma.	
103	#1 0-300 #2 0-300 #3 -50 to+50 Parallel 1 & 2 0-300	0-75 ma. 0-75 ma. 0-5 ma. 0-150 ma.	unregulated
400B	0-400 0-150 Bias	0-150 ma. 0-5 ma.	TO 0.02%
730B	0-350	0-3 Amp.	
720B	0-350	0-2.25 Amp.	
710B	0-350	0-1.5 Amp.	
700B	0-350	0-750 ma.	
780B	0-600	0-3 Amp.	TO 0.01%
770B	0-600	0-2.25 Amp.	
760B	0-600	0-1.5 Amp.	
750B	0-600	0-750 ma.	
605	0-600 0-150 Bias	0-500 ma. 0-5 ma.	
615B	0-600 0-150 Bias	0-300 ma. 0-5 ma.	
2500	0-2500	0-50 ma.	TO 0.004%
1520B	0-1500	0-200 ma.	
1220C	0-1200	0-50 ma.	
1250B	0-1000	0-500 ma.	
KR16	0-150	1.5 Amp.	0.1%
KR17	100-200	1.5 Amp.	
KR18	195-325	1.5 Amp.	
KR19	295-450	1.5 Amp.	
KR8	0-150	600 ma.	
KR5	100-200	600 ma.	
KR6	195-325	600 ma.	
KR7	295-450	600 ma.	
KR12	0-150	300 ma.	
KR3	100-200	300 ma.	
KR4	195-325	300 ma.	
KR10	295-450	300 ma.	
KR11	0-150	125 ma.	
KR1	100-200	125 ma.	
KR2	195-325	125 ma.	
KR9	295-450	125 ma.	

CIRCLE 63 ON READER SERVICE CARD

complete cancellation of r-f output power.

With phase-balanced conditions and one of the Amplitrons acting as a passive element, performance was rated under reduced operating conditions. This is almost as if an amplitude unbalance of ratio better than 3:1 existed. All the r-f power might be expected to end up in the output load and little, if any, r-f out-of-phase power anticipated. But, because of phase shift between a cold and an operating Amplitron, the ideal condition of just amplitude unbalance is nonexistent; the phase unbalance results in an increase in the out-of-phase power.

Should one Amplitron under parallel operations go bad and act as a short circuit, operation under reduced power can continue while the defective Amplitron is replaced. This was proved by the following experiment.

One Amplitron was removed and a short circuit was placed on the arm of the input hybrid T that led to it. On the same arm of the hybrid T a matched load was placed. The r-f output power divided evenly between the output load and the E arm of the output hybrid T. Part of the r-f power was reflected by the short circuit and absorbed in its E arm. Depending on the phase of the short, almost all the power can be absorbed in this auxiliary load.

An array that uses at least ten parallel circuits would suffer a loss of only 7.5% of the total r-f power should one Amplitron go bad.

Space Flight Radiation Problems Under Study

COMPREHENSIVE study project may indicate ways in which satellites and space vehicles can cope with the problems of radiation. Investigations include techniques for shielding space vehicles, methods for making electronic equipment more resistant to radiation and even medical approaches to make crews less susceptible to the effects of radiant energy. Mathematical studies are also included that may enable space vehicles to avoid heavy concentrations of radiation.

The series of studies is being conducted by Boeing Airplane Company, which is designing electronic equipment that is resistant to radiation. The firm's space medicine section is studying the use of drugs such as crysteiamine, which may increase human resistance to radiation by 50 percent.

An electrostatic generator may provide protection to crew and equipment against some types of particles. A negative charge would form an invisible shield repelling electrons from the path of the vehicle.

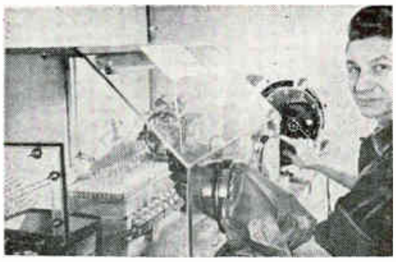
Exotic metals may also provide some protection from radiation belts, cosmic rays and solar flares. Zirconium hydride and lithium hydride have been examined as possible shielding materials.

The radiation hazard increases when the vehicle loses the protection of the earth's atmosphere. Beyond the Van Allen belts surrounding the earth, the space craft encounters galactic cosmic rays and effects from solar flares. The investigations indicate that the vehicle structure, fuel, water and food supply offer the most promising shielding material at this point in the planning. Dense metals like lead that provide effective shielding severely limit payload.

To avoid overestimating shielding requirements and adding unnecessary weight, Boeing physicists are using mathematical models to calculate shielding needs. All variables in the shielding problem are expressed in mathematical terms usable by computers. Computers can then be used to determine shielding required for a specific mission.

Solar flares, often accompanied by sudden high concentrations of radiant energy, are presently the most unpredictable source of space radiation. Attempts are being made to determine the nature of these disturbances. By collecting sufficient data about solar flares, the researchers hope to determine statistically the conditions or times or both under which they occur. If the probability of solar flares can be predicted, space flights and required protection can be planned accordingly.

Another part of the project involves avoidance of heavy concentrations of radiation. A space flight launch might well be planned to follow a path from either the north or south pole where the vehicle would largely avoid both Van Allen belts.


Although the Soviets are going all out to encourage the use of light-sensitive devices for automation, our work here indicates many more ingenious uses for electronics. Photos above, taken at Clairex in New York City, show technicians: assembling photoconductive elements in glass enclosures (left); sealing the glass-enclosed cells in controlled atmosphere chamber (center); and incorporating light cells into an eight-channel punched-tape reader (right)

Progress Report on Light-Sensitive Cells

POINTS UP MANY AREAS FOR FURTHER EXPLOITATION

SOVIET ACTIVITY in the area of light-sensitive devices was gleaned from a story appearing in a Czech periodical, forwarded here by our Vienna correspondent. Although there is nothing in this story to indicate Soviet advances not known here, the story stressed the "significance of the photocell in Soviet economy, and the role allotted to this device in the design of automatic machines that multiply the productivity of human labor."

The use of a light signal to control electrical and electronic equipment continues to fascinate engineers both here and abroad. And this is due in part to the nature of light itself. A light beam is a remarkable medium both for the control and for the transmission of intelligence.

Photocell applications in this country have been reported in these columns (ELECTRONICS, p 74, Aug. 5). And one of the most recent innovations was an electro-optical switch developed by Raytheon (ELECTRONICS, p 152, Aug. 12). Within the past months, the use of a light cell in the Polaroid Land Camera, has accounted in part for the very attractive sales of this camera both here and abroad. Both of these devices use light cells developed by Clairex of New York City.

The broad range of light-sensitive devices includes a variety of photo-conductive cells that use lead sulphide, cadmium sulphide and cadmium selenide and are called by many names: light-dependent resistors, photodiodes, and phototransistors.

In an exclusive interview with A. F. Deuth, President of Clairex, this column uncovered several significant facts about the photoconductive cell area[1]. His company is one of the most active firms that offers both cadmium sulphide and cadmium selenide light cells. Although Clairex has been in the photoconductive cell business for only 7 years, it is about the oldest existing company that manufactures these new cells.

Just back from an examination of both the Japanese market, and the European market, Deuth is quite aware of photoconductive cell interest and activity both here and abroad. According to Deuth, cadmium sulphide and cadmium selenide are the most interesting materials for photoconductive cells from an applications view. And there is still a lot of work that can be done to further exploit these materials before going into others.

Selenide types are more useful for work near the infra-red range. As an example, they are used in burglar alarms. And with a deep red filter at the transmitter, light can't be seen, but the cell still responds. This range will be extended by cadmium teluride, further into the infra-red (8,000 A); and zinc sulphide will peak at around 4,000 A, extending the range in the blue direction. Work with lead teluride is still in the laboratory stage.

