December 29, 1961

electronics

A McGraw-Hill Publication 75 Cents

Photo at right

SONAR FOR FROGMEN

Locates underwater objects, p 37

MICROCIRCUIT 'SLIDE RULE'

Molecular circuit multiplies and divides, p 40

DIGITAL TRACKING

Keeps radar locked on target, p 46

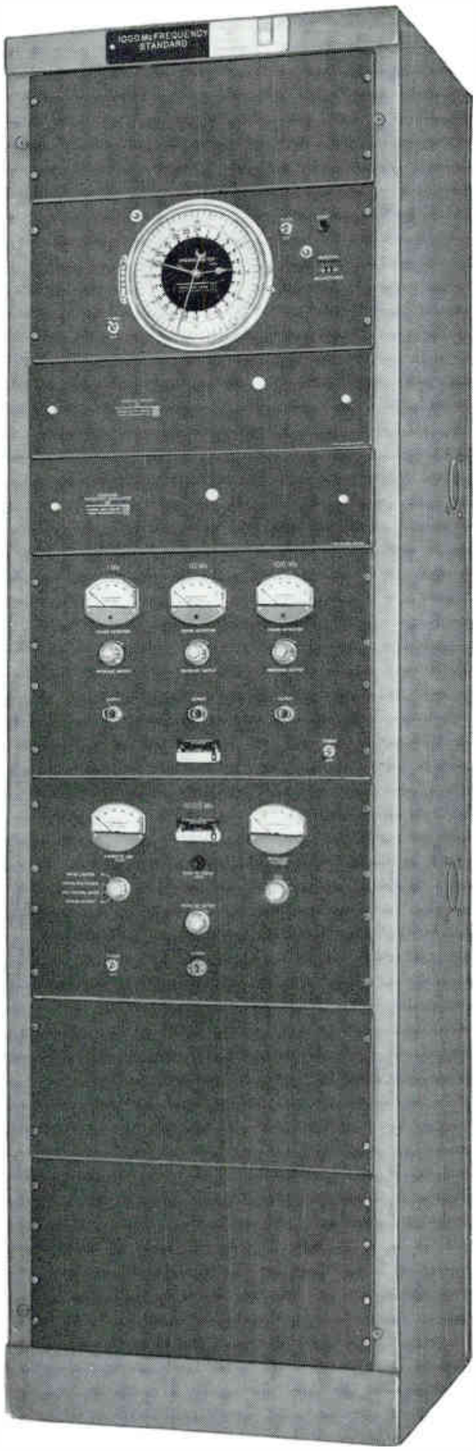
CAMERA PERISCOPE

For cathode-ray-tube photography, p 51

1000-Mc Standard

Short-term and long-term stabilities comparable to the best crystal controlled standards available . . . at less than ⅔ the price!

Outputs from 100c to 1000 Mc at decade intervals, plus 60c, 400c, and 5 Mc . . . more outputs than any other commercial unit provides.



Two big reasons why you get so much for so little money in a G-R Frequency Standard:

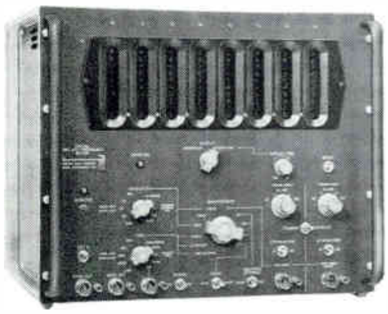
1 *NO* militarization . . . why pay more for *extreme* shock and fungus protection — it doesn't make a standard more stable nor does it contribute to laboratory usefulness.

2 Years of experience . . . this standard's ancestors include the *first* commercially-available crystal-controlled primary frequency standard.

- ★ 5-Mc fifth-overtone crystal and two-stage oven.
- ★ Short-term Stability: 1 part in 10^{10} per min., using 1-sec samples.
- ★ Harmonics for measurements well beyond X-band can be produced.
- ★ Outputs from 100c to 1000 Mc at decade intervals.
- ★ Low Noise: pulse-type dividers give fail-safe operation and minimize phase noise below 5 Mc; phase-locked crystal oscillators provide clean signals above 5 Mc — f-m noise less than 1 part in 10^9.
- ★ Long-term Stability: 5 parts in 10^{10} per day, averaged over 10 days after 60 days operation.
- ★ Syncronometer resolution is better than ±0.2 msec for time comparisons consistent with stability of sky-wave signals from WWV and other stations.
- ★ 10-kc and 100-kc square wave available for triggering purposes.
- ★ Emergency Power Supply available as an accessory.
- ★ Optional Plug-In Units provide 400- and 60-cycle outputs.

Type 1120-AH 1000-MC Frequency Standard . . . $6450 complete

Includes, from top to bottom, 1103-B Syncronometer . . . $900
1113-A Standard Frequency Oscillator . . . $1550
1114-A Frequency Divider . . . $950
1112-A Standard Frequency Multiplier (1,10,100 Mc) . . . $1450
1112-B Standard Frequency Multiplier (1000 Mc) . . . $1360
plus rack and all interconnection provisions.



also available for
automatic frequency measurement
1130-A Digital Time and Frequency Meter "The Counter With A Memory".

Write for information regarding a system for frequency measurements to **one part in 10^{11}.**

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WEST CONCORD, MASSACHUSETTS

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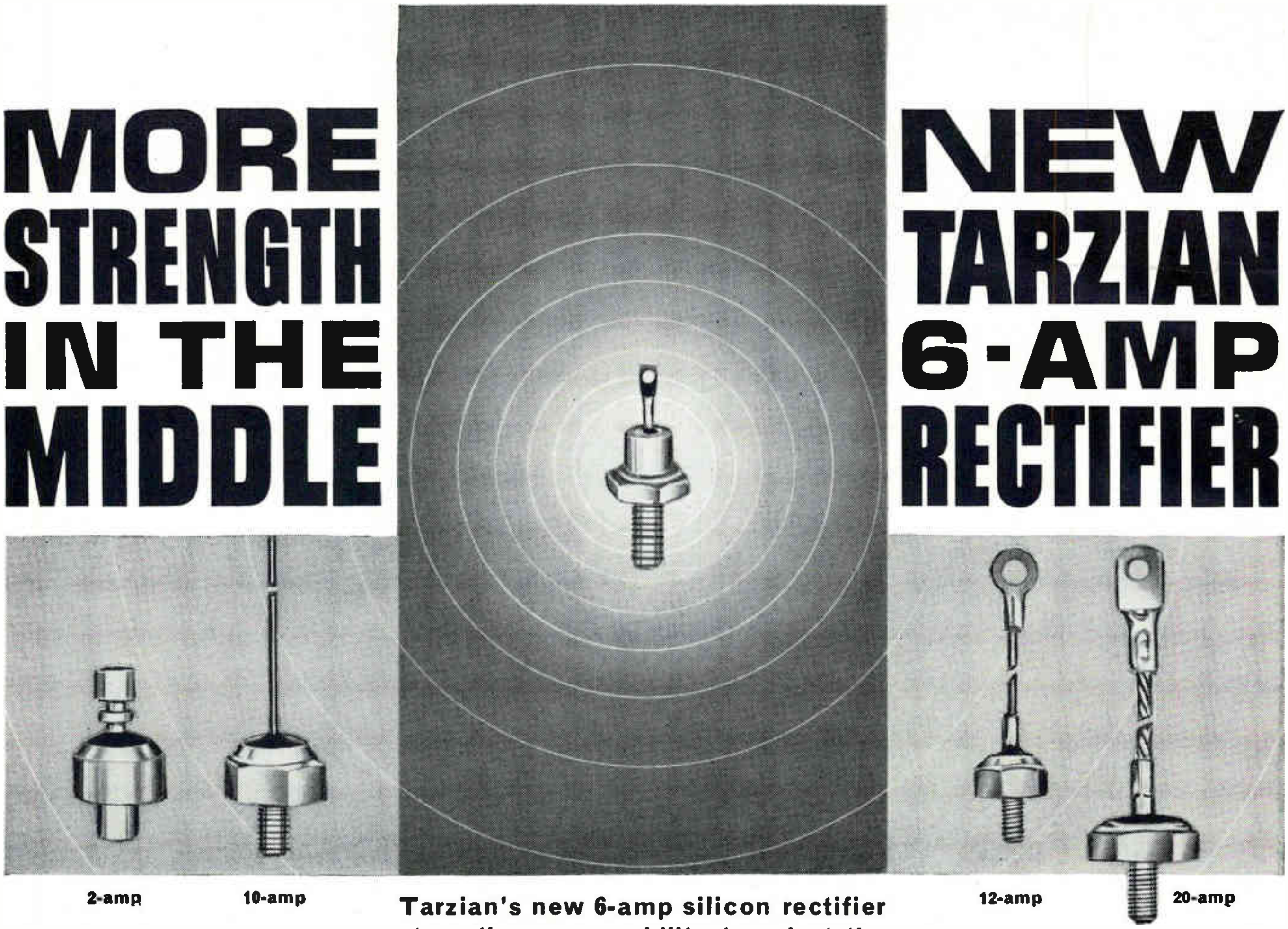
December 29, 1961

electronics

A McGraw-Hill Publication *75 Cents*

MORE STRENGTH IN THE MIDDLE

NEW TARZIAN 6-AMP RECTIFIER



Tarzian's new 6-amp silicon rectifier strengthens your ability to select the right rectifier for every medium current requirement.

The new line-up gives you a wider choice of units—2, 6, 10, 12, and 20-amp —each delivering quality performance at traditional Tarzian prices. Each unit gives you a choice of ratings from 100 to 600 PIV, in increments of 100...from 70 to 420 maximum RMS voltage, in increments of 70.

You'll find additional specifications spelled out in the new Tarzian catalog. Free copies, and free application engineering service, are yours for the asking. Ask!

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

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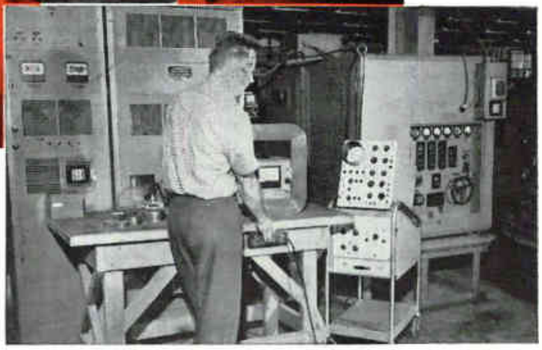
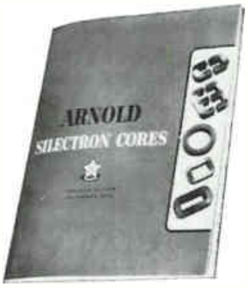


Arnold Pulse Transformer Cores are individually tested under actual pulse conditions

7372D

Here's technical data on

ARNOLD SILECTRON CORES



Bulletin SC-107 A

. . . this newly-reprinted 52-page bulletin contains design information on Arnold Tape Cores wound from Silectron (grain-oriented silicon steel). It includes data on cut C and E cores, and uncut toroids and rectangular shapes. Sizes range from a fraction of an ounce to more than a hundred pounds, in standard tape thicknesses of 1, 2, 4 and 12 mils.

Cores are listed in the order of their power-handling capacity, to permit easier selection to fit your requirements, and curves showing the effect of impregnation on core material properties are included. A valuable addition to your engineering files—*write for your copy today.*

ADDRESS DEPT. E-12

The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

For example, Arnold 1 mil Silectron "C" cores—supplied with a guaranteed minimum pulse permeability of 300—are tested at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gausses. The 2 mil cores, with a guaranteed minimum pulse permeability of 600, receive standard tests at 2 microseconds, 400 pulses per second, at a peak flux density of 10,000 gausses.

The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

This is just another of Arnold's facilities for better service on magnetic materials of all description. ● Let us supply *your* requirements. *The Arnold Engineering Company, Main Office & Plant, Marengo, Ill.*

ARNOLD

SPECIALISTS In MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES

Find them FAST in the YELLOW PAGES

electronics
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CROSSTALK

Shakeup, Not Shakeout

WE'RE WONDERING what happened to the big shakeout in the electronics industry that so-called experts have been predicting for the past couple of years. As this year winds up and the reports come in we still don't see this major holocaust.

We see changes in technology. We see new patterns of sales and distribution. We see new markets opening up. The sight of the nation's cities littered with the corpses of electronics companies, however, is something we don't see . . . nor do we expect to.

Against this bullish attitude, adequately bolstered from within our industry, we do see areas where glamor dazzled reason. This, however, has been on a small scale in terms of the entire industry.

In all likelihood, fingers that were burned would have gotten that way had they been handling electronics, apple pies or costume jewelry.

We cannot, from anything we know, extrapolate a picture of companies falling by the wayside in droves. The declines within the electronics industry derive from changing technology. What some observers-from-without fail to realize is that technological improvement does not create voids. It fills needs. For each category of equipment that declines from the market, a new category or class of categories comes into being.

The manufacturer sensitive to the changing technologies of this industry will change with it and prosper. The inflexible management, seeing no view but the one immediately before it, will bulldog its way to oblivion and not be missed by the industry at large.

The more doomsday predictions we hear about the electronics industry the more we recall Mark Twain's quip following the mistaken appearance of his obituary in a small town newspaper. "The reports of my death have been grossly exaggerated!"

Coming In Our January 5 Issue

SUMMING UP. For several years, our way of editorially greeting the new year has been to take a long-range look at electronics market opportunities. This year, we assigned four men—backed up by our regional editors—to hunt up fresh, authoritative statistics, evaluation and predictions. They used the News System (North, East, West, South), contacting top executives throughout the industry, U. S. and foreign government officials. Finally, they condensed the facts into 32 pages and picked an appropriate title, "Our Growing Markets." Appropriate because they found that wide-awake companies with a talent for research, development and production will find many opportunities for new products and bigger sales in the years ahead.

COMMENT

Proprietary Rights

I want to congratulate you on the excellent editorial on proprietary rights that appeared in the Oct. 27 issue (p 98).

I have personally been faced with this problem on a good many occasions, particularly when I was with Aircraft Radio Corporation. I think one point that I might add, that possibly has not been stressed enough in your editorial or other articles on this subject, although it is usually mentioned, is that a supplier of electronic equipment to the military *must* assume that the military will need drawings and specifications for certain replacement parts in order to catalog them properly. They will also need information for the maintenance and overhaul of the equipment and this means that a certain minimum number of drawings and specifications *must* be supplied, whether the manufacturer wants to or not.

The manufacturer cannot assume that the equipment is to be delivered and then be forgotten about forever. If arrangements can be made with the Contracting Officer to supply specific drawings for the above purposes *only*, I think the manufacturer will have done his duty and the military will have received all the information that they really need for operation and maintenance.

A. W. PARKES, JR.
President
Ballantine Laboratories, Inc.
Boonton, New Jersey

Plasma Engineering

I think your articles [p 47, July 14; p 33, Aug. 4; p 29, Sept. 1] gave a concentrated but comprehensive picture of current plasma physics research. The outlook for industrial plasma research in the U. S. was especially interesting.

In Uppsala, our work on low-inductance capacitors and very fast discharges continues. We will keep you informed about results.

LARS HOGBERG
Fysiska Institutionen
Uppsala, Sweden

Transistor Circuit Design

In the Nov. 3 issue (p 48) there were errors in the article, Computer-Derived Curves Simplify Transistor Circuit Design, by D. McLarin, of Martin.

In the sentence following Eq. 7 (p 49), change $R_1/R_1 = 3$ to $R_1/R_2 = 3$.

Graph F (p 50) should be labeled $R_1/R_2 = 3$, rather than $R_1/R_2 = 1$.

In Eq. 17 (p 51), Z_{in} is stated incorrectly. One term of the numerator is missing, and part of the denominator is placed above Eq. 18 in the next column. Equations 17 and 18 should be as follows:

$$Z_{in} = \frac{h_{ie}R_1R_2\,(1 + j\omega C_2R_3) + R_1R_2R_3\,(1 + \beta_2)}{R_1R_2\,(1 + j\omega C_2R_3) + (R_1 + R_2)\,[R_3\,(1 + \beta_2) + h_{ie}\,(1 + j\omega C_2R_3)]} \quad (17)$$

$$i_{b1} = i_c - \frac{i_cR_{in}}{R_0 + R_{in}} \quad (18)$$

The sentence following Eq. 30 (p 54) should be: Substituting Eq. 17 and $1/\omega C_1$ in Eq. 30, rather than $1/\omega C_0$.

Equations 31 and 32 (p 54) will be in error due to the error in Eq. 17. Equations 31 and 32 should be as follows:

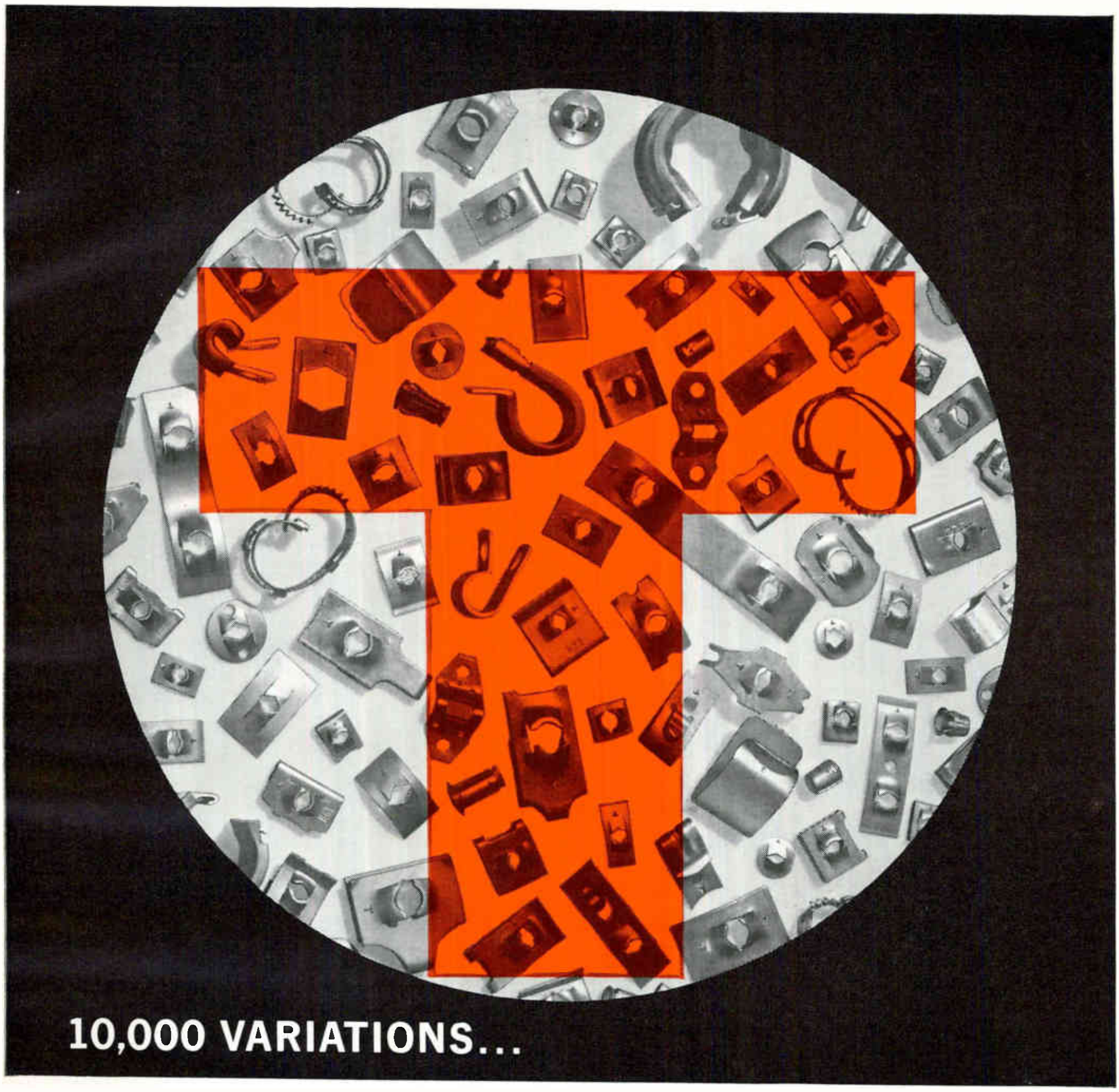
$$\frac{1}{\omega C_1} = \frac{R_1R_2\,[h_{ie} + \omega C_2R_3h_{ie} + R_3\,(1 + \beta_2)]}{R_1R_2\,(1 + \omega C_2R_3) + (R_1 + R_2)\,[R_3\,(1 + \beta_2) + h_{ie}\,(1 + \omega C_2R_3)]} \quad (31)$$

$$C_1 = \frac{R_1R_2\,(1 + \omega C_2R_3) + (R_1 + R_2)\,[R_3\,(1 + \beta_2) + h_{ie}\,(1 + \omega C_2R_3)]}{\omega R_1R_2\,[h_{ie} + \omega C_2R_3h_{ie} + R_3\,(1 + \beta_2)]} \quad (32)$$

Equation 34 (p 54) should be

$$\frac{1}{\omega C_0} = \frac{R_0h_{ie}}{R_0 + h_{ie}}$$

STANLEY C. LOGAN
Information Services
The Martin Company
Orlando, Florida



all stamped with the T-MARK of total reliability

Other spring fasteners may *look* like Tinnerman SPEED NUTS. But only those stamped with the T-mark really *are* SPEED NUTS, made to Tinnerman's high, precise standards of reliability. Tinnerman quality controls are the most stringent in the industry. And only Tinnerman stocks a *half-billion* SPEED NUTS . . . is tooled to turn out 10,000 variations . . . develops 25 *new* designs each week. Protect your product's good name by insisting on genuine SPEED NUTS. Stamped with the Tinnerman "T"—the mark of total reliability. *Tinnerman Products, Inc., Department 12, Box 6688, Cleveland 1, Ohio.*

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TINNERMAN
Speed Nuts®
Look for the Tinnerman "T"

NEW 457A AC TO DC CONVERTER

New 457A AC to DC Converter lets you inexpensively measure ac voltage, 50 cps to 500 KC, with the ease and high resolution of a dc digital voltmeter.

The average-responding 457A permits ac measurements to ±0.3% of reading ±0.001 v to 50 KC and ±0.75% ±0.001 v to 500 KC. This accuracy permits you to read ac voltages on a dc digital voltmeter (such as the 405BR/CR) with three digits resolution.

Waveform errors are minimized by this new converter. The dc output of the 457A is always between 0 and 1 volt for up to full scale input. Full scale is selected manually in decade ranges. Your measurement convenience is further increased with overranging by more than 2 to 1 and an input impedance of 1 megohm.

The 457A Converter can be used with an 560 Series Digital Recorder, plus a digital voltmeter, to provide a permanent printed record. Either the 457A analog or digital voltmeter output data is suitable for other data logging equipment. The digital data may be transferred, for example, to card or tape punches.

New instrument modular packaging permits easy stacking of instruments on the bench and simple conversion to rack mount.

Specifications

Input Range:	0 to 300 v rms, in 4 decade ranges corresponding to 1, 10, 100 and 1,000 v rms full scale.
Frequency Range:	50 cps to 500 KC
Accuracy:	±0.3% of reading ±1 mv, 50 cps to 50 KC; ±0.75% ±1 mv, 50 KC to 500 KC.
Output:	0 to 1.0 v dc, responding to average value of ac input, with output calibrated as rms value of sine wave.
Output Impedance:	10,000 ohms.
Input Impedance:	1 megohm, shunted by 30 pf.
Size:	16¾" wide, 3⅜" high, 13¼" deep. Weight, 12 lbs.
Price:	$350.00

DEPENDABLE AUTOMATIC DIGITAL VOLTMETERS

405BR/CR Digital Voltmeter

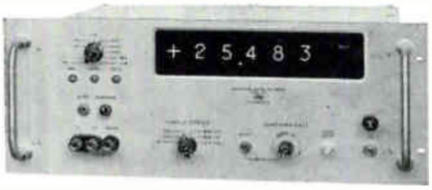
Ideal for use with the 457A AC to DC Converter, the 405BR/CR Digital Voltmeters feature automatic ranging, simple touch-and-read measurement and bright, clear readout. By using the 405 in conjunction with the 457A, you can read ac voltages on the 405 to three digits with an overall accuracy of ±0.4% of reading ±0.001 v to 50 KC, ±0.75% of reading ±0.002 v to 500 KC. The 405BR and CR are identical except that the 405CR includes (a) provision for external sampling command, (b) digital recording outputs, plus (c) reading hold-off capability, (d) print command when overranging, and (e) remote readout outputs.

Specifications

Ranges:	0.001 to 999 v dc, 4 ranges.
Presentation:	3 significant figures, polarity indicator.
Accuracy:	±0.2% of reading ±1 count.
Ranging Time:	0.2 sec to 2 sec.
Input Impedance:	11 megohms to dc, all ranges.
Response Time:	Less than 1 sec.
AC Rejection:	3 db at 0.7 cps; min. 44 db at 60 cps.
Size:	7" high, 19" wide, 13⅞" deep behind panel. Weight, 26 lbs.
Price:	405BR, $850.00; 405CR, $925.00.

FOR EVEN GREATER SYSTEMS FLEXIBILITY, USE DYMEC 2401 INTEGRATING DIGITAL VOLTMETER!

DY-2401 Integrating Digital Voltmeter



Unique flexibility for simple and complex systems applications is yours with the Dymec 2401 Integrating Digital Voltmeter, which effectively eliminates the effects of noise and hum by reading the average value of voltage applied over a definite, selected sample period. Range, sample period and sample rate are externally programmable. Applications are further extended by the nature of the 2401, actually a voltage-to-frequency converter, combined with a 300 KC electronic counter.

Equally versatile in systems application is the Dymec Model 2410 Multi-Converter (not shown), which converts ac volts, resistance and dc volts to a proportional dc voltage with 1 volt nominal full-scale output. $1,975.00.

Specifications

DC Voltage Ranges:	±0.1, 1, 10, 100, 1,000 v nominal full scale.
Overall Accuracy:	0.05% nominal.
Stability:	Greater than 0.01%/day, 1 v range and above.
Input Impedance:	1 megohm on 1 v and higher ranges, 100,000 ohms on 0.1 v range.
Price:	$3,750.00.

Call your Hewlett-Packard/Dymec representative today for further information or for a demonstration on your bench.

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

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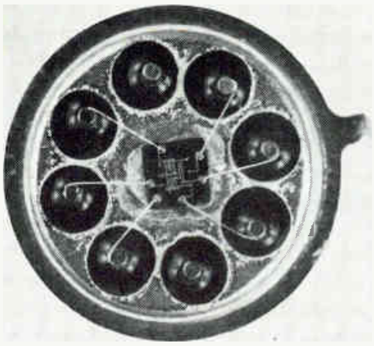
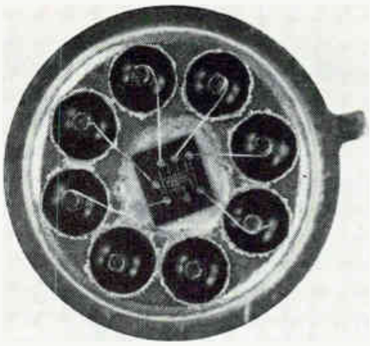
7273

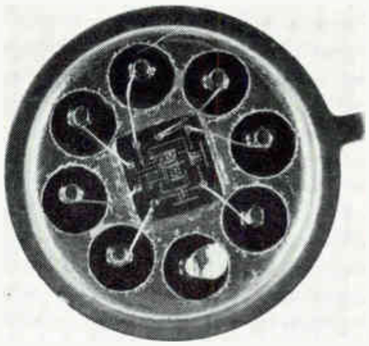
UNRETOUCHED PHOTOGRAPHS MAGNIFIED 4⅔ TIMES



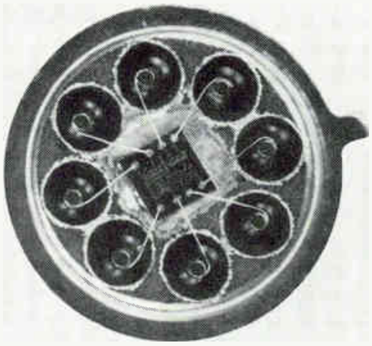
FLIP-FLOP
"F" Element



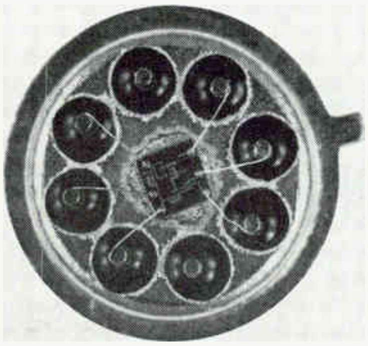
GATE
"G" Element



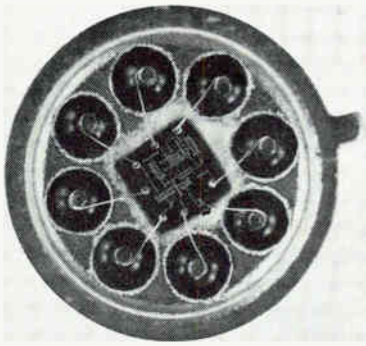
HALF-SHIFT REGISTER
"S" Element



HALF-ADDER
"H" Element



BUFFER
"B" Element



COUNTER ADAPTER
"C" Element

MICROLOGIC ELEMENTS

are a compatible set of integrated digital functional blocks in which transistors and resistors are diffused via the Planar process into a single, monolithic chip of silicon. This family of functional elements is sufficient to efficiently fabricate a computer logic section. No other components are required.

They are designed to operate in a full military environment, over a temperature range of −55 degrees C to +125 degrees C. When integrated into a computer, they will operate at 1 mc clock rates over the above temperature range.

Micrologic elements are designed primarily to permit highly reliable data processing logic at very low cost. They make possible a simplified approach to the job and hence greatly reduce the lead time to the prototype computer.

The cost savings are to computer manufacturers and the computer user. The choice of the elements and the nature of the package, are great factors in the total cost reduction associated with the reliability, maintainability, repairability, logistics, and training.

The size reduction (one order of magnitude) gained with Micrologic is an important by-product of the main objectives of the program.

IMMEDIATE AVAILABILITY

All 6 Micrologic elements are available **now** for immediate volume delivery. Contact your Fairchild Field Sales Office.

90% COST REDUCTIONS IN LOGIC DESIGN & ASSEMBLY

Micrologic elements can cut logic system design and assembly costs up to 90%; space requirements up to 95%; power needs up to 75%. These savings are made possible through simplified layouts, standard handlings of TO-5 type packages, fewer inter-board connections, single clocks, one power supply.

PLANAR RELIABILITY

Fairchild Micrologic elements have been life tested for 1,000,000 element operating hours at 125° C without a single electrical failure. The Fairchild Planar process provides total protection with its integral oxide surface.

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SEMICONDUCTOR

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. · YORKSHIRE 8-8161 · TWX: MN VW CAL 853
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

GENERAL SPECIFICATIONS FOR MICROLOGIC ELEMENTS

Speed	• 50 nsec. delay per stage for all loads (1 mc clock rates over temp. range of −55°C. to +125°C.)
Power	• 15 mW per node
Fan Out	• 5* over temp. range of −55° C. to +125° C.
Voltage	• 3 V ±30%
Package	• 8 lead TO-5 type (.170 height)

*The buffer element has a fan out of 25

μL and μLogic are trademarks of Fairchild Semiconductor, a Division of Fairchild Camera and Instrument Corporation

ELECTRONICS NEWSLETTER

Thermionic Solar Power System Passes Test

FEASIBILITY tests of a full-scale solar thermionic power system indicate such systems have a potentional energy conversion efficiency of 15 to 20 percent, General Electric reported last week. Future system for space applications may produce 10 w/lb.

