Can 12 Men Run a Submarine?

page 28

electronics

A McGRAW-HILL PUBLICATION JANUARY 29, 1960 PRICE SEVENTY-FIVE CENTS

Cryotron Shift Register

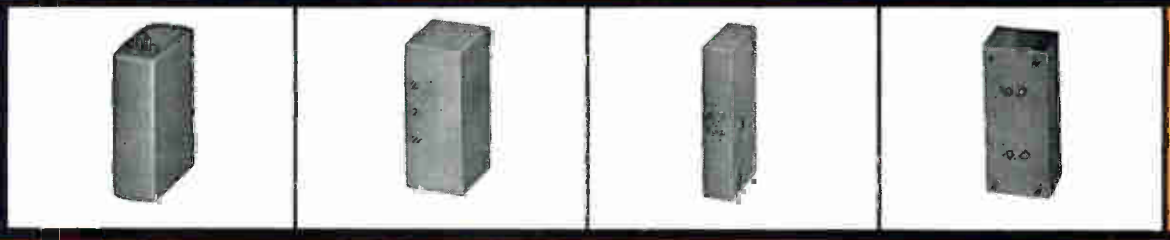
page 55

For Your Special Applications

The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

FILTERS

All types for frequencies from .1 cycle to 400 MC.



400 ⎓ telemetering, 3 db at ⎓ 7.5%, 40 db at 230 and 700 ⎓, ⅜ x 1¼ x 2"

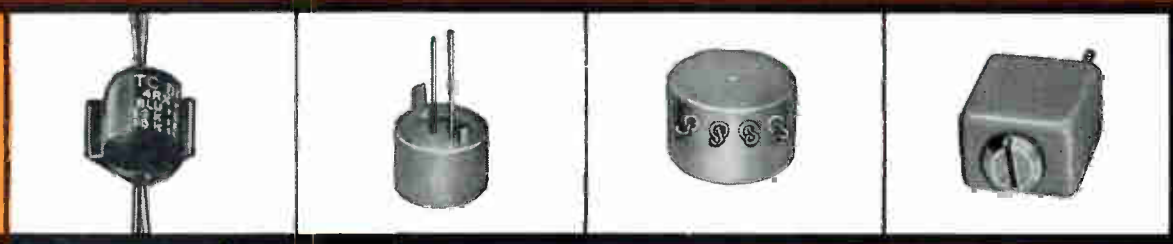
15 ⎓ BP filter, 20 db at 30 ⎓, 45 db at 100 ⎓, phase angle at CF less than 3° from —40 to + 100° C.

LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.

LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

HIGH Q COILS

Toroid, laminated, and cup structures from .1 cycle to 400 MC.



Tuned DO-T servo amplifier transformer. 400 ⎓ .5% distortion.

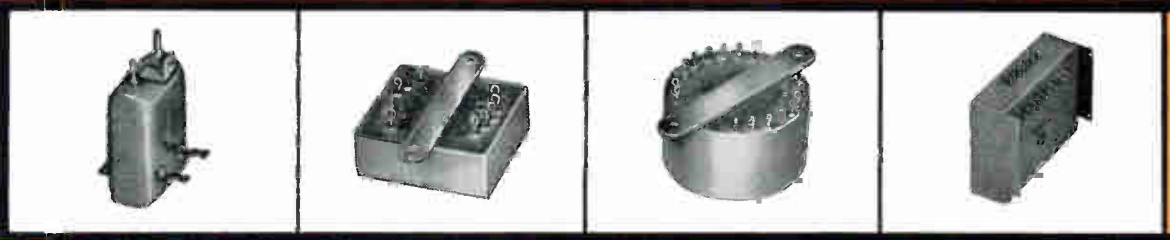
Toroid for printed circuit, Q of 90 at 15 KC.

Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.

HVC tapped variable inductor for 3 KC oscillator.

SPECIALTIES

Saturable reactors, reference transformers, magnetic amplifiers, combined units.



RF saturable inductor for sweep from 17 MC to 21 MC.

Voltage reference transformer .05% accuracy.

Multi-control magnetic amplifier for airborne servo.

Input, output, two tuned interstages, peaking network, and BP filter, all in one case.

PULSE TRANSFORMERS

From miniature blocking oscillator to 10 megawatt.

Wound core unit .01 microsecond rise time

Pulse current tansformer 100 Amp.

Pulse output to magnatron, bifilar filament.

Precise wave shape pulse output, 2500 V 3 Amps.

POWER COMPONENTS

Standard and high temperature . . . hermetic, molded, and encapsulated.

Multi-winding 140 VA, 6 KC power transformer 1¼ x 1¼ x 1"

200° C. power transformer, 400 ⎓, 150 VA

400 ⎓ scope transformer, 20 KV output.

60 ⎓ current limiting filament transformer, Sec. 25 Mmfd., 30 KV hipot.

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CABLES: "ARLAB" PACIFIC MFG. DIVISION, 4008 W. Jefferson Blvd., Los Angeles, Cal.

electronics

JANUARY 29, 1960

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Vol. 33 No. 5

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OUTSTANDING PRODUCT FEATURES

highest device dissipation
400 mw at 25°C
170 mw at 125°C

highest junction temperature
200°C

guaranteed β at 150°C
(2N1440 series, only)

guaranteed high temperature I_{CBO}
(2N1440 series at 150°C)
(2N327A series at 125°C)

contamination-free...
no desiccants used

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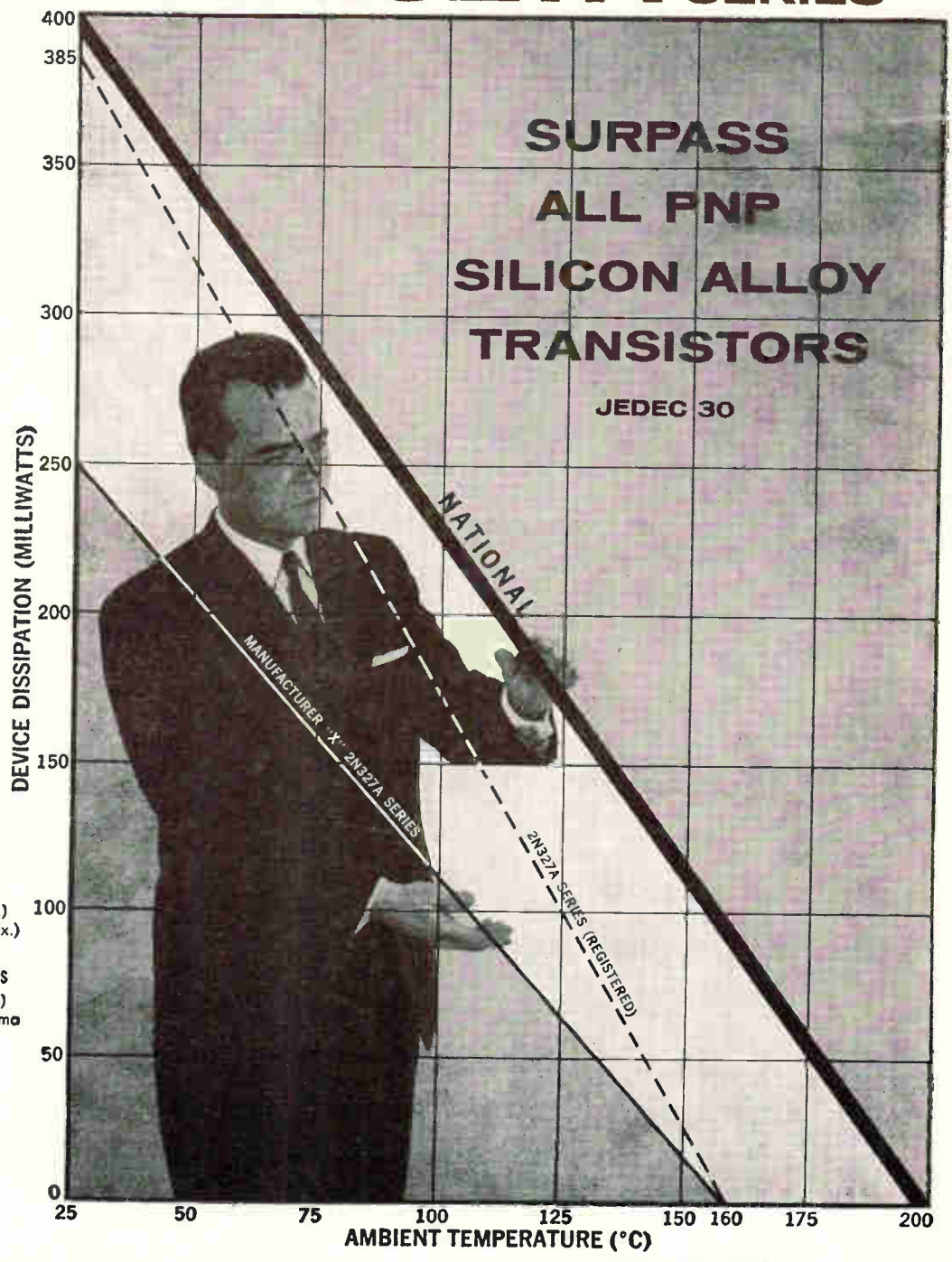
(2N1440 series, 25mμa max.)
(2N327A series, 100mμa max.)

guaranteed β at low currents
(2N1440 series, at I_C = 1 ma)
(2N327A series, at I_B = 0.1 ma and I_B = 1.0 ma)

low saturation resistance

shock and vibration...
exceed MIL-S-19500B



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Sizes of MLP and MHP MICROIDS

400 cps to 1.9 kcs — $1\frac{1}{16}$ x $1\frac{15}{16}$ x $\frac{1}{2}$
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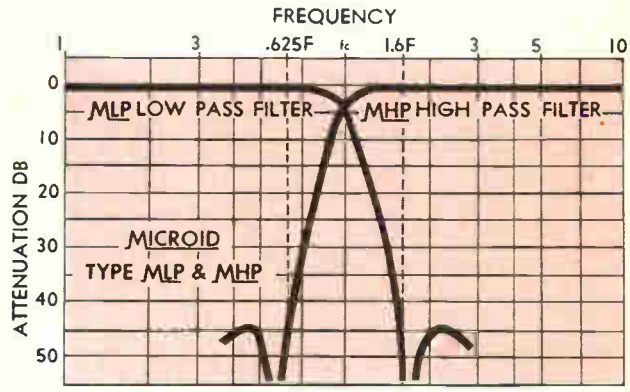
5 kcs and up — $\frac{5}{8}$ x $1\frac{15}{16}$ x $\frac{1}{2}$

Weight of all MLP and MHP Microids—approx. .3 ozs. each

Send now for your free membership card in the Space Shrinkers Club. And if you don't already have our Catalogue #104 describing Burnell's full line of toroids, filters, and related networks, please ask for it.



Note: First informal meeting of Club members will be held in Burnell Booths 2919-2921 during the IRE Show, New York Coliseum, March 21-24. See you there.

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SHOPTALK . . . editorial

INTERNATIONAL SYMBOLOGY. This spring a U.S. engineer will travel to Paris to represent our National Committee at an International Electrotechnical Commission meeting on letter symbols for electronics.

There is nothing unusual about U.S. engineers attending international meetings. However, in the past they usually paid their own way—unless going to full-dress plenary meetings or to IEC meetings of high trade interest such as those dealing with standardization of hardware. This time, the delegate is going to a working meeting of a purely professional group and the Institute of Radio Engineers is paying part of his expenses.

This is a badly needed step in the right direction and here is why: the IEC advises the International Science Organization, an arm of the United Nations, on electrical matters. The international standards set by IEC often make up the book of technical rules U.S. firms must play by when doing business abroad. And in the areas of contract proposals, patent proceedings and equipment maintenance international standards for letter symbols, graphical symbols and terminology are as important as standards for equipment and components.

Although U.S. delegates have attended plenary sessions of purely professional IEC groups, they have often been there only to agree to an agenda hammered out in advance by a working or experts' group.

Nevertheless, we wonder whether professional organizations alone should have to help with the expense of sending delegates to meetings where their work will also benefit U.S. industry. Isn't the support of the U.S. National Committee of the International Electrotechnical Commission an obligation that might also be assumed by electronics trade associations whose members stand to benefit from increased export business?

Coming In Our February 5 Issue . . .

NOISE DISPLAY. Computing the ratio of two time-varying quantities is an important step in various data processing operations. Both analog computers with servo control and digital computers have been used for this purpose. However, for special applications it is often more desirable to use an electronic analog computer because of its high speed compared with the servo type and its simplicity compared with the digital type.

In our next issue, J. Tamiya of the University of Minnesota describes an electronic analog computer that automatically computes and displays the noise suppression factor of tube shot noise. This instrument, which is part of a noise display machine being developed by A. van der Ziel, samples plate current and noise output. The amplitude ratio of these sampled values is transformed into a time ratio whose denominator is constant. The time quantity in the numerator becomes the only variable and represents the desired ratio of true to pure shot noise. This ratio is displayed as a vertical deflection on a cathode ray oscilloscope.

CERAMIC ROD ANTENNAS. Ceramic rods used as antenna elements have high power handling ability limited only by the temperature effects of the low-loss material. With high-dielectric materials, the volume of the individual elements is reduced, thereby minimizing weight.

These characteristics make such rods suitable for uhf antenna arrays according to C. W. Morrow and J. L. Moore of Melpar, in Falls Church, Va. They describe a 17-element array of Alite rods and indicate its radiation pattern for X-band frequencies.

HOW TO SELECT HIGH RELIABILITY CAPACITORS

At one time Sprague Electric was the only manufacturer offering true high reliability capacitors. The buyer had no problem. But today there are many manufacturers who claim that their capacitors meet high reliability standards. Some are even so bold as to claim that theirs are *the most reliable.*

Check the record before you choose

The only sound approach to evaluate these claims is to investigate the *reliability record* achieved by each of the companies under consideration. Remember, it takes test data to establish the reliability of a product. Claims are not enough.

Now let's look at the record

Sprague Electric can substantiate its claim that its HYREL® Q Capacitors are "the most reliable capacitors made" with the most extensive test data available in the entire electronic industry. The performance of HYREL Q Capacitors is virtually impossible to surpass . . . now and for some years to come.

But let's start at the beginning—*the specifications.* Sprague Electric's high reliability capacitors were originally made under Sprague Electric Specification PV-100—*the first high reliability capacitor specification for missiles and other critical applications.* This specification and a later revision, PV-100A, have proven so comprehensive and so successful in providing "the highest order of reliability known to capacitor manufacturing" that their provisions are currently reflected in *every* military specification covering high reliability capacitors. This is a distinction shared by no other capacitor manufacturer.

Now look at the record of HYREL Q Capacitors

On accelerated life tests the failure rate of HYREL Q Capacitors has been less than 0.05%, after more than 16 million unit hours accumulated on tests of 250 hours at 140% rated voltage, 125 C. On high frequency vibration tests, there hasn't been a single failure in the more than 50,000 units tested. On seal, moisture resistance, and temperature cycling and immersion tests, the failure rate has been less than 0.1%.

Such performance from production line capacitors can only be achieved through the most intensive (and expensive) kind of reliability program—in design and development, in production engineering, in manufacturing facilities, in testing intensity and extensity—all of which should be investigated thoroughly.

After you've checked the record, then decide for yourself which capacitor is "the most reliable made."

For complete facts and figures on HYREL Q Capacitors, call your Sprague District Office or Representative, or write for HYREL Bulletin 2900A and Specification PV-100A to Technical Literature Section, Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts.

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Here's reliability . . . Since their introduction, over 24 months ago, not one Regatran has lost a series transistor due to short circuits or overloading.

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- low output impedance
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- High-speed regulation
- null balance control

- sensing terminations
- front panel calibration
- any grounding arrangement
- small size, light weight

Regatran Semiconductor Power Supplies are available in various ratings up to 0 to 60 V dc and 0 to 30 amperes, depending on model. Write for Bulletin 721.

e/m

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MEASUREMENTS
COMPANY OF RED BANK
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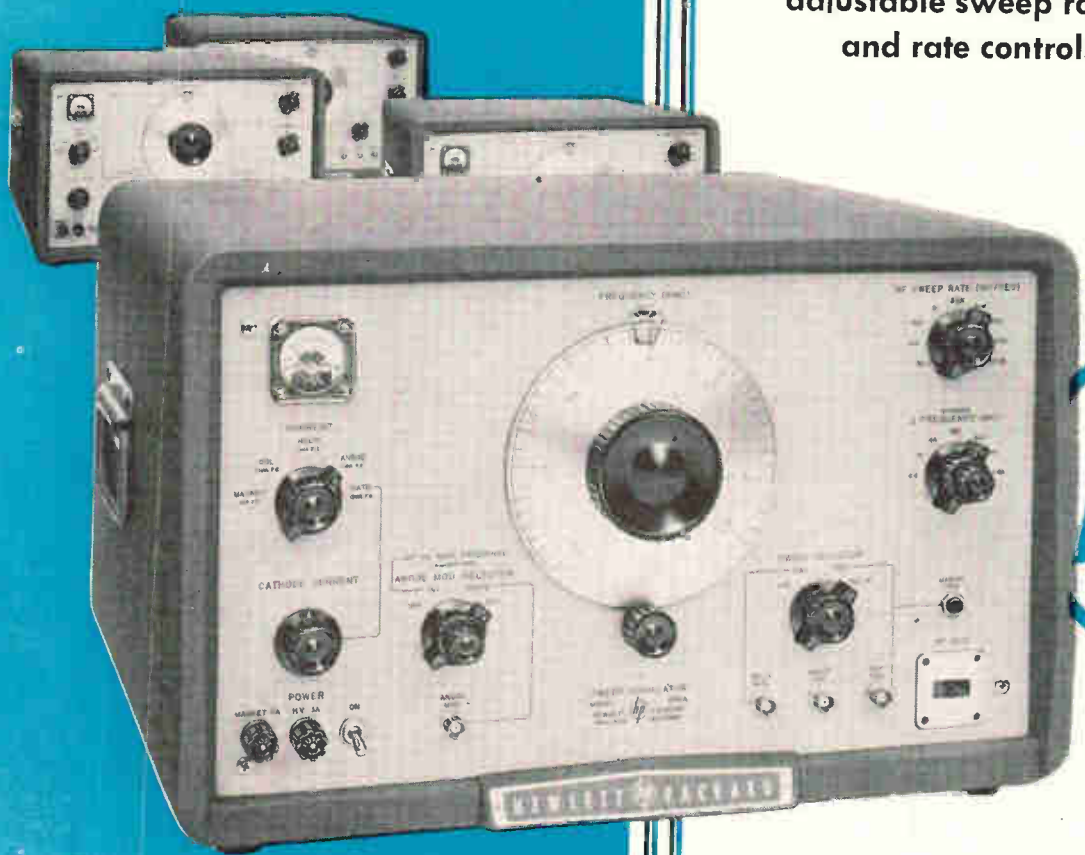
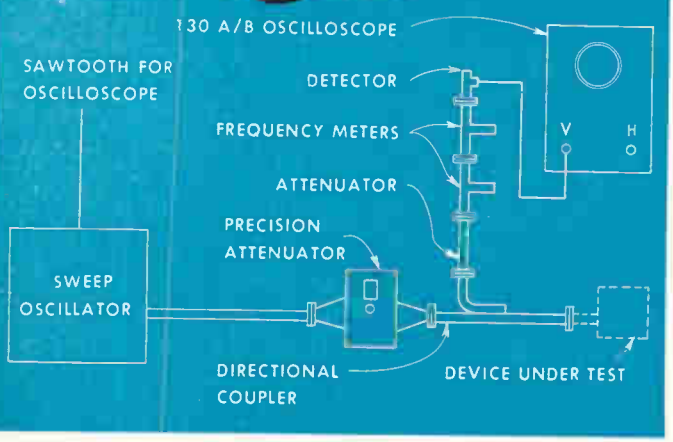
NOW!

4 new microwave sweep oscillators

speed, simplify measurements 2.0 to 18.0 KMC

Covers full band, or any part
Use with 'scope or recorder
All electronic; no mechanical sweep
Direct reading, independently adjustable sweep range and rate controls





◀ Figure 1. Arrangement for high speed microwave measurement to provide rapid visual display with hp 130A/B oscilloscope.

hp Dependable, quality

Hewlett-Packard Electronic Sweep Oscillators are new measuring tools deliberately designed to give you simpler, faster microwave measurements. Four models are provided, covering frequencies 2.0 to 18.0 KMC as follows: Model 683A, 2.0 to 4.0 KMC; Model 684B, 4.0 to 8.1 KMC; Model 686A, 8.2 to 12.4 KMC and Model 687A, 12.4 to 18.0 KMC.

These instruments make possible microwave investigations and evaluations with a convenience previously associated only with lower frequency measurements. These oscillators provide a wide range of sweep speeds so that measurements of reflection, attenuation, gain etc., can be displayed on an oscilloscope or recorded in permanent form on X-Y or strip-chart recorders.

Electronic Sweeping

Specifically, the new oscillators provide either a CW or swept rf output throughout their individual bands. The instruments employ new backward wave oscillator tubes whose frequency is shifted by varying an applied potential. Thus, troublesome mechanical stops and tuning plungers are eliminated. Sweep range is continuously adjustable and independently variable; sweep rate is selected separately, and either can be changed without interrupting operation. The full band width can be covered in time segments ranging from 140 seconds (very slow for mechanical recorder operation) to 0.014 seconds (high speed for clear, non-flickering oscilloscope presentation).

Linear Frequency Change

The swept rf output from the hp sweep oscillator is linear with time, and a linear sawtooth voltage is provided concurrent with each rf sweep to supply a linear time base for an oscilloscope or recorder. In addition, for convenience in recording and other operations, rf sweeps can be triggered electrically externally and single sweeps can be triggered by a front panel push button. The rf output can also be internally AM'd from 400 to 1,200 cps and externally AM'd or FM'd over a wide range of frequencies.

Rapid Visual Presentation

The variety of sweep rates and band widths available from the new oscillators insures convenience and accuracy for reflection and transmission coefficient measurements and many other production line and laboratory tests. For maximum speed, an oscilloscope such as hp 130A/B may be used as indicated in the diagram on opposite page. For maximum information and a permanent record, an X-Y or strip chart recorder may be used.

Complete details of a rapid visual method using an oscilloscope or a maximum-data, permanent record method using a recorder may be obtained from your hp field engineer. Detailed discussions of these methods are also contained in the hp Journal, Vol. 8, No. 6, and Vol. 9, No. 1-2, available on request.

TYPICAL SPECIFICATIONS

Below are specifications for -hp- 686A Sweep Oscillator, 8.2 to 12.4 KMC. Specifications for -hp- 683A, 684B, and 687A (P band) are similar except for frequency range and other minor variations.

Types of Outputs: Swept Frequency, CW, FM, AM.

Single Frequency Operation

Frequency: Continuously adjustable 8.2 to 12.4 KMC.

Power Output: At least 10 milliwatts into matched waveguide load. Continuously adjustable to zero.

Swept Frequency Operation

Sweep: Recurrent; externally triggered; also manually triggered single sweep. Rf sweep linear with time.

Power Output: At least 10 MW into matched waveguide load. Output variation less than 3 db over any 250 MC range; less than 6 db over entire 8.2-12.4 KMC range.

Sweep Range: Adjustable in 7 steps 4.4 MC to 4.4 KMC.

Sweep Rate-of-Change: Decade steps from 32 MC/sec. to 320 KMC/sec.

Sweep Time: Determined by sweep range and rate; from 0.014 to 140 seconds over full-band.

Sweep Output: +20 to +30-volt-peak sawtooth provided at a front-panel connector concurrent with each rf sweep.

Modulation

Internal Amplitude: Square wave modulation continuously adjustable from 400 to 1200 cps; peak rf output power equals cw level ± 1 db.

External Amplitude: Direct coupled to 300 KC; 20 volt swing reduces rf output level from rated cw output to zero.

External Pulse: +10 volts or more, 5 microsecond maximum duration.

External FM: Approx. 350 v peak to modulate full frequency range.

General

Input Connectors, Impedances: BNC; above 100,000 ohms.

Output Connector: Waveguide cover flange (686A, 687A); Type N, female (683A, 684B).

Power Requirements: 115/230 volts ±10%, 50/60 cps; approximately 540 watts.

Price: hp 683A (2.0 to 4.0 KMC) $3,000.00.
hp 684B (4.0 to 8.1 KMC) $2,900.00.
hp 686A (8.20 to 12.40 KMC) $2,900.00.
hp 687A (12.40 to 18.00 KMC) $3,400.00.

(Prices above are f.a.b. factory for cabinet models. Rack mount instruments $15.00 less.)

Data subject to change without notice.

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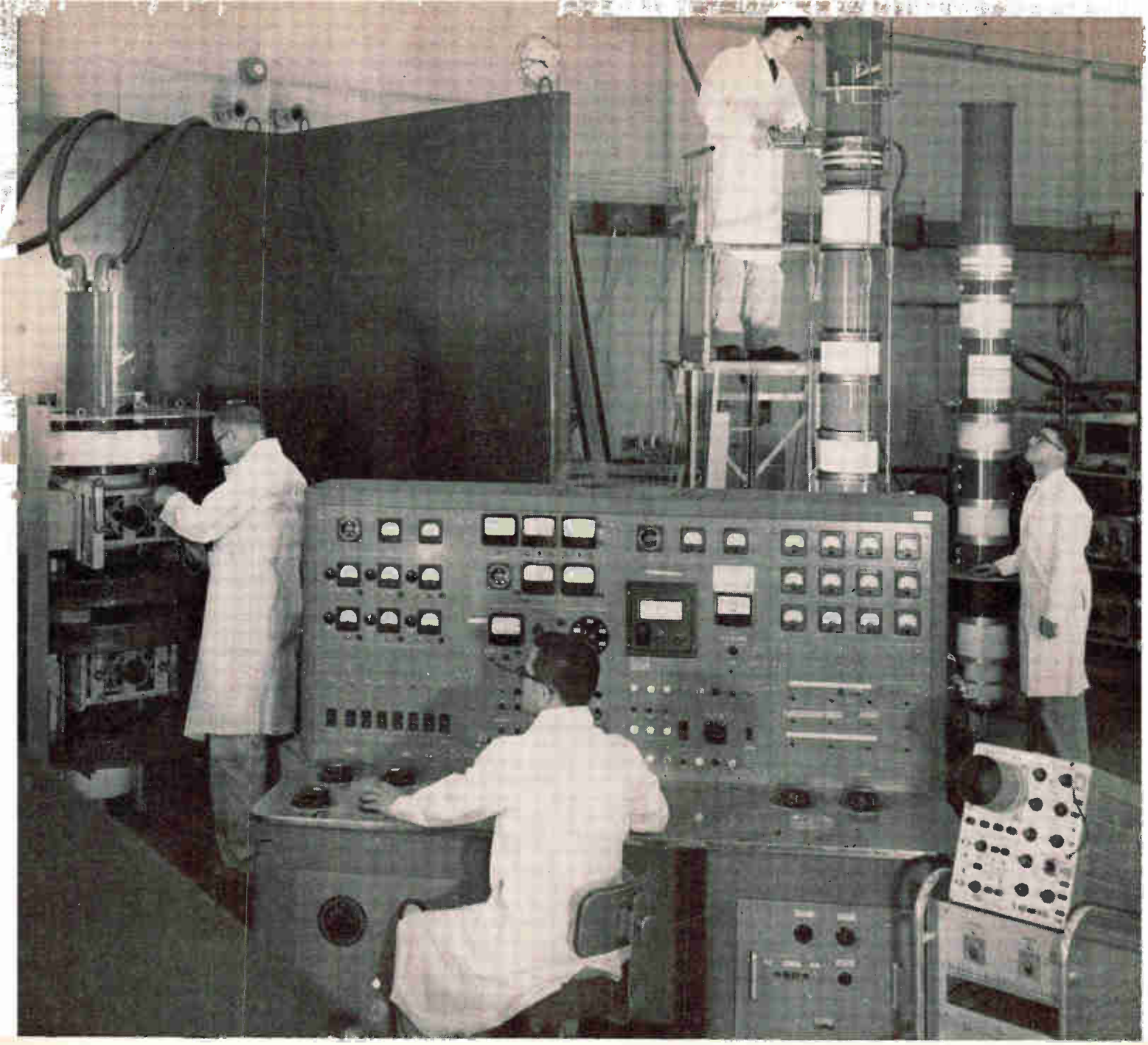

Portion of Eimac's extensive super-power klystron production and test area

MORE EIMAC KLYSTRONS PRODUCED FOR UHF SUPER-POWER RADAR THAN ALL OTHER TUBES COMBINED

A decade ago Eimac decided that negative-grid tubes were impractical to generate high power at UHF. Instead, Eimac developed external cavity klystrons and opened the upper spectrum to high power propagation. With high power at UHF new applications and systems have been made possible.

Custom, laboratory-made tubes can't begin to meet the demands of systems such as UHF space radar. In keeping with its pioneering tradition, Eimac was a leader in developing super-power, long-pulse klystrons for this system—and followed through with quantity production.

This combination of development and production has placed Eimac klystrons in more tropospheric communications and UHF super-power radar transmitters than all other makes of final amplifier tubes combined. And Eimac will continue to convert its developments to production to meet the increasing demand.

For high power at ultra-high frequencies, investigate the many advantages of Eimac external cavity amplifier klystrons.

EITEL-McCULLOUGH, INC.

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BUSINESS THIS WEEK

Superconductive Gyro Called Feasible; Use Seen in Subs and Space Vehicles

Superconductive gyro under development at GE's new $100,000 low temperature facility in Schenectady, N. Y. is expected to give significantly higher accuracy and reliability than conventional gyros. The gyro, which operates at about −452 F., is expected to find applications first in nuclear submarines and later in space vehicles. A cooling system would be required. Although a laboratory working model may not be ready until the end of the year, GE cryogenicists have demonstrated its feasibility. Gyro rotor is freely suspended in a magnetic field, operates at liquid helium temperatures.

Work, dubbed Project Spin, is being done under a $214,000 first-phase contract from the Army.

New Magnet Memory Units To Be Produced by Bell System

Twistor permanent magnet memory conceived at Bell Telephone Laboratories only 14 months ago is reported now ready for mass production by Western Electric. The two Bell System companies, in an unusual joint announcement, say computer technology will be advanced by the memory unit which they report is comparatively inexpensive and easy to produce, yet capable of supplying bits of information in millionths of a second.

Unit consists of alternating grids of "twistors"—hair-thin copper wires around each of which is wrapped a magnetic tape 1/10 the thickness of the wire—and plastic cards with arrays of minute bar magnets. The "Magnet-Twistor memory" stores data by the presence or absence of a bar magnet at a specific location on the plastic card.

Multivibrator 'Grown' from Pool Of Molten Semiconductor Materials

Scientists of Westinghouse Electric reported last week they are able to "grow" a multivibrator directly from a pool of molten semiconductor materials. This development, made possible by the dendrite process of growing crystals, is the latest application of the firm's molecular electronics concept.

Both Westinghouse and the Air Force claim this approach makes possible subsystems 1/1,000 the size of those presently used. Westinghouse says it has developed and demonstrated eight classes of function blocks including: an audio amplifier, two-stage video amplifier, a variable potentiometer, an analog-to-digital converter, and a variety of multivibrators. Col. W. S. Heavner, Chief of the Wright Air Development division's Electronic Technology Laboratory, looks for a complete system—a molecularized vhf receiver—to be produced during 1962.

Electroluminescent Device Output Will Increase for Several Markets

Plans to expand production of electroluminescent devices have been announced by Sylvania Electric, for a wide variety of military and civilian applications. These will include computers, radar and general information displays for the military, and clock faces, switch plates, instrument faces in commercial application. A large volume of sales will go to automative manufacturers, some of whom are already including electroluminescent lighting in car dashboards. Company officials say the most valuable feature of the new devices is that they can be made to perform the logic and memory functions required in computer applications as well as to display information.

ELECTRONICS NEWSLETTER

Microelectronics will come in for some special attention at the 1960 Solid-State Circuits Conference in Philadelphia Feb. 10-12. Five technical papers will be presented on the subject; six representatives from electronics firms and two from universities are expected to discuss different approaches to the problem of component density. Other highlights: sessions on tunnel diodes (ELECTRONICS, p 32, Jan. 1) and thin films.

Soviet semiconductor production rate in 1965, the last year of the current seven-year plan, will be 205 times the output in 1950, according to Tass. Computer production is slated to increase by 4.7 times in 1965 over 1959.

Semiautomatic silicon crystal-growing furnace which is said to triple the production capacity of conventional furnaces will be marketed by Hoffman Electronics Corp. Four of the units can be operated at one time by a technician, with furnace operating cycles automatically controlled. Cost: about $12,500.

Increasing U. S. demand for its f-m transistor radios, says Sony Corp. of Japan, will boost its monthly exports to the U. S. from 3,000 to 10,000 starting in March.

U. S. forces in Japan, whose garrison status has been extended by the mutual security treaty signed last week in Washington, will be supplied with a 24-channel, Japanese-made tropospheric scatter communications system. Nippon Electric will supply $1.9 million worth of gear including 60 transmitters and 72 receivers. System will operate in 2,000-mc band, use parametric amplifiers, 33-ft parabolic antennas and permit expansion of transmission capacity to 60 channels.

new word for designers and producers . . .

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for the designer

1. **Space** — compact, encapsulated subassemblies assure maximum space utilization.
2. **Insulation** — better *internal* electrical insulation between circuit elements; better *external* insulation. Corona is minimized.
3. **Matching** — components may be electrically matched, then assembled or replaced as a single unit.
4. **Stability** — temperature stability in critical circuits is improved.
5. **Environment** — greater mechanical stability, resistance to shock, vibration, and resonance.

for the producer

1. **Maintenance** — input and output are quickly checked; circuits may be readily replaced.
2. **Inventory** — one item to buy and stock instead of multiple items.
3. **Assembly** — just plug it in and put it to work; many Circuit-Paks are available from stock.
4. **Design** — save time with Circuit-Paks that meet your specifications; they are ideal for applications such as comparators, bridges, choppers, flip-flops.
5. **Testing** — Raytheon Circuit-Paks are factory pre-tested — your test requirements minimized.

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WASHINGTON OUTLOOK

HOUSE ARMED SERVICES Committee, which made big headlines last year with an investigation into alleged influence-peddling on defense contracts, has come out with its report. It calls for changes in the conflict-of-interest laws to tighten restrictions on retired military brass employed by defense contractors. But the proposals are not so widesweeping as might have been expected from the tone of the committee's probing.

Special Investigations subcommittee chairman F. Edward Hebert (D., La.), who ran last year's show, wants a two-year ban on retired regular officers' selling to any military service, with criminal penalties for violations. Present rules ban selling only to the officer's own former service. And in many cases—notably in the Navy—the penalty is simply the withholding of government retirement pay.

"Sales" have been interpreted very narrowly. The rules at present forbid only direct selling which involves actual contract negotiations. Hebert wants to broaden the definition of selling to include such things as preparation of proposals and performing of spadework on submission of bids.

Under proposed new rules, the case of former Chief of Naval Operations Fechteler—cited by Hebert—would be considered a violation. Fechteler arranged for General Electric's exhibition of a weapons-system scheme before defense officials. Under present rules an activity like this is not considered direct salesmanship.

- **Hebert has introduced a bill** which incorporates many of the committee's recommendations. But it omits the language that spells out what sales efforts on defense contracts constitute. The language is included in the report; Hebert surprisingly shied away from putting it into legislation.

  The bill will probably sail through Congress, but it is not likely to present any significant problems to defense producers who employ former military officers—at least, not as it is now written. Says Hebert: "We're not kidding ourselves. Industry, with its Philadelphia lawyers, will find ways of getting around this."

  Hebert's report lists 1,400 retired officers of field or flag rank who are on the payrolls of the 72 top Pentagon contractors.

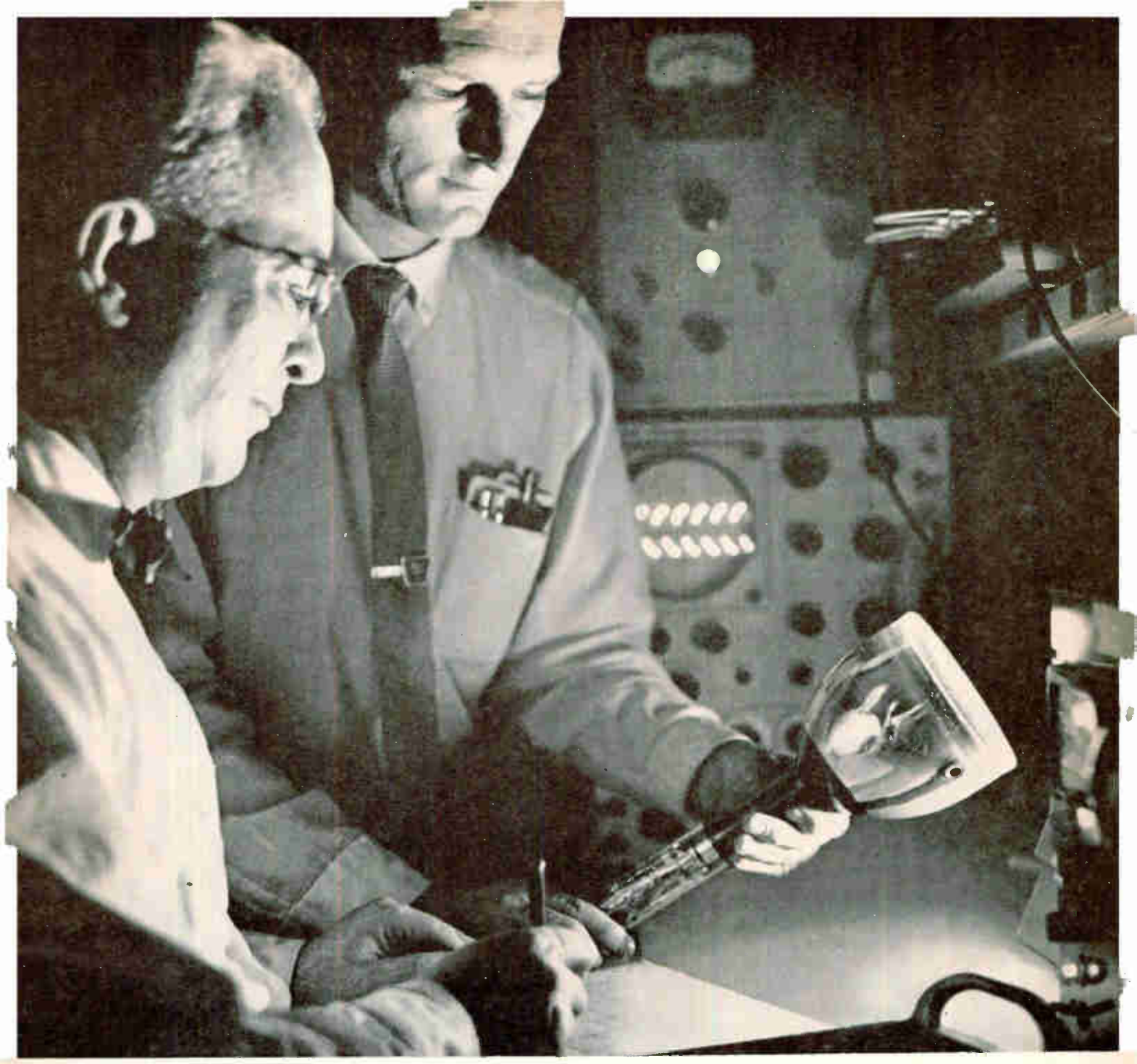
- **Electronics producers show up more prominently** than ever in the Pentagon's latest roster of leading defense contractors.

  The new list covers fiscal 1959, includes 100 companies that accounted for 73.8 percent of the $22.6-billion worth of new orders.

  Of this sum, 64 percent of the value of contracts over $500,000 went for aircraft and missiles—much of it representing electronic apparatus—and another 11 percent went for so-called pure electronic projects.

  The top five companies are General Dynamics, with $1.6 billion in contract awards for the year; Boeing, $1.2 billion; North American Aviation, $1 billion; General Electric, $914 million; and Lockheed, $898.5 million.

  Other prominent electronics firms listed include Hughes Aircraft, number 9 on the list, with $494 million; AT&T, 10th, $476.5-million; Sperry Rand, 12th, $403.2 million; Raytheon, 13th, $392.6-million; IBM, 17th, $276.9 million; Bendix Aviation, 18th, $271.3 million; Westinghouse, 19th, $238 million; RCA, 22nd, $199.7 million; Avco, 23rd, $183.7 million; IT&T, 26th, $139.1 million; Burroughs, 29th, $120.9 million; Collins Radio, 30th, $114.9 million; Minneapolis-Honeywell, 32nd, $104.6 million; Thompson Ramo Wooldridge, 33rd, $102.5 million; American Bosch Arma, 35th, $101.5 million; Philco, 37th, $95.9 million, and General Precision Equipment, 47th, $72.7 million.



