SPECIAL  Survey of latest automatic checkout systems, how to design them and how to use them with military, industrial and aerospace equipment

NASA technicians check out first stainless-steel satellite
SMOOTH OUT

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6-KVA regulator

Type 1570-ALR LINE-VOLTAGE REGULATOR, 115v, 60 cps . . . $530

... a simple, reliable, proportional-control servomechanism. It has only three major elements: ... a motor-driven Variac® autotransformer, a "buck-or-boost" step-down transformer, and a control circuit to position the Variac autotransformer automatically. Its design simplicity assures long trouble-free service.

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STEEL SATELLITE—Technicians at NASA's Goddard Space Flight Center, Greenbelt, Md., check out unnamed project S-6 satellite. Its instrumentation will measure characteristics of the upper atmosphere such as ion density and chemical composition. 

Budd Corp. of Philadelphia built the all stainless-steel vehicle.

IRE + AIEE = IEEE—Will the Merger Prosper? Success depends on quick solution to a number of problems. Although there have been strongly differing opinions expressed as to ways and means, relatively few engineers question the overall logic of the merger.

TELSTAR SATELLITE GETS LAST MINUTE MODIFICATION. Bell Telephone Labs' engineers replaced three antennas with one compact, stationary antenna. Ground stations in U.S. and England are ready for long series of planned tests.

NEW APPLICATIONS FOR MILITARY COMPUTERS received emphasis at the Sixth National MIL-E-Con in Washington. Operational model using thin-film memory executes the pre-flight and in-flight programs on guidance techniques. Panel discussion on nonprofit corporations agreed on need for their existence but specified limitations.

PHOTO RECONNAISSANCE SYSTEM for high speed aircraft. Automatic recording of position and heading is made directly on film's edge for each exposed frame. Picture-taking exposure control compensates for three possible lighting conditions.

AUTOMATIC CHECKOUT EQUIPMENT for Today's Complex Systems. Here is information you can put to work for you:
- How to test complex electronic equipment
- Designing checkout systems
- Making checkout equipment adaptable
- New trends in automatic checkout

This equipment resolves the dilemma of what to do when testing time exceeds planned meantime between failures.

By George V. Novotny

FIRST DESIGN DETAILS: The Paramp that Tracked a Space Probe 70,000 Miles. Negative-resistance parametric amplifier uses three separately tuned cavities closely coupled at the varactor diode. Design affords rapid tuning over a broad range with low noise.

By A. P. Heyman, General Electric

NEW WAY TO MULTIPLY Q With Transistors. Emitter follower and grounded-base amplifier with feedback make a negative impedance converter. It achieves high Q in audio tuned circuits.

By T. Ormond, Sylvania
CONTENTS continued

STEERING RADAR ANTENNA BEAMS With Lossless R-F Matrix. New radar systems achieve rapid scanning by a phased antenna array that uses electronic beam forming and scanning. This system uses an r-f beam-forming matrix and does away with need for coherent mixers and amplifiers between antenna and beam former. By W. P. Delaney, Lincoln Laboratory 50

INEXPENSIVE CONVERTER Gives 5,000 Volts D-C Circuit consists of sinusoidal oscillator and a voltage-doubler rectifier circuit. It is 2½ inches high by ½ inches square and delivers 50 microamperes. By R. D. Morrow, Morrow Products 54

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IEEE: Now Let’s Get to Work

THE VOTES are in and counted. And by a substantial majority the members of the Institute of Radio Engineers and the American Institute of Electrical Engineers have agreed to merge. So, whether you call the new body the IEEE, the I-triple-E or just IE3, the Institute of Electrical and Electronic Engineers, more than 160,000 strong, will come into being January 1, 1963.

Some of us had misgivings about the merger. These misgivings were not over the desirability of achieving unity within our profession. They were, rather, over many unanswered questions about the detailed operations of the combined society.

We who voted for the merger in many cases did so in spite of doubts. In effect, we gave the officers of IRE and AIEE and the committee members who put the merger together a blank check on faith because we felt the advantages of the combined society would outweigh its disadvantages. In many cases, members voted affirmatively in spite of uncertainty concerning the constitution and the articles of consolidation and equivocal statements of society officers, not because of them.

Now that the merger is a fact it is up to the officers and members of the IEEE to make the new institute really work. It should combine the best features of both the IRE and AIEE.

Let’s look at some of the objections and questions raised during merger talks:

• Some AIEE members said the new society would be less democratic than the AIEE. The AIEE has a nominating committee that represents both incumbent national officers and professional and regional interests. In the new society, the nominating committee is the incumbent Board of Directors itself. It could become self-perpetuating. However, if the board is unresponsive to legitimate interests of groups or individuals, or acts in an arbitrary or inequitable fashion, the constitution can be amended to curb the board’s powers and change its manner of nomination. Amendment can be proposed by petition of 500 members, and achieved by two-thirds vote among the membership; twenty percent or more of all members must cast ballots.

• The first IEEE Board of Directors will have to make many important decisions. Membership requirements must be spelled out in detail. And here a firm line must be drawn between professional qualifications and society size. Will IEEE membership be meaningful, or will we take everybody with a few dollars in his jeans and a hankering to wear our membership insignia?

• The existing IRE Professional Groups and AIEE Technical Groups must be realigned into IEEE Professional Technical Groups. The ground rules say that groups with conflicting interests must consolidate or redefine their fields of interest. It will take infinite wisdom to accomplish this without alienating many sincere and dedicated individuals.

• Merger papers say that IRE and AIEE sections may delay consolidation where two sections exist in one overlapping area. But how long may they delay? Might we not have, in fact, a single institute that is really a federal union of two institutes if consolidation drags on indefinitely? There has to be some time limit, however generous.

• There has been no decision on what to do about the institute’s publications. It is generally believed that the Proceedings of the IEEE will be a vehicle for publication of original work of broad significance. The Transactions of the various PTGs will provide for publication of important work of narrower interest. What happens to Electrical Engineering? Is it needed at all?

• Last, but far from least, there is the matter of engineering standards for definitions, measurements, terminology and symbology. To some engineers this is a key activity of the institute. The merger documents are uniformly silent on this important issue.

The IEEE ballots are in and the word is out. The largest professional engineering society in the world is on its way. But the work for officers and members alike has just begun.

Coming In Our July 20 Issue

MICROWAVE PHOTOTUBE. R. G. E. Hutter of Sylvania describes how these tubes detect microwave modulation and mix modulated with unmodulated laser beams to make possible superhet optical receivers.
COMMENT

Complex-Dielectric Capacitors

On page 66 of the May 11 issue of ELECTRONICS, which contained the story round-up on Modern Electronic Components, there appears a statement by Mr. J. F. Ferrante, Vice President and Research Director of Cornell-Dubilier Electronics that "A forthcoming capacitor development will employ Mylar and polystyrene film that will feature a T-C curve that is virtually horizontal.

We would appreciate it if you would call to the attention of your readers that capacitors employing a complex dielectric consisting of polyethylene terephthalate (Mylar) and polystyrene are not a new development. These capacitors were invented by Dr. Preston Robinson, Director and Consultant to the Sprague Electric Company, and Mr. David B. Peck, now Vice President and Manager, Special Products Division.

Our patent application was filed on October 22, 1952, and U. S. Letters Patent 2,740,490 were granted on June 5, 1956.

Capacitors employing this complex dielectric and having a virtually horizontal T-C curve have been commercially marketed by Sprague under the trademarks Isofaread and Filmite "F" as plastic-encased and metal-clad capacitors, respectively.

SIDNEY L. CHERTOK
Sprague Electric Company
North Adams, Massachusetts

R & D and Profit

I have been a reader of ELECTRONICS for a considerable number of years. I saw my first copy in the early 1930's and have subscribed over a substantial number of years. I've seen the magazine change from a thin pioneer to a commanding position as a monthly record of the practical and useful, and to its current weekly format. It is in this context that I find myself greatly encouraged by your editorial [on R & D and profit]. The Dangerous Years, in your issue of June 1 (p 122).

There are two sources of en-
FOR YOUR MICROWAVE APPLICATIONS
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Arnold C-type Alnico Magnets are available in a wide selection of gap densities ranging from 1,000 to over 7,500 gausses. There are six different basic configurations with a wide range of stock sizes in each group.

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When used in transverse field isolators, Arnold C Magnets supply the magnetizing field to bias the ferrite into the region of resonance, thus preventing interaction between microwave networks and isolating the receiver from the transmitter. These magnets are also used in differential phase shifters and dupplexers, and Arnold is ready to design and supply tubular magnets to provide axial fields in circular wave guides.

A feature of all Arnold C Magnets is the excellent field uniformity along the length of the magnet. Versatility in design may be realized by using multiple lengths of the same size magnet stacked to accomplish the needs of your magnetic structure.

Let us work with you on any requirement for permanent magnets, including high coercive force Alnico VIII for TWT focusing applications. For information on Arnold C Magnets, write for Bulletin PM-115. For data on Alnico VIII, ask for Bulletin PM-119. Address The Arnold Engineering Company, Marengo, Illinois.