Right now the cadmium selenide cells are the most interesting for about two-thirds of all applications. They are about ten to one faster, than cadmium sulphide types. A good cell made of either cadmium sulphide or cadmium selenide is about a million times more sensitive than a photomissive cell; and about 1,000 times more sensitive than a selenium photovoltaic cell. This sensitivity is at the expense of the speed of the photomissive types.

Cadmium selenide is more applicable when the light source is an incandescent lamp. For a daylight or fluorescent light source, a sulphide cell is more apt to be used. The selenide cell is a much better switch and has a much higher ratio of light to dark current, although the temperature characteristic is poorer than the sulfide cell.

New applications, and increased use of photocells in old applications has caused the market in these devices to *double* each year, during the past few years. These applications cover a dozen or more broad fields, from toys to missiles.

Applications of light-sensitive devices have been growing fast in photography. Until a year ago, only one kind of cell was used here, and this was the selenium photovoltaic cell which had been around for a

CIRCLE 67 ON READER SERVICE CARD

long time. Since both camera film and lenses have been getting faster and better, photographic instruments have been forced to go to the photoconductors.

One new photo light meter will be on the market next summer. A Clairex cell will be used in this meter which is manufactured by Gossen in West Germany. Kling Photo Corp of New York City will take on this instrument for distribution in this country. The new meter uses cadmium sulphide which is about 128 times more sensitive to light than any meter that works on selenium. The meter operates at such low light levels that a flashlight is sometimes needed to read the meter. Deuth predicts that in a few years most cameras, both still and motion picture, will incorporate photocells, principally photoconductors.

Right now the market for automatic street light switches is about one-half million units a year. This is but a fraction of the potential seen in the years to come. The use of light-sensitive devices to light up telephone booths has shown activity in the past few weeks. And one big hotel chain operator is currently interested in equipping all of his hotel rooms with cells that will detect smoke and fire in his enormous chain of hotels. Installation is relatively inexpensive and maintenance costs are low.

Computer people can envision photoconductive elements coupled to electrolumenescence units to form logic circuits. Even though their speeds are much slower, their capacity will be so tremendous, and their cost so reasonable, that their use will make them very attractive.

Deuth can enumerate any number of intriguing uses of photoconductive cells. Use in electronic organs will eliminate key clicks. And eventually every key on the organ could work in conjunction with photoconductive cells. In the automobile area, laws may one day incorporate the use of automatic headlight dimmers, and use in rear-view mirrors; as they now require on the automatic signaling devices.

Although the Soviets claim they have worked out several designs based on new materials like cadmium selenide and cadmium sulphide it is very apparent that we have many more types here. Clairex alone offers at least 25 standard types of yielding a wide range of design parameters, and have at least that number again of types that have been worked out for special applications.

One very useful survey of light-sensitive devices has been made by Philips of Einhoven[2]. The Philips brochure discusses the principles underlying the photoelectric effect, followed by detailed examination of the properties of light-sensitive devices with a view of their suitability for certain applications. In Europe, they seem to be using more photocells for tv controls and oil burner controls. But here in this country we have a tremendous number of important applications which the Europeans do not even bother with.

At the present, there are no accepted standards in photoconductors, but it is assumed that with increased awareness of the use and function of these units, both in military and commercial applications, definite standards will evolve.

Russian applications of photocells follow industrial-control applications obvious here: automatic counting, alarm and safety devices, edge-position control, direct control of thyratrons, transistor circuits and relays: all accurate and rapid methods of measurement, regulation and control.

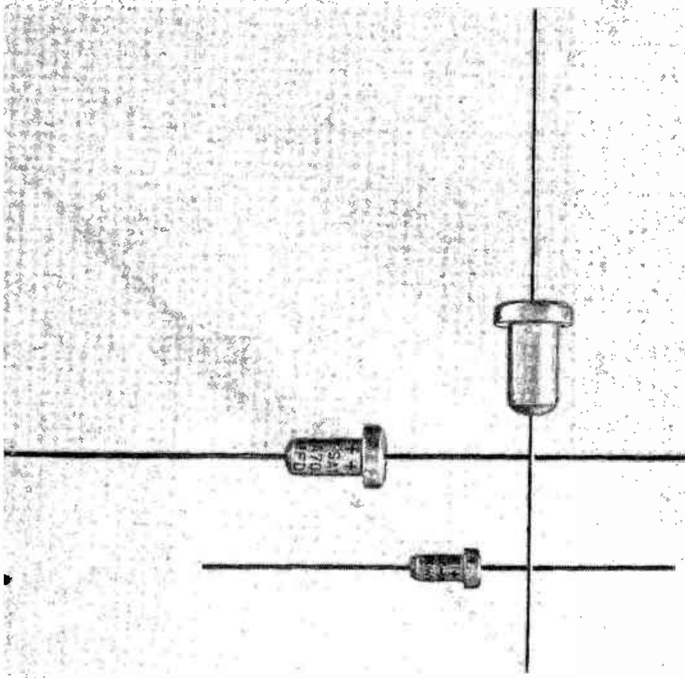
REFERENCES

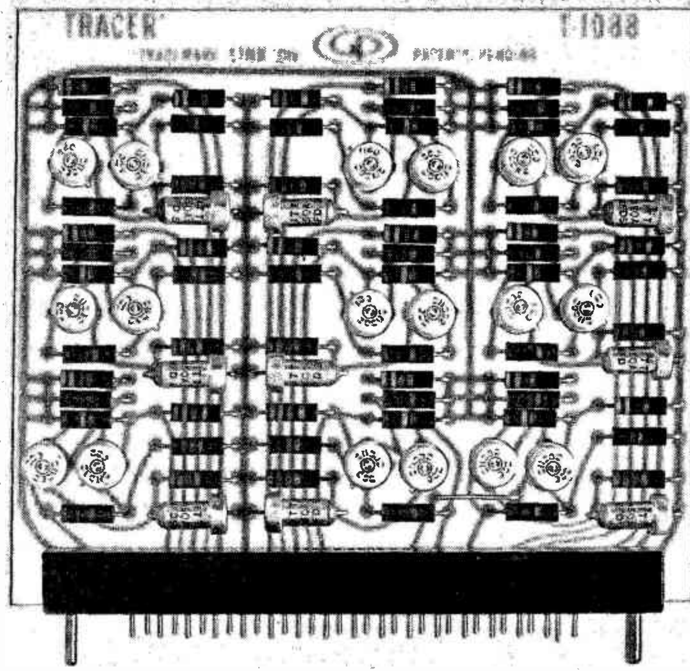
(1) A. F. Deuth, President, Clairex Corporation, 19 West 26th St., New York City.

(2) Light-Sensitive Devices, Philips Electron Tube Division, Industrial Components and Materials Division, Einhoven, Holland.

Microminiature Bearing For Computers

FLY-SPECK sized bearing recently announced by GM's New Departure Division, has 0.01 in. inside and 0.047 outside diameters with eight 0.01-diameter balls. Although not designed for a specific application, one manufacturer is evaluating the bearing for use in a miniature gear box associated with an analog computer considerably smaller than any built to date. A firm making elapsed time indicators is also interested in the development.





Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.

TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER

HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.

ITT

COMPONENTS DIVISION
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
815 SAN ANTONIO RD., PALO ALTO, CALIF.