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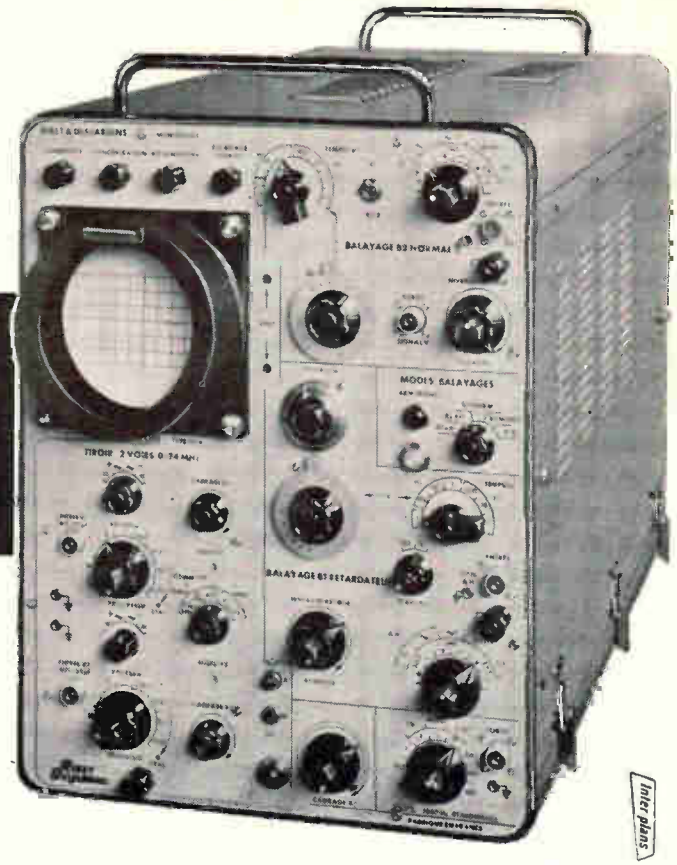

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CHARACTERISTICS

Flat faced cathode ray tube - Ø = 5" - Usable area 10 x 5 cm
Accelerating potential = 10 KV.

Time Base providing 2 sweeps

Delaying sweep : 7 positions calibrated from 10 sec/cm to 1 μs/cm.

Normal sweep : 8 positions calibrated from 10 sec/cm to 0,1 μs/cm and reaching up to 0,02 μs/cm if expanded five times.

Single shot for all normal sweep.

Horizontal amplifier 0-300 KC/S (- 3 dB) - Sensitivity 0,25 V/cm - Direct calibration.

Plug-in unit T 130 - 1 channel

Passband	Rise Time	Sensitivity
0 - 30 MC/S (- 3 dB)	= 0,012 μs	= 50 mV/cm
5 C/S - 20 MC/S (- 3 dB)	∼ 0,020 μs	∼ 5 mV/cm

Plug-in unit T 224 - 2 channels by electronic switch

Passband	Rise Time	Sensitivity
0 - 24 MC/S (- 3 dB)	0,015 μs	= and ∼ 50 mV/cm
10 C/S - 24 MC/S (- 3 dB)		

All high impedance attenuators provide nine calibrated positions.
Delay line 0,1 μs.

Differential pre-amplifier : sensitivity 1 mV/cm - Passband 500 KC/S approx.

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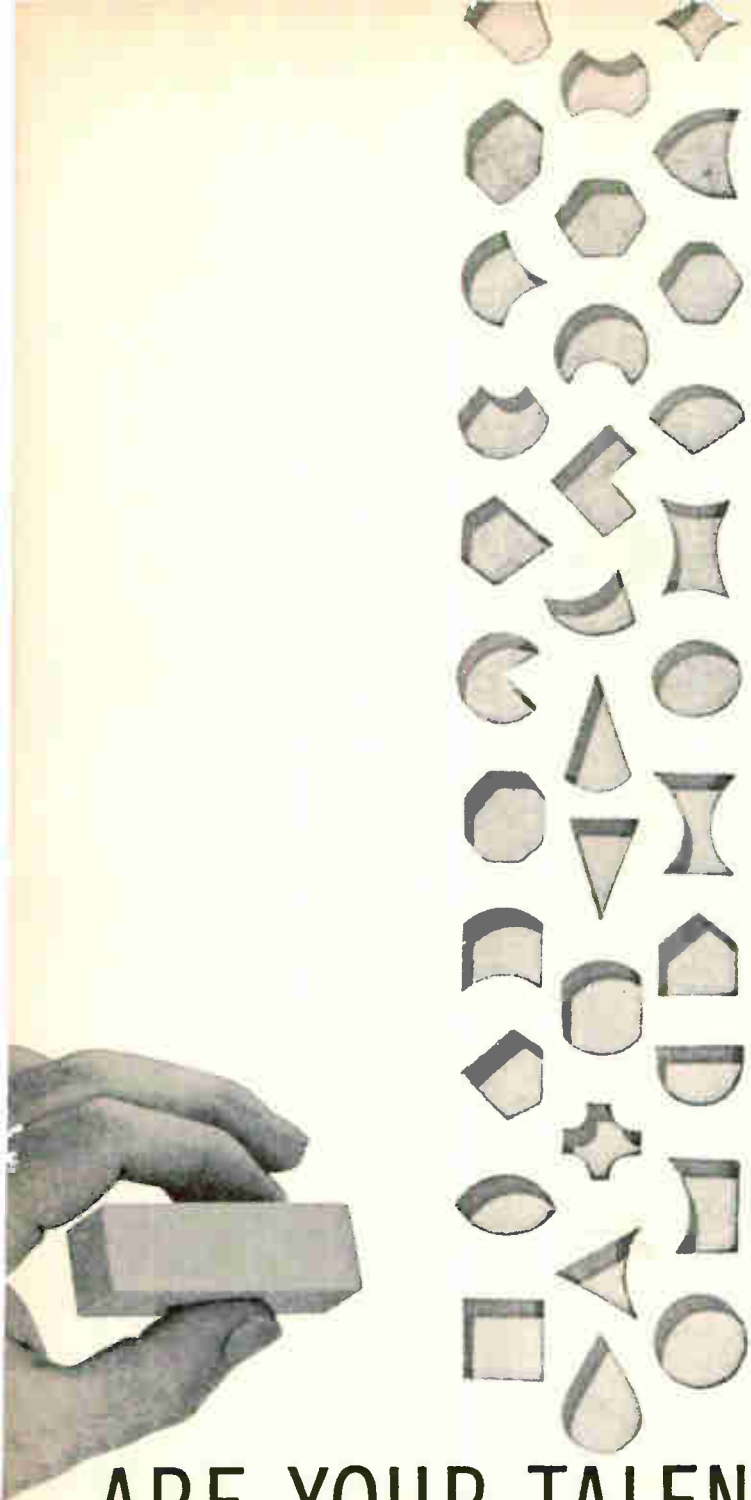
CIRCLE 16 ON READER SERVICE CARD



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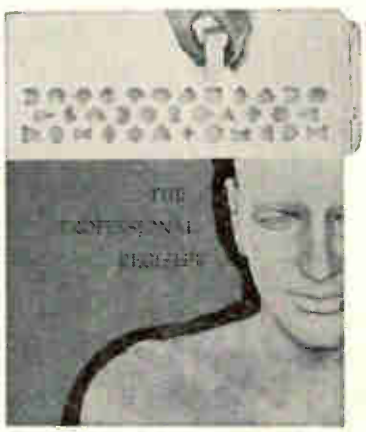

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Please complete this card, fold, staple and mail. The information you give constitutes the first phase of the Professional Register Program and will enable our professional staff to make a preliminary evaluation of your abilities. All inquiries will be answered immediately. When you complete the Program, the inventory of your talents and capabilities will be recorded on over 20 electronic data-cards available for instant use in guiding your future progress at HUGHES-FULLERTON.

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- ☐ Testing/Process Control
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The Register makes instantly available a complete record of every individual's abilities, interests and accomplishments. Previously hidden talents can now be put to use. Often these can mean the difference when reassignments or promotions are being made. Your potentials become a very real resource of Hughes-Fullerton Research and Development Staff.

Areas covered in the Register range from language skills through patents to books and articles published. It includes teaching experience, professional affiliations. All data is kept up-to-date and handled by automatic data processing equipment for utmost efficiency.

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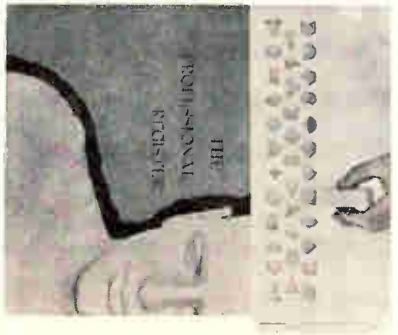
These are a few reasons why you should investigate Hughes-Fullerton. Openings exist at several experience levels for a variety of engineering specialties. For full information fill out the post card and mail it today!



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CTI SETS A NEW STANDARD FOR WIRING-HARNESS TESTERS

After carefully reviewing customer requests received during the past few years, CTI has designed an automatic tester incorporating every feature desired by the manufacturer or user of wiring harnesses and cables. Compact, inexpensive, and simple to operate, the new Model 165 Cable Tester can handle the most complex wiring test problems. Test capacity can be increased indefinitely by adding small switch-unit modules to the basic equipment.

Only the CTI Cable Tester offers all these features:

- Completely automatic
- Simple operation, go/no-go readout
- Simultaneous continuity, leakage, and hi-pot measurements on each test
- Leakage measured from the circuit under test to all others
- Self-testing and fail-safe — validity of tests is assured
- Wide choice of test parameters from calibrated, front-panel controls
- Simple programming without complex patchboards
- Branch circuits can be programmed without sacrificing additional test points
- Precision bridges assure accuracy and stability of measurements
- Provides control of relays in the circuit under test
- Accessory printer lists rejects
- Manufactured by a company that has pioneered automatic testing

SPECIFICATIONS

Continuity test currents: Off, 0.1, 0.5, 1.0, and 2.0 amps d-c

Continuity accept limits: 0.1, 0.5, 1.0, 5.0, and 10.0 ohms (maximum test current on the 1-, 5-, and 10-ohm ranges is 1.0 amp.)

Hi-pot voltages: Off, 28, 100, 500, 1000, and 1500 volts d-c (hi-pot current limited to approximately 1 ma)

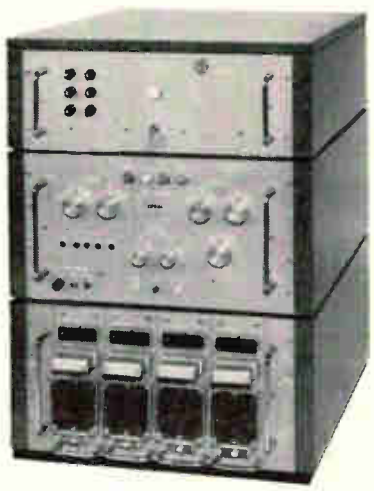
Leakage-resistance limits: 1, 5, 10, 100, and 500 megohms

Hi-pot dwell time: continuously variable from 0.2 secs to 100 secs

Test rate (maximum): 5 circuits per second (0.2 seconds dwell time)

Test capacity: 200 tests plus 200 for each complete, additional Switching Unit used. Switching Unit panel may be supplied with 50-test switch modules as needed.

Each of the above test parameters can be selected independently of the others. All values are set with front-panel selector switches.



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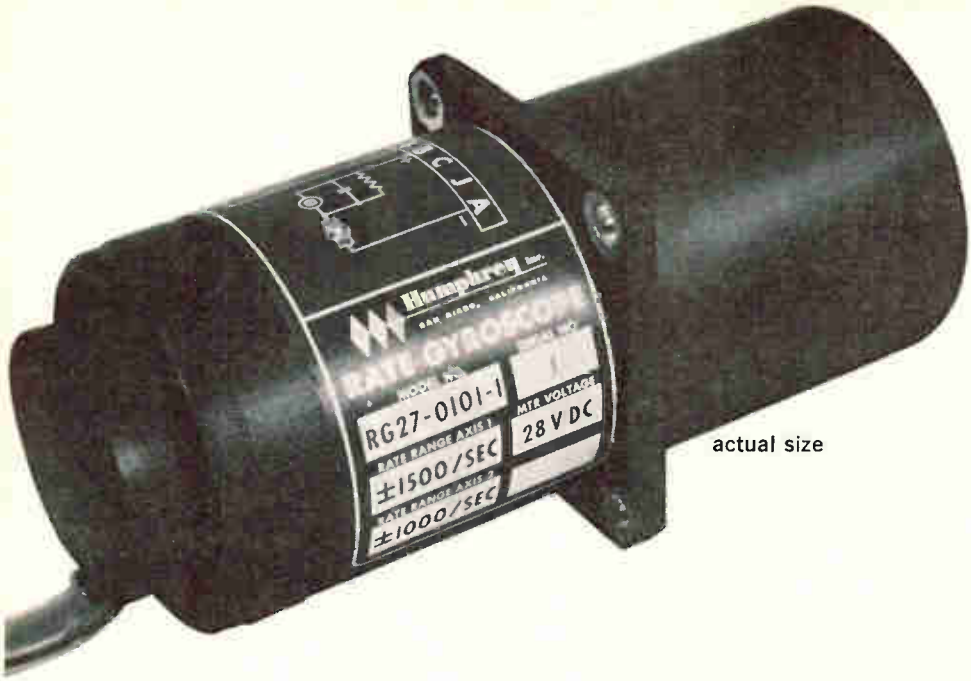
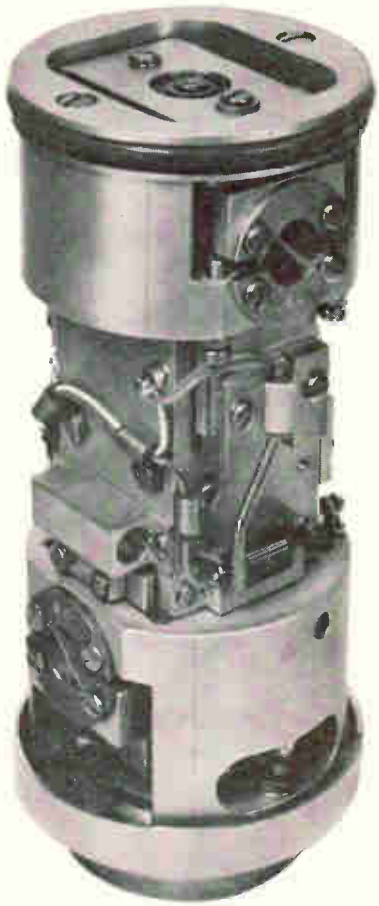


actual size

new dual-axis miniature d-c rate gyro



actual size

A miniaturized Humphrey dual-axis rate gyro only 4 inches long and 1¾ inches in diameter saves space and reduces cost by doing the work of two gyros. It may be used to measure rates about two different axes, such as pitch and yaw in a missile.

Features include center flange mount, hermetically sealed steel case; rate ranges from 50 to 2000 degrees per second; precision potentiometer output; all metal pot construction for high level excitation and powerful output signal; up to 2 watts dissipation in pot; excitation voltage up to 60 volts; can be furnished with 28-volt d-c or 12-volt d-c motor. Also available as single axis unit with shorter length. For more information, write Humphrey, Inc., Dept. E-10, 2805 Canon St., San Diego 6, Calif.

Humphrey Inc.

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New Stock Split Planned

TWO-FOR-ONE stock split has been approved by **Westinghouse Electric** stockholders to become effective on Feb. 9. Split was recommended in the fall of last year when quarterly dividends went from 50 to 60 cents per share after reports of the highest third quarter earnings in the company's history. The increase will raise to 50 million shares the 25 million now outstanding. Par value will go from $12.50 to $6.25.

• **Republic Foil,** Danbury, Conn. manufacturer of aluminum foil for electrolytic capacitors and packaging reports sales of more than $5 million for 1959. The total in 1958 was slightly over $4 million. The company plans to open a new plant next month in Salisbury, N. C.

• **Telecomputing Corp.,** Los Angeles, announces that an offer has been made to buy **Narmco Industries, Inc.,** San Diego, Calif. for $7 million in stock. Telecomputing would exchange 497,000 shares of stock for all outstanding Narmco stock if the transaction goes through. Final decision is expected next month. Narmco manufactures adhesives and hardware for aircraft and missile applications.

• **Itek Corp.,** Waltham, Mass. plans to hold stockholders meeting in Boston on Feb. 9. The company reports income from sales and services of approximately $25 million in fiscal 1959 as compared with $3,464,000 for fiscal 1958. Anticipated net earnings per share in fiscal 1959 are expected to run at approximately 57 cents per share on the 833,797 shares that are now outstanding.

• **General Instrument Co.,** Newark, N. J. reports a rise of $1,378,233 for the fiscal year just ended as compared with the previous fiscal year. Sales for the period were at a record $41,277,875, and backlog stood at $33,238,000, highest in the company's 37-year history. Per-share earnings were 90 cents on 1,529,473 shares compared with last year's earnings of 70 cents a share on a slightly lower number of shares.

• **Servo Corporation of America,** Hicksville, N. Y. announces acquisition of **Electro-Pulse, Inc.,** Culver City, Calif. subject to approval of the California Corporations Commissioner. The West Coast firm manufactures long-time delay generators, precision pulse generators and related equipment. Sales for Electro-Pulse were $800,000 in 1959. Details of the acquisition were not disclosed.

• **United Components, Inc.,** Orange, N. J. reports sales of $91,640 for the Sept.-Nov. period of 1959 as compared with $65,689 in the five preceding months. Gross profits for the former period were $16,676, and for the latter, $11,665. Stockholders voted last week to increase to 1 million the number of shares outstanding.

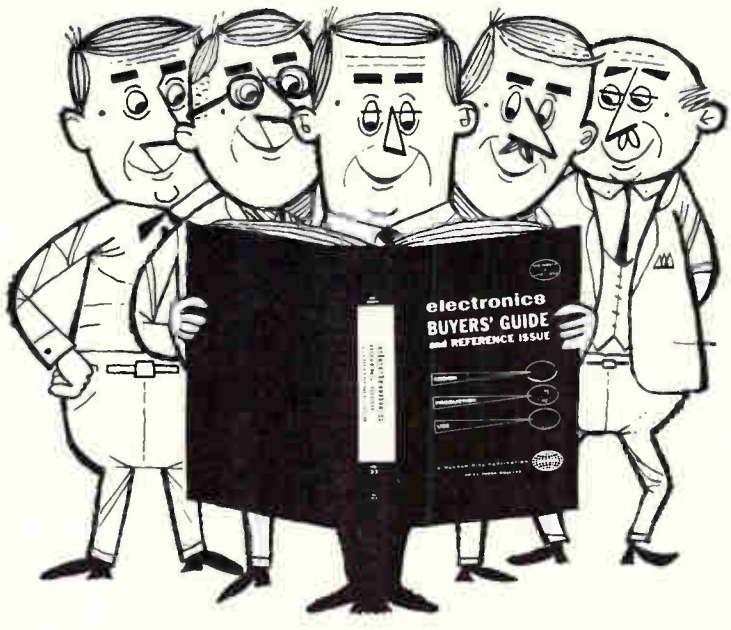
25 MOST ACTIVE STOCKS

WEEK ENDING JANUARY 15

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Ampex	902	109½	97½	105
Gen Electric	870	96⅝	91⅝	93½
Avco Corp	816	14⅞	14	14⅜
RCA	806	66	63	65⅛
El-Tronics	784	1⅞	1½	1⅝
Sperry Rand	767	24¾	23⅝	23¾
Int'l Resistance	703	25⅜	21⅛	24
Reeves Sndcrft	606	11⅝	9¾	10⅝
Collins Radio	570	64⅝	60	63
Gen Dynamics	562	53⅜	50⅛	50⅞
Elec & Mus Ind	545	11¼	10⅛	11¼
Int'l Tel & Tel	516	37⅜	35⅞	36⅝
Univ Control	512	18¼	17⅛	17⅞
Litton Ind	512	62	57⅝	60⅜
Philco Corp	504	32¼	29⅝	31⅝
Raytheon	477	51¾	50	50⅛
Gen Tel & Elec	466	83	80⅛	82
Texas Inst	384	169½	159½	168
Westinghouse	335	109⅞	102⅞	106
Compudyne	310	13⅞	11¾	13
Lear Inc	309	19¼	18½	18½
Spartan Corp	267	9½	8½	8⅝
Varian Assoc	266	43¼	39¾	41¾
Loral Electrncs	261	44⅝	36⅝	44
Dynamics Corp	237	12	11¼	11⅜

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.

NEED PRODUCT INFO? LOOK IN THE NEW



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Engineers' homes are invariably a credit to the community, for engineers take pride in what they do, just as in business. They're thorough, particular, precise... forever demanding the best.

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MARKET RESEARCH

Semiconductor, Tube Markets

YEAR 1960 will see substantial increases in sales of semiconductors and maintenance of high level 1959 sales of electron tubes, predicts L. Berkley Davis, general manager of the electronic components division of General Electric. Sales estimates represent domestic production only.

Semiconductor sales total will advance from $400 million in 1959 to $550 million this year, an increase of 37 percent, Davis says.

Transistors

He expects dollar sales of transistors in 1960 to gain 40 percent over 1959 and unit sales to gain 53 percent. Dollar sales will mount from $225 million to $315 million while unit sales advance from 85 million to 130 million. Average unit price is expected to decline from $2.65 in 1959 to $2.42 in 1960.

Market division of transistor sales predicted for 1960 is: consumer $45 million, industrial $120 million, military $150 million.

Semiconductor rectifier sales will increase by about 18 percent in 1960, with sales of low-current germanium and silicon types accounting for almost half the total.

Diode sales are expected to total $110 to $120 million in 1960 while a miscellaneous group of semiconductors including solar cells, infrared and zener devices are expected to produce $15 million to $25 million in sales.

Much experimental use of tunnel diodes is looked for in 1960, but samples will be limited to small quantities pending the development of circuits, says Davis.

Receiving Tubes

Domestic manufacturers will produce 415 million tubes worth $345 million, Davis estimates. However, about 435 million receiving tubes will be placed in service. Imports will account for the difference.

Sales of commercial tube types will amount to about $275 million, with over half in the renewal market. Tv set manufacturers, who will buy nearly 100 million domestic receiving tubes, will take the bulk of the tubes that go into the original equipment market.

High reliability receiving tubes for aircraft, industrial and military equipment will generate approximately $70 million worth of sales, with about 70 percent of the volume purchased by manufacturers of new equipment. Sales in 1960 of industrial and military tubes for replacement purposes will increase approximately 13 percent over 1959 to a total of $9 million.

Power Tubes

Power tube sales in 1960 will reach a new high of $300 million as sales continue to increase at a rate of 10 percent.

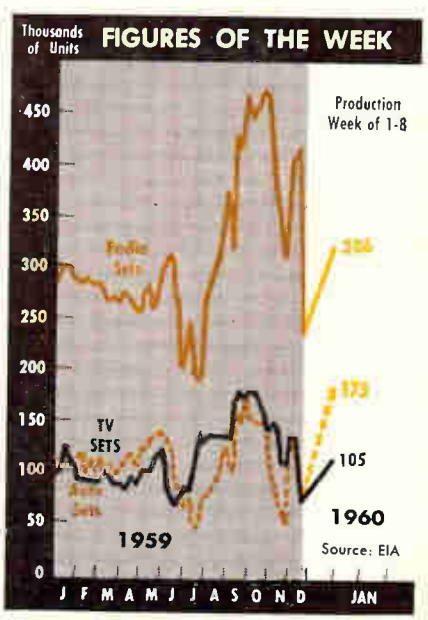
The greatest increase will be in sales of tubes to the military which will use more of them in space weapons, defense, detection and control systems and in communications.

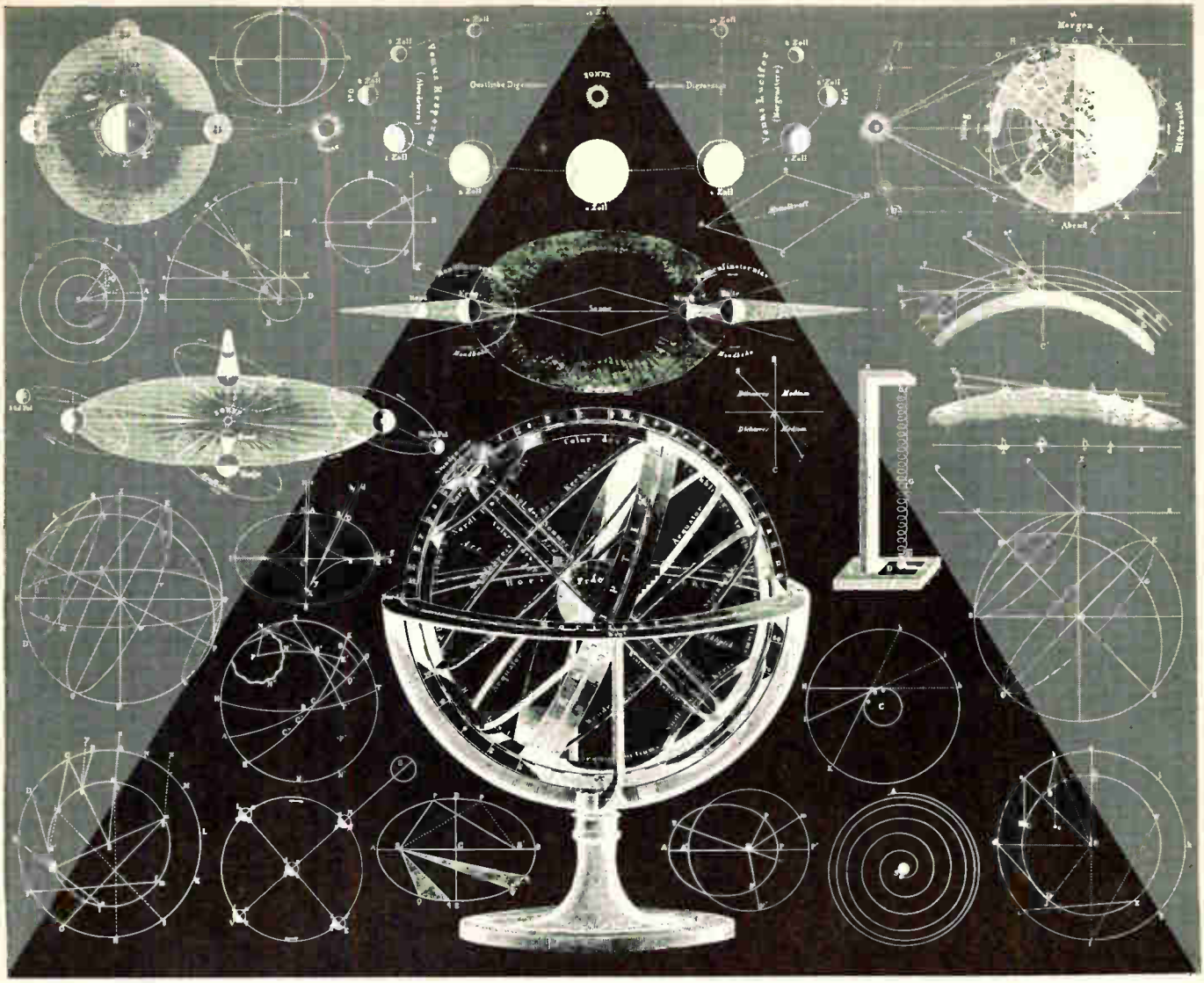
Demand for power tubes for industrial applications in 1960 will hold steady. Use of ignitrons and thyratrons may yield to pressure of solid-state devices, Davis says, but good demand for tubes in many new uses can be expected.

Cathode-Ray Tubes

Nearly 13 million tv picture tubes will be sold for approximately $260 million during 1960, an increase of five percent over 1959.

More than half of 1960's sales will be used for replacement, the remainder in new television sets.





Guided tour of the solar system

The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

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WHAT IS THE RECORD BEHIND HOFFMAN TRANSISTORS?

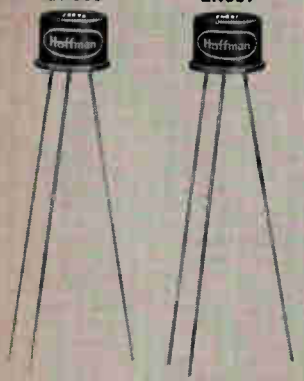
1 ■ MORE EXPERIENCE IN SILICON TECHNOLOGY.

For seven years—practically the full span of semiconductor history—Hoffman Semiconductor Division has worked exclusively with silicon devices. Company achievements include the world's first commercial silicon diodes, zener diodes and solar cells. Hoffman makes the most extensive line of silicon devices in the industry.

2 ■ MORE EXPERIENCE IN DIFFUSED-JUNCTION DEVICES.

The diffused-junction concept, one of the most important in transistor technology, was adapted by Hoffman as early as 1955. To date, the company has produced over five million diffused-junction devices—more than any other company in the electronics industry.

2N696 2N697



For further information and complete technical specifications, contact the factory or your area Hoffman sales engineer.

3 ■ NEW CONCEPT IN QUALITY CONTROL.

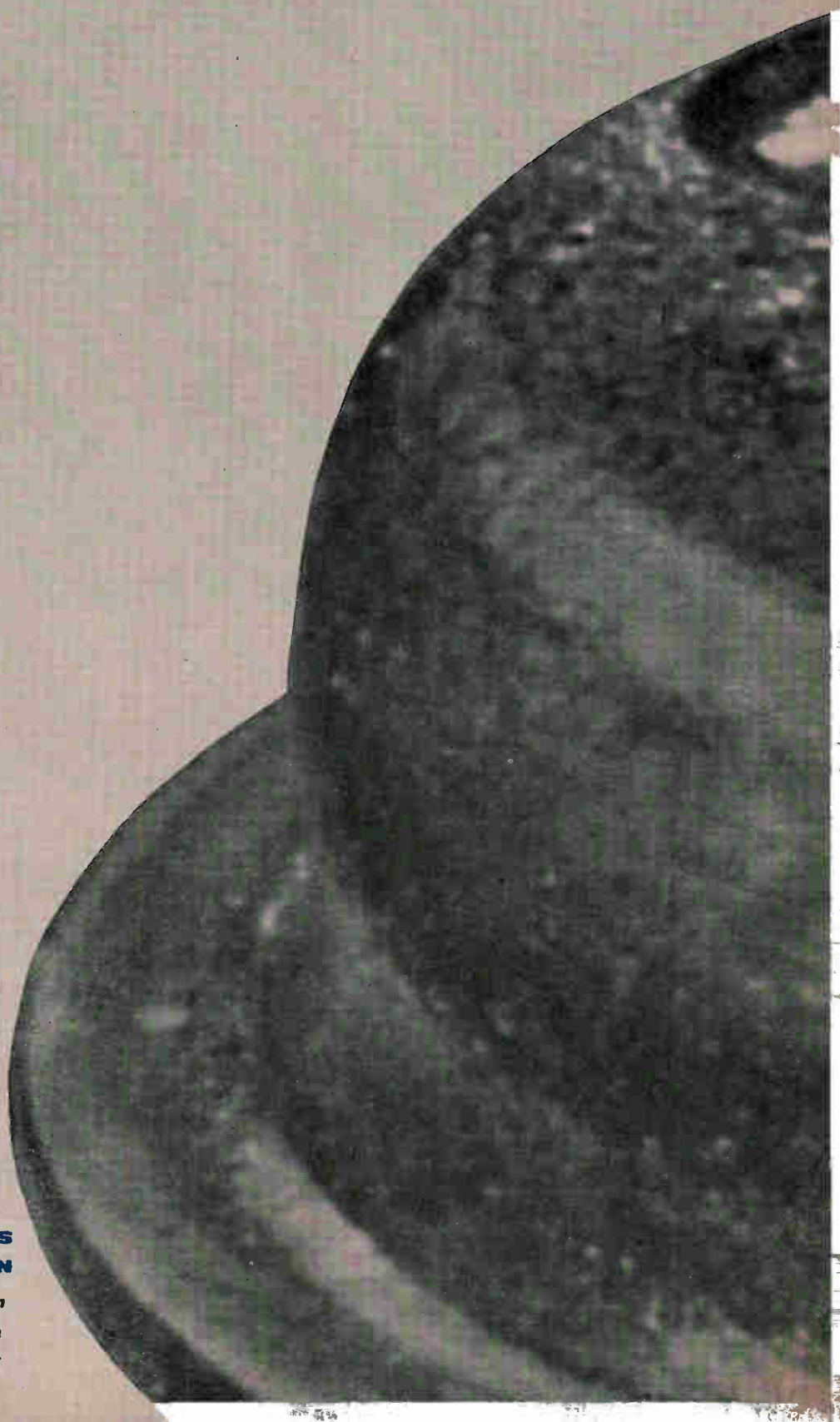
Hoffman has developed a completely new quality assurance and quality control concept which will enable the company to ship devices that meet the most stringent military and commercial requirements.

4 ■ RELIABILITY BACKED BY NUMBERS.

Hoffman has made and shipped more than ten million silicon semiconductor devices.

5 ■ A FACILITY DESIGNED ESPECIALLY FOR TRANSISTORS.

Hoffman's new 109,000-square-foot facility was designed especially for the development, production and testing of transistors. It houses extremely advanced equipment, much of it Hoffman-developed.



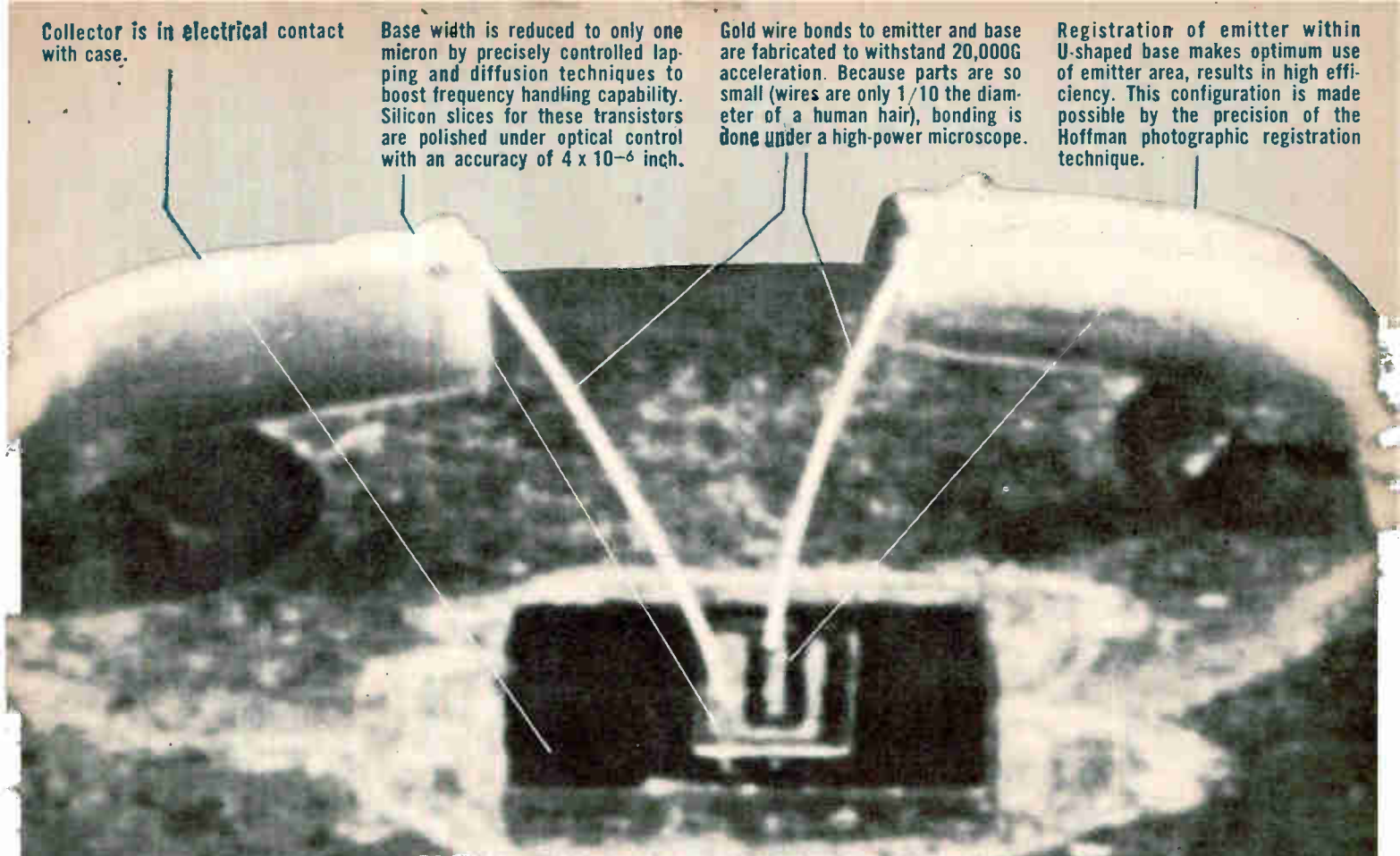
Hoffman

Hoffman / ELECTRONICS CORPORATION

Semiconductor Division

1001 Arden Drive, El Monte, California

Plants: El Monte, California and Evanston, Illinois



NOW...HOFFMAN RELIABILITY IN TRANSISTORS

ANNOUNCING THE HOFFMAN 2N696 AND 2N697 NPN DIFFUSED-JUNCTION DRIFT-FIELD SILICON MESA TRANSISTORS

WITH THREE TIMES THE HIGH-FREQUENCY POWER GAIN OF SIMILAR DEVICES

By increasing the usefulness of the emitter area, Hoffman engineers have boosted the minimum high-frequency gain at large currents to 6 at 20 mc ($I_C = 50$ma, $V_C = 10$V)--more than three times the industry standard. Hoffman's unique base-emitter configuration, coupled with a photographic fabrication technique that offers control accuracy of the order of light wavelengths, has also lifted current and frequency characteristics well above industry specifications. Reasonable current gains at 40mc have been measured. Since the photo process is far more controllable than mechanical fabrication, these transistors have exceptionally uniform characteristics. Stability, too, is outstanding, because Hoffman pre-ages every transistor at 300°C and seals it hermetically in an inert-gas atmosphere.

A wide range of useful current gain and operating frequencies makes these units ideal for computer, radar and many other applications. You can count on them in your most important circuit. Reliability is built into every unit.

ABSOLUTE MAXIMUM RATINGS (25°C)

V_{CBO} Collector-to-base voltage	60V
Total dissipation at case temperature 25°C	2W
Storage temperature range	−65°C to +175°C

ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTIC	MIN.	MAX.	TEST CONDITIONS
h_{FE}	D.C. pulse current gain (2N696)	20	60	I_C = 150ma V_C = 10V
	(2N697)	40	120	I_C = 150ma V_C = 10V
V_{BE} (sat)	Base saturation voltage		1.3V	I_C = 150ma I_B = 15ma
V_{CE} (sat)	Collector saturation voltage		1.5V	I_C = 150ma I_B = 15ma
h_{fe}	Small signal current gain at f = 20mc	6	9	I_C = 50ma V_C = 10V
C_{ob}	Collector capacitance		35uuf	I_E = 0ma V_C = 10V
I_{CBO}	Collector cutoff current		1.0ua	V_C = 30V T = 25°C
			100ua	V_C = 30V T = 150°C

Physical dimensions in accordance with JEDEC 30 (TO-5). Manufactured to meet MIL-S-19500B requirements.

Navy Plans 12-Man Killer Sub

Human engineering using electronic data processing and display is breeding a new generation of automated submarines

A FULLY automated 12-man submarine moved closer to realization this week. The Navy ends Phase II of its SUBIC (Submarine Integrated Control) program and begins Phase III.

Operation of a highly maneuverable, subsurface attack weapon with only a dozen men (the *USS Nautilus* has a crew of about 100) will be achieved by automation, integration of controls and systematic coordination between man and machine.

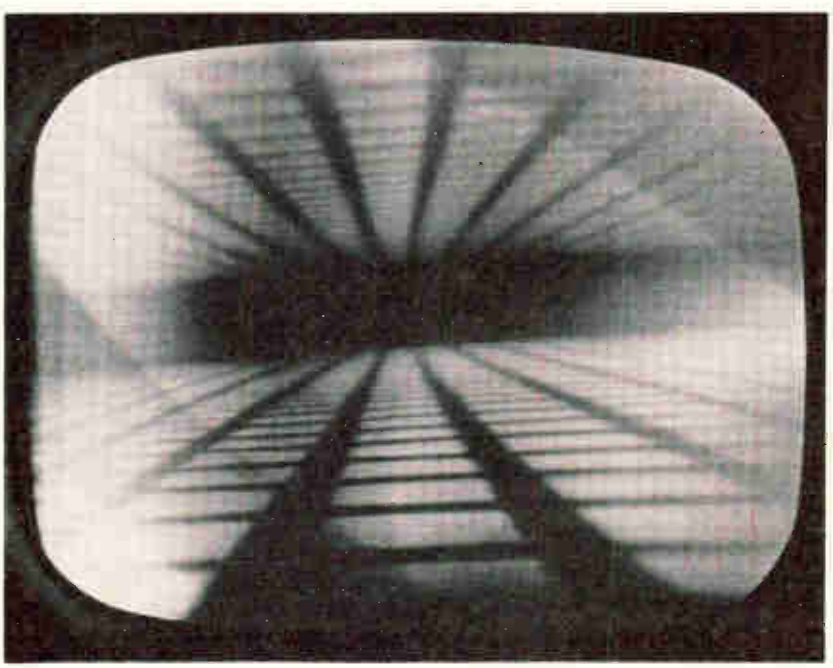
Five fundamental control areas, or "loops," will be automated and integrated: ship control, engineering, communications, weapons control and environmental. These separate control loops are then integrated into a master submarine command control system. Hundreds of bits of digital data will be electronically collated and converted to a simple positional display so that the human action required for maneuvering the sub will be self-evident.

Ideally, one man could handle each of the five control loops in operation under normal conditions. If no torpedoes are being fired, the ship's control operator could also monitor the weapons control loop. In case of emergency, crew members off duty would of course assist the one-man areas where needed.

Initiated in 1958, with General Dynamics' Electric Boat division named prime coordinator, Phase I paved the way by establishing the objectives and the techniques for attaining them. During Phase II, nine subcontractors studied the five control loops, determined the problems, and have come up with suggestions for suitable designs.

Phase III consists of digesting and consolidating the recommendations of the nine subcontractors, testing the proposals in simulated form at Electric Boat's simulation laboratory, in Groton, Conn., and coming up with an initial integrated control concept.

As the design concepts for the various loops get far enough along, new subcontracts will be awarded for specific design details.