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Announcing an innovation from Eimac: the Iso-Klystron. A superior reflex klystron matched with ferrite isolator — in a unified package of optimum design. Time saved, performance improved. Three Eimac Iso-Klystrons are now available: X-band 1K20 series, C-band X-1079, fixed frequency C-band 1K75CS. And four more are on the way. Another example of how Eimac meets tomorrow's tube needs today. Another reason to keep your eye on Eimac — for advanced microwave tubes, high power klystrons, power grid tubes, accessories.


KEEP YOUR EYE ON
NATO Air Defense Market To Be Competitive

ADMINISTRATIVE ORGANIZATION for creating an air defense system for the NATO countries of Europe will be set up in Paris early next month and functioning by mid-September. Initiated by the Defense Department's Office of Research and Engineering, with consulting support by the non-profit Mitre Corp., the NATO group will be called the Systems Engineering Management Organization (SEMO).

Parallel with SEMO will be a team of national experts to assist SEMO in preparing specifications for the equipment to be bought. For this group, Mitre will provide the leadership and about 10 to 12 technical staff members. Industry will lend about 10 technical men to Mitre for the duration, probably one year.

How elaborate the air defense system will be, how much gear will be bought from the U.S. and how much from Europe, remains to be seen. At best, competition will be tight.

Where Bulk of NASA's 1963 Money Will Go

WASHINGTON—Largest layout in NASA's 1963 spending will go for Advanced Manned Space Flight—$863,628,000. For the manned 1-day missions—$122.9 million; Gemini—$203.2 million; and Apollo—$863,628,000.

Infrared Generating Diode Developed at MIT

BEDFORD, MASS.—A gallium arsenide diode has been developed at Lincoln Laboratory that generates modulated ir light with an intensity of 5,000 watts per sq cm.

The diode does not produce coherent radiation, but is said to provide a combination of high power, narrow spectral bandwidth and high speed reaction to input. It may be a candidate for some communications applications proposed for the optical maser.

When operated at liquid nitrogen temperatures, electrical input is converted into ir light in a band of 100 angstroms wide, centered at 8,600 angstroms. Tests a peak ir power of 3 watts has been achieved. Larger diodes are expected to yield peak outputs of 15 Kw.

The diode is fabricated from N-type single-crystal Ga-As diffused with P-type zinc. For optimum efficiency, the diodes are operated at liquid nitrogen temperature. At room temperature, a light spectrum of about 300 angstroms wide, centered at 9,300 Mc is produced.

Can The Electronic Lock Be Picked?

WASHINGTON—President Kennedy's request to Congress for $23.3 million for the Atomic Energy Commission for production of an electronic lock to reinforce safeguards against accidental or unauthorized firing of nuclear weapons raises a number of questions.

If the device is "an electro-mechanical system controlled by a radio signal to be sent from a command headquarters remote from the actual missile site" (as it was described by the Associated Press), how can efficient radio communications be assured to unlock the weapons should they be needed? What is to prevent jamming, or deliberate, unauthorized unlocking? Will SAC's nuclear bombs be locked? No one was answering these questions when Electronics went to press.
Moon. The Senate authorized $400,000 for continuation of in house studies on the project. Total Senate committee authorization for R&D and operations (which means "salaries and expenses") is $2,958,278,000.

The Senate committee also restored some of the money the House had knocked off NASA's request for construction of facilities. The House had cut off $82.7 million. The Senate committee reduced NASA's request by approximately $60 million. Total now authorized is $791,237,250. NASA also gets new 1962 money: $55 million for land acquisition at Canaveral and $16 million at the Mississippi Test Facility.

Soviets Say Cosmos VI Continues Space Research

MOSCOW—The Soviet Union's sixth Cosmos scientific satellite, launched June 30, is rounding the earth every 90.6 minutes, inclined 49 deg to the equator, according to Soviet news agency Tass.

Apogee is reported at 360 km, perigee at 274 km. Besides its payload for "space research" the satellite is said to carry a multichannel transmitter for telemetry, radio devices for trajectory measurements, and a transmitter operating at 90.0233 Mc.

FAA Symposium Hears Air-Collision Avoidance Plan

WASHINGTON—Air-collision avoidance technique outlined yesterday by National Co. at the FAA-sponsored symposium provides a new way to utilize altitude, minimum range and estimated time to collision—criteria that heretofore have not been considered practical due to the large airborne computer required.

National's approach reduces the demands on the computer, and therefore the computer's size. The technique measures the altitude in each aircraft with an aneroid barometer, periodically transmitting this information to all other planes. The range and range rate are measured by one-way radio transmissions from each plane, transmitted at a time precisely known to all other aircraft. Time of arrival of the signals at each aircraft is then converted to range. Precise timing is achieved by use of precise synchronized clocks.

FAA has given National a nine-month feasibility contract.

In Brief...

Mysterious Resumption of Continuous Transmission from NASA's Orbiting Solar Observatory after it developed a malfunction due to excessive spin rate on May 22 and transmitted only intermittently thereafter may be due to two things, NASA says: the spin rate was slowed back down due to either bearing friction within the turning wheel or the position of the satellite in respect to the earth's magnetic field.

MOTOROLA will develop and fabricate the ground-to-air uhf voice communications equipment (AN/TRC-87) for the 412L Air Weapons Control System.

NASA will soon open a Northeastern Operations Office in the Boston area to conduct technical and administrative liaison with contractors in the area. In the last ten months, NASA has awarded $15 million worth of contracts in New England.

RCA will build a Mobile Random Access Fielddata Computer System for the Army Electronic Proving Ground, Ft. Huachuca, Ariz. under a $2 million contract.

Burroughs Corp. will produce Back Up Interceptor Control—BUIC—systems for USAF under $8 million contract. Main components of the radar course directing gear are electronic computers and display equipment. BUIC is a backup for Sage.

Japanese Government has approved a joint venture between Komatsu Works, a leading heavy machinery manufacturer, and Hoffman Electronics of Los Angeles, with capitalization of $4 million to manufacture silicon diodes, solar batteries, and semiconductors that are not being currently produced in Japan.

Nippon Musen of Japan has sold weather radar to Pakistan to be delivered next June. More Southeast Asian countries are expected to follow suit in ordering weather radar from Japan.
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These mil-type devices are part of a complete line of 10 Watt Zener Regulators, including standard 5%, 10% and 20% tolerances, with voltage ratings from 6.8 thru 200V. All are packaged in our exclusive environment-proof “bubble pack,” another Hoffman quality assurance.
What data recorder can take pictures under the sea? **AMPEX AR-300.**

So small it can fit into the hatch of a submarine. So advanced it can capture visual images, digital data, analog data, sound waves—all at the same time. That's the Ampex AR-300. It records from 10 cycles to 4 megacycles—a wideband performance matched by no other recorder. It goes down to the sea or up into the sky. (Needs only 3½ cubic feet of space.) Together with the FR-700 laboratory recorder/reproducer, the AR-300 provides a remarkable recording system for many uses: laboratory experimentation, predetection, radar tracking, oceanography, any wideband application of today—and tomorrow. For more information on the FR-700/AR-300 write the only company providing recorders and tape for every application: Ampex Corporation, 934 Charter Street, Redwood City, California. Sales and service engineers in major cities throughout the world.
The Bendix® E-200 series of lightweight, small size capacitors is designed for installations requiring a high degree of component reliability at operating temperatures as high as 200°C.

High temperature capability and mica-like electrical characteristics enable the E-200 series to withstand extremely high orders of AC in small envelope size at all ambients under 200°C.

The new series is designed and manufactured to a Bendix specification which is patterned after the high reliability specification MIL-C-14157B, proposed.

Hermetically sealed in tubular or rectangular housings, these capacitors offer superior resistance to mechanical and climatic environments.

E-200 CHARACTERISTICS: • Wound mica papers • Solid impregnants • Exceptional stability • High insulation resistance • Radiation resistance • Outstanding dependability

For full details, write Scintilla Division, Sidney, New York

Scintilla Division


July 13, 1962
MEASURE
Without Breaking Leads

DC CURRENT METERS

Measure and record dc current, 0.1 ma to 10 amps without breaking leads or loading circuit

428A/B current meters make fast, accurate measurements in circuits where conventional current-measuring devices would alter conditions to such an extent that the desired measurement would no longer be accurate!

In any application, 428A/B current meters are without equal for ease and speed of operation. Just clip the jaws of the probe around a bare or insulated wire and read dc—even in the presence of equally strong ac on the same wire. These current meters are also valuable for measuring sums and differences of currents in separate wires. When the probe is clipped around two wires carrying current in the same direction, their sum is indicated on the meter; when one of the wires is reversed, their difference is measured.

Models 428A and 428B are almost identical except for their current measurement range. 428B has three more ranges than 428A to give it full scale readings from 1 ma to 10 amperes. 428B also has a recorder/oscilloscope output, dc to 400 cps, to make it easy to record dc levels as well as analyze ground bus, hum and ripple currents on an oscilloscope—all without circuit loading.