Phone these ITT-CD Capacitor Sales Offices:

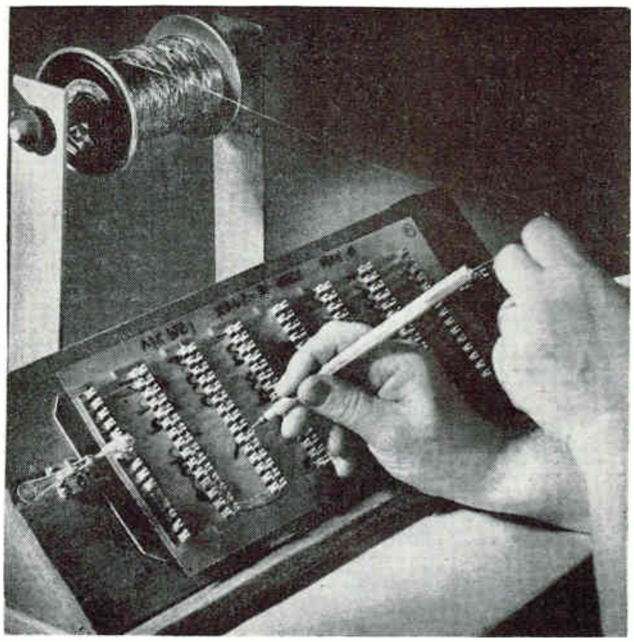
Albuquerque	AX 9-8013	Los Angeles	HI 6-6325
Boston	CA 7-2980	Miami	MI 4-3311
Chicago	SP 7-2250	Minneapolis	WE 9-0457
Cleveland	GR 5-3080	New York	LO 5-1820
Dallas	EM 1-1765	Philadelphia	TR 8-3737
Dayton	BA 8-5493	Phoenix	WH 5-2471
Denver	KE 4-5091	Rochester	FI 2-1413
Detroit	TO 8-3322	San Francisco	LY 1-7321
Fort Wayne	HA 0641	Seattle	MA 2-5433
Kansas City	JE 1-5236	St. Louis	EV 2-3500

IN STOCK AT ITT DISTRIBUTORS:

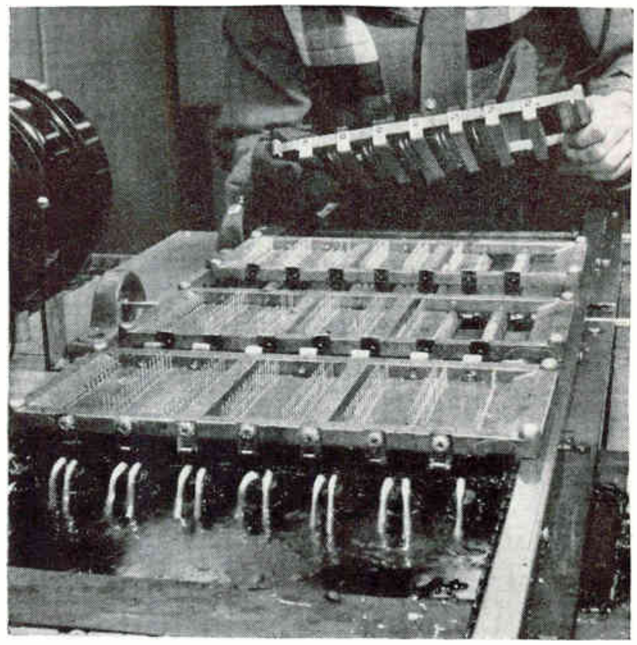
- TWO TYPES—M-Type and P-Type, for applications from −55 to 85 and 125 C. respectively
- 29 VALUES—from 1.75 to 330 mfds over a working voltage range to 125 VDC and maximum surge voltages to 140 VDC
- COMPACT AND RUGGED—sintered tantalum slug in fine-silver cases for 2000-hour life at maximum temperature and working voltage
- GUARANTEED—to 80,000 ft. and accelerations of 20 G's with a 0.1 in. excursion in 50-2000 cps range
- LONG STORAGE LIFE—tantalum-oxide dielectric is completely stable; assures trouble-free operation

COMPLETE SPECIFICATIONS ON ITT wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

ENGINEERS: Your ITT representative has a complete set of qualifications and quality control tests for your inspection.



Pencil is used to thread jumper wire along route marked on template



Rows of computer panel terminals are carried over jets of molten solder

Solder Jets, Wire Pencil Speed Paneling

MULTISTREAM SOLDERING machines provide a method of rapidly, selectively and thoroughly soldering connections spaced in even rows on component boards. The Electronic Data Processing Division, Minneapolis-Honeywell Regulator Co., Boston, Mass, reports that this method results in reduced cost and improved quality for electronic computer panels.

Rows of terminals characterize a type of panel used by the firm. After jumper wiring has been placed on the terminals (by the method described below) and components are mounted, the panels are secured in metal mounting frames. The frames are placed on moving tracks, which carry them through a fluxing station and then over the soldering streams or jets.

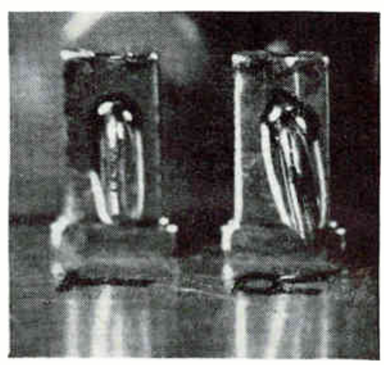
The height and direction of the solder streams are controlled by nozzles in the solder pot. The nozzles are fed from a pump located in the molten solder. Each stream bathes a row of terminals as the frame passes over the pot. Eutectic solder is used. Solder temperature is automatically controlled. Oil covers the entire surface of the pot to prevent dross formation.

There are nominally 210 terminals per panel. The machine solders a panel every 18 seconds, about a tenth of the time needed for bench soldering. In addition, the streams coat the entire wire-terminal connection with a bright coating of minimum thickness, saving solder and making any poor lead positioning easy to spot.

The jumper wiring technique which Minneapolis-Honeywell has devised for preparing the panels takes about an eighth of the time required by conventional methods, the company reports. It eliminates individual wiring of connections and constant reference to blueprints or run sheets.

The wiring pencil is a standard drafting-type pencil with a specially hardened tip locked in its jaw. The wire is threaded through the pencil and tip. The assembler is also given a plastic template, cut to fit the panel, and marked with red and black lines indicating a continuous wire route. The rows of terminals fit through the cutouts in the template.

The panel and template are placed in a holding fixture. The operator starts jumpering at a terminal position marked "S" on the template. He holds the tip end of the wire in position with his left hand while the right hand holding the pencil makes a 360-degree wrap around the first terminal.



Solder outlines wire and terminal with a minimum coverage of solder

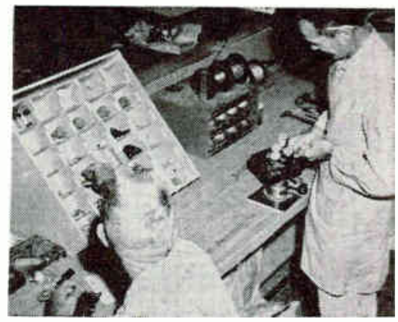
Next, the left hand grasps the wire above the pencil to secure correct tension on the wire, while the right hand with the pencil follows in sequence the black and red lines. A 360-degree wrap is made around each designated terminal.

After the last wrap, the wire is

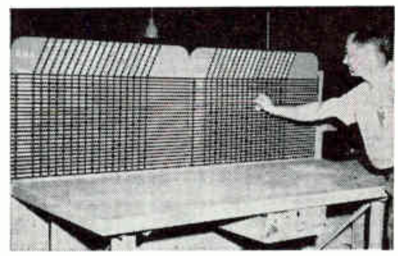
cut. All wires corresponding to red lines on the template are cut out. The remaining wire ends are crimped with narrow, long-nose pliers.

Racking Large Parts Ends Hunting in Bins

Subassemblies racked ready for final assembly. Below table are boxes formerly used



Two assemblers share rack of gear-box parts



Progress of Units is noted on indicator board

PLACING LARGER parts in open racks at eye level makes it unnecessary for assemblers to waste time hunting through storage bins and boxes. The racks are made of wood, with a series of pigeon holes. Inclining the racks prevents parts from falling out and makes them easy to see. Assembly indicator boards are another timesaver used by Dalmo Victor Co., Belmont, Calif. These tabulate the progress of a unit through various subassemblies and tests. Anyone who wants to know the status of a unit looks at the board instead of interrupting production personnel.