However, efficiency obtained in the initial test was low: 12.18 w were produced, using 195 sq ft of petal-shaped aluminum honeycomb collectors and 105 vacuum thermionic converters. Average converter temperatures during the test were about 250 C below the optimum of 1,150 C. GE says the converters are capable of 1.5 watts at 2.65 percent efficiency.

More efficient cesium vapor converters have been developed and advanced vapor types could be 25 percent efficient. One purpose of the tests, performed under a $300,000 Air Force contract, is to indicate design improvements.

The system includes switching to apportion output between battery and load during light and dark periods, a regulator to maintain output at 26 to 29 v, a 23-cell nickel-cadmium battery and solar orientation sensors. The latter adjust pedestal through servo controls.

Nuclear Generator Runs Buoy, Weather Stations

SNAP-7A NUCLEAR power generator is being tested by AEC and Coast Guard as a power source for ocean navigation buoys. Similar generators are now being used at automatic weather stations in the Arctic and Antarctic.

The buoy power supply, made by Martin Marietta, consists of strontium-90 pellets whose radioactive decay heat is converted to electricity by 60 thermocouples. Output of 10 w at 5 v d-c is converted to 32 v d-c to trickle charge nickel-cadmium batteries. Life expectancy of the power system is 10 years. Regular buoy batteries must be recharged every year or so.

Also this month, the Navy delivered to its base at McMurdo Sound the Antarctic's first nuclear power plant. Martin prefabricated the 1,500-Kw plant. Instrumentation was supplied by Tracerlab.

First of New Satellite Tracking Stations Built

NASA REPORTS it is testing the key station in its new network to track and receive data from satellites. The $5 million station, near Fairbanks, Alaska, has an 85-foot dish antenna and enough automatic equipment to keep operating crews small.

The program calls for a second station at Rosman, N. C., and others in the Far East, Newfoundland and possibly elsewhere. The stations will record data from orbiting astronomical and geophysical observatories. The first OGO, scheduled for 1963, is to contain 19 experiments.

NASA is building another 85-footer near Fairbanks to receive data from future Nimbus weather satellites.

Ben Franklin—1962

NEXT SUMMER, the bronze-hulled school Azara will be sailing around the Caribbean, trying to get hit by lightning.

Originally outfitted as a generator of artificial atmospherics, the Azara is used for research in vlf propagation and the potential uses of both natural and man-made sferics for navigation and long-range communications (ELECTRONICS, p 53, July 22, 1960).

New program, directed by E. A. Lewis, of Air Force Cambridge Research Lab, will seek to intercept lightning bolts, some of which generate a terawatt of power for about 100 μsec. Bolts will be triggered by shooting wires into clouds with rockets.

FCC May Give Community Tv Grants a Back Seat

WASHINGTON—FCC has tentatively decided that if a proposed community antenna tv service threatens an existing tv station, the tv station will be protected. The commission has directed its staff to write a decision denying a microwave grant to Carter Mountain Transmission Corp., which is seeking permission to provide service to three Wyoming communities. If FCC adopts the decision, it will reportedly be the first time it has denied such a grant to protect a going tv station.

Pistol-Packaged Laser Offered to Researchers

PORTABLE laser was commercially introduced last week by Kollsman Instrument for research and demonstration applications in such fields as optical communications, crystallography and medicine.

The 9-in.-long ruby laser head is packaged like a pistol with double trigger grips. Power supply, operating from battery or line power, is in a case occupying less than a cubic foot. Laser threshold pump power is 90 joules, coherent light output wavelength is 6,943 A and light pulse train duration is 0.2 msec.

Looks Like West Ford Package Is Space Junk

INTENSIVE RADAR search for Project West Ford dipoles has yielded additional returns indicating that the orbiting package has broken up into several pieces. Several small objects in the right orbital plane appear at times close to the calculated schedule.

The returns were picked up by MIT Lincoln Laboratory's Millstone

Hill radar, not the West Ford radar, indicating the binder still hasn't released the dipoles. Chances are the fragments will wind up as space junk.

Neither Lincoln Lab nor Air Force will say if there are plans to try again. Unofficial sources point out that the first launch was made only after presidential approval and that a second try is not likely until it is determined what went wrong.

Airborne Computer Scans Jet Engine Performance

COMPLEXITY of jet aircraft panels is reduced by a digital computer-scanning system announced last week by Bendix. In the Air Force's four-engine test plane, 10 indicators monitor 80 engine performance conditions.

The system automatically calculates which engine is operating at its most critical value for a flight situation. This engine's conditions are displayed on vertical scales with movable indices indicating maximum efficiency values.

If an engine function exceeds a critical value, the crew is alerted to the engine number. The crew can check any engine at any time by using selector switches.

Time Moves Faster, NBS Changes Frequency

IRREGULAR rotational speed of the earth—it's getting faster—has prompted National Bureau of Standards and U. S. Naval Observatory to change the standard frequency and time broadcasts.

At zero hours GMT, Jan. 1 (7 pm EST, Dec. 31), standard frequencies transmitted by NBS stations (ELECTRONICS BUYERS GUIDE, p R47, July 20) will be made higher by two parts per billion.

Time pulses in 1962 will be offset from atomic time to correspond with time based on earth rotation. In 1962, frequencies will be 13 parts per billion lower than the cesium atom clock, whose frequency is 9.192631770 Gc. Changes will also be made by Coast Guard's east coast Loran-C stations.

Microwave Tube Center Is Slated for Midwest

CHICAGO—Hallicrafters and Compagnie Generale de Telegraphie sans Fil (CSF), of France, will set up a firm to produce high-power microwave tubes. The new company will be called Warnecke Electron Tubes, after the director of CSF's tube division. Ground for a 17,000 sq-ft plant will be broken in February at one of three locations now under consideration in the Chicago suburbs.

Robert F. Halligan, Hallicrafters president, said at a meeting of company stockholders last week that it will have complete facilities for microwave tube R&D and production. Hallicrafters, which is investing some $250,000, will have a 42 percent interest, CSF the rest. Maurice Ponte, of CSF, will be chairman of the new firm.

Seattle Schools Plan F-M Emergency System

SEATTLE—School board plans to install an f-m emergency signal radio system in 119 school buildings. The installation, subject to FCC approval, is primarily a civil defense safety measure, but will also give the schools what amounts to a closed-circuit communications system. Additional expense will be $28,800 for receivers plus $60 for each installation.

Four Subcontractors Named for Apollo

NORTH AMERICAN AVIATION last week named four subcontractors for the command module of NASA Apollo spacecraft. Collins Radio will receive more than $40 million for telecommunications; Minneapolis-Honeywell Regulator, $30 million, stabilization and controls; AirResearch, $10 million, environmental control, and Radioplane, $1 million, recovery system.

In Brief . . .

MAGNETIC Recording Industry Association members expect sales gains of 12 to 15 percent in f-m stereo and 20 to 50 percent in tape. Tenney Engineering estimates environmental test and equipment volume in 1961 was $225 million, up $75 million.

SIMULTANEOUS control of as many as 20 satellites will be studied by Planning Research Corp. under Lockheed contract.

BURROUGHS is setting up its own finance corporation to expedite computer sales and leasing.

TRAINING simulator contracts include $2.2 million to Curtiss Wright and $668,000 to Link, from Navy. Link will also build four fighter pilot trainers for Japan, which is getting 200 F104J's.

GROUND DATA handling subsystem of the AN/USD-7 Air Force reconnaissance system will be made by Airborne Instruments Lab under $4 million contract. The $40 million system is being designed and produced by AIL, General Telephone, Sperry Rand, Raytheon and Filtron.

OTHER AIR FORCE awards include $7.5 million to Adler Electronics for long range, transportable communications systems; $2 million to AC Spark Plug for stellar inertial guidance R&D; $1.6 million to CompuDyne for analog-digital engine test stands; $1.8 million to Raytheon for radar countermeasures.

NAVAL equipment contracts include $300,000 to Transonic for sonobuoy transducers; $195,000 to Packard Bell for a digital system; $140,000 to Nytronics for airborne decoders.

ARMY orders include $922,000 to Taffet Electronics for field communications components; $250,000 to Craig Systems for communications shelters; $105,000 to Datex Corp. for an automatic meteorological data acquisition system.

MOTOROLA will build a 500-mile microwave relay for Santa Fe Railway; Philco, a 250-mile net from Voice of America studios in Washington to the 4.8-Mw transmitter at Greenville, N. C.

WASHINGTON OUTLOOK

MINUTEMAN PRODUCTION will be increased as a result of the Pentagon's decision to scrap the mobile version and concentrate on fixed-base deployment. Funds initially earmarked for the mobile system will now be spent on additional underground launching silos. Concern over guidance was a factor in the decision, but the overriding reason was cost. The railcar version costs close to 50 percent more than the fixed-base missile.

NAVY will use its own advanced fire control system in the carrier-based version of the TFX tactical fighter plane which it and Air Force are developing jointly. Navy's fire control system will presumably be optimized for air-to-air operations, as distinguished from the Air Force's emphasis on air-to-ground combat. Navy's Bureau of Weapons plans to award an R&D contract shortly for the new system.

Similarly, Air Force plans to award the prime contract on TFX within the next couple of months. TFX is planned as a successor to the Air Force's Republic F-105 and the Navy's McDonnell F4H. Initial operation is scheduled for about 1966. Meanwhile, the Air Force plans to buy F4H aircraft next year and reduce scheduled production of the older F-105.

UPCOMING CONSOLIDATION of military supply management of electronic parts will cover 450,000 different common-use Pentagon catalog items, including a considerable quantity of electrical components. The items represent a military inventory worth $600 million with annual purchases now averaging $150 million. No decision has been reached on when the consolidation will be made.

CENSUS BUREAU has started issuing its detailed statistics from the 1960 census on the use of appliances, tv and radio sets in U. S. homes. Brief advance summaries have been issued for a number of states. Both advance reports, and the vastly more detailed final reports, have been issued for Utah and Vermont. The rest can be obtained as they are issued, between now and May 1, from the Bureau.

Validity of comparisons between the 1960 and 1950 census figures has been questioned because of changes in reporting methods. For example, in 1950 census takers asked the questions, but last year, those selected for detailed queries filled out the forms themselves. In addition, the definition of "household" was broadened in 1960. In some cases, the number of homes having a particular appliance increased, but the saturation percentage declined.

HARNESSING THE ELECTRON BEAM

WHAT IS E-BEAM EQUIPMENT? WHAT DOES IT DO? CAN IT BE PUT TO WORK FOR YOU ECONOMICALLY?

WHAT IT IS: Alloyd Electronics' electron beam equipment consists of a line of completely self-contained units employing electron bombardment heating, carried out in a vacuum, for evaporating, welding, brazing or zone refining.

MAJOR APPLICATIONS:

Evaporation: Alloyd electron beam equipment can be used to produce high purity thin metallic and non-metallic films by vapor deposition of high temperature materials. Films can be made from the most difficult materials, including beryllium, tantalum, silica, alumina.

Useful thin-film applications: Electronics, where thin films can perform as capacitors, resistors, magnetic memory devices, etc. . . . optics, where thin films with unusual optical properties are being developed . . . and countless other applications.

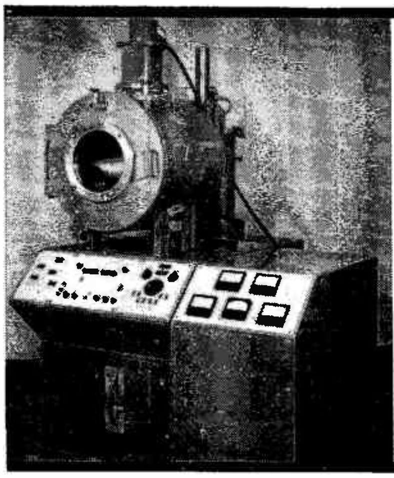
Welding: Alloyd Electron Beam Welders (see below) are designed for experimental or production welding and brazing of refractory and reactive metals. High vacuum is coupled with high power density — makes possible contamination free, narrow heat affected zone welds in titanium, beryllium, tungsten, molybdenum, etc.

MAJOR ADVANTAGES OF ALLOYD EQUIPMENT: 1. Modular design, for flexibility: basic components of any Alloyd system, including electron gun and power supply, vacuum chamber, and vacuum pumping system are available in practically unlimited combinations for maximum flexibility, and can be easily and economically tailored to any application. 2. Voltage is low and safe (30,000 volts max.) eliminating x-ray hazards to the operator. 3. Maintenance is simplified. For example, the electron gun filament in any Alloyd unit can be serviced without removing the gun. 4. Operation is simplified. Fingertip controls, located directly underneath the chamber, make for maximum operating ease and efficiency.

Benefits to be derived from Alloyd's look-ahead modular design are both numerous and substantial, not only in terms of reliability, but in terms of flexibility and cost.

It will be well worth your while to write today for complete information.

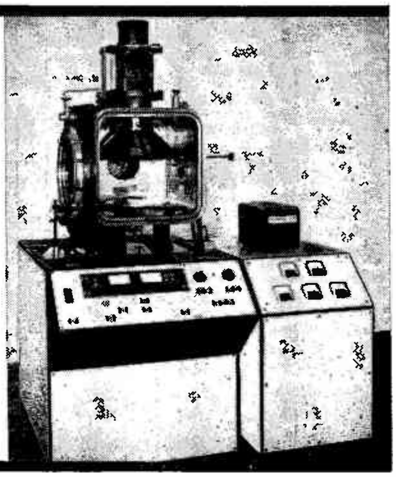
alloyd electronics corporation 35 Cambridge Parkway, Cambridge 42, Massachusetts



Mark VI Electron Beam Welder — for clean, crack-free welds in even the most refractory and reactive metals by electron bombardment. High vacuum eliminates contamination. Ultra-narrow heating zone permits optimum control and precision in handling very thin pieces or welding thin-to-thick sections.

Mark V Electron Beam Evaporator— a reasonably priced, highly flexible unit for producing thin metallic and non-metallic films by vapor deposition through electron bombardment heating. Completely self-contained. An invaluable research and development tool for thin-film applications, including micro-miniaturized electronic circuitry, optical filters, resistors, capacitors, memory devices, countless other components.

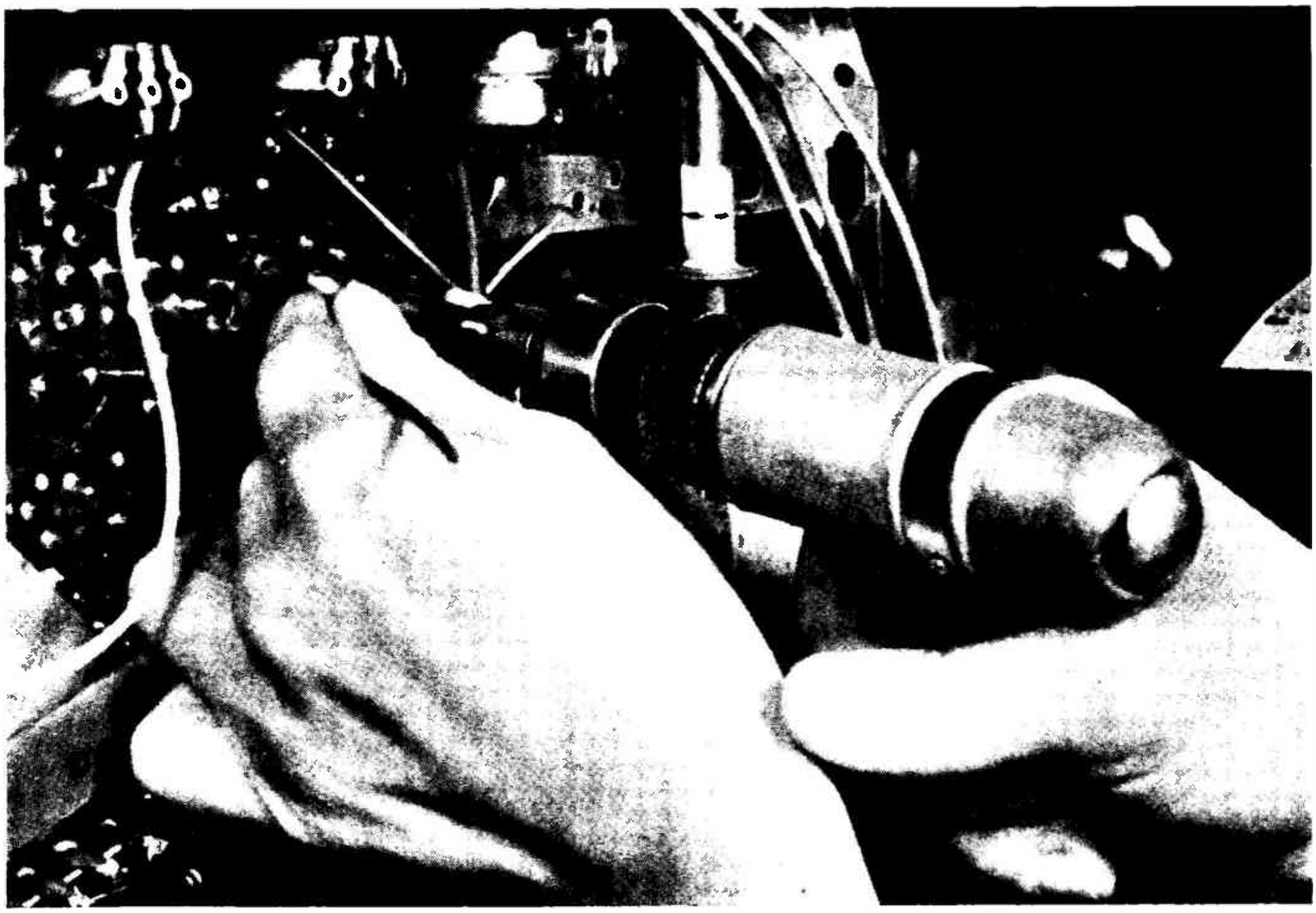
The Electron Beam at your service — Our laboratory is part of an advanced, complete facility for electron beam welding, brazing, evaporating, melting and zone refining maintained by Alloyd to meet custom requirements. We also offer engineering, consulting and R&D services in systems design and development. Ask us for complete information.



CIRCLE 17 ON READER SERVICE CARD

CIRCLE 18 ON READER SERVICE CARD→

Almost all security minded nations depend on



With Wire-Wrap® tools these hands wrap up wiring jobs fast

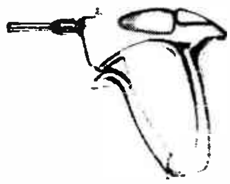
Keep expensive hands working at top efficiency and get permanent, solderless electrical connections in a hurry with Gardner-Denver "Wire-Wrap" tools.

Proved superior by leaders in communications and electronics, solderless wrapped connections are lastingly secure, conquer vibration failure and corrosion. And only Gardner-Denver offers a complete line of equipment for making such connections—including custom-designed, automatic machines to expedite multiple operations.

Air-powered "Wire-Wrap" tool.

Electric-powered "Wire-Wrap" tool.

Manual wrapping and unwrapping tools.



Hand-Squeeze "Wire-Wrap" tool.

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CIRCLE 21 ON READER SERVICE CARD

When should you use Mercury-Wetted Contact Relays?

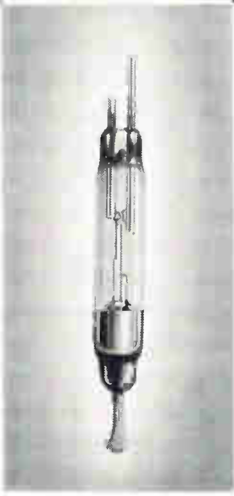
An unusual combination of advantages found only in mercury-wetted relays has led many design engineers to specify them for tough switching jobs. Here are but 3 typical characteristics of our JM series:

RELIABILITY. Sealed-in-glass mercury contacts are renewed with every operation. Won't pit or weld. Make or break is positive . . . every time. No bounce, no chatter. Signals ranging from a few micro amps to 5 amps are switched with singular consistency.

LONG LIFE. Think in terms of *billions* of operations when considering JM series relays. Proper application, of course, is a requisite.

SPEED. Operate time is just less than 3 milliseconds using 2 watts of power. Release time is about 3.2 milliseconds. Thus, relays can be driven 100 times per second.

If your project calls for exceptional relay performance, perhaps the answer lies in our JM Mercury-Wetted contact relay.



JM SERIES ENGINEERING DATA

Contact Rating:
5 amperes maximum
500 volt maximum
250 volt-amp max. with required contact protection.

Contact Configuration:
Each capsule SPDT. Combination of capsules in one enclosure can form DPDT, 3PDT, 4PDT. (All Form D.)

Terminals:
Plug-in or hook solder; 8, 11, 14, or 20-pin headers.

Coil Resistance:
2 to 58,000 ohms.

More information?
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MICRO LOGIC MODULES

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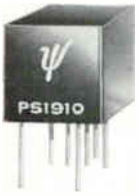

Dual Emitter Follower

Dual Inverter

Flip Flop

"And" Gate

"Or" Gate

all operating at two megacycles

Here is the logical answer to the logic circuit designer seeking micro-size units for the microminiaturization program he needs to put into effect *now!*

Delivery is good . . . prices are surprisingly low . . . performance and reliability are tops! These new 2mc Micro Logic Modules will measure up to your most exacting standards of reliability because PSI Micro-Diodes and Micro-Transistors are used in every unit.

All-welded assembly and epoxy encapsulation assures high resistance to shock and vibration . . . excellent moisture integrity. The Micro Follower, Inverter and Flip Flop are ½" cubes; the gates only 7/16". Terminals are on .1" grid spacing.

For detailed specifications, prices and delivery schedules call any PSI Field Engineering office. See your Yellow Pages.

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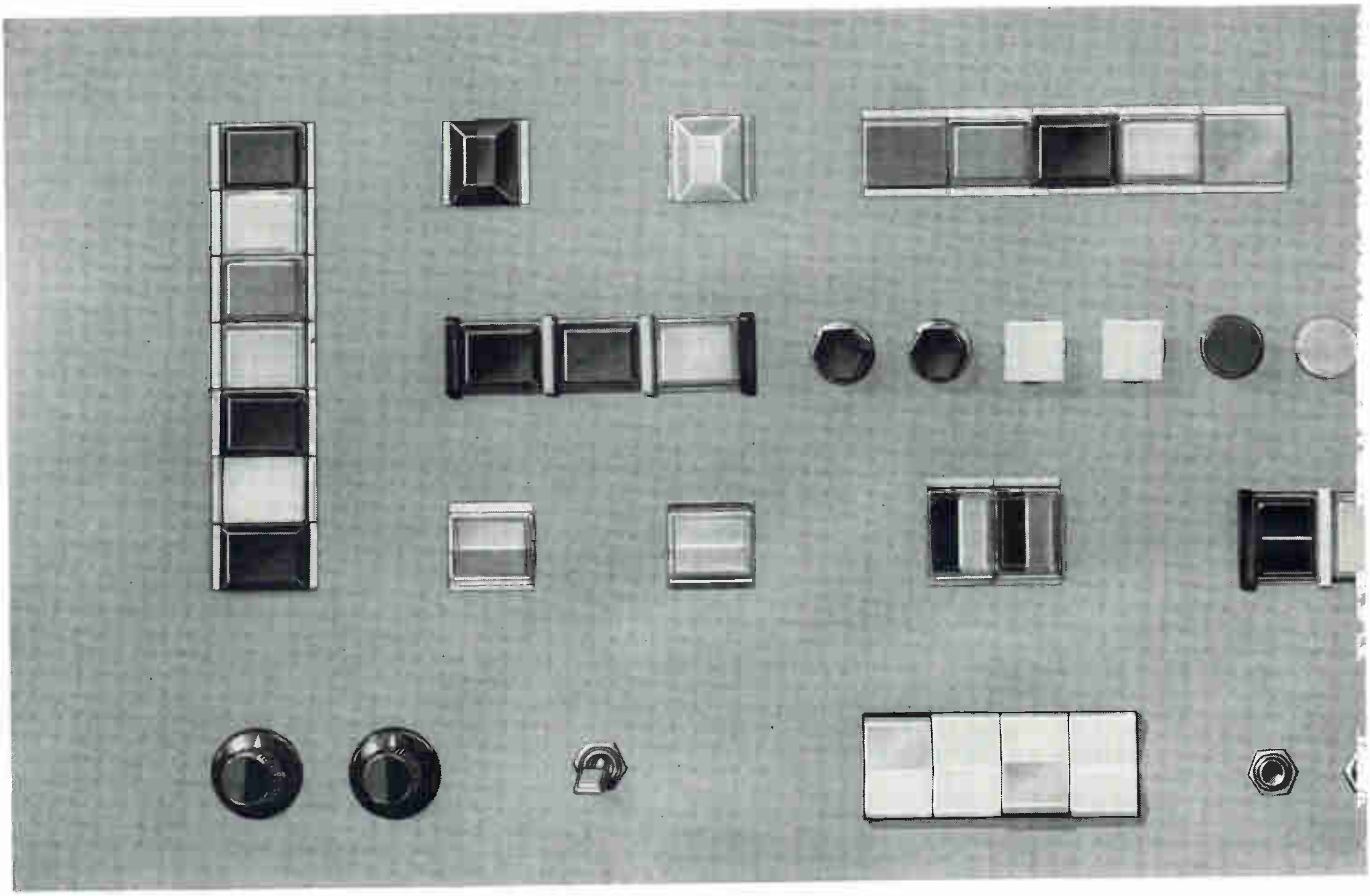
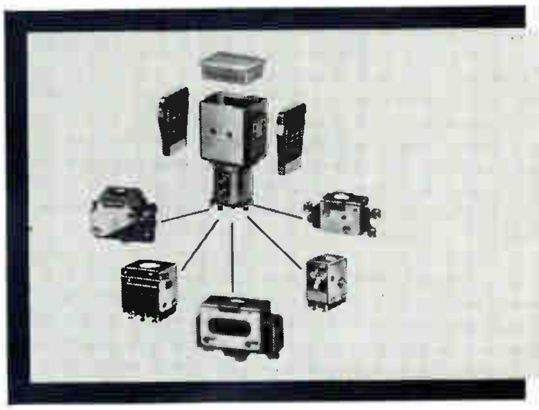


NEW

(Actual Size)

Alternate Action Lighted Pushbutton

In one cubic inch: double-pole double-throw switching; split-color screen (your choice of 15 color combinations); two lamps under screen. Also available in same size: momentary action switch, and indicator unit without switching function. Write for Data Sheet 182.



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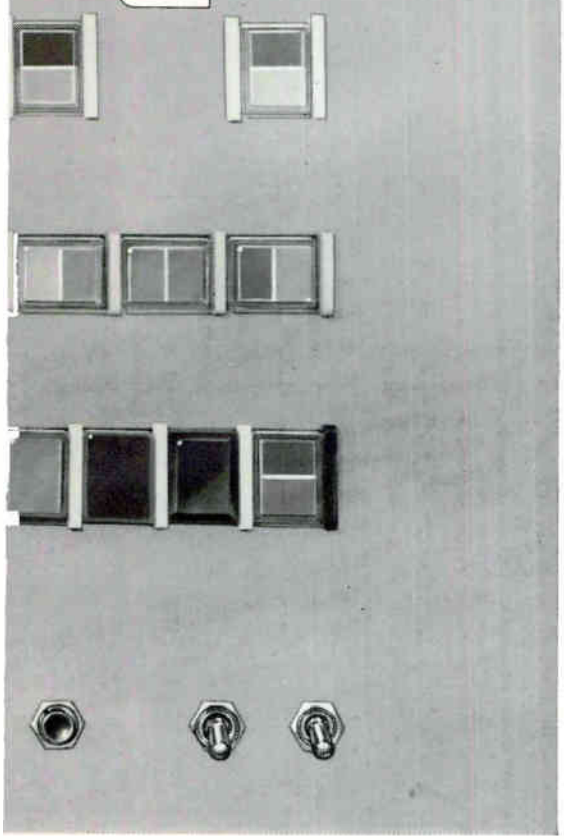


MICRO SWITCH HAS MORE ANSWERS FOR CUSTOMIZING YOUR CONTROL PANELS!

Modular "Series 2" | "50 PB" lighted push-button assembly | Rocker actuator switch | "6 AT" toggle switch | "13 AT" toggle with tab indicator | "17 AS" rotary selector switch | "2 PB" push-button switch assembly

MORE SWITCH DESIGNS, MORE FLEXIBILITY IN THE **MICRO SWITCH** PUSH-BUTTON LINES

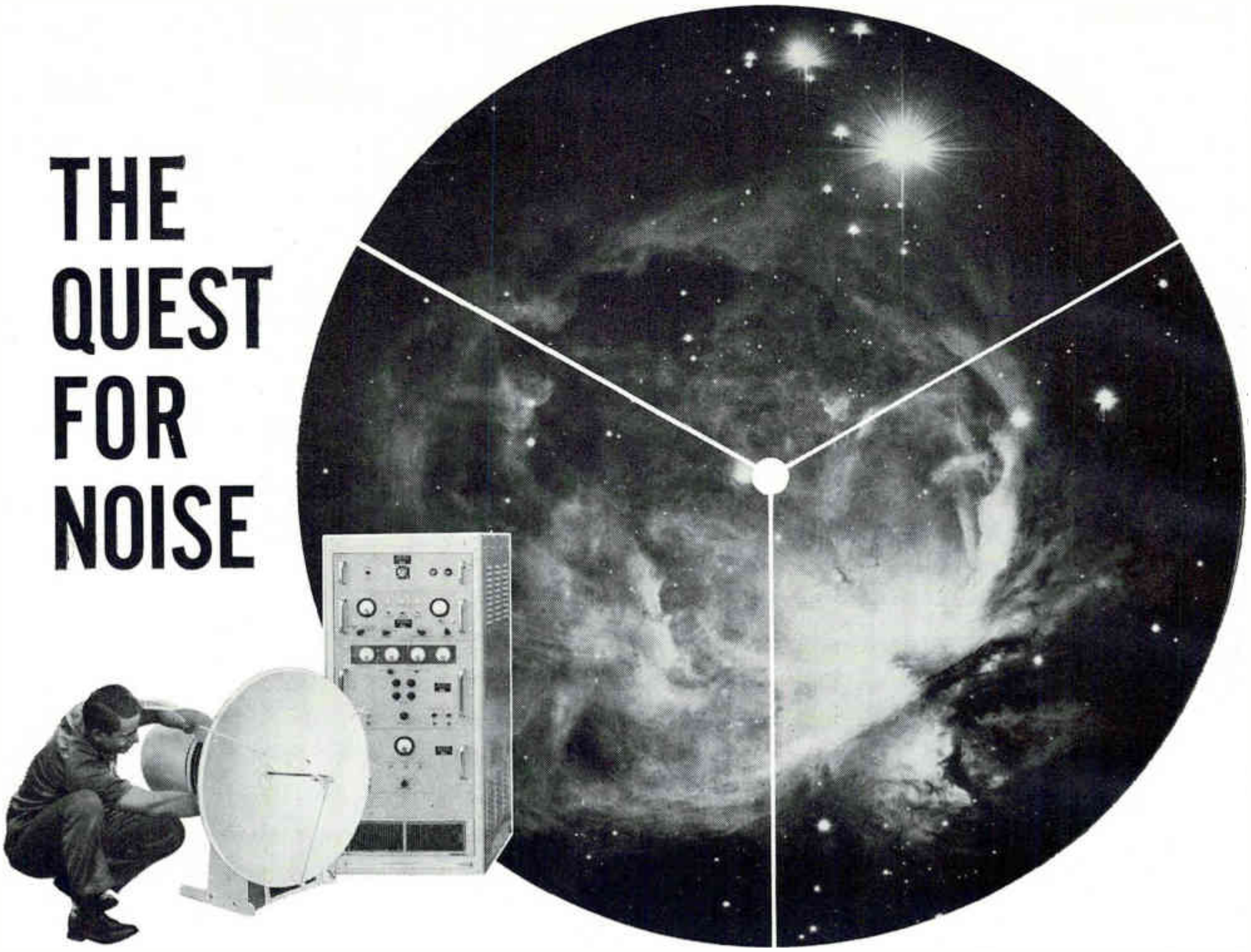
When you want a control panel precisely tailored to your equipment and absolutely reliable, start with MICRO SWITCH. You'll find the wider selection fits your ideas, rather than your ideas having to fit the selection.