SPECIFICATIONS

Current range:
- 428A, 3 ma to 1 amp full scale in 6 ranges
- 428B, 1 ma to 10 amp full scale in 9 ranges

Accuracy:
- ±0.1 ma
- ±3% of full scale

Probe inductance:
- Less than 0.5 μh introduced into measured circuit

Probe induced output:
- Less than 15 mv into measured circuit

AC rejection:
- AC with peak value less than full scale affects meter accuracy less than 2% at frequencies above 5 cps and different from the carrier (40 Kc) and its harmonics. (On 428B 10 amperes range, ac is limited to 4 amperes peak.)

Output:
- 428B approximately 1.5 volts and 1 ma max. for full scale

Probe insulation:
- 300 v maximum

Probe tip:
- ¼ inch x 9/32", Aperture diam. 3/16"

Size:
- Cabinet, 7½"x11½"x14¼"; rack mount, 19"x7"x13" behind panel

Weight:
- Cabinet, 19 lbs.; rack mount, 24 lbs.

Price:
- 428A, $50.00 (cabinet); 428AR, $505.00 (rack mount)
- 428B, $60.00 (cabinet); 428BR, $605.00 (rack mount)

Accessory Probes for the 428A/B DC Current Meters

New 3529A Magnetometer Probe—Useful anywhere magnetism is found and an accurate measurement of the magnetic field strength is desired: i.e. orientation of components for minimum magnetic interaction. Features direct conversion of milligauss to millamps, so that 428 meters read magnetic field directly. Accuracy 3% ± 0.1 milligauss. Accuracy also depends on calibrating the probe with the specific 428 meter being used. $75.00.

New 3528A Clip-On DC Current Probe—2½" aperture for large conductors: wires, pipes, multi-conductor cables (including lead-sheathed), ground straps, waveguide testing, waveguide circulating dc current testing. Accuracy obtainable equal to that of 428 meters. $350.00.
CURRENT
Without Loading Circuit

456A AC CURRENT PROBE
Converts ac current to ac voltage directly! 1 amp = 1 volt for reading on your scope or voltmeter

Measure ac current with an ac voltmeter with the 456A AC Current Probe. Useful in observing current waveforms with an oscilloscope or measuring signal current in vacuum tubes or transistors. May also be used with electronic counters to measure frequency.

Just clamp the 456A probe around the wire under test and view or read ac current directly on your scope or voltmeter. Model 456A's 1 ma to 1 mv unity conversion permits direct readings up to 1 ampere rms. No direct circuit connection is required; there is no loading, no appreciable impedance change in the circuit under test, and the impedance of the test circuit is immaterial.

SPECIFICATIONS

Sensitivity:
1 mv/ma ±1% at 1 KC

Frequency response:
+2%, 100 cps to 3 MC
+3%, 60 cps to 4 MC
-3 db at 25 cps and greater than 20 MC

Maximum input:
1 amp rms; 1.5 amp peak. 100 ma above 5 MC

Maximum dc current:
DC up to 0.5 amp has no appreciable effect

Input impedance:
Probe adds to test circuit only approx. 0.05 ohms in series with 0.05 μh

Power:
Two Mallory Battery Co. TR 233R and one TR 234 batteries. Life approximately 400 hours. AC power supply optional at extra cost

Size:
5" wide, 6" deep, 1½" high

Price:
456A with batteries, $130.00; with ac supply installed, $210.00; ac supply for field installation, $40.00

AC-21F CURRENT PROBE

AC-21F probe with 100-ohm terminations permits measurement and observation of ac currents on your scope or voltmeter without breaking circuit or inserting a resistor. The probe clamps around the wire and forms a transformer with a single-turn primary. Output is 1 mv per ma. Maximum current is 10 amps above 20 KC. Below 20 KC current capacity is reduced proportional to frequency and is 1 amp at 2 KC. DC current up to 0.5 amp has no appreciable effect on probe's operation. $100.00.

Two 100-ohm terminations are available for use with AC-21F Current Probe: AC-67B Feed-Through Termination, 2,500 cps to 30 MC bandpass, $17.50; AC-67C Compensated Termination, 1,400 cps to 30 MC bandpass, $30.00.

Data subject to change. Prices f.o.b. factory.

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WASHINGTON OUTLOOK

MANUFACTURERS OF TV SETS and the technical staff at the Federal Communications Commission have begun working out procedures for the swing to all-channel receivers. FCC officials hope major manufacturers will go still further and initiate broad-scale promotion of 82-channel sets before they are legally required to do so.

FCC Commissioner Robert E. Lee, one of the Commission's staunchest promoters of full use of the 70 uhf and 12 vhf channels, told ELECTRONICS that it will probably be two years before manufacturers are required to market all-channel sets.

Based on a turnover rate in sets of 15 percent or 20 percent per year, it will take five to six years for substantial saturation of all-channel sets. Saturation will come sooner, Lee pointed out, if manufacturers move to promote all channel sets without waiting for the FCC's rules. Major manufacturers, he said, will be safe in moving ahead now, for they are already making sets that are certain to meet the specifications FCC sets for "adequately" receiving uhf signals.

AWARD TO DEVELOP and produce a joint Air Force-Navy tactical fighter plane, TFX (USAF calls it the F-111A) has been delayed until Fall.

The two competitors for the contract, Boeing Co. and General Dynamics Corp. (teamed up with Grumman Aircraft Engineering Corp.) have been given 60 days to refine their proposals in a way that iron out differences in Air Force and Navy design requirements and that will establish definitive cost estimates.

Unit costs estimated by Boeing, General Dynamics and the DOD vary anywhere from $5 million to $10 million. To draw up a fixed price contract, DOD needs firm figures than these.

SENATE FINANCE COMMITTEE HEARINGS on the President's trade bill, already passed by a sweeping majority in the House, will not begin until sometime next week. Until then, industry spokesmen will have time to voice their opinions.

The bill does two major things: It gives the President power to cut tariffs—over a minimum of five years—a small amount or 100 percent (20 percent each of the five years). He can also raise tariffs up to 700 percent in some cases and work out import quota arrangements.

Second, it attempts to balance these new negotiating powers with a list of checks, restrictions, and new Presidential and other governmental responsibilities. A new trade negotiator post has been created that could turn out to be one of the country's top cabinet-level jobs.

Congress will get to send four representatives to each tariff negotiation plus a simple majority veto right over a negative decision by the President on any tariff commission ruling that recommends higher tariffs or other trade adjustment assistance.

The bill, soon to go before the Senate, is different from the one proposed by the administration. The bill now has more of a balance between an industry's right to appeal for higher tariffs and its right to be given adjustment assistance in the form of loans, technical help or tax rebates. The tariff commission will have more of a role as arbitrator than was originally envisioned by the administration.

These modifications seem to be stimulating bi-partisan support for the bill in the Senate.
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And plenty doesn't say enough! Now Capitron adds this silicone rubber encapsulated Wafer Capacitor to its more than 2,500 special capacitor designs, available as standard in our line. When your requirements go beyond this ... we will create a capacitor to fit your requirements. If you're working in advanced areas of design—atomic energy, radar, communications and control—there's no need to let ordinary "off-the-shelf" capacitors freeze your design creativity ... you may find exactly what you want in the big Capitron line. From single wafers to encapsulated multiple capacitors ... whatever your choice or requirement ... you can depend on Capitron products for:

- high resistance to thermal extremes (−65°C to +125°C)
- maximum stability, reliability and longevity with AMPli-film® dielectric
- choice of waxdipped, encapsulated or armored types

Complete information on Capitron Capacitors available upon request.


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AMP INCORPORATED
Elizabethtown, Pennsylvania

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July 13, 1962
NEW LIGHT ACTIVATED PNPN SWITCH

ALL VOLTAGES IN STOCK

New applications are being found every day for the new ZJ235 subminiature silicon switch that can handle up to 160 watts of power continuously with complete electrical isolation between input and output. The circuits shown are just a few samples. The ZJ235 is 1/3 inch long, 1/8 inch diameter, rated at 400 ma d.c. in latching applications, with surge current rating of 5 amps. A short impulse of light of as little as 80 foot candles will trigger the ZJ235 into conduction, making it ideal for applications such as card and tape reading, character recognition, logic circuits, relay replacement, explosion proof static switches, tower light monitoring, and many others.

Available from stock in all voltage ratings from 50 PRV to 400 PRV, ZJ235 prices range from as low as $5 to $25 in single lot sample quantities. Ask your G-E Semiconductor Products District Sales Manager about the help available from our Application Engineering Center. Or write Section 16G66, Rectifier Components Department, General Electric Company, Auburn, New York. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 159 Madison Avenue, New York 16, N.Y.
Larger and more costly lathes can often be relieved of the burden of microrange production with the installation of the proper LEVIN lathe. In addition, the speed and ease of operation of LEVIN instrument lathes generally surpasses that attainable on larger machines. With 41 standard models to select from, there is a proper LEVIN lathe for your application. Available in 3/16", 5/16", and 1/2" collect capacities.

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RUSSELL-HOLBROOK & HENDERSON, INC.
292 Madison Ave., New York 17, N.Y.
DYMEC'S Model 6100 Industrial Voltage Scanning System permits automatic, unattended data monitoring, complete with printed record, of 50 single-wire or 25 two-wire channels. The inexpensive system is useful in quality control, production checkout, routine lab measurements, system checkout, environmental and reliability tests... in any application where dc voltage is the parameter of measurement. With a converter, the DY-6100 also permits multi-point ac measurements.