Clean Room for Bearing Assembly

Walls of this clean room slant outward from the ceiling and are made of metal and glass. The metal is grounded with copper wire. Design is intended to prevent dust from settling by gravity or static. Among other precautions are sloping assembly hoods, rounded corners, flush-mounted plate glass doors, joints filled with plastic metal. Room was built by New Departure Div., GM, Sandusky, O., for instrument bearing assembly

1960 Semi-annual Index to electronics

McGRAW-HILL PUBLISHING CO.
330 West 42nd St. New York 36

July through December Issues VOLUME XXXIII

INDEX CODE KEY

The letters preceeding the page number and Issue date indicate the type of article or regular editorial department, as follows:

BF-Business Article
CM-Components and Materials
CT-Comment
EN-Engineering Newsletter
ERS-Electronics Reference Sheet
MR-Marketing
PC-Picture with Caption
PT-Production Techniques
RD-Research and Development
SR-Special Report
TF-Technical Feature Article
WD-Washington Outlook

A

CRYSTALS

CURVES

D

DATA PROCESSING

DETECTORS

DIGITAL TECHNIQUES

DIODES & DIODE CIRCUITS

DISPLAYS

E

ENVIRONMENTAL TESTING

EXHIBITIONS

F

MINIATURIZATION

MISSILES

MODULATORS

N

NAVIGATION

NETWORKS

NOMOGRAPHS & CHARTS

NUCLEONICS

O

OCEANOGRAPHY

OPTICS

OSCILLATORS

PULSE TECHNIQUES

Q

R

RADAR

RADAR & RADIO ASTRONOMY

RADIATION

RECEIVERS

RECORDERS

RECTIFIERS

(See also Diodes, Power Sources)

REGIONAL DEVELOPMENTS

REGULATORS

SOLID STATE PHYSICS

SONAR

SPACE

SUPERCONDUCTIVITY

SWITCHES & SWITCHING

T

TELEMETRY

TELEVISION

TEST EQUIPMENT

AUTHORS' INDEX

(All entries are technical feature articles unless otherwise indicated by prefix)

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

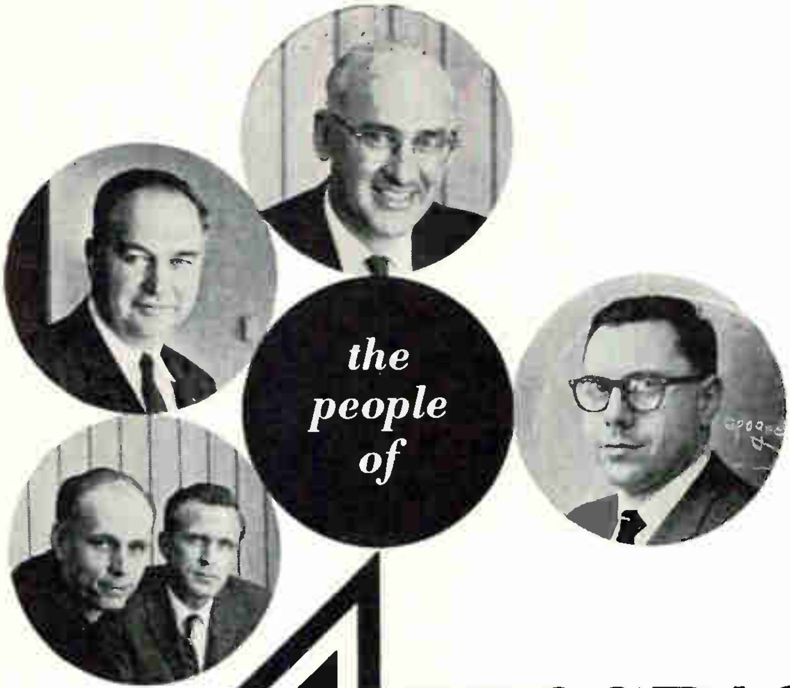
U

V

W

X Y Z

To order Reprints of this Index address requests to Reader Service Dept. Electronics, 330 W. 42nd St., N.Y. 36, N. Y. Price: 1-10, 50¢ each, 11-24, 40¢ each, 25 or more 30¢ each.



AEROSPACE CORPORATION

are creating a climate conducive to significant scientific achievement

"Essentially, this corporation will be people—people of the highest quality. The United States Air Force recognizes that men of great scientific and technical competence can perform at their best only when they can exercise their initiative to the full under leadership which creates the climate for creativity. We expect Aerospace Corporation to provide that kind of environment."

SECRETARY OF THE AIR FORCE

Among those providing their leadership to this new non-profit public service corporation are: Dr. Ivan A. Getting, president; Allen F. Donovan, senior vice president, technical; Jack H. Irving, vice president and general manager, systems research and planning; Edward J. Barlow, vice president and general manager, engineering division; and Dr. Chalmers W. Sherwin, vice president and general manager, laboratories division.

These scientist/administrators are now selecting the scientists and engineers who will achieve the mission of Aerospace Corporation: concentrating the full resources of modern science and technology on rapidly achieving those advances in missile/space systems indispensable to the national security.

The functions of Aerospace Corporation include responsibility for: advanced systems analysis; research and experimentation; initial systems engineering; and general technical supervision of new systems through their critical phases, on behalf of the United States Air Force.

Aerospace Corporation is already engaged in a wide variety of specific systems projects and research programs—offering scientists and engineers the opportunity to exercise their full capabilities, on assignments of unusual scope, within a stimulating environment.

Immediate opportunities exist for:

- SENIOR ELECTRONICS ENGINEERS:
  - Communications Systems
  - Navigation Electronics
  - Radio Techniques
  - Electro-Mechanical Design
  - Information Theory
  - Sensing Systems
- SPACE VEHICLE SPECIALISTS:
  - Senior Power Systems Engineer
  - Sr. Flight Performance Analyst
  - Re-entry Aerodynamicist

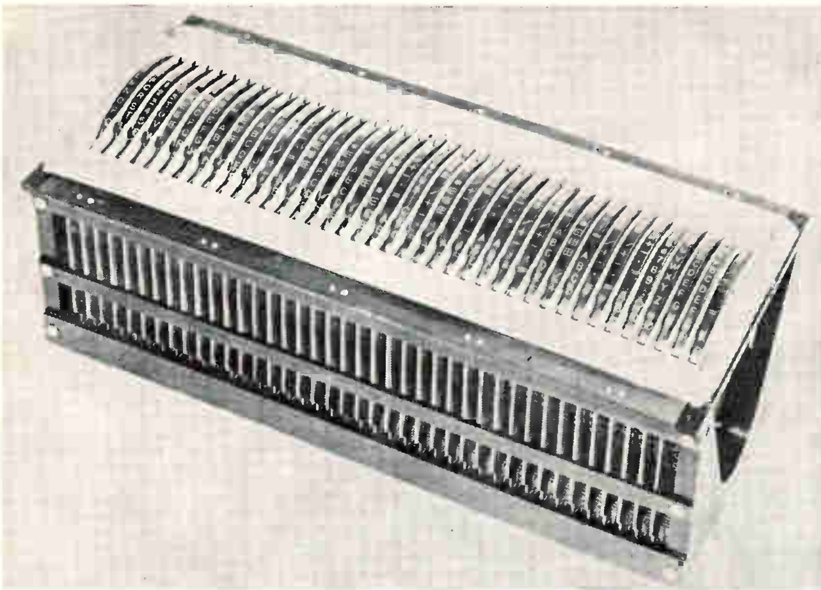
Those capable of contributing in these and other areas are invited to direct their resumes to:

Mr. James M. Benning, Room 110
P.O. Box 95081, Los Angeles 45, Calif.