New "302 PB" Miniaturized Lighted Push-Button Switches provide infinite lamp life, double-pole double-throw switching and 2-color indication in a unit requiring only one cubic inch of panel space.

Modular "Series 2" Lighted Push-Button Switches offer customized combinations of eight different basic switches and dozens of colored indicators—and they snap together without tools. New truncated display screens add dimensional visibility.

MICRO SWITCH also makes the "Series 50 PB" lighted push-button switches as well as hundreds of different toggle switches and assemblies. Everything you need for customizing control panels. See the Yellow Pages for the nearby MICRO SWITCH Branch Office. Write for illustrated catalogs on push-button and toggle switches for control panels and machine control stations.

THE QUEST FOR NOISE



Parametric Amplifier with regulated power supply developed for use in 700 to 3000 mc range.

TWT Preamplifier with weatherproof case for use in 8 to 12 Gc range.

MICROWAVE RADIOMETER

The measurement of this noise radiated by all objects according to their temperature and surface characteristics makes possible:

- Detection of distant invisible radio stars
- Location of icebergs through clouds from high flying aircraft
- Mapping of the surface of the sun
- All-weather celestial navigation
- Detection of objects under the ground or snow
- Mapping of the earth's surface from moving aircraft

MELABS has been a pioneering leader in this relatively new field. Its activities have ranged from theoretical studies to development and manufacture of a wide range of radiometer systems and components.

SYSTEMS: RMR-1 35 Gc Radiometer System (illustrated to the left above) features 0.5°K sensitivity and 0.8° antenna resolution. Uses 1 kc ferrite reference switch. Reference is adjustable from 77°K to 15,000°K.

TWT Radiometers at 1400 and 3000 mc feature low noise TWT broadband amplifiers.

Solar Spectroheliograph—3000 mc radiometer for mapping sun's surface.

COMPONENTS: Parametric Preamplifiers—available from 700 mc to 6000 mc with broad bandwidths (20% or greater).

Ferrite SPDT Switches—electronically switched at 100-1000 cps for switching between antennas and reference loads. Available from 1 to 35 Gc.

Ferrite Circulators and Isolators with ultra-low loss, (0.1 db typical) for radiometer front ends.

TWT Preamplifiers—for broadband radiometers with noise figures of 5-10 db. Mounts on antenna.

Masers—broadband traveling wave types for the ultimate in system sensitivity.

Melabs invites your inquiries on Radiometer Systems and Components.

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DEPT. B-7

Iterative Techniques Widen Applications of

Small analog and digital computers at Eastern Joint Computer Conference point up data processing trends. Input-output systems gain in speed

By WILLIAM E. BUSHOR,
Senior Associate Editor

WASHINGTON—Iterative techniques —opening the door to application of analog systems in statistical work—was one of the important trends evident on the exhibit floor at the Eastern Joint Computer Conference. While big computers were prominently showcased, it was the smaller computers—both analog and digital—which set the pace.

Shown was GPS Instruments' iterative analog computer for simulating missile flight paths. High-speed predictions of impact point location can be determined from given missile data.

The computer, operating in a fast, repetitive mode, accepts flight data as its initial conditions. It computes the flight paths, evaluates how far the missile will miss the target and makes incremental changes in flight path parameters to minimize miss distance.

The new parameter values are fed back to the missile control system to correct the trajectory. New flight data is then used for another iterative solution series. In the photo, an engineer varies the controls to simulate changing flight data. Effect on missile trajectory prediction is displayed by the cro and an x-y plotter.

The system gives 50 solutions a second. Because a time scale compression of 3,000 to 1 is used, wideband components such as a d-c to 1-Mc operational amplifier and d-c to 40-Kc multiplier are needed.

GPS expects this approach can also be used to simulate sampled data systems and transport delays, and to evaluate double integrations using multiple time scale integrators.

Another new analog computer is Electronic Associates' solid-state Pace TR-48. This desk-size unit has enough capacity for complex research and engineering problems, particularly in the aerospace and process sciences, but does not need an air conditioned environment or special power supply. It can be placed on a cart and wheeled around labs or engineering areas.

While parts of the computer are operating at high repetitive speeds, the remaining circuits can work on other problem variables at slower repetitive rates or real time. Thus, it can handle certain classes of design problems—such as multidimensional flow and heat transfer—ordinarily solved on larger computers, EIA says.

Among other small computers were Comcor's analog system, Harvey-Wells Electronics' general-purpose digital system and Control Data's 160-A. The latter, a desk-sized digital computer, exchanges data with input-output devices at any rate up to 70,000 words a second. It buffers data while computing or while the operator manually enters data.

Continuing problems of developing peripheral equipment able to match computer speeds aroused the usual interest in input-output devices. This year, the emphasis centered on recording equipment.

For example, General Dynamics/Electronics' S-C 4020 can operate on-line at most computer speeds or can work off-line from magnetic tape. It records characters at 21,000 a second and plots graphs at 12,500 points a second. Complex multiview engineering drawings, schematics, numerical tool paths or diagrams like the Pert network illustrated (ELECTRONICS, p 30, Nov. 17) can be made in a half second. Curves, tables, alphanumeric printing or a combination of these, derived from digitally-coded data, are displayed on a shaped beam tube. The image is split optically to fall on the lenses of microfilm and photorecording cameras, producing both films for storage and hard copy on paper.

A special projector allows conventional formats to be combined with the image, making preprinted forms unnecessary. An axis generator draws horizontal and vertical graph axes starting at any point in the display area. A vector generator draws straight lines between any two points.

Omnitronics' Omni-Data ETR-7 gets around mechanical tape punching by electrostatically producing black spots on tape in the same code configurations used on punched tape. The company says this meth-

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EJCC SIDELIGHTS

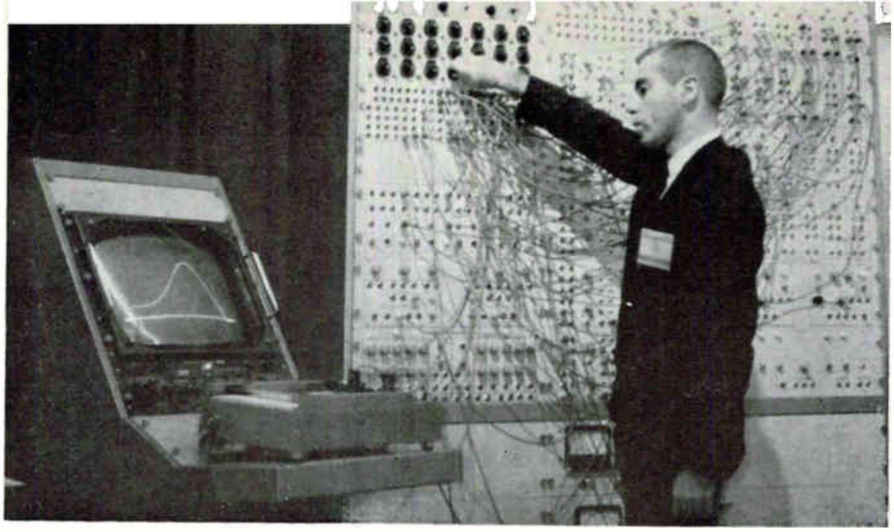
Change was the byword for this, the 19th Joint Computer Conference. It had a new sponsor, the American Federation of Information Processing Societies. IFIPS does not plan to continue the regional format next year.

Attendance, more than 4,000 conferees and over 90 exhibits, was the largest yet. There were 29 papers —selected from a total of 242 manuscripts after 961 reviews—and 27 movies presented.

The theme was "Computers: Key to Total Systems Control." The keynote speaker was D. L. Bibby, president of Remington Rand. He urged that the ratio of time spent in hardware development as against improving computer utilization, now about 1,000:1, be changed.

Computers, he feels, are not exploited sufficiently for maximum benefit to national defense, business, manufacturing techniques, medicine, sciences and education.

Analog Systems



GPS analog system plots changing missile trajectory

od is reliable, long-lived and can be used with high-speed digital computers.

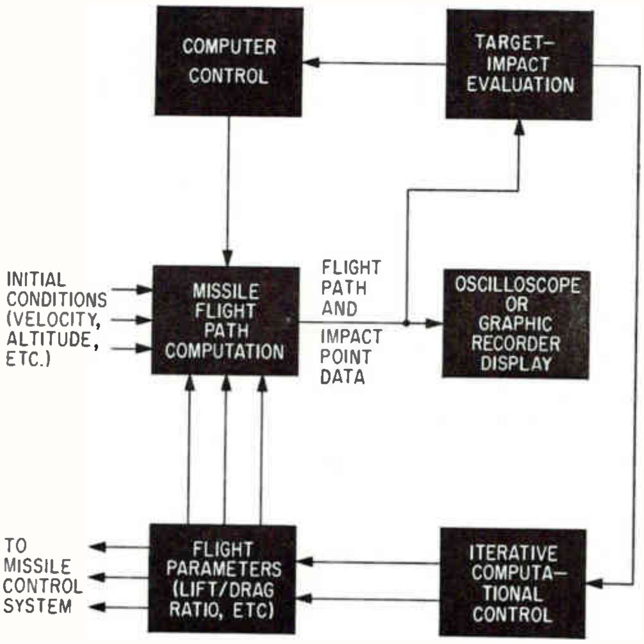
Demonstrated with Omnitronics' photoelectric tape reader, the system recorded 400 characters a second. Higher speeds and greater packing densities are possible, it was reported.

Ampex introduced a random-access ferrite core memory which operates at 1.5 μsec for each complete operating cycle (667 Kc). Each module of 32 planes can store 2,048 56-bit words. The module uses a linear (word select) drive system and operates in the read-restore, clear-write and split read-and-write modes.

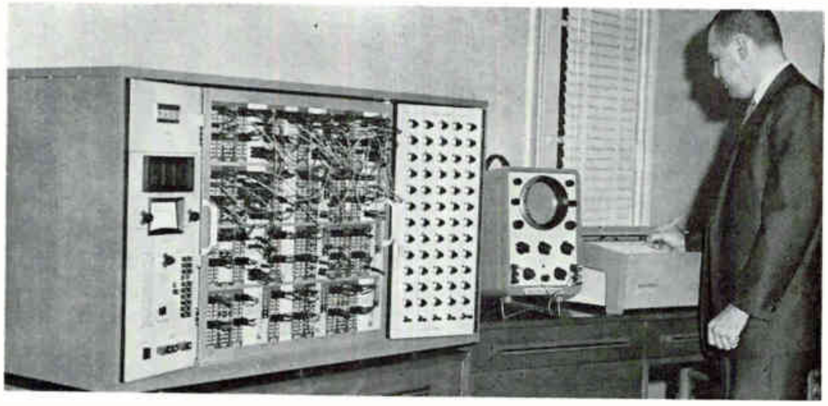
Basic unit of the TM-4 tape memory is a plastic strip with 30-mil-thick ferrite cores mounted along the edge. A read and write drive line traverses all cores associated with one word. Planes contain 35 strips. Sense-digit lines are threaded through each core in a plane associated with a specific digital position in a word.

For preventive maintenance of tape, General Kinetics showed a cleaner which removes loose oxide, tape base chips and dirt without affecting stored data. It uses high-energy sonic and ultrasonic cavitation in a detergent solution directed at tape edges and surface.

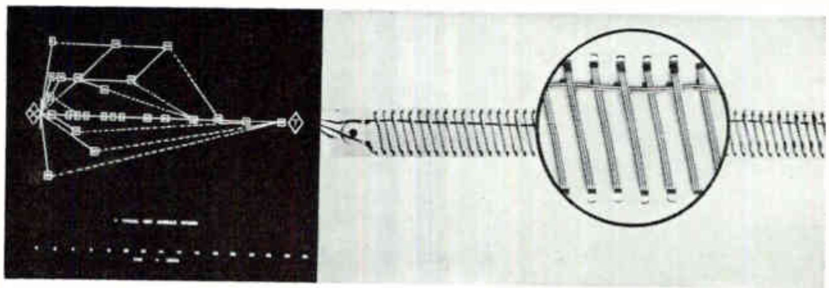
Other systems, previously announced but exhibited for the first time, included Digitronics' system for transmitting tape or card input information over phone lines to a central computer at 1,500 wpm. National Cash Register operated their memory which uses cards carrying seven magnetic tracks. The memory has 16 cartridges, each containing 256 cards, each of which can store 21,700 characters. Any card can be selected in 170 msec.



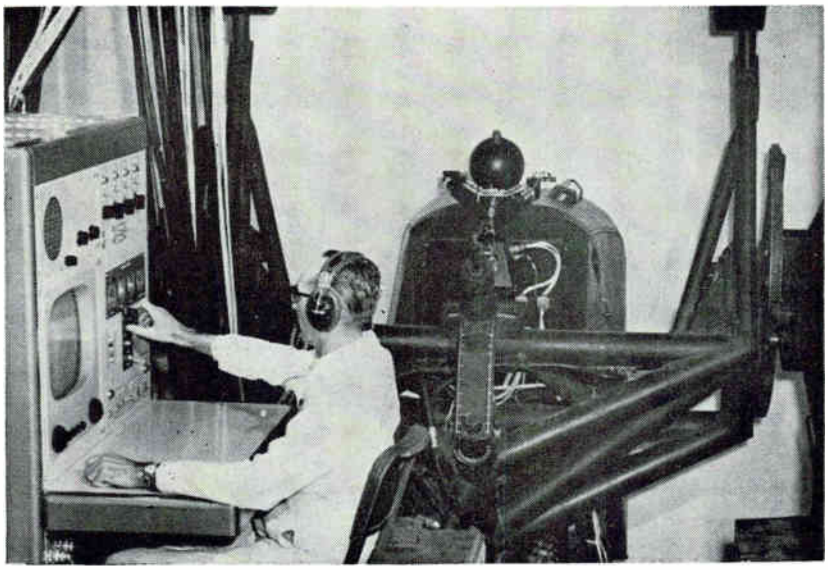
System uses automatic iterations for logic control

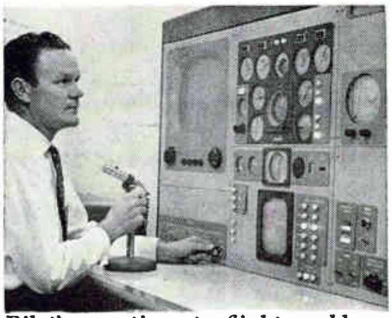


Operator of EAI computer can use oscilloscope for readout of repetitive operation



Pert network is formed on image tube of GD/E recorder (left). Basic unit of Ampex memory is string of cores on plastic strip





Pilot's reactions to flight problems are shown on control console

Safety engineer sits at monitor console as gondola moves inside ball-shaped plastic "universe"

Gondola Makes Dry Runs in Space

DALLAS—Space flight simulator controlled by an analog-digital computer system is being used by Ling-Temco-Vought to duplicate realistically flights in manned orbiting, lunar and interplanetary vehicles.

All phases of a mission, including launch, orbit, rendezvous, mid-course guidance, reentry and landing, can be performed. To heighten realism, a tv system shows the pilot the type of space scenes he would see through a periscope. The pilot is also watched, on a tv monitor.

The pilot sits in a single-place gondola with a complete set of working controls and instruments. Movement of the gondola, instrument operation and a star field are controlled by the computers as the pilot is subjected to flight situations. The company plans to add noise and other factors contributing to pilot sensations and instrumentation to measure his physical reaction to flight stresses.

A general purpose analog computer with added analog-digital conversion and digital computation capabilities is used. The system includes 800 operational amplifiers and potentiometers, 11 multipliers, 47 multiplying servos, 31 function generators, 13 six-channel recorders and six course plotters. All the cockpit instruments are repeated on the control panel.

The flight simulator is part of a simulator center under development. An automatic controls evaluation simulator is also in operation and an environment simulator for testing satellites, vehicles and systems will be added soon.

The company recently installed a nuclear facility with a 3-Mev Van de Graaf accelerator and a plasma arc machine. It is being used to investigate radiation effects on materials and equipment, to design plasma engines, to study the nuclear-powered missile, Slam, and for other development work.

Engineer Supply Drops Sharply

SHORTAGE of engineering graduates during the next several years is predicted by the Engineering Manpower Commission of Engineers Joint Council, New York. The shortage will come at a time when demand is rising sharply, EMC said, indicating a "crisis" may be near.

A survey of 186 colleges showed that freshmen engineering enrollments have dropped two to three percent this year, continuing the trend for the fourth year. Only the East South Central, Mountain and Pacific states showed an increase. Middle Atlantic enrollments dropped the most, 6.6 percent.

Engineering students represented 10.8 percent of all freshmen in 1957. This year, they are less than seven percent. In 1950 there were 52,700 graduating engineers; in 1960, 37,800. Present enrollment will yield about 32,000 in 1965.

EMC points out that this will not supply half the average annual demand forecast by the National Science Foundation: 81,000 engineers a year during 1961-70.

Some of the drop may be reflected in increased science enrollments. Among 46 schools that supplied information on both types of enrollments, science enrollments rose 24.4 percent, but engineering enrollments also rose 2.5 percent in these schools.

Computer Runs Parking Garage

NEW YORK—A fully automatic elevator garage opened here this month. One attendant-cashier sitting at a console selects a parking stall for a customer and collects the fee. The rest of the operation—

from parking and retrieving the car to computing the fee—is handled by a small computer and other controls.

Developed by Speed Park, Inc., and Otis Elevator Co., the garage on West 43rd St. has two elevator towers, each servicing two parallel sections nine stalls long and eight stalls high. Some 27 cars can be parked in 10 minutes.

The motorist drives his car onto one of two parking stations and leaves it. A barrier is raised around the car. The attendant selects a key numbered and cut to designate the stall. The key is inserted in a keyhole. Photoelectric cells sense the stall location from the key shape. The key is given the motorist as his claim check, along with a printed record of stall number and time.

The car is lifted in the station on parallel ribs. Steel fingers on an elevator draw the car into the elevator. The elevator delivers the car to the stall. The operation is reversed when the motorist returns with the key. The parking fee is displayed on a screen and time and fee are printed on a receipt.

The parking computer is based on standard digital logic modules made by Digitronics Corp. It has a magnetic memory of some 8,100 cores, 30 for each stall. They store information on whether a stall is occupied, parking time and date.

Key inserted in control board selects parking stall

Car is lifted from parking station by fingers of elevator

Members of the Project Oscar Association with their satellite

Hams Orbit Their Own Satellite

AMATEUR RADIO operators officially got into the space business shortly before noon on Dec. 12 when Oscar (Orbiting Satellite Carrying Amateur Radio), a ten-pound transmitter, piggy-backed into space from Vandenberg Air Force Base on Discoverer 36.

Oscar separated shortly afterwards to establish its own orbit. Initial radio pick-up was made by KC4USB, Marie Byrdland, at 1:08 PST as the satellite made its first pass over the South Pole.

Continuing around the world, the orbit's second fix was established at Kodiak, Alaska by KL7EDM at 2:08 PST. Subsequently, it was heard in the Hawaiian Islands and again at the South Pole, establishing that it was in its expected orbit.

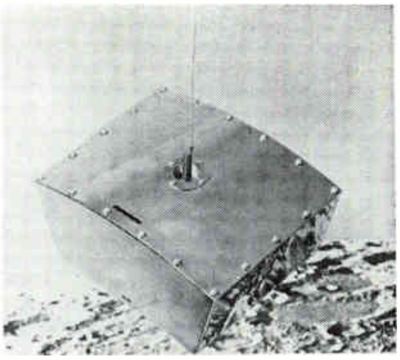
Project Oscar, conceived and executed by a group of radio amateurs in the San Francisco Bay area, ultimately aims at providing the world's hams with an international satellite communications system to back up conventional communications in time of emergency. First satellite of the program is merely a transmitter which beams out the word HI at approximately 10 times a minute. The group hopes to build relay capabilities in future satellites.

Oscar operates on a band of two meters at a frequency of 145 Mc, and puts out a 100 milliwatt beacon signal. Expected life was three weeks to one month. Hams with sensitive receivers and high gain antennas should be able to pick up the signal as far away as one thousand miles. The American Radio Relay League estimates that many of the world's 300,000 radio amateurs are participating in tracking.

The satellite uses transistor oscillator, power amplifiers and keyer. The rate at which it sends its signal is governed by a thermistor. Outside measurements of the satellite are one ft square by six in. deep. The mechanism which ejected the satellite from its parent satellite automatically turned on the transmitter and erected the antenna.

Project Oscar was originated in 1959 by Donald Stoner, Alta Loma, Calif. He was joined in the effort by several engineers from various California space and missile companies. Director of field operations for the project is Fred Hicks. Both are employed by Lockheed Missile and Space Division in Sunnyvale, Calif.

All work on Oscar has been performed by the group during off-duty hours and funds for the effort have been privately raised.



Satellite is a foot square and a half-foot deep

MEETINGS AHEAD

RELIABILITY AND QUALITY CONTROL Symposium, PGRQC of IRE, AIEE, ASQC, EIA; Statler Hilton Hotel, Washington, D.C., Jan. 9-11, 1962.

OPTICAL CHARACTER RECOGNITION Symposium, Nat. Bur. Stds.; Dept. of Int. Aud., Wash., D.C., Jan. 15-17, 1962.

ELECTRICAL ENGINEERING Exposition for electrical-electronics industry, AIEE; N.Y. Coliseum, N.Y.C., Jan. 29-Feb. 2, 1962.

REDUNDANCY TECHNIQUES FOR COMPUTING SYSTEMS, Office of Naval Research; Dept. of Interior Aud., Washington, D.C., Feb. 6-7, 1962.

MILITARY ELECTRONICS Convention PGMIL of IRE; Ambassador Hotel, Los Angeles, Feb. 7-9, 1962.

SOLID STATE CIRCUITS, Internat. Conf., PGCT of IRE, AIEE; Sheraton Hotel and U. of Penn., Philadelphia, Pa., Feb. 14-16, 1962.

APPLICATION OF SWITCHING THEORY TO SPACE TECHNOLOGY Symp., USAF, Lockheed Missiles & Space; at Lockheed, Sunnyvale, Calif., Feb. 27-Mar. 1, 1962.

SCINTILLATION AND SEMICONDUCTOR Counter Symp, PGNS of IRE, AIEE, AEC, NBS; Shoreham Hotel, Washington, D.C., Mar. 1-3, 1962.

MISSILES & ROCKET TESTING Symposium, Armed Forces Communications & Electronics Association; Coca Beach, Fla., Mar. 6-8, 1962.

EXTRA-HIGH VOLTAGE COMMUNICATION, CONTROL & RELAYING, AIEE; Baker Hotel, Dallas, Tex., Mar. 14-16.

IRE INTERNATIONAL CONVENTION, Coliseum & Waldorf Astoria Hotel, New York City, Mar. 26-29, 1962.

QUALITY CONTROL Clinic, Rochester Soc. for Q.C.; Univ. of Rochester, Rochester, N.Y., Mar. 27, 1962.

ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, AIEE, IAS, IRE, U. of Rochester; U. of Rochester, Rochester, N.Y., Mar. 28-29, 1962.

SOUTHWEST IRE CONFERENCE AND SHOW; Rice Hotel, Houston, Texas, April 11-13, 1962.

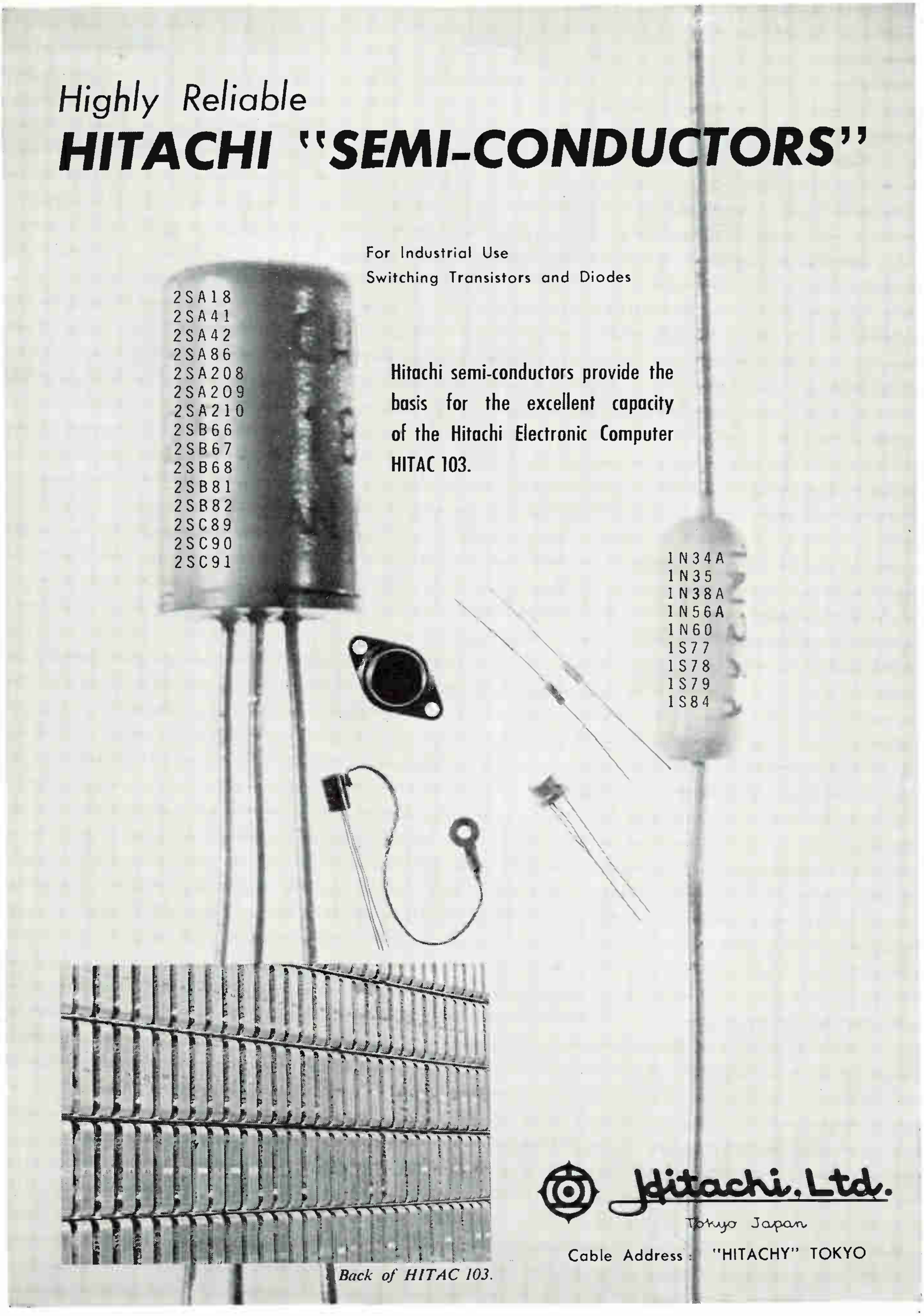
JOINT COMPUTER CONFERENCE, PGEC of IRE, AIEE, ACM; Fairmont Hotel, San Francisco, Calif., May 1-3, 1962.

HUMAN FACTORS in Electronics, PGHFE of IRE; Los Angeles, Calif., May 3-4, 1962.

ELECTRONICS COMPONENTS CONFERENCE, PGCP OF IRE, AIEE, EIA; Marriott Twin Bridges Hotel, Washington, D.C., May 8-10, 1962.

NATIONAL AEROSPACE Electronics Conference, PGANE of IRE; Biltmore Hotel, Dayton, Ohio, May 14-16, 1962.