The basic system consists of the Dymec Model 2900A Input Scanner, an hp 405CR Digital Voltmeter and hp 561B Recorder. It measures dc voltages 0.001 to 750 volts with automatic ranging and polarity, and it provides visual and printed readout of measurement, channel identification and polarity.

A scan limit selector switch permits simple omission of unused channel points, and the scanner provides four operating modes: System scans continuously, system scans all data points once and then stops, system is manually stepped by front-panel or remote control, system repeatedly measures a single point.

Input impedance is 11 megohms for minimum circuit loading. Accuracy is better than ± 0.2% of reading ± 1 digit. Effective rejection of 60 cps permits accurate measurements even in the presence of noise.

Optional equipment available for the system includes a digital clock which mounts adjacent to the recorder and permits time data logging and automatic programming, plus an ac converter (hp 457A) which permits measurement of ac voltages in ranges of 1, 10, 100 and 1000 volts, 300 volts rms maximum, 50 cps to 100 KC.

You may purchase the entire basic system for just $3100 (cabinet optional at extra cost) or, merely add the DY-2900A Scanner to your present hp 405CR and 561B for $950 (plus cabling). Write or call today for complete information or a demonstration on your bench.

Data subject to change without notice. Prices f.o.b. factory.
NEW Simpson PANEL METERS

New 1½" Wide-Vue
Another new member in this popular family. Needs only 3.1 sq inches of panel area. Supplied in DC, AC (rectifier), and VU types. Colors are standard black or your choice. Self-shielded core magnet type movements. Forty-seven stock ranges in six types . . . Model 1212C, DC; Model 1214C, AC and VU. This very popular style of meter is also stocked in 2½", 3½", and 4½" sizes. See your electronic distributor for the many stock ranges.

Segmental (Expanded Scale)
AC Voltmeters—3½" and 4½"
Stock meter reads 100 to 130 AC volts. Other ranges supplied on special order. Frequency range is 20-2,000 cps. Accuracy is ±0.5% of center scale value at 25°C and 60 cps sine wave. Self-shielded core type movement; rectangular cases. Stock units are 3½" Model 1347C (Wide-Vue Style), 4½" Model 1349C (Wide-Vue Style), and 4½" Model 49C. See your electronic distributor.

1½% and 2% DC Meters From Stock
Rectangular 6" cases. Mirror scales on 1½% meters. Self-shielded core movement or external magnet type depending on range. Order Model 1150-E and specify either 1½% or 2% accuracy. Milliammeters and microammeters stocked in both accuracies; voltmeters, millivoltmeters, and ammeters stocked in 2% only. See your electronic distributor. For other than stock ranges, send us your specifications.


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INSTRUMENTS THAT STAY ACCURATE

July 13, 1962

CIRCLE 19 ON READER SERVICE CARD 19
**IRE + AIEE = IEEE — Will**

**CONSTITUTION** — Even so, the IEEE constitution is expected to reflect more of the IRE constitution than the AIEE's.

A point that bothers some AIEE members is the replacement of their technical committees with professional technical groups "wherever possible." The new society may contain 35, 40, or more such groups, raising fears that former AIEE members will have less control over technical guidance and publications.

Also, in AIEEE, the board and the technical committees have equal representation. IEEE will probably adopt an IRE type of governing board, which has much greater power.

Signatures required for independent nomination will be raised from 25 to "at least one-third of one percent of the total number of voting members" of IEEE — close to 500 signatures. This may tend to

**MERGER HIGHLIGHTS**

- IEEE's Constitution will resemble IRE's more closely than AIEE's.
- IEEE may contain 40 or more professional technical groups.
- AIEEE Technical Committee will be replaced by Professional Technical Groups wherever possible.
- IEEE will retain the IRE type of governing board.
- IEEE operating expenses will exceed income for the first two years.

---

**PROBLEMS** — It seems unlikely that the merger could miscarry, but there is a possibility that the bond may not be a firm one unless many problems facing the combined society are ironed out in a reasonable time (see p 3, this issue).

An appreciable minority feels that the merger has been rushed too fast and that a necessary catalyst in the form of adequate membership consultation has been lacking. Relatively few question the overall logic of the merger, but some express reservations about what they consider overcentralization.

One implication is that electrical and electronics engineers may find themselves divided by issues and practices when membership action is attempted at the level of the professional technical groups and chapters.

Another impression is that IRE traits will dominate in the IEEE, not only because of IRE's larger membership, but because of a point in the agreement of merger.

Paraghaph 5 says the agreement will be terminated unless AIEE amends its constitution to conform to the IEEE constitution. There is no mention of amending the IRE constitution. This, we are told, was done to avoid the hiatus in corporate existence that would occur if both societies ceased to exist before the actual merger. The IRE will be discontinued first and merged into the AIEE, so there will be no IRE constitution to amend.
the Merger Prosper?

delegate independent nominations of officers essentially to the larger metropolitan area sections.

Basic items, such as membership qualifications, terms of office of the directors and details of nominations are to be included in bylaws that can be changed by the board.

ADVANTAGES—The majority in favor of the merger say it will:
  • Bring closer together the various specialties in engineering.
  • Form a single institution more efficient than the two separate ones (some 5,000 to 6,000 engineers are members of both IRE and AIEE).
  • Remove the duplication in meetings, technical conferences and engineering committees.
  • Advance the cause of unity in the engineering profession.

IRE and AIEE leaders say the merger must be done quickly to work out the practical details of the new organization.

IMPLEMENTATION COMMITTEE
IRE members:
L. V. Berkner, Past IRE President
P. E. Haggerty, IRE President
R. L. McFarlane, Past President
Haraden Pratt, IRE Secretary
3 Additional Members

AIEE members:
C. H. Binder, former AIEE President
Hendley Blackmon, Westinghouse's Engineering Manager of Association Activities
W. H. Chase, AIEE President
W. R. Clark, AIEE Treasurer
Elgin B. Robertson, former AIEE President
L. M. Robertson, Manager of Engineering at Public Service Co. of Colorado
B. R. Teare, Dean of Science and Engineering at Carnegie Tech and president-elect of AIEE

AIEE
PRESIDENT
ELECTED BY MEMBERS
BOARD OF DIRECTORS
EXECUTIVE COMMITTEE

COMMITEES ON
FINANCE, CONSTITUTION
AND BYLAW, PLANNING AND
COORDINATION, ETC.

GENERAL
ADMINISTRATION
DEPARTMENT

PROFESSIONAL
DEVELOPMENT
AND RECOGNITION
DEPARTMENT

PUBLICATIONS
DEPARTMENT

TECHNICAL
OPERATIONS
DEPARTMENT

TECHNICAL DIVISIONS

COMMUNICATION GENERAL APPLICATIONS INDUSTRY INSTRUMENTATION POWER SCIENCE AND ELECTRONICS

GENERAL COMMITTEES AND STANDING COMMITTEES

OPERATIONAL character of AIEE is emphasized by this simplified organizational chart

POTTER Instrumentation Co., Inc.
Sunnyside Boulevard • Plainview, New York

"Nothing is impossible to diligence and skill" Samuel Johnson

POTTER Tape Tester guarantees
PERFECT tapes

The new, improved Model 3320A Tape Tester was designed to accommodate the ever-increasing demands for high-quality digital instrumentation tapes. By testing new tapes and periodically checking used tapes, the reliability of digital computers and digital systems is increased, errors decreased, maintenance costs substantially reduced, and tape costs brought under close control.

The Potter Tape Testers now in use are capable of testing over a million miles of tape annually.

Complete specifications on the fully automatic Model 3320A are available on request. Simply write...

July 13, 1962

CIRCLE 21 ON READER SERVICE CARD 21
ELECTRONIC INSTRUMENTATION FOR INDUSTRIAL, MILITARY AND PETROLEUM APPLICATIONS

SOLID STATE POWER SUPPLIES From milliwatts to kilowatts


Regulated DC-DC converters for reliable performance in marine, airborne, mobile, and portable electronic equipment. Provides regulated or unregulated DC power for 3V or bias circuits from 6 to 48V input.

DC-AC inverters are superior to motor-generator sets, assure reliability and afford excellent frequency stability. Available in regulated or unregulated models with free running oscillator, fork, or crystal-controlled frequency control. Supplies sine or square-wave output from DC input of 6 to 48V.

AC-DC for research and test laboratories, automatic control, and ground-support telemetry installations. Extremely low output impedance, low ripple and negligible servicing make a BER an ideal replacement for storage batteries.

TRANSFORMERS AND CHOKES

A representative number of the complete line. Many show how EIC custom design has been employed. Many constructed with inorganic materials to meet Class H specifications.

MAGNETIC RECORDING HEADS

Wide range of electrical and mechanical characteristics adapts these heads to many laboratory and industrial applications in recording, control, and data analysis. Vacuum impregnated, potted in epoxy resin, available singly or in multihedr blocks. Used for drum, reel, or disk recording; sound or seismic recording; process instrumentation and control computers.