AEROSPACE CORPORATION

A new and vital force engaged in accelerating the advancement of space science and technology

New On The Market

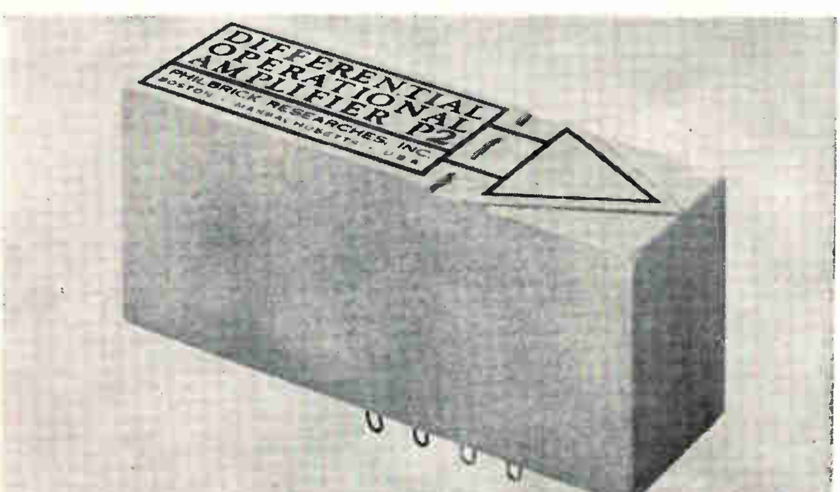


Printed-Circuit Switch
THOUSANDS OF POSITIONS

PRINTED CIRCUITS and modular construction are used by Instrument Systems Corporation, College Point, L. I., N. Y. in a compact high-capacity data switch. The model shown has 40 single-pole switches, each of which can be manually positioned to select one of 56 contacts on glass fiber, laminated printed-circuit boards. A typical application for this particular arrangement is to signify the keyboard characters of a teletypewriter. Knurled edges and high visibility of the markings allows messages or programs to be set up quickly. Positive detents are provided.

The thin, compact design extends 6 inches behind the mounting panel; 12 switches fit in less than 5 inches of length. Banks of the units, with front cover masks to expose a single line of characters, and provided with accessory strip channels for removable reminder tapes, can, with high reliability, accommodate long messages.

CIRCLE 301 ON READER SERVICE CARD



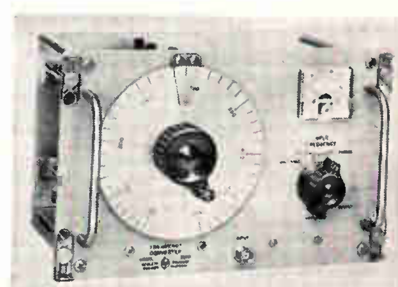
Operational Amplifier
ALL SOLID STATE

ALL SOLID-STATE differential operational amplifier, Model P2, is a true d-c differential amplifier whose input is entirely floating and yet has long-term drift stability in the sub-millivolt region. Typical input current is under a tenth of a nanoampere, thus making possible the amplifier's use in long-time-constant integrating circuits or in electrometer-type amplifier circuits. There is no limit on the size of a common mode signal except the dielectric strength of the insulating materials.

Price is \$185 in lots of 25; internal dissipation is about 300 milliwatts, fully loaded; size is $1\frac{1}{4}$ W × $1\frac{11}{16}$ H × 4 inches L; power supply is ±15 volt d-c. Typical open loop gain is over 30,000; frequency response has a smooth roll off, with the unity gain frequency above 75 Kc.

The amplifier is suited to high reliability test and control equipment, although it was designed originally for computing systems. The low current drain of 10 ma makes possible compact, battery operated measuring instruments. High input impedance and low input leakage current allow the amplifier to be used with the same values of resistance and capacitance normally used with vacuum-tube units. Operational amplifier is manufactured by George A. Philbrick Researchers, Inc., 285 Columbus Ave., Boston 10, Mass.

CIRCLE 302 ON READER SERVICE CARD



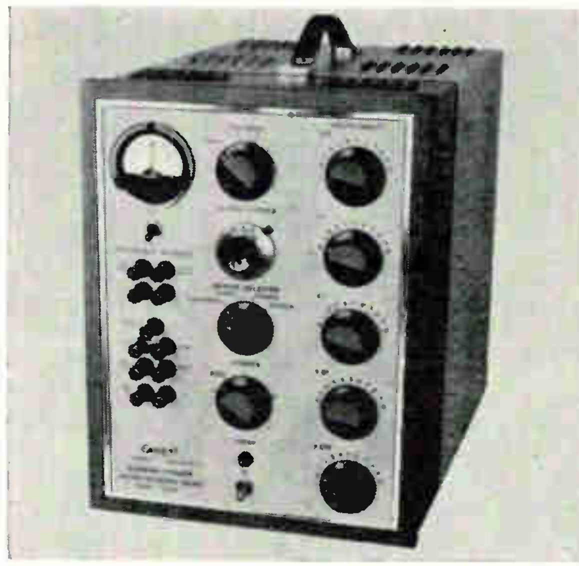
Plug-in Adapter
UPS COUNTER TO 510 MC

VERSATILE plug-in unit that increases the measuring capability of Model 524 electronic counters to 510 Mc is now available from Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif.

The frequency converter unit, Model 525C, can be used in Model 524B, C or D counters to measure frequencies between 100 and 510 Mc with 100 mv sensitivity, and to amplify signals between 50 Kc and 10.1 Mc with 20 mv sensitivity.

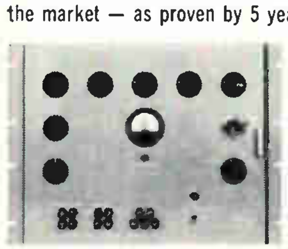
IN PRECISION INSTRUMENTATION

EPSCO DELIVERS ITS SPECIFICATION



IF YOU NEED .01% ACCURACY IN VOLTAGE REFERENCES

Epsco Secondary Standard Voltage References outperform all others on the market — as proven by 5 years of outstanding service in the most critical and demanding applications. These precision instruments perform a wide range of functions in research and production calibration and testing. Available from stock in 4 standard models. For full details, call or write for Bulletin #26001.



FEATURES:

- Accurate to 0.01%, stable to 0.005%
- 1 μV resolution down to zero volts
- Output impedance less than 0.006 ohms
- Direct reading: more speed, fewer errors
- Adjustment-free, drift-free operation
- Built-in null meter
- Self-contained, portable or rack mount

SPECIFICATIONS:

REFERENCE OUTPUTS:
Voltages . . . ±100 v d-c, 200 v d-c
Current . . . 5 ma d-c
Resistance . . . 1 ohm max.
Absolute accuracy . . . ±.01% initially
Drift . . . ±.02% per year, ±.005% max. during first hour after ten-minute warmup

SELECTABLE OUTPUTS:
Decimal voltage range . . . ±111.112 v d-c
Binary voltage range . . . ±100.0008 v d-c
Current . . . ±15 ma

Epsco INSTRUMENTS

A division of Epsco, Incorporated, 275 Massachusetts Ave., Cambridge 39, Mass. Telephone UNiversity 4-4950

Features include stability of 5 parts in 10^8 per week for frequency indications to 10.1 Mc directly, time interval from 1 microsecond to 100 days, period from 0 cps to 100 Kc, and maximum resolution of 100 nanoseconds.

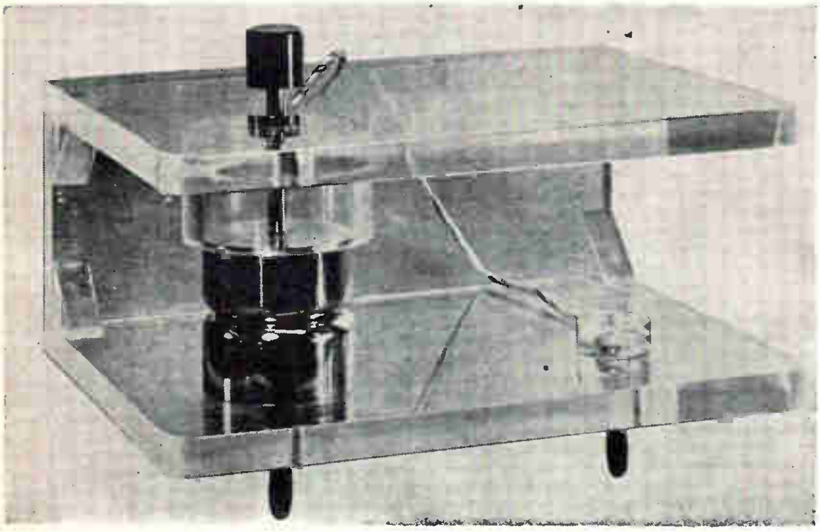
The plug-in contains a capacitance-loaded cavity for frequency determination, a diode harmonic generator and a transistorized amplifier. A go no-go meter on the front panel shows when the signal has enough amplitude for frequency measurements.