MICROWAVE Theory & Techniques National Symposium, PGMTT of IRE; Boulder, Colo., May 22-24, 1962.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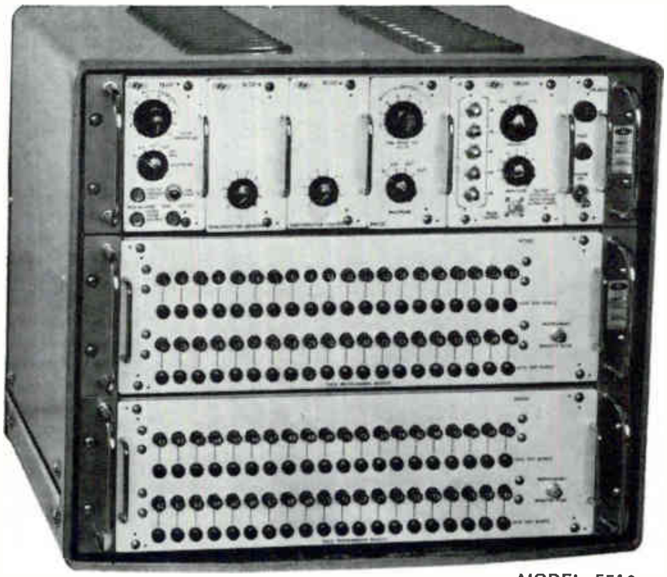
PULSE POINTERS

SERVO modular serial word generators offer broad test flexibility for digital circuitry and logic design



MODEL 5510

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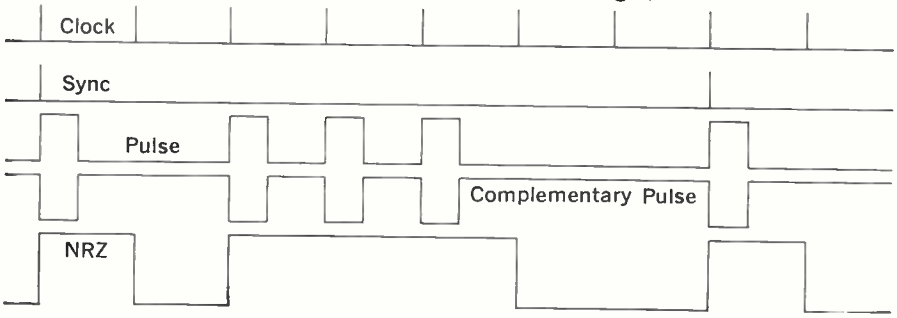

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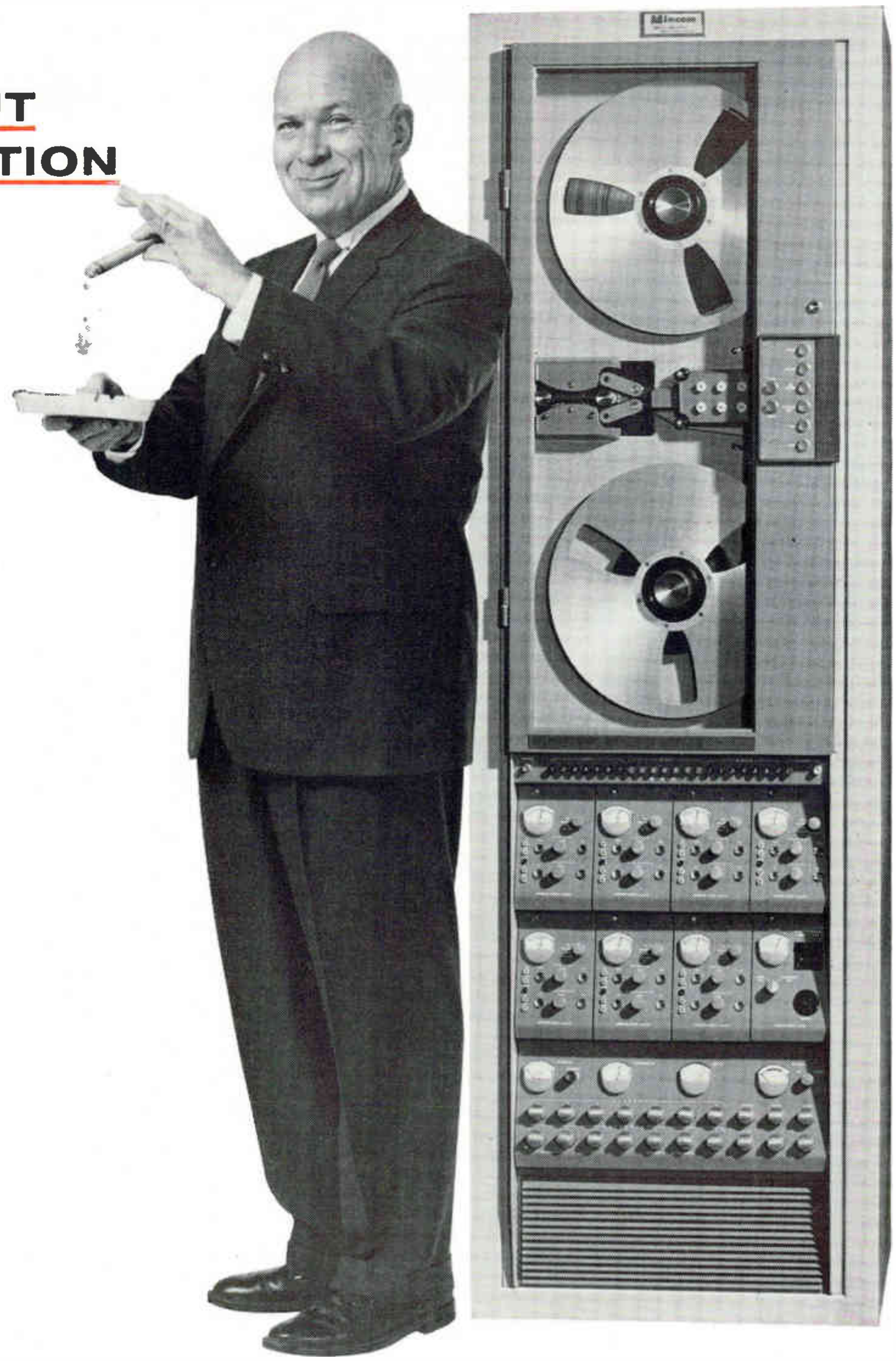

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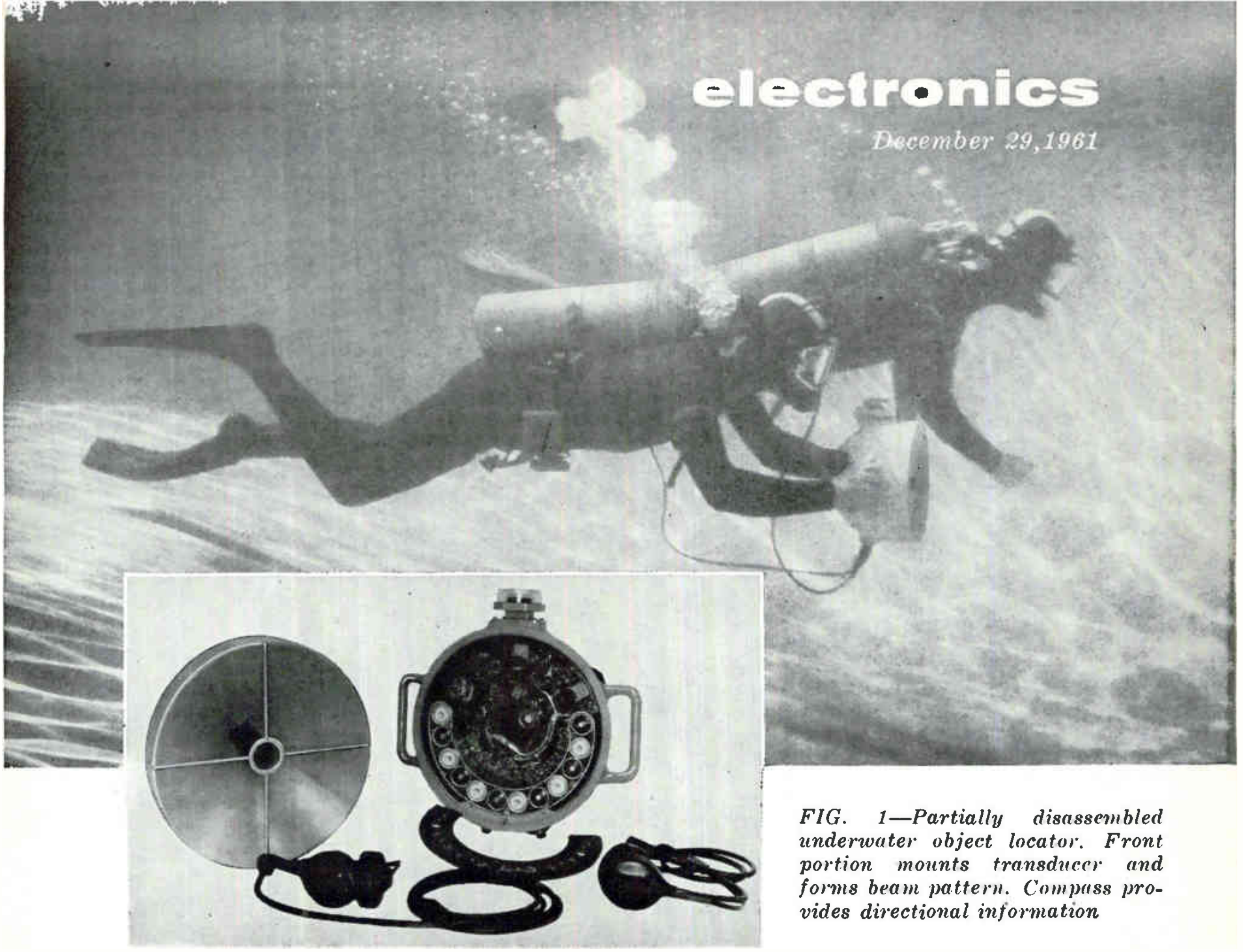


FIG. 1—Partially disassembled underwater object locator. Front portion mounts transducer and forms beam pattern. Compass provides directional information

Portable Sonar for Frogmen

Has a range of 120 yards with both active-search and passive-listen modes. Range is presented as a variable audio tone

By I. R. COLLDEWEIH
E. L. WALLS
R. D. LEE
Dalmo-Victor,
Division of Textron Inc.,
Belmont, California

SCUBA (self contained underwater breathing apparatus) swimmers have always been handicapped in their operations by limited underwater visibility. Only in a few geographic areas is the water clear, and even on bright days the usable light from the sun extends only about 50 feet below the ocean surface. In muddy rivers and bays, visibility is reduced to only a foot or slightly more and underwater searchlights are only a partial solution because they are extremely limited in their application.

The portable underwater object locator, shown partially disassembled in Fig. 1, has been developed to extend the scuba swimmers ability to locate and identify submerged objects within a range of 120 yards regardless of water clarity. The design provides for two modes of operation; an active-search mode, and a passive-listen mode capable of receiving ultrasonic marker buoy signals.

The underwater object locator is a continuous-transmission frequency-modulated sonar that produces a narrow, sharply-defined acoustic beam. The output signal is a linearly decreasing f-m signal whose repetition period is determined by the range scale.

Returning echos from underwater objects are heterodyned with the transmitted signal and presented to the operator as an audio tone in his water-tight headset. The pitch of the tone indicates the distance to the target; the lower the tone, the nearer the operator is to his object. A magnetic compass that may be illuminated by pressing a button indicates direction. Thus, the equipment provides both range and bearing information to

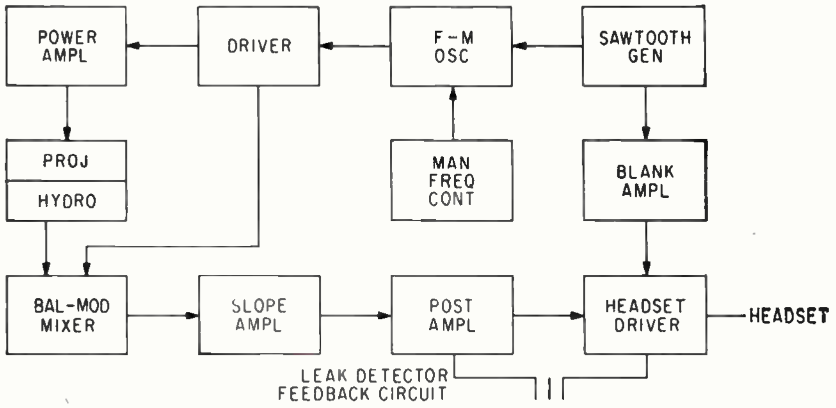


FIG. 2—F-m oscillator is modulated by the sawtooth generator in the search mode and by manual frequency control in the listen mode

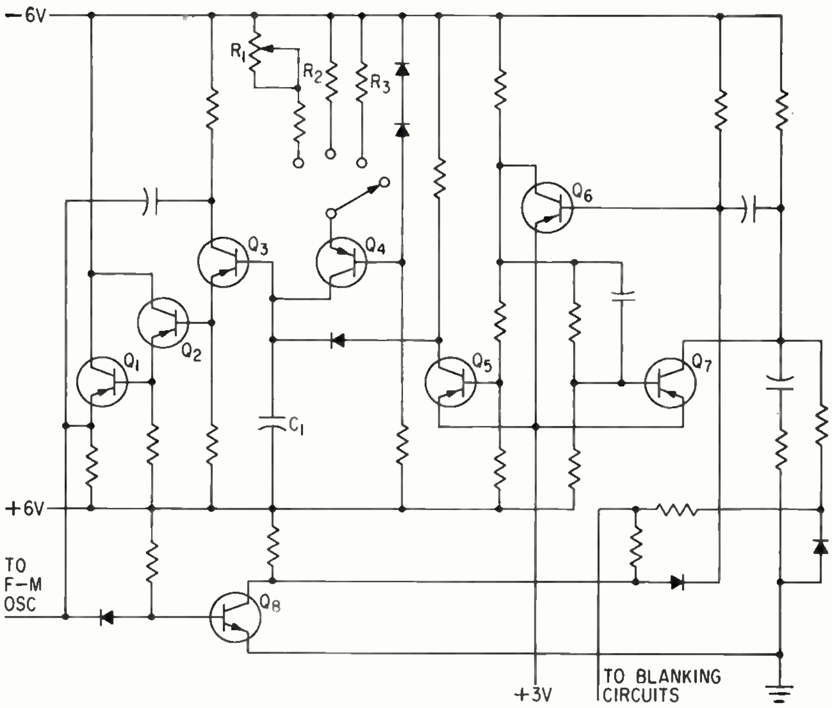


FIG. 3—Sawtooth generator uses a series of emitter followers to reduce output impedance. Sawtooth period is determined by selection of resistor

the scuba diver operating it.

By positioning the active-listening control in the listen position, the operator can use the underwater object locator to locate marker beacons transmitting in the range of 30 to 40 Kc. The operator manually tunes the local oscillator until an audible signal is received. The pitch of the tone is not an indication of the distance to the marker beacon, but the direction to the marker buoy can still be determined because of the beam pattern of the receiving hydrophone. The device is enclosed in a two-part cast-aluminum water-tight housing. The front portion of the housing is an inverted right circular cone that mounts the transducer and forms the acoustic beam pattern. The rear hemispherical portion of the housing contains the printed-circuit board and flashlight battery power supply. The control knobs, headset connectors, and an illuminated compass are externally mounted on the housing. Two large guide handles are provided for aiming the equipment while in operation. The object locator is designed to be ½ pound buoyant when submerged to provide for easy handling and directing. Seals are used between the case halves and shafts to prevent water leakage into the equipment. The set contains a leak detector to provide an audible signal to the operator in case of failure of the water seals. Two water proof headsets provide for the operator and a buddy swimmer.

Figure 2 is a block diagram of the equipment. The sawtooth generator provides a linearly decreasing voltage whose repetition rate or period is a function of the range scale. The sawtooth voltage is applied to a voltage sensitive multivibrator or frequency-modulated oscillator.

The multivibrator output is amplified to drive the projector portion of the transducer. The receiver consists of a balanced modulator mixer, slope amplifier, post amplifier, blanking amplifier and headset driver. Signals received from the hydrophone are heterodyned with a sample of the transmitted signal in the balanced modulator, resulting in many sum and difference frequencies. Only the difference between the received and transmitted frequency is used. The echo signal traveling from the unit to the target and return undergoes a time delay resulting in the received frequency being higher than the transmitted frequency. The greater the distance, the greater the difference frequency and consequently, the higher the tone presented to the operator. The rate at which the frequencies are swept in a sawtooth manner is adjusted to permit the difference frequency to be in the audible range for the three range scales of 0-20, 0-60 and 0-120 yards. With experience, the operator becomes proficient in estimating target range, depending on the scale in use.

In the listen mode of operation, a manually controlled d-c voltage is substituted for the sawtooth generator. Additional capacitance is switched into the frequency-modulated oscillator to allow the operator to tune over the frequency range of 30 to 40 Kc. The power amplifier, projector and blanking amplifier are switched out of the circuit as they are not used in the listen mode.

One of the major problems in the design of the underwater object locator was to obtain an output frequency which varies linearly with time over the temperature range of 0 to 50 C and with variations in battery voltage. Since the range signal presented to the operator is the instantaneous difference between the transmitted and received signals, linearity of $\Delta F/\Delta T$ is essential to present accurate information as a trained operator can detect linearity variations of less than 1 percent. To achieve the required linearity, temperature compensation was introduced in the sawtooth generator and f-m oscillator circuits. A schematic is shown in Fig. 3.

The sawtooth period is controlled by capacitor C_1 and resistor R_1, R_2 or R_3 as selected by the range switch. Transistor Q_4 provides a constant current to charge capacitor C_1. The constant current characteristic is achieved by maintaining the base of transistor Q_4 at a constant voltage obtained from silicon diodes D_1 and D_2, operating in a forward-biased condition. Transistor Q_4 causes capacitor C_1 to charge negatively while the series of emitter follows, Q_1, Q_2 and Q_3 provide high input impedance so that the base of transistor Q_3 will not load the constant-current circuit. The output of this series of emitter followers is obtained at the emitter of Q_1 where the circuit impedance is low. The output signal from transistor Q_1 drives the frequency-modulated oscillator and the recycle circuit. The recycle circuit blanks the transmitter output at the end of each sawtooth period.

The frequency modulated oscillator, is shown in Fig. 4. Emitter follower Q_1 gives a high input impedance while transistors Q_2 and Q_3 operate as an astable multivibrator.

Acoustic energy traveling through a water medium is attenuated inversely as the fourth power of distance traveled. The receiver circuit has a sloping frequency-gain characteristic to compensate for this acoustic transmission loss and effectively provide an output signal level independent of range to the target. A schematic diagram of this portion of the receiver circuit is shown in Fig. 5. The received signal from the hydrophone is supplied to a balanced ring mixer circuit. The instantaneous received signal is mixed with the outgoing transmitted signal to produce a difference signal whose frequency lies in the range of 250 to 2,500 cps, dependent upon the range to target. This difference frequency signal is applied to the base of the transistor. The capacitor-inductor network in the collector circuit provides the slope-frequency gain characteristic. The design of this network required consideration be given to the frequency response of the following amplifier stages, as well as the headset response. The net effect of the combination is to produce a constant audible signal level in the headset as the operator swims toward a target. To accomplish this, the system response increases approximately 10 db per octave over the receiver frequency range.

The leak detector consists of a pair of wire electrodes extending from the printed circuit board to the lowest point in the case. Current between the electrodes due to salt-water conductivity provides a regenerative feedback path around the receiver audio amplifer circuits. Entrance of only a few drops of water is sufficient to complete the circuit and cause the receiver to oscillate at an audible frequency, thus alerting the operator and preventing extensive water damage.

The headset design uses a bone-conduction element to withstand the hydrostatic pressures encountered at depths as great as 200 feet. The elements are mounted in molded Neoprene ear cushions attached to a beryllium copper headband. Waterproof quick-disconnect plugs provide for attachment of the headsets. The acoustic response of the elements provides a rising frequency response characteristic to compensate for the target range, but cuts off sharply above approximately 3,000 cps to eliminate unwanted noise.

The transducer contains a series of concentric rings of barium titanate connected to form the transmitting projector and receiving hydrophone. The hydrophone consists of ten separate elements and the projector six elements. The projector is acoustically isolated from the hydrophone by Coprene rubber spacers. The crystal assembly is encapsulated in a Rho-C material to match to the acoustic impedance of sea water, the entire unit is protected by a rubber boot.

The underwater object locator was conceived by engineers at the U. S. Naval Electronics Laboratory, San Diego, California, who constructed several vacuum-tube models for naval evaluation.

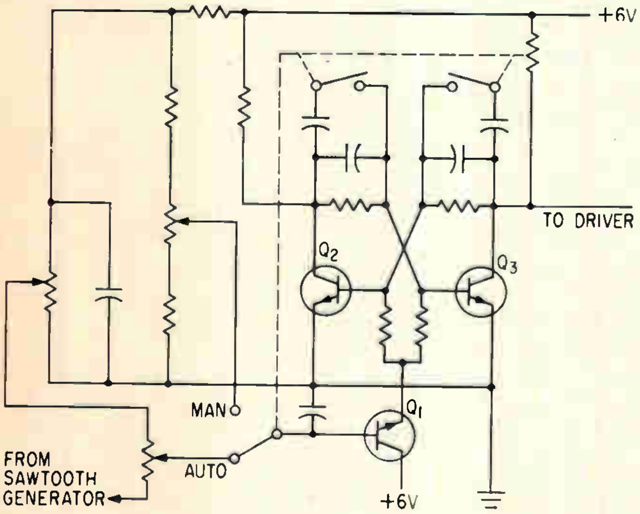


FIG. 4—F-m oscillator can be placed in either the automatic or manual mode. It is an astable multivibrator

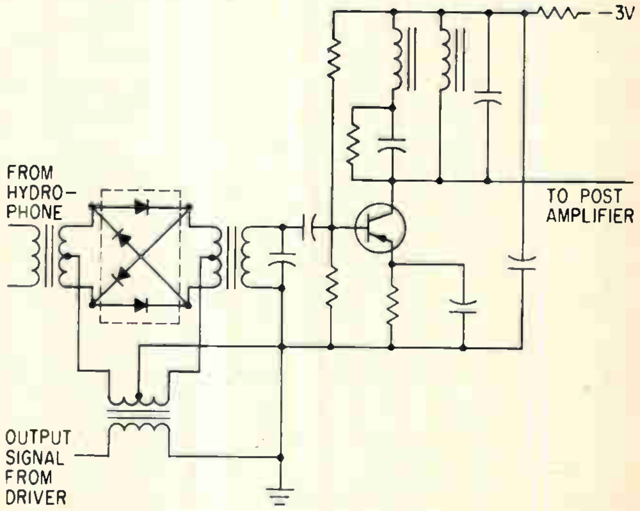
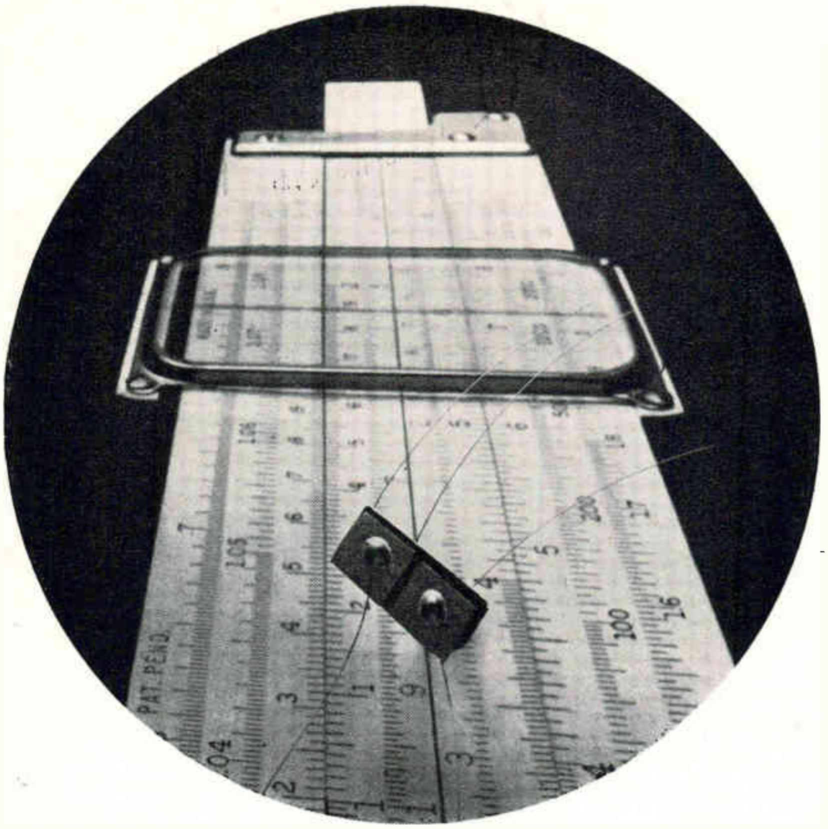


FIG. 5—Slope amplifier has frequency-gain characteristic to make output level independent of range

Semiconductor Functional Blocks



Diode and transistor elements fabricated from monolithic semiconductor blocks form analog multiplification and division circuits

By H. C. LIN,
C. E. BENJAMIN,
P. W. SMITH,
B. S. ARONSON,
Central Research Labs.,
Westinghouse Electric Corp.,
Pittsburg, Pa.

THESE SEMICONDUCTOR functional blocks perform multiplication or division by a process similar to that used by a slide-rule. Logarithmic addition or subtraction, followed by extraction of the antilogarithm, gives the product or quotient of two inputs. Forward-biased *p-n* junctions provide the logarithmic relationship, because in the range where the effects of series and shunt resistances and saturation current are negligible, diode voltage is directly proportional to the logarithm of the current.

Functional blocks for multiplication were constructed to have an input range of 10 to 1 and an output range of 100 to 1. Accuracy was within 5 percent at higher outputs, with a maximum error of about 10 percent at the lowest outputs. Built-in temperature compensation provides stable operation over a reasonable temperature range without significantly increasing the heat generated within the block. By applying the same fabrication processing to uniform material for all *p-n* junctions in each block, diodes were produced with identical electrical characteristics.

One functional-block design uses an output transistor, rather than an output diode. This modification gives more useful power output levels than can be obtained from the all-diode block. Multiplication accuracies of the transistor-output blocks are not as good as with the all-diode blocks.

When the logarithms of two quantities are added, the sum is equal to the logarithm of the product. Thus, if $Z = XY$, then $\log Z = \log X + \log Y$.

The forward *V-I* (voltage-current) characteristic of a typical semiconductor *p-n* junction is logarithmic over a considerable range. Where diode series and shunt resistance are negligible, the *V-I* characteristic of a *p-n* junction can be described by

$$I = I_o\,(e^{qV/nkT} - 1) \qquad (1)$$

where I is the current, I_o is theoretical saturation current, q is electron charge, V is the voltage across the junction, k is Boltzmann's constant, T is absolute temperature, and n is a constant involving various physical processes in the junction region, with values from 1 to greater than 3 for different junctions.[1] In the region where $e^{qV/nkT} >> 1$, Eq. 1 can be expressed as

$$\ln I/I_o = qV/nkT \qquad (2)$$

Thus, if I is made proportional to one of the quantities to be multiplied, V is proportional to the logarithm of I.

The equivalent circuit of the multiplier is shown in Fig. 1A. Diodes D_1 and D_2 convert input currents I_1 and I_2 into logarithms V_1 and V_2. The sum voltage $V_3 = V_1 + V_2$ is proportional to the logarithm of the product I_1I_2. The antilogarithm of V_3 is the current I_3 through *p-n* junction diode D_3.

For each diode D_m

$$V_m = (nkT/q)\log_e(I_m/I_{om}) \qquad (3)$$

Therefore by adding the two logarithms of the two inputs and taking the logarithm of the output

$$I_3 = (I_{o3}/I_{o1}I_{o2})\,I_1 I_2 \qquad (4)$$

The analysis holds only for d-c operation. For small-signal a-c

Perform Multiplication and Division

operation the addition of a-c voltage drops of known a-c currents passing through diodes does not yield a sum a-c voltage proportional to the logarithm of the product. This is due to a term proportional to the sum of the inputs as well as one proportional to their product, and the former term is usually larger than the latter.

Unfortunately, the d-c characteristic of a semiconductor *p-n* junction is sensitive to temperature. At room temperature, the I_o of a silicon diode will change by about 9 percent per deg C; this change is approximately proportional to qE_g/nkT^2, where E_g is the energy gap (1.1 ev in silicon).

In the expression for I_3 in Eq. 4, the proportionality factor is equal to $I_{o3}/I_{o1}\,I_{o2}$. Since all of the saturation currents have the same temperature coefficient, the quantity $I_{o3}/I_{o1}\,I_{o2}$ is as temperature sensitive as any one saturation current alone, that is, it will vary by about 9 percent/deg C.

To compensate for this temperature variation, another *p-n* junction diode, D_4, is introduced (Fig. 1B). If I_1, I_2, I_3, and I_4 are the forward currents through the four respective diodes, and I_{o1}, I_{o2}, I_{o3}, and I_{o4} are the theoretical saturation currents of these junctions, output current I_3 can be shown to be

$$I_3 = \left(\frac{I_{o3}\,I_{o4}}{I_{o1}\,I_{o2}}\right) \times \frac{I_1\,I_2}{I_4} \qquad (5)$$

Because the saturation currents all have approximately the same temperature coefficient, the quantity in parentheses will not vary with temperature. Thus if I_4 is held constant, then I_3 will be proportional to the product I_1I_2. For best accuracy, good thermal coupling should be maintained between the four diodes to equalize the temperature. A monolithic structure provides intimate thermal coupling within the semiconductor crystal.

For maximum accuracy independent of temperature (T), both $(\partial V/\partial \log I)_T$ and $(\partial V/\partial T)_I$ must remain constant. Measured curves of V versus I as a function of T and V versus T as a function of I for a typical forward-biased diffused silicon diode are shown in Fig. 1C and 1D. These relationships hold except at relatively high temperatures and low currents. The diode whose characteristics are shown has a junction area of 0.19 square inches, and would be used in a multiplier/divider block as D_1, D_2, or D_4 at relatively high currents, to avoid operation in the low-current range. Smaller-area diodes, such as those more commonly used in the functional blocks, would not show deviations such as shown in Fig. 1C and 1D until higher temperatures or lower currents, because these deviations are due to the -1 becoming significant in Eq. 1; this effect becomes more pronounced with increasing I_o, and this current is directly proportional to the area.

The arrangement of the junctions shown in Fig. 1B involves ohmic interconnections of *n* regions to *p* regions at points *a* and *b*. On the other hand, in Fig. 1E all four diodes are connected back-to-back (*p* region connected to *p* region and *n* region connected to *n* region), and no external interconnections or separate interconnection regions are needed. For fabrication in a monolithic block, this is the most desirable arrangement, even though no common connection is permitted between the two input circuits.

If an appreciable portion of either input current should flow through the output branch instead of the desired input diode, accuracy would be impaired. Output current I_3 in Eq. 5 would then be modified

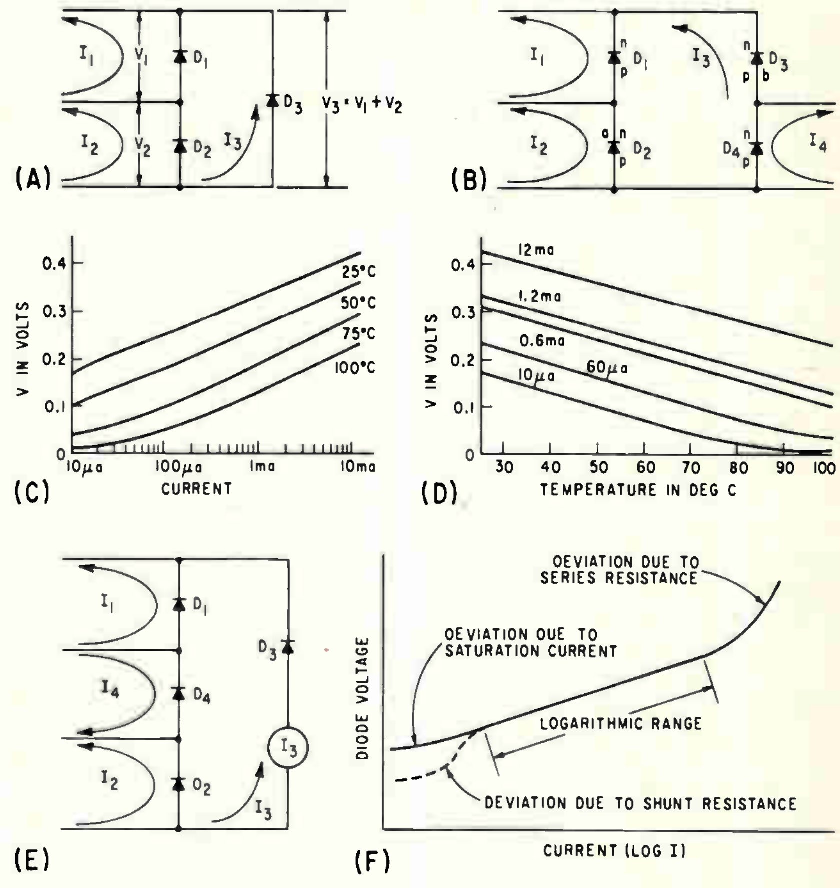


FIG. 1—Basic multiplier (A); with temperature-compensation diode added (B). Curves for silicon diode in (C) and (D) are for V versus I and V versus T, respectively. Configuration of diode multiplier in (E) aids fabrication. V-I curve for typical Si diode (F)

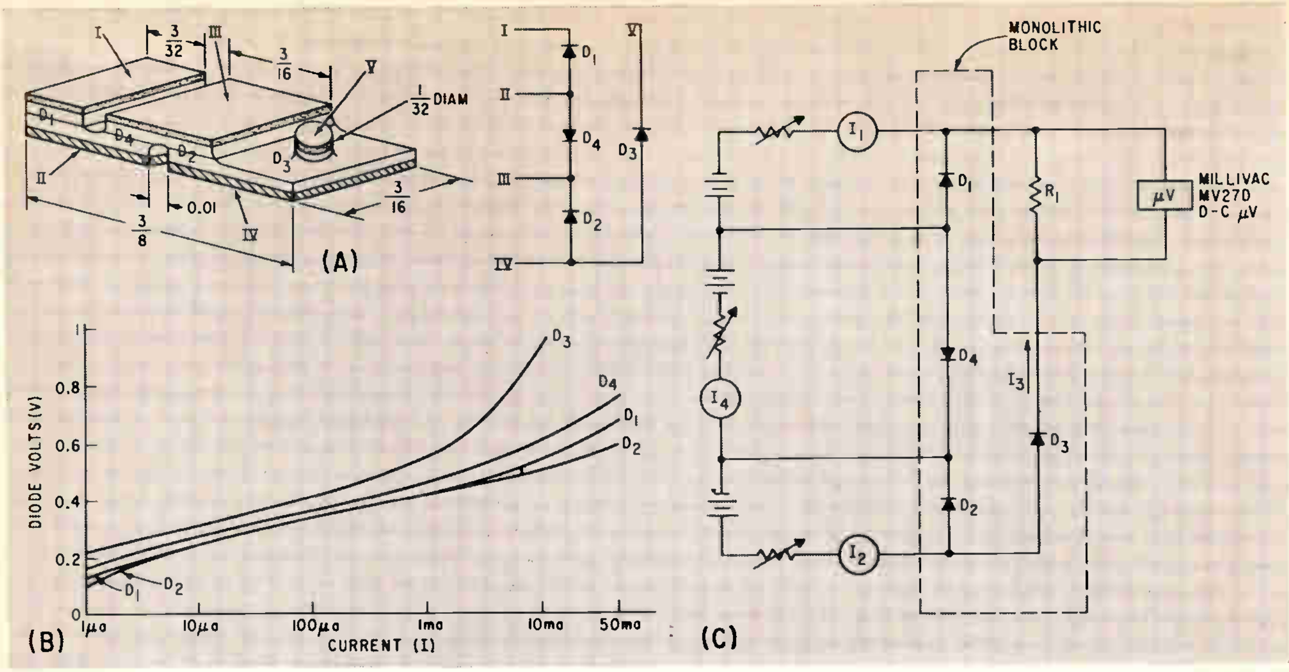


FIG. 2—Construction and equivalent circuit (A) of 4-diode multiplier-divider; V-I characteristics of its diodes (B). Test circuit for checking multiplication characteristics (C)

as

$$I_3 = \left(\frac{I_{o3}\,I_{o4}}{I_{o1}\,I_{o2}}\right) \times \frac{(I_1 - I_3)\,(I_2 - I_3)}{(I_4 + I_3)} \quad (6)$$

Equation 6 shows that for accurate multiplication I_3 should be very small compared with I_1, I_2, and I_4.