Contact analog display shows sub commander electronically-generated picture of his ship's position in water environment

First application of the results of the SUBIC program will go into a new generation of antisubmarine warfare (ASW) killer subs. The *Tullibee*, one of the present generation of killer subs now under construction, will weigh 2,175 tons. SUBIC killer subs will probably weigh less than 1,500 tons. The SUBIC concept, however, is in no way limited by tonnage; it could serve any category of submarine. A later generation of Fleet Ballistic Missile subs might also incorporate the SUBIC design. Eventually such savings in manpower, space and operations costs are expected to be incorporated in all subsurface craft.

Integration of the five control systems into a single master command control console for the commander was the joint responsibility of Melpar, Alexandria, Va., and Human Sciences Research Inc., Arlington, Va. (the latter is still working on certain phases of the subcontract scheduled for completion by July).

Command Console

The control center is the nucleus of the ship's entire system. All information required for command decision flows into a console where it is rapidly integrated, visually displayed on the contact analog display, and continuously revised as changes occur in any segment. The display illustrates the internal status of the submarine as well as its situation in relation to the environment.

The picture presented by the contact analog display is an electronically-generated system of squares. Squares at the bottom represent the bottom of the sea, squares at the top, the surface. The ship's own position is shown as a dark shadow between the two. As the ship approaches the bottom, or the floor of the sea suddenly climbs, the pattern of grids immediately reflects the change in the ship's environment. The commander can thus "see" his

ship's situation and can dispatch command decisions to the five fundamental control areas.

The contact analog display is one segment of the SUBIC program that may lend itself to retrofitting existing nuclear subs.

Ship Control

Librascope, Glendale, Calif., and Cornell Aeronautical Laboratories, Buffalo, N. Y., are responsible for the ship control loop. Librascope's portion of the study will be delivered in March.

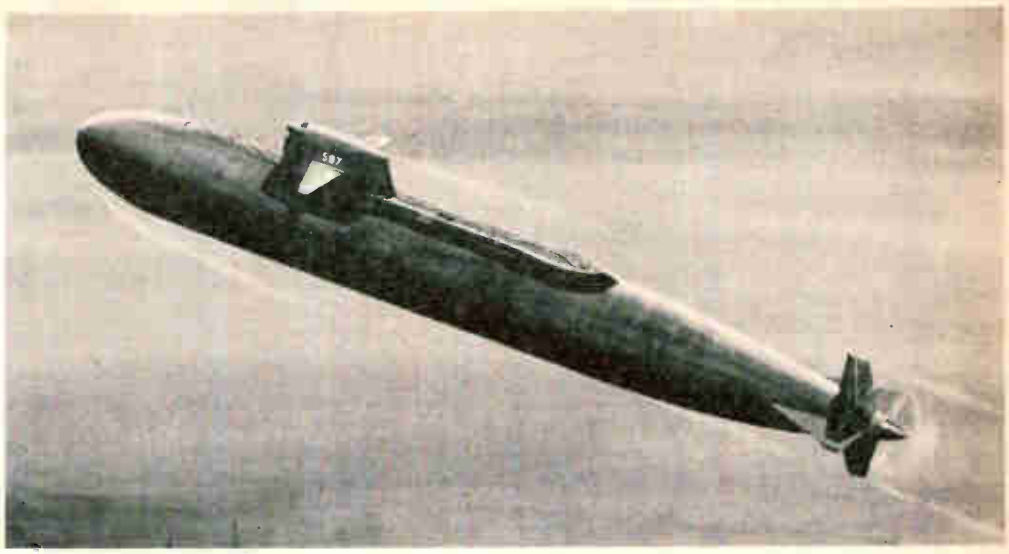
SUBIC promises one-man control of all steering and diving operations. (World War II subs required eight men; new nuclear subs, three.) The operator is assisted by automatic depth, course, trim and buoyancy control mechanisms. A central control computer provides essential information to displays and automatic mechanisms. Status of the sub is continuously revealed by an integrated dynamic display and situation plot.

The ship's control system is now being tested as part of Phase III by simulating electronically all the geographical and physical elements the ship's commander must be conscious of, such as the ocean's surface, floor, and other ships. This information is displayed by closed-circuit tv.

Weapons Control

International Business Machines Corp., Owego, N. Y. is studying the weapons control loop which includes the detection of targets, determination of target location, classification of contacts, precision navigation and firing orders to weapons. IBM's study, to be completed by mid-year, emphasizes the important correlation that exists between weapons control and ship control. This tie-in will be resolved at the command level. Correlation of these controls becomes increasingly vital as submarine missions involve engagement with multiple targets.

Major components of the weapons control loop include: a computer capable of accepting, storing and processing all available information; a display in situation plot form continuously indicating identity, position and movement of multiple targets as well as the sub's own position and movement; visual display of information with an indication of the most feasible type of action to take.



First of forthcoming generation of nuclear killer subs, *Tullibee*, is under construction. Next generation, based on SUBIC, will be fully automated with a crew of 12

Engineering Control

Franklin Institute, University of Pennsylvania, Philadelphia, is working on this phase of the program. Under normal conditions one man will control the main propulsion plant. A single display shows the operator the status of the power plant at all times. The operator is equipped with automatic means of effecting change in operation of the engineering plant for stand-by propulsion, repairs, special conditions or casualty correction. Necessary data is automatically stored and processed.

Communications Control

Study by Westinghouse's Air Arm div., Baltimore, Md., includes both external and internal communication. Subsystems indicated are: automatic transmitter-receiver to provide reliable high-speed transmission with a human operator as monitor and maintainer; automatic encryption-decryption unit to allow rapid receipt and transmission of messages; and rapid-access storage and automatic processing and dissemination of intelligence information and communications received.

Environmental Control

Study by Ionics, Inc., Cambridge, Mass., involved continuous air revitalization and automatic detection, monitoring and elimination of atmospheric contaminants; continuous control of environmental factors which promote maximum human effectiveness; display of casualty status information and controls for effecting corrective action.

Daystrom, La Jolla, Calif., is responsible for a number of the sensors used in the loops: electromagnetic, temperature, force, inertial, physical quantity, and geometry.

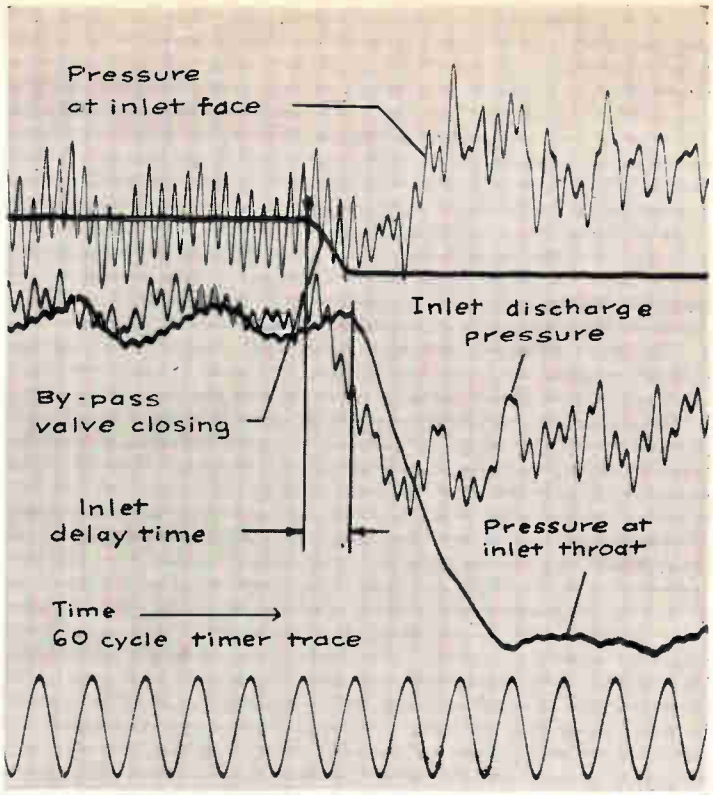
SUBIC, under the administration of the Office of Naval Research, (ONR), is one part of a three-pronged program. ONR also administers a similar program called SURIC (Surface Integrated Control) for surface craft, with Sperry Rand as prime contractor. Army and Navy sponsor ANIP (Army Navy Instrumentation Program) for both fixed wing and helicopter/VTOL aircraft, primed by Douglas and Bell Helicopter.

Objectives for all three efforts are in essence the same: to provide instrumentation, display and control capabilities required to achieve the maximum effectiveness of the operator or pilot-vehicle combination under all environmental conditions.

ONR sees SUBIC as a continuing program. The work will not end with design of a new submarine. New concepts, tested in breadboard models, will be turned over to the Bureau of Ships for use in the fleet's inventory of weapons. While BuShips is turning these into hardware, SUBIC will continue investigating new designs.

In research...

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations... "buzz"... for engineers at the NASA Lewis Flight-Propulsion Laboratory in Cleveland. "Buzz" is an unsteady variation in the pressure and airflow characteristics of a supersonic aircraft or missile inlet. These Visicorder studies defined the buzz-free operating limits of the inlet, and provided the designers with structural load information in case the inlet were inadvertently caused to operate on buzz during flight. This load information is vital, for inlet buzz can result in fluctuating structural loads of the order of 1000 psf... loads which could cause structural failure of the inlet and loss of the airplane. Visicorder records such as this have played an important role in the design of inlet control systems.

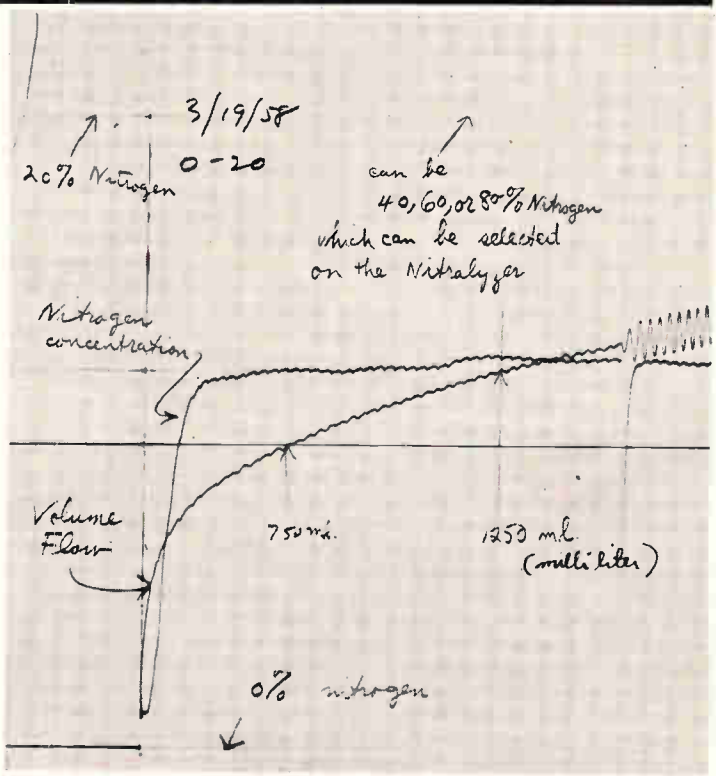


these are records of leadership

In medicine...

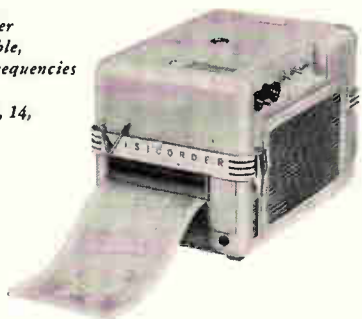
This directly-recorded Visicorder chart has told the scientists of the U. S. Public Health Service Occupational Health Program an important story about uneven alveolar ventilation in the human lung during a single breath of oxygen. In these lung function tests, the Visicorder measured anatomic dead space and abnormalities in the distribution of inspired gas in the alveoli of the lungs. The subject, under test, inhaled 100% oxygen to dilute nitrogen in the lungs. The Visicorder recorded the volume and the nitrogen percent of the exhalation. In these and in hundreds of other scientific and industrial applications, Visicorders are bringing about new advances in product design, computing, control, rocketry, nucleonics and production.

For information on applying the unlimited usefulness of the Visicorder to your specific problems, phone your nearest Honeywell Industrial Sales Office.



Visicorder records 2/3 actual size.

The Honeywell Visicorder provides instantly-readable, high-sensitivity data at frequencies from DC to 5000 CPS. There are models with 8, 14, or 36-channel capacities.



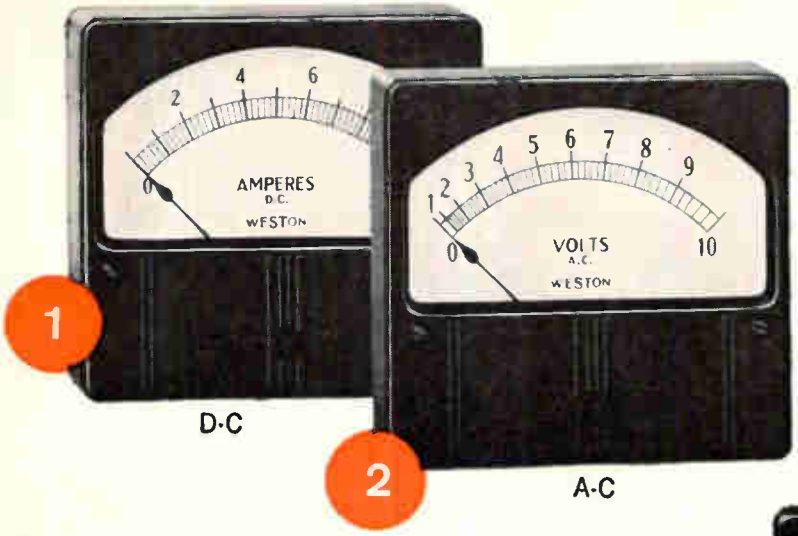
Honeywell

Industrial Products Group

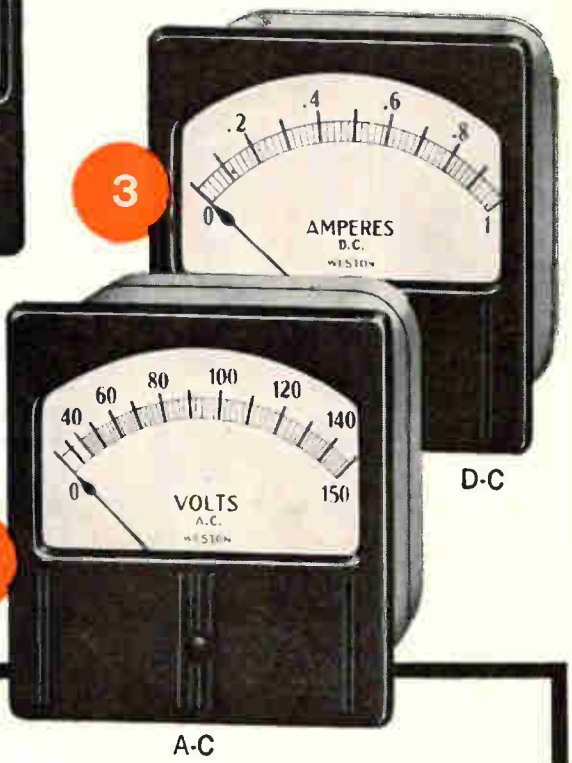
Reference Data: Write for specifications on Visicorders 906B, 1108 and 1012.

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

Model 961 Group Instruments



Model 741 Group Instruments



Feature by Feature

THESE WESTON RECTANGULARS LEAD THE FIELD

The well-balanced design, fine appearance and desirable features of these Weston instruments reflect a 70-year tradition of fine engineering and craftsmanship. If you're not already well acquainted with these notable models, look over this check list — you'll not find better value anywhere.

1 2 3 4	Long scales (Model 961 Group: 3.17" . . . Model 741 Group: 3.24" A-C and 3.52" D-C)
1 2 3 4	Excellent natural illumination (self-contained lighting optional)
1 2 3 4	High rated accuracies (Model 961 Group: 2% of full scale value . . . Model 741 Group: 1%)
1 2 3 4	High sensitivities . . . low response times
1 2 3 4	Excellent torque-to-weight ratios
1 2	Dielectric test — 5000 volts A-C
2 4	Group includes A-C rectifier type instruments
1 3	D-C and rectifier type instruments have magnetic shunts for precise adjustment

These instruments are particularly suitable for a wide variety of specialty applications where other than cataloged accuracies are desirable.

For full information, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom International, 100 Empire St., Newark 12, N. J.*

WESTON *Instruments*

A DAYSTROM UNIT

WORLD LEADER IN MEASUREMENT AND CONTROL

New Budget: Electronics Holds

WASHINGTON—FEDERAL SPENDING for electronics in the coming fiscal year (starting July 1) will be held pretty close to last year's figures. The distribution of goods will show up to be different from last year as the various agencies go to Congress for money, but the overall total will not change much. The biggest buyer of electronics, the Department of Defense, has been forced to cut its total buying power slightly in order to keep within the President's budget ceiling of $40.9 billion.

Congress, however, is sure to challenge the administration on its defense efforts and may well hike specific elements of the military budget. Long before the defense budget gets congressional sanction, hearings will probe into the strength of the U. S. relative to the Soviets. And political soundings already indicate many legislators are not happy with the nation's present standing. The so-called U. S. missile and space lag, for instance, is sure to provoke sharp congressional criticism of current aerospace programs.

Individual military leaders, too, will be quick to plug for favorite programs once they get before congressional committees. Air Force officials, for example, are openly critical about having to trim back the B-70 program. They will try to win congressional backing to restore the program to its original schedule.

More Aircraft

Aircraft procurement remains one of the major programs in the current budget. Money has been earmarked for a total of 1,510 craft, of which 633 are for the Air Force, 658 for the Navy, and 219 for the Army. This amounts to 99 more aircraft slated for procurement than were purchased last year, but 224 less than were bought in fiscal 1959.

Air Force planes to be purchased include B-52H heavy jet bombers, more supersonic B-58 medium jet bombers and supporting KC-135 jet tankers, plus additional F-105 supersonic fighter-bombers and C-130 turboprop transports. Navy will buy supersonic A3J attack craft and F8U-2N and F4H all-weather interceptors. Navy will also buy more GV-1 tanker-assault transports and S2F antisubmarine planes.

Army budget calls for a jump of some 35 percent in aircraft procurement fiscal 1960. More orders are slated for Mohawk turboprop observation aircraft, Caribou twin-engine transports, and Iroquois utility helicopters. The first production quantities of the Chinook helicopter are also slated for procurement in fiscal 1961.

Missiles Level Off

In the missile field, total procurement in fiscal 1961 is down $21 million from 1960 estimates. However, the Pentagon disclaims any total reduction in missile spending. Increased research, engineering and test money, plus new programs, will keep overall spending comparable to 1960's figures, the defense budgeters explain. Even though prices have increased one or two percent in 1960, the military argue that more product is being bought for the dollar through state-of-the-art advances. This offsets the price increases, Pentagon spokesmen say.

Missile money for fiscal 1961 will virtually finish the procurement for the Bomarc and Nike-Hercules air-defense missiles. Money will continue to be pumped into the Talos, Terrier and Tartan fleet air-defense missiles, however. "Large numbers" of air-to-air missiles such as the Sparrow, Falcon and Sidewinder will be purchased in 1961. Procurement of the Hound Dog and Quail for use by the B-52 will be "continued at a high level."

Spending on Atlas and Titan ICBMs will continue to take a big bite of the defense dollar. Present programs call for 13 Atlas squadrons of 10 missiles each and 14 Titan squadrons of 10 missiles each. So far, all 13 Atlas squadrons are funded: 10 squadrons are fully

ELECTRONICS IN THE NEW BUDGET

	FISCAL 1960		FISCAL 1961	
	OBLIGATIONS	ESTIMATED EXPENDITURES	OBLIGATIONS	ESTIMATED EXPENDITURES
	(All figures in millions of dollars)			
DEPARTMENT OF DEFENSE				
Aircraft Electronics	$1,485.0	$1,667.5	$1,503.2	$1,506.7
Missile Electronics	1,239.0	1,225.0	1,331.7	1,217.6
Shipborne Electronics	75.0	82.5	87.0	82.2
Communications and Other	1,067.2	920.0	985.5	979.2
Research, Development, Test and Evaluation	1,200.0	1,000.0	1,200.0	1,100.0
DEPARTMENT OF DEFENSE TOTAL	$5,066.2	$4,895.0	$5,107.4	$4,885.7
FEDERAL AVIATION AGENCY				
Air Traffic and other Facilities	$ 88.6	$ 75.0	$ 146.2	$ 105.0
Research and Development	24.3	18.0	32.5	25.0
FAA TOTAL	$ 112.9	$ 93.0	$ 178.7	$ 130.0
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION				
Tracking and other Facilities	$ 22.2	$ 10.9	$ 22.3	$ 17.5
Research and Development	80.0	48.2	138.2	87.5
NASA TOTAL	$ 102.2	$ 59.1	$ 160.5	$ 105.0
POST OFFICE Modernization Program	$ 40.0	$ 40.0	$ 40.0	$ 40.0
NATIONAL BUREAU OF STANDARDS R&D	$ 8.6	$ 8.4	$ 9.8	$ 9.7

The government has no official breakdown for electronics purchases or for electronics research programs. Officials use estimates as to the percentage of a program which involves electronics. For example, the official estimate of the amount of aircraft procurement which represents electronics is 25 percent; since the total allocation for aircraft procurement in fiscal 1961 is $6,027 million, electronics' share comes to $1,506.7 million. Here are the percentage figures used in compiling this table:

DEPARTMENT OF DEFENSE Aircraft, 25 percent; Missiles, 35 percent, Shipborne Electronics, 5 percent; Research, Development, Test and Evaluation, 25 percent; Communications and Others, 50 percent. FAA Air Traffic and Other Facilities, 75 percent; Research and Development, 50 percent. NASA Tracking and Other Facilities, 25 percent; Research and Development, 25 percent. POST OFFICE 50 percent. NATIONAL BUREAU OF STANDARDS 50 percent.

the Line

funded, and items with long lead-times are funded for the others. No new orders will be placed for Thor and Jupiter IRBMs in fiscal 1961.

More Space Research

Money budgeted for military space programs will continue or speed up several satellite projects, including the Midas early warning system, the Samos reconnaissance satellite, the Notus communications satellite and the Transit navigation system. Money to start construction of another BMEWS (ballistic-missile early-warning system) facility in England is also included in the new military budget.

The National Aeronautics & Space Administration's money request jumps from around $500 million for this fiscal year to $802 million for fiscal 1961. This increase is partly the result of including in the NASA budget approximately $140 million for the big million-pound-plus thrust engine Saturn, which the President recently transferred from the Army to the space agency. Actual expenditures for 1961 are expected to climb to around $634 million, compared with $370 million in 1960.

Some $32 million has been budgeted to boost the agency's tracking and data-acquisition network. Included is a special tracking network for the Mercury man-in-space project. Additional electronics money will go into the tracking facilities at missile ranges.

Air Traffic Controls

The Federal Aviation Agency will be coming purse in hand to the electronics industry for such things as air navigation facilities. For instance, $17.7 million is earmarked for Vortac (vhf omnirange with Tacan-compatible distance-measuring equipment); $8.3 million for instrument-landing systems; $37.3 million for long-range radar; $50.4 million for traffic control centers, and $13.3 million for air-traffic communications.

The National Bureau of Standards has budgeted some $7 million for physics and electronics, another $4.2 million for radio propagation.

Umbilical

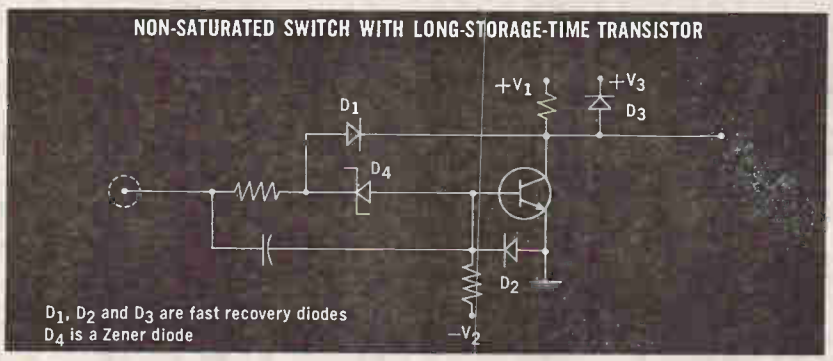
The MSC-built Umbilical Launching Cable... an example of the product diversity of Missile Systems Corporation. Like all products that bear the MSC label, this system has proven its reliability. Just as it is a life-line to the success of a mission, so also are MSC's contributions material to the future accomplishments of *all* facets of the electronic industry. MSC's variety of products form one continual life-line... feeding an industry which is already changing the life patterns of generations to come.

MSC

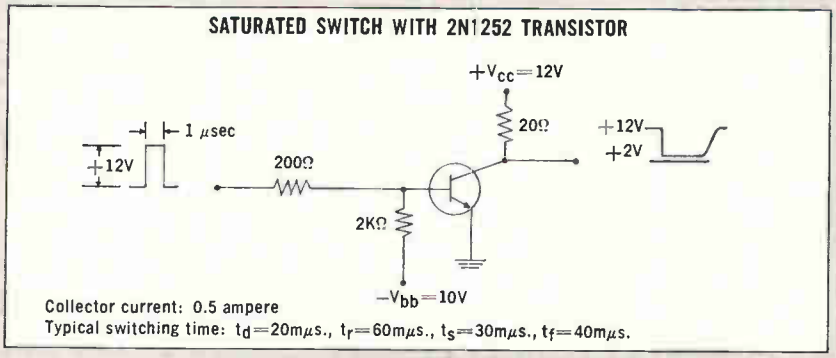
MISSILE SYSTEMS CORP.
11949 VOSE ST., NORTH HOLLYWOOD, CALIF.

Engineering and Manufacturing Corporation of Texas / subsidiary
Dallas, Texas

RELIABLE SILICON TRANSISTOR SWITCHING



9 COMPONENTS REPLACED BY 4



HOW? – By using Fairchild's 2N1252 or 2N1253 **lowstorage** silicon mesa transistors. The guaranteed low storage characteristic permits a simple saturating circuit to achieve switching speeds that previously required complex non-saturating circuits.

WHY? – Improved reliability and reduced cost – one semiconductor instead of five and fewer soldered connections. Power dissipation is only 1/3rd to 1/5th as great, making possible much higher component densities in packaging. Cost and reliability are improved all the way from development through volume production.

WHERE? – Switching circuits in general. The 2N1252 and 2N1253 are ideally suited to high-speed high-current switching applications such as magnetic-core drivers, drum and tape write drivers, high-current pulse generators and clock amplifiers. In addition, the transistors are applicable to medium-speed saturated logic circuits.

FAIRCHILD 2N1252 and 2N1253

Symbol	Characteristic	Rating	Min	Typ	Max	Test Conditions
h_{FE}	D.C. pulse current gain 2N1252		15	35	45	$I_C=150mA$ $V_C=10V$
	2N1253		30	45	90	
P_C	Total dissipation at 25°C case temperature	2 watts				
$V_{BE\ SAT.}$	Base saturation voltage			0.9V	1.3V	$I_C=150mA$ $I_B=15mA$
$V_{CE\ SAT.}$	Collector saturation voltage			0.6V	1.5V	$I_C=150mA$ $I_B=15mA$
h_{fe}	Small signal current gain at f=20mc 2N1252		2	4		$I_C=50mA$ $V_C=10V$
	2N1253		2.5	5.5		
I_{CBO}	Collector cutoff current			0.1μA	10μA	$V_C=20V$ T=25°C
				100μA	600μA	$V_C=20V$ T=150°C
t_s+t_f	Turn off time			75mμs	150mμs	$I_C=150mA$ $I_{B1}=15mA$
						$I_{B2}=5mA$ $R_L=40\Omega$
						Pulse width=10ms

For full specifications, write Dept. A-1.

FAIRCHILD
SEMICONDUCTOR CORPORATION

545 WHISMAN ROAD • MOUNTAIN VIEW, CALIFORNIA • YORKSHIRE 8-8161 • TWX: MOUNTAIN VIEW CAL 122

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Washington D.C.: NAtional 8-7770 • Chicago: BRowning 9-5680 • Los Angeles: OLeander 5-6058

New Approaches to Reliability

Military weapon system development is said to stress too much breakthrough research and too many unit cost compromises

CHANGES in government-supported R & D and in contract bidding to increase the reliability of military electronic systems were called for last week at the sixth annual Symposium on Reliability and Quality Control.

J. K. Sprague, president of Sprague Electric Co., said in a keynote address that the government could help attain reliability by fostering sound, long-range research and development programs aimed at systematic upgrading of reliability.

Too much of our R & D effort, he said, is concentrated on breakthrough research. The results frequently bear on specific applications, and do not serve to increase the reliability of standard parts and materials.

He urged the Department of Defense to stress that quality and reliability are the most important ingredients of weapon systems, which in turn precludes "excessive concern with unit cost as a valid criterion in weapons requirements." There must be complete and uniform specifications, he said, without loopholes, so that some individuals cannot make compromises in the interest of lower cost and at the expense of reliability.

He charged that the practices of waiving test requirements and lot-by-lot control procedures for lower cost is "very widespread today."

Would Limit Bidding

Sprague called for "modified" competitive bidding, with suitable restriction on those contracts which require high levels of reliability. He would limit bidding to those manufacturers who have demonstrated their ability to produce to required reliability levels.

The qualified products list should be revised, he said, to be sure that products listed continue to meet requirements. He advocated maximum standardization of high reliability components.

Components have been overlooked in the glamour of many large systems, said banquet speaker Vice Admiral J. T. Hayward, USN, assistant chief of naval operations, in his address on research and development aspects of reliability. Admittedly, he said, it has been easier in the past to obtain money for many large systems but the results have shown "we should have paid more attention to our homework on the components."

In the coming year, he told the group, more emphasis will be placed on reliability in components and on materials used in these components. Components and materials represent the very heart of any reliability program, he said.

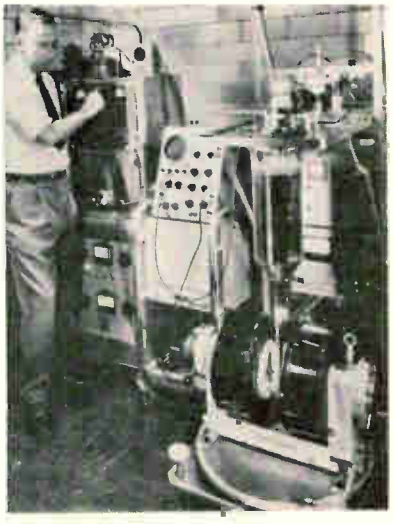
Comments on Sessions

Other symposium papers presented new developments or analysis of problems in various phases of reliability and quality control. Between the sessions, which attracted about 1,100 engineers and scientists from 19 countries, there was considerable discussion of these problems and new devices. Here are two comments:

C. R. Knight, research director, Arinc Research Corp., said progress in reliability at the systems level is disappointingly slow—a lot slower than we are technically capable of moving. "We need a more unified approach both technically and financially," he said. "The trouble lies between the economic and technical points of view in the development stage."

He believes the economic point of view often does not take into consideration the overall cost of the system, including both development and maintenance. Reliability can be traded against time and dollars, he said.

Knight believes some technical people may share the blame in not developing economic arguments with sufficient care. He said the computer, where both in development and maintenance the dollars come out of one pocket, is a good example of an area of unity.



Device materials such as germanium and silicon are subjected to "cold weather" approaching 460 F below zero in this set-up at Sylvania Research Laboratories, Bayside, N. Y.

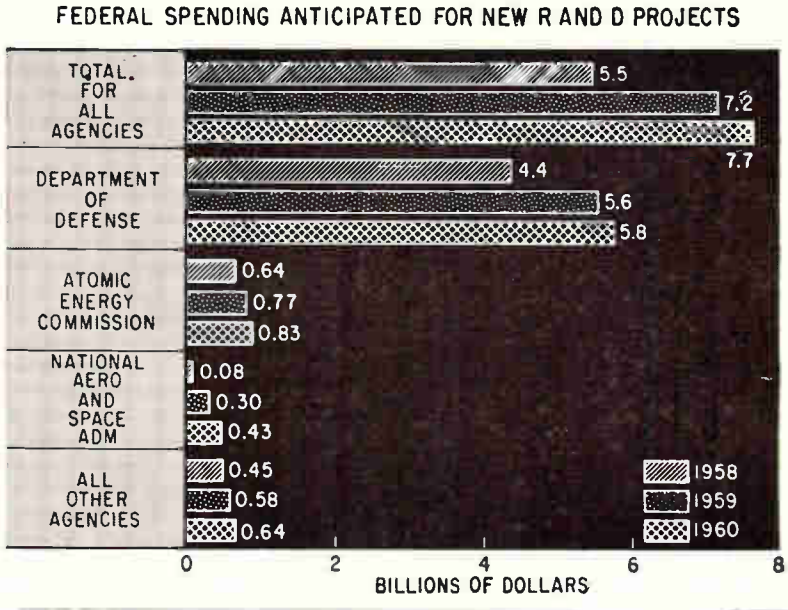
Technical Approach

A technical approach to reliability came from H. Voegtlen, manager of Applied Research Projects, RCA, Rome, N. Y., and winner of a citation for an outstanding paper at last year's symposium. The problem, he said, in the technical area is that there are no accurate tools for measuring or forecasting total costs of weapons systems for their operational life.

Support costs frequently amount to from 10 to 100 times the procurement cost of equipment during its useful life, he said. Voegtlen suggests that relatively small investments in development of reliability and maintainability prediction techniques that can be applied from design inception through equipment service life will pay off large dividends in reducing support costs.

One session was devoted to a discussion of various programs for the exchange of information between companies in such a way as to further the state-of-the-art in component reliability, reduce costs and shorten delivery delays of equipment.

R & D to Surpass



Federal spending for research and development will set a new record this year

RESEARCH and development spending by the federal government will hit the highest point in history this year, according to a survey by the National Science Foundation.

What proportion of total R & D spending will go for electronics is not certain, but Washington sources are now framing estimates. (See p 32 for budget details.)

Total outlay for federal R & D spending will be about $15½ billion compared with last year's estimated $14½ billion and 1958's $10¼ billion.

Actual contracts for 1960 have been committed or are in negotiation for about $7½ billion. More than an additional $8 billion is earmarked for additional projects.

Lion's share of the now uncommitted funds will be the Defense Department's $5.8 billion for military projects. Last year's total was about $5.6 billion, with $4.4 spent in 1958 (see graph).

It is likely that a good 65 percent of all military R & D will go to "profit organizations" or private industry. Nine percent will probably go to educational institutions, while some 24 percent will be administered within federal defense agencies. Of this 24 percent, a portion of the funds may find their way into private industry through subcontracts.

Contractors to the Atomic Energy Commission, the second largest beneficiary of this year's R & D budget, will see about $830 million spent on new projects. AEC's distribution of funds to industry, government agencies and other organizations will break down in much the same way as DOD's.

National Aeronautics and Space Administration will receive the third largest share of the federal R & D funds. Total estimated spending for the year on new projects will be $430 million. In 1958, NASA's R & D budget was only about $8 million, rising to close to $300 million in 1959. (NASA assumed the activities of the former National Advisory Committee for Aeronautics and combined them with responsibility for civilian studies of outer space.)

FAA Funds Rise

Also increasing is the budget for the Federal Aviation Agency whose estimated R & D obligations rose from $16 million in 1958, to $20 million in 1959 and will hit $49 million this year. (FAA last year took over the research and development programs of the Airways Modernization Board, the Civil Aeronautics Administration and other civilian aviation responsibilities.)

New work planned by federal agencies is divided according to the

$15 Billion

branches of science for budgetary purposes. While the life sciences will get some $550 million for new work in the fields of biology, medicine and agriculture, it is the physical sciences which will gain the greater share. Total spending in the physical science area will come to about $1.1 billion. Of this, $509 million will go for engineering science, $54 million for mathematical studies and $533 million for other areas.

In 1959 the engineering sciences received about $414 million, and in 1958 some $278 million.

Of an Army total of $1,090,900. $141,564 will go for applied research, $20,113 for basic research and $907,301 for development.

Similarly, the Navy will probably disperse some $1,298,226 as follows: $1,113,305 for development, $135,295 for applied research and $49,250 for basic research.

Expectations are that the Air Force will spend a greater amount on R & D than either the Army or the Navy. Of a total of $2,768,538, the Air Force will spend some $1,113,305 for development, $135,295 for applied research and $36,000 for basic research.

Million-Watt Transmitter Set

SUPER-POWER transmitter in Cutler, Me., will be completed before the end of this year according to Navy spokesmen.

Output will be more than one million watts with signals beamed largely at undersea missile submarines. Broadcasts will be in the vhf band.

All main towers in one of the two projected arrays have been completed. Each array includes a six-pointed complex of elevated wire panels supported by a central tower 980 ft high.

Antenna efficiency is projected at 70 percent as against 30 percent for any similar station now in use.

The big arrays will be able to detect missile and atomic launchings anywhere in the world by detecting echoes caused by ionized trails.

electronics buyers' guide and reference issue
THE ELECTRONICS MAN'S BASIC BUYING BOOK

A McGRAW-HILL PUBLICATION
330 West 42nd St., New York 36, N. Y.