CIRCLE 303 ON READER SERVICE CARD

used to activate the switch. The counters may be directly cascaded and can be driven by a 12-volt signal, making them compatible with existing transistor logic circuits.

Price is $100, with deliveries scheduled to begin during Jan., from Burroughs Corporation, Electronic Tube division, Box 1226, Plainfield, N. J.

CIRCLE 305 ON READER SERVICE CARD



Insulation Test Fixtures
TO ASTM STANDARDS

LINE OF interchangeable fixtures for testing dielectric strength of insulating solids, films, sheets and liquids in accordance with ASTM standards has been developed by Associated Research, Inc., 3777 West Belmont Avenue, Chicago 18, Ill.

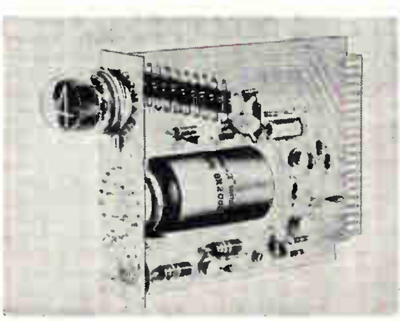
Fixtures with electrodes of various sizes and designs meet ASTM specifications for: thin sheet material; cloth tapes; thick, solid materials; sheet and plate materials; friction and rubber plates; solid compounds; and laminated sheets. An adapter cup makes possible tests in oil.

Although primarily intended for use with the company's line of insulating materials testers, the fixtures may be used with many other instruments when the Model 8539 high-voltage test cage is installed. The test cage has plug-in connectors for the complete line of test fixtures. It is constructed of transparent Lucite, allowing safe viewing of the insulation sample under test. An interlock switch removes output voltage when the test cage is opened.

CIRCLE 304 ON READER SERVICE CARD

Decade Counter
OPERATES TO 110 KC

TRANSISTORIZED decade counter is first in a series of units that use the Shielded Beam-X switch tube. Packaging design permits the counting tube and a visual readout to be mounted on a single plug-in module. Since the Shielded Beam-X switches can be stacked side by side without magnetic interaction, the Nixie indicator tube can be an integral part of the decade-counter package.

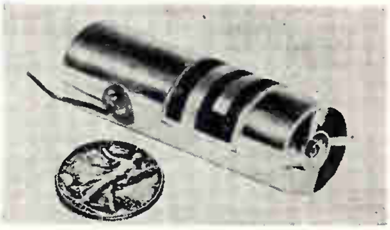


The DC-114 counter, designed for frequencies to 110 Kc, provides both visual readout and 10 individual constant current outputs for printing, gating, or presetting. A transistorized driving circuit is

Miniature Blower
MOVES 10 CFM

MINIATURE d-c blower, smaller in diameter than a fifty-cent piece, is designed to move 10 cfm of air against 0.3 inch H_2O back pressure. The tube axial blower is $1\frac{1}{8}$ inch in diameter by $3\frac{1}{4}$ inches long, and operates on 27 v d-c. Lower voltages may be used with different motor windings. Unit weighs 3.5 ounces.

The unit shown uses the type VS



motor and is typically used for spot cooling of critical components in a circuit. Blower is manufactured by Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

CIRCLE 306 ON READER SERVICE CARD

Miniature Recorder
INSTRUMENTATION GRADE

PORTABLE MAGNETIC tape recorder has been introduced by Pacific Electro Magnetics Co., 942 Commercial St., Palo Alto, Calif. The model PMR-500 is primarily designed for data acquisition under field or mobile conditions where low power and weight are major considerations.

The unit, $5 \times 7 \times 10\frac{1}{2}$ inches and weighing 10 pounds, will handle data from d-c to 100 Kc at 30 ips (upper frequency proportionally less at lower tape speeds) using a-m and f-m techniques. Any combination of record or reproduce totaling 7 channels can be handled with $\frac{1}{2}$

Tung-Sol Silicon Power Rectifiers

Diffused Junction and Alloy Junction

New freedom for designers

Designers who seek more freedom to use economical components while obtaining maximum equipment reliability should become thoroughly familiar with the Tung-Sol line of silicon rectifiers.

All Tung-Sol rectifiers are designed and manufactured to the same unexcelled standards of quality. At the very minimum, the entire line meets the toughest requirements laid down by military specifications. And you can be sure that wherever more rigid commercial specifications exist, Tung-Sol rectifiers will equal or exceed these higher performance and reliability demands. All in all, Tung-Sol rectifiers afford the widest design flexibility.

This select Tung-Sol line is available in production quantities immediately from stock and at conservative prices. Tung-Sol Electric Inc., Newark 4, N.J.

New Interchangeability chart available

Write for Tung-Sol silicon power rectifier interchangeability chart and catalog today. Forty-four Tung-Sol types replace more than 300 competitive types.

TUNG-SOL®

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. CANADA: Toronto, Ont.

70 A MIN.

20-50 A

70 A MIN.

80 A MIN.

12 A MIN.

250-750 mA

1 A MIN.

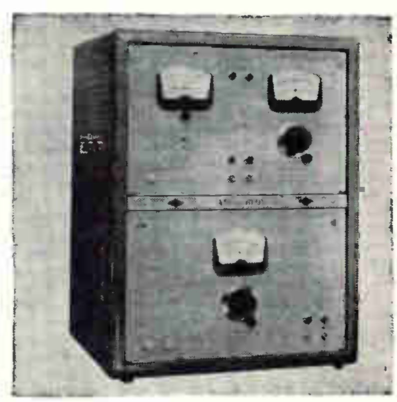
inch tape on precision 5-inch reels. The reels accommodate 900 feet of 1-mil tape, allowing six minutes of recording at 30 ips and up to 96

minutes at $1\frac{7}{8}$ ips. Tapes can also be reproduced on laboratory type recorders.

Specifications of the modular, solid-state unit include: wow and flutter 0.2 percent rms d-c to 300 cps; frequency response 300 cps to 100 Kc ±3 db, direct; d-c to 10 Kc, f-m; power supply 22-30 volts d-c, 20 watts maximum or 115 volts 60 cps; end of reel sensing.

Delivery is 60 days; price is $2,500 to $8,000, depending on model.

CIRCLE 307 ON READER SERVICE CARD

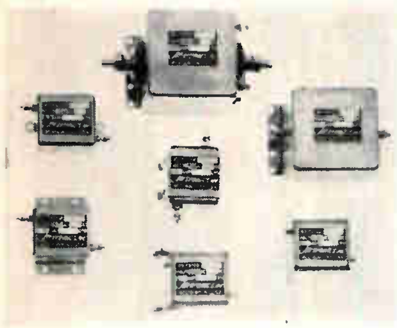


Atomic Clock

BUY OR RENT

MODIFIED precise frequency standard is now available for general industrial purposes at a cost within the budget of many laboratories and industrial organizations. The primary standard is commercially available at a price competitive with that of secondary crystal standards. There are applications for the Atomichron wherever a precise standard is required. The general-purpose industrial clock has fewer controls than the standard unit and is thus simpler to operate. Sale price is $15,000 but the instrument can also be rented on a monthly basis from National Company, 61 Sherman Street, Malden, Massachusetts.