ANALOG INTERVAL TIMER AND PLOTTER

Used in any application requiring seismological evaluation of subterranean structures for geophysics, civil engineering foundation tests, for buildings, roadways, dams and excavations, college laboratories and research.

SEISMIC INSTRUMENTATION

Transcoders - Interval Timers - Data Logging Systems - Complete Field Equipment - Multichannel recording oscillographs - Modulators and demodulators - AM-FM - Direct-recording magnetic tape systems - Recording and data-reduction systems

OTHER AREAS OF EIC APPLICATION

Subassembly Electromechanical
• Electronic Research and Development

OCEANOGRAPHIC

Broadband underwater acoustic transducers
Magnetic detectors • Research and Development

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of ALITE®

STANDARD HIGH ALUMINA BUSHINGS

In Over 100 Types and Sizes

More than 100 sizes of standard Alite high voltage terminals, feed-throughs, cable end seals and high amperage bushings are stocked for immediate, "off-the-shelf" delivery to simplify design problems, save time and help reduce costs. One of these standard Alite high alumina ceramic-to-metal hermetic seals may be just the answer to your problems of reliability and maintenance where service conditions are extremely severe or critical.

- Alite hermetic seals - tested for vacuum-tightness with a high sensitivity helium mass spectrometer — are adaptable to virtually any assembly procedure, such as welding, brazing or soldering.
- Alite's mechanical strength and thermal-shock properties far exceed those of glass or porcelain.
- Alite retains its dielectric properties at elevated operating temperatures.
- Alite's smooth, white glaze resists build-up of contaminants on surfaces — easy to see, easy to clean.

From ceramic formulation to finished part, every manufacturing step is handled within our own plant. Strict quality control assures absolute adherence to specifications, utmost uniformity and reliability.

When special bushings are called for, it is often possible to save time and money by modifying one of the standard units. However, when necessary a team of Alite engineers stands ready to help you by designing new bushings.

ALITE DIVISION

U. S. STONEWARE

BOX 119

ORRVILLE, OHIO

Write for these free helpful brochures. Bulletin A-40R illustrates, describes and gives complete specifications of standard Alite bushings, both high voltage and high amperage. Bulletin A-8 provides detailed descriptions of Alite formulations.

July 13, 1962

CIRCLE 23 ON READER SERVICE CARD 23
Put extra sales power into new products

Scale down the size of your new product. Make it more easily portable. Add to its service life and dependability. Turn battery power into selling power . . . by designing with Mallory Mercury Batteries.

These are the high-performance batteries chosen for reliability in ultra-critical military and space applications, and for superior service in many kinds of industrial and consumer products. Here's why.

Mallory Mercury Batteries deliver 3 to 4 times more energy per unit volume, last 3 to 5 times longer than conventional batteries. Voltage remains steady during their discharge life, relatively unaffected by temperature from $-65^\circ$ to $+80^\circ$C. They withstand temporary overloads of up to 1 amp. Mallory Mercury Batteries can be stored for six years or more without serious loss of capacity. And they're leakproof.

Choose from a broad line of single or multiple voltage cells. Custom power packs developed on request. Write for engineering data or to arrange a consultation.
TRANSISTORIZED METRONOME, the "Baton" designed and made by Connecticut Technical Corporation, flashes in synchronization with audible beat, is powered by Mallory Mercury Battery that provides 5 years or more average service. Mallory was selected for constant voltage discharge, long-term service.

with Mallory Mercury Batteries

LUCIEN PICCARD WATCH WITH BUILT-IN LIGHT New "Lumin-esque" is tiny watch with flower-seed-size bulb that lights when cover is raised. Mallory Mercury Battery was choice for small size, long-lived dependability. Battery is scarcely larger than a sequin.

PORTABLE POTENTIOMETER New recorder made by Instrument Corporation of America uses Mallory Mercury Battery as constant voltage reference against which input signal is nulled by potentiometer circuit. Mallory was specified for enduring voltage precision of ±1/2%, freedom from leakage, long life in service and storage.

Mallory Battery Company
North Tarrytown, N.Y.
a division of P. R. Mallory & Co. Inc.

Mallory Battery Ltd., Crawley, Sussex, England
Mallory Battery Company of Canada Limited,
Clarkson, Ont.
**MECHANICAL CHIPPERS**

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**Closures**

- BBM = 45%
- MBB = 55%

**MINISCAN RELAYS**

- LIFE—1 billion operations
- SPEED—600 a sec. maximum pull in and drop out
- LOW NOISE—2 ìV in 300K ohms
- LOW THERMALS—Less than 1 ìV
- POSITIONING—Non-critical
- VIBRATION AND SHOCK RESISTANT
- MODELS FOR ALL SWITCHING SPEEDS AND CIRCUITS

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**INSTRUMENT TRANSFORMERS**

- Balanced 4 windings to .05%
- Electrostatic shields on all windings to 105 db
- Magnetic Shielding to 135 db
- Low thermal shielded lead out

**MINIATURE TRANSFORMER**

JAMES "decade box" type miniature transformer kits save time and money in the application of transformers.

- Model C-2450, a kit of 12 transformers, 250 milli-watt, 4 winding 8 terminals. Each 1/4" dia. x 1/4", covering the full transformer range.
- Model C-2650, a kit of 10 micro-miniature, 25 milli-watt transformers, 4 winding "plug in" or "solder in", 1/8" dia. x 1/2" covering the full transformer range.
a new dimension...

IN POTENTIOMETERS

SPECIFICATIONS
Composition element rated at 0.5 watts @ 40°C, linear, 0.25 watts tapered. Resistance range from 1,000 ohms to 5 megalohms. Resistance tolerance is plus or minus 20% of stated value. Tested at 2,000 volts AC breakdown. Recommended maximum operating voltage, 150 volts AC. Mechanical rotation is 300°. Electrical or effective rotation, 280°. Standard torque, 1 to 5 oz. in. Diameter: 1-3/16". "Pancake" configuration, 3/32" from mounting surface. Knobs optional. Strip or singularly mounted.

Look again—here's a new dimension in potentiometers that excites the engineer's imagination. The Clarostat Series 81 lends itself to entirely new mounting techniques, new control panel designs, saves space and performs like a much more expensive pot. Ideally suited to entertainment equipment, industrial instrumentation, and any other application looking for a fresh approach.

Write for complete details. Ask your Clarostat representative to show you the amazing new Clarostat Series 81.
TELSTAR prototype model communication satellite, being assembled in a surgically clean environment at Bell Telephone Laboratories in Hillside, N.J.

HORN REFLECTOR satellite communications antenna at Andover, Maine, to be used for experiments in broadband communications by the Telstar satellite. Antenna is built as rigidly and accurately as a fine watch.

To eliminate "one more thing that could go wrong" in the first Telstar satellite, which at press time was scheduled for launch early Tuesday, the telemetry-command-beacon antenna system has been modified.

Originally, telemetry during launch was to be sent back to the ground by two small whip antennas at the base of Telstar. After the protective launching nose fairing had been cast off, an antenna atop the satellite was to be extended by a telescoping mechanism.

In recent months, Bell Telephone Laboratories' engineers incorporated a small compact antenna system as part of the top surface of the vehicle. No release mechanism is required, and the whip antennas at the base have been removed.

A Delta vehicle will place the 34-inch sphere into an elliptical orbit of 500 to 3,000 nautical miles. Inclination will be about 45 degrees, and the period of orbit 2 hr. 40 min. Launch of a second Telstar is planned for the Fall.

Nerve center of the historic experiment is in Andover, Maine, at the world's first permanent ground station for satellite communications.

PERFORMANCE—First two or three passes of the orbiting sphere will be used strictly for testing the tracking, command and beacon circuits. Then, also on the day of launch, first domestic communications experiments will be tried between Andover and BTL in Holmdel, N.J. A series of telephone calls, which will probably include the voice of President Kennedy, will be transmitted to and from various parts of the country, using the satellite as just one link in transmission over land telephone lines.
microwave relay towers and perhaps a short section of underwater cable in the waters of Portland, Me. Transmission of video tape will also be attempted the first day.

Second phase is expected to come about two weeks after the launch, when the system's potentiality for overseas communications will be demonstrated. Transmission will be attempted between Andover and the British General Post Office station at Goonhilly Downs, England, the first of the overseas ground facilities to be ready. Also in this phase, the first live trans-Atlantic telecasts will be attempted, with Eurovision beaming a show from Euro- pean capitals, and the American networks transmitting to viewers in Europe. Discussions are being held with Soviet officials for possible participation.

ANDOVER SYSTEM — Overall noise temperature of the ground station system is 50 deg K at antenna elevation of 74 degrees above the horizon. This includes background noise, antenna, maser and receiver. When the antenna is pointed at the zenith, system noise temperature is 26 deg K.

The ruby traveling-wave maser designed by BTL's H. E. D. Scovel contributes only 4 deg K to the system. Engineers say parametric amplifier front-end may also be tried in future Telstar ground stations. The maser at Andover is immersed in liquid helium dewar surrounded by a liquid nitrogen jacket. Later, a closed-cycle continuous refrigeration system, under construction by A. D. Little Inc., will be installed at the Andover site.