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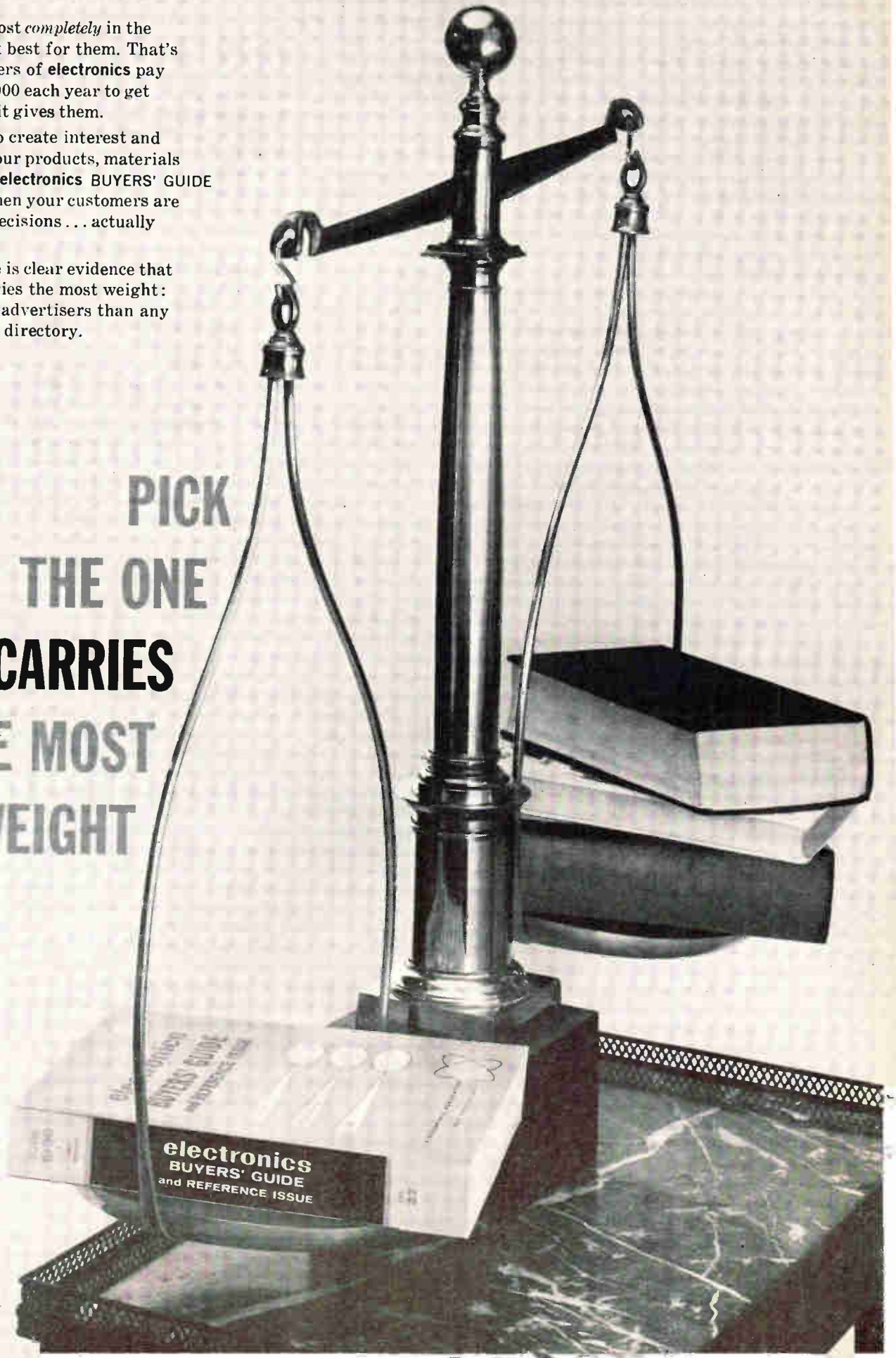
PICK THE ONE THAT CARRIES THE MOST WEIGHT



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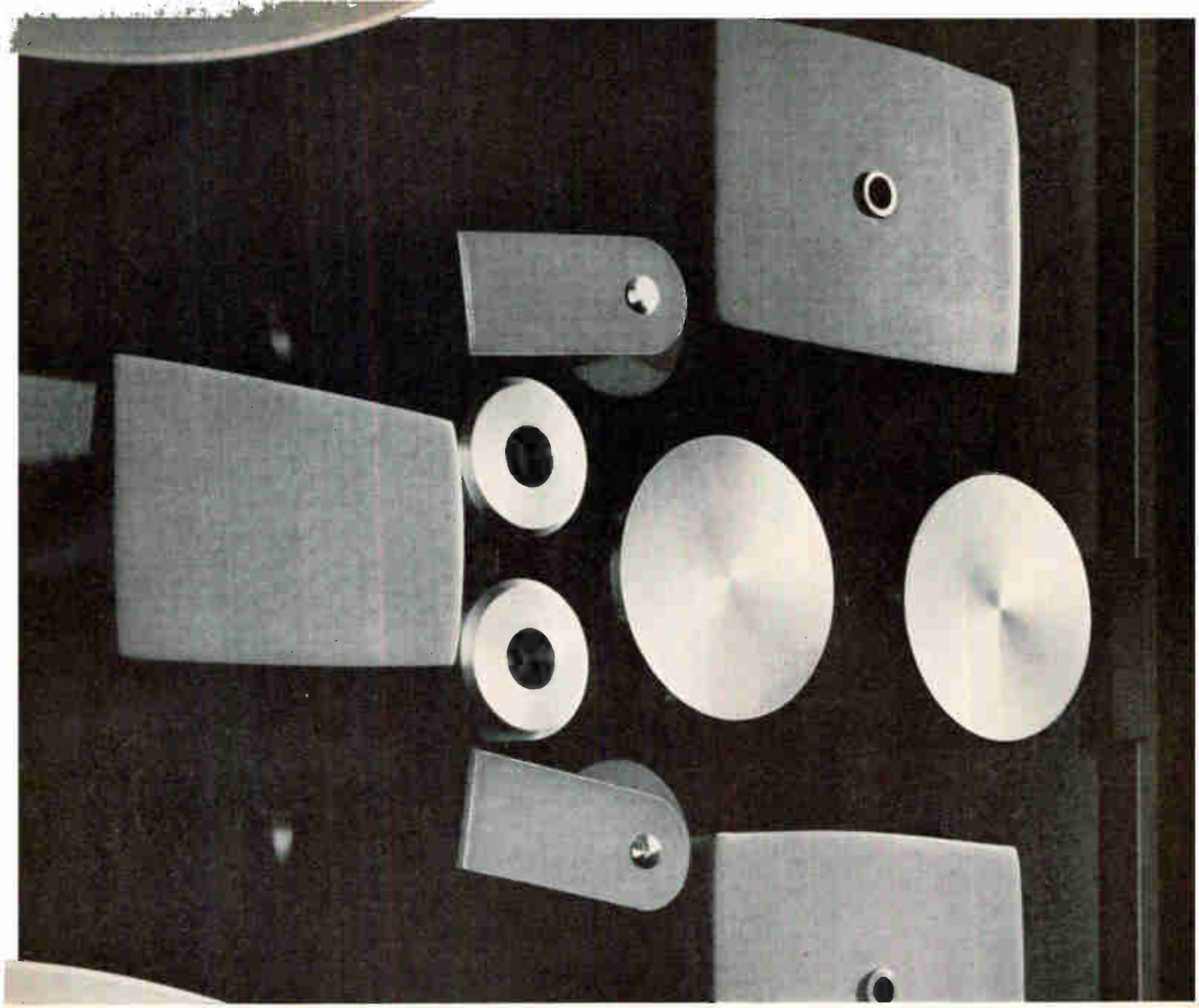
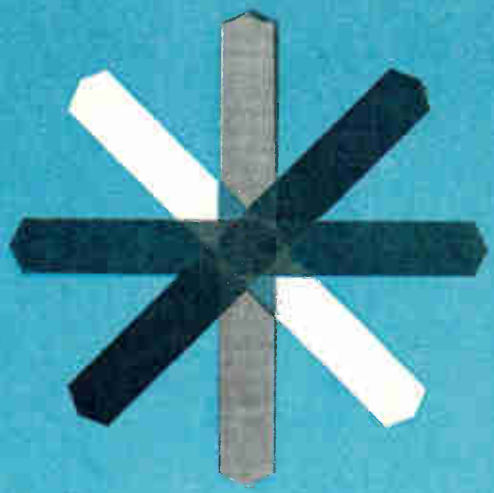


Better machines make good machines obsolete. *Usually*. The remarkable thing about the new Ampex FR-600 is that it doubles the usefulness of every Ampex analog recorder ever built. And it *is* unquestionably a better machine. But it is compatible with earlier models. It actually lets you do things with them you never could before. Like record the same bandwidths at half the usual speed. 100 kc at 30 ips, for instance. Twice as many minutes on the same reel of tape therefore. Pretty important in airborne use of the Ampex AR-200, or mobile use of Model 800's. Even important in lab installations using FR-100's or 1100's. Doubled recording time is always useful. Sometimes indispensable. It's possible because bandwidth is determined by the reproduce head. If your data will be reproduced on an FR-600, you simply drop the bias current on earlier machines to 9 milliamperes. A 5-minute screwdriver adjustment. Then you record the same bandwidth at half the speed and get twice the recording time. A good reason for getting the full FR-600 story. AMPEX DATA PRODUCTS CO., 934 Charter St., Redwood City, Calif.

This machine doubles the value of every Ampex analog recorder

FR 600 AMPEX



Lockheed Missiles and Space Division

invites your inquiry into these

UNUSUAL RESEARCH AND DEVELOPMENT OPPORTUNITIES

Important career positions are available at Lockheed Missiles and Space Division at its new facilities on the beautiful San Francisco Peninsula – one of the choicest living areas in the nation. Headquarters for the Division are at Sunnyvale, California, with Research and Development Facilities located in the Stanford Industrial Park in nearby Palo Alto.

The Division is widely diversified—having complete capability in more than 40 areas of science and technology, from concept to operation. Areas of work include: metallurgy; sonics; reconnaissance; computer design and development; propulsion and exotic fuels; space physics; hydrodynamics; the flight sciences; space medicine; manned space vehicles; telemetry; electronics; applied mathematics; operations research and analysis; space communications; reentry; design; and test, both environmental and flight.

Equipment and facilities are completely modern and include one of the largest computer centers in the world.

The Division is systems manager for several major, long-range projects and its research and development programs reach far into the future. It is a rewarding future with a company that has an outstanding record of leadership and progress.

Unusual opportunities exist for experienced engineers and scientists to contribute to the solution of new problems in the areas listed on the next page. If you are experienced in these areas, or have background in related fields, we invite your inquiry. Please write: Research and Development Staff, Dept. A-22, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense clearance required.

AERO AND FLIGHT DYNAMICS AND PERFORMANCE

Advanced degree preferred with background in one or more of the following areas: flight test analysis of reentry trajectories and/or systems evaluation; flight test analysis of trajectories and separation evaluation; theory of subsonic and hypersonic aerodynamics; underwater stability and control hydrodynamics; aerodynamic preliminary design studies; research in gas dynamics studies of thrust vector controls, stage separation, propulsion systems analysis, and rocket nozzle design; or wind tunnel studies and testing.

ANALOG COMPUTING

Advanced degree required with real time experience with analog computers. For the solution of problems in flight controls; guidance; aero and thermo dynamics; dynamic analysis and process controls.

ANTENNA DESIGN

Advanced degree in E.E. preferred with background of several years' experience in antenna design for space vehicles.

CHEMISTRY

Ph.D. preferred, advanced degree required, with strong research background for development work in fuel cells; batteries; the direct conversion of electrochemical energy; electrode kinetics; catalysis; photochemistry; thin film; and solid state. Work concerns both military and commercial applications.

Advanced degree required, Ph.D. preferred with background in either physical-organic chemistry; inorganic chemistry; analytical chemistry; or electrochemistry for research and development work in such areas as: instrumental analytical techniques including infrared, ultraviolet and mass spectroscopy; gas solid reaction kinetics; microchemical analysis techniques; surface treatment of metals and surface reaction kinetics; molecular resistance of substances to various environments including formulation of elastomers; or reinforced plastics.

INFRARED

Advanced degree in E.E. or physics preferred but not required, with experience in infrared systems research and development, or electrical engineers with background in electronics information theory; servomechanisms; specialized circuitry, as in low-level voltage circuits, or physicists with background in optics or semi-conductors. For work in infrared physics research; advanced systems development; or physical measurements in infrared.

TELECOMMUNICATIONS

Degree in E.E. or communications with background in design of UHF, VHF and RF transmitters; telemetry systems and components; circuit design or logical design components.

LOGICAL DESIGN

Background of graduate work in E.E. or math., with interest in advanced areas of computer research in such efforts as: pattern recognition; automata studies; logical design and switching theory; information retrieval; and behavior patterns of artificial neurons patterned closely after those of the human brain.

MECHANICAL DESIGN

Advanced degree in M.E. preferred with background of mechanisms and small structures desirable. For research in experimental design and the development of a variety of research test models.

Advanced degree in M.E. preferred with experience in the design of aero and thermodynamic missile scale models including previous work in wind tunnel model design and test. Shop liaison experience desirable.

METALLURGY

Advanced degree preferred for basic and applied research in one or more of the following areas: metallurgical behavior and mechanisms concerning high temperature and advanced missile materials with interest in metal physics; deformation and fracture; phase equilibria; transformations; or diffusion. Also, to conduct basic and applied studies in refractory metals; dispersed phase systems; fiber metallurgy; ceramics and thermal protective materials systems. Also, for X-ray and electron diffraction research and studies in single crystals; point defects; parameter measurements; pole figure determinations.

MICROWAVE

Experience required in MASER amplifiers and variable reactance parametric devices, for experimental research in microwave.

ORDNANCE

Degree in E.E. or M.E. required and several years' experience in developmental testing of ordnance and pyrotechnic devices, preferably in the missile field, with complete familiarity with high speed oscillography; pin techniques; pulse circuitry techniques; high speed photography; and instrumentation methods for recording pressure; shock; velocity and temperature for the development of ordnance equipment for missiles.

SOLID STATE DEVICES

Advanced degree required and Ph.D. preferred in E.E., physics or chemistry and evidence of creative, original work through published articles, patents or superior Ph.D. theses for research work in one or more of the following: thermoelectric; photovoltaic; lumistor; ferrite; logic component; sensor; thermistor; or cryogenic devices. Also, materials analysis and evaluation; processing techniques design and development of novel electronics devices and components; circuit analysis; circuit topology; or microminiaturization.

Lockheed / MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER Program and the MIDAS and SAMOS Satellites; Air Force X-7; and Army KINGFISHER

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIF. • CAPE CANAVERAL, FLA. • ALAMOGORDO, N.M. • HAWAII

This is NASA's

Inflatable Communications Satellite

. . . as tall as a 10-story building

This shimmering sphere of aluminized plastic, merely one half of a thousandth of an inch thick, is 100 feet in diameter, yet it weighs only 150 pounds. The satellite will be several times brighter than the Pole star and will be plainly visible with the naked eye while orbiting the earth every 118 minutes at an altitude of 1,000 miles.

The NASA inflatable satellite is a significant step in the development of advanced global communications. The satellite will reflect radio and radar signals from powerful earth-bound transmitters for investigation of forward scattering techniques of communications and propagation. NASA has invited scientists around the world to participate in this project.

This endeavor—only one of many now in advanced stages of fruition . . . is indicative of the calibre of NASA projects, personnel and resources.

If you are a scientist or engineer and would like to become associated with NASA, address your inquiry to the Personnel Director of any of the following NASA research centers:

Langley Research Center,
Hampton, Va.

Ames Research Center,
Mountain View, Calif.

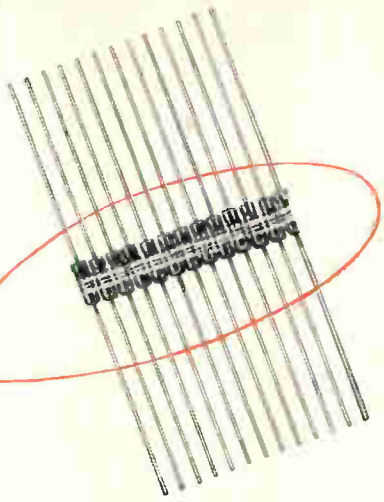
Lewis Research Center,
Cleveland 35, Ohio

Flight Research Center,
Edwards, Calif.

Goddard Space Flight Center,
Washington 25, D. C.

NASA National Aeronautics and Space Administration

Now available in commercial quantities!



Sylvania D-1820 germanium High-Speed Switching Diode

4 mμSECS

GUARANTEED MAXIMUM RECOVERY TIME!

SYLVANIA D-1820 is the forerunner of an outstanding family of diodes, designed, produced and controlled specifically for logic circuitry. The cost of this new SYLVANIA diode is low enough to make it especially attractive for use in quantity-produced electronic computers. SYLVANIA D-1820, and the circuits designed around this diode, feature:

high-speed operation — with recommended circuits, all units are guaranteed to provide a maximum recovery time of 4 millimicroseconds. However, recovery times of 2.5 millimicroseconds are typical.

long-life performance — proved in 1000-hours operating and 7000-hours storage life tests.

high reliability — basic point-contact structure has been field-proved for more than a decade. Withstands environmental conditions of shock and vibration.

exceptional uniformity of electrical characteristics—assures complete interchangeability within the type—result of modern automated-production techniques employed in the manufacture of SYLVANIA D-1820.

economy — SYLVANIA pioneered the field of germanium point-contact diode manufacture, has "know-how" of superior-quality, large-quantity economical production. SYLVANIA is able to pass these savings on to you.

simplicity—diode-logic circuitry is relatively uncomplicated, requires few components. It reduces computer construction costs. It adds to equipment reliability.

compactness—SYLVANIA D-1820 "package" is miniature all-glass.

availability—units can be supplied immediately through your local Sylvania Semiconductor Distributor or through your local Sylvania Field Office.

Complete sales information on quantity prices, delivery and sampling for your own evaluation is available from your local Sylvania Semiconductor Distributor or Field Office. For engineering data sheets on the new Sylvania D-1820 High-Speed Switching Diode or on any Sylvania Semiconductor Device, write Sylvania Semiconductor Division, Dept. 22-1, Woburn, Mass.

ELECTRICAL CHARACTERISTICS— SYLVANIA D-1820	
Absolute Maximum Ratings*	Typical Operating Conditions*
Fwd. Volt .....1.3 V†	Fwd. Volt.....0.9 V
Fwd. Curr. .....50 mA	Fwd. Curr. .....2.0 μA
Back Volt .....20 V	Rev. Recovery.....2.5 mμs
Pwr. Diss. .....80 mW	

†at 10 mA *at 20° C.

SYLVANIA

Subsidiary of GENERAL TELEPHONE & ELECTRONICS

MEETINGS AHEAD

Jan. 31-Feb. 5: Winter General Meeting, AIEE, Statler Hilton Hotel, New York City.

Feb. 1-4: Instrument - Automation Conf. and Exhibit, ISA, Sam Houston Coliseum, Houston.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid-State Circuits Conf., AIEE, IRE, Univ. of Penn., Hotel Sheraton, Philadelphia.

Feb. 10-12: Cleveland Electronics Conf., ISA, IRE, AIEE, CPS, CIT and WRU, Cleveland Eng. & Scientific Center, Cleveland, Ohio.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 16-18: Nondestructive Testing of Aircraft & Missile Components, Southwest Research Institute, Hilton Hotel, San Antonio, Texas.

Feb. 19-23: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Feb. 25-26: Scintillation Counter Symposium, AIEE, AEC, IRE, NBS, Hotel Shoreham, Wash., D. C.

Mar. 17-18: Synchro Design and Testing Symposium, Bureau of Naval Weapons, Dept. of Navy, Dept. of Commerce Auditorium, Wash., D. C.

Mar. 21-24: Institute of Radio Engineers, Annual A. & M. College of seum & Waldorf-Astoria Hotel, N. Y. C.

Apr. 3-8: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 11-13: Protective Relay Engineers, Annual, A. & M. College of Texas, College Station, Texas.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 86.

YORK-HOOVER GUARANTEE

The York-Hoover Body Division occupies 350,000 square feet of modern manufacturing facilities. Highly skilled engineers, metal workers, welders and finishers take traditional Pennsylvania Dutch pride in producing this top quality Shelter S-141.

This is your guarantee, backed by 67 years of creative engineering and production "know how."

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announces the new electronic shelter S-141

IN MISSILRY . . .
as a tracking
center

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. . . as a GCA and ILS
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. . . as a maintenance
shop

MIL-S-52059 (Sig C)

IN RAPID AIR
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shipping container

EXCLUSIVE FEATURES

ALL WELDED CONSTRUCTION—Inert arc welded aluminum frame resistance welded to the outer skin results in the most rugged and reliable semi-monocoque construction.

SQUARE INSIDE CORNERS—Maximum internal space utilization is achieved; simplified corner installation of ducting, raceways and equipments is permitted.

LIGHTWEIGHT CONSTRUCTION—The unique combination of high strength to weight ratio foams results in the lightest weight sandwich panel construction consistent with military specifications.

REPLACEABLE SKIDS—Designed to permit easy replacement of skids.

FLEXIBLE DESIGN WITH MINIMUM COST—The York-Hoover shelter design lends itself to maximum individual custom requirements, such as, access openings, internal reinforcements, overall dimensions and similar modifications.

TESTED AND APPROVED—The York-Hoover S-141 Shelter has been tested and complies with U. S. Army Signal Corps specification.

PARTIAL LIST OF CUSTOMERS

U. S. Army Signal Corps
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York-Hoover Loading Device permits simple and reliable loading of shelters on military type trucks in all terrains.

YORK-HOOVER CORPORATION

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Creative Engineering for Industrial and Military Products Since 1892

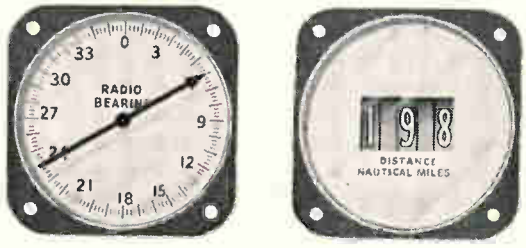
Write for Bulletin No. 949

Miniaturization means only active components G-E subminiatures use to give miniaturization

HOFFMAN TACAN: MEETS 780% - HIGHER AGREE* SPEC!

*Advisory Group on Reliability of Electronic Equipment, which has set a new standard of 150 hours mean-time-to-failure for TACAN.

General Electric subminiature tubes with heat-resistant glass have played a key role in advancing the reliability of Hoffman Electronics Corporation's new ARN-21C to nine times that of older TACAN equipment.



Compactness is a feature... transmitter, receiver, and electronic computer functions all are grouped in one "black box" that measures only 8 by 11 by 17 inches. Heat build-up necessarily is substantial.

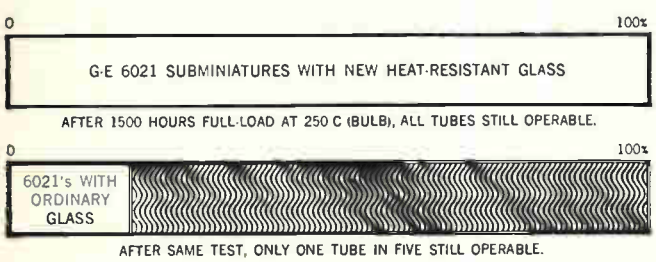
In General Electric subminiature tubes, Hoffman found the answers to their pressing need for tubes that would stand up to heat *with no sacrifice in reliability.* 28 G-E subminiatures are used in the ARN-21C.

heat. Tubes  are the that can withstand heat. new heat-resistant glass with reliability.

ACTUAL SIZE

WHAT TESTS SHOW

Life tests of G-E subminiatures with new heat-resistant glass prove that high-temperature operation has no adverse effect on reliability. Check the total absence of failures with G-E type 6021 after 1500 hours at 250 C, against the high failure rate of ordinary 6021's under the same conditions!



Type 6021 is a key tube in Hoffman's TACAN circuit. Glass electrolysis—cause of 90% of tube failures at high temperatures—has virtually been eliminated by General Electric in the 6021 and other subminiature receiving tubes.

SPECIFY FOR RELIABILITY

Small...smaller...smallest! The trend in electronic equipment is *down* in size, *up* in reliability requirement. Heat is the gremlin ready to play hob with your circuitry, unless you take steps to specify devices that are completely dependable when temperatures rise sharply.

General Electric subminiature tubes are proved performers at high temperatures. And their small dimensions give you the extra compactness you need to meet tight equipment size limitations. Telephone your nearest General Electric Receiving Tube Department office below!

NEW YORK	CHICAGO	LOS ANGELES
Wisconsin 7-4065,6,7,8	SPring 7-1600	GRanite 9-7765

Progress Is Our Most Important Product

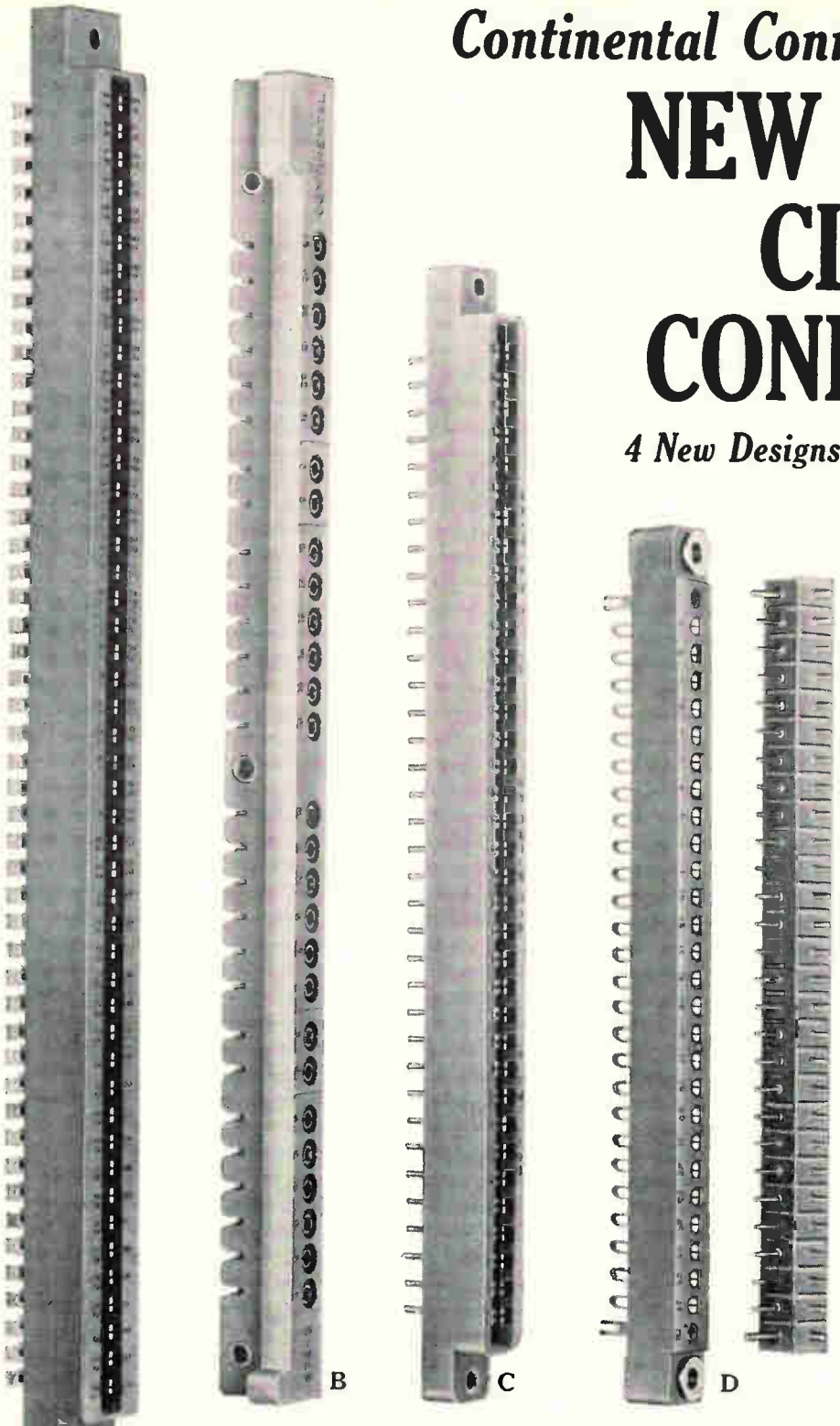
GENERAL ELECTRIC

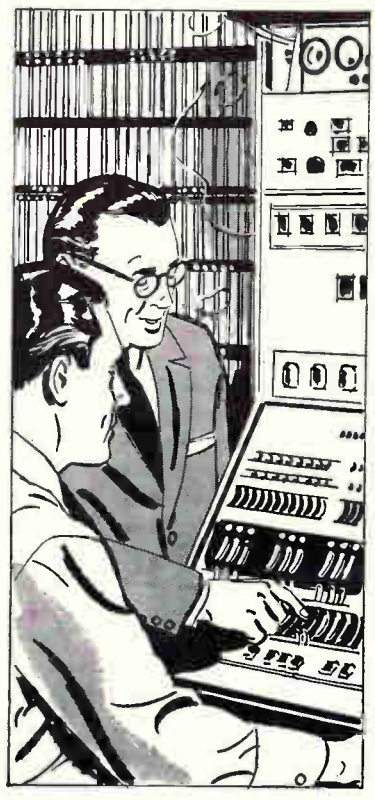
431-201

Continental Connector Announces

NEW PRINTED CIRCUIT CONNECTORS

4 New Designs for Computer Applications





A—48-contact printed circuit connector for 1/16-inch printed circuit board; dual row, up to 96 connections. "Bellowform" contacts.

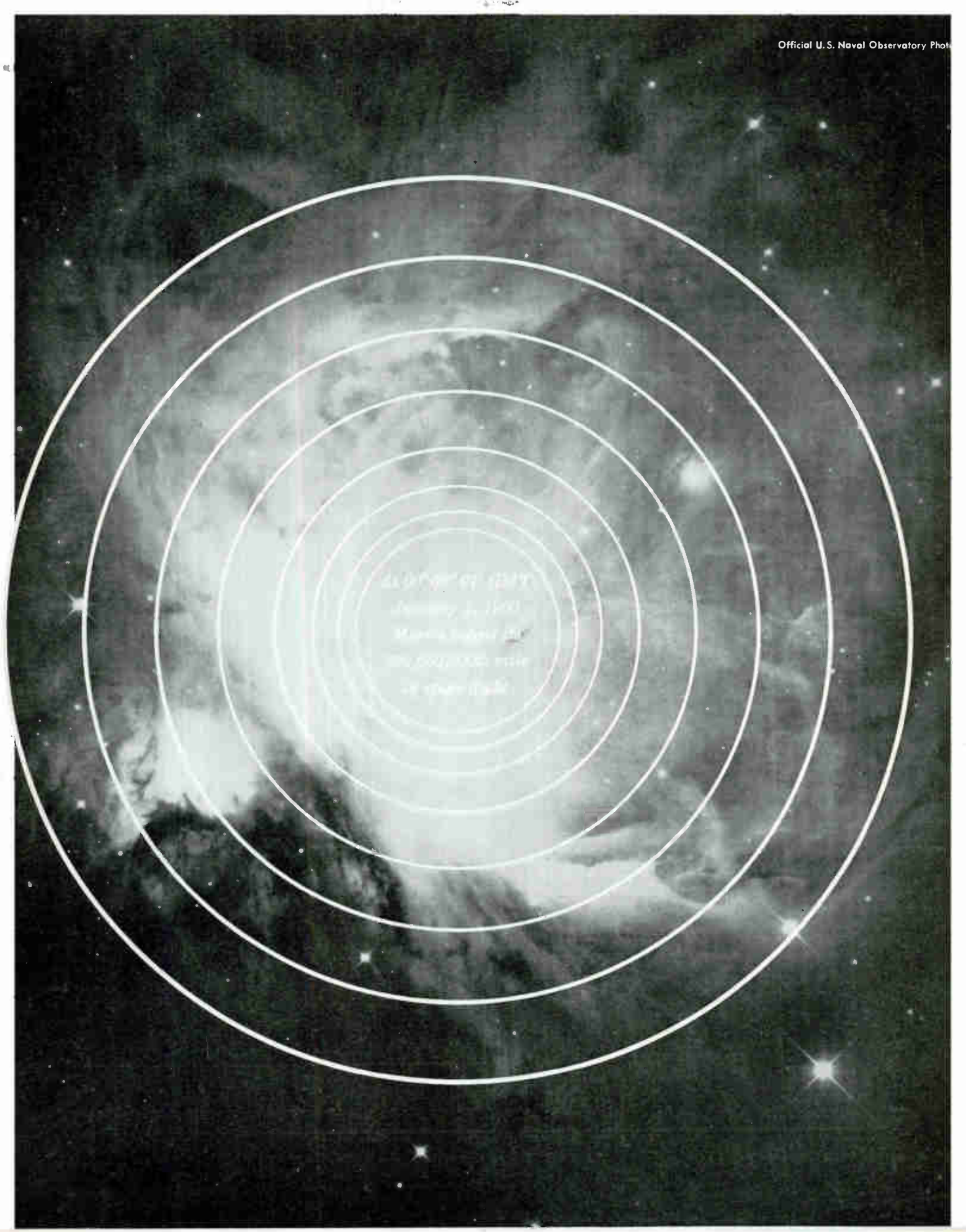
B—Test Point Connector. 28 closed entry contacts, threaded mounting inserts molded into body. For dip soldering to printed circuit board.

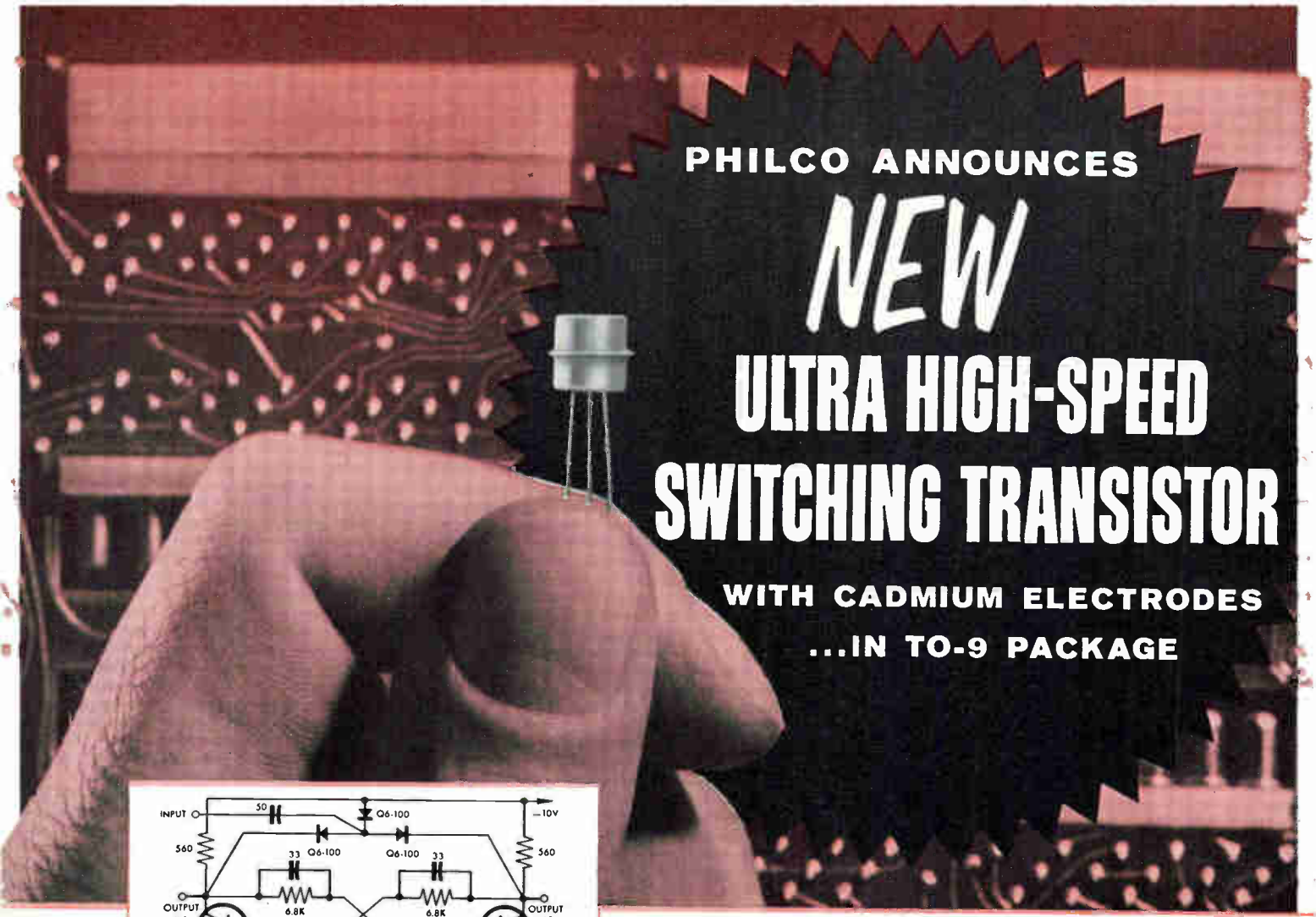
C—36-contact printed circuit connector for 1/16-inch printed circuit board, featuring new "Bellowform" contacts.

D—Right angle plug and socket for dip soldering to printed circuit board; floating mounting bushings, 28 contacts.

Continental Connectors

Proven reliability . . . high precision . . . choice of molding compounds. Write for details on complete line of printed circuit connectors to Electronics Division, DeJUR-AMSCO CORPORATION, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agents).



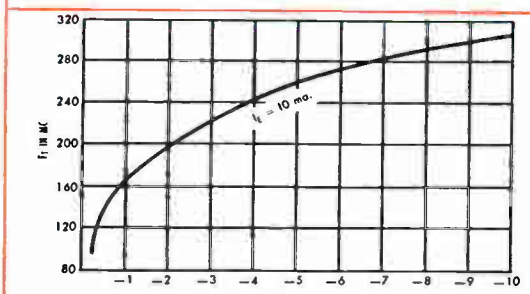


PHILCO ANNOUNCES

NEW ULTRA HIGH-SPEED SWITCHING TRANSISTOR

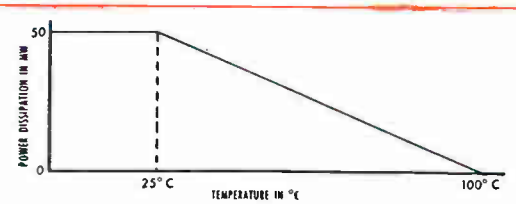
WITH CADMIUM ELECTRODES ...IN TO-9 PACKAGE

SIMPLE 20MC BINARY STAGE



COLLECTOR VOLTAGE V_{CE} IN VOLTS

TYPICAL GAIN-BANDWIDTH PRODUCT, f_T VS. COLLECTOR VOLTAGE



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Max. Ratings		Typical Parameters				
T_{STG} ° C	V_{CB} volts	t_r mμsec	t_s mμsec	t_f mμsec	h_{FE}	$V_{CE(SAT)}$ volts
100	−15	12	7	4	35	−0.1

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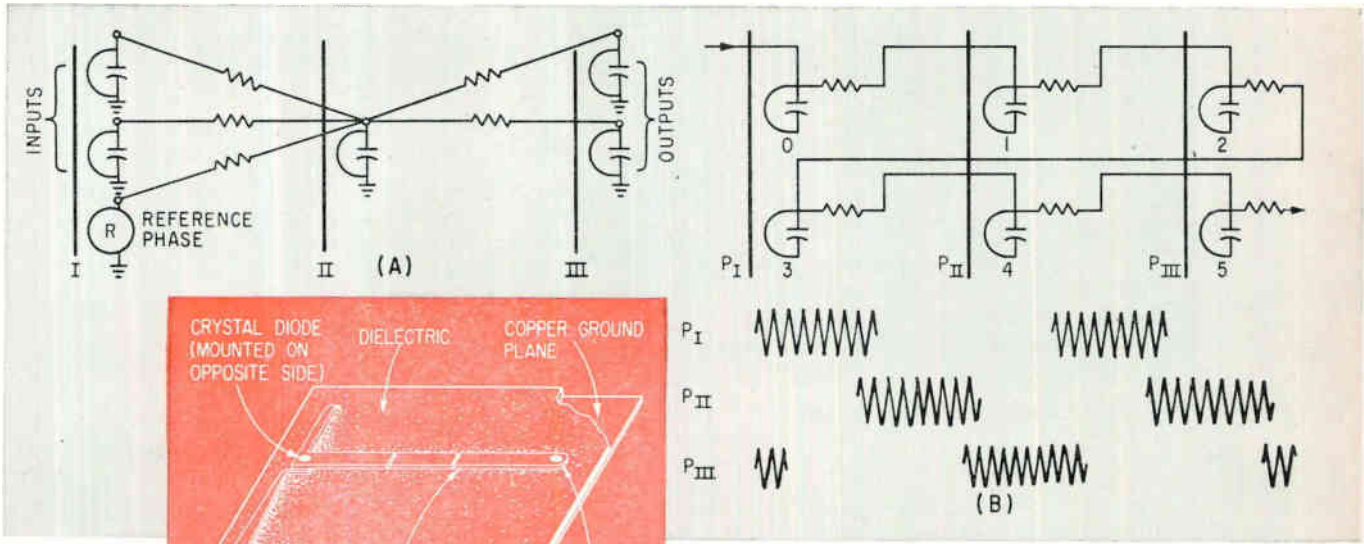

FIG. 1—Generalized PLO logic circuit (A) can be extended to shift register with three-phase pump system (B)

FIG. 2—Microwave subharmonic phase-locked oscillator has 2 kmc quarter-wave resonator with diode in shunt, 4 kmc resonator bar isolating pump and oscillating circuit

Computers Head for 1,000-Mc Operation

Phase-locked oscillators, tunnel diodes and crossed film cryotrons rate high interest as computer elements at Eastern Joint Computer Conference

By **THOMAS MAGUIRE,** New England Editor

COMPUTERS INCORPORATING self-organizing techniques, human-like language and speech recognition, simplified input-output, and vastly improved optical displays, will reach the laboratory stage in 10 years.[1]

They will be microminiaturized special purpose systems for economical on-line real-time use. Their design will require batch-bulk processing, automated logical synthesis and equation-controlled manufacturing. Service will be accomplished by replacing the whole computer.

CHARACTERISTICS—Devices, packages and interconnection will be inseparably merged in the new computers. Major system functions will be produced from bulk materials in computer-controlled, continuous manufacturing processes. Miniaturization will allow vast amounts of available electronic storage and this will drastically alter programming methods.

The path from present-day to future systems will be cleared principally by increased logical capabilities, improved input-output methods, more speed, advances in the art of interconnection as well as active devices, and vast amounts of storage. (See ELECTRONICS, p 77, Nov. 20, 1959.) It is estimated that one-million-bit storage will be needed.

Two uses—now embryonic—offer particularly expansive vistas for computer applications in the future, Eastern Joint Computer Conference Chairman Frank

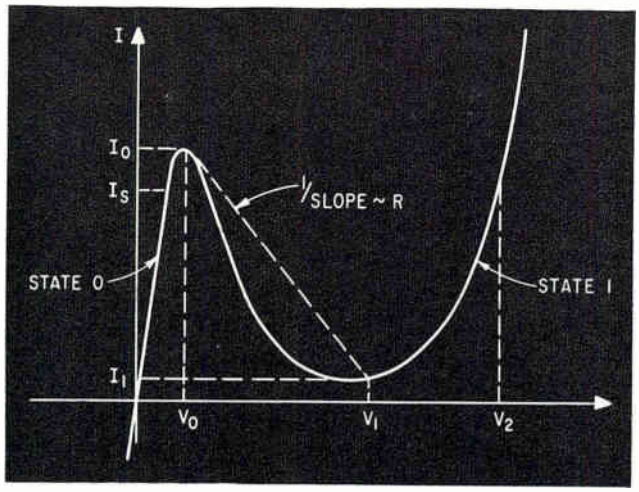

FIG. 3—Tunnel diode characteristic has two distinct regions that are used to denote the 0 and 1 states

E. Heart of MIT's Lincoln Lab points out. The first may be tagged the library problem: efficient storage and retrieval of information, new ways to tap the experience of the past, to connect pertinent researchers to pertinent research—in science, medicine, law and virtually every field of human interest. The second is in the study of the characteristics of biological systems, a field which will generate an invaluable feedback for further computer advances and an approach to artificial intelligence.

HEADING FOR 1,000 MC — Two types of two-terminal semiconductor device, the variable capacitance diode and the tunnel diode, in combination with microwave coupling techniques, give promise of 1,000-mc computers.[2] Both devices provide amplification of binary signals by mechanisms depending on negative resistance and have speed limitations two magnitudes higher than transistors.

Variable capacitance diodes in parametric subharmonic phase-locked oscillators have permitted pumping up to 10 kmc and designing of 4 kmc-pumped, 100-mc logical circuits. Diodes of an order of magnitude higher than conventional types have been developed, with a cutoff frequency of 150 kmc and a high variation of capacitance with voltage.

When a circuit composed of fixed inductance and a capacitance whose value depends on the voltage across it (that is, a junction diode), is excited by a frequency $2f$, approximately twice the resonant frequency of the circuit, oscillations of frequency f can be sustained in either of two opposite phases which can be used to denote 0 and 1. The phase-locked oscillator (PLO) therefore constitutes a storage cell. Oscillations will build up in the phase closest to the phase of a small locking signal which is thus amplified.

Logic can be performed, as shown in Fig. 1, by arraying the PLO's in three groups, which are separately activated. Every PLO is loosely coupled to PLO's in other groups through couplings which determine the task to be performed. Clocking of the groups in succession with some overlap causes information to flow in a given direction despite the bilateral character of the PLO. A PLO will start at the phase determined by the phase of the majority of oscillating PLO's to which it is coupled. The majority decision can be reduced to AND or OR decisions by the use of a reference signal. Negation is obtained by phase inversion.