The specifications for ranges of operating values were one decade for each of the inputs and two decades for the output. Therefore, since I_3 is derived from the current sources for I_1, I_2 and I_4, I_3 should be less than 1/100 that of I_1, I_2 and I_4 so that the loading effect is insignificant. If we insert this requirement into Eq. 5 by making I_1, I_2, and $I_4 \geqq 100\ I_3$, then $I_{o3}\ I_{o4}/I_{o1}\ I_{o2} \leqq 0.01$. The saturation currents I_{om} are proportional to the junction areas of their respective diodes. If D_1, D_2, and D_4 have equal areas, Eq. 5 will be satisfied by making the area of D_3 1/100 that of the other diodes.

All four diodes must exhibit the desired *V-I-T* relationship over the full ranges within which they will operate. In a forward-biased p-n junction, the *V*-log *I* proportionality does not hold at low currents where the operating current is small compared to the saturation current (that is, where $e^{kV} \sim 1$ in Eq. 1, where $k = q/nkT$) or to the shunt leakage current. Operation at greater than approximately 0.2 volt (so that $e^{kV} >> 1$) is necessary. To minimize effects of shunt-leakage current, proper junction fabrication techniques must be used, along with mechanical protection and surface stabilization at the junction periphery.

At high currents, the series resistance predominates over the logarithmic relationship, and the voltage drop in this region is linear rather than logarithmic. These effects are shown in Fig. 1F, where log *I* is plotted against *V* for a typical silicon diode. For a diffused-junction diode, a low series resistance is obtained by making the junction area (particularly D_3) large and the thickness and resistivity of adjacent semiconductor material low. The resistance of output current meter, I_3 in Fig. 1E, should be as small as possible.

It is important that all four diodes exhibit the same logarithmic slope ($dV/d\ log\ I$). From Eq. 2 it can be seen that the multiplication operation

$$(I_1/I_{o1})\ (I_2/I_{o2}) = I_3/I_{o3} \quad (7)$$

is obtained by making

$$e^{kV_1} \times e^{kV_2} = e^{kV_3} \quad (8)$$

where $k = q/nkT$ and is inversely proportional to the logarithmic slope. Therefore accuracy does not depend on the value of k, as long as it is identical for all of the diodes, but if logarithmic slopes should vary among the diodes in a block, serious errors will be introduced.

Several basic physical phenomena are involved in making *n* different from the value of unity used in Shockley's original analysis of *p-n* junctions.[3] Recombination within the *p-n* junction space-charge region[4] will produce adjacent portions of the forward characteristic with $n = 1$ and $n = 2$; however in practice the distinction between these regions is so obscure that a considerable region often exists with a value of *n* constant at some value between 1 and 2. For more abrupt junctions, internal field emission[5] will result in even higher values of *n* and excessively high values of I_o. However, the structures have extremely graded junctions, with correspondingly low fields, and effects from this phenomenon appear to be negligible.

For silicon diodes made by various processes, logarithmic slopes have been observed from 0.08 to 0.18/current decade, corresponding to values of *n* from 1.3 to 3. However, by using uniform semiconductor material and processing all four diodes identically, uniform logarithmic characteristics can be consistently obtained. All of the diffused junctions used in multiplier/divider functional blocks exhibited logarithmic slopes of approximately 0.09 v/current decade, corresponding to an *n* of 1.5.

Details of construction and the equivalent circuit of the four-diode multiplier/divider are shown in Fig. 2A. The monolithic block was fabricated from a wafer of low resistivity silicon of overall dimensions $\frac{3}{16}$ in. $\times$ $\frac{3}{8}$ in. $\times$ 0.006 in. The block has a *p* and an *n* layer. Metal foils are alloyed for ohmic contacts and reduction of thermal resistance. Region isolation is provided by the troughs.

To determine the quality of a completed multiplier, the forward V-I characteristic of each diode was measured for the four diodes of a typical unit (Fig. 2B). Each diode must be operated in a region of its characteristic curve linear on this graph. For diodes D_1 and D_2, a straight line region of one current decade is necessary; for D_3 two current decades are required. The current through D_4 is set to permit operation of D_3 over its best two-decade region, while allowing D_1 and D_2 to operate at current levels that are as high as possible. This adjustment feature allows multiplier/divider functional blocks with diodes of different characteristics to be set for operation in their optimum regions without additional circuits.

Inputs to D_1 and D_2 were 0.2 ma to 2 ma, with D_3 driven from 1 μa to 100μa. The current required for D_4 is that which causes 1 μa of current through D_3 when D_1 and D_2 each have a current of 0.2 ma. When I_1 and I_2 are each 0.2 ma, V_1 and V_2 are each approximately 0.35, for a total of 0.70. The voltage across D_3 should be about 0.24 to cause I_3 to be 1 μa. Thus, bucking voltage V_4 must be $0.70 - 0.24 = 0.46$v. A current through D_4 of 1.1 ma produces V_4.

Multiplication characteristics were checked in the circuit shown in Fig. 2C. Each input current was varied independently over its full one-decade range, and output current was monitored by the d-c microvoltmeter, which measures the voltage drop across resistor R_1. Output current, which is proportional to the product of inputs I_1 and I_2, was then obtained by dividing the measured voltage by the resistance of R_1.

Figure 2B shows that the d-c resistance of D_3 at the bottom of the operating range (1 μa) is 2.5×10^5 ohms, and at the top of the operating range (100 μa) it is 4×10^3 ohms. Therefore, the voltage drop across R_1, a 10-ohm resistor, is negligible.

The analog multiplier can be used as an analog divider by having the input currents fed to diodes D_1 and D_4 of Fig. 2C. The combined voltage is $(V_1 - V_4)$, a logarithmic difference, corresponding to the logarithm of the quotient in division. Diode D_3 supplies the antilogarithm as I_3, thus producing an output current proportional to the quotient of the input currents. Diode D_2 is used for temperature compensation and bias.

A typical unit exhibited division accuracy within 5 percent for about 1⅓ decades; at higher output currents series error was introduced as the output current became comparable to that of one of the inputs. This problem is more serious with dividers than with multipliers, since in multiplication the maximum output current is obtained only when both inputs are at their maximum, whereas with division maximum output is obtained with one of the inputs at its minimum. Input diodes that are logarithmic at higher currents would eliminate this error.

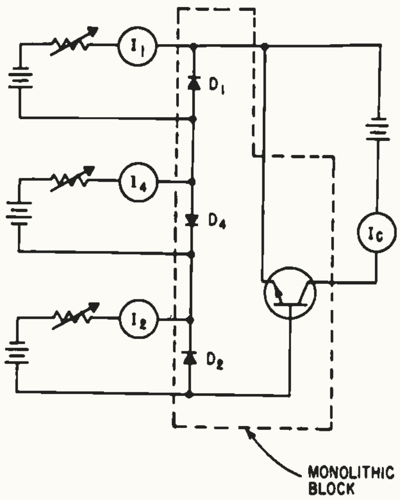


FIG. 3—Diode-transistor multiplier-divider block and test circuit

As in multiplication, the output diodes must be logarithmic over two decades if the inputs are allowed to vary independently over one decade each in division. Since diodes D_1, D_2, and D_4 all have the same area in this design, the unit can be used for either multiplication or division by interchanging D_2 and D_4 for the input and temperature-compensating.

The output information from the four-diode multiplier/divider functional block is difficult to work with in practical circuits. Being a d-c voltage in the microvolt range, such information requires d-c amplifiers to raise the output to a level that can be used in the conventional circuits of computers or controls. Since the transfer characteristic of a transistor (I_{out}-V_{in}) is also logarithmic, a transistor can be substituted for the output diode of a four-diode block (Fig. 3). Transistor output current I_c is proportional to the product of the two input currents, requiring no auxiliary circuits for practical applications. This transistor is incorporated into the monolithic block in place of the output diode. The inherent current gain of the transistor allows its input current to be small enough to be negligible with respect to the input diode currents, while the output current can be at usefully high levels and is relatively insensitive to load. The transfer characteristic generally does not depend upon current gain fall-off at low currents in the transistor.

Multiplication accuracy of the alloyed emitter multiplier/divider block is good. Curves of *V-I-T* have also been measured for the transfer characteristics of transistors being fabricated within multiplier/divider blocks. Although the families of curves are not as linear and parallel as those for simple diodes, they are of the same general character and tend to provide the same temperature compensation.

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ILLUMINATION STABILIZER for Photosensing System

Feedback circuit generates precise pulses to control light levels of light-sensitive devices that use a lamp as the light source. Feedback loop obviates elaborate circuits usually associated with switched control stabilizers

By J. R. DYKE,
Computer Developments Limited,
Middlesex, England

FOR RELIABLE OPERATION of the photovoltaic system in a punched-card or punched-tape reader, the illumination level of the card at the reading station should be constant.

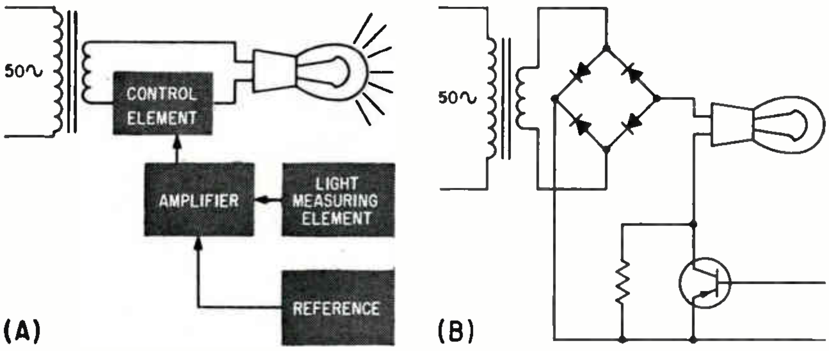


FIG. 1—Stability control includes lamp output in the feedback loop (A) and uses transistor as a control element (B)

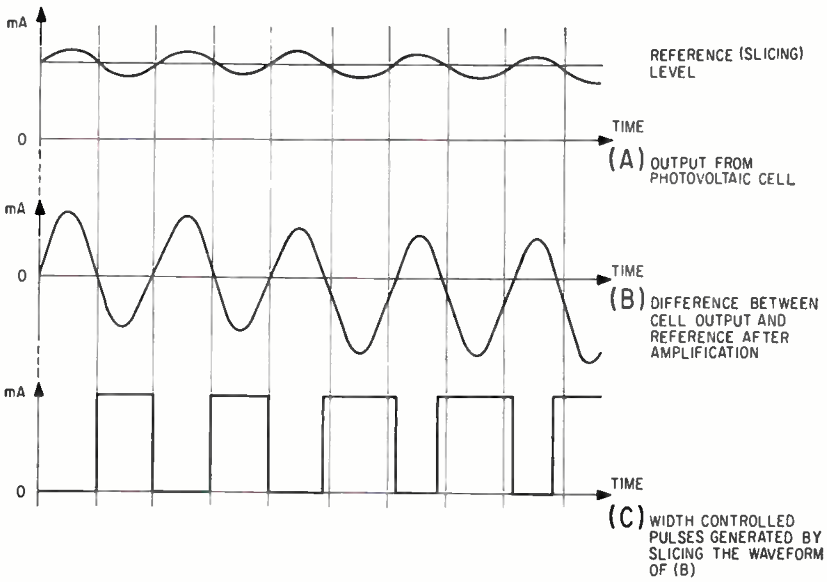


FIG. 2—Waveforms of pulses generated by light stabilizer

Where the light source is a low-voltage tungsten-filament lamp supplied through a transformer from the main power supply, constancy of light output cannot be assumed.

Variations in illumination have been due to variations in main power supply and individual differences between bulbs, changed regularly to avoid failures.

For a constant illumination source, not affected by changing bulbs, it is not enough to stabilize the voltage across the bulb or the current through the bulb, instead, the feedback system must include the light from the bulb in its control loop, see Fig. 1.

Photoelectric cells, already used in the reading stations, were chosen for measuring the illumination level. Sensitivity of the cells is substantially independent of ambient conditions, and they are rugged.

However, control for the lamp current presented a problem. Magnetic devices were ruled out because of weight, bulk and expense. Silicon controlled rectifiers were almost as expensive, and required more complex circuits. So transistor controls were chosen.

In a simple control arrangement, the base of a transistor may be supplied with a steady control current, or with pulses that switch the transistor on and off. A resistor placed across the transistor reduces dissipation and, in the switched system, limits the peak voltage appearing across the transistor. Less power is dissipated in the transistor, especially if the switching rate is low, but this usually requires a more

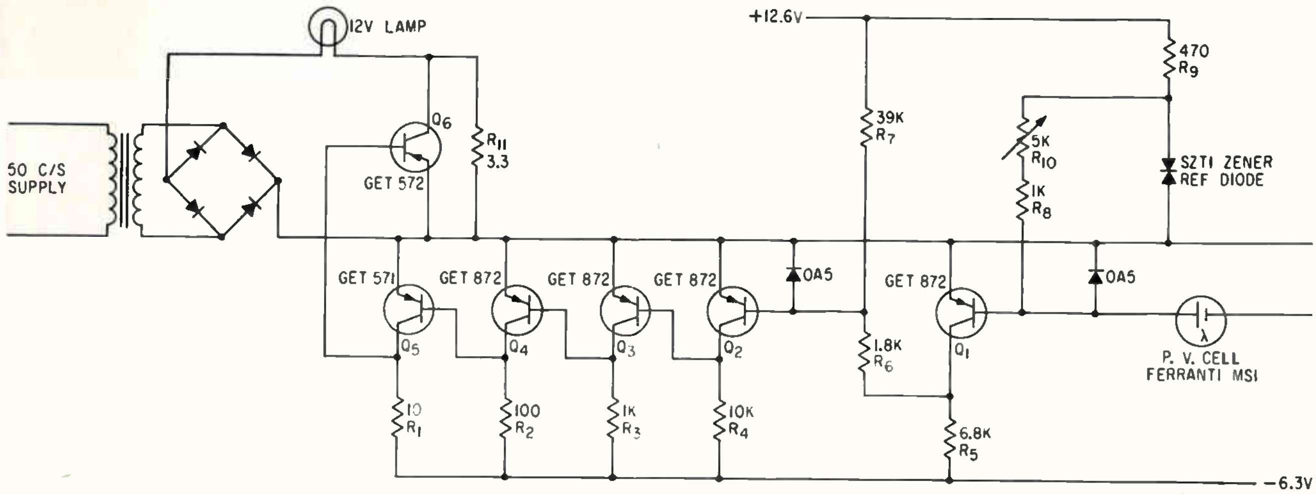


FIG. 3—Complete circuit of stabilizer. Difference between reference current supplied by zener diode and current from photocell is amplified by transistor chain, and then supplied to control element Q_6 to adjust lamp current

complex amplifying circuit to generate switching pulses of controllable width. Since a 48-watt bulb was to be controlled, dissipation in the transistor was important, so a simple method for producing the required pulse was devised.

Pulse generation of the stabilizing circuit (Fig. 3) is illustrated by Fig. 2. Light output from the bulb contains about 1 percent of 100-cps ripple, which lags nearly 90 deg on the 100 cps component of the supply to the bulb because the thermal time constant of the filament is much longer than 0.01 sec. The difference between the current from the photovoltaic cell in Fig. 2A, and the reference current, is amplified to the waveform in Fig. 2B. Applying this pulse to a slicing transistor (Q_2 in Fig. 3) produces the width-controlled pulses of Fig. 2C. Pulse widths of this train increase with a reduction in the mean level of illumination, so that after amplification, these pulses drive the control transistor (Q_6 in Fig. 3).

The circuit is polarity sensitive, not waveform sensitive. If the photocell is connected the wrong way, feedback will be positive instead of negative, and the light output will not be stabilized.

In the stabilizer circuit, Fig. 3, the reference current is supplied from the Zener diode through R_8 and R_{10}. The difference between this current and the current from the photovoltaic cell is amplified by Q_1 and applied to the base of Q_2. These pulses are amplified by Q_3, Q_4 and Q_5, and supplied to Q_6.

The range over which the illumination is stabilized extends from the point where, with Q_6 conducting all the time, there is only enough current flowing to provide the required illumination—to the point where, with Q_6 off all the time, too much current will flow. This range is determined by the transformer secondary voltage, and the value of R_{11}. The variation of illumination over the controlled range is equal to the percentage of ripple in the output of the bulb, usually one percent peak-to-peak.

Transistor Q_6 carries the full lamp current when conducting but, as it is saturated at this time, the mean dissipation is low. This is an important feature of the circuit.

The transformer power supply is followed by a full-wave rectifier so that the transistor deals with a unidirectional current. Thus the ripple problem is not aggravated by half-wave action.

The photovoltaic cell is mounted to obtain a mean short-circuit current of approximately 1 μa at the illumination level.

Nominal component values should not exceed the following tolerances: ± 5 percent variation of all resistors except R_8 and R_{10}; ± 5 percent variation in d-c supply voltages; β variation of GET872 transistors down to 20; β variation of GET571 transistors down to 20 at a collector current of one amp; β variation of GET572 transistors down to 15, at a collector current of 4 amp.

The dissipation in Q_6 is less than 2 watts; in Q_5, less than 200 mw. In each of the other transistors, dissipation is less than 10 mw.

Circuit stability is primarily determined by the stability of the reference current and of the photocell sensitivity. Drift can be caused by dust on the photocell or on part of the lamp facing the photocell, or by change in the leakage current of Q_1. The cell must be mounted so that the sensitive area is not obscured by dust, while Q_1 is selected for low leakage. A silicon transistor can be used only if the circuit is modified to allow for the increased base-emitter voltage required to drive the silicon device.

The percentage of ripple in the light output of the bulb is the main factor determining the precision of the system. Since precision is inversely proportional to the percentage ripple, precision may be increased by smoothing slightly the output from the rectifier, or using a bulb with a longer time constant.

Precision is also dependent on the effectiveness of Q_6 in controlling the filament current. This is optimum if Q_6 is arranged to be switched off during the time when the voltage from the rectifier is maximum. This operation, which also minimizes the ripple in the light from the bulb, is secured automatically because of the 90-deg phase lag introduced by the long thermal time constant of filament.

Effectiveness of control may be improved by increasing the value of R_{11}, but this increases switching losses in Q_6. The precision of the system is independent of the gain of the transistors, providing this gain is sufficient to secure rapid switching of Q_6.

DIGITAL CIRCUITS

Achieve Automatic Control of Radar Range Tracking

Tracking modern high-speed targets imposes tremendous demands on radar systems. This digital system locks its range gate onto the target and holds it there, adjusting the range gate with every target movement, and producing a highly accurate range readout

By DARRELL L. NEPVEUX, Advanced Electronics Center, General Electric Co., Ithaca, N. Y.

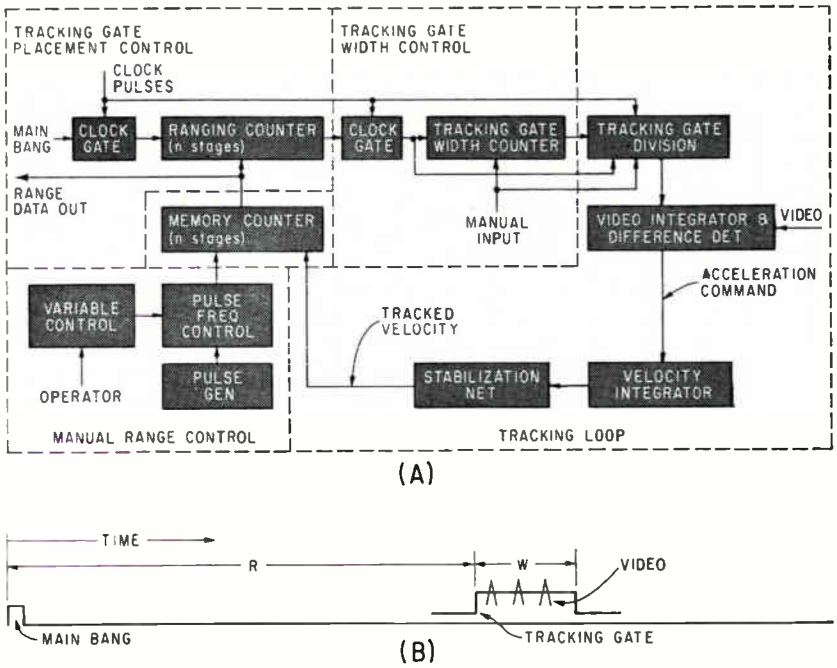
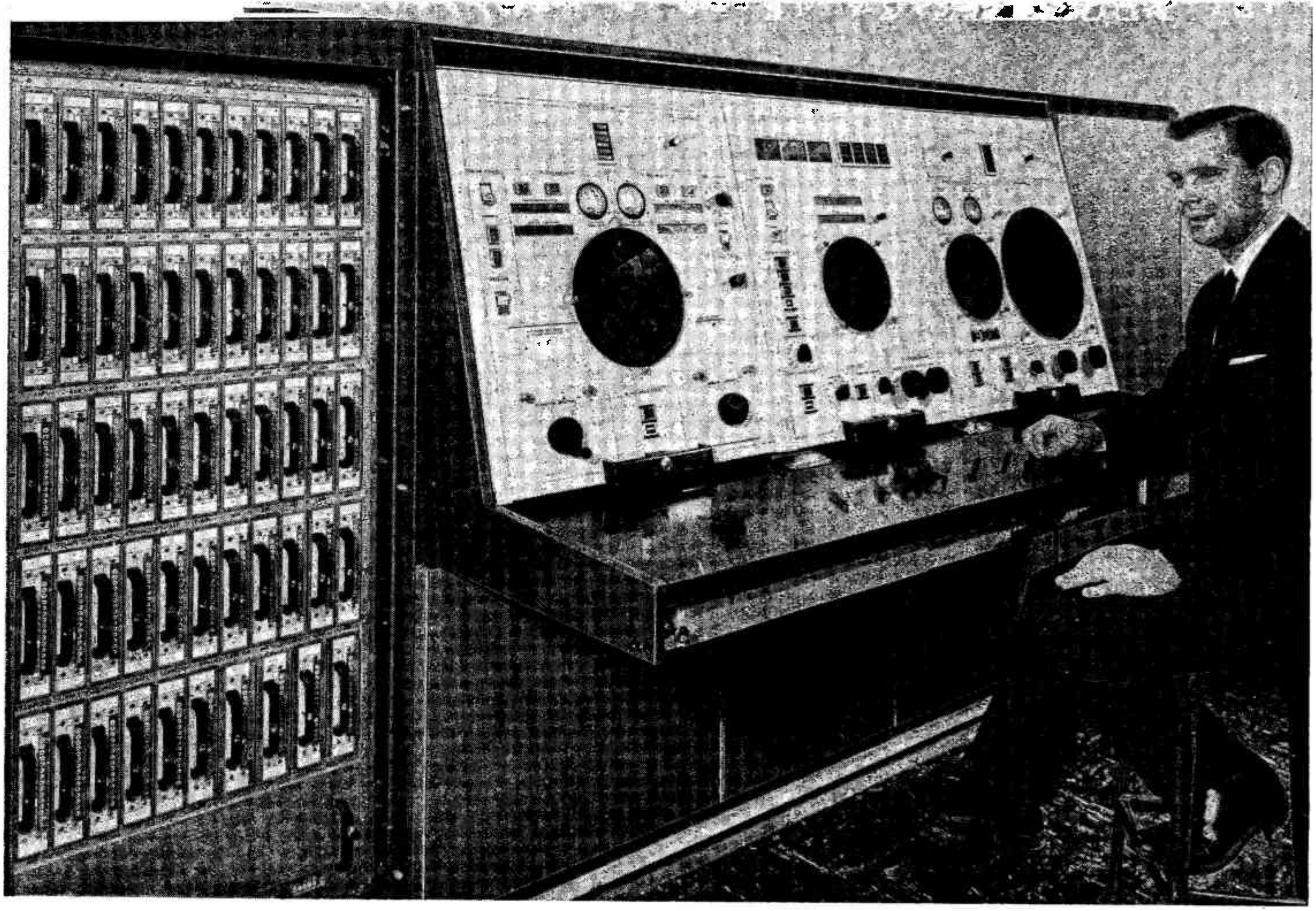


FIG. 1—Only one ranging counter is shown in digital range tracking system (A). Pulse diagram (B) indicates relationship of tracking gate to main bang

ALTHOUGH modern long-range systems bear a basic resemblance to their ancestors, many new and modified techniques have been made necessary by the extended requirements of such systems. In first generation radars it was sufficient to look with the receiver system at any and all video returns between two radar transmission pulses. Range data was processed by the operator noting the track of a specific video return pulse on a ppi cro. In using modern long-range radars, such techniques are no longer feasible for these reasons: although radar range has been greatly extended, the video of interest is normally confined to a small segment of overall range; the extended range usually requires a round-trip propagation time that extends over several interpulse periods of the radar prf. Due to the high performance capabilities of targets automatic tracking of



Master display and control console for pincushion radar set contains digital range tracking system, which is in cabinet at right of operator

target-return video is necessary.

This article describes a digital automatic range-tracking system that tracks a single target or cluster of targets. The system defines range by surrounding a video (or group of video) return(s) with a tracking gate (Fig. 1). A tracking gate may be manually or automatically placed or moved to any position within overall range. In typical operation, the operator first cranks range information into the system and then automatic tracking takes over the control of the tracking gate, which then follows the target through every range change.

To obtain accuracy and resolution in range control, the control functions are implemented by digital logic and circuits. The range value (in ft) of a single binary bit in a digital system is derived from: ft of range/bit =

$$\frac{\text{propagation velocity}}{2 \times \text{clock frequency}}$$

Thus, maximum range of the system is prescribed by a sequence of binary-arithmetic bits. The range value of a single binary bit determines the maximum bit length of the binary sequence that is necessary to provide the maximum range of the system. Any point within the range is resolved to the accuracy allowed by the range value of a single binary bit. Placing the tracking gate in a range position is accomplished by counting out a specific binary number and relating the elapsed time of the count to the predetermined point in range. The tracking gate is moved by changing the binary number, either manually or automatically.

In Fig. 1A, the ranging counter controls the R (or range) parameter (Fig. 1B) and the tracking gate width counter controls the W (or gate width) parameter. The video-integrator-difference detector block and the tracking loop provide the automatic movement of the tracking gate by changing R; a manual input to control R is also shown.

The primary components of the system are the ranging counter and the memory counter. In operation, digital range information goes from the memory counter to the ranging counter, which then counts clock pulses.

The memory counter is the binary storage area, which contains at all times the digital equivalent of range R (Fig. 1B). It is a static counter, since the only allowable changes in its content are controlled by the operator's variable control or the automatic tracking loop input. Maximum operating speed of the memory counter is dictated by the maximum rate at which corrections in binary value of range are to be made. This speed is nominally an order of magnitude less than the

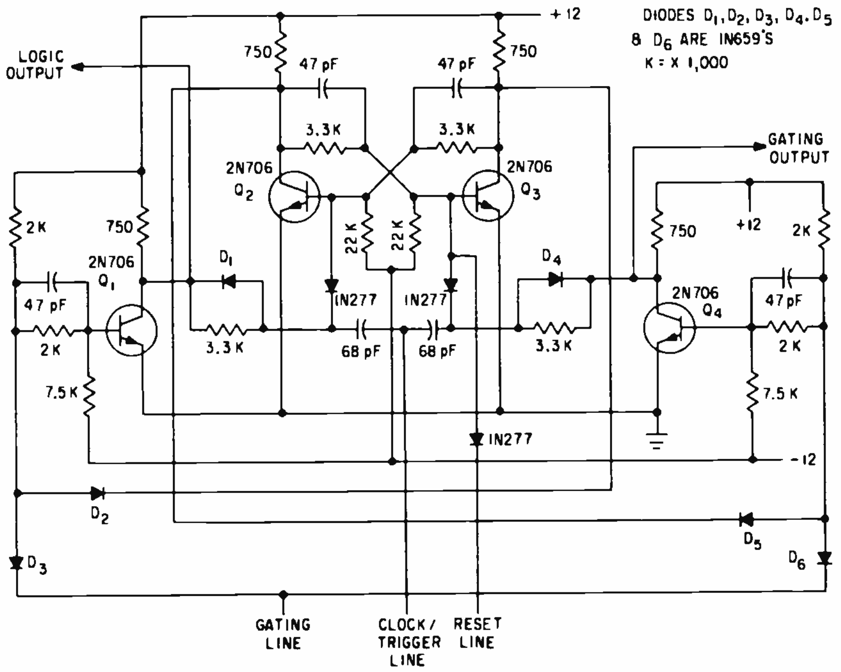


FIG. 2—High-speed buffered flip-flop of ranging counter

clock frequency. The memory counter is a reversible counter since both an increase and decrease in decimal range must be permitted. Binary range information held by the memory counter goes to external processors or recorders, as well as to the ranging counter.

Generation of a signal pulse that indicates the beginning of the tracking gate is performed by the ranging counter. This counter is an n-stage shift register, which can count to the maximum value of range, and operates at the system clock frequency. Counting in this unit is done dynamically. The unit begins to count clock pulses at the appearance of a radar transmission pulse and continues to count until a number of clock pulses equivalent to the decimal range has been counted. At this point, it generates a signal pulse which starts the tracking gate.

To provide a high range-resolution capability, the clock pulse frequency is high. Clock frequencies in the 1 to 10 Mc range are usually specified. These clock pulses are counted in the ranging counter, which is composed of a series of transistor flip-flop stages. The first stage of this register must therefore count at the rate of the system clock. This stage, a high-speed buffered flip-flop, is shown in Fig. 2. Buffering is used in this circuit to increase the load-handling capability and maintain the high operating speed.

The counting technique in this portion of the system provides the least complicated performance of the ranging counter. The technique allows the ranging counter to start from a preloaded condition with the restraint that the number of clock pulses necessary to take the counter from its preloaded condition to its full condition (when all of its stages are in the ONE state) is equivalent to the decimal range. This restraint is met by taking the complement of the decimal range and preloading this into the ranging counter. Since the decimal range value is contained in a parallel binary form in the memory counter, it is simple to complement each digit of this binary number and preload the complemented decimal range into the ranging counters. The ranging counter can then be turned on by the transmission pulse (main bang) of the radar, count clock pulses until it reaches a full count, then generate a carry pulse that fixes the location (in time, relative to the radar transmission pulse used to start the counter) of the tracking gate. The ranging counter functions as an asynchronous counter having a high-speed counting capability in its first few stages. Although the ranging counter functions asynchronously as a unit, its first few stages run synchronously (this was required to implement another function).