CIRCLE 308 ON READER SERVICE CARD



R-I Filters
STANDARDIZED LINE

ALL-TRONICS, INC., 45 Bond St., Westbury, N. Y., has introduced a line of preengineered, standardized r-i filters designed to be installed in any piece of 400 cycle electronic equipment that generates radio interference. All units are designed for use on critical military equipment. They are available in seven basic case sizes, voltage ratings of 150 v a-c and 250 v a-c, current ratings of 0.40 ampere to 100 amperes and six different types of mounting brackets. Terminals can be had in the following types: threaded, solder (45 or 90 deg) or shielded lead. Since units are standardized, availability is only 1 week. Prices range from $4 to $25 per unit.

CIRCLE 309 ON READER SERVICE CARD

Magnet Wire
MULTICONDUCTOR

SPECTRA-STRIP WIRE & CABLE CORP., Box 415, Garden Grove, Calif., has available Formvar insulated wire in multiconductor cables of the ribbon type. The round wires are bonded into flat cables, using any number of conductors from 2 to 30, and gages from 26 to 44. Production has been centered around 2-4 conductors of 36 to 40 Awg, which are largely used in memory networks and toroid coils.

CIRCLE 310 ON READER SERVICE CARD

Literature of

ELECTRONIC SYMBOLS Chart-Pak, Inc., 1 River Road, Leeds, Mass. A 40-page booklet is devoted to Symbltak pressure-sensitive symbols for electronic drawings and precision die-cut symbols for the printed circuit draftsman.

CIRCLE 311 ON READER SERVICE CARD

VIDEO AMPLIFIERS Motorola Semiconductor Products Inc., 5005 E. McDowell Road, Phoenix, Ariz., has available a 4-page application note describing design of high-quality video amplifier circuits using low-cost 2N741 mesa transistors.

CIRCLE 312 ON READER SERVICE CARD

TRANSISTOR POWER SUPPLIES Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J., announces the availability of its new 8-page, 2-color condensed transistor power supply catalog No. 120.

CIRCLE 313 ON READER SERVICE CARD

RELAY - POTENTIOMETER Raytheon Company, 55 Chapel St., Newton 58, Mass. A full report on the Raysistor, an electro-optical, relay-potentiometer, is contained in a recently published brochure.

CIRCLE 314 ON READER SERVICE CARD

CAPACITOR TESTER Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J. Features, an illustrated description, and specifications for the type A101 capacitor tester are included in a single-page bulletin.

CIRCLE 315 ON READER SERVICE CARD

INCREMENTAL DIGITAL ENCODERS Dynamics Research Corp., 38 Montvale Ave., Stoneham, Mass. Incremental digital encoders based on versatile Optisyn design for digital servos, numerical control systems, integrating accelerometers and inertial platforms are described in new 4-page catalog sheets No. 604-606.

CIRCLE 316 ON READER SERVICE CARD

LOW PASS FILTER Maury & Associates, 10373 Mills Ave., Montclair, Calif., has published a bulletin containing a description, specifications and dimensional drawings of the miniaturized series LP type 2 low pass filter.

CIRCLE 317 ON READER SERVICE CARD

MULTIPLE CONNECTORS AMP Inc., Harrisburg, Pa. An illustrated six-page folder describes a complete line of pin-and-socket type multiple connectors.

CIRCLE 318 ON READER SERVICE CARD

PREDETERMINED COUNTER Potter Aeronautical Corp., Route No. 22, Union, N. J. A four-page folder describes and illustrates an automatic predetermined counter that provides push button control of fluid measuring, batching, mixing or blending.

CIRCLE 319 ON READER SERVICE CARD

MYLAR FILM CAPACITORS John E. Fast & Co., 3598 N. Elston Ave., Chicago 18, Ill., has prepared a bulletin describing the new low-priced Fast series 9FM tubular capacitors with Mylar dielectric and plastic cases.

CIRCLE 320 ON READER SERVICE CARD

ACCELEROMETERS Schaevitz Engineering, Rt. 130 at Schaevitz Blvd., Pennsauken, N. J., announces publication of a four-color, four-page bulletin describing its full line of linear and angular accelerometers.

CIRCLE 321 ON READER SERVICE CARD

SERVO DEVELOPMENT KIT Precision Mechanisms Corp., 577 Newbridge Ave., East Meadow, L. I., N. Y. Bulletin 105 illustrates and describes a kit consisting of a permanently packaged group of standardized servomechanism components from which a virtually unlimited variety of mechanisms and gear trains can be assembled.

CIRCLE 322 ON READER SERVICE CARD

BONDABLE POLYETHYLENE Mereco Products Division, Metachem Resins Corp., 530 Wellington Ave., Cranston 10, R. I., announces a new brochure, TSB-3-625-1060, entitled "Preparation of Polyethylene Surfaces For Bonding." Copies may be obtained by writing on company letterhead.

Bradburn: What Can You Do Best?

NEWEST MEMBER of Burroughs Corporation's board of directors is a soft-spoken man with firm convictions. James R. Bradburn speaks with equal candor on subjects ranging from company production methods to engineering education.

In this latter category, he is, perhaps, more qualified to speak than many, as he holds both electrical and mechanical engineering degrees —California Institute of Technology, 1932—plus a master's degree from the Harvard School of Business Administration, 1934.

After graduation, Bradburn worked in both engineering and administration capacities for General Electric, Eastman Kodak and others. His industrial career was set aside during World War II. He rose to the rank of major, served as chief of the Rochester Ordnance District Artillery branch.

After the war, he became treasurer of Consolidated Electrodynamics Corp., in California, and also served as assistant to the president. He became director of sales and, later, vice president in charge of engineering. When Consolidated established a new computer division in 1953, Bradburn was chosen to head it. In 1954, when the division was made into a separate entity, ElectroData Corp., he was made its president.

Three years later, ElectroData was acquired as a subsidiary of Burroughs. Bradburn was made a vice president of Burroughs and general manager of the operation. A few weeks ago, he was made a director of the firm.

In his new role, Bradburn maintains the same principle that led him to his present post, his great interest in people. "How do you apply people's abilities? What can this man do best?" are questions he keeps constantly in mind. His personal interest in people around him was shown graphically in a recent Community Chest drive in Detroit.

Not content with merely circulating a memorandum urging employees to participate in the fund-raising effort, he joined with Burroughs president Ray Eppert and went from plant to plant talking to workers and telling them his feelings about the company's role in the community. "A company, like an individual, must be a good neighbor if it wants to be respected in the neighborhood," he said.

Regarding engineering education, he joins with many members of the electronics industry by saying engineers should include subjects in their curriculum that will make them better able to communicate with nontechnical people. He goes this one better, however, by suggesting that part of the communications burden must also be assumed by the liberal arts man. "Ideally, liberal arts programs should contain at least 20 percent of effort directed towards understanding technology."

Regarding prospects for his teenage sons, Kenneth and James, becoming engineers, he says, "I think any young person with the aptitude would do well to go into engineering, but I still say it's a matter of what you do best and how you can apply it." He adds with a smile that one of the boys is making his own f-m receiver with no help from dad.

Recreational activities for Bradburn have changed since he moved to Michigan from California. He is regaining enthusiasm for squash and tennis, while still enjoying an occasional game of golf. In addition, woodworking and electronics kits occupy home leisure time. Besides these activities, Bradburn is a member of Tau Beta Pi, Eta Kappa Nu, American Management Association, AIEE and IRE. He also belongs to the Association of Computing Machinery and the Instrument Society of America.

Besides the two boys, the Bradburns have a daughter, Alice, in college. The family lives in Birmingham, near Detroit.

Heins Takes Key Post With Servo Corp.

JOHN L. HEINS has joined Servo Corp. of America, Hicksville, N. Y., as director, defense systems.

Before coming to Servo, Heins was vice president, engineering, with G. B. Electronics Corp., a subsidiary of General Bronze Corp.

DeJur-Amsco Appoints Aaron Blaustein

RALPH A. DEJUR, president of DeJur-Amsco Corp., Long Island City, N. Y., announces the appointment

of Aaron Blaustein as chief research and development engineer of a new R&D department established for the design and manufacture of a line of transducers, accelerometers and pressure switches.

Blaustein was formerly associated with Fairchild Controls Corp. of Hicksville, N. Y.