To obtain 1,000-mc information rates, pump frequencies of about 30 kmc are required. An experimental program ultimately aimed at frequencies of this order resulted in the PLO illustrated in Fig. 2. This device has a broad operating range, efficiencies of a few percent and required pump power levels of about 100 mw. Gold-bonded diodes in series give good results.

Special germanium tunnel diodes have been developed for computer use, with switching times of less than one millimicrosecond. In tunnel diode computers, logic is performed with pulse signals. Two distinct regions of the current-voltage characteristic on either side of the negative region are used to denote 0 and 1, as shown in Fig. 3. Gain is obtained through a triggering action: a large change in output current can be caused by a small input current driving the operating point over the maximum of the characteristic. Practical nearness of biasing to maximum permits logic gains of six. Switching is accomplished by interconnecting simple elements, each made of one or two tunnel diodes and serving as a bit-store, amplifier and threshold majority gate. The single port of each element is connected to a number of inputs and outputs and to clock sources. Three types of element are shown in Fig. 4.

Random access memories can be made using arrays of tunnel diodes. Each bit is stored by a current-driven, bistable tunnel diode. Rows and columns are resistively coupled to the diodes. Selective write-in and read-out is possible either by bit or word addressing because the extrema of the diode characteristic are sufficiently sharp and uniform. Read-out signals

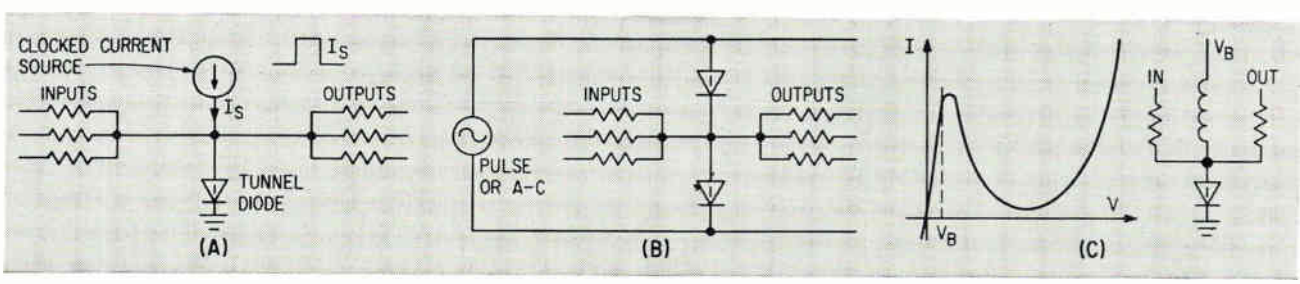

FIG. 4—Tunnel diode logic elements can be of the single bistable type (A), the symmetric bistable type (B) and the monostable type (C)

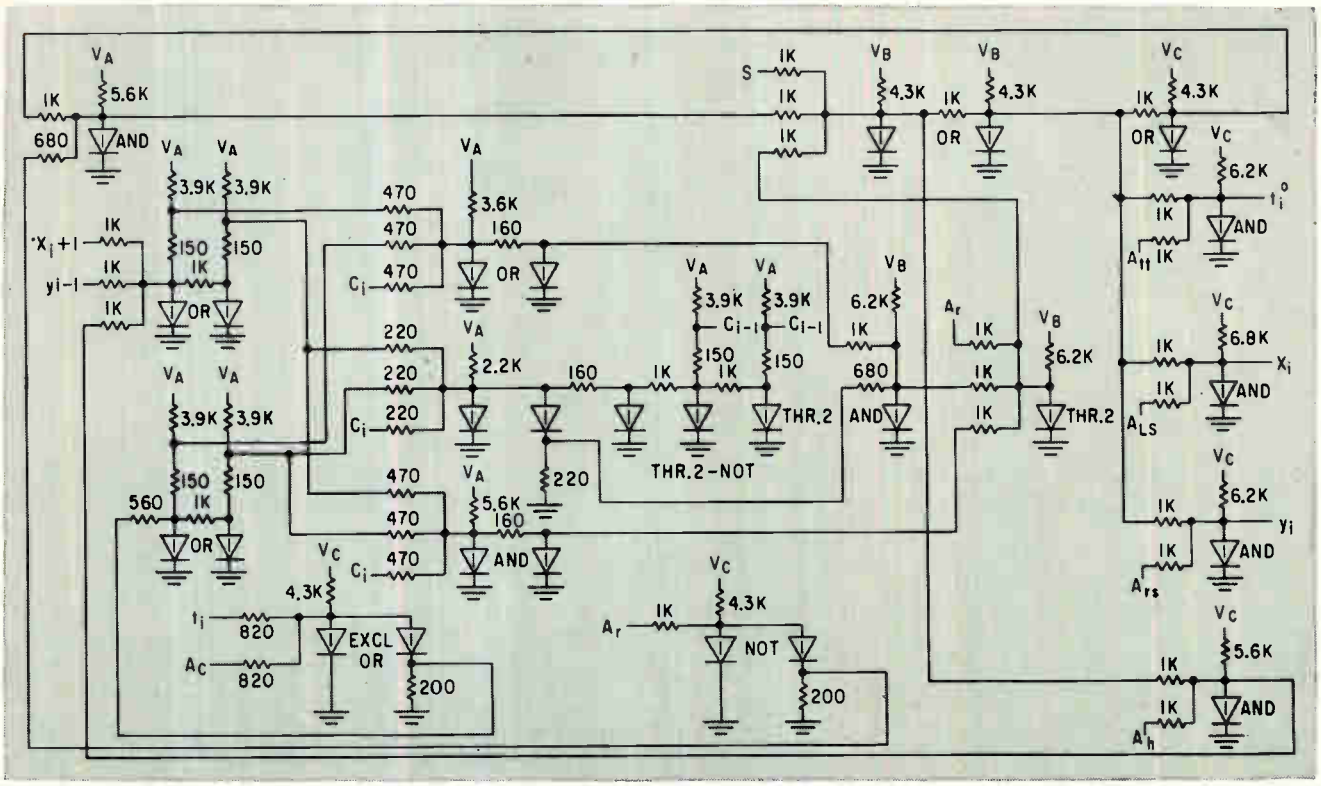

FIG. 5—Arithmetic cell uses 27 tunnel diodes, is powered from a transistorized, three-phase pulse supply

can be detected directly or through inductive pickup of selectively induced oscillations. Drivers for tunnel memory arrays require considerable power which may be switched at sufficient speed by transistors or transistor-tunnel diode combinations. Tunnel diode memories offer promise of 10-millimicrosecond access times.

TUNNEL DIODE AS COMPUTER COMPONENT—Preliminary tests confirm the very high-speed operation capability of the tunnel diode.[3]

Experimental circuits include: single-ended threshold gate consisting of a single tunnel diode powered by a pulse current-source; balanced or symmetrical threshold gate, with its trigger sensitivity independent of power supply variations; an inverter configuration consisting of two tunnel diodes and a resistor powered by the pulse current source; EXCLUSIVE-OR circuit created by extending the principles of the basic inverter configuration to yield a circuit with more than two operating points; a circuit to realize the SUM output of a full adder, using three tunnel diodes and a resistor.

A three-phase, pulse-overlap system is found to be compatible with dynamic storage—circulation of the stored bit around a closed loop. A given gate or group of gates is powered by one phase, drives other circuits powered by the next phase and is driven by still other circuits powered by the previous phase. The excitation pulses overlap in time such that information propagates between two stages during the period when both are energized simultaneously.

Using the pulse supply scheme, three gate circuits, each powered by a different phase, are arranged in a closed loop. The circuit has built-in amplification, reshaping and clocking. Three dynamic storage circuits are possible—a flip-flop, a binary counter and a shift register stage.

Fig. 5 shows a simple experimental arithmetic cell containing 27 tunnel diodes, using resistive coupling throughout and powered from a transistorized three-phase pulse supply. Repetition rate is 1 mc. Unit demonstrates the operation of all the basic logic circuits including dynamic storage.

CROSSED FILM CRYOTRON—Crossed film cryotrons deposited on insulated superconductors have been applied to switching and storage circuits.[4] A shift register circuit has been deposited in an area corresponding to 20,000 active elements a square foot. Calculations show that with this component density a computer or memory containing more than one million elements can be accommodated in a one-cubic-foot liquid helium container using presently available refrigeration methods.

An experimental crossed film cryotron has a time constant of less than one microsecond and is approximately 100 times faster than the original vacuum deposited cryotron. The d-c dissipation is less than five microwatts and the active area of each element is approximately 5×10^{-4} square centimeter. Cryotrons and all interconnecting circuitry can be vacuum deposited at the same time in a few simple steps.

Basic structure of a crossed film cryotron is shown in Fig. 6. Device is made up of tin, lead and insulator films. Of these only the tin films change their state

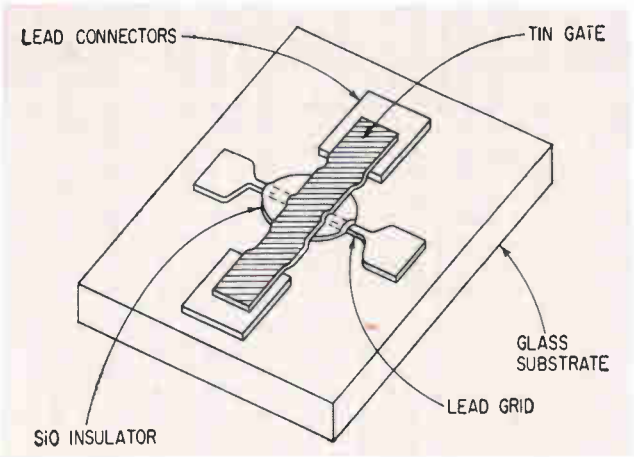

FIG. 6—Crossed film cryotron is approximately 100 times faster than original vacuum deposited cryotron

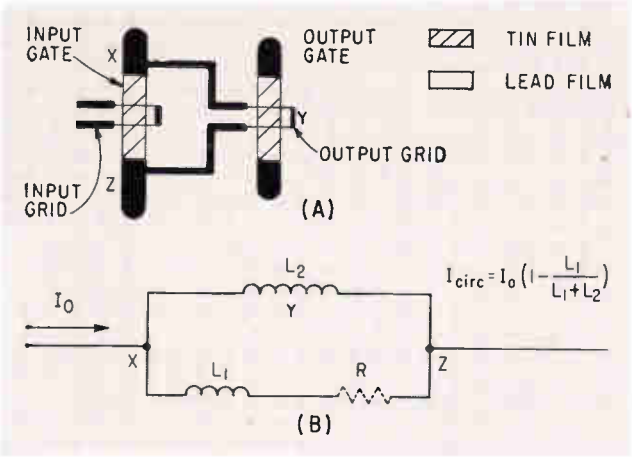

FIG. 7—Cryotron storage cell (A) with equivalent circuit (B) has been applied to a shift register. (See the front cover)

during operation. If a sufficiently large current is passed through the grid film, the resulting magnetic field produces a resistive channel across the much wider tin gate film. The grid remains superconducting at all times.

Shielded cryotron using a shield insulation thickness of about four microns has been found to be an order of magnitude faster than the unshielded. A tin film which lies adjacent to a lead shield plane has a higher critical current than a similar tin film deposited on glass because of the field configuration. A film in the shape of a cylinder will carry twice as much current as the same film unwrapped into a flat plate. When current passes through a tin film adjacent to a superconducting shield, surface currents are induced in the shield to prevent flux penetrating into it. These surface currents double the field between the film and the shield and produce an approximately zero field on the opposite side of the film. This field configuration is the same as would occur if the tin film were in the shape of a cylinder. So the critical current is increased from the value for the unshielded flat film to that for the cylinder.

Crossed film cryotrons make possible improved memory structures where each storage element can have logic associated with it. Memories appear as an attractive first application because their structure is repetitive and because they have many fewer logic levels than even the simplest computer. Figure 7 shows a cryotron storage cell and equivalent circuit.

Computers are presently built from plug-in circuit packages where each plug-in unit represents a few logical elements. Crossed film cryotrons make it possible to deposit the equivalent of a present-day rack of plug-in units on a small plate in a few hours. The problems of testing and fault correction in such a complex multilevel logic module are real but reportedly not greater for cryotrons than for any other component which would allow similar packing densities.

MAGNETIC DISK MEMORY UNIT—Principles of fluid motion discovered by Bernoulli are used in Laboratory for Electronics' Bernoulli disk to maintain a controllable and small separation between the storage medium and the read-write heads.

A flexible Mylar magnetic disk is rotated close to a smooth stabilizing backplate in which read-write heads are imbedded flush with the smooth surface. The tape disk is attached by flanges directly to the shaft of an electric motor, and an air inlet is located at the center of the backplate to permit air to enter between the rotating disk and the stabilizing plate.

When the tape disk is at rest, it falls away from the backplate; but in motion the limp disk becomes flattened by centrifugal force and the disk pumps air through the orifice and out at the disk periphery. At this point the hydrodynamic forces of the air between the disk and the stabilizing plate, together with the dynamic and elastic forces of the revolving disk, cause the disk to conform to the backplate at a controllable separation.

FIG. 8—Magnetic disk memory unit is designed to operate from a solar cell

Complete memory cylinder shown in Fig. 8 includes circular printed-circuit cards, 40 tracks and read-and-write amplifiers, solid-state matrix selection switch and inverter to run 400-cycle motor. Clock rate of various models will range from a few kc to 3 mc, depending on motor speed. Off-shelf item due in about four months will store 50,000-60,000 bits. Models with storage as high as one million bits are planned.

MINIATURE HIGH-DENSITY MEMORY — A 10-pound magnetic drum memory has been developed for airborne and missile weapons systems under an Air Force contract.[5] The unit can store 300,000 bits, operates at a clock rate of 546 kc, has a temperature range of 125 C to −50 C, and will withstand shock loads of 16 g and continuous vibration of 4 g peak up to 2,000 cps. The drum, shown in Fig. 9, stores information on 122 channels including seven circulating registers and can operate at peripheral speeds of 120 feet a second. The head-to-recording-surface spacing is achieved by mounting large numbers of record-read heads in sliding pad assemblies. The pads are supported on the boundary layer of air above the drum and do not touch the recording surface. Technique amounts to an air bearing or gas lubrication. Record-read heads are so small that 30 a linear inch

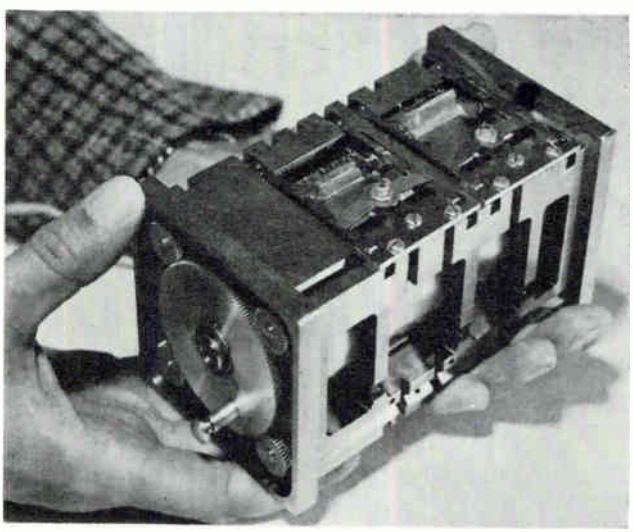

FIG. 9—Magnetic memory drum can store 300,000 bits of information, is operated at a bit rate of 546 kc

can be mounted side by side in a single pad. Head-to-drum spacing of 200-300 microinches is a compromise between cost and signal amplitude.

The sliding pads are self-aligning and self-adjusting. A single cantilever spring provides a force on two pivoted arms. Pivots on the arms force the pads against the drum by riding in V grooves in the pads. The V grooves are placed at a point on the pads such that a stable angle is maintained between pad and drum so that lift is obtained from the boundary layer of air around the drum. The calculated resonant frequency of the sliding pad (for small amplitudes) is

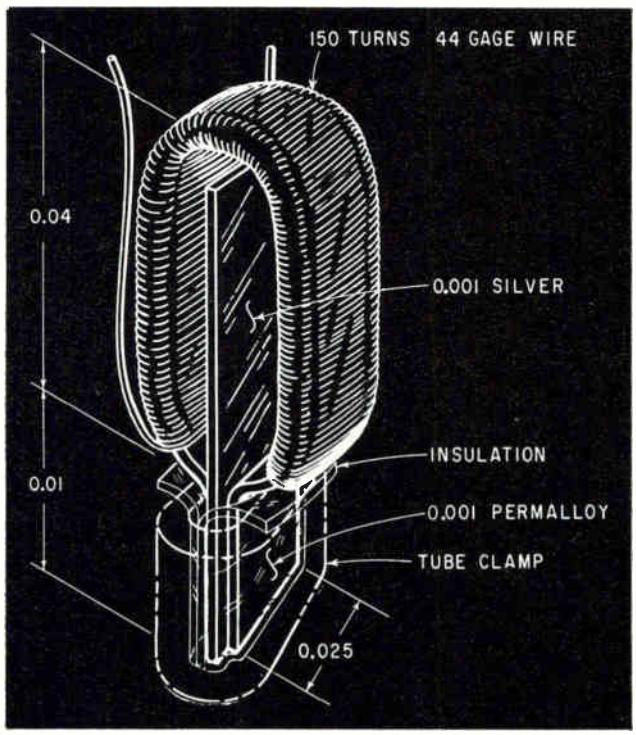

FIG. 10—Magnetic head consists of coil wound over four-layer core

about 3,000 cps and the mechanism appears to be more than critically damped.

Magnetic heads, essentials of which are shown in Fig. 10, feature small size and weight to make possible in-line assembly of 27 heads in a pad 1.25 inches wide. The head consists of a core of four layers of Permalloy over which the coil is directly wound. Core and winding is formed into a U shape whose legs are separated by a thin silver shim which forms the gap. After assembly, the pads are ground and finally finished by lapping. At present, read-back signals are 10-20 mv at 546 kc. Recording requires about 100 ma current. A six-volt transistor battery supply is sufficient for recording. Recording density can be increased up to 500 bits an inch with the present design.

A very hard nickel-cobalt magnetic plating was developed, using as a starting point an electroless plating method developed by the Bureau of Standards for nickel. The coating is said to have superior magnetic characteristics to iron oxide, and greater wear resistance. Coating saturates at 6,000 gauss, and demagnetizes to 3,200 gauss at the recording density of 350 bits per inch assuming a coating thickness of 150 microinches.

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The papers listed below were all presented at the Eastern Joint Computer Conference, Boston.

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(2) J. A. Rajchman, RCA Laboratories, Princeton, N. J., Solid State Microwave High Speed Computers.

(3) M. H. Lewin, RCA Laboratories, Princeton, N. J., Negative-Resistance Elements as Digital Computer Components.

(4) V. L. Newhouse, J. W. Bremer, H. H. Edwards, General Electric Co., Schenectady, N. Y., The Crossed Film Cryotron and Its Application to Digital Computers.

(5) M. May, R. A. Howard, G. Miller, G. Shifrin, Ramo-Wooldridge, Los Angeles, Calif., A High-Speed, Small Size Magnetic Drum Memory Unit for Micro Miniature Digital Computers.

Solid-State Guidance For Able-Series Rockets

Here are the transistorized circuits for guiding the Able series of probes into space. Lightweight, simple, reliable, these circuits may be applicable to many types of control

By **ROBERT E. KING and HENRY LOW,**

Members of the Technical Staff, Space Technology Laboratories, Inc., Los Angeles, Cal.

THE ABLE SERIES of missiles is being used for space exploration experiments. An Able missile consists of a Thor or Atlas first stage, a second-stage liquid rocket, a solid-propellant third stage, a solid- or liquid-propellant fourth stage, and an experiment package or payload.

The control system to be described is for the second stage. It makes the missile follow a predetermined course in response to commands generated by an internal programmer, or in response to guidance commands from the ground.

One of the primary design criteria for the second-stage attitude-control system was light weight without compromising the ability of the equipment to survive and operate in a high-vibration environment. Thus, this system uses transistor and magnetic-amplifier circuits instead of vacuum tubes. A novel modular design uses stacked etched circuit board. Weight of similar equipment in the earlier Able missiles was 120 lb. The corresponding control equipment described here weighs about 30 lb. Power requirements were reduced from 200 to 18 v-a.

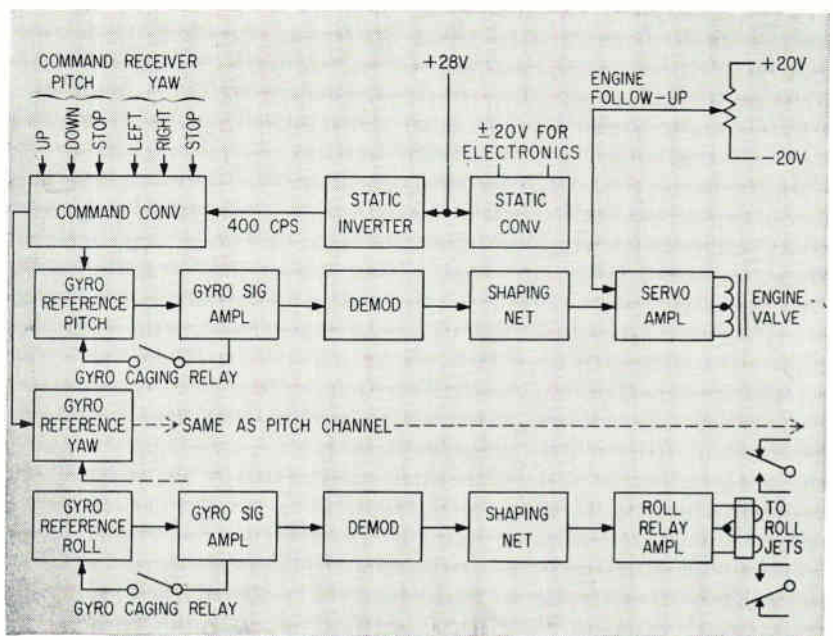

FIG. 1—Attitude-control system. Not shown here is the provision for internal programming in the command converter

Figure 1 shows the attitude-control system. The command converter normally converts signals from a command receiver; it can also establish an attitude program.

Receiver commands are converted to gyro torquing currents. Gyro output signals command pitch, yaw and roll channels. Pitch and yaw channels, which are identical, control missile attitude in these axes by gimbaling the second-stage rocket engine with hydraulic actuators. The roll channel operates pneumatic jets located on the periphery of the airframe.

A stop command from the receiver interrupts the gyro torquing currents. After being servoed to its new attitudes, the missile follows a constant course until the next gyro-torquing commands arrive.

Pitch and yaw channels have more than 10 db of gain margin and 30 deg of phase margin at all times during flight, without the complexity inherent in the use of rate gyros. A lead network with a break frequency of 2.5 radians per second provides rate damping, and an ad-additional lag term acts to stabilize for missile bending.

The roll control channel is a discontinuous on-or-off servo system which exerts a corrective torque on the missile for roll angles greater than 3 deg. This torque is obtained by the action of four fixed pneumatic jets which are controlled in pairs by solenoid-operated valves. Working fluid for the jets is helium, which is supplied from the

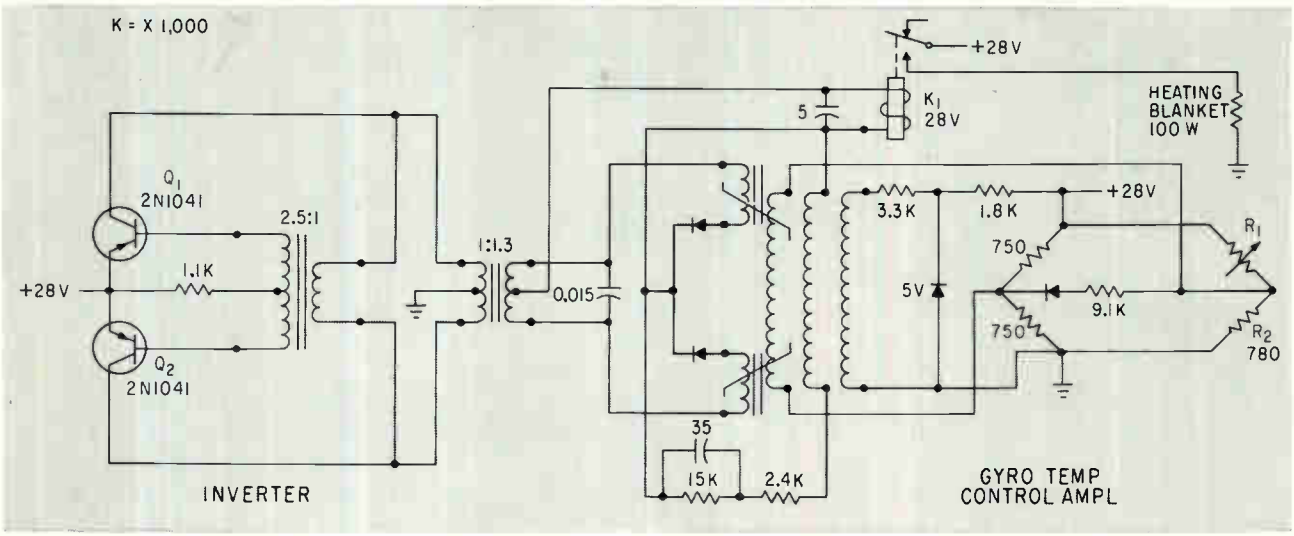

FIG. 2—Gyro temperature control connects and disconnects heater

propellant gas-tank pressurization system. Each jet can exert 15 lb of thrust. In flight, the missile roll attitude oscillates continuously at a fixed amplitude between the plus and minus 3-deg limits. Instead of a rate gyro, a lead network provides rate damping to minimize the pneumatic impulse requirements. A low-pass filter attenuates demodulator ripple. This filter has negligible effect on system dynamics.

Power from a 28-v silver-zinc battery is converted to 115 v, three phase, at 400 cps, which is then transformed to the distribution voltage of 10 v. A regulated plus and minus 20 v d-c for the control circuitry is produced by a transistorized static-converter voltage regulator.

Command Converter

Some of the commands that come from the receiver are: pitch up, pitch down, pitch stop, yaw left, yaw right, and yaw stop. These commands are received in the form of a relay contact closure which persists for 5 seconds. An arrangement of relays in the command converter causes these momentary contact closures to supply and maintain a constant a-c of the proper phase to the gyros, thus commanding the desired missile attitude change. Transmission of a stop command in a particular channel causes the current to be interrupted, and the missile will then follow a constant heading.

The command converter also has a provision for establishing an attitude program consisting of a constant pitch turning rate for a specified time. Turning rate is established by setting the current with a series rheostat, and time is established by a transistorized time-delay relay operating from a regulated d-c supply.

The command converter also contains a three-phase transformer which converts the 115-v output of the static inverter to the 10 v required by the gyro spin motors and demodulator reference transformers.

Gyro References

Each channel of the gyro reference assembly has a body-mounted hermetic integrating gyro of the HIG-4 type, a gyro temperature-control amplifier, circuits to excite the gyro, and spin-motor monitoring circuits.

Each gyro is mounted with its input axis parallel to either the pitch, roll or yaw axis of the missile; hence, each is sensitive to attitude deviations in only one axis.

Gyro temperature is regulated to $\pm\frac{1}{2}$ F by a temperature-control amplifier (Fig. 2). The amplifier senses differences between gyro-mounted, temperature-sensitive resistance R_1 and fixed resistance R_2, both connected in a bridge circuit. If the gyro temperature is higher or lower than the desired 165 F, the bridge has an output. This voltage goes to the control winding of a high-gain single-stage magnetic amplifier, which de-energizes or energizes relay K_1; the closed relay contacts connect a heater element within the gyro to the 28-v d-c power source. Operating frequency of the magnetic amplifier is 1 kc, permitting use of relatively small cores. This h-f power is generated in a two-transistor (Q_1, Q_2) low-power static inverter.

Gyro heat losses and heating power requirements were reduced by mounting the gyros in metal rings which are thermally isolated from the case by a dimensionally stable epoxy-glass mounting board. Each gyro is contained in a gold-plated, thin metal can, which reduces heat loss due to radiation. Each can is, in turn, encased in a thick molded-in-place shell of foamed polyurethane plastic. The foamed plastic adds structural rigidity to the entire package, and its thermal insulation property reduces warm-up time; the reduction in heater cycling increases the useful life of the control relays.

Current transformers are incorporated in one leg of each gyro spin motor. Before launching, the output of these current transformers is monitored on a recorder in the blockhouse. The current level indicates performance of the gyro spin motor.

Pitch and Yaw Channels

The pitch and yaw channels (Fig. 3) are identical, each containing a gyro signal amplifier,

demodulator, shaping network, and servo amplifier. The gyro signal amplifier uses silicon transistors Q_1, Q_2 and Q_3 to provide a voltage gain of 1.5 at 400 cps with a power output of approximately 100 mw. An amplifier phase shift of 50 deg lagging, which compensates for the phase shift of the gyro signal, is obtained by an R-C filter at the input of Q_1. In order to avoid loading the gyro signal generator, the necessary high input impedance was obtained by a large resistance (R_1, R_2) in the series arm of the filter. To prevent the gyro signal amplifier from loading the input filter, the first stage has an input impedance of approximately 100,000 ohms. The three amplifier stages are direct coupled, and base bias for the first stage is obtained from the voltage developed across resistor R_3. This feed-back arrangement assures stability of the operating point of all three transistors despite variations of temperature and of transistor parameters.

The amplifier gain is obtained in the first stage, which is operated as a heavily degenerated amplifier.

Gyro signal amplifier coupling to demodulator transformer T_1 uses capacitor C_1 to avoid saturation of the transformer core by the d-c component of the amplifier output. The demodulator is a full-wave sum-and-difference type using four silicon diodes. Input to the demodulator from T_1 is a 400 cps signal; demodulator output is a d-c or l-f signal whose amplitude is proportional to the amplitude of the input signal and whose polarity is dependent on the phase of the input signal. A 400-cps reference signal is fed to the demodulator by T_2, an 80-v center-tapped transformer. Output circuits of the demodulator include an R-C low-pass filter to attenuate ripple components resulting from the rectification process and a balance potentiometer to permit setting the output to zero when no input signal is present.

The demodulator has a voltage gain of 9.4 and provides a maximum output of ± 60-v with a linearity of 3 percent of full scale.

The shaping network which follows each demodulator is a lead-lag resistance and capacitance network which provides the desired anticipatory system response.

The servo amplifier is a direct-coupled differential amplifier with a gain of 5 differential ma per volt of input. Output differential current goes to a dual-coil hydraulic valve. Maximum linear output is 10 differential ma into a dual 1,000-ohm-coil valve.

The amplifier has two inputs: one from the shaping network which represents attitude error of the missile, and one from the engine follow-up potentiometer which represents engine gimbal angle. In operation, the amplifier causes a current to flow in the hydraulic valve which causes engine motion in such a direction that the output of the engine follow-up potentiometer R_3 will equal and cancel the output of the shaping network.

To reduce drift effects, seven silicon transistors are used in a balanced configuration with their base-emitter voltages matched. Use of Sensistors further reduces drift. The last stage acts as a differential current amplifier, which uses transistor Q_4 instead of a large common emitter resistor to minimize the common-mode effect. A range of temperatures from + 20 C to +65 C causes a maximum drift of about 2 percent of full-scale output. Emitter followers in the servo amplifier's input stages provide high input impedance and avoid loading effects on the shaping networks.

Roll Channel

The gyro signal amplifier and demodulator of the roll channel are identical to those of the pitch and yaw channels. As shown in Fig. 4, a signal from the roll-channel demodulator goes to its roll shaping network, which applies it to the switching amplifier.

The roll switching amplifier is composed of two sections. The section whose input transistor is Q_1 operates for positive error signals and the section whose input transistor is Q_2 operates for negative error signals.

Trasistors Q_1 and Q_3 operate as a cascaded emitter follower to ob-

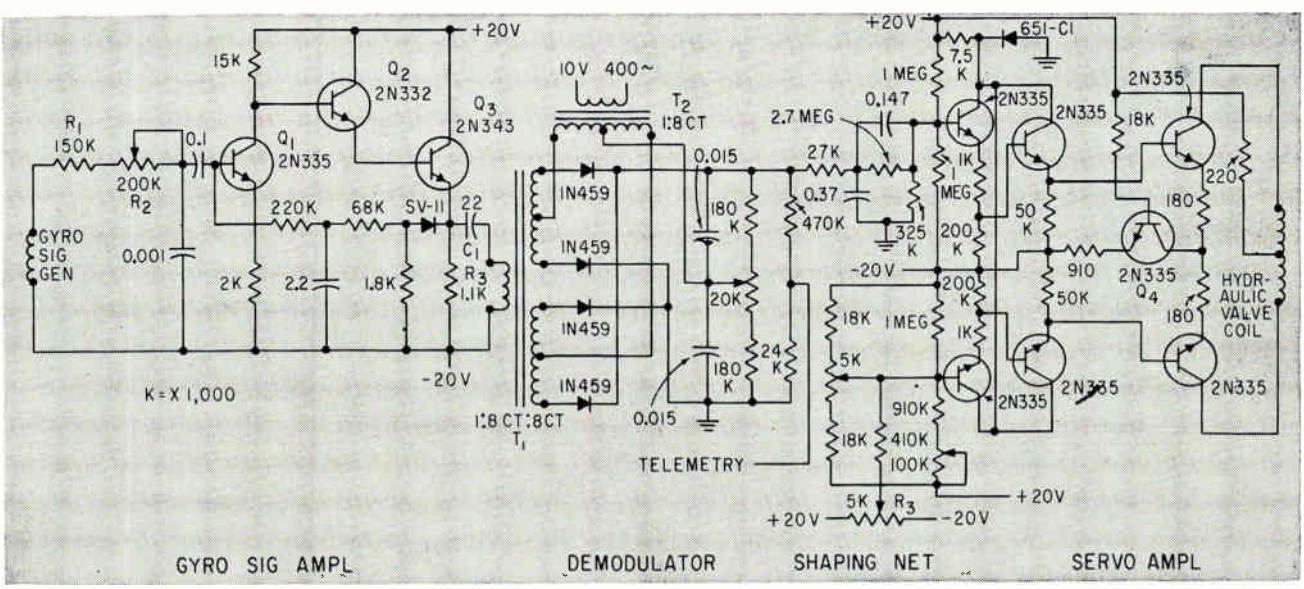

FIG. 3—This is the schematic of either the pitch or the yaw channel; channels are identical

tain a high input impedance. An input impedance of one megohm is necessary to prevent loading the shaping network and changing frequency-response characteristics of this network. Output of the emitter followers activates a Schmitt trigger circuit, and a 10,000-ohm potentiometer sets the input level at which the trigger circuit will operate. This potentiometer is normally set so that the trigger actuates at a shaping-network voltage output corresponding to 3 deg of missile-attitude error; this voltage is approximately + 2.5 v.

The Schmitt trigger is arranged so that in the OFF state transistor Q_4 conducts heavily and Q_5 is effectively cut off. When the input signal reaches the proper value Q_5 starts to conduct, turning off Q_4. When Q_4 turns off, the voltage at its collector rises toward the + 20 v and in so doing sufficient current is supplied to the base of Q_6 to turn it on. Transistor Q_6 now causes Q_7 to conduct, thereby energizing pilot relay K_1 and actuating the clockwise solenoid valve. Since relay K_1 requires approximately 100 ma to actuate and the saturation resistance of Q_7 is 5 ohms, only 50 mw of power is dissipated in the transistor in the ON state. Silicon diode D_1 is connected across the relay coil to protect the 2N389 driving transistor from inductive transietents.

The other section of the roll switching amplifier is essentially the same in function as the section just described. However, this circuit is energized by a negative voltage input and *pnp* transistors are used in place of *npn* types. Since the output circuit uses *npn* types it was necessary to include two additional stages to change the level and polarity of the base drive to Q_8.

In both of these switching circuits the hysteresis was adjusted to be less than 1 percent for reasons of missile dynamic stability and to minimize the amount of gas used in correcting roll-attitude deviations.

Power Supply

The power supply for the channels consists of a commercially available transistorized static converter-regulator which provides ± 20 v d-c regulated to ± 1 percent. Prime power is obtained from the 28-v missile battery.

The static inverter consists of an oscillator, semiconductor power switches, control circuits, and output filters.[2]

The open loop gyro torquing technique used to program missile maneuvers imposes strict limits on voltage and frequency regulation. Total angle through which the gyros are torqued is a function of the gyro's angular momentum, the torquer current, and time; thus it is necessary to hold each of these factors to close tolerance in order to achieve a precise program.

Since angular momentum depends on wheel speed, which in turn is dependent on frequency, the frequency is regulated to ± 0.25 percent. Since gyro torquing current depends on supply voltage, it is necessary that the output voltage of the static inverter be regulated to ± 0.5 percent. These tolerances were determined from trajectory considerations.

Environmental Testing

On the basis of data obtained from Vanguard, Jupiter, Redstone, Thor, and other missile flights, it was estimated that maximum vibration levels would be near 3-g rms over a 5 to 2,000-cps range for the second-stage powered flight, with a burst of somewhat higher vibration levels at second-stage cutoff.

The equipment described was designed to withstand environmental specifications more severe than field or flight conditions in order to provide better assurance of locating design faults. These test environments were not intended to be severe enough to exceed reasonable safety margins or to excite unrealistic modes of failure.

Packaging

Electronic packaging is unusual in that individual circuits are assembled on separate etched wiring boards which are stacked vertically. Interconnections between boards are made by flat-tape cables, which permit the whole assembly to be unfolded for servicing and checkout. Size and weight are reduced and reliability is increased by eliminating plugs and keeping the number of soldered connections to a minimum.

A separate test plug is provided on each package for checkout of the control system after it is installed. Calibration and testing of the system is done with simple equipment.

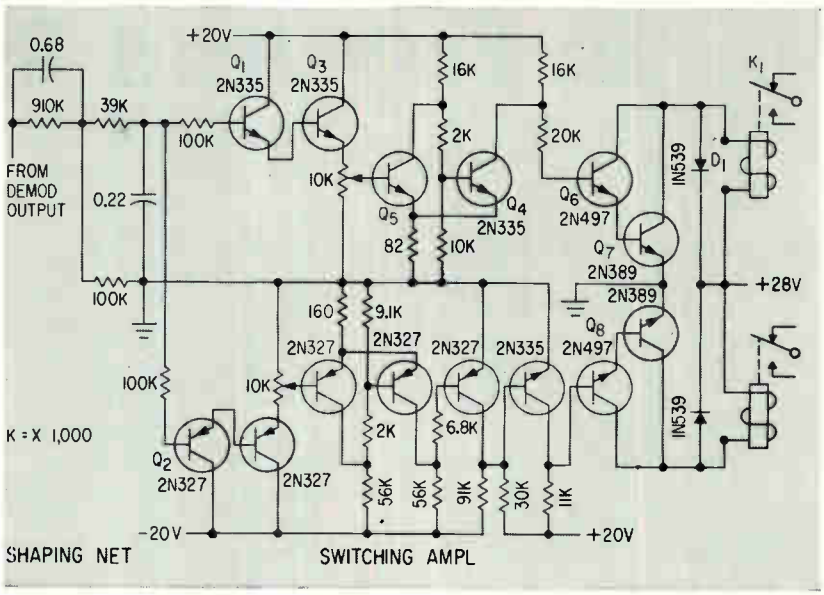

FIG. 4—Roll channel. Since gyro signal amplifier and demodulator are same as those of pitch and yaw channels, they are not shown

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In Fog And Rain—Sight,

By M. E. SEYMOUR, Advanced Electronics Center, General Electric Co., Ithaca, New York

DECREASE IN PERFORMANCE of a detection system is, in general, largest during weather conditions in which the scattering particles are near in size to the wavelength used for detection. Visual detection is difficult in haze and fogs, infrared detection is difficult in heavy fogs and K-band radar detection is difficult in heavy rain.

Scattering occurs when the energy in a beam is absorbed by a particle such as a raindrop, then re-radiated with the particle as a spherical center of radiation. Beam energy in the direction of propagation is decreased by the amount lost by scattering. When the scattering particles are much smaller than the radiation wavelength, scattering is proportional to $(a/\lambda)^4$, where a is the radius of the particle and λ the wavelength of the radiation (the Rayleigh relationship). When the particles are much larger than the radiation wavelengths, scattering depends only on the cross section and density of the particles. For this second condition, the attenuation depends on the amount of material in the path of transmission. A comprehensive mathematical treatment of scattering is contained in Reference 1. Figure 1 indicates the relationship between wavelength, particle size and scattering coefficient.

VISUAL DETECTION—An object can be detected by contrast with its background. Both positive and negative contrast are common; target radiation may be greater or less than background radiation, particularly during daylight hours.

Targets at temperatures belowe 1,000 K have low luminous efficiencies since they radiate little in the visible region. Therefore, they can be easily seen only by negative contrast, with maximum range for black targets. A useful estimate of range, assuming 5.5 percent detectable contrast[2] and targets of reasonable size is $R_v = 2.9/\sigma$, where σ is the scattering coefficient ($\exp[-\sigma R_v] = \exp[-2.9] = 0.055$).

A series of nomographs was devised for military use[3] giving range as a function of target area.

For pure air, the scattering coefficient is 0.015/km[4]. In haze, scattering coefficients range between this value and about 4/km. The condition in which the scattering coefficient is greater than about 4/km is called fog, and coefficients at least as large as 40/km have been measured.

In rain, the scattering coefficient, σ_r, is a function of rainfall intensity, Z, usually measured in millimeters per hour. For orographic rain (rain caused by the rising of moist air up mountain slopes), $\sigma_r = 0.25Z^{0.63}$; for nonorographic rain, $\sigma_r = 1.2Z^{0.33}$. It is surmised that drizzle has a coefficient close to σ_r. These coefficients are representative if there is no fog or dust, and rain is the only obstruction to visibility.