Since the ranging counter tabulates the elapsed time between a main bang and the desired beginning of the tracking gate, it is necessary to use the main bang to initiate counting in the ranging counter. However, the maximum range of the radar may include several interpulse periods of the radar prf. Therefore, there must be sorting or counting of radar main bangs before they are used with the ranging counters.

Figure 3 shows how this is performed. The radar main bangs are accepted into the system serially, on a single line. System specifications dictated the number (m) of the parallel ranging counters necessary to cover the maximum range. Each counter is started sequentially, in the 1...... m sequence, by a main bang. Only a single such ranging counter appears in Fig. 3. The main bangs are divided in a $1/m$ counter to provide the sorting, with one main bang being fed to each ranging counter in sequence. Each main bang sets a start-stop flip-flop which, when set, opens a clock gate allowing clock pulses into the ranging counter which has been preloaded. (There are m flip-flops, clock gates and ranging counters.) On reaching a full condition, the ranging counter generates a carry pulse which resets the flip-flop, closing the clock gate and putting the ranging counter in condition to accept the next preloading of complemented decimal range. All

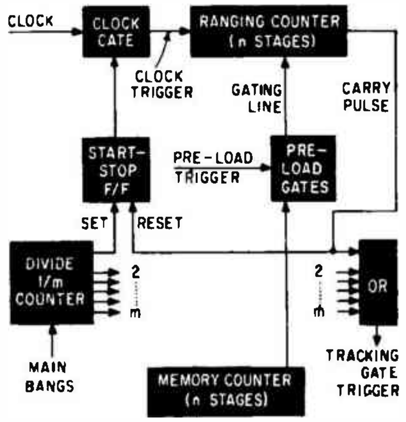


FIG. 3—Inputs and outputs identified as 2 to m would go to other ranging counters that are not shown

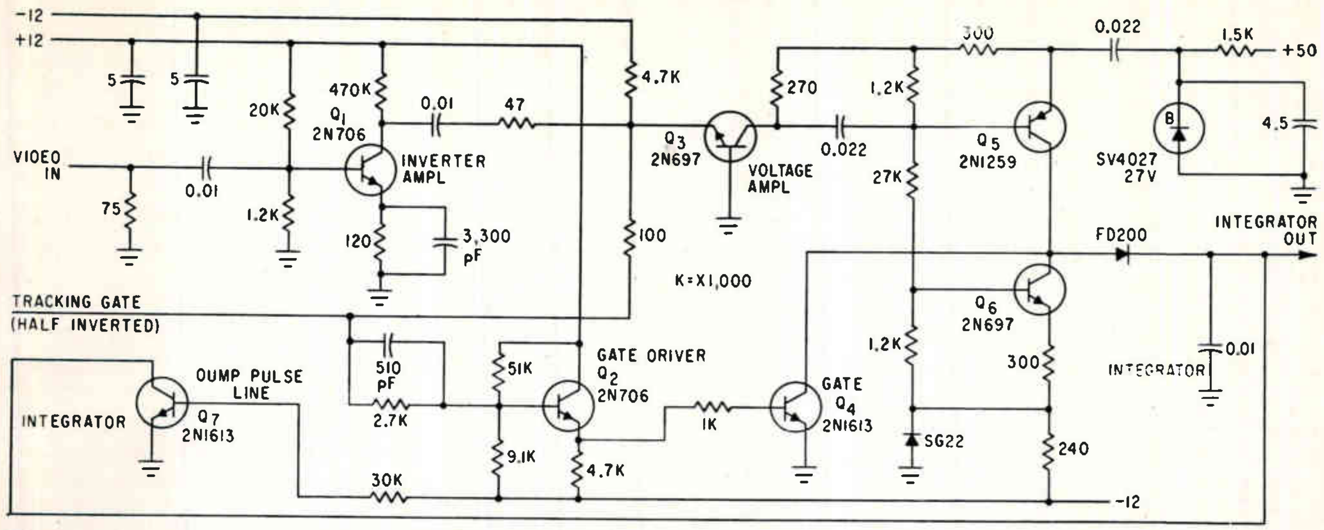


FIG. 4—Output of this video integrator goes to difference detector

preloading is accomplished at the command of a trigger pulse that occurs at some convenient time previous to the main bang used with the ranging counter.

The carry pulse generated by the ranging counter is now positioned in time at the point where the tracking gate will begin. Since each of the m ranging counters provides a carry pulse, and these occur in a serial time sequence, the OR block combines all of the carry pulses on a single line, and delivers tracking gate triggers to the tracking gate width control.

The tracking gate triggers are generated at a rate equivalent to the radar prf. If the information contained in the memory counter is not changed, the position of the tracking gate will not change.

The tracking gate width control provides some video return pulse selectivity and allows for the dispersion of video pulses over a predetermined range increment. The technique that provides this control is identical to the technique that provides tracking gate placement. The operator throws a switch that supplies information, in parallel binary form, that determines the width of the tracking gate. Since it is proper to expect the same resolution of the tracking gate width as obtained in the placement of the tracking gate, the range value of a single binary bit is identical to its value in the ranging counter, and the same clock frequency is used. Since the gate width counter is triggered at the radar prf rate, only one such unit is necessary.

The memory counter controls the location of the tracking gate. Information is stored in the memory counter in binary form; therefore, all changes inserted into the memory counter must be in binary form. To comply with the requirements of the system, changes in the contents of the memory counter are allowed in two modes: manual and automatic.

The method used in the manual mode is range-rate control and is the one preferred from a human-factors standpoint. The operator has one control that controls the frequency of a pulse source fed into the memory counter. Operating at any one frequency results in a constant rate of change of range, since a constant stream of pulses is fed into the memory counter, each pulse representing a single binary bit value of range. This method presents the advantage to the operator of continuous control over movement of the range parameter without physical action, with the disadvantage of requiring a second source of information on the value of absolute range. This disadvantage is overcome by providing a decimal readout of the range value.

The automatic control of information entered into the memory counter is determined by the tracking loop. The requirement placed upon the system in the automatic tracking mode is that it maintain a predefined spatial relationship between a single video, or group of video, and the tracking gate, under specified conditions of target-return video velocity and acceleration. This requirement means that the tracking gate is centered on the video pulses appearing within its limits.

The operation of defining the center of the tracking gate is performed in the tracking gate division block. This block receives manual gate width control information. The tracking gate division block contains a binary shift register into which this parallel-binary gate-width information is fed. The size of this shift register is such that the least significant binary digit of the width of the tracking gate is not entered into the register. Thus, a binary division by two is performed and counting out this register with clock pulses will cause a carry pulse to be generated at the center of the tracking gate. The center of the gate is defined to a resolution of one bit value of range. The other inputs to this division block are the tracking gate trigger (indicates the beginning of a tracking gate), the carry pulse from the tracking gate width counter (indicates the end of a tracking gate), and the system clock. The outputs of the division block are three pulses, indicating the beginning, center, and end of the tracking gate.

Since the tracking-gate center is defined, it is possible to determine the video contents of each half of the tracking gate. To restrict the influence of noise on the tracking loop, a video-signal-plus-noise-integration method was used. The triggers of the tracking-gate-division block open two separate but identical integrator circuits. One of these integrator circuits is shown in Fig. 4. The first integrator accepts all of the video and noise signals within the first half of the tracking gate and performs a voltage-time integration, which yields a certain result. The second integrator performs a similar function to the interval of time inclosed by the second half of the tracking gate. The results of these two integrations are then compared, providing two possible conditions: first, the two volt-time integrations yield identical results which means that either there is no video in the tracking gate or that it is properly centered; second, the integrations are not identical, which provides an error signal of proper polarity to cause the tracking gate to center on the video. Performing the integration function on the raw video and noise reduces the random effects introduced by the noise peaks. The output of the video integrator and difference block is an error signal of proper polarity for use with the remaining components of the tracking loop.

The input to the tracking loop indicates the position of the video that must be tracked (it is in one of two halves of the tracking gate); at the other end of the loop is the memory counter. The ranging counter, tracking gate width counter, and tracking gate division components have no effect on the tracking dynamics, since their influence is contained within a single tracking period, (where tracking period is defined as the time between two adjacent main bangs). The memory counter, however, has a continuing effect on the tracking loop. Operating as a digital component, it is a position integrator.

The analysis begins from the tracking gate position. This is the contents of the memory-counter position integrator (since a parallel binary format is used). The position integrator is a binary shift register that accepts binary corrections and performs a binary integration of these corrections. Thus, on a long-term basis, the corrections provided to the position integrator must be a true indication of the velocity of the video being tracked; for example, video target pulses with constant velocity can be successfully tracked only if a constant number of range unit corrections are entered into the position integrator at the initiation of each cycle.

Some measure of tracked velocity must be obtained from the preceding components of the tracking loop for use with the position integrator. This uses the velocity integrator and stabilization network. The error signal output of the video integrator and difference detector is used as an acceleration command to the tracking loop. An integration of these commands provides the tracked velocity information. This integration is performed in the velocity integrator. If a Bode diagram is drawn for the system, it would show the single, 40-db-per-decade slope caused by the two integrators in the loop, the position integrator and the velocity integrator. Since the zero-gain line is crossed at a slope of 40 db per decade, the system will not appear to be stable. This is the reason for the inclusion of the stabilization network, a lead network which provides an overall Bode diagram with a 20-db-per-decade slope at the zero-db crossover point.

The operations that must be performed by the velocity integrator and stabilization network on the error signal to yield the proper inputs to the memory counter (position integrator) can be implemented in either an analog or digital manner. The analog implementation, the least complicated of the two, requires conversion of the error signal pulses to an analog quantity. The integrator is a capacitor and the stabilization network is a resistor-capacitor combination providing a wide range for selection of time constants. Digital implementation of the integrator is similar to that of the position integrator and can use the error signal pulses directly. The digital stabilization network is more complicated to provide the proper range of time constants.

The velocity performance of this digital tracking system in the automatic tracking mode is a direct function of the maximum number of correction pulses that may be entered into the memory counter in one correction cycle, the number of correction cycles in one second and the range value of one correction pulse. This last quantity is determined by the system clock frequency. Since the tracking gates are generated at the prf rate of the radar, the correction cycles per second will be equal to the radar prf. Therefore, the only parameter available for specification is the number of correction pulses per correction cycle, a quantity easily manipulated to meet system specification.

A similar approach yields information on the acceleration performance of the tracking loop. The important consideration is the time rate of change of velocity. In determining this factor, the weighting of the acceleration command and the time constants of the stabilization network are of prime importance. It is relatively simple to make changes in the velocity and acceleration capability of the tracking loop. This is due to the digital nature of the data being processed in the tracking loop.

The system described above is truly minimal. A complete digital range tracking system would have many necessary and useful auxiliary functions not mentioned. A few of these are visual range displays and display triggers, automatic radar prf control, provisions for multiple tracking gates, automatic coasting on loss of video, and rate-aided manual acquisition. While these functions require extension and modification of some of the techniques covered, the components and techniques that are described are the primary requirements of a digital range tracking system.

The digital range tracking system described has been designed and built, and is operational as a component of the Pincushion Radar system. This effort was part of a contract from the Advanced Research Projects Agency, as a project of RADC. The work was done on a subcontract for Raytheon, Inc. on the Pincushion Radar Project.

CAMERA PERISCOPE FOR

Cathode-Ray Tube Photography

Design of optics for photographing a crt display is straight forward. An engineer working on the electronic system complete the task by following explanation presented here

By DANIEL LEVINE,
Staff Scientist Lockheed Missile and Space Co., Sunnyvale, Calif.

IN PHOTOGRAPHING a radar, television or oscilloscope display, the camera may either be in-line with the cathode-ray tube, or the light path many be folded in a camera periscope, see Fig 1 (left). The latter arrangement is widely employed to obtain more compact packaging or to permit simultaneous viewing of the display by use of beam splitters. The following explanation eliminates tedious computations in periscope design.

In Fig 1 (top center) the triangle represents a cross section of the outer limit of the cone of light between the crt face plate on the right and outer lens element on the left. All rays which enter the camera lens from the phosphor lie within this cone. It is important to note that the distance from the tube to the apex of the cone is *not* equal to the distance from lens to object used in the lens equation. The distance L_L between the front lens element and the crt must be measured on an experimental mock-up, or else computed by means of the lens equation with allowance made for the length of the lens. Then the height of the cone, L, is determined by similar triangles: as seen in Fig. 1 (top center). Then

$$\frac{L}{\rho_M} = \frac{L - L_L}{\rho_L} \text{ or } L = \frac{L_L \, \rho_M}{\rho_M - \rho_L} \qquad (1)$$

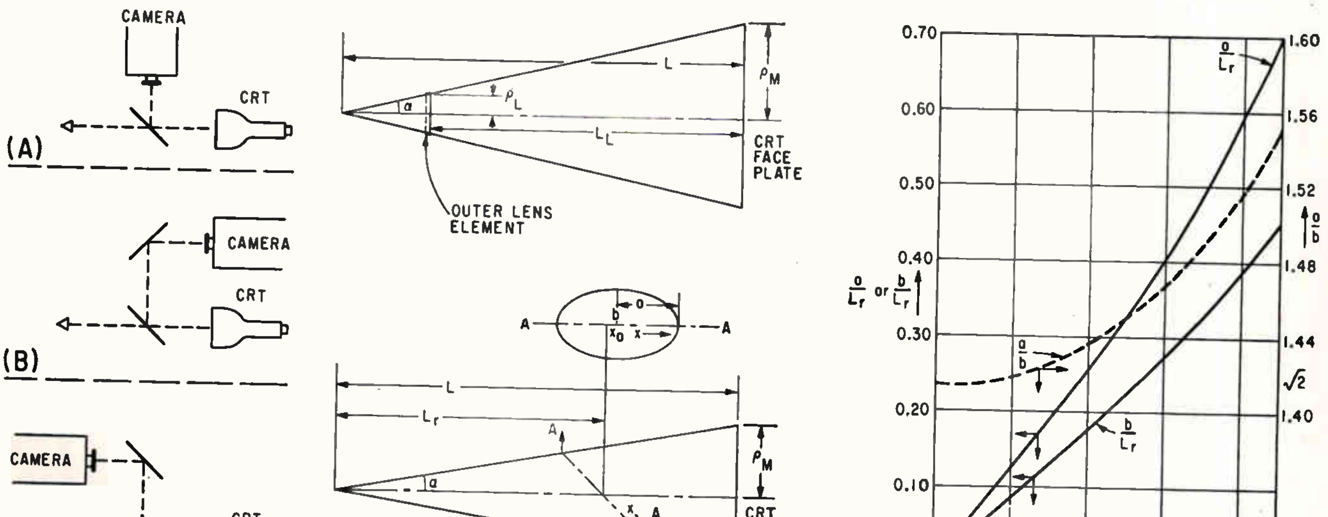


FIG. 1—Alternative arrangements (left) for photographing a display: (A) single bend, (B) folded optical path, (C) offset camera indicator. The bounding cone (top center) is determined by the active sweep on the crt and the outer lens limit. Periscope installation (bottom center) between camera and crt with view of the elliptical intercept. Axes of the ellipse are at right

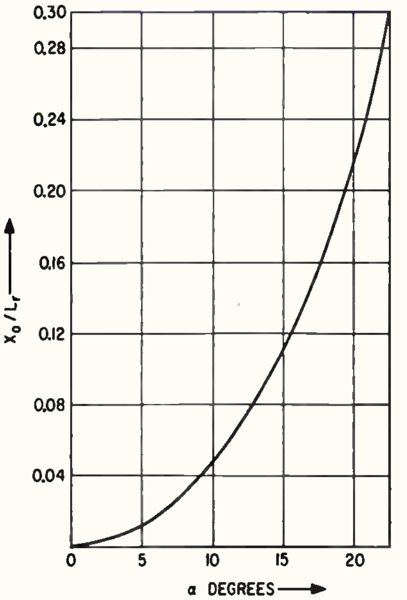


FIG. 2—Displacement of the center of the ellipse from the optical axis

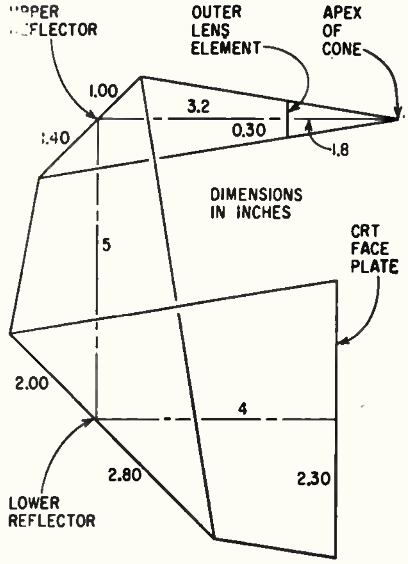


FIG. 3—Periscope design

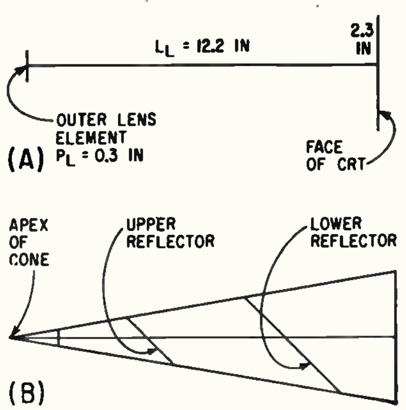


FIG. 4—Second design method

the cone semi-angle, denoted by α, is equated as,

$$\alpha = \tan^{-1} \frac{\rho_M}{L} \qquad (2)$$

The function of a periscope mirror is to bend all the light rays in the cone of Fig 1 (top center) through an angle of 90 deg. Thus, the sketch of Fig 1 (bottom center) reproduces the bounding cone of light, that has an elliptical intercept with the plane of the periscope mirror. This ellipse is the smallest surface that can reflect all the usable light emitted by the crt. When it crosses the optical axis a distance L_r from the apex of the cone, its semi-axes are

$$\frac{a}{L_r} = \frac{\sqrt{2}\tan\alpha}{1 - \tan^2\alpha} \qquad (3)$$

$$\frac{b}{L_r} = \frac{1}{\sqrt{\cot^2\alpha - 1}} \qquad (4)$$

so that the axial ratio is

$$\frac{a}{b} = \sqrt{\frac{2}{1 - \tan^2\alpha}} \qquad (5)$$

In Fig 1 (bottom center), the center of the ellipse is *not* on the optical axis, but displaced x_o.

The offset distance is,

$$\frac{x_o}{L_r} = \frac{\sqrt{2}}{\cot^2\alpha - 1} = \sqrt{2}\left(\frac{b}{L_r}\right)^2 \qquad (6)$$

The axial values may be read from the graph of Fig 1 (right), while the offset between the center of the ellipse and the optical axis is plotted in Fig 2.

As an example, a 5-inch crt with a usable sweep length of 4.6 inches is to be photographed with a 35-mm F/2.3 lens, and the measured value of L_L for the desired image size is 12.20 inches. A two-reflector periscope to fold the optical path as in Fig 1B (left) is to be designed, with the mirrors at 4 and 9 inches from the tube face. Find the dimensions of the reflective surfaces and their offset distances for mounting purposes.

First Method:

The diameter of the aperture of an F/2.3 lens is equal to that of the front lens element when it is wide open. Consequently, the radius is

$$\rho_L = \frac{\text{Maximum diameter}}{2} \qquad (7)$$

$$= \frac{\text{Focal length}}{2\ (\text{F-number of lens})}$$

or

$$\rho_L = \frac{35}{2\,(2.3)} = 7.6 \text{ mm} = 0.3 \text{ in.}$$

Then Eqs (1) and (2) lead to

$$L = \frac{(12.2)\ (2.3)}{2} = 14 \text{ in.}$$

$$\alpha = \tan^{-1}\frac{2.3}{14} = 9.3 \text{ deg}$$

from Fig 1 (right) and Fig 2,

$$\frac{a}{L_r} = 0.240;\ \frac{b}{L_r} = 0.167;\ \frac{x_o}{L_r} = 0.040.$$

The two values of L_r (which is the distance from the apex of the cone to the reflector measured along the optical axis, are 10 and 5 inches. The corresponding mirrors have the design values:

a_1 = 2.40 in.; b_1 = 1.67 in.; x_{o1} = 0.40 in.;
a_2 = 1.20 in.; b_2 = 0.84 in.; x_{o2} = 0.20 in.

The essential periscope dimensions are drawn to scale in Fig 3. The physical structure often is much larger than the bounding cone near the camera in order to retain good mechanical strength. When this is the case, light baffles with inner radii only slightly larger than this cone should be inserted in order to reduce the stray light. The periscope reflectors should not be much larger than the minimum dimensions.

Second Method:

After computing ρ_L by means of Eq (7), the tube face and outer lens element are drawn to scale with the known distance between them, as in Fig 4A. The triangle determined by these two line segments is then completed, and lines at 45 deg are inserted at the reflector positions on the optical axis, as in Fig 4B. This figure represents a cross section of the light cone before the reflectors are actually inserted to fold the light path. Consequently, the major axes of the ellipses and the offset distances can be measured directly on the scale drawing. The minor axes are found from the axial ratio of Fig 1 (right), which shows that for α = 9.3 deg,

$$\frac{a}{b} = 1.434$$

Alternatively, the minor axes may be found by rearranging Eq (6):

$$b = \left[\frac{x_o L_r}{\sqrt{2}}\right]^{1/2} = 0.8409\sqrt{x_o L_r}$$

The results, of course, are identical to those of the first method. In general, the second method is faster and slightly more accurate when the drawing scale is large.

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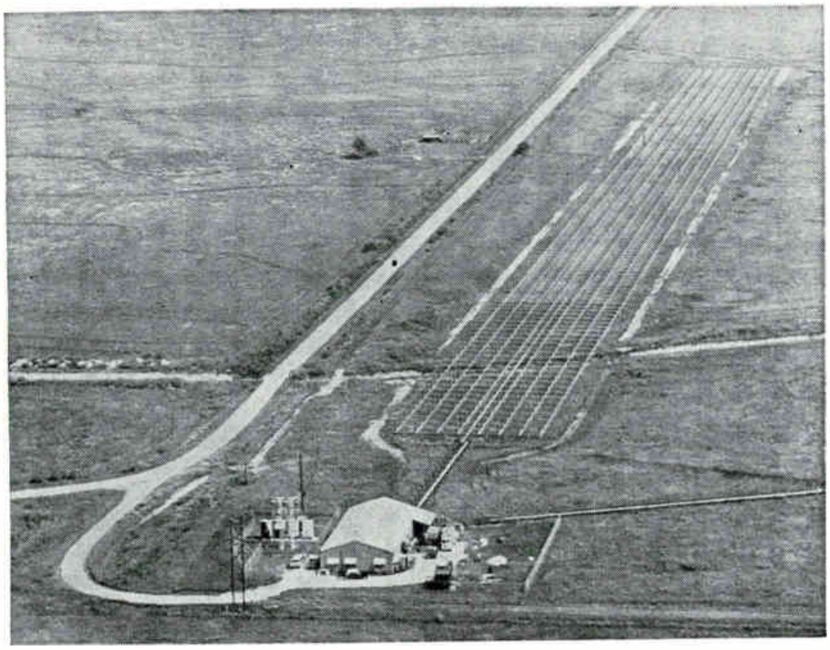
Powerful Vhf Radar Probes Sun's Corona



Half megawatt radar and 1,024-dipole antenna array are gathering data about solar phenomena

LONG-TERM STUDY of radar echoes from the sun is providing valuable scientific information. The continuing systematic experiments could improve prediction of solar activity to avoid interruptions to radio communications and reduce hazards to space exploration.

The detailed study covers 32 radar measurements made during an eleven-week period from April 19 to July 7 near El Campo, Tex. Lincoln Laboratory of MIT is conducting the project with joint U. S. Army, Navy and Air Force support. Although the first radar contacts with the sun were made by Stanford in April 1959, these are the first regular measurements over an extended period.

Scientific Data Provided

Radar studies provide valuable information about the corona, which ejects huge showers of high-energy particles during sunspot activity. The particles cause interruptions of communications and present one of the most serious hazards to space travel. With radio and optical techniques, radar can improve warning of these outbursts, measure their location and intensity and possibly predict them.

One indication of the tests is that the sun is 50 to 100 times less capable of reflecting radio waves than reported by Stanford. However reflectivity increased up to 50 times in later individual tests when solar activity was much more pronounced. Also these measurements are being made at 38.25 Mc, while those of Stanford were made at 26 Mc where reflectivity may be greater. These differences indicate the wide variations in solar phenomena associated with radar reflections and the valuable information that radar can provide.

Thickness of the irregularly shaped corona as observed by radar is comparable to the visible ball of the sun, called the photosphere. Reflection (radar cross section) depends on size of the reflecting object and its reflecting efficiency. Although apparent diameter of the corona at these frequencies exceeds 1.5 million miles, average cross section in the experiments appears to be only a few hundredths the size of the photosphere. This low reflectivity indicates the extent that radio waves penetrating into the corona are absorbed.

Measured cross section at this frequency is substantially less than had been calculated from theoretical models, which are based on assumptions made without detailed information. One assumption is that electron temperature in the corona is about 1 million degrees C. If temperature were assumed to be one-half million degrees, theoretical cross section for a quiet sun would be much closer to that measured.

Effective size and shape of the corona and its changing reflectivity with sunspot activity can be studied systematically with radar. Present observations of a quiet sun indicate that radar echoes were obtained up to a half million miles from the photosphere. The great fluctuations in effective size, shape and intensity of the corona expected because of violent solar activity have already been observed. Long-term radar observations will yield quantitative data about these phenomena.

Radar Penetrates Corona

Radar reflections from the sun are unlike those reflected from solid objects that permit precise range measurements. Signals penetrate the gases of the corona distributing reflections over the depth. This phenomenon combined with the turbulence and irregular shape produce complex radar returns that enable radar studies to obtain data about the nature and extent of electrical phenomena and disturbances.

Violent activity associated with sunspots causes large clouds of high-energy particles to be ejected from the corona that interact with the ionosphere and disrupt radio communications. The effect occurs about 18 hours after the solar activity has been detected. These clouds, which are a menace to space flight, are sometimes sufficiently intense to damage or destroy electronic instruments in space probes. Systematic radar observations can

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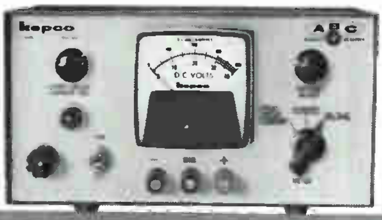

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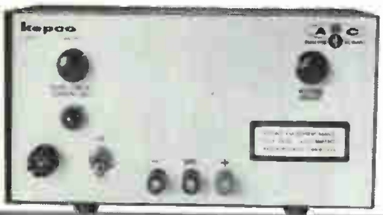

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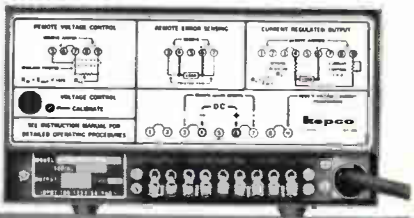

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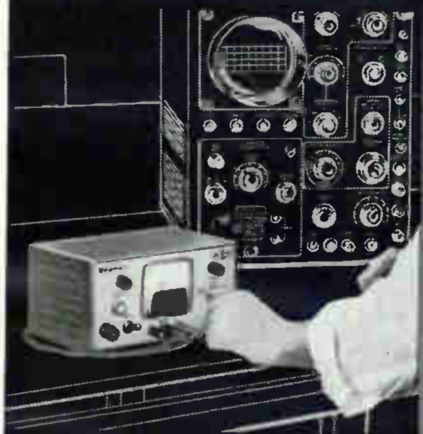

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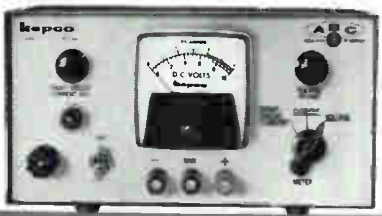

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ABC 15–1	0–15	0–1 amp	4¼″	8 5/32″	9⅝″	$139.00

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be a valuable supplement to radio and optical methods for studying the nature, scale and frequency of these disturbances.

The radar transmitter provides 0.5 megawatt continuous output. It feeds an array of 1,024 dipoles in 8 rows 15 feet apart and about $\frac{1}{3}$ mile long. The fan-shaped beam is 15 degrees in the east-west direction and $\frac{3}{4}$ degree in the north-south direction. It is aimed by adjustment of the individual dipoles.

Since the photosphere subtends an angle of about 0.5 degree viewed from the earth, beam thickness permits observation of the photosphere and the surrounding corona. The sun travels from east to west along the 15-degree beam width in a little over a half hour, which is the time for a complete radar run. The radar transmits continuously for 16 minutes, which is the round-trip time of sun-reflected signals. After 16 minutes when signals begin to return, the transmitter is switched off and the receiver on for 16 minutes.

The 38.25-Mc transmitting frequency is switched up or down 8 Kc every 8 seconds to distinguish echoes from cosmic and sun-generated noise.

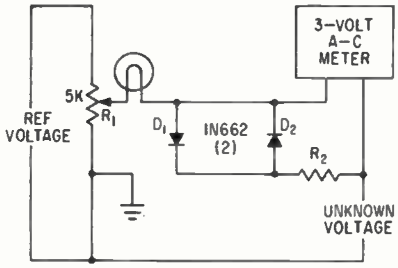
Circuit Permits Accurate Voltage Ratio Measurement

By P. A. LENK,
Reactor Control Labs.
General Dynamics/Electronics.
Rochester, N. Y.

ACCURATE measurement of the ratio of two voltages is provided by a simple circuit using readily available parts. Its resolution is better than 0.1 percent.

The ratio of two voltages must often be measured accurately. For example, it may be necessary to measure an output voltage as a function of a maximum level or to determine linearity in terms of the ratio of input to output voltage.

The circuit in the figure was developed specifically to measure the ratio of two in-phase a-c voltages of about 80 volts rms to within 0.1 percent. Potentiometer R_1 is a ten-turn potentiometer with a ten-turn dial. The diode provides the indication of the ratio between the unknown voltage and a reference voltage. In this case, a value of 5,000



Voltmeter becomes accurate null detector when difference voltage is less than one half volt

ohms was suitable for R_1.

A 115-volt, 6-watt incandescent lamp limits voltage applied to the voltmeter when the difference between the unknown and reference voltages exceeds 0.5 volt. Both R_1 and the lamp must be selected for the particular application, including the maximum power they will be required to dissipate.

The value of R_2 is chosen so that a full-scale deflection is obtained on the meter when the difference between the two voltages is maximum. Thus if the reference voltage were zero, full-scale meter voltage would be equal to the maximum value of the unknown voltage.

Circuit Operating Principles

In operation, diodes D_1 and D_2 conduct when the difference between the unknown and reference voltages exceeds 0.5 volt, and the meter is shunted by R_2. Also, high voltage difference heats the lamp, which further reduces the voltage applied to the meter. The two voltages are balanced by rotating the potentiometer in a direction that reduces the meter deflection.

When the difference between the unknown and reference voltages is less than 0.5 volt, the resistance of the lamp becomes negligible and the two diodes do not conduct. The difference voltage is now applied to the meter with no appreciable series or shunt impedance so that the 3-volt meter becomes a sensitive null detector. At null, the ratio of the two voltages is indicated on the dial of the potentiometer.

The circuit has proved to be useful, particularly since it can be assembled from parts readily available in most laboratories. Accuracy has not yet been fully determined. Resolution is better than 0.1 percent, which is the smallest increment of adjustment provided on the potentiometer.

Devices Featured At Japanese Forum

By CHARLES L. COHEN,
McGraw-Hill World News

TOKYO—Interest here in small devices—crystal resonators, capacitors, resistors, photocells, magnetic materials, varactor diodes, and indicators for transistor circuits—was evidenced by more than 1,000 Japanese engineers who showed up to spot useful components for circuit design at the recent three-day meeting of the Japanese Institute of Electrical Communications Engineers.