Louis Lavine Heads Programming R&D

APPOINTMENT of Louis R. Lavine as manager, programming research and development for the computer division, government and industrial group, Philco Corp., Willow Grove, Pa., is announced. He was formerly assistant manager, and succeeds Saul Rosen who has entered private practice as a consultant in the general field of computing and data processing.

Falls Assumes New Motorola Post

EDWARD L. FALLS, JR., has been named general manager of Motorola Aviation Electronics, Inc., Culver City, Calif. He was transferred from Chicago to assume the position left vacant by the resignation of Kenneth M. Miller.

A vice president of Motorola Communications and Electronics, Inc., Falls has been associated with Motorola since 1948 in several managerial posts.

Shure Brothers Expands Evanston Factory

CONSTRUCTION has started on a 38,000 sq ft manufacturing addition to the Evanston, Ill., plant of Shure Brothers, Inc. The two-story addition will add 43 percent more space to the company's present 88,000 sq ft building. Completion date is scheduled for July 1, 1961.

Since it was organized in 1925, the company moved to larger quarters several times. It was located in, or adjacent to, downtown Chicago for 31 years. In 1956, the Evanston plant became the company's permanent home.

Elion Appoints Department Head

ELION INSTRUMENTS, INC., Bristol, Pa., has announced the appointment of Arthur E. Hartung to the position of manager, product engineering department.

Hartung came to Elion from the RCA defense electronics plant in Moorestown, N. J., where he held the position of manager, special projects unit of the radar advanced project development department.

Acton Labs Announces Name Change

LEROY C. BOWER, general manager, announces a change in name from Acton Laboratories, Inc. to Technology Instrument Corporation of Acton.

This change is expected to simplify marketing of the Acton, Mass., firm's diversified product lines con-

EMPLOYMENT OPPORTUNITIES

sisting of measurement and control instrumentation, rocket, missile and satellite instrumentation and systems, and communications equipment.

Norden Division Hires Vavoudis

SOCRATES N. VAVOUDIS has joined United Aircraft Corporation's Norden Division, Stamford, Conn., as supervisor of the environmental laboratory.

He comes to Norden from Itemlab Inc., Port Washington, N. Y., where he was director of engineering. He previously served in various engineering capacities with General Precision Laboratory and Electricoil Transformer Corp.

Sperry Gainesville Ups Five Key Men

IN A REALIGNMENT of division management, Sperry Electronic Tube Division of Sperry Rand Corp., Gainesville, Fla., has promoted the following key men:

Luther K. Cisne—formerly product engineering superintendent, now assistant to the general manager for long range planning.

George A. Holschuh—formerly purchasing and production control superintendent, who was named manufacturing services manager.

Paul B. Bergman—named plant engineering manager from his former post of building services and security superintendent.

Phillip M. Lally—elevated to product engineering manager from previous duties as production engineering superintendent.

Harry R. Furst—promoted to contracts manager from his previous position as planning superintendent.

INDEX TO ADVERTISERS

Audited Paid Circulation

* See Advertisement in the July 20, 1960 issue of Electronics Buyers' Guide for complete line of products or services.

■

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

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

electronics

Audit Bureau of Circulations

Associated Business Publications

Audited Paid Circulation

BRUCE A. WINNER,
Advertising Sales Manager

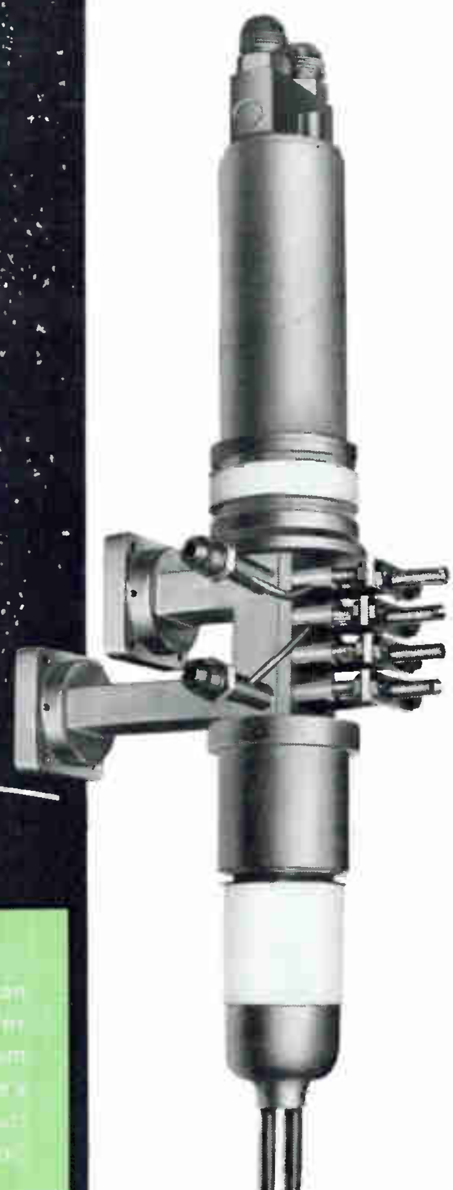
R. S. QUINT, Assistant Advertising Sales Manager and Buyers' Guide Manager; FRED STEWART, Promotion Manager; RICHARD J. TOMLINSON, Production Manager; GEORGE E. POMEROY, Classified Manager; HUGH J. QUINN, Circulation Manager.

ADVERTISING REPRESENTATIVES: NEW YORK Donald H. Miller, Henry M. Shaw, George F. Werner; BOSTON William S. Hodgkinson, Donald R. Furth; PITTSBURGH David M. Watson; PHILADELPHIA Warren H. Gardner, William J. Boyle; CHICAGO Harvey W. Wernecke, Martin J. Gallay; CLEVELAND P. T. Fegley; SAN FRANCISCO T. H. Carmody, R. C. Alcorn; LOS ANGELES Carl W. Dysinger, D. A. McMillan, Marshall Freeman; DENVER J. Patten; ATLANTA M. Miller; DALLAS Robert T. Wood; LONDON Edward E. Schirmer; FRANKFURT Stanley R. Kimes; GENEVA Michael R. Zeynel.

BRANCH OFFICES: National Press Bldg., Washington 4, D.C.; McGraw-Hill Bldg., Copley Square, Boston 16; Four Gateway Center, Pittsburgh 22; Six Penn Center Plaza, Philadelphia 3; 520 North Michigan Avenue, Chicago 11; 55 Public Square, Cleveland 13; 68 Post Street, San Francisco 4; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2; 1301 Rhodes-Haverty Bldg., Atlanta 3; 901 Vaughn Bldg., Dallas 1; McGraw-Hill House, London E.C.4; 85 Westendstrasse; Frankfurt/Main; 2 Place de Port, Geneva.

for space systems

20kW CW at X-band



Varian's new VA-849 amplifier klystrons are rated to deliver higher CW power at X-band than any existing tube in the world . . . 20kW!

Varian's new VA-849 power klystron opens up a variety of new design approaches to space systems. Possible applications exist in communication concepts such as repeater satellites, moon-bounce signalling, or in reflections from clouds of tiny orbiting needles. Radio astronomers, too, will welcome the VA-849.

Immediate applications include CW radar and illuminator service. Low incidental noise. Water cooling. Electromagnet focusing. Another significant advance in microwave components from Varian's broad experience and research in super-power tubes.

FEATURES

- **7.125 to 8.5 kMc**
- **20 kW CW**
- **50 db Gain.**
- **30 Mc Minimum Bandwidth**
- **Tunable 60 Mc.**

[illegible]

VARIAN associates

PALO ALTO 1, CALIFORNIA

Representatives throughout the world

BOMAC LABORATORIES, INC.
VARIAN ASSOCIATES OF CANADA, LTD.
S-F-D LABORATORIES, INC.
SEMICON ASSOCIATES, INC.
SEMICON OF CALIFORNIA, INC.
VARIAN A.G. (SWITZERLAND)