INFRARED DETECTION—Although negative contrast is used in infrared, most applications use positive contrast. Targets at temperatures above 300 K are generally detectable; targets at lower temperatures have spectral distributions of energy peaked at longer wavelengths. Low altitude ir (infrared) detection is limited even in clear weather by the selective absorption of atmospheric water vapor and carbon dioxide. The equation for ir is $H_\lambda = J_\lambda T_A(\lambda, R) \exp(-\sigma_\lambda R)/R^2$ where H_λ is irradiance at ir receiver in watt/cm^2, J_λ is radiant intensity of target in watts/steradian, and $T_A(\lambda, R)$ is transmittance of the clear atmosphere. The overlapping effects of many closely spaced absorption lines prevent a simple exponential expression being adequate for $T_A(\lambda, R)$, but procedures for calculating this transmittance have been established[5].

Table I—Coefficients for Range Calculations

Atmospheric Condition	Fog Density, ρ in g/m^3	Rain Intensity Z in mm/hr	Scattering Coefficients α, in db/km, for λ in microns				
			0.5	2	10	3000	9000
Light Fog	0.032	...	20.7	4	1.3	0.12 + 1	0.021 + 0.18
Heavy Fog	2.3	...	413	413	220	9.5 + 1	1.5 + 0.18
Light Rain	.....	1	1.09	1.09	1.09	0.95 + 1	0.22 + 0.18
Heavy Rain	.....	16	6.24	6.24	6.24	8 + 1	3.5 + 0.18
Cloudburst	.....	100	19.8	19.8	19.8	33.3 + 1	22 + 0.18

IR or Radar?

Infrared scattering coefficients are much smaller than visual coefficients for weather conditions in which small particles predominate, since the λ^{-4} law then holds. For example, the coefficient at 10 microns in haze is less than one tenth that in the visible. In fogs the difference is smaller, with coefficients at 10 microns being about one half those in the visible region. In rain, ir scattering coefficients should be identical with visual coefficients, since raindrops are still much larger than the useful wavelengths of ir (wavelengths shorter than 15 microns).

Maximum infrared detection range R_i occurs for the minimum useful value of H_λ. Separating all factors dependent on range, $R_i\ T_\lambda\ (\lambda, R)^{-1/2}\ e^{R/2} = [J_\lambda\ A_o / NEP\ (s/n)]^{1/2}$ where NEP = noise equivalent power, s/n = minimum useful signal-to-noise ratio, A_o = collecting area of system and $NEP\ (s/n)/A_o = H_{min}$.

RADAR DETECTION—Active radar systems are limited by atmospheric absorption and scattering also, particularly at short wavelengths (less than 1 cm), with water vapor and oxygen the most important absorbing molecules. For a two-way path, radar energy reflected from small targets to the receiver is $H = kP_T \exp(-2\ \sigma_e\ R)/R^4$ where P_T is transmitted power, and σ_e is the combined attenuation coefficient for scattering and absorption.

Working values of scattering coefficients in rain and fog are provided by empirical expressions.[6, 7, 8]

Wavelength (cm)	3.2	1.8	1.24	0.9
Rain	$0.0017Z^{1.31}$	$0.010Z^{1.14}$	$0.028Z^{1.06}$	$0.051Z^{1.0}$
Fog	0.0483ρ	0.128ρ	0.311ρ	0.647ρ

Values are for temperatures of 18-20 C.[6] Density ρ is in g/m³ and Z is intensity in mm/hr.

Maximum radar detection range R_r occurs for minimum useful value of H; $R_r \exp(\sigma_e\ R/2) = (kP_T/H_{min})^{1/4} = R_r\ 10^{0.05\alpha R}$ where α is attenuation in db per unit of range ($\sigma = 0.23\alpha$).

RANGE AGAINST AIRCRAFT—A typical problem is that of detecting aircraft. The following assumptions will be made to afford a basis of comparison.

1. The target is a twin-engine aircraft with 800 K emission from hot parts of 375 watts per steradian, equivalent to a black body with a projected area of 0.05 m².

2. The ir system has a collecting area of about 500 cm² and two types of detectors; lead-sulfide, PbS, with NEP of 10^{-10} watts in the 1.8 to 3 micron region (germanium filter cutoff at 1.8 micron); and thermistor bolometer with NEP of 10^{-8} watts in the same range with useful s/n of 4.

3. The 0.9 cm and 0.3 cm radar systems have a range, for no scattering or absorption, of about 10

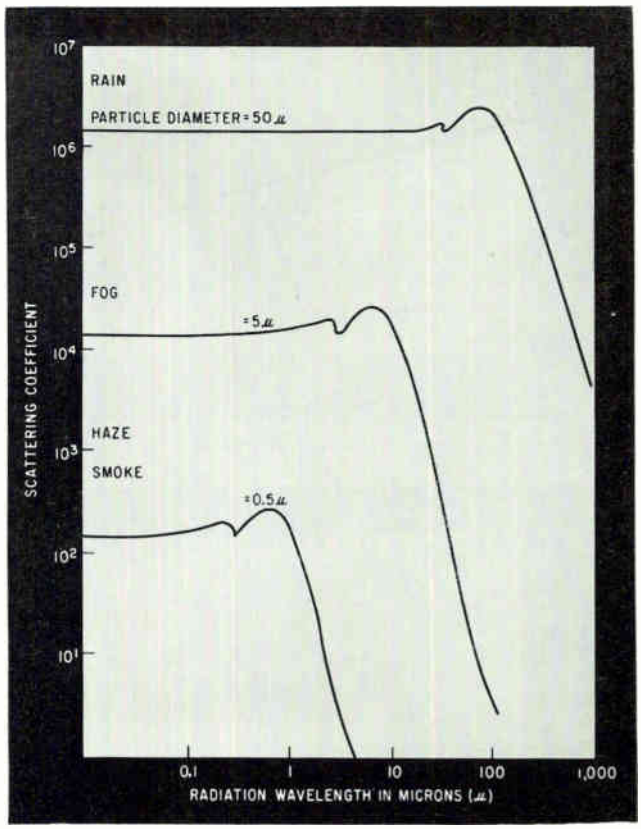

FIG. 1—Scattering coefficient plotted against particle size and radiation wavelength

TABLE II—Comparison of Range

Atmospheric Condition	Maximum Range (km) Against Aircraft					Maximum Range (km) Against Auxiliary Lights			
	Visual	Infrared		Radar		Visual		Infrared	
	(Daylight only)	PbS	Bolometer	0.3 cm	0.9 cm	Overcast Day	Night	PbS	Bolometer
Light Fog	0.61	1.7	3.7	5.2	9.8	0.44	1.5	9.3	6.8
Heavy Fog	0.031	0.13	0.17	1.6	4.4	0.008	0.050	0.18	0.20
Light Rain	11.5	9.4	3.8	4.1	7.2	16.0	40.0	25.0	7.5
Heavy Rain	2.0	3.8	2.5	1.7	2.9	0.72	3.8	6.5	2.9
Cloudburst	0.64	1.4	0.89	0.30	0.93	0.45	1.6	2.5	1.3
Overcast	12.5	27.0	6.1	5.4	8.5	24.0	65.0	300.0	19.0

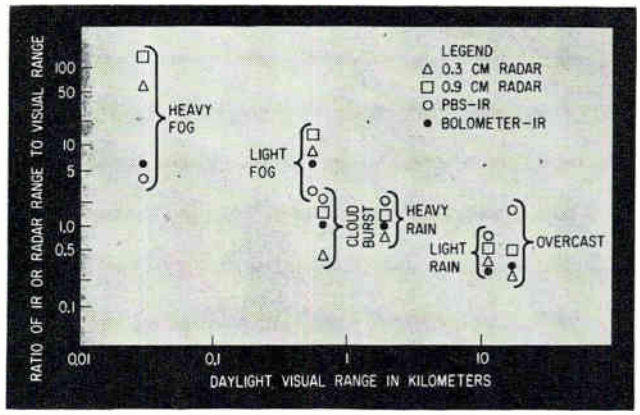

FIG. 2—Comparison of methods for detecting a twin-engine aircraft

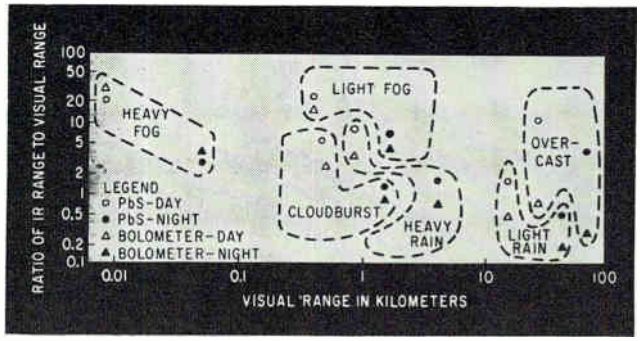

FIG. 3—Performance of infrared against auxiliary lights

km for the target.

4. Temperature is 18 C and absolute humidity is 15 g/m³ (100 percent relative humidity).

Table I shows the fog and rain conditions and lists the coefficients for the range formulas.[6, 8, 9, 10]

The equations will be worked out for the condition of light fog. From the assumed conditions, visual range (negative contrast), is $R_r = 0.61$ km.

Infrared detection range using a lead sulfide cell can be obtained by factoring an estimate of T_t in the expression for effective radiation[5], $R_t 10^{0.05 \times 4R} = [(375 \times 0.03)\ 5 \times 10^{-8}/10^{-10} \times 4]^{\frac{1}{2}} = 37.4$ km. By an iterative process, the answer is found to be approximately, $R_t = 1.7$ km.

The solution for range with ir bolometer is similar; $R_t\ 10^{0.05 \times 1.3R} = [(375 \times 0.08)\ 5 \times 10^{-9}/10^{-8} \times 4]^{\frac{1}{2}} = 6.12$ km. Therefore $R_t = 3.65$ km.

Range with 0.9 cm radar is $R_r\ 10^{0.05 \times 0.2R} = 10$ km; $R_r = 9.8$ km.

Range with 0.3 cm radar is $R_r\ 10^{0.05 \times 1.12R} = 10$ km and $R_r = 5.2$ km.

The above results are listed in Table II along with the results of similar calculations for other atmospheric conditions. For the assumed conditions, the 0.9 cm radar performs better than the 0.3 cm set. Except in light rain, one or the other of the ir systems has a greater range than vision. Ranges for the radars are of course limited by their maximum assumed range of 10 km.

RANGE AGAINST AUXILIARY LIGHTS—Targets will be assumed to be auxiliary light sources at 3,000 K (emissivity of 1), with ir-transmitting optical material used for protecting windows (50 percent transmission in the band from 1.8 to 13 microns), and a total projected area of 0.02 m². The luminous intensity is thus about 3×10^5 candles.

The ir systems have the same sensitivities as in the previous example, and the temperature and humidity are the same.

Attenuation coefficients for the various weather conditions are the same and are listed in Table 1.

Only the calculations for light fog will be worked out. Ranges for the various weather conditions are listed in Table II.

From referenced material $R_r = 0.44$ for an overcast day (background luminance of 100 ft lambert), and $R_r = 1.5$ km for a background of starlight (10^{-4} ft lambert).

For ir detection with PbS cell, $R_t\ 10^{0.05 \times 4R} = [(7.3 \times 104 \times 0.05)\ 5 \times 10^{-8}/10^{-10} \times 4]^{\frac{1}{2}} = 676$ km, from which $R_t = 9.3$ km.

For ir detection with bolometer, $R_t\ 10^{0.05 \times 1.3R} = [(7.3 \times 10^{1} \times 0.004)\ 5 \times 10^{-8}/10^{-8} \times 4)^{\frac{1}{2}} = 19.1$ km, from which $R_t = 6.8$ km.

The above calculated results, as well as those for other weather conditions, are tabulated in Table II. The same data is plotted in Fig. 2 and 3.

CONCLUSIONS—Simple expressions can be used to estimate the performance of infrared and radar systems in rain and fog. Sample calculations indicate the different degrees to which several types of ground-level ir and radar systems are affected. For the typical examples chosen, maximum range calculations on a reciprocating engine aircraft reveal the following:

1. In fog, long-wavelength ir systems are superior to short-wavelength systems, but radar systems are still better, especially in heavy fog.

2. In rain of intensity ranging from light to cloudburst, short-wavelength ir systems are better than other ir or radar systems.

3. Radar performance is degraded seriously in the millimeter region, particularly in heavy rain.

Auxiliary light sources could be used to improve ir performance. For such targets, long-wavelength systems are best in heavy fog, but short wavelength systems are superior under other weather conditions, both day and night. The higher sensitivity possible at short ir wavelengths is an important factor here.

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Detecting Signals By Polarity Coincidence

Weak low-frequency signals in a high noise background can be detected by this polarity coincidence multiplier. Output indicates presence and phase shift of signals received at dual inputs

By **BERNARD M. ROSENHECK,** Columbia University, Hudson Laboratories, Dobbs Ferry, N. Y.

POLARITY COINCIDENCE MULTIPLIERS can be used as detectors of weak signals in the presence of noise, as phasemeters, or as infinitely clipped correlators. Using digital techniques, the multiplier shown functionally in Fig. 1 features low drift and 1-percent accuracy for inputs of 1 to 500 cycles.

The output of the multiplier is a measure of the probability that its two input signals have the same polarity. A maximum output occurs for two signals perfectly in phase whereas no output occurs for signals 90 degrees out of phase. If the input signals have the same frequency, the output depends upon the relative phase of the signals, and the instrument acts as a phasemeter.

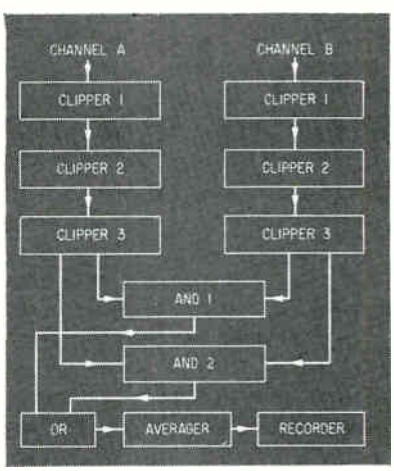


FIG. 1—Functional diagram of polarity multiplier does not include calibration circuit

When noise adds to the input signals, out-of-phase random peaks are introduced, reducing the output. When the signal-to-noise ratio is above 4 to 1, the addition of noise has essentially no effect; at a signal-to-noise ratio of 1 to 1, a maximum output of 1 is reduced theoretically to 0.733.

Theory indicates that when only the polarity signs of the signals are retained, a surprisingly small amount of information is sacrificed.[1] This method allows the signals to be processed in a digital manner, making possible a low-drift, simple and accurate instrument.

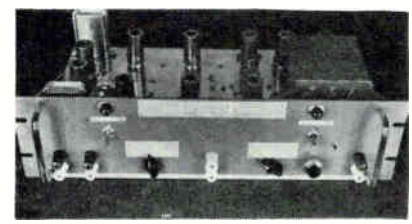
System Description

The instrument consists of two signal channels designated in the functional block diagram (Fig. 1) as channel A and channel B. These channels pass the signals through three stages of clippers, the clippers[2] ideally performing the mathematical operations

$$F(t) = \begin{cases} +K \text{ when } f(t) > 0 \\ -K \text{ when } f(t) < 0 \end{cases}$$

where $f(t)$ is the clipper inputs and $F(t)$ the outputs. Outputs equal a positive voltage K for inputs above the zero voltage axis and a negative voltage $-K$ for inputs below the zero voltage axis.

Clipped signals from the two channels are multiplied by a sign multiplication process. If the signals are both positive or both negative at the same time, the multiplier yields its output; if they have different signs, no output occurs.



Front view shows how instrument is constructed for relay rack mounting

Four-quadrant multiplication is accomplished by feeding one clipped set of input signals having the original phase into an AND circuit. The AND circuit produces an output only when both of its inputs are negative at the same time; if one or both inputs are positive, no output will occur. Simultaneously, phase-inverted replicas of the clipped signals obtained from the third clipper stages feed into a second AND circuit. The second AND circuit produces an output only when both of the original inputs are positive at the same time. The outputs of the two AND circuits drive an OR circuit which yields an output whenever one of the AND circuits operates. Only one AND circuit can operate at a time.

Figure 2 illustrates the waveforms occurring in the multiplier circuits. The multiplier selects the $(+, +)$ or $(-, -)$ polarity combinations of the input signals and

rejects the combinations of (+, −) or (−, +).

The output of the multiplier is time-averaged (Fig. 1) and recorded on a pen recorder which retains a permanent copy of the time-average of the polarity coincidence of the two input signals and its variation about an average level.

Theory of Operation

Assume signals of some alternating nature, not necessarily sinusoidal, to exist at the input of both channels of the instrument. Superimposed upon these signals are random signals of instantaneous noise amplitude N having a Gaussian amplitude distribution with a mean value of zero and a variance N^2_{rms}. The probability density[3] of the noise amplitude N is

$$p(N) = [1/(2\pi)^{1/2}N_{rms}] \exp(-N^2/2\,N^2_{rms}) \quad (1)$$

The probability $P(\text{plus})$ that the amplitude $S+N$ is positive is the probability that N has a magnitude between $-S$ and ∞ when the signal is positive. Quantity S is a constant value equal to the rms value of a square-wave signal. Thus,

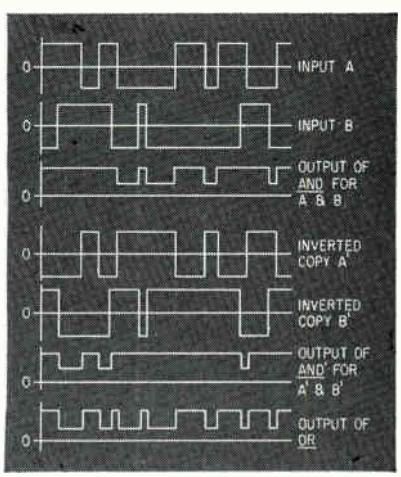


FIG. 2—Multiplier waveforms show how output depends upon polarity of inputs

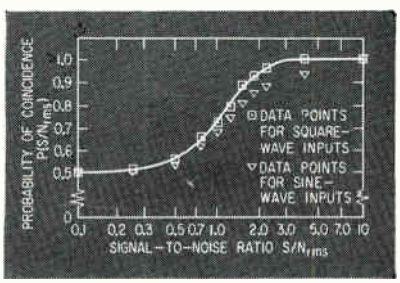


FIG. 3—Graph compares theoretical and experimental data

$$P(\text{plus}) = 1/(2\pi)^{1/2}N_{rms} \int_{-S}^{\infty} \exp(-N^2/2\,N^2_{rms})dN \quad (2)$$

Defining $t = N/\sqrt{2}\,N_{rms}$ yields

$$P(\text{plus}) = 1/\pi^{1/2} \int_{-S/\sqrt{2}N_{rms}}^{\infty} \exp(-t^2)dt \quad (3)$$

In terms of the Gaussian Error integral defined as

$$Erf(x) = 2/\pi^{1/2} \int_0^x \exp(-t^2)dt \quad (4)$$

therefore

$$P(\text{plus}) = \tfrac{1}{2}[\text{Erf}(\infty) + \text{Erf}(S/\sqrt{2}\,N_{rms})] = \tfrac{1}{2} + \tfrac{1}{2}\,\text{Erf}(S/\sqrt{2}\,N_{rms}) \quad (5)$$

The probability that the amplitude $S-N$ is negative when the signal is positive is

$$P(\text{minus}) = 1 - P(\text{plus}) = \tfrac{1}{2} - \tfrac{1}{2}\,\text{Erf}(S/\sqrt{2}\,N_{rms}) \quad (6)$$

For simplicity of analysis, assume that the signals of both channels are in phase, although the probabilities for any other case could be derived. Therefore, at any instant when both signals are positive, the probability that the resultant instantaneous amplitude of signal plus noise is positive for both channels is $P(\text{plus})^2$, and the corresponding probability that the amplitude is negative is $P(\text{minus})^2$. The probability that the sign of the amplitude is the same for both channels at any instant of time is therefore

$$P(S/N_{rms}) = P(\text{plus})^2 + P(\text{minus})^2 \quad (7)$$

Figure 3 is a plot of $P(S/N_{rms})$ vs. S/N_{rms}. It also compares experimental values with values calculated[4] from Eq. 7. Excellent verification of theory (within the 1-percent accuracy of the instrument) may be seen for the theoretical curve and the corresponding data points for square-wave signal inputs.

Circuits

The complete circuit diagram of the instrument is shown in Fig. 4. The clipper stages (V_1 to V_6) are identical symmetrical-differential amplifier stages.[5] Grids of each stage are held at a fixed bias of 50 v.

The input half section of each clipper stage may be considered a cathode follower. The common cathode signal in turn is the equivalent signal for the right-hand stage, which amplifies and limits the excursions of the signal.

Each time the signal passes through one of the cascaded clipper stages, its slopes become steeper, until, at the output of the third clipper, the signal is completely squared. For a 50-v sine wave at the input, the output of the third clipper will be a square wave with periods symmetrical to within 0.1 percent and slopes having rise times of less than a few microseconds. Reasonable square waves may be obtained from signals as low as 150 millivolts, although a 1-volt input is recommended.

Since the input of each clipper section is a cathode follower, grid current will not be drawn for large input signals. This is extremely important, for if grid current is drawn through the input coupling condenser on the positive half cycle of the input waveform, a net negative bias shift will occur (due to the charging of the condenser) producing asymmetry in the signal swing about the quiescent level of the stage.

The right-hand grids draw current, but as they are directly connected to the bias bus their bias level will not change.

Sign Multiplier Stages

Both half sections of the AND stages (V_7 and V_8) are quiescently biased in a full ON state. Their grid-to-cathode voltages are approximately zero and the tubes are drawing maximum current.

A change in state of these stages will occur upon application of a negative gate simultaneously applied to both grids, the tube going from full ON to cut off (zero plate current flow). Removal of one or both negative gates will cause the stage to resume its full ON condition. Application of a negative gate to one grid only will not turn the stage off as conduction of plate current still occurs in the other half of the stage. Diodes V_9 and V_{10} restore[6] the entire input signal below the quiescent level of the stage, thus insuring sufficient signal drive to cut the stage off.

Sign multiplication is achieved through use of two AND stages. Their outputs combine into one signal by the OR circuit, diodes D_1 and D_2. When either AND stage cuts off, the voltage at its cathodes tends to

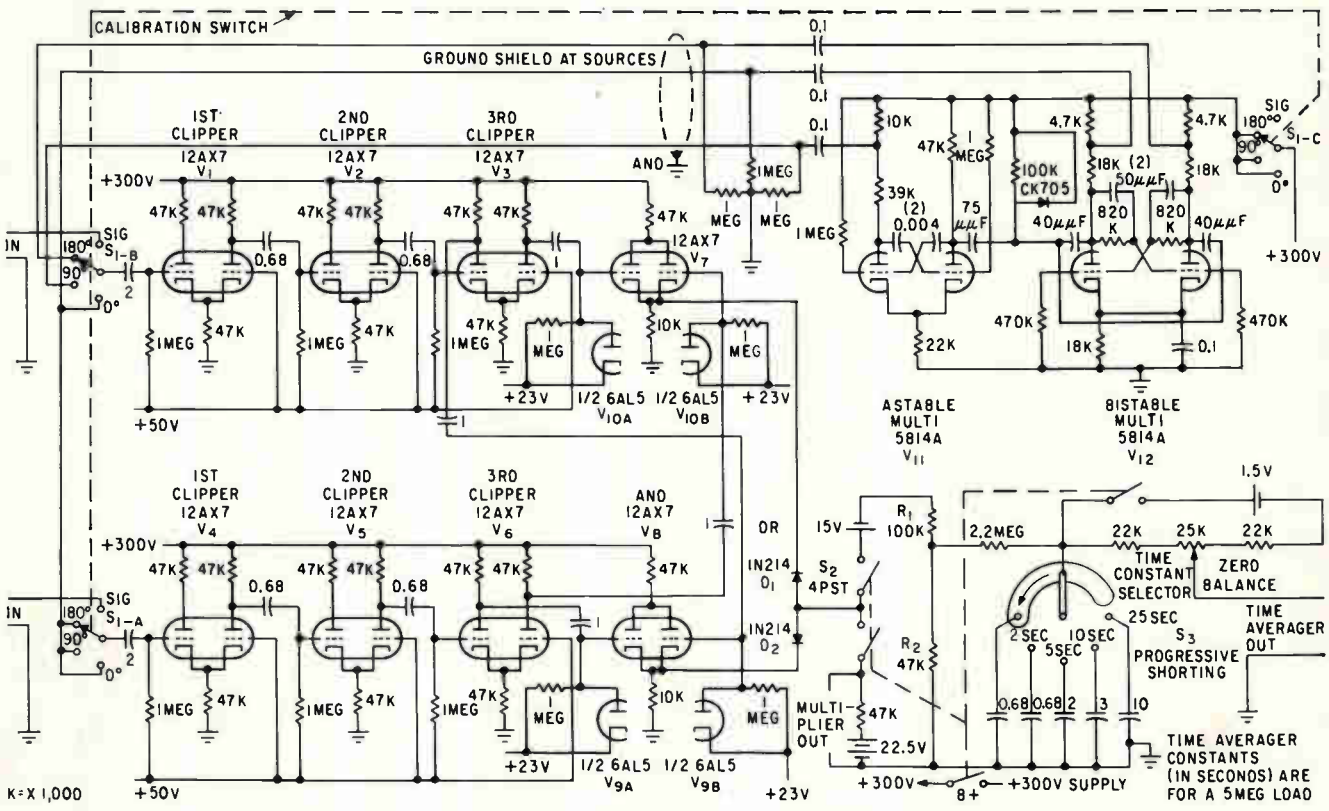


FIG. 4—All batteries used in multiplier are mounted inside a thermally shielded box in order to stabilize temperature. This insures low drift of output signal

falls to zero, allowing the OR circuit diode connected to these cathodes to conduct. Since the two AND stages act separately and at different times, the output of the OR circuit will show whenever both AND stages cut off, indicating the times when polarity coincidence occurs between the two input signals.

Time-Averager Circuit

A progressive shorting-switch type R-C filter time-averages the OR circuit's output, producing a d-c voltage proportional to the average output level of the OR circuit. Resistors R_1 and R_2 provide isolation between the filter and the OR circuit. This isolation insures linear filtering of the signal as the diodes offer different charge-discharge resistances for the filter condenser.

The 15-v and 1.5-v batteries, in conjunction with the ZERO BALANCE pot, allow bucking of the time-averaged d-c signal such that the 90-degree calibration switch position can correspond to zero output.

Calibration Circuit

Astable multivibrator V_{11} feeds bistable multivibrator V_{12} to produce a square wave whose period is symmetrical to within 0.1 percent. Outputs of the two multivibrators are fed into the clipper stages by the calibration switch to allow signals that are in phase and 180 degrees out of phase to pass through the system. At the 90-degree position of the calibration switch, the signal from the astable multivibrator is multiplied by the signal from the bistable multivibrator (at half the frequency), and the mean output is set to zero by adjusting the ZERO BALANCE pot.

Plate voltage is removed from these multivibrators when the calibration switch is at the signal position to avoid pickup from these stages.

Physical Description

A front view of the instrument is shown in the photograph. The front panel measures 19 in. wide (for relay rack mounting) by 5¼ in. high. The instrument is 10 in. deep and has a total weight of 10 pounds. The bottom plate of the chassis may be removed by loosening light self-taping screws.

Access to all signal connections is from the front through color-coded binding posts.

This instrument has been repeatedly tested and employed in the field to detect signals in the presence of noise. Excellent verification of theory was made both in the laboratory and in the field and surprisingly good correspondence between data and theory was found. The small size, rugged construction and freedom from excessive servicing requirements make the instrument suitable for multichannel experiments conducted at field laboratories.

This work was supported by the Office of Naval Research.

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(4) Table of Error Function and Its Derivatives, *National Bureau of Standards, Applied Mathematics Series*, No. 41, Government Printing Office, 1954.

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Transistorized Slicer Analyzes Signal Amplitude

Simple circuit uses basic characteristics of diode AND gate to measure amplitude probability density functions. Width of output is proportional to time that input signal is between specified voltage levels

By T. A. BICKART, The John Hopkins University Radiation Laboratory, Baltimore, Md.

MEASUREMENT OF AMPLITUDE probability density functions is important in statistical measurements of signals and noise. The technique described here measures density functions by generating a rectangular pulse. Pulse width is proportional to the time that the signal being measured is between two specified voltage levels. This relationship is indicated in Fig. 1A.

Basic System

The basic system for making these measurements is shown in Fig. 1B. This technique employs the fundamental characteristics of the diode AND gate to establish a two-level Schmitt trigger circuit.

The characteristic of the diode AND gate is that its output is equal to the least of its inputs. With this in mind the signal handling characteristics of the inverter and diode AND gate, as illustrated in Fig. 2, are quite clear. If the triggering level of the Schmitt trigger following the diode AND gate is set at $-\Delta V/2$, then a pulse is generated whenever the signal is within the interval ΔV at $V = 0$. This is depicted in Fig. 2C and D. The level V can be assigned a value other than zero by adding to the signal a bias voltage equal to $-V$.

Transistorized System

A transistorized circuit embodying the principles just outlined is shown in Fig. 3. The circuit differs from the block system of Fig. 1B in that a diode limiter (D_1 and D_2) is employed to prevent overloading of the transistor inverter, Q_2. Diodes D_3 and D_4 are employed to control the pulse amplitude and level at the output of the Schmitt trigger. The pertinent operational characteristics of the circuit are:

Peak input signal	±5 v
Schmitt trigger	
Rise time (10 to 90 percent)	49 μsec
Fall time (90 to 10 percent)	19 μsec
Hysteresis	0.15 v

An operating range diagram for the circuit can be constructed with this information. It must be noted that the smallest-width, full-amplitude pulse that will emerge from the Schmitt trigger will have a width somewhat greater than the rise time plus the fall time of the Schmitt trigger. This is, then, approximately 80 microseconds. It must secondly be noted that the minimum window width is equal to the Schmitt trigger hysteresis voltage; this is apparent from the fact that with the width control set to a zero voltage on-triggering level the input signal must rise by a value equal to the hysteresis voltage before the off-triggering level is reached. With a sinusoidal input signal of radian frequency ω and peak amplitude E, the time spent by the signal at any one time in the

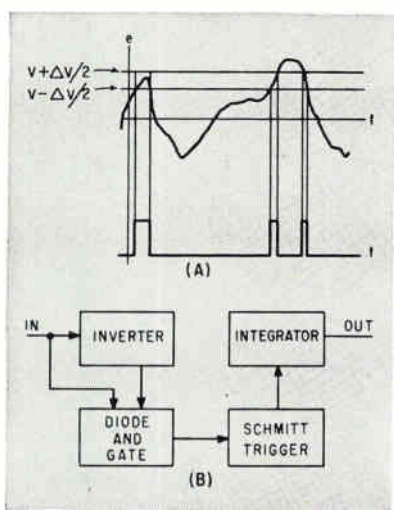

FIG. 1—Input-output characteristics (A) and block diagram (B) of amplitude probability density function measuring circuit

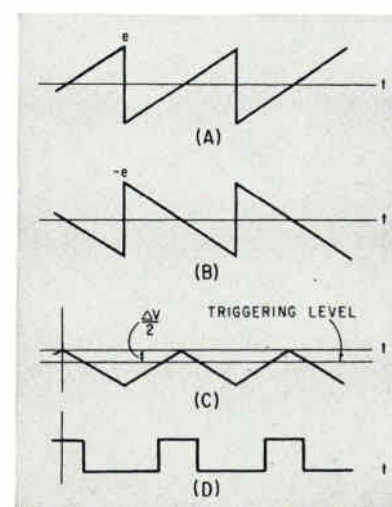

FIG. 2—Waveform of signal (A), inverter output (B), gate output (C) and Schmitt trigger output (D) indicate how system operates

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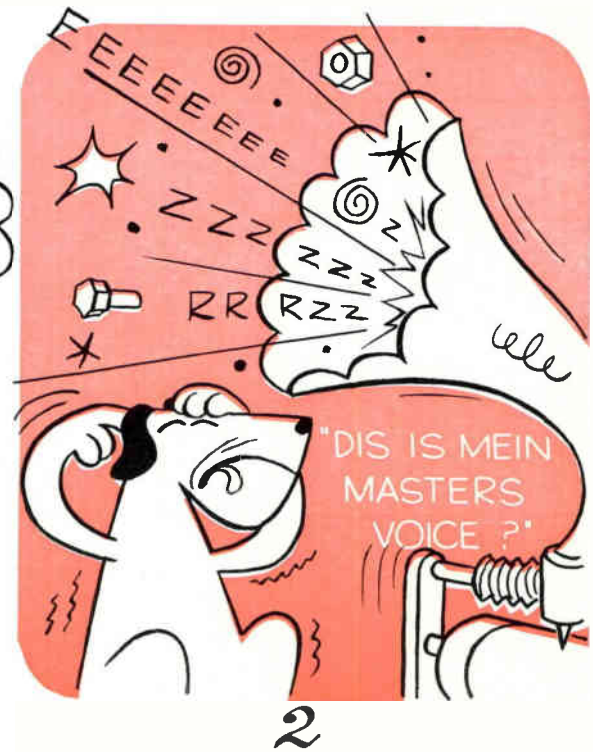

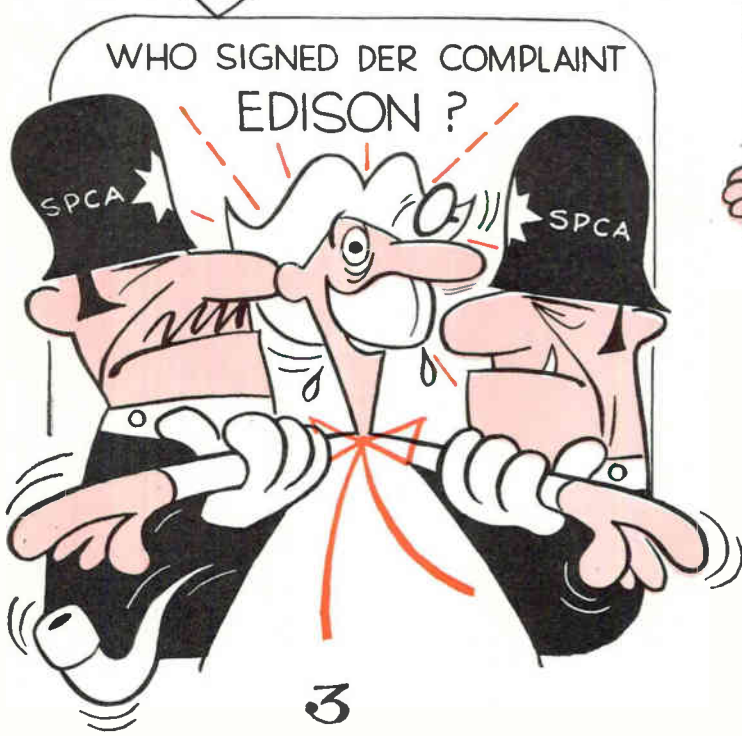

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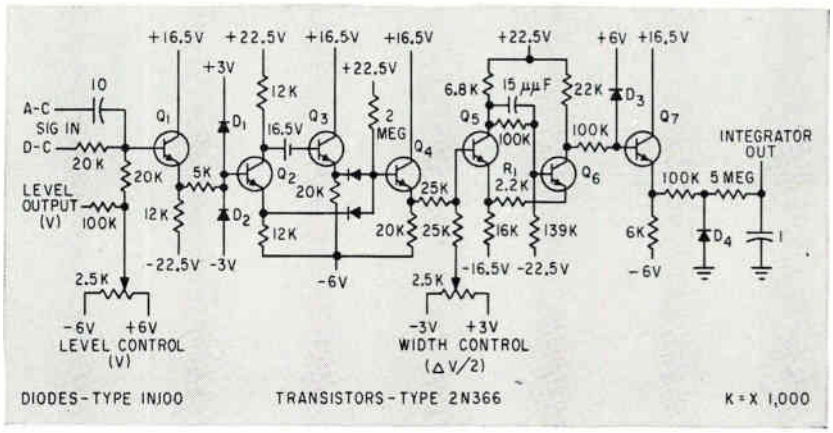

FIG. 3—Actual circuit differs only slightly from basic system outlined. Circuit can handle peak voltages of plus or minus 5 volts.

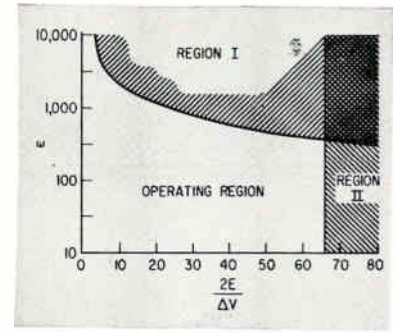

FIG. 4—Limits of operation are shown

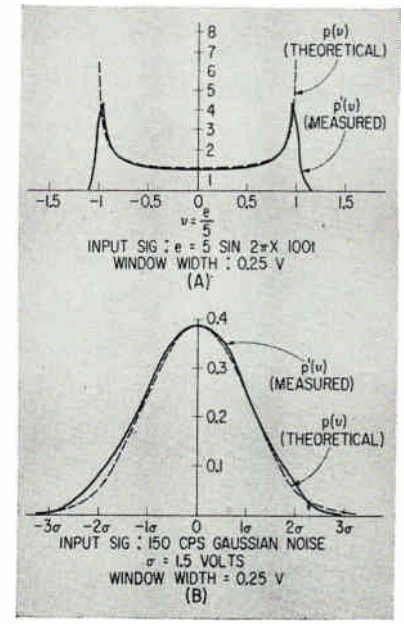

FIG. 5—Density functions for sinusoid (A) and Guassian noise (B)

interval ΔV centered at zero can be shown to be

$$\Delta t = \frac{2}{\omega} \text{ arc sin } \frac{\Delta V}{2E}$$

$$\text{If } \Delta V << 2E, \text{ then } \Delta t \approx \frac{2}{\omega} \frac{\Delta V}{2E},$$

The zero crossing interval was chosen to arrive at an expression for Δt, since, when the sinusoid is in the neighborhood of zero, Δt is a minimum. Now, on a plot of ω versus $E/\Delta V$, curves can be plotted which mark the limits of operation, this has been done in Fig. 4. Region I is restricted by the specification of the minimum Δt, and region II is restricted by the specification of the maximum peak signal. The curves are plotted on the basis of ΔV being set to its minimum value; this ensures the best possible approximation of the measured density function $p'(v)$ to the actual density function $p(v)$.

Conclusion

Measured density functions compare favorably with corresponding theoretical characteristics. This is shown for two common signals in Fig. 5A and B. In addition, the measured characteristic for the sinusoidal signal (Fig. 5A) is in excellent agreement with the expected characteristic for a finite window analyzer.[1]

The circuit functions well and requires component selection only in the case of the cathode coupling resistor in the Schmitt trigger (R_1 of Fig. 3). This resistor is chosen to reduce the Schmitt trigger hysteresis voltage to an acceptable minimum value.

The system, whether built with transistors or with vacuum tubes, appears to be sound in principle and is recommended for the measurement of amplitude probability density functions on the basis that there is no known or foreseen physical circuit characteristics which would result in poor measured data.

This work was supported by the United States Air Force under contract AF 33(616)-3374.