Crystal Resonator Wafers

At one of these sessions, Atsushi Tachibana of Hibachi described the construction of quartz crystal resonators on 8 mm sq Al_2O_3 micromodule wafers. Space occupied by the terminals leaves only 6 mm sq space available for mounting crystal. Total height from bottom of wafer to top of metal crystal cover is only 2 mm. Crystal resonators measure 4.3 × 4.3 mm, resonance frequency is 45 Mc, resonance resistance is 20 to 40 ohms.

Another small component seen was the silicon oxide dielectric capacitor, developed by Tsuyoshi Matsunaga of Nippon Electrical Co. The dielectric of this device is Si_2O_3, rather than SiO and SiO_2 previously reported in Japan.

To construct this capacitor, an aluminum electrode is first evaporated on 10-mm-sq glass substrate in vacuum. Si_2O_3 is evaporated at a pressure of 1×10^{-5} mm mercury, and then a second aluminum electrode is evaporated. Entire capacitor is baked after lead connections are made with silver paste.

Area of dielectric between electrodes is 0.25 sq cm, capacitance is 250 pf. Insulation resistance at 20 v d-c is greater than 2×10^5 megohms, tan θ at 1 Kc is better than 5×10^{-4}. Temperature coefficient between −40 and 85 C is 50×10^{-6} per deg C, capacitance change due to temperature cycling is less than 0.02 per cent. However at frequencies above 1 Mc capacitance increases slightly.

Resistors and Thermistors

Tadtsugi Ito, of Waseda University, explained the theory of a potentiometer with no sliding contact. The gap between the parallel or concentric resistance element and the metal pickup element is bridged with CdS. Point of contact is moved by changing the position of a beam of light. Problems still remaining to be solved for practical use are reduction of the resistance of the CdS, which is too high for low-resistance potentiometers, and lowering of the CdS lifetime for fast response.

Precise reproducible thermistors were fabricated by Tomojiro Asaba, of Tokyo Institute of Technology, from 35 to 45 ohm-cm germanium. Chemical etching after fabrication allows precise resistance values to be obtained.

Also small are the silicon photovoltaic cells for card reading in electronic computers, introduced by Hiroyuki Nishimi of Fuji Communications Apparatus Co. Major advantage of units in pilot production, which consist of two rows of nine cells each on the same silicon wafer, is ability to self-check. One row is used for reading, while the second row is used for checking.

Construction is similar to solar batteries. Boron is diffused into a 25 mm diameter wafer of 0.1 to 1 ohms silicon; then grooves are etched to separate individual functional devices on same wafer. Cells on wafer may be in rows, or in multiple rows. Negative electrode is common, leads are attached to individual positive electrodes. Effective area of devices built to date is 1 to 25 sq cm.

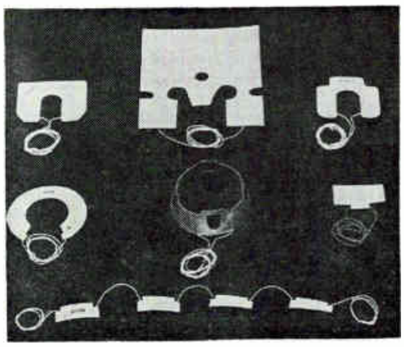
Other advantages include small size, self-generating voltage which eliminates the need for bias sup-

Heat Blanket for Accelerometers

A MOLDABLE, uncured silicone rubber and glass fabric with an aluminum coating on one side is helping to solve heat applications problems in several missile components at Thermal Systems, Inc, formerly Electro-Flex Corp., Gardena, Calif.

In an application on the Minuteman missile, a heater made from the silicone based material, Irvington brand SRGA fabric 0208, (Minnesota Mining and Manufacturing Co.), is used to maintain a constant temperature inside a black box in the autonetics system.

By using SRGA fabric to control environment for two accelerometers inside the box, designers of the heating assembly were able to hold down the weight of the heat blanket, reduce the wattage requirements, conserving the limited power available in the missile, and reduce the insulation necessary to stabilize temperatures within the box.



Typical shapes of heaters for missile electronic components made by Thermal Systems, Inc.

These fabrics are made of specially woven and treated glass base cloth, coated with silicone rubber and a micro-thin facing of vapor coated aluminum which imparts a closely knit surface of highly-reflective particles. Fabrics retain flexibility, drape and heat resistance characteristic of silicon rubber-coated cloths.

plies, fast response, spectral characteristics similar to the human eye, insensitivity to temperature changes, and long life. Output current is approximately 50 $\mu A/mm^2$ for light source of 3,200 K, 10,000 lux; under these conditions output voltage is approximately 0.45 volts.

Also for computers is a method of using commercially available 1.2 mm ferrite cores in memories which feature non-destructive reading. This development, reported by Hiroji Ihara of Nippon Electric Co., makes use of reset, writing and symmetrical reading pulses.

Yukio Fukukawa, of Fuji Communication Apparatus Co., introduced a small three-electrode neon bulb indicator which operates with a small voltage change on its control element. This tube is especially useful as an indicator in transistorized computers and counters. Concept applied is reminiscent of the Philips decade indicator (see ELECTRONICS, Nov. 3, p 60).

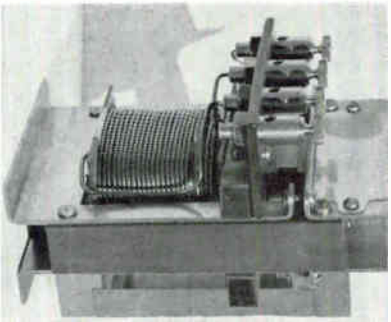
Varactor Diode Application

Akio Sasaki, of Kobe Kogyo, developed a new method of controlling the frequency of reflex klystrons. The change of capacity of reversed biased varactor diodes was used to change the resonant frequency. Microwave Associate's MA 4600 diodes were used in this experiment. With the diodes located in the cavity outside of the evacuated portion of the 7V204 reflex klystron, approximately 2.5 to 10 Mc variation could be obtained at 7,000 Mc.

It would be desirable to vary both repeller and diode voltage simultaneously to realize the following conditions; electron conductance G_e plus circuit conductance G_c equal zero. Electric susceptance B_e plus circuit susceptance B_c equal zero. Then output frequency could be varied over a relatively wide frequency band with almost constant power output. This would enable FM signals with small AM component and low differential modulation distortion to be obtained.

Several means of eliminating interference to X-band radar from rain and snow were explained by Noriomi Ochiai, of Tokyo Keiki Seizocho KK, in the symposium on Aeronautical and Marine Radar. Circularly polarized radiations were used. The metal grid circularizer was developed for marine radars, which customarily use horn-fed reflector antennas. Ochiai showed a comparison of ppi radar patterns made using horizontal polarization and those made using circular polarization. A buoy clearly visible through heavy rain when using circular polarization was completely masked when using horizontal polarization.

Indium Antimonide Used As Voltage Regulator Element



OUTPUT VOLTAGE of this magnetoresistance voltage regulator is kept constant by an indium-antimonide semiconductor, measuring ¾ by ¼ by 0.004 inch, whose resistance varies in proportion to the strength of an applied field.

Designed specifically as a supply source for a tunnel diode, this device is one of the first practical units to use the phenomenon of magnetoresistance. An increase in input produces a stronger field in the electromagnet (coiled wire in the photo), thereby increasing the resistance of the indium-antimonide element.

The regulator can maintain a 0.15-volt output within ±5 per cent at 0.1 amp, even when load resistance changes 50 per cent with a simultaneous 10 per cent change in input voltage, which is normally 1.5 volts. Much more precise regulation than this can be achieved when magnetoresistance is used in regulators with outputs of one volt or more.

The regulator was developed by Battelle Memorial Institute, Columbus, Ohio, as part of a program to determine the feasibility of employing indium-antimonide in electronic devices.

Clock Motor Speeds Servo Motor Tests

By THOMAS POTTS
Servo Dynamics Corp.
Somersworth, N. H.

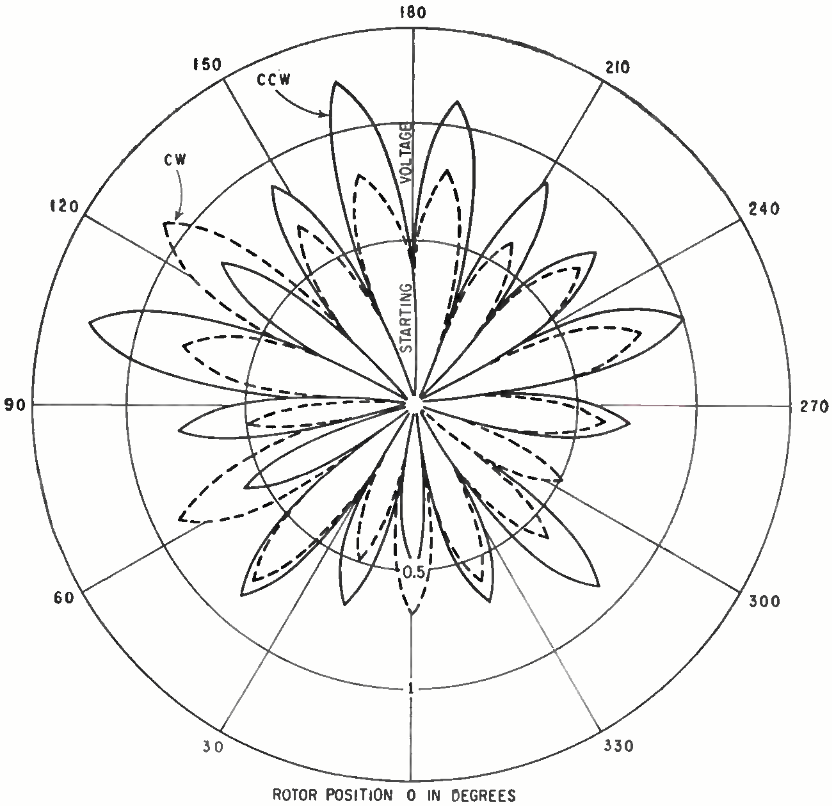


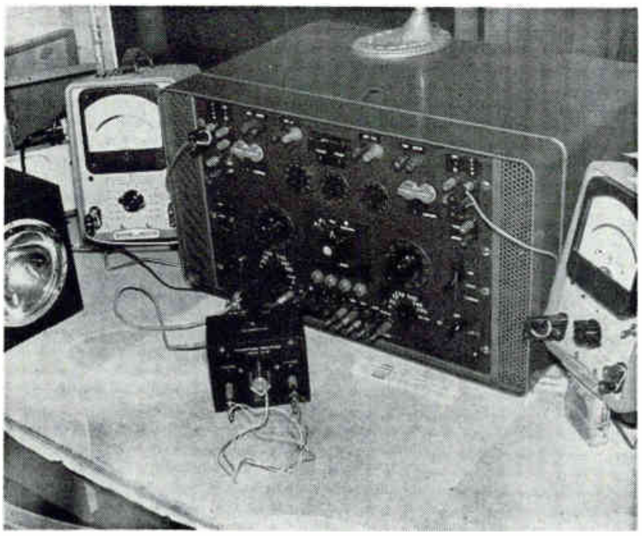
FIG. 1—Plots of starting voltage for cw and ccw rotation. Rotor slots create localized effects where starting voltage essentially goes to zero

MANY SERVO MOTORS in use today have never met the starting voltage requirement they were designed and tested for, due to the inadequacy of the methods and test procedures used to measure starting voltage. Over the past few years many different methods of measuring the starting voltage of a servo motor have been tried,[1, 2, 3, 4, 5] but all give values that are inconsistent and unrepeatable; usually the test must be repeated several times and the poorest result used as the best approximation. Even after tests have been run many times, it is still possible that the poorest value for a particular unit has not been found[6].

Plots of starting voltage versus the initial position of the shaft may, under some conditions on some units, vary as much as five to one. In addition, clockwise and counterclockwise tests (Fig. 1) shows that variations in maximum and minimum values of starting voltage are not necessarily the same for both directions of rotation. This is caused by magnetic and electrical anomalies, not bearing friction as is generally supposed.

To insure that a servo motor will always start in a system at rated starting voltage, the testing method should meet several requirements: it should be practical for production testing, find all the points of high starting voltage for both directions of rotation, be easily and quickly accomplished with a minimum of extra equipment, and be repeatable from day to day and be independent of test operator judgment.

In actual system use, servo motors are almost never run no-load. In most systems either a tachom-



Servo motor test set-up showing special fixture for motor and related measuring equipment

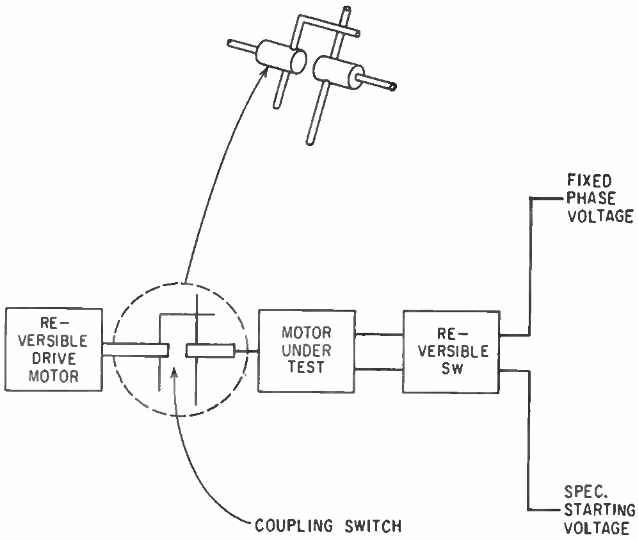
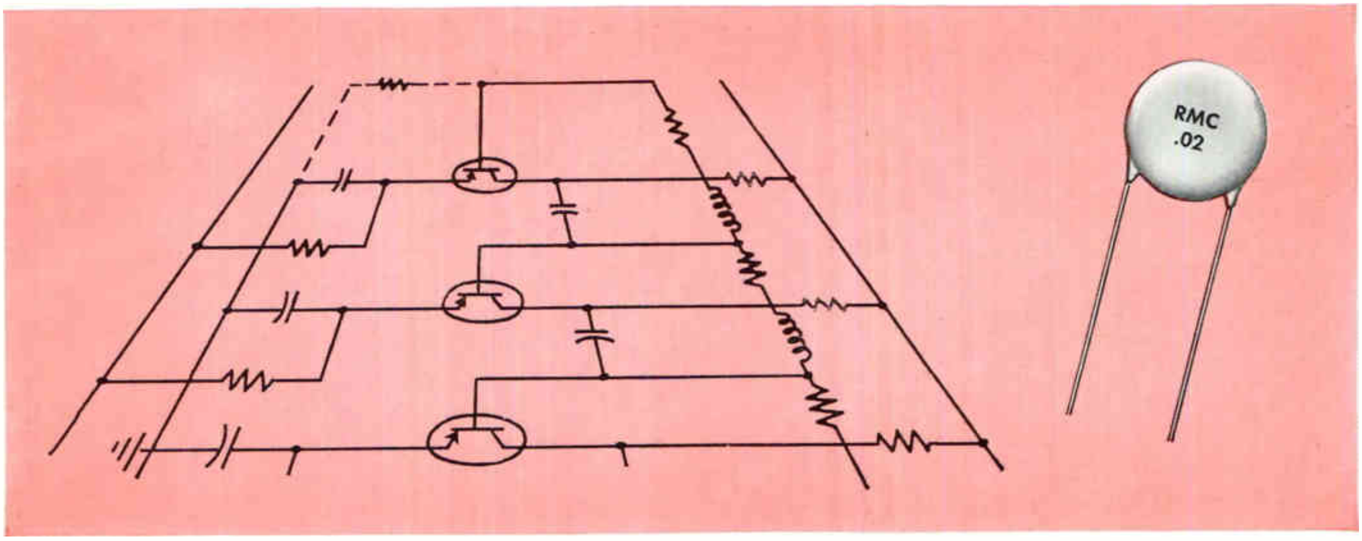


FIG. 2—Clock motor is enough load on the servo motor to stop it if starting torque is below specs

RMC "HEAVY DUTY"

BY-PASS DISCAPS®



SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)

POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 2000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

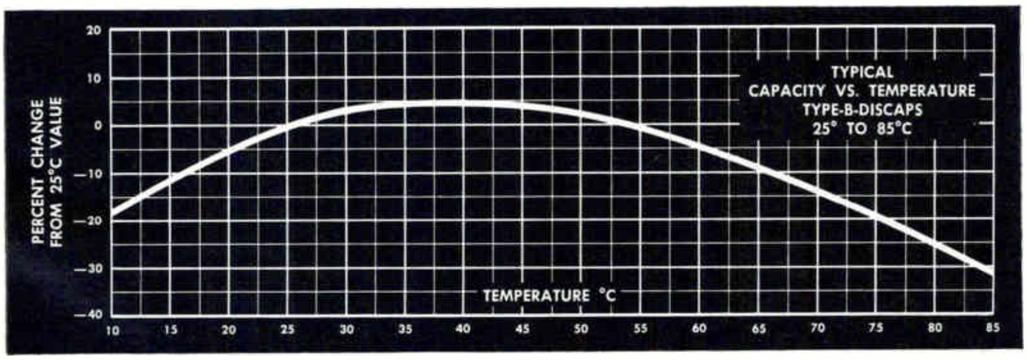
INSULATION: Durez phenolic—vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

Type B DISCAPS meet or exceed all EIA RS-198 specifications for Z5U ceramic capacitors. Designed for by-passing, coupling, or filtering applications, Type B DISCAPS are manufactured in capacities between .00015 and .04 MFD.

A heavy ceramic dielectric element provides a safety factor where steady or intermittent high voltages occur. Type B DISCAPS show a minimum capacity charge between +10°C and +85°C (see curve).



DISCAP CERAMIC CAPACITORS

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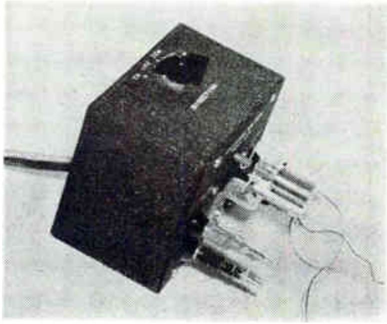
CIRCLE 63 ON READER SERVICE CARD

eter, synchro, gear train, indicator, etc., presents some small load to the motor. Further, tests indicate that under conditions of a small load, the variations in maximum and minimum starting voltages increases. Thus there are larger discrepancies in the characteristics of a motor in a system than are predictable from normal methods of measuring starting voltage. To meet all of the above requirements, Servo Dynamics Corp. developed a method for testing each motor for all positions of the rotor in both directions of rotation, under conditions of a very light load. This test, shown in Fig. 2, is simple, quick, eliminates operator judgment, and gives repeatable results in production.

The reversible drive motor is a low speed clock motor connected to run so that the drive half of the



As long as the two halves of the coupling remain in contact, servo motor meets starting voltage specs

coupling linkage moves in the same direction as the motor under test. Thus the linkage acts as a brake or load on the motor being tested. During the test the servo motor is energized with normal fixed phase voltage and with specified maximum starting voltage on the control phase. The reversible drive motor is then run and the operator observes whether or not the two halves of the coupling linkage remain touching at all times during one complete rotation of the motor output shaft. The phase of the control voltage is then reversed and the drive motor is reversed. The test is then re-run, again observing whether or not the two halves of the coupling linkage remain touching for one revolution. If the servo motor stops, allowing the two halves of the coupling linkage to separate, then the starting voltage of the servo motor exceeds the specified maximum. The test has been valuable for production testing since it is a uniform and reproducible method that is wholly determined by the motor itself and is independent of the skill or judgment of the test operator.

To find the actual maximum or minimum starting voltage of a motor, the voltage on the control phase can be adjusted until the motor under test just rotates for both directions of test without permitting the linkage halves to separate. To eliminate marginal units, all motors can be tested at 95 percent of specified starting voltage.

REFERENCES

(1) ARP-497, "Aeronautical Recommended Practice-Precision Control Motors", SAE.
(2) ARP-667, "Aeronautical Recommended Practice-Precision Motor Tachometer Generator", SAE.
(3) MIL-S-17087, "Servo Motors-2 Phase, 400 Cycle".
(4) MIL-S-17806, (NOrd), "Servo Motor-Tachometer Generator, 2 Phase, 400 Cycle".
(5) MIL-S-22432 (WEP), "Servo Motors-General Specification".
(6) Bureau of Naval Weapons, "Study of Standardization of Servo Motor and Tachometer Generator Acceptance Test Equipment," June 1960. Contract N164-8637 of Lockheed Electronics.

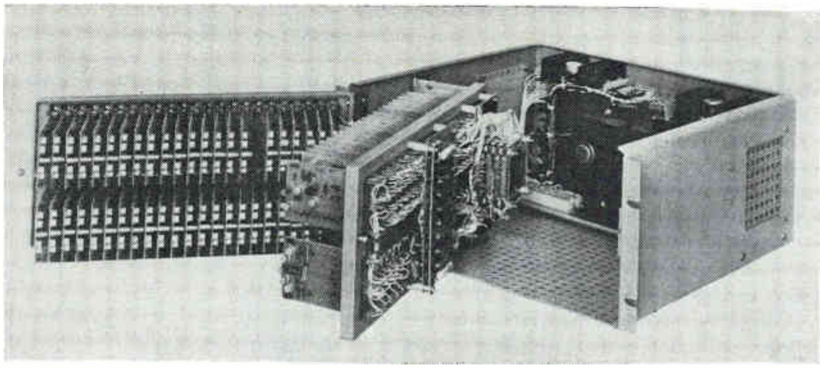
Silicon Rectifiers Directly Soldered

A DIRECT soldering technique has been developed for manufacturing silicon power rectifiers. The method uses a diffused silicon junction to which copper disks are soldered; molybdenum or tungsten washers are not required. Cells with current ratings to 400 amps, and with peak inverse voltage ratings from 1,000 to 1,200, can be produced.

The technique is based on the stress, strain and thermal expansion characteristics of silicon and copper. Calculations show, and experiments confirm, that if t_c/D is approximately 0.2 or greater (where t_c is the thickness of the copper electrodes and D the diameter), and if t_s/D is approximately 0.02 or less (where t_s is the thickness of the silicon disk and D its diameter), thermal stresses will not be strong enough to cause rectifier failure during normal operation. The two copper disks are the same diameter as the silicon disk and are the outer layers of the rectifier sandwich.

Otomi Fujii describes the process in the Summer 1961 issue of Toshiba Review.

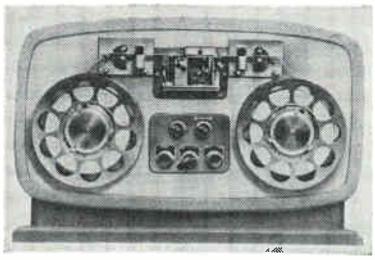
New On The Market



Memory Systems
COINCIDENT CURRENT

DAYSTROM, INC., Archbald, Pa. Military derived coincident current memory systems offering cycle times to 3.5 μsec are available at commercial prices. The CCM series is available in random access, sequential-interlaced and sequential-non-interlaced models. Design permits modular construction and facilitates incorporation of the unit in a wide variety of data handling systems. A variety of memory capacities are available with word sizes to 4096 and bit lengths to 64. Capable of operating with a temperature range of 10 C to 35 C.

CIRCLE 301 ON READER SERVICE CARD



Tape Storage Unit
MILE-A-MINUTE

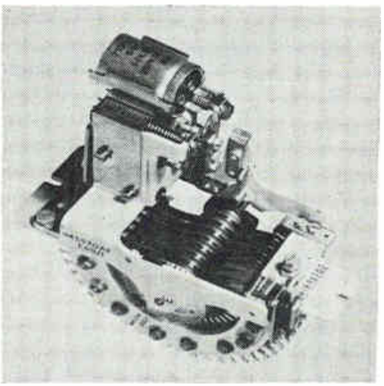
INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., 320 Park Ave., New York 22, N.Y. The ITT British associate, Creed & Co. Ltd., has introduced a tape storage unit that provides automatic retrieval and read-out of prepunched tape data on reels revolving at speeds of 60 mph. Model 2000 has a capacity of 240,000 alphanumeric characters per reel. Maximum access time is 13 sec.

CIRCLE 302 ON READER SERVICE CARD

Transponders
SMALL AND LIGHT

AERO GEO ASTRO CORP., 1200 Duke St., Alexandria, Va. The AGA S/T-CV and AGA C/T-CV transponders weigh slightly more than 5 lb each. These units, designed for use in missiles and drone targets, increase the volume of radar signals from the missiles or drones, thus aiding ground stations in tracking and other operations.

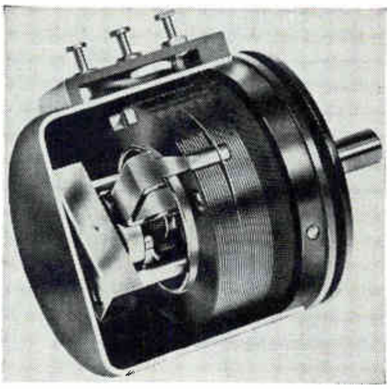
CIRCLE 303 ON READER SERVICE CARD



Stepping Switch
UNIFORM RATCHET WEAR

DAVIS RELAYS LTD., P.O. Box 549, Times Square Station, New York 36, N.Y. Stepping switches give 250 million operational steps in accelerated life tests; hence a stepper with 5 bands of 50 contacts and costing \$24.70 scans a million inputs for just under two cents. Staggered wiper-and-brush springs provide uniform ratchet wear and smoother stepping. Electrical contacts are rated at 3 amp when the stepper is at rest and 1 amp when the rotor is turning. Stepper has application in systems that require a programmed sequence of operations.

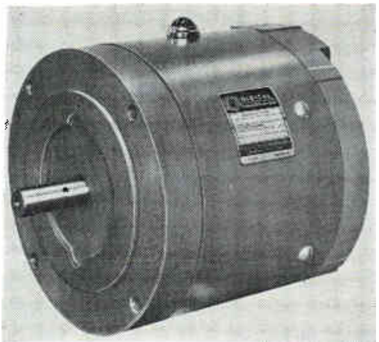
CIRCLE 304 ON READER SERVICE CARD



Wire-Wound Pot
FINE RESOLUTION

VOGUE INSTRUMENT CORP., 2350 Linden Blvd., Brooklyn 8, N.Y. Based on a lift slidewire design, model 181-S pot combines infinite resolution with stability of wirewound pot. Wiper rides on a lead screw and the wire is always in contact with one point only on the wiper blade. With continuous rotation and life, the unit develops lower noise. Resistance ranges: from 2 to 750 ohms per turn, with a max of 40 turns available. Linearity can be maintained to 0.01 percent.

CIRCLE 305 ON READER SERVICE CARD



Pulse Generator
FOR INDUSTRIAL USE

RELIANCE ELECTRIC AND ENGINEERING CO., Cleveland 17, O. Pulse gen-

THE SIZE DIMINISHES; THE POWER REMAINS AS HIGH

Tiny New 3/8″ (0.375″) Squaretrim® Potentiometer Dissipates One Full Watt In Still Air!

The performance of this new Daystrom subminiature Squaretrim is as great as its half-inch cousins. Further, the one-watt rating is based on *still-air tests*...typical of our conservative specifications. Contained in a stackable package only ⅜″ square and just ⅛″ thick, the new Series 200 Squaretrims permit great circuit density (27 per cubic inch) and the 144 different models offered give wide design latitude. The Series 200 Squaretrims range from 10 ohms to 35K, operate from −55 to +150°C, and need no mounting brackets for stacking. A true precision instrument with all the exclusive features of the Daystrom line, this new potentiometer is designed to meet MIL R-27208 and MIL R-22097. Write for detailed information.

DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA

CIRCLE 67 ON READER SERVICE CARD

erator is designed for industrial digital control systems. Device is a quantizer that provides a digital output that is a function of the speed or accumulated rotary position of its input shaft. It is constructed to withstand the normal abuse of in-plant usage. It will operate from zero speed up to 4,000 rpm and accurately generate a maximum of 15,000 pps. Each pulse is a 15 v square wave at all speeds, with a minimum duration, at top speed, of 25 μsec.

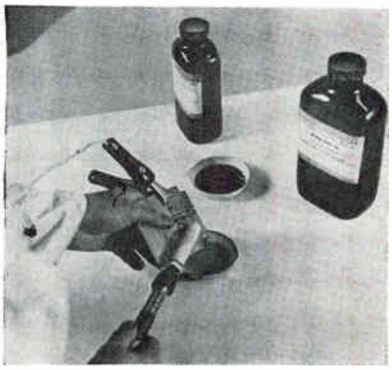
CIRCLE 306 ON READER SERVICE CARD

Controlled Rectifiers

UP TO 600 VOLTS

SEMICON, INC., 200 Sweetwater Ave., Bedford, Mass. These semiconductor triode switches are designed for use in power control and high current switching applications requiring blocking voltages up to 600 v. Units are applicable for load currents up to 5 amp. Long leakage path eliminates voltage breakdown between terminal and case. A triple diffused silicon pellet makes for maximum uniformity and reliability. Units exceed MIL-E-1 and MIL-S-19500B.

CIRCLE 307 ON READER SERVICE CARD



High-Speed Electrolytes

SELECTIVE PLATING

SELECTRONS, LTD., 153 E. 26th St., New York 10, N. Y., announces high-speed selective electroplating solutions, intended for use with the company's table-top electroplating systems. By means of special styluses and power- packs, controllable amounts of alloys, as well as metals, are deposited on selected areas without having to immerse the entire object in electrolyte.

CIRCLE 308 ON READER SERVICE CARD

Literature of the Week

IR TEST INSTRUMENTATION Infrared Industries, Inc., Box 989, Santa Barbara, Calif. A brochure describes a line of laboratory and production test equipment for infrared components and systems. (309)

SERVO ACCELEROMETER Gulton Industries, Inc., 212 Durham Ave., Metuchen, N.J. A technical bulletin describes and illustrates Glennite unidirectional, biaxial and triaxial servo accelerometers. (310)

TRANSDUCER POWER SUPPLY & BALANCE Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif. Data sheet PB-1 describes transducer power supply and balance units, models PB-290 and PS-290. (311)

STATIC RELAY Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N.J. Bulletin PS-9 describes the ult-Relay, an ultrasensitive static relay. (312)

HEAT SINKS Astro Dynamics, Inc., Second Ave., Northwest Industrial Park, Burlington, Mass., has prepared a manual for rapid selection of the proper heat sink to meet specific conditions. (313)

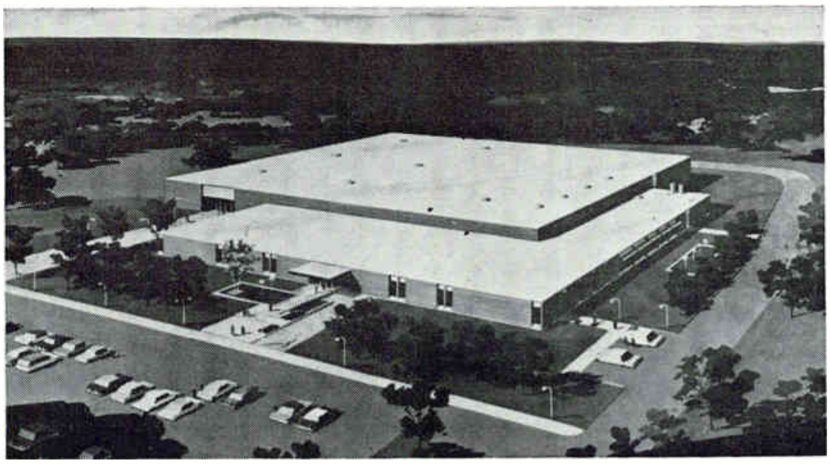
VOLTMETERS Trio Laboratories, Inc., Dupont St., Plainview, L.I., N.Y. Engineering bulletin catalogs a complete line of single and multi-range a-c and d-c vacuum-tube and transistorized voltmeters. (314)

R-F CONVERTERS Centimeg Electronics, 312 E. Imperial Highway, El Segundo, Calif. R-F amplifiers and converters are described in data sheet 1161. (315)

COMPUTER ELEMENTS Ransom Research, 374 W. Eighth St., San Pedro, Calif. Catalog C covers a line of printed-circuit, solid-state computer elements. (316)

MICROWAVE DEVICES Microwave Technology Inc., 235 High St., Waltham 54, Mass. A four-page short form catalog describes over 75 advanced microwave devices. (317)

TEST LEADS & COAX CABLES Angler Industries, Inc., 75 Winthrop St., Newark 4, N.J. Four-page catalog constitutes a handy quick ordering guide to a full line of test leads and coaxial cables. (318)



Filtors Erecting Space Age Plant

FILTORS, INC., Huntington, L.I., N.Y., recently broke ground for construction of what its officials termed "the factory of the future." When completed next fall, the plant will produce hermetically sealed subminiature and microminiature relays on an automated production line in controlled atmosphere under ultraclean conditions.