A complete receiver system, including maser and fm feedback circuitry, is installed in the cab at the apex of the horn antenna. Telstar satellite will transmit a 3-watt signal, but this will be only about 10^-12 watt when it is scooped in by the 340-ton cornucopia-shaped antenna. Also in the cab is the transmitting equipment, providing an unusual combination of high power, extreme bandwidth and continuous operation. Amplification for the broadband Bell System transmitter is provided by a 4 ft, 3 in. long water-cooled traveling-wave tube, one of the largest ever built. Power output on the 25 Mc bandwidth transmitter is about 2 Kw.

Just outside the control building are two tracking antennas. A quadruple command tracker like the one at Cape Canaveral will pick up the satellite's 136 Mc beacon and telemetry and transmit commands to the satellite on about 120 Mc (ELECTRONICS, p 23, Dec. 22, 1961). Once the satellite has begun to transmit its broadband communications signal and associated 4,080 Mc precision beacon, the other antenna, an 8-ft dish with a parametric amplifier, will track on this signal.

TRACKING—Also as part of the cooperative program to achieve transoceanic broadband communications, a transmitter for NASA's Relay satellite is being installed at the Andover station to help test the first Relay, which will be launched late this Summer. The program also includes cooperation with communications organizations in England, France, Italy, West Germany and Brazil. The Andover station, an identical one close to completion at Pleumeur-Bodou, France, and an 85-ft parabolic antenna at Goonhilly Downs, England, will be used for tv, voice and data communications experiments with both Telstar and Relay. Voice and data transmissions via Relay will be conducted from the ITT 40-ft dish at Nutley, N. J., and a 30-ft dish near Rio de Janeiro. The Italian station, a 30-ft dish, near Milan, will have voice receiving capability this year, and a transmitter is being installed for full participation in 1963. An 85-ft dish, being built near Munich, Germany, will be ready next year.

Modulated Ionosphere Offers Secure Communications

MICROWAVE cross-modulation of the ionosphere using the Luxemburg effect may open up intercept-free communication channels, according to Prof. Ladislaus Goldstein, head of the University of Illinois' gaseous electronics lab.

Goldstein's group has modulated several types of plasmas with 5- to 10Gc lab-scale transmitters over the past three years, to demonstrate the possibility that microwaves might control ionospheric propagation.

Energy transferred from microwaves to the plasmas, at cyclotron resonance, increased the temperature of free electrons and changed those plasma properties which control propagation, Goldstein said.

An Aerobee rocket fired 40 to 60 miles above Eglin Air Force Base, Fla., in early May provided the first field check on efficiency of microwaves in altering ionospheric propagation. A transmitter aboard fed a pulsed 10-20 usec signal to 12-foot antenna elements at 1.4 Mc—close to the electron gyro frequency.

Meanwhile, a ground transmitter beamed a 2.1-Mc signal to a tuned receiver in the rocket. The rocket's transmitter relayed this signal back to earth, where tapes recorded the effects of presence, and wake of the excitation pulses at 40, 40 w and 400 w.

Although a complete analysis won't be finished for a year, early results have confirmed the lab experiments. Radio waves from ground or a rocket can probably make transmissions easier at certain frequencies and more difficult at others, Goldstein said, by modulating or controlling density of electrons in the ionosphere.

Selective control of these properties, in chosen regions, could open paths for messages which would be denied to any but the addressee alerted and equipped to pick them up, he suggested.
Latest Military Computer Applications

Digital techniques explored at PGMIL Conference

By LAURENCE D. SHERGALIS, Associate Editor

COMPUTERS and their application to military systems were prominent among the wide range of subjects discussed at the Sixth National MIL-E-CON in Washington, D. C., last month. Among the new devices announced was an operational computer using a thin-film memory. Designed by the Univac div. of Sperry Rand Corp., the machine utilizes modules made by the microminiature cordwood technique. The computer weighs 88 lb, occupies 1.2 cu ft and is expected to achieve over 10,000 hours of operational time without a failure.

Called the ADD-1000 (for Aerospace Digital Development), the computer has a random-access memory consisting of 6,656 24-bit words of permanent, and 256 24-bit words of variable storage. Basic operating clock frequency is 1 Mc, and the basic instruction phase cycle is tied to the memory cycle time of 3 microseconds. In describing the capabilities of the computer, B. J. Jansen of Univac’s Advanced Engineering Development Dept. indicated that the machine is capable of executing the preflight and in-flight programs associated with a number of guidance techniques.

COMPUTER BATTLES — Computer-controlled battles are being simulated at the Army Electronic Proving Ground, Ft. Huachuca, Arizona, to determine effectiveness of communication systems in a combat environment. Some of the parameters fed into the computer include the range of a radio set, reliability, electromagnetic environment, and attrition of personnel and material.

Digital control of aerial cameras was described by C. Walter Diem of the Librascope div. of General Precision, Inc. His system uses an adaptive calibration technique with a digital computer to control film velocity. Camera functions that are controlled include image motion compensation, shutter speed, diaphragm opening and exposure rate. To reduce blur caused by image motion, and adaptive calibration technique used in a digital servo moves the film across the camera focal plane at the velocity of the image.

SEARCH MEMORY — Digital computers have been supplemented by a search memory to reduce the computational time in determining a radar target track. In a paper by E. C. Joseph and A. Kaplan, Remington Rand Univac, a system was disclosed that reduces the time devoted to correlation of target tracks by a factor of 400. The search memory complements the conventional memory. Where input to a conventional memory is an address and the output is the data contained in that address, the input to the search memory is the data and the output is the address of data that matches the input data. When a match occurs, the address is used to retrieve

WHAT ROLE FOR NONPROFIT LABS?

Panel discussion on the role of government and nonprofit laboratories in the national defense effort revealed that technical standards in government laboratories must be raised and morale improved to avoid mediocrity. The panel, consisting of representatives from government, industry, a nonprofit corporation and a university, also indicated that the role of the nonprofit laboratory is to develop concepts and evaluate advanced techniques; it must not undertake applied research and development nor produce hardware. Also, panel members said, it must have stringent policies against conflict of interest.
associated information.

Therefore, the function of the target track correlator is to associate a set of radar returns with existing returns. The association begins when a radar return is compared with the predicted positions in track storage. This is done by determining whether the radar return lies within a volume of space around a predicted target position.

Gerald B. Speen, ITT Federal Laboratories, described an all-pneumatic gyro that rotates on gas films. The device is reported to have a better drift rate than that of conventional gyros.

DIGITAL MODULES — Martin Marietta Corp., Electronic Systems and Products div., announced the availability of a set of digital module patchboards, unique in that jumpers are used from one patchboard to another to breadboard an entire system. Consisting of 32 modules and four patchboards, the system permits a designer to set up any logic scheme. Terminal connections are standardized to provide flexibility in placing the modules in receptacles.

Computers Developed for Spacecraft, Aircraft

MINNEAPOLIS—Two new computer developments for support and checkout systems were recently announced by Minneapolis-Honeywell.

For long-term space missions, a check-out computer will permit continuous in-flight monitoring of entire spacecraft systems. Operational performance of subsystems is calculated by scanning a small number of major test points rapidly enough to approximate simultaneous sampling. Impending failure is predicted long enough in advance for the electronic subsystem to be repaired before failure occurs.

In another development, maintenance requirements for a number of aircraft weapon systems can be checked in one central ground location. Data from on-board automatic systems analyzers are transmitted to a ground-based digital computer. Modularized microminiature NOR circuits and digital mechanization are used in the monitor systems.

CUSTOM PACKAGING IS NO NOVELTY AT SPRAGUE'S SPECIAL PRODUCTS DIVISION

Sprague Electric Company's SPECIAL PRODUCTS DIVISION was founded originally to meet the electronic industry's needs for reliable packaged assemblies and subassemblies.

Sprague has developed and produced packages with countless variations in electrical characteristics and mechanical configurations, in all shapes and sizes, with and without semiconductors, as wiring boards, in encapsulated cases, in cast blocks, in hermetically-sealed packages.

In Sprague packaged assemblies, internal components are connected by soldering, welding, wire-wrapping, or printed wiring techniques.

Sprague versatility offers several basic types of construction, including molded cellular, high-density "cordwood", and molded multiple-circuit construction, permitting densities in excess of 200,000 standard components per cu. ft.

For application engineering assistance without obligation, write or call the Special Products Division, Sprague Electric Company, 35 Union Street, North Adams, Massachusetts.

SPRAUGE COMPONENTS

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

THE MARK OF RELIABILITY
PHOTO RECONNAISSANCE system records navigation data direct on film edge. Four-camera design is shown.

AIRCRAFT CAMERA
Records Position Automatically

The Royal Canadian Air Force has taken delivery of a photo-reconnaissance system that automatically records position and heading information.

The system processes navigation information and applies it to a data recorder mounted on each of the cameras. Position is printed on each exposed frame. The RCAF installation, in a pod slung below the aircraft, operates four cameras.

The system was designed for low-level, high-speed aircraft reconnaissance by Computing Devices of Canada Ltd. in Ottawa, Ontario, and employs cameras of British manufacture.

The 70-mm cameras receive automatic exposure control signals to compensate for three possible lighting conditions. A light level monitor views down and slightly ahead of the aircraft. Signals are fed to an aperture computer that automatically adjusts the camera iris.