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THEORY OF MEASUREMENT

The amplitude probability density function of a signal voltage, v, is written $p(v)$ and defined at $v = V$ to be

$$p(V) = \Delta V \xrightarrow{lim} 0 \frac{1}{\Delta V} P\left(V - \frac{\Delta V}{2} < v \leqq V + \frac{\Delta V}{2}\right)$$

where $P(V - \Delta V < v \leqq V + \Delta V)$ is the probability that v is within the interval

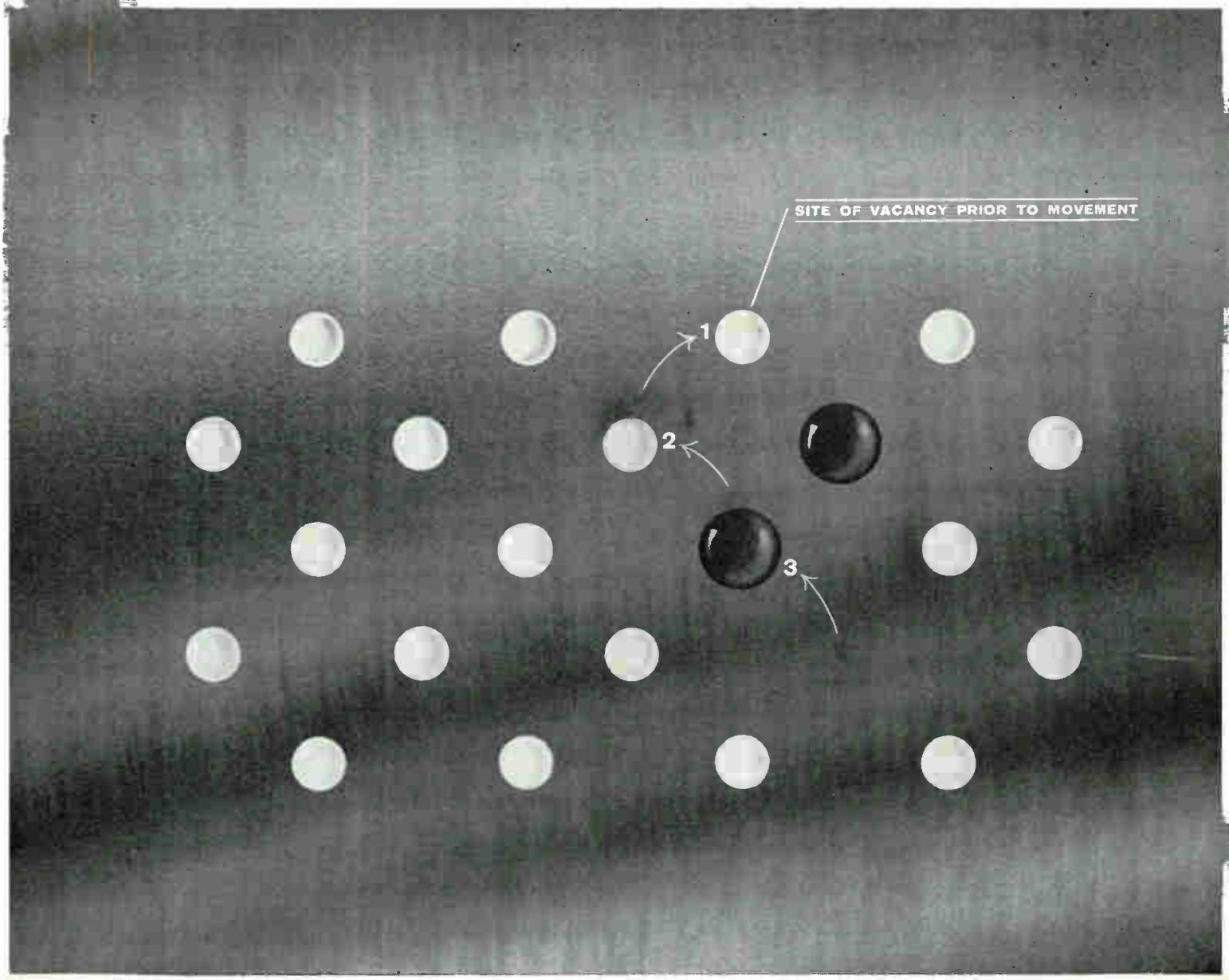
$$\left(V - \frac{\Delta V}{2}, V + \frac{\Delta V}{2}\right).$$

It has been shown that the function $p'(V)$ defined as

$$p'(V) = \frac{1}{\Delta V} P\left(V - \frac{\Delta V}{2} < v \leqq V + \frac{\Delta V}{2}\right)$$

yields a good approximation to $p(V)$ if ΔV can be assigned a value much less than the peak signal value.[1]

The measurement technique establishes a measure for $p'(V)$. This is accomplished by generating a fixed-amplitude, rectangular pulse having a width equal to the time spent by the signal in the interval ΔV about V (Fig. 1A). A time average of the pulsed waveform will yield a d-c level which is a measure of $P\left(V - \frac{\Delta V}{2} < v \leqq V + \frac{\Delta V}{2}\right)$ but which, because ΔV is fixed, is also a measure of $p'(V)$.



Report from IBM *Yorktown Research Center, New York*

HOW ATOMS JUMP IN SOLID SOLUTIONS

It is known that in many solid solutions, such as alpha brass, atomic rearrangement can be induced by an applied stress. Experiments of this nature have confirmed that the atomic mobility required for this rearrangement derives chiefly from the presence of lattice vacancies. A simple example is seen in the reorientation of a pair of solute atoms.

The time required for these atom jumps is under investigation by metallurgists at IBM Research.

By observing this rearrangement—a relaxation effect seen as a peak in a curve of internal friction vs. temperature—it is possible to measure atom mobility at temperatures far below those at which ordinary diffusion experiments can be carried out. It is also possible to freeze an excess of defects into the lattice of an alloy by quenching rapidly from high temperatures to produce an abnormally short relaxation time.

Through these experiments IBM scientists are determining how the equilibrium concentration and mobility of vacancies change with temperature. They seek to learn the manner in which the excess of vacancies retained after quenching disappears within the alloy.

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Spectrometer for Basic Research

RELATIVE amounts and weights of atoms can be determined by a double-focusing mass spectrometer operating at the Argonne National Laboratory. The instrument can also measure the energy that holds the atomic nucleus together.

The spectrometer will be used by the Special Materials Division for research in nuclear chemistry and physics. It will sort atomic nuclei of different relative masses with greater accuracy than previously has been possible.

Operation

The machine is shaped like a backward letter *S* horizontal to the floor. A source of ions at one end is passed through the machine and they are sorted according to relative mass. At the other end a detector measures quantity of nuclei of each mass.

The source unit, one of four principal parts, charges and accelerates atoms into the machine. Velocity differences of the charged atomic nuclei are compensated in the electrostatic analyzer. The magnetic analyzer sorts nuclei according to weight, and the collector unit detects the ions.

A sample to be analyzed is introduced into the source unit and vaporized if it is not already a gas. An electron is removed forming positive ions that are accelerated into the machine.

The instrument transmits more than 95 percent of the ions produced in a conventional mass spectrometer ion source, with a resolution of 10,000. The largest conventional analytical mass spectrometer transmits from 1 to 10 percent of the ions, with a maximum resolution of 2,000.

A vacuum of 10^{-8} mm Hg is maintained throughout the spectrometer to allow unrestricted ion motion. The sample container can be introduced and removed without breaking the vacuum. In the source unit, the ions pass through electron-optical lenses that define beam width and divergence angle in two directions.

Analyzers

On leaving the source unit, the ions pass into the electrostatic analyzer, which is a 75-degree portion of a sphere with 100-inch radius. Each of its seven opaque fused-quartz sections is made up of two concentric electrode surfaces coated with gold.

The magnetic analyzer is a 14-ton permanent magnet with a field of 2,000 gauss. It has parallel poles describing a 110-degree section of a circle with 100-inch radius. The magnetic analyzer is mounted on a movable carriage to permit focusing.

Ions leave the source unit with slightly different velocities, fanning out in slightly different directions. The electrostatic analyzer spreads the ions in a parallel beam according to velocity and direction so that the magnetic analyzer can focus them, separated according to mass.

In the electrostatic analyzer, the ions pass within the walls of a curved passage formed by the gold-covered quartz sections. The inner (convex) wall bears a negative charge, and the outer (concave) wall carries a positive charge. Slower moving ions travel in paths with small radii, being attracted more to the inner wall.

The magnetic analyzer operates like the electrostatic unit except that the bending forces are dependent on mass rather than velocity. Ions with the least mass are pulled closest to the center of curvature.

The ion beam is focused according to mass at the collector unit. The heaviest ions are on one side, the lightest on the other. The electron multiplier that detects the ions can register a single ion.

Applications

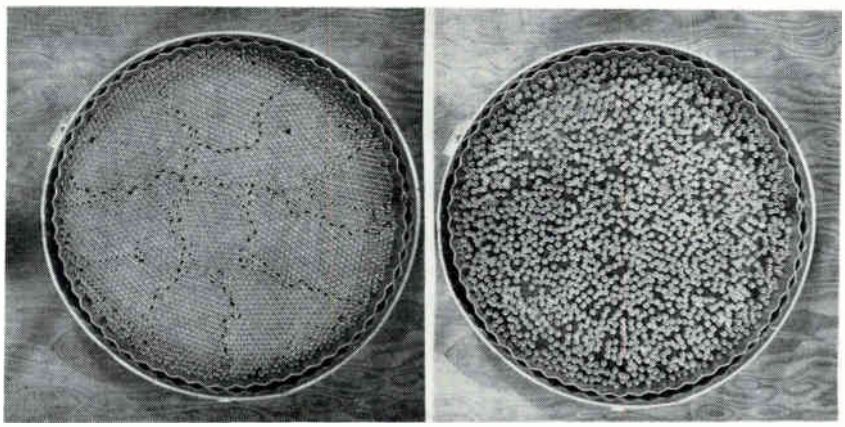
The new spectrometer will provide a series of chart-recorded peaks each representing sorted nuclei of a different mass. By measuring exact masses of nuclei, it will be possible to study amount of energy binding nuclei because energy has a mass equivalent.

The instrument will permit study of a variety of problems. For example, analysis of the isotopic composition of the small amount of uranium in a meteorite sample can be compared with the isotopic composition of uranium on the earth.

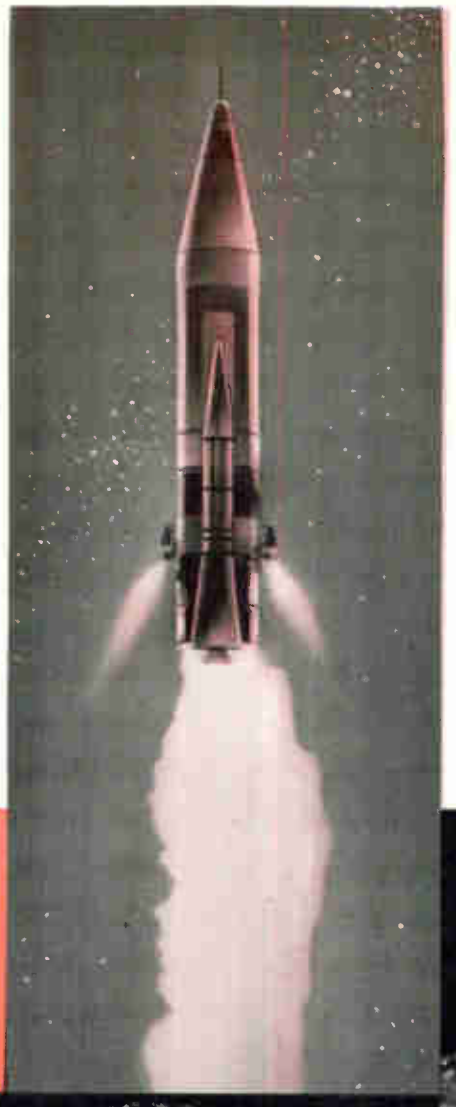
Also, a search can be made for curium-247, which has been found in the debris of a nuclear explosion. It is thought that this isotope may exist in minute amounts in nature.

Half-life of cesium-137 can be

Vibrator Simulates Atomic Motion



Vibrating platform at GE Research Lab keeps beads in constant random motion similar to atoms. Tightly packed beads show clear grain boundaries (left); loosely packed beads show atomic behavior in liquid (right)



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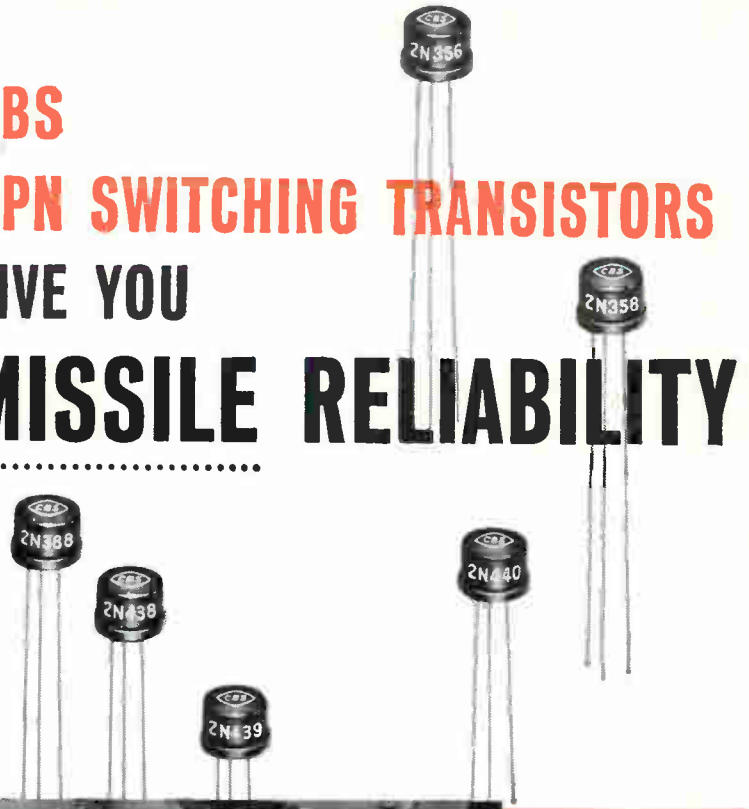

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measured more accurately. Cesium-137 is also a fission product. The spectrometer will extend investigations that have resulted in the first identification of isotopes such as plutonium-244, curium-247, curium-248 and californium-251. Each element can have a family of isotopes, each with a different mass because each has a different number of neutrons. Hydrogen, for example, has three isotopes.

Another analytical application will be to determine the kinds of atomic nuclei created when target atoms are bombarded by particles from a high-energy particle accelerator. The instrument will be used in this manner in conjunction with the zero gradient proton synchrotron now under construction at Argonne.

Apart from its analytical applications, the instrument will determine precisely the masses of species of atomic nuclei. Many species (nucleides) of medium and heavy atomic weights have not been precisely measured.

Simulator for Target Selection

RESEARCH program sponsored by the Army Signal Corps should enable air defense weapons systems to realize more fully their potentialities. The program, conducted by the National Bureau of Standards, involves development and implementation of rules for selecting best possible target among all in-range attackers.

Selection Problem

During an air attack, the enemy may delay recognition and accurate location of some attackers. Therefore, it is extremely important to make each shot most effective.

Factors involved in target selection include nearness and velocity of attacker. If all relevent criteria point to the same attacker, there is no selection problem. But such a simple situation rarely arises. A selection rule must combine relevant factors into a single composite criterion that yields an unambiguous choice of best target. Constructing a selection rule requires careful

analysis of the relationship between the various criteria, singly and collectively, and the objective of the defense.

Target selection would be simpler if each firing decision could be made with full foreknowledge of the future course of the air defense battle, which is obviously unattainable. Probabilistic prediction, though conceivably possible, would require extensive calculations incompatible with rapid decision making. Because the future of the battle can be treated only approximately, effectiveness of a proposed selection rule cannot readily be determined by theoretical means. Experiments are therefore performed in which a high-speed computer simulates a number of air defense battles and reports results of target selections.

Computer Simulation

An examination has been made of the general problem of conducting simulations as effectively as possible. The usual outputs of such studies are sufficient to indicate differences in effectiveness between two target selection rules, but cannot be used to detect the source of the difference. Methods for obtaining and presenting this more detailed information, which is necessary for the systematic improvement of selection rules, have been developed and are currently being automatized.

Another study, which dealt with computer functions common to most such simulation problems, suggested creation of a modular computer program so that different selection rules, defense systems and attack situations could be plugged in.

A prototype of such a program was prepared and is now in use. It performs standard simulator functions of moving attackers and defense missiles along their paths, umpiring hit or miss when a defense missile reaches its impact, determining when a target has carried out its mission and keeping a detailed record of all significant simulated events. Operation of this kind of a program has provided valuable information on possible use of computers to implement target selection rules.

Cesium Cell for Power Conversion

SUCCESSFUL CONVERSION of heat directly into alternating current electricity in significant amounts, without use of rotating machinery or d-c—a-c converter, was reported last week by scientists of General Dynamics Corporation's General Atomic Division.

Prior to this announcement, direct current had been obtained from experimental thermoelectric devices in several of the country's research laboratories, but scientists had been unable to produce an appreciable quantity of alternating current. The utility companies require alternating current for home and most industrial uses.

Scientists at General Atomic Division's John Jay Hopkins Laboratory for Pure and Applied Science in San Diego, Calif., used a high temperature cesium cell converter which produced sufficient alternating current to illuminate a series of small light bulbs. The cesium cell is one of several direct conversion methods under study.

Thermoelectric Research

Thermoelectric research, which has been underway since 1957, is partially supported by nine investor-owned utility companies of the western states. Eight of the companies are members of the Rocky Mountain-Pacific Nuclear Research Group. The other is the San Diego Gas and Electric Company.

Member companies of the Rocky Mountain-Pacific Group are: Arizona Public Service Company, California Electric Power Company, Pacific Power & Light Company, Portland General Electric Company, Public Service Company of Colorado, Public Service Company of New Mexico, Utah Power & Light Company, and Washington Water Power Company.

Frederic de Hoffman, senior vice president of General Dynamics Corporation and president of General Atomic Division said: "This discovery brightens the prospects that direct conversion equipment, including the cesium cell, may eventually be used in power plants instead of steam boilers, turbines and generators. It may prove possible to bring about reductions in both the capital and operating costs of electric power generation through the use of simpler and more compact equipment."

However, a great amount of research and development work lies ahead of us before we can begin to speak of large-scale commercial applications of direct conversion of heat into electricity.

The electric generating industry in the United States long ago generally abandoned the production of direct current power because alternating current—at high voltages—is required for efficient transmission. Direct current must be converted to alternating current before it has widespread commercial value.

Direct Conversion

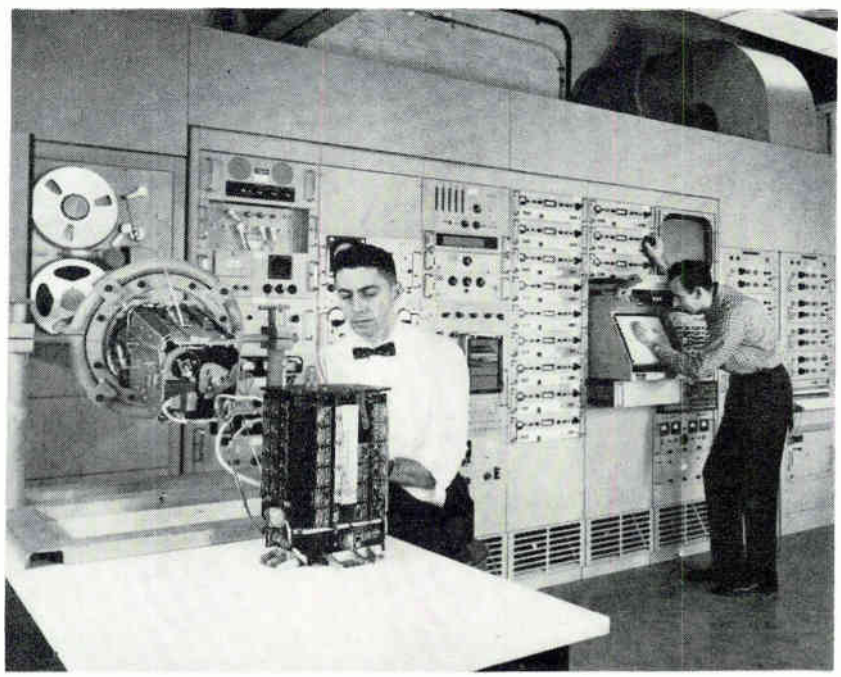
De Hoffman said General Dynamics has a particular interest in thermoelectric power because of the Corporation's leading role in the development of advanced, high temperature nuclear reactor systems.

"High temperature reactors are eminently suited to exploit the potential of high temperature thermoelectric direct conversion, as exhibited by the cesium cell," he explained.

The thermoelectricity program at General Atomic is under Robert W. Pidd, formerly professor of physics at the University of Michigan and one of the principal investigators in reactor tests in which heat produced by nuclear fission was directly converted into electricity for the first time.

Pidd said the alternating current produced in the cesium cell con-

Checking Out Subroc Components



Nine racks of six-foot high electronic equipment are used to complete a reliability checkout of a compact package of telemetering equipment developed by Goodyear Aircraft Corporation here for the Subroc antisubmarine weapon. The telemetering package, which is approximately 10 in. in dia. and 24 in. long, transmits 80 channels of test data. To checkout this capability, the test rack includes equipment requiring 100 signal lights, 550 vacuum tubes, 100 transistors, thousands of connections and 100 miles of wire. Shown working on the telemetering equipment is development engineer Donald T. Wight. At the chart recorder is Douglas Bohannon, an electronic instrument specialist.

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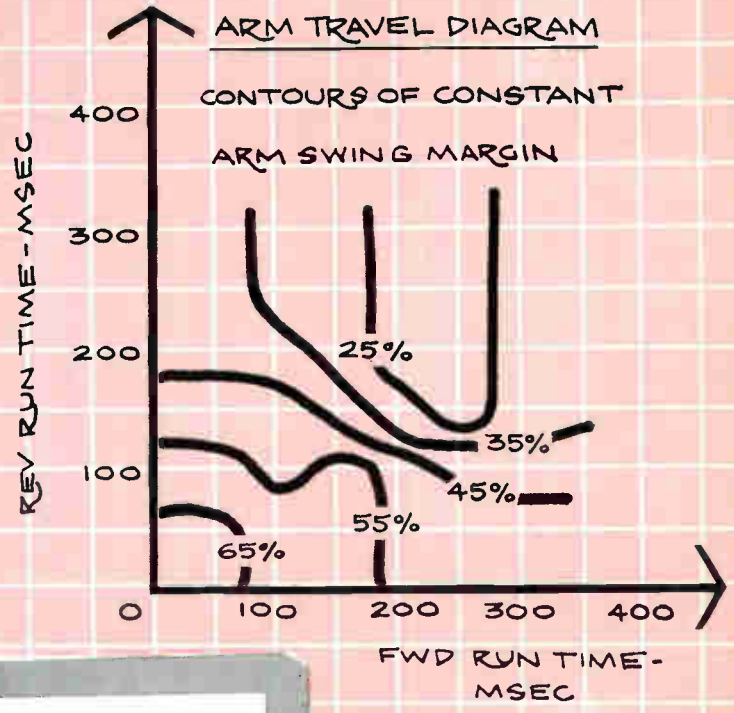
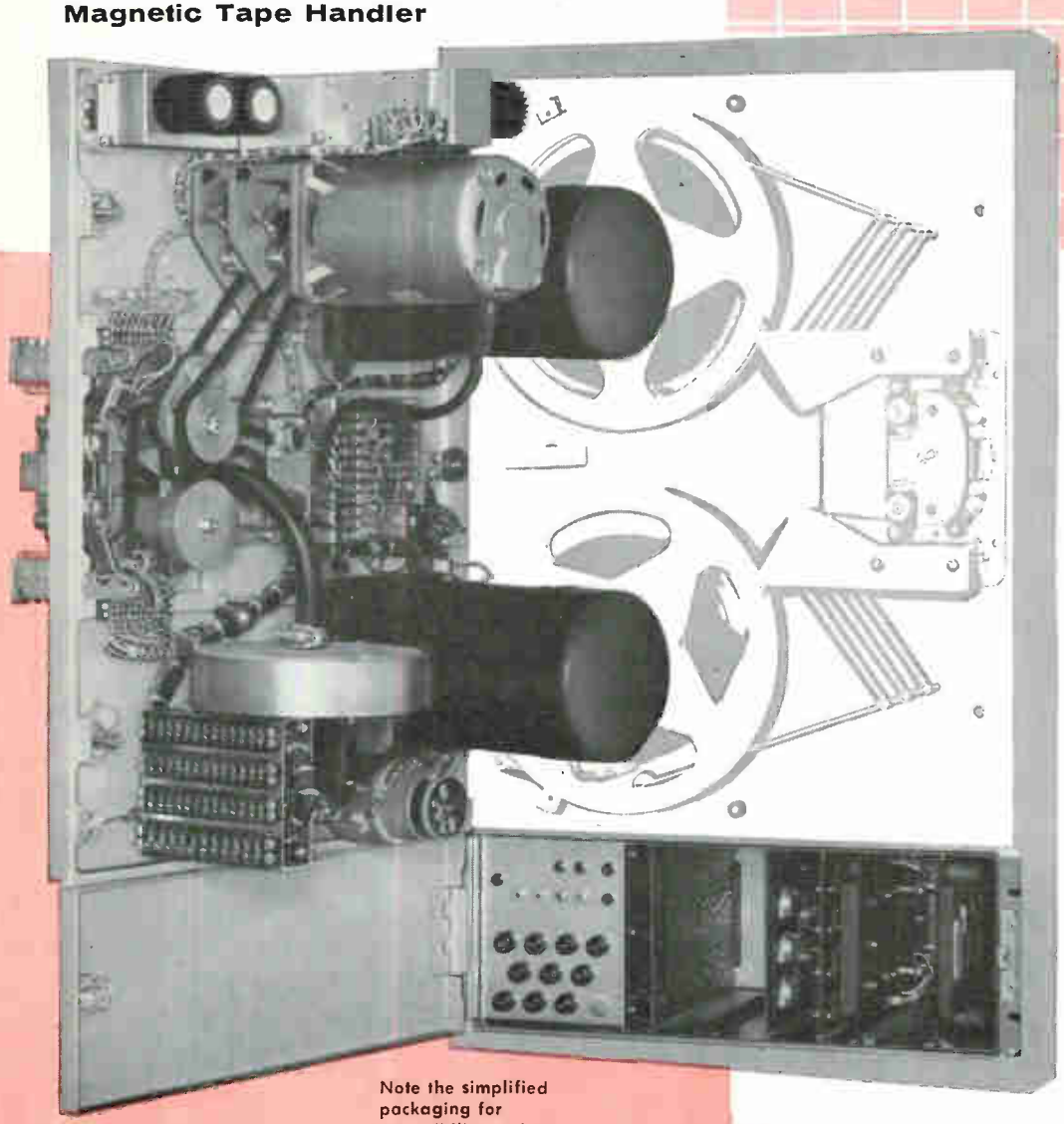
Magnetic Tape Handler





Note the simplified packaging for accessibility and easy maintenance.

SPECIFICATIONS

TAPE SPEED
100 and 50 ips, standard. Maximum speed: 150 ips. Minimum speed: 1.0 ips.

START TIME
3 milliseconds or less.

STOP TIME
1.5 milliseconds or less.

STOP DISTANCE
0.100" ± .035" at 100 ips.

REWIND
300 ips constant speed either direction. 1¾ minutes for 2400 feet, millisecond start-stop, with 1/2" tape.

INTERCHANNEL TIME DISPLACEMENT
±2 microseconds at 100 ips from center clock to outside track on 1/2" tape.

COMPUTER INPUTS
All functions including speed selection, FWD, REV, FAST FWD, FAST REV, controlled with 0 volt "OFF," —5 volt "ON," level type signal. Other level or pulse control signals can be accommodated on special order.

BLOCK FEED REP RATE
200 blocks/second maximum.

TAPE TENSION
3 oz. nominal, 1/2" tape. Maximum tension in guide system, approximately 6 oz.

SIZE
24½" high swing-out panel for 19" rack mount. Hinge mounts separately for ease of installation.

POTTER INSTRUMENT CO., INC. Potter **Sunnyside Boulevard, Plainview, L. I., N.Y.**
OVerbrook 1-3200

CIRCLE 79 ON READER SERVICE CARD

verter is not in the conventional frequency range of 60 cycles but in the 100 kc range transmission.

Another aspect of the discovery which is the subject of further study is the fact that the cesium cell simultaneously produces both alternating and direct current.

The cesium cell is based on one of the oldest principles of electronics—the Edison effect. During his early experiments on the light bulb, Edison found that a white hot metal boils electrons out of its surface, much as water boils out of its surface when heated. This was the founding idea of all radio tubes in which electrons are boiled off hot wires and collected by an adjacent plate within the tube.

Boiled Electrons

In the cesium cell, a metal plate is heated white hot. The electrons boiled out of the hot plate, or emitter, are collected on an adjacent cold plate called a collector. The hot and cold plates act as the poles of a battery, delivering current to electric wires for distribution. Part of the heat put into the hot plate is converted directly into electric current.

A vapor of cesium metal, added in small amount to the cell, performs three functions which greatly enhance the direct conversion process: the vapor steps up the rate at which the electrons boil off the hot surface; it reduces the energy loss at the cold surface; and most important of all, it creates an ionized gas or plasma which neutralizes the electron space charge in the region between the hot and cold surfaces, thereby causing the current to pass more readily through the region.

The cesium cell can be made into practical shapes for incorporation into atomic power reactors.

Teflon Wire Coating Solves Corona Problem

FAILURE UNDER CORONA stress has been eliminated by a new Teflon-coated wire created by W. L. Gore & Associates, Inc., Newark, Delaware. This coating achieves corona resistance upwards of 70 times greater than Teflon-insulated hookup wire heretofore available.

The new development gives Tef-

lon about the same corona-stress resistance as the widely used silicone insulations; and where the latter are limited to about 200 C, Teflon withstands temperatures running more than 100 C higher.

Bouncing Ions

Corona begins with ionization resulting from increasing voltage stress. Teflon, like all insulations, normally contains microvoids at the coating-wire interface. Ions formed by high voltage stresses are bounced around in these minute cavities by an alternating current. When they bombard the surfaces containing them, this generates heat—and the combined effects of heat and impact begin enlarging the cavities.

The result is a runaway reaction. Temperature and extent of ionization increase as the cavities grow, until the ions finally break through the insulation.

Aircraft and missile wiring is especially prone to this kind of failure, because the corona initiation level drops as atmospheric pressure decreases. As an example, corona stress may begin at about 2,000 volts in a typical 10-mil insulation at sea level; but at high altitude, or in outer space, the initiation level might be reached at less than half this voltage.

Once corona is initiated, there's an added factor: extinction voltage —that is, the point to which deterioration will continue—may be 500 volts lower than the initiation level. Teflon has been quite susceptible to corona stress. And, while there have been other materials with far better corona resistance, none of these have Teflon's electrical properties and heat resistance.

The new Teflon wire covering, Type CR, is based on two elements: a special formulation compounded to minimize corona initiation and prevent cavity growth; and manufacturing techniques which apply the Teflon in a homogeneous, essentially void-free wire covering.

The development is marketed as MONO-TET CR single-conductor wire in sizes from AWG 28 to 0; it comes in 10 basic colors and with stripes. It's also available in shielded and coaxial conductors, and as MULTI-TET CR in ribbon cable.

Develop Strippable P-C Negatives

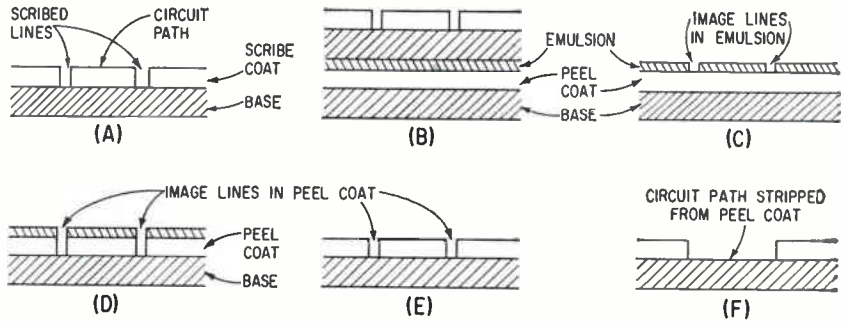
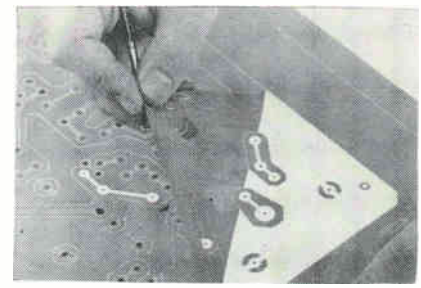


FIG. 1—Steps in production of scribed master and printed wiring negatives



Peel-coat is pulled off after photographic processing. Technique also eliminates opaquing of large areas

PRINTED CIRCUIT layouts and negatives made by a method combining film scribing and photographic techniques are reported to offer improvements in accuracy and design flexibility, while reducing drafting time and expense.

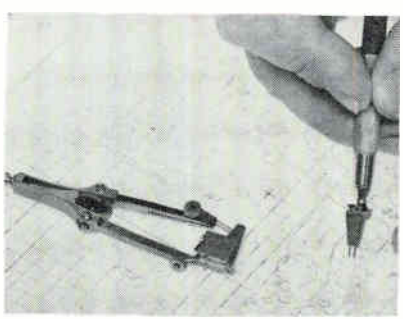
Techniques were developed by General Electric Company's Heavy Military Electronics Department, Syracuse, N. Y., in cooperation with the Keuffel and Esser Co., Hoboken, N. J. K & E supplies the Mylar-base film (Stabilene) with a strippable coating on which the layouts are made.

Masters are produced by a method similar to that previously reported (ELECTRONICS, p 62, August 29, 1958). However, as shown in Fig. 1, the circuit path is not peeled from between the scribed lines.

Negatives used to print the circuit boards are produced in six steps. The outline of the circuit paths are scribed on scribe-coat film master (Fig. 1A). Peel-coat film is exposed to the master (Fig. 1B), producing a line image in the photo emulsion layer of the peel-coat film. The master can then be filed or further reprinted.

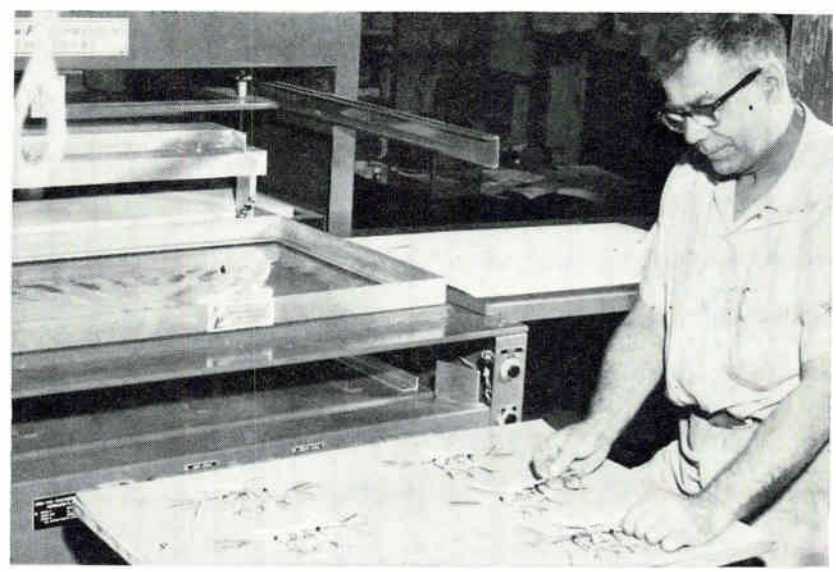
Image lines in the photo emulsion are removed by developing (Fig. 1C). The film is wiped with an alcohol-dampened cloth, dissolving the image lines down to the Mylar base (Fig. 1D). Photo emulsion is washed off in a Clorox bath (Fig. 1E). The peel coat between the lines is peeled off, leaving finished circuit paths (Fig. 1F). The remaining peel coat acts as a photographic resist during board printing.

The tools used to scribe the circuit path and land outlines are made with steel alloy points in graduated widths. They are equipped with spring-type shock absorbers to maintain accuracy on curved lines. Changes in the patterns can be made with touch-up fluids on the master, peel-coat negative or final pattern.



Original drafting layout is made on master film containing grid lines. Scribers outline circuit paths and connection pads

Plastic Skin Packages Components



Six wiring harnesses are positioned for packaging. Loading bed is slid under film at left

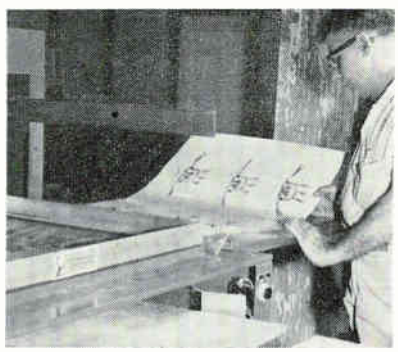
SKIN PACKAGING, which has been primarily used by the consumer goods industries, can also be used to package electronic components, wire and circuit board assemblies and electromechanical parts, according to Print-A-Tube Company, Paterson, N. J.

The parts illustrated were packaged on machinery made by the firm's Skin-Pak Machinery Co., Division. The skin is Mylar extruded

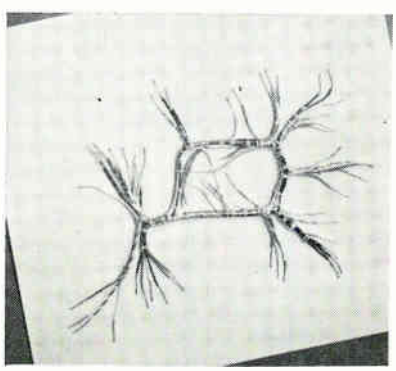
over polyethylene. Foil, paper, Saran or other materials may be included in the laminate, depending on strength or permeability required and temperature sensitivity of the parts packaged.

Parts are placed on a sheet of uncoated cardboard about 0.030 inch minimum thickness, laid in the loading bed. Film drawn from a roll is heated for 8 to 10 seconds to soften the polyethylene. A vacuum is then drawn under the film for 5 to 6 seconds, draping the film over the parts and sealing the polyethylene to the cardboard. The master card is cut into individual packages or strips.

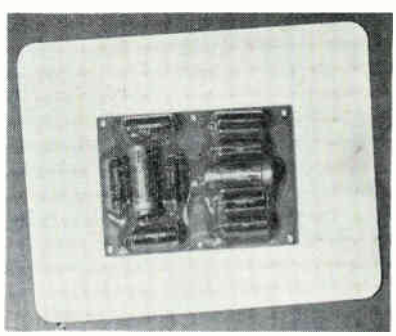
Minimum film thickness is 1 mil. Heavier films are better for tightly conforming films since their added strength allows more stretching



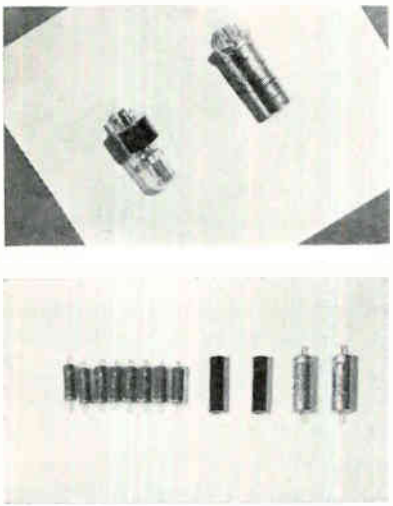
As package is removed from machine, fresh film is drawn into position



Finished harness package



Packaged circuit board



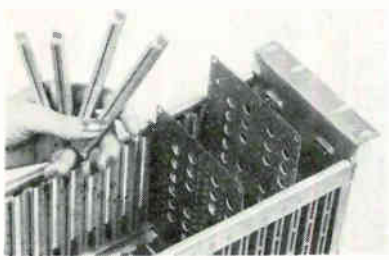
Relays and axial-lead components

and draping by lengthening the vacuum cycle.

Large parts are generally hand-positioned on the cardboard. Small parts can be scattered over the board. If a regular arrangement is desired, a cutout can be placed over the cardboard, the parts scattered so they fall in the depressions, and the cutout lifted off before film is applied. The backing can also be die-cut to receive odd-shaped parts, such as transistors.

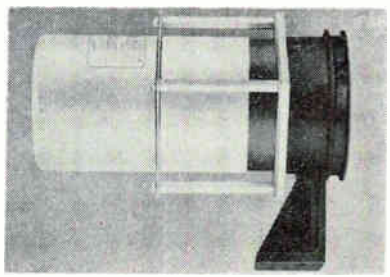
The fusing temperature is generally below 240 F, the melting point of the polyethylene. The woven wire heater plate can be provided with shields to protect temperature-sensitive parts or prevent the polyethylene from adhering to the parts. The sheet strips off in a single piece because of the air gap around the packaged parts.

Circuit Card Holders



HOLDERS for rack-mounted printed circuit cards are being molded of plastic by Space Products Co., North Long Beach, Calif. The material used is a high-impact plastic (Koppers Dylene 800) which resists bowing.

On The Market



Diameter Equalizer for disk recording

CINEMA ENGINEERING DIVISION, 1100 Chestnut St., Burbank, Calif. New stereo unit is effectively a dual equalizer that provides automatic compensation for losses in high frequencies. H-f losses are corrected continuously between the 5 in. and the 12 in. diameter point, maximum equalization being 8 db at 10 kc. Unit is mounted directly on the recording machine and attached by the spring drive to the recording head carriage. Dimensions are $3\frac{3}{8}$ in. in diameter; $6\frac{3}{4}$ in. long; mounting bracket extends 2 in. with net weight of $2\frac{1}{2}$ lb.

CIRCLE 301 ON READER SERVICE CARD

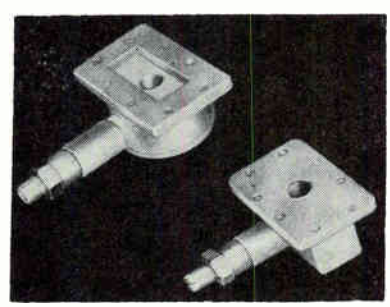
Tachometer highly sensitive

AIRPAX ELECTRONICS INC., Seminole Division, Fort Lauderdale, Fla. The Tach-Pak completely self-contained tachometer has an accuracy of better than 0.25 percent. RPM measurement is accomplished with no mechanical or electrical linkage between this tachometer and any rotating system component. Transistor and magnetic circuits convert a signal input from a magnetic pickup into a current output which can be indicated on any 0-1 ma average reading device. Power requirement is less than a watt and the source may be a 60 or 400 cps a-c line or 12 v battery.

CIRCLE 302 ON READER SERVICE CARD

Microwave Cavities cast invar

PORTCHESTER INSTRUMENT CORP., 114 Wilkins Ave., Port Chester, N. Y. A series of cast invar cavities, tunable over a 10 percent frequency range, are available for frequencies from 5,925-7,750 mc, and



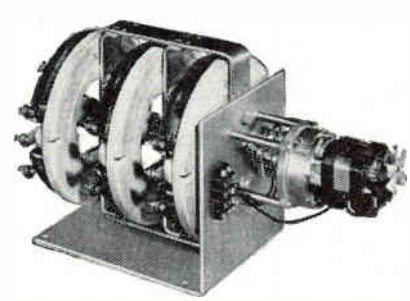
can be designed in frequencies from L band through Ku band. The cavities, when used with a waveguide discriminator, are capable of controlling the frequency of transmitting klystrons to conform to FCC specs. The technique of invar casting and glass sealing has reduced the price considerably.

CIRCLE 303 ON READER SERVICE CARD

Motorized Rheostats for remote control

OHMITE MFG. CO., 3677 Howard St., Skokie, Ill., can now supply complete motor-driven rheostats or variable transformers. Such units are employed in remote control applications or where a predetermined rate of resistance or voltage change must be smoothly achieved. Standard drives consist of a motor with integral gear reducer, and cam-operated limit switches to accomplish reversal of the control. Standard assemblies are arranged for horizontal surface mounting but assemblies for vertical mounting may be provided.