The company also recently announced a research program to develop a "second generation of super-reliable relays" to be produced in the new plant.

Filtors' new facility will occupy 62,900 sq ft on 22 acres in the Township of Huntington, about 40 miles from downtown Manhattan. The single-story structure will have double walls of concrete blocks separated by a 4-in. air pocket. The production area, totalling 37,900 ft, will be windowless and be equipped with a 220-ton air conditioner, a humidity-control system that will maintain a relative humidity of 50 percent, and an electrostatic dust filtering system. In addition, 1,600 sq ft have been set aside within the production area for a "white room." In this room, which has extra atmosphere control, technicians garbed in lint-free clothing will assemble the new relays.

According to C. G. Barker, vice president for sales, the new facility will permit an annual sales volume of over $12 million compared with $8 million at present. The plans provide for expanding production capability to about $20 million annually.

At the present rate of production, Filtors will employ approximately 400 people and bring an annual payroll of more than $2 million to the Suffolk County area.

Micro Link Acquires Additional Space

FURTHER expansion of the activities of the Micro Link Corp. has necessitated the leasing of additional space at 1355 Marconi Blvd., Copiague, L. I., N. Y.

The Micro Link Corp., a wholly owned subsidiary of LEL Inc., is engaged in the development and manufacture of low cost point-to-point microwave links for use on frequencies allocated to the business radio services.

Honeywell Buys Denver Plant

MINNEAPOLIS-HONEYWELL REGULATOR CO. announced it has purchased the Thompson Ramo Wooldridge plant near Littleton, Colo.

James H. Binger, Honeywell president, said the company will use the 146,000-sq ft building as manufacturing and engineering headquarters for its Denver-based division.

Currently, Honeywell's Denver operation employs 550 people. It will have moved into the new location by New Year's Day, according to William D. Owens, general manager.

Owens also said production of certain products previously made by Honeywell in a leased facility at Beltsville, Md., will be integrated into the Denver operation. These include high-speed magnetic tape data recording and playback systems for industrial, military and scientific uses.

Pietenpol Joins IBM Components

WILLIAM J. PIETENPOL has joined IBM's Components division in Poughkeepsie, N. Y., as manager of component development. He comes to IBM from Sylvania Electric Products, Inc., where he was vice president and general manager of the Semiconductor division.

From 1950 to 1958, Pietenpol was with Bell Telephone Laboratories, serving as director of development, semiconductor devices, for three years.

Bart Manufacturing Appoints Marvin

APPOINTMENT of Albert A. Marvin, formerly with Amphenol-Borg Co., to the post of manufacturing manager for the Bart Mfg. Corp. and its subsidiary, F. C. Kent, Inc., both in Newark, N. J., is announced.

Bart Mfg. is engaged primarily in the electroforming of electronic

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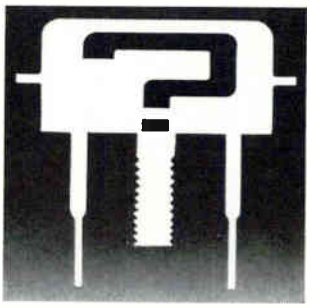

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You see, Delco has made more power transistors than anybody else around. We've made them in all sizes. Diamond and round base. Industrial and military. In a wide variety of parameters. For endless applications. With high reliability. ■ Sometime—perhaps today—you may be looking for a transistor that's not in our catalog . . . or <u>any</u> catalog. You may need samples or production quantities. Chances are we already have it, and at a price you'll like. ■ Clip the coupon, fill in the information and mail to our nearest office, listed below. Your inquiry will be processed immediately.

GENTLEMEN: I need a power transistor that will meet these specifications.

Collector diode voltage________________

Emitter diode voltage________________

Emitter current (continuous)________________

Base voltage________________

Saturation voltage________________

Thermal resistance (junction to case)________________

Thermal capacity for pulses in the 1 to 10 millisecond range________________

Collector to emitter voltage________________

Estimated quantity required________________

My name________________

Company________________

Street address________________

City________________Zone______State__________

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Division of General Motors
Kokomo, Indiana

DELCO RADIO
DEPENDABILITY
RELIABILITY

components and components for missile and space applications.

Kent is a precision tube bending concern which produces components for aircraft and missiles and makes waveguide forms for the electronic industry.

American Electronics Elects Loomis

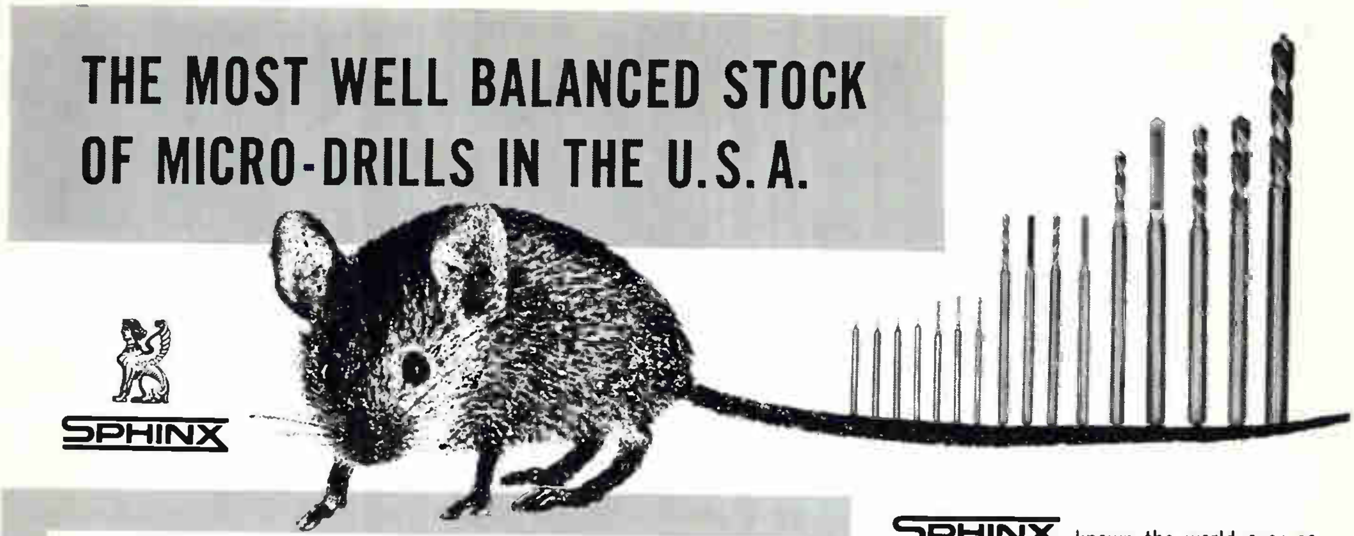
ROBERT C. LOOMIS has been elected president and chief executive officer of American Electronics, Inc., Fullerton, Calif., effective January 1, 1962. Prior to joining the firm, he was president of the Convair San Diego div. of General Dynamics.

In his new post, Loomis will be in full charge of the company's multi-division operations in Fullerton and Culver City, Calif.

PEOPLE IN BRIEF

David D. Doran, formerly with Daystrom, Inc., named director of R&D for the Van Dyck Corp. **Thomas H. Miller** leaves Vitro Laboratories to join Frederick Research Corp. as director of engineering. Geophysics Corp. of America promotes **Richard D. Coons** to v-p and mgr. of technical operations. **Dan Cameron,** ex-Litton Industries, now on technical staff of Computer Control Co. **Robert E. Shuken,** previously with ACF Industries, appointed electronic projects mgr. at Northeastern Engineering, Inc. **Cecil R. Frost** and **Arthur S. Sheppard,** formerly with Rocketdyne and Electronic Specialty Co., respectively, hired by Canoga Electronics Corp. as senior project engineers. **Harrison Randolph** leaves Northern Ordnance, Inc., to become v-p and g-m at Raven Industries, Inc. **Wellesley J. Dodds,** ex-Bomac Laboratories, now chief engineer of beam tubes at Metcom, Inc. **Edwin Greenstein,** formerly with Teleprompter Corp., appointed v-p in charge of engineering for Video Engineering Co., Inc. **Dean Knutson,** previously with Telemeter Magnetics, Inc., joins Electronic Memories, Inc., as senior applications engineer. **Rodolfo M. Soria,** v-p research and engineering, Amphenol-Borg Electronics Corp., is elected a director of the company.

THE MOST WELL BALANCED STOCK OF MICRO-DRILLS IN THE U.S.A.



SPHINX

IN STOCK FOR IMMEDIATE DELIVERY

TYPE	STYLE	STOCK SIZES
Spirec Pivot Drills	Right Hand	0.10mm to 3.00mm by 0.01mm increments
Flat Pivot Drills	Right Hand	0.04mm to 1.00mm by 0.01mm increments
Spirec Pivot Drills	Left Hand	0.10mm to 1.00mm by 0.01mm increments
Spirec Center Drills	Right Hand	0.10mm to 0.70mm by 0.05mm increments

Other sizes and styles available on special request.

SPHINX known the world over as the symbol of the finest in micro-drills. Insist on them by name. Your best assurance of quality and precision.

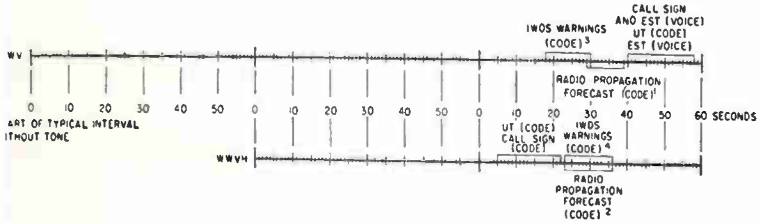
SEND FOR COMPLETE DRILL CIRCULAR

LEVIN®

LOUIS LEVIN & SON, INC.

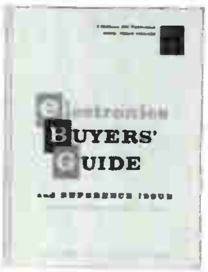
3573 Hayden Ave., Dept. E • Culver City, California

CIRCLE 204 ON READER SERVICE CARD



PRIMARY STANDARDS

Whether you want to pace a city's clocks or time the transit of an artificial satellite, you'll find the standard time intervals and frequencies broadcast by the National Bureau of Standards of vital assistance.
You'll find a complete run-down on this NBS service in your 1961 **electronics** Buyers' Guide and Reference Issue, plus information on how you can obtain NBS calibration of practically any secondary standard, from resistance to the complex elements of the tensor permeability matrix.
Wealth of information like this makes your 1961 EBG a primary reference volume in the electronics field.
You'll find new uses for it every day.



electronics BUYERS' GUIDE and Reference Issue

The Basic Buying Guide in Electronics *since 1941*

SENIOR, JUNIOR ELECTRONICS ENGINEERS

NOW OPEN: TOP-LEVEL POSITIONS IN A TOP-LEVEL COMPANY IN THE FIELD OF PRECISION MATERIALS TESTING . . .

Inventiveness and ingenuity are essential requirements for these positions, and some mechanical experience would be helpful. You will be designing electronic and electromechanical instruments including analog and digital systems for the physical studies of materials.

Some experience is required in general electronics, servo-mechanisms, transistor and relay circuitry, and transducers. Opportunity to participate in a variety of interesting projects, as well as introduce new concepts of instrumentation in the field of materials testing.

About INSTRON and OPPORTUNITY . . .

Instron is an acknowledged front-runner in the field of instrumentation for precision materials testing. This is not only a stimulating and exciting area — it is a growth field if there ever was one. We choose our engineers with care, and when we've found the right man we do everything in our power to make him want to stay. If you're looking for a challenging and rewarding opportunity, CALL 828-2500 OR SEND YOUR RESUME TO D. R. ERB.

INSTRON®

ENGINEERING CORPORATION
2500 Washington St., Canton, Massachusetts

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

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

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

STRICTLY CONFIDENTIAL

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

WHAT TO DO

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

COMPANY	SEE PAGE	KEY #
EITEL-McCULLOUGH, INC. San Carlos, California	55*	1
ERIE ELECTRONICS DIVISION Erie Resistor Corp. Erie, Pennsylvania	75	2
ESQUIRE PERSONNEL SERVICE, INC. Chicago, Illinois	55*	3
GPL DIVISION General Precision Inc. Pleasantville, New York	75	4
INSTROM ENGINEERING CORP. Canton, Massachusetts	73	5
MICROWAVE SERVICES INTERNATIONAL INC. Denville, New Jersey	75	6

* These advertisements appeared in the 12/22/61 issue.

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME ....

HOME ADDRESS ....

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

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check)

12291

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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

Method for measuring an engineer...

What's his technical publication?

When an engineer pays for a technical publication, it's a safe bet that that is the one he respects most.

He makes it his business to read **electronics**. It keeps him well informed of up-to-the-minute events and developments in the electronics industry and the technology to which he contributes his experience.

Where your recruitment program calls for engineers and other technical people of this calibre, you can reach them in the EMPLOYMENT OPPORTUNITIES section of:

electronics

A McGRAW-HILL PUBLICATION

CLASSIFIED ADVERTISING DIVISION

POST OFFICE BOX 12 NEW YORK 36, NEW YORK

NATIONAL COVERAGE

EMPLOYMENT OPPORTUNITIES

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

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

DISPLAYED ———RATES——— UNDISPLAYED

DISPLAYED

The advertising rate is $40.17 per inch for all advertising appearing in other than a contract basis. Contract rates quoted on request.

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

Subject to Agency Commission.

UNDISPLAYED

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

Box Numbers—counts 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 to CLASSIFIED ADV. DIV. of ELECTRONICS, P.O. Box 12, N. Y. 36, N. Y.

TV ENGINEER

To evaluate closed circuit TV equipment designed and manufactured by the company. This involves design of test equipment, preparation of test procedures and review of test data.

Education: equivalent of EE degree required. Must have 2-3 years experience in operation and maintenance of studio or industrial TV equipment.

Please write or submit resume indicating current earnings to: Raymond L. Oakley.

GPL DIVISION
GENERAL PRECISION, INC.

63 Bedford Road, Pleasantville, N. Y.
An Equal Opportunity Employer

TRANSFORMER ENGINEER

With experience in the design and development of Hi-Frequency and Pulse transformers for commercial and military applications.

Ideal opportunity for ambitious man to develop full potential of present small department. Salary—open. Location—Erie, Pa. Call or send resume to Chief Engineer

Erie Electronics Division

Erie Resistor Corporation

645 West 12th Street, Erie, Pa.
GL 6-8592

FOR INFORMATION

About Classified Advertising

Contact The McGraw-Hill Office Nearest You

ATLANTA, 9
1375 Peachtree St. N.E. — TRinity 5-0523
D. HICKS

BOSTON, 16
Copley Square — COngress 2-1160
M. SHOUVLIN

CHICAGO, 11
645 No. Michigan Ave. — MOhawk 4-5800
W. J. HIGGENS

CLEVELAND, 13
1164 Illuminating Bldg. — SUperior 1-7000
I. C. HILL

DALLAS, 2
1712 Commerce St., Vaughn Bldg. — Riverside 7-5117
J. GRANT

DENVER, 2
1700 Broadway—Tower Bldg. — ALpine 5-2981
J. PATTEN

DETROIT, 26
856 Penobscot Bldg. — WOodward 2-1793
WM. H. GINDER, JR.

HOUSTON, 25
Prudential Bldg., Holcombe Blvd., Rm. W-724 — JAckson 6-1281
J. PAGE

LOS ANGELES, 17
1125 W. 6th St. — HUntley 2-5450
W. C. GRIES

NEW YORK, 36
500 Fifth Ave. — OXford 5-5959
H. T. BUCHANAN
T. W. BENDER - P. BOND

PHILADELPHIA, 3
Six Penn Center Plaza — LOcust 8-4330
W. B. SULLIVAN - F. W. McCARTHY

PITTSBURGH, 22
4 Gateway Center — EXpress 1-1314

ST. LOUIS, 8
3615 Olive St. — JEfferson 5-4867

SAN FRANCISCO, 11
255 California St. — DOuglas 2-4600
J. A. HARTLEY

COMMUNICATIONS APPLICATION ENGINEER

Analysis of advanced electronic communication systems including radio, carrier, telephone, microwave:

Must have design and marketing experience with commercial and military users.

EE degree, 5 yrs. exp. min.

Send Resume to:

Microwave Services International Inc.
Consulting Engineers
Route 46, Denville, N. J.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

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

PROPOSALS, $2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

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

SPECTRUM ANALYZERS

Vectron Mod. SA25 with 20 LI Plug in head—Freq. 800-2400 MC $895.00 complete. used, good cond.

BEACON ELECTRONICS
1226 S. 26th St. Phoenix 34, Arizona

CIRCLE 460 ON READER SERVICE CARD

FOR RENT:

PATERSON, N. J. 1 st. Brk. 26.000 ft. 11.500' bsmt. spkld. Hi pressure stm. RR siding, fenced yd. unrstd. Exc. cond.

FR-8033, Electronics
Class Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

CIRCLE 461 ON READER SERVICE CARD

INDEX TO ADVERTISERS

Audited Paid Circulation

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

INDEX TO CLASSIFIED ADVERTISERS

• See Advertisement in the July 20, 1961 issue of Electronics Buyers' Guide for complete line of products or services.

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

electronics

Audit Bureau of Circulations

Associated Business Publications

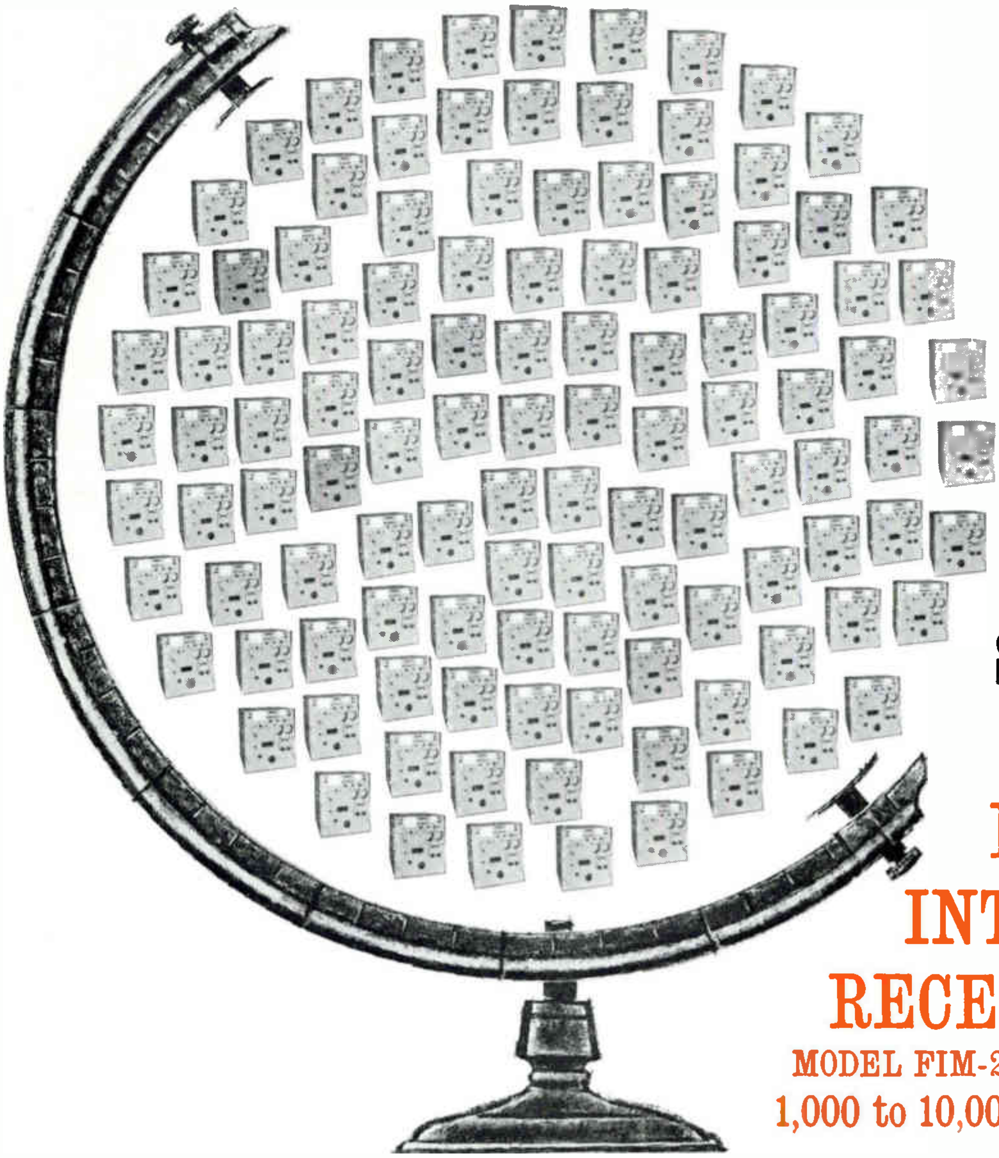
Audited Paid Circulation

JAMES T. HAUPTLI
Advertising Sales Manager

R. S. QUINT:
Assistant Publisher Buyers' Guide and Business Manager
FRED STEWART:
Promotion Manager
B. ANELLO:
Marketing Service Manager
RICHARD J. TOMLINSON:
Production Manager
GEORGE E. POMEROY:
Classified Manager
HUGH J. QUINN:
Circulation Manager

ADVERTISING REPRESENTATIVES

NEW YORK (36):
Donald H. Miller, Henry M. Shaw, George F. Werner
500 Fifth Avenue, OXford 5-5959
BOSTON (16):
William S. Hodgkinson, Donald R. Furth
McGraw-Hill Building, Copley Square, Congress 2-1160
PITTSBURGH (22):
David M. Watson
Four Gateway Center, Express 1-1314
PHILADELPHIA (3):
Warren H. Gardner, William J. Boyle
6 Penn Center Plaza, LOcust 8-4330
CHICAGO (11):
Harvey W. Wernecke, Robert M. Denmead
645 North Michigan Avenue, Mohawk 4-5800
CLEVELAND (13):
Paul T. Fegley
55 Public Square, Superior 1-7000
SAN FRANCISCO (11):
R. C. Alcorn
255 California Street, Douglas 2-4600
LOS ANGELES (17):
Peter S. Carberry, Ashley P. Hartman
1125 W. 6th St., Huntley 2-5450
DENVER (2):
J. W. Patten
Tower Bldg., 1700 Broadway, Alpine 5-2981
ATLANTA (9):
Michael H. Miller
1375 Peachtree St. N.E., Trinity 5-0523
HOUSTON (25):
Joseph C. Page, Jr.
Prudential Bldg., Holcomb Blvd., Jackson 6-1281
DALLAS (1):
Frank Le Beau
The Vaughn Bldg., 1712 Commerce St.
Riverside 7-9721
LONDON W1:
Dennis McDonald
34 Dover St.
FRANKFURT/Main:
Stanley R. Kimes
85 Westendstrasse
GENEVA:
Michael R. Zeynel
2 Place du Port



A WORLD WIDE STANDARD POLARAD FIELD INTENSITY RECEIVERS

MODEL FIM-2

1,000 to 10,000 mc.

Hundreds of Polarad Calibrated Field Intensity Receivers are in use today throughout the world. Why?

...because the FIM series, in production since 1956, offers ±1db accuracy because of its self-contained signal generator.

...because the Model FIM-2 is the only single unit microwave system capable of measuring rf interference and susceptibility. It has been designed for measurements in accordance with all military RFI specifications.

...because the FIM-2 is an integration of two instruments in one, it is always available in your laboratory as either a sensitive microwave receiver or an accurate signal generator.

...because UNIDIAL® tunes both the receiver and signal generator simultaneously; and, the front-panel meter indicates average, peak, slide-back peak or quasi-peak value of rf signals, the Polarad of FIM-2 is the most convenient instrument in use today.

MODEL FIM-2 FEATURES

MAIL THIS COUPON

FREQUENCY RANGE: 1 gc to 10 gc in 4 tuning units; 2 more tuning units under development will extend frequency to 20 gc.
FREQUENCY DIAL ACCURACY: ±1%
SENSITIVITY: 20 microvolts
MAXIMUM RF INPUT: 3 volts
IMPULSE BANDWIDTH: 5 mc
IMAGE AND SPURIOUS RESPONSE REJECTION: 60 db
OUTPUTS: Video, audio, recorder
SIGNAL GENERATOR OUTPUT POWER: 0.223 volts to 5 microvolts (for susceptibility measurements)
SIGNAL ATTENUATION: 0 to 80 db in 1 db steps

FREE LIFETIME SERVICE

POLARAD ®PEC
ELECTRONICS CORPORATION
43-20 34th Street, Long Island City 1, N.Y.

Representatives in Principal Cities (See your yellow pages)

POLARAD ELECTRONICS CORPORATION:
43-20 34th St., Long Island City 1, N. Y.

Please send me information and specifications on:

☐ Model FIM-2 Calibrated Microwave Field Intensity Receiver
☐ Notes on Microwave Measurements

POLARAD

My application is ____________________

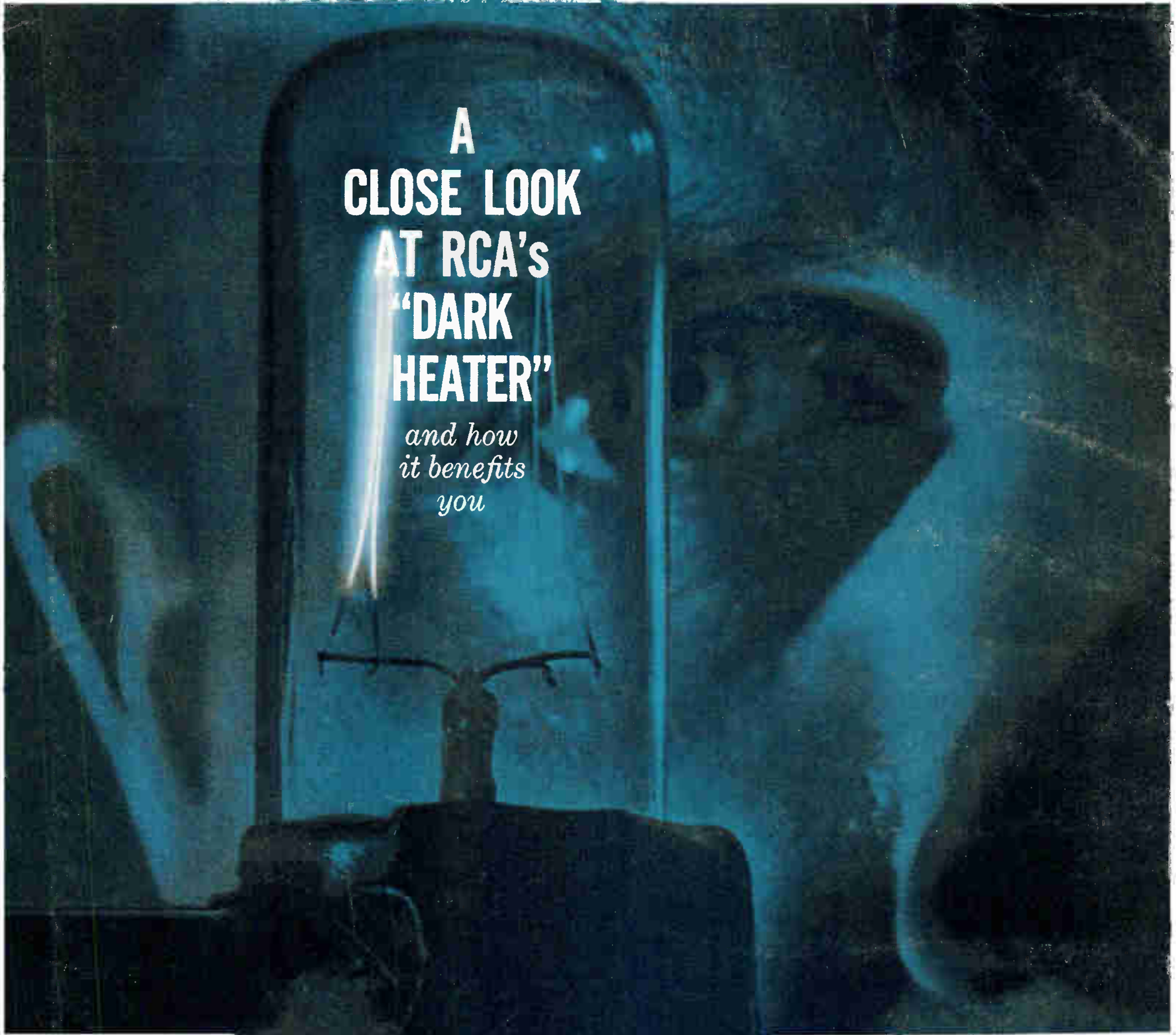
Name ____________________

Title ____________ Mail Station ____________ Dept. ________

Company ____________________

Address ____________________

City ____________ Zone ________ State ________



You are looking at a major advance in tube technology. The filament at the right in this special demonstration envelope is a new RCA "Dark Heater". The "Dark Heater" operates at a temperature about 350°K below that of the 1500 to 1700°K of a conventional heater (left). Yet at this much lower temperature, the "Dark Heater" can produce the same cathode temperature as the conventional heater. Reason: the superior thermal emissivity of the dark coating.

The cooler operating "Dark Heater" offers many receiving tube advantages to equipment manufacturers, including:

- **Longer heater life**—because of the inherently greater tensile strength of heater wire at lower temperatures.
- **Reduced chance of heater failure**—because the smaller thermal change during heater cycling and the greatly reduced operating temperatures minimize tendency toward recrystallization and burnout.
- **Heater-current stability on life**—especially desirable in maintaining a constant cathode temperature.
- **Reduced AC heater-cathode leakage and hum**—due to elimination of "spike" or pulse leakage currents.
- **Greater safety factor in established heater-cathode voltage ratings**
- **Improved mechanical stability**—cooler operation of the "Dark Heater" minimizes changes in heater shape during life, reducing the possibility of heater damage and heater shorts.

The revolutionary "Dark Heater" is the key to improved performance and longer life for receiving tubes. Now available in an increasing number of RCA receiving tubes, the "Dark Heater" will be incorporated in those RCA receiving types where potential benefits of increased life and reliability can be realized.

For additional information on the "Dark Heater" call your RCA Field Representative or write Commercial Engineering, Sec. L-19-DE-5, RCA Electron Tube Division, Harrison, N. J.

EAST: 744 Broad Street, Newark 2, New Jersey, HUmboldt 5-3900 · MIDWEST: Suite 1154, Merchandise Mart Plaza, Chicago 54, Illinois, WHitehall 4-2900 · WEST: 6801 E. Washington Blvd., Los Angeles 22, Calif., RAymond 3-8361.

RCA The Most Trusted Name in Electronics