A camera junction unit distributes power and control signals, and a control console incorporates a run-duration timer and film-rate control. The data-control unit accepts position and heading information from the aircraft's navigation system and converts it for operation of the data recorders. Servo control loops and synchros are used and supply a synchro receiver and counter in the data recorder mounted on each camera. An optical system on the camera relays the numerical image to the film edge. Navigational data recorded on the film is printed directly with the photo during processing. Transistor circuits and modular packaging are used in the aperture computer for light control, and the data-control unit that converts information to proper form for the data recorders.

An in-flight processing system is being developed by the Canadian firm to handle 100 feet of standard 70-mm film in a magazine using a saturated web monobath process.

Cheminax

Advantages

- 40% less weight
- Lower attenuation
- Lower capacitance
- Stronger center conductor

Weight reduction is proportional to a positive gain in payload and fuel. This gain has greatest significance where it can be effected without loss of reliability or performance.

Cheminax has this property of conserving weight while also presenting an equally important benefit, a larger center conductor. This larger center conductor means a stronger, more reliable cable with no over-all dimensional increase.

Greater strength, reduced weight, and increased reliability are engineered into Cheminax.
**CHEMINAX**
MINIATURE COAXIAL CABLE
replaces RG 180

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<th>CONDUCTOR</th>
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LEADER IN RADIATION CHEMISTRY
FOR ELECTRONIC WIRE AND CABLE

July 13, 1962

RAYCHEM CORPORATION

CIRCLE 33 ON READER SERVICE CARD 33
draw your own conclusions...

ABOUT TRYGON'S MERCURY SYSTEM SERIES

Just follow the reasons from point to point and it's easy to see why Trygon's man in the white coat has developed a series of DC regulated power supplies which are uniquely qualified to power your electronic systems. He has combined the economy and small panel height of fixed voltage supplies with the flexibility of a wide range unit.

Here is truly unique design, with a voltage vernier on the front panel to allow narrow range adjustment and four toggle switches on the rear panel, which provide a wide voltage range by switching input transformer taps. The Mercury System design achieves significant savings in space and costs, yet retains the highest standards of quality in components, construction and overall performance.

This new series more than measures up in models too, with 16 individual units to choose from, ranging up to 160 volts and 30 amperes...2 different panel heights: 3" and 5½". Prove-out computations have shown MTBF figures of 15,000 to 20,000 hours, depending on the specific unit involved. Prove it to yourself...an inquiry will bring complete data—plus a box of crayons for the kids (you've drawn the conclusion, let them color the picture).

OUTPUT:
- 0-15 VDC, 10 and 20 Amp
- 0-36 VDC, 2.5, 5, 10, 15, 20 Amp
- 0-60 VDC, 5, 10 Amp
- 0-160 VDC, 1, 2, 3 Amp
- 6, 12, 18 VDC @ 30 Amp

REGULATION: 0.01% or 3 mv

RIPPLE: Less than 1 mv RMS

TRANSIENT RESPONSE: Better than 50 µsec

PANEL HEIGHT 3½" and 5½"

MEETINGS AHEAD

RADIO PROPAGATION COURSE, National Bureau of Standards and University of Colorado; NBS Boulder Laboratories, Boulder, Colo., July 16-Aug. 3.

LUNAR MISSIONS MEETING, American Rocket Society; Pick-Carter and Statler-Hilton Hotels, Cleveland, Ohio, July 17-19.

MEDICINE & BIOLOGY DATA ACQUISITION AND PROCESSING, IRE-PMME, AIEE, ISA; Strong Memorial Hospi., Rochester, N. Y., July 18-19.

INTERNATIONAL SOUND FAIR, Institute of High Fidelity Manufacturers, Magnetic Recording Industry Assoc. et al; Cobo Hall, Detroit, July 25-29.

ENERGY CONVERSION PACIFIC CONFERENCE, AIEE; Fairmount Hotel, San Francisco, Calif., Aug. 13-16.

CRYOGENIC ENGINEERING CONFERENCE, University of California; Los Angeles, Calif., Aug. 14-16.


APPLICATIONS & RELIABILITY SYMPOSIUM, Precision Potentiometer Manufacturer's Assoc., Statler-Hilton Hotel, Los Angeles, August 20.

WESTERN ELECTRONICS SHOW AND CONFERENCE, WEMA, IRE; Los Angeles, Calif., Aug. 21-24.


INFORMATION PROCESSING INTERNATIONAL CONFERENCE, IRE-IPCO; IFIPS, AIPPS; Munich, Germany, Aug. 29-Sept. 1.

INFORMATION THEORY INTERNATIONAL SYMPOSIUM, PIGT and Benelux Section of IRE; Brussels, Belgium, Sept. 3-7.

DATA PROCESSING INTERNATIONAL EXHIBIT, Assoc. for Computing Machinery; Syracuse, N. Y. Sept. 4-7.

ADVANCE REPORT

ELECTROMAGNETIC COMPATIBILITY CONFERENCE, Army, Navy, Air Force, IEEE; Armour Research Foundation, Chicago, Ill., Oct. 15-Nov. 1. Aug. 1 is the deadline for submitting a 100-word abstract or a copy of the paper to: J. E. McManus, Conference Chairman, Armour Research Foundation, 10 West 31st Street, Chicago 16, Illinois. Areas of interest include: interference prediction; equipment design techniques; instruments; measurement techniques; interference reduction measures.
You may not need capacitors as good as these

Fansteel GOLD-CAP® tantalum capacitors satisfy a very particular need for extremely high reliability. Your design may not justify their extra cost. If so, Fansteel makes and stocks twelve other types of tantalum capacitors that will surely fill the bill. Gold-Caps are produced under Fansteel Spec. No. 6CA-101 which exceeds the requirements of any Mil. Spec. The stability of each and every unit is tested at temperature extremes for Capacitance, D-C Leakage, E S R, and Impedance. Altogether, 7,891 readings, calculations, examinations, and comparisons are made for every 100 units by Fansteel's tough Reliability Center with the aid of modern computers. When a capacitor is given a GOLD-CAP tag, individually serialized, and provided with certified test results, it has earned it. No, we can't be positive that these are the best tantalum capacitors in the world, but we have no reason to think that they aren't. Send for GOLD-CAP Spec. No. 6CA-101 and see what we mean. Rectifier-Capacitor Division, Fansteel Metallurgical Corporation, North Chicago, Ill.

This is what you get—certified test data, such as illustrated, is furnished with each and every GOLD-CAP capacitor. Further inspecting or testing is unnecessary.

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July 13, 1962

CIRCLE 35 ON READER SERVICE CARD
To Contractors and Subcontractors on U.S. Government Projects

UNIFORMITY
of semiconductor devices

Western Electric-Laureldale semiconductors are designed to meet specific requirements and do not depend upon selection from a broad distribution of products.

Typical reproducibility of Laureldale's semiconductor devices is illustrated in these monthly parameter distribution charts for the JAN 2N1195 diffused base germanium mesa transistor:

3 HIGH-FREQUENCY PARAMETERS (median values)

Western Electric-Laureldale, working together with Bell Laboratories' design and development team, produces a broad range of transistors and diodes, both germanium and silicon. These devices are available only to U.S. Government agencies, their contractors and subcontractors and may be purchased in quantity directly from Western Electric's Laureldale Plant. For technical information, price and delivery, address your request to Sales Department, Room 102, Western Electric Company, Laureldale Plant, Laureldale, Pa. Telephone—Area Code 215—929-5811.

LAURELDALE PLANT
MAKER OF ELECTRON PRODUCTS

Western Electric
MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM
Automatic Checkout Equipment

FOR TODAY'S COMPLEX SYSTEMS

With automatic checkout equipment coming into general use, new trends are emerging in its development. This report summarizes recent approaches to equipment and system design, where and how to use automatic checkout equipment.

By GEORGE V. NOVOTNY, Assistant Editor

July 13, 1962
As electronic systems become more and more complex, and the number of components in a system approaches the order of one million, the mean time between failures (MTBF) of the equipment as a whole tends to grow shorter. Thus, a system containing one million components, each with a reliability of 99.9999 percent, might have an overall reliability of nearly zero, with a correspondingly low confidence that it can ever perform its mission.

The electronic system in a modern supersonic bomber has an MTBF of the order of ten hours. At the same time, its complexity makes it impossible to check the entire system in that time, using conventional manual methods: the system may fail long before a normal checkout procedure can be carried out.

To perform a confidence check on such a system and still have enough of the operating lifetime to perform a mission, the check must be done by a high-speed automatic tester. Hence, automatic testing today is not a luxury but a necessity; this justifies its sometimes high cost.

Automatic testing, coupled with the corresponding repair ability, is one technique for improving equipment reliability. Testing and repair imply the availability of spare parts for replacement of faulty ones. In fully automated test-and-repair systems, such as will be used aboard advanced space vehicles, spare parts and provision for their installation will be carried aboard, and the system will thus have become a self-adapting redundant one.

Automatic system checkout minimizes the need for trained operators, saving training time. By eliminating the chance of human error, a high degree of test uniformity is attained. The on-time of the equipment under test is reduced, thus eliminating some failures and allowing longer useful service life.