CIRCLE 304 ON READER SERVICE CARD



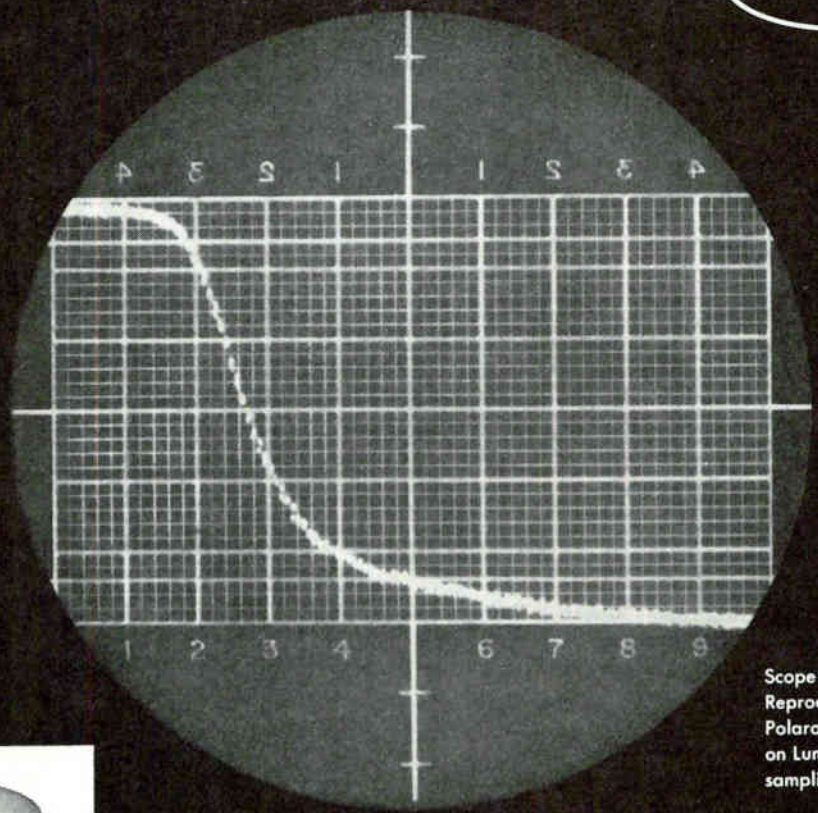
Micro-module Wafers hard and tough

CORNING GLASS WORKS, Corning, N. Y., has available Fotoceram micro-module wafers which are produced by chemically machining glass to "micro accuracy" from a photographic reduction, then converting it to a ceramic. The wafers are nonporous, dimensionally stable, and shock resistant. Company says that designs other than four patterns in stock can be produced economically in a matter of days. Further information may be readily obtained by writing on company letterhead.

Tiny Terminals compression seal

THE SPHERE CO., INC., 25 Amity St., Little Falls, N. J. Subminiature compression seal terminals (nine on an AF cover) are $\frac{11}{64}$ in. in diameter and vary from $\frac{13}{64}$ in. to $\frac{1}{4}$ in. in height, depending on head style. They are made with an L-3 Steatite,

ANOTHER FIRST FROM RAYTHEON



Scope shows millimicroseconds! Reproduced from unretouched Polaroid photograph of trace on Lumatron Model 12AB sampling oscilloscope.

New Avalanche Mode Silicon Transistor Switches in 2½ milli-μsec!

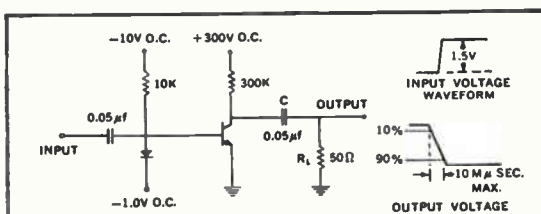
FASTEST SWITCHING! The new Raytheon 2N1468 silicon NPN transistor, designed for avalanche mode operation, has a *guaranteed* switching time of 10 millimicroseconds maximum when used in the circuit shown. Speeds faster than 1½ millimicroseconds are feasible.

HANDLES 40 WATTS! The new Raytheon avalanche mode transistor is capable of switching 40 watts peak power. Average power dissipation is 250 milliwatts.

HIGH TEMPERATURE! Silicon – the maximum operating temperature of the new Raytheon 2N1468 is 125°C.

PATENTED! Protected by U.S. Patent No. 2,843,515 (covering junction transistors exhibiting current amplification of at least unity when operated in the avalanche breakdown region), this revolutionary new transistor is a Raytheon exclusive.

AVAILABLE NOW! Production quantities of this new Raytheon 2N1468 are available *now* for your evaluation. For data sheets and other technical information, contact your nearest Raytheon office.



Switching circuit employing the Raytheon 2N1468 avalanche mode transistor.

CHARACTERISTICS OF 2N1468 AT 25°C.
Thermal Dissipation Coefficient (in air) $K_a = 0.5°C/mw.$

	Min.	Avg.	Max.	Units
Avalanche Voltage	40	70	–	Vdc
Emitter Cutoff Current VEB-10V	–	–	1.0	μAdc
Switching Time in Circuit	–	2.5	10.0	mμsec.
Peak Collector Current	–	–	2	A max.
Junction Operating Temperature	–	–	125	°C max.

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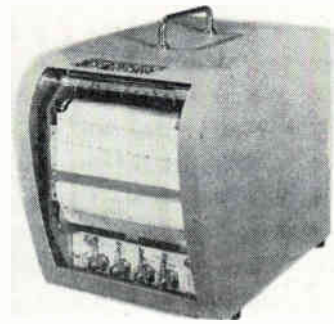
meeting JAN-1-10 specs. Head styles available are: notched lug, turret head, hollow turret, and lug with hole. They are supplied with a Neoprene, or Silicone seal. Covers can be drop shipped to Sphere for the assembly of terminals in the pattern of the customer's choice. Prices are as low as $77/M assembled to covers.

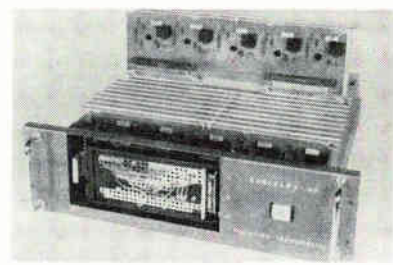
CIRCLE 305 ON READER SERVICE CARD



Portable Recorder 6-in. chart

SYSTRON CORP., 950 Galindo St., Concord, Calif., has developed a line of potentiometer recorders for applications such as strain gage or thermocouple monitoring. New optional features include ball point pen, 1 mv span preamp, and resistance bulb bridge for temperature measurements. Units are available for either portable or rack mounting use. With selectable 9 to 120 mv span, gear shift selection of chart speeds, 0.8 sec balance time, and ¼ percent sensitivity, the units provide extreme versatility.

CIRCLE 306 ON READER SERVICE CARD



Commutator eliminates preamps

RADIATION INC., P. O. Box 37, Melbourne, Fla. The Radiplex answers the need for high-speed electronic sampling of low-level signals. Basic unit contains 50 diode gates which sequentially connect the inputs to

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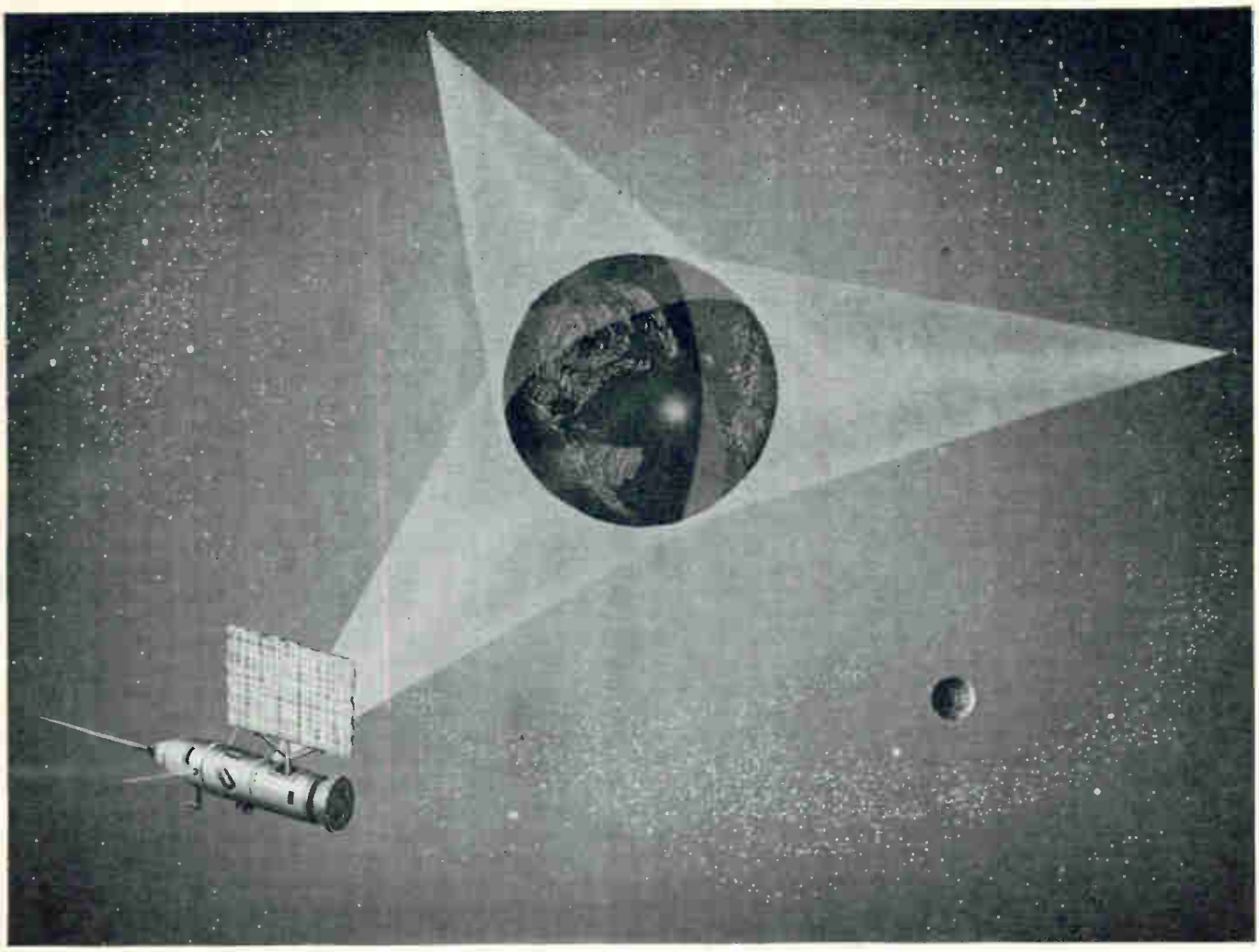


THE FAR REACHES OF MAN'S KNOWLEDGE

Over the years ITT Laboratories has made significant contribution to advancing the state of the art in electronics. Today highly evolutionary progress is moving apace in such areas as broadband communications systems, low-noise parametric amplifiers, atomic clocks, inertial navigation systems, high density storage tubes, and space guidance, navigation and flight control. Major achievements are resulting in stored program digital computers and digital communications.

While engineers and scientists at ITT Labs meet the urgencies of today, they are simultaneously exploring the far reaches of man's knowledge, accepting small failures, making small successes, to unlock the doors to revolutionary achievements in electronics.

Communications, as essential to civilization as food and shelter, is an area of unlimited challenge which constantly occupies our efforts. To find more room within the radio spectrum for electronic communications — from direct current to the cosmic rays — is a major goal. Revolutionary ways to extend communications is another. We foresee early success with single satellite systems of the delayed-transponder type, and possibly passive reflector satellites. In only a few years ITT's "Earth Net" communication system may be a reality, providing global communications via three satellites in orbit. Within a generation, world-wide television may be a commonplace.

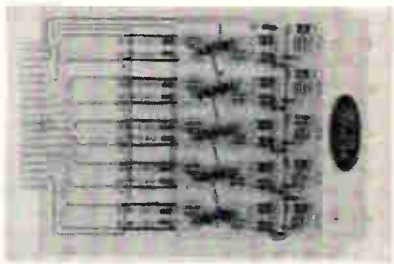
Positions of responsibility, challenge and reward are open to engineers with minimum B.S. degree and U.S. Citizenship. For information regarding specific positions, write G. T. Wall, Technical Placement Director.

ITT LABORATORIES

A Division of International Telephone and Telegraph Corporation
500 Washington Avenue, Nutley, New Jersey
Fort Wayne, Indiana • San Fernando and Palo Alto, California

a single output line with negligible losses and distortion at rates of as high as 24,000 total samples per sec. Signals at full-scale amplitude levels of as high as ± 10 v may be multiplexed intermixed with signals at levels of as low as ± 10 mv.

CIRCLE 307 ON READER SERVICE CARD



Flip-Flop Storage for digital data

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. Model 307 flip-flop storage register contains five independent transistorized flip-flops for the storage of digital data. Set and reset inputs and ONE and ZERO outputs are available for each flip-flop. A common buss is provided for simultaneous resetting of all five flip-flops. Model 307 is 5 by 6 in glass-epoxy p-c card, $\frac{1}{16}$ in. thick and is used with an 18 pin p-c receptacle. Only one voltage, −12 v is required. Standard levels are −6.8 v for ONE and −0.2 v for ZERO.

CIRCLE 308 ON READER SERVICE CARD

Voltage Regulator static components

GENERAL ELECTRIC CO., Pittsfield, Mass. The Sta-Vo-Trol voltage regulator uses special rate feedback and Zener diode sensing. Static components eliminate tubes, brushes and other moving parts. Rated 1 kva, single phase, 0 to 8.5 amperes, 120 v, the unit maintains ±0.25 percent bandwidth accuracy for a constant power factor load.

CIRCLE 309 ON READER SERVICE CARD

AlSiMag®

offers . . .

the widest variety of technical ceramics from any single source

Specialized engineering talent in depth • The quantity you need . . . deliveries and quality as agreed • Special speedy service on prototypes • Specialized equipment for smaller quantity production • Unequaled facilities for volume production when you really need volume.

from one source . . .

These are typical samples picked up in our Inspection Department over a week end. They illustrate the great variety of technical ceramics constantly flowing through our ultra-modern plants.

Parts are shown approximately ½ size.

Property Chart Sent on Request.

A Subsidiary of Minnesota Mining and Manufacturing Company.

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
58TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Cal. New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash.
All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

Literature of

MAGNETIC AMPLIFIER. Airpax Electronics Inc., Seminole Division, Fort Lauderdale, Fla. Bulletin M-62 describes the Preac, a high sensitivity d-c magnetic amplifier having an extremely stable null.

CIRCLE 350 ON READER SERVICE CARD

TEST EQUIPMENT. Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J. A 36-page catalog describes a complete line of equipment which measures the electrical characteristics of control synchros, torque synchros and computing resolvers.

CIRCLE 351 ON READER SERVICE CARD

SOLENOID-LOCK MECHANISM. Electro Switch Corp., King Ave., Weymouth, Boston 88, Mass. Bulletin No. 18 describes application of solenoid locking mechanism to standard ESCO type JR rotary switches.

CIRCLE 352 ON READER SERVICE CARD

MODULAR HOUSINGS. Stantron Division of Wyco Metal Products, 6914 Beck Ave., N. Hollywood, Calif. Catalog No. 100 completely describes and pictures a new line of modular electronic housings.

CIRCLE 353 ON READER SERVICE CARD

MAGNETIC TAPE ERASER. Southwestern Industrial Electronics Co., 10201 Westheimer, Houston 27, Texas. The MTE-2 magnetic tape eraser, designed to provide clean demagnetization of either direct or f-m recorded tapes, is described and illustrated in a recent bulletin.

CIRCLE 354 ON READER SERVICE CARD

DELAY LINES. Valor Instruments, Inc., 13214 Crenshaw, Gardena, Calif. Bulletin DL1159 describes a standard line of miniature lumped constant delay lines. Design factors that should be considered when establishing specifications for special delay lines are also explained.

CIRCLE 355 ON READER SERVICE CARD

ZIPPER TUBING. Alpha Wire Corp., 200 Varick St., New York 14, N. Y. Catalog Z-2 discusses the

the Week

characteristics, new constructions, applications, specifications, and production advantages of Alphlex zipper tubing.

CIRCLE 356 ON READER SERVICE CARD

C-BAND RADAR BEACON. General Electric Co., Schenectady 5, N. Y. Publication WCP59-0812 describes the C-band radar beacon, a 9.8 lb, airborne, pulse-type missile tracking and identification aid.

CIRCLE 357 ON READER SERVICE CARD

SUPERALLOYS. Metals Division, Kelsey-Hayes Co., New Hartford, N. Y. Two new technical bulletins cover performance data on vacuum induction melted Waspaloy and M-252 superalloys.

CIRCLE 358 ON READER SERVICE CARD

NYLON TIP JACKS. Herman H. Smith Inc., 2326 Nostrand Ave., Brooklyn 10, N. Y. Catalog No. 59 covers a line of molded Nylon tip jacks featuring metal shell which eliminates stripping threads during assembly.

CIRCLE 359 ON READER SERVICE CARD

FREQUENCY METERS. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. Bulletin 32 on Frahm resonant reed frequency meters is now available.

CIRCLE 360 ON READER SERVICE CARD

COMPRESSION TERMINALS. Electrical Industries, 691 Central Ave., Murray Hill, N. J. Bulletin TCT-59-102 covers a line of glass-to-metal tubular single-lead compression terminals.

CIRCLE 361 ON READER SERVICE CARD

TESTING FACILITIES. Horkey-Moore Associates, 24660 Crenshaw Blvd., Torrance, Calif. A 4-page brochure describes the firm's environmental, qualification and reliability testing facilities.

CIRCLE 362 ON READER SERVICE CARD

GERMANIUM DIODES. General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y. Ten-page brochure GD-40 describes a complete line of germanium gold bonded diodes.

CIRCLE 363 ON READER SERVICE CARD

Filtron Opens in Midwest

FILTRON CO., INC., of Flushing, N. Y., and Culver City, Calif., has opened a central regional field service office in Dayton, O.

The new facility will supply specialized radio-frequency interference engineering services to both industrial manufacturers and government agencies throughout the Midwest. Special services will be available to the U.S. Air Force complex at Wright-Patterson AFB, near Dayton.

Engineering facilities will include screen-room services, component and systems testing, and a model shop for producing prototype interference filters for special applications. In addition the branch will serve as a liaison unit of Filtron's Systems Engineering division, for consultation on r-f interference analysis and control.

John L. Moe, formerly a project engineer with Filtron's Systems Engineering division, will be engineering manager. Marketing manager for the new branch will be J. Kent Thompson, who has served as a field engineer for Filtron in the Ohio area for the past five years.

Bambara Joins Servo Corp.

JOSEPH E. BAMBARA has been appointed director of industrial products engineering for Servo Corp. of America, Hicksville, L. I., N. Y. He heads an engineering laboratory engaged in research, development and design of infrared instruments and systems, as well as control and data processing systems for industrial applications.

Before coming to Servo Corp., Bambara was for almost nine years with CBS Laboratories, where he was vice president of CBS' electronic systems laboratory.

Teleregister Ups Schneider

THE TELEREGISTER CORP., Stamford, Conn., has appointed Philip Schneider engineer-in-charge of the Systems Development Group, a new unit of the engineering department.

Function and responsibility of Schneider's group is to study and develop new concepts and requirements for input/output devices, communications systems, data processing systems and mathematical models and techniques required in the company's field of interest, which is the design, manufacture and operation of automated data processing systems.

Schneider has been a systems engineer with Teleregister since April 1959. He previously spent 7 years with Bell Telephone Laboratories as a member of the technical staff in switching systems engineering. He was in charge of a group responsible for engineering pcm transmission systems.

Corby Takes New Post

ROBERT R. CORBY has been appointed to the position of staff engineer in the program planning department of Motorola's Western Military

CIRCLE 202 ON READER SERVICE CARD

CIRCLE 203 ON READER SERVICE CARD

CIRCLE 97 ON READER SERVICE CARD

Electronics Center, Phoenix, Ariz. He joined Motorola in 1953 as assistant manager in microwave products in Chicago. In 1955 he became manager of military microwave sales and in 1958 was transferred to the Military Electronics Division in Phoenix as marketing coordinator for the company's six military plants.

In his new position Corby will be responsible for the development of new areas of product and program activities. This will include the analysis, organization and coordination of technical and promotional effort required to match Motorola's skills most appropriately to the military's needs.

Spectrol Hires D. C. Beem

DONALD C. BEEM has been named senior design engineer in charge of design and development of solid state power supplies of the Special Products Group of Spectrol Electronics Corp., San Gabriel, Calif., manufacturer of precision electronic components.

Prior to joining Spectrol, Beem was in charge of quality control at Owens Labs of Pasadena.

News of Reps

Two manufacturers' reps were recently appointed to handle commercial-industrial products of Lear Inc., Grand Rapids, Mich.

Berndt Associates of Glencoe, Ill., will cover the states of Wis-

consin and Illinois and the Gary, Ind., area.

Electro-Mation Associates of Warren, Mich., will handle sales in Michigan and the Toledo, Ohio, area.

Maxwell S. Symon, formerly sales manager of Electric Regulator Corp., has formed a new sales rep organization known as **Symon Associates** in New York City. His organization will represent components and instrument manufacturers in the metropolitan New York area.

Ovenaire, Charlottesville, Va., manufacturer of crystal and component ovens, names **Kenneth E. Hughes Co., Inc.,** of Union City, N. J., as sales rep for New York State and northern New Jersey.

Paul G. (Tiny) Yewell of Yewell Associates, Burlington, Mass., electronic representatives, announces the appointment of **Philip P. Perry** as business manager. He will handle business affairs for the electronic sales and service organizations and coordinate the field activities of the Eastern Division offices at Bridgeport, Conn., and Poughkeepsie, N. Y.

Ace Electronics Associates, Inc., manufacturer of precision wirewound and conductive plastic potentiometers and trimmers, announces the appointment of the following reps:

C. H. Roller Sales, Inc., for the Michigan territory; **Callaghan-Bach, Inc.,** for southwest Ohio; and **Thunderbird Engineering Sales & Services, Inc.,** for St. Louis, Mo., Wichita, Kan., and Kansas City, Mo.

Paul Epstein was recently added to the sales staff of **Jules J. Bressler Co.,** Union City, N. J., manufacturers' rep firm.

The Government & Industrial Division of Philco Corp., Philadelphia, Pa., has appointed **Western Scientific Contracting Corp.,** Redwood City, Calif., as sales and service rep for its closed circuit tv equipment and systems throughout northern and central California and Nevada.

COMMENT

The Old Returneth

This nostalgic discussion came in with our New Years' mail, appropriately enough.

Normally I try to obey the old adage that old people shouldn't live in the past. However, a story on old-time equipment brought back memories of old-time rigs, and I began to wonder if some use couldn't be found for this gear in the missile age. In checking I was surprised at the amount of old equipment that already had been modernized . . .

The exasperating cat-whisker detector has grown into the dependable crystal diode and ultimately into the transistor. The most unreliable coherer is now on the market as a semiconductor relay. Magnetic recording, which dates from the 1880s, now puts out hi-fi and the Geisler tube has become a neon sign. I have even seen a William Duck super double slide tuner, all automatic.

Now, as near as I can figure, this leaves the magnetic, electrolytic and loose-contact detectors, and spark and arc generators—but how to modernize them will have to be someone else's problem: I am 65 years old. I believe that no real engineering has ever been done on these items, which date from the days when radiation was propagated through a mystical ether—or, as some theorists had it, there was no radiation at all, only earth conduction.

About the earliest attempt at wireless communication was placing two ground rods alongside of a small river, placed a considerable distance apart. These were connected with a battery and mike in series. Across the river, two similar ground rods were placed a shorter distance apart and connected to phones. Stray earth currents with voice would be picked up by the phones. I am very dubious that this system will be modernized, as it was easier to shout across.

Operation of magnetic detectors depends on the fact that when iron is in the process of being magnetized, it is very sensitive to small changes in the magnetizing force.

The old magnetic detectors consisted of a flexible band of insulated wire moved by clockwork around two pulleys. The tube through which the band passed contained a primary winding in series with the antenna. A secondary winding connected through the phones. Close to the windings were placed the poles of two magnets which magnetized the band of wires. Oscillations in the primary produced momentary changes in the magnetization of the bands under the magnets, and these changes induced oscillating audio currents in the secondary, which operated the phones.

With some trepidation, I will say this principle has never been used since the early days.

The loose-contact coherer consisted of a needle placed across a pair of sharpened carbon blocks, where the variable resistance modulated the r-f carrier. I am certain no one would want to bring this back. However, when placed on a concrete pier, it made a very sensitive pickup for earth noises.

The electrolytic coherer was usually made of a fine platinum wire touching a 20-percent sulphuric acid electrolyte in a platinum cup. A critically small current was introduced through an r-f choke, which soon polarized the cell and current ceased. When the r-f to be detected was introduced across the cell, the molecular film broke down and current flowed. Possibly some use could be found for this device, which I do not believe has been used for fifty years.

The old spark transmitter—a high-voltage transformer charging a capacitor which was in parallel with a spark gap and the primary of an r-f transformer—is definitely out as a communications transmitter, although at the present time it is being used in industrial heating.

The Alexanderson r-f alternator, which consisted of a toothed rotor revolving at high speeds past d-c powered stator windings, is probably hopeless for this age of high frequencies.

Modern technical progress might find some use for this historical equipment—but I am willing to pass over if I ever hear of a spark transmitter on a missile.

DEXTER S. BARTLETT
SEATTLE, WASH.

EMPLOYMENT OPPORTUNITIES

The advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

— RATES —

DISPLAYED: The advertising rate is $34.23 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED: $2.10 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box numbers—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send New Ads on ELECTRONICS Class. Adv., P. O. Box 12, N. Y. 36, N. Y.

SELLING
TO THE
EUROPEAN MARKET

Excellent sales opportunities exist in the European Common Market for industrial equipment and technical products. A New York international business firm with office in Geneva, and established marketing outlets throughout Europe, is interested in adding several selected manufacturing accounts. We function as your European sales office, and represent you on the highest commercial and technical levels.

Only reputable firms with good references considered.

Box H-22, Suite 1606,
Times Tower Bldg., New York 36, N. Y.

ELECTRONIC ENGINEERS

Circuits; Micro-wave; instrumentation; semiconductors, etc.—also sales. Nationwide listings—many fee paid. Phila. interviews—

HEILVEIL & WOOD (Emp. Agcy)
830-31 Land Title
Phila., 10 LO 4-2060

Put Yourself in the Other Fellow's Place

TO EMPLOYERS - TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

Mr. Employer, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

Mr. Employee you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section.

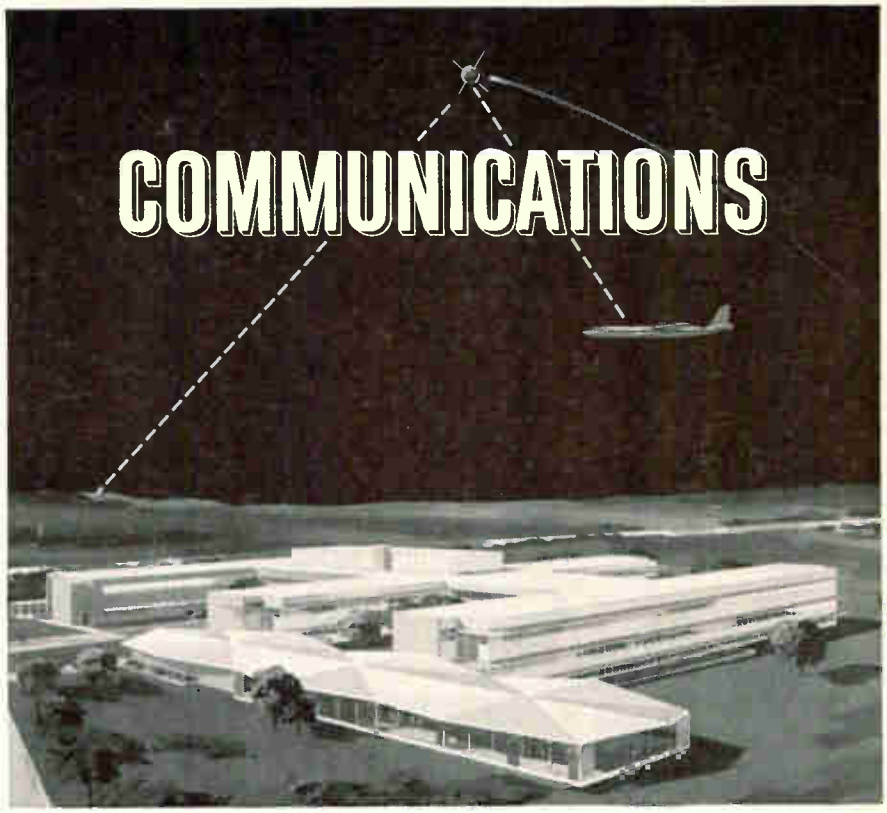
We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division

McGRAW-HILL PUBLISHING CO., INC.

330 West 42nd St., New York 36, N. Y.



At Bendix Systems Division, advanced communications research is being carried out for the Nation's most challenging space and defense systems. New opportunities are offered in such areas as:

SATELLITE COMMUNICATIONS—Equipment design and system studies for the SAC Polar Satellite Communications System.

JAM-RESISTANT COMMUNICATIONS—Analysis, design and laboratory demonstration of jam-resistant modulation and AFC techniques.

MISSILE SYSTEM COMMUNICATIONS—Analysis of EAGLE communication requirements & instrumentation techniques.

SATELLITE NAVIGATION—Preliminary system design of airborne, ground and satellite equipments for global navigation.

PROPAGATION—Applied research & analysis of propagation through the plasma sheath surrounding hypersonic vehicles.

MAGNETOHYDRODYNAMICS—Advanced studies in MHD mode coupling for information transfer.

RADIATION-RESISTANT SUBSYSTEMS—M&TC equipment designs for airborne and space radiation environment.

Ann Arbor, home of The University of Michigan, is an ideal residential and professional environment for Bendix scientists and engineers. Your academic program can be continued with day-time graduate studies at U. of M. You can enjoy year 'round recreation, Big-Ten sports, concerts, and plays available in the Ann Arbor area. You will live in residential areas so close to work that big city commuting is unnecessary.

Contact us today for information about career opportunities in:

ANTENNA DESIGN
CIRCUIT DESIGN
NETWORK SYNTHESIS
INFORMATION THEORY
PROPAGATION
RADIATION EFFECTS
PACKAGING
SYSTEMS DESIGN & ANALYSIS

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

SEARCHLIGHT SECTION
(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

BOX NUMBERS count as one line additional in undisplayed ads.

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

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

BUSINESS OPPORTUNITY

Company French American management manufacturing resistors and silvered mica capacitors wishes to cooperate with American producer of electronic components interested in the opportunities offered by the European common market. BO-3473, Electronics.

ELECTRONIC

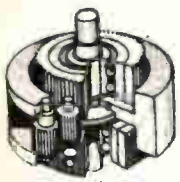
WAR TERMINATION INVENTORIES

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F.O.B. PASADENA, CALIFORNIA

C&H SALES CO.

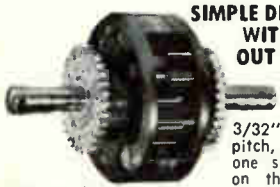
2176-E East Colorado St.
Pasadena 8, California
RYan 1-7393

SIMPLE DIFFERENTIAL WITH BALL-BEARING SUN GEARS



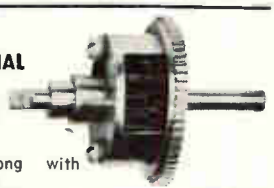
The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 11/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. ¼" lg. 2-13/16" dia. is required to clear the body.
Stock no. A6-115.....each **$15.00**

SIMPLE DIFFERENTIAL WITH SPACED-OUT SUN GEARS



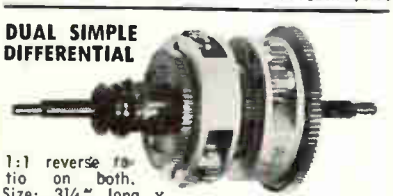
1:1 reverse ratio spur gears are aluminum, 3/32" face, 32 pitch, 32 tooth on one side, 48 tooth on the other. The body is ¾" thick, but the sun gears are spaced out so that they are 1½" apart. ¼" dia. shaft on each side is 23/32" long. OA length 3⅛". Requires 1-23/32" dia. to clear the body.
Stock no. A6-124.....each **$4.50**

SIMPLE DIFFERENTIAL



1:1 reverse ratio, 60 teeth on large gear; ¼" shaft. Size: 3" long with 1-15/16" dia.
Stock no. A6-104.....each **$3.95**

DUAL SIMPLE DIFFERENTIAL



1:1 reverse ratio on both. Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".
Stock no. A6-107.....each **$7.50**

SPERRY VERTICAL GYRO

Part #673073, Motor 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch 85°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±½°. Weight 3½ lbs. Approx. dim. 5¾" L., 4½" W., 4½" H. **Price $35.00**

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64.
Price $22.50

VARIABLE SPEED BALL DISC INTEGRATORS (All Shafts Ball Bearing Supported)

No. 145 Forward & Reverse 2¼-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. ⅜" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x ⅜" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾".....**$17.50**

No. 146 Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long: Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4". **$18.50 ea.**

SMALL DC MOTORS

(approx. size overall 3¾" x 1¼" dia.:)

5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm.	$7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
±5069625 120 rpm, mfr. Delco, 27 VDC governor controlled	$15.00
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
±5069800 575 rpm, mfr. Delco, 27 VDC, PM reversible governor controlled, equipped with 27 VDC clutch	$17.50
5072735 Delco 27 VDC 200 rpm governor controlled.	15.00
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., .7 amp. contains brake	15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp	15.00

400 CYCLE PM GENERATOR

Mfgd. by T K M Electric Corp.
Model =A-12
120/208 volts, 400 cycle, 1 or 3 phase, 1 kva, pf 0.8, rpm 8,000. Approx. dim. 6" x 5½". Internal spline drive. **Price $100.00**

400 CYCLE 1/3 PHASE GENERATOR

115 VAC. 3 KVA. Mfg. Bogue Elect. Mod. 2800S. External excitation 107 VDC. 1.1 amp. 3450 rpm. 1" shaft. **$200.00**

HONEYWELL VERTICAL GYRO MODEL JG7003A-1

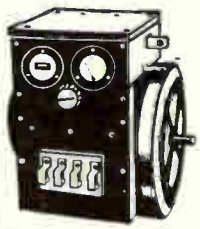
115 volts, 400 cycles, single phase, 35 watts. Pitch and roll potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°.
Weight 5.5 lbs. **Price $35.00 each**

SILICON RECTIFIERS

IN1446	750 amp.	100 volts	.65
IN1447	750 amp.	200 volts	.75
IN1448	750 amp.	300 volts	.85
IN1449	750 amp.	400 volts	1.00
IN05K7	25 amp.	50 volts	2.50
IN1454	25 amp.	100 volts	3.00
IN1455	25 amp.	200 volts	3.50
IN1456	25 amp.	300 volts	4.00
IN1457	25 amp.	400 volts	4.50
IN05M7	35 amp.	50 volts	3.00
IN1458	35 amp.	100 volts	3.50
IN1459	35 amp.	200 volts	4.00
IN1461	35 amp.	400 volts	5.00
IN05P7	50 amp.	50 volts	6.00
IN1462	50 amp.	100 volts	7.00
IN1463	50 amp.	200 volts	8.00
IN1464	50 amp.	300 volts	9.00
IN1465	50 amp.	400 volts	10.00
IN05R7	75 amp.	50 volts	9.00
IN1466	75 amp.	100 volts	10.00
IN1467	75 amp.	200 volts	11.00
IN1468	75 amp.	300 volts	12.50
IN1469	75 amp.	400 volts	14.00
05T7	100 amp.	50 volts	12.50
10T7	100 amp.	100 volts	13.00
20T7	100 amp.	200 volts	14.00
30T7	100 amp.	300 volts	15.00
IN05V7	150 amp.	50 volts	16.50
IN1474	150 amp.	100 volts	17.00
IN1475	150 amp.	200 volts	17.50
IN1476	150 amp.	300 volts	18.00
IN05X7	200 amp.	50 volts	19.00
IN1478	200 amp.	100 volts	19.50
IN1479	200 amp.	200 volts	20.00
IN1480	200 amp.	300 volts	21.00

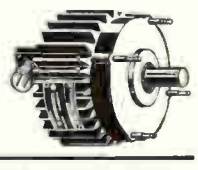
400 CYCLE, 3 PHASE GENERATOR

BY MASTER ELECTRIC



Type AG, frame 364Y, 7.5 kw, 3428 rpm, pf .95 Star connected 120/208 3 phase, 22 amps. Delta connected 120 volt single phase 66 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long; overall dim. of unit: 21"x18"x 20".
Price **$395.00** each

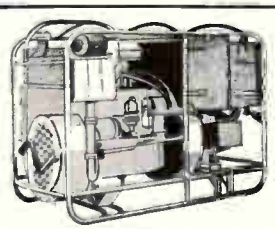
400 CYCLE PM GENERATOR



115/200 volts A.C. 1- or 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4¾" dia.; 3" long; ½" shaft, AN connector. **$75.00**

400 CYCLE MOTOR GENERATOR

Mfgd. by General Electric
Model =5ATB324E5
Output 120/208 volts AC, 400 cycle, 11.75 kva, 32.6 amp., pf .85. Input 220/440 volts AC, 60 cycle, 3 phase, 15 h.p. Unit complete with motor starter and controls. **Price $750.00**



POWER UNIT PU-104/U

5 KW 120/208 volt AC single or 3-phase permanent magnet type 400 cycle alternator. Alternator is driven by Hercules model ZXB 4-cylinder 4-cycle "L" head liquid cooled gasoline engine. This unit is complete with a control panel.
Price $495.00

CIRCLE 460 ON READER SERVICE CARD

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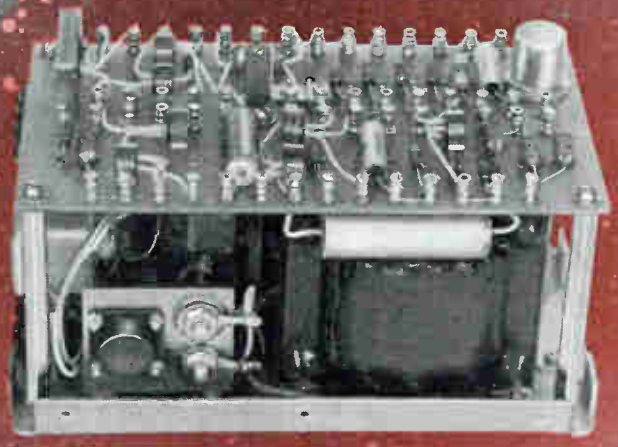
ULTRA-STABLE

Transistorized power supply

62 AR



AC to DC—regulated ±0.1% for 6 months

Characteristics

Input: 115 V AC 60 cps or 400 cps **or**
115/208 V AC 3 phase 60 cps or 400 cps

Output: Available in discrete steps of 0.5 volt from

either a. 12.0 volts DC to 28.0 V DC at 1.0 ampere

or b. 28.0 volts DC to 50.0 V DC at 0.5 ampere

Output is floating and can be used either as a positive or negative supply.

Load Regulation: Output voltage is regulated within ±0.1% from 0.5 to 1.0 ampere.

Line Regulation: Output voltage is regulated within ±0.1% for line variations of ±10% in voltage and frequency.

Temperature: Output voltage is regulated within ±0.1%, under full or minimum load, over the temperature range of —55°C to +85°C.

Ripple: Less than 1 milli-volt RMS or 3 milli-volts peak to peak.

Stability: 0.1% for a period of 6 months under a fixed load and line.

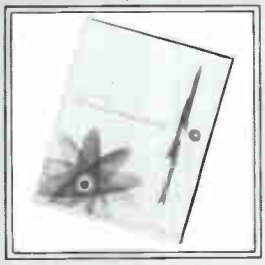
Reliability: Better than .95 for a period of 365 days, at 8 hours a day with a life expectancy of 10 years.

Output Impedance: Less than 20 micro-ohms at DC.

This unit can be supplied as a DC to DC Power Supply.

Applications

- Voltage reference in computers and complex networks.
- Laboratory voltage standard.
- Cascaded to provide higher voltages without degradation of performance.



Read about this unit and many other missile and airborne types in the new Daven Catalog of Transistorized Power Supplies!

THE DAVEN CO. LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN Ⓓ STANDS FOR DEPENDABILITY

AND NOW THE NEW RCA

50FE5

FOR LOW-COST STEREO

Your answer to low-cost stereophonic or monophonic phonographs with high power-output capability is the new RCA-50FE5—the amazing beam power tube with big-league sound. Only 3 tubes—two RCA-50FE5's and one RCA-12AX7 and you have a complete, compact stereo amplifier.

At B+ voltage of only 145 volts, this 3-tube stereo amplifier can deliver up to 4.3 watts of audio output per channel with cathode bias, and up to 5.6 watts per channel with fixed bias. In a monophonic system with the same low B+ voltage and cathode bias, two RCA-50FE5 tubes in a push-pull circuit can deliver up to 8.5 watts of audio power.

So, if it's high power output at low cost you're after, design your stereophonic and monophonic circuits with the RCA-50FE5. There's a 6-volt heater type (RCA-6FE5) available too! Ask your RCA Field Representative for all the facts. For technical data, write RCA Commercial Engineering, Section A-19-De 5, Harrison, N. J.

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