Automatic testing techniques have been applied to testing components as well as to system testing. Since component testers as a rule are much less complex than system checkout units, this report is not concerned with them.

**BASIC KINDS OF TESTS**—There are three basic kinds of tests to be done on an electronic system. All of these can be performed manually or with varying degrees of automation.

- **Confidence check** merely assesses the readiness of a system to function or to perform a mission. The confidence check usually takes place in the field or on the flight line, with time severely limited, and little or no chance for repair. It may be a GO-NO GO test, or it may determine the possibility of a limited-performance mission by measuring how far outside normal limits the system is functioning. Example: pre-flight checkout.

- **Certification test**. This is usually a periodic test, done on a system kept in readiness; its purpose is to certify the system's reliability and to predict the success of a possible mission. Time may be limited, but there is more chance for fault isolation and for replacement of major components. Example: periodic testing of a Polaris missile's gyroscope aboard the parent submarine, with spare gyroscope units available for replacement.

- **Maintenance test**. Involves primarily the isolation of malfunctioning parts and their replacement, hence it's a diagnostic test. Depending on limitations of time and equipment, an attempt is made to isolate malfunctions to the smallest replaceable component. The faulty parts are then replaced and a certification test usually follows before the equipment is considered in readiness.

While this classification is based on military and space systems, it applies as well to industrial and civilian equipment, with simplifications. However, the time squeeze produced by the high complexity of an electronic system rarely occurs, at the present time, in industrial systems. When automatic testing equipment is applied to such systems, it is usually a simplified version of a military or space checkout system, or a single-function production testing machine of a lower order of complexity.

**HOW TO TEST EQUIPMENT**—There are a number of ways of testing a piece of equipment: inspection and testing of individual components, signal tracing, transfer-function analysis and white-noise techniques and transient response analysis. However, most present-day automatic checkout systems use the approach derived from signal-tracing servicing of radio receivers. See Fig. 1.

- **Stimulation**. A stimulus, such as a voltage, current or r-f signal, is fed into the equipment under test. Often this stimulus is intended to be a close approximation of the working conditions, however, some systems use stimuli such as step voltages, transients or white noise, when these can reveal better erroneous conditions of the unit. Included under stimulation are dummy loads, used to approximate operating conditions. Power is supplied to the equipment under test within limits of normal power-supply operation.

- **Measurement**. The response of the equipment to the applied excitation is then measured at convenient output points. Again the measurement may be a voltage, frequency or any other physical quantity, that is then converted by a transducer into an electrical signal. Enough measurements must be made at enough points to insure satisfactory diagnosis. In a fault isolation test, more measurements will generally be made than in a confidence check. Present-day checkout systems generally have the following measurement capability: a-c and d-c voltage, a-c and d-c current, frequency, time interval, events per unit time, voltage ratio, phase, continuity and
leakage, resistance and impedance.

*Conversion to digital information.* Since as a rule the comparison and logic circuits are digital, measured quantities must be converted into digital data. This is often done by a separate analog-to-digital converter. Or a digital measuring device, such as a voltmeter, may be used. The closer the conversion to the point of measurement, the less degradation of the signal occurs. The output of the converter is generally a binary train.

*Comparison.* This operation compares the digital information from the measurements against preset quantities or acceptable limits, which are stored in a memory or supplied by the programmer for each measurement. The comparator has logic and arithmetic units, their complexity depending on the kind of readout and the nature of the check. The comparator may be required to give a simple go-no go readout, or it may be designed to compute the amount and direction off limits.

In a fault isolation test, a considerable number of logic circuits may be needed to determine which component is faulty, using the available measurements. A trade-off situation exists: the fewer measurements are made, the more sophisticated the logic circuits must be; on the other hand, if enough tests have been made (which consumes more time) the analysis is simpler and the faulty module is more easily isolated. The final compromise depends on required speed, space and weight limitations, cost and other factors. Some advanced automatic test systems have the data-processing capacity and speed of a medium-size computer.

*Printout and display.* This may be a simple go-no go indicator, depending on the equipment and the test. High-go-low, or even more detailed. For example the early DATS (Dynamic Accuracy Test System, by RCA) checkout system for aircraft fire control equipment was designed to indicate, in addition to go and no go, the miss distance in azimuth and elevation, in yards, and also to indicate whether the armament fired early or late. This quantitative readout enables the operator to make a decision in a tactical situation where a somewhat defective system may still be acceptable, providing the deviation from normal is known. Quantitative readout, of course, requires an arithmetic unit such as the DATS miss computer.

In a fault isolation test, the printout unit gives the serial number of the no go check, and often gives the faulty reading. See Fig. 2. Some systems will print out instructions for the operator to make an adjustment or to replace a specific module.

*Controlling unit or programmer.* This unit sequences the tests according to a predetermined program. The program may be inserted as punched paper or plastic tape, magnetic tape or punched cards. Punched 8-channel Mylar tape, see Fig 3, is popular in medium-speed checkout systems. Some systems, such as Race, read off the program from a tape and then store it on a magnetic drum. The selection of the programming medium depends on the duration, number, speed and repeatability of the tests. The programming medium may also tell the allowable limits on each measurement.

The automatic programmer will generally sound an alarm and stop the testing sequence when a no go reading is entered, forcing the operator to acknowledge the situation by manually restarting the sequence. Alternatively, the programmer may switch into a fault-isolation subroutine. In testing missile engines a no go reading will be programmed to automatically disable the unit under test to prevent damage.

Other functions of the control unit include introducing time delays into the sequence as required by the unit under test, and selection and insertion of tolerances into measurement-limit storage. Periodically the programmer may switch in a self-check sequence to test the automatic tester itself.

*Self checking provisions.* The automatic checkout system is highly complex and likely to fail occasionally. To increase confidence in the testing, most modern systems contain provisions for self-check, which is carried out automatically at intervals as a subroutine, sometimes while a test is in progress. Motorola's Plate system, for example, carries out a self check periodically, and if a no go reading is encountered, switches itself into a further self-test sequence, which then isolates and identifies the faulty module of the test system. The self-check exercises all Plate's digital circuits; their
logical response is compared against the response that should occur. The measuring units are also tested, by connecting them to secondary standards and evaluating the measurements against known values.

- Means of access to equipment under test. Connections must be made from the tester to the unit under test. This includes connecting the stimuli to the input points, connecting dummy loads to output points, and making measurement connections. Since automatic checkout must be done rapidly, connecting and disconnecting must be quick and easy. Most testing systems have adapter cables for each kind of unit tested; this accommodates the requirement for a variety of connectors, simplifies test system design and reduces required operator skill.

In checking out a large, complex system, 12,000 wires to and from the equipment may be required. This poses a problem with mobile systems, where cable hoists, booms and similar equipment may be needed; another problem is how to store the cables.

Many techniques have been applied to reducing the number of connections. These are mostly switching techniques, including multiplexing with remote switching amplifiers. An increased logic capacity in the test control computer can make many connections unnecessary, since it can draw more conclusions from fewer figures. Usually it is also desirable to use all input and output connections on the equipment, and to take advantage of all interconnections and information channels in the system under test.

DESIGN OF CHECKOUT SYSTEMS—The speed of a checkout procedure is vital. It is speed that forced the introduction of automatic checkout equipment in the first place, and there is a continuing effort to reduce the overall time of each test cycle. It is desirable also to keep to a minimum the on time of the equipment under test to prevent unnecessary failures.

Switching, both at the input and output, limits speed. Most checkout systems use relay-tree switching, cross-bar, stepping-switch and latch relay configurations, although electronic solid-state switching has been introduced in some advanced systems. In contemporary checkout systems millisecond switching times are normal.

Memory access and readout times in most of today's systems are of the order of 5 milliseconds. With punched tape programming, mechanical readers are being replaced with photoelectric readers; this increases readout speed from about 20 frames a second to up to 200. Block readout techniques, supplementary memories and similar approaches have cut readout time to the order of 1 millisecond. Shorter times are encountered in some computer-controlled units.

Another speed limitation is the measurement and conversion speed. These are intrinsic limitations of the measurement units.

However, the overall checkout speed in modern systems is limited not so much by the checkout system itself as by the equipment under test: warmup time, built-in delays, response time, the time taken by the operator to dispose of no go indications, to make adjustments, the connecting and disconnecting time.

Early automatic checkout systems were custom built. However, with the rapid obsolescence of space and military equipment types, and their increasing complexity, this proved uneconomical; large amounts of support equip-
ment carried with each electronic system frequently had to be replaced, and were unsuited for anything else. At the same time, the automatic checkout system became more complex and its control and logic circuits came to resemble a general computer.

It soon became apparent that a test system that could be adapted to handle several weapon systems would be more practical and economical, and several ways of building adaptability into test equipment were developed. Most of the large automatic testing systems today are flexible, and some are called universal.

However, custom-designed testing systems, designed for one job only, are common in industrial applications and where complexity is low. Testers for repetitive production-line work, such as the one shown in Fig. 4 for testing movements of electronic watches, are not likely to be adaptable to other work.

Similarly, automatic selftesting systems for use aboard space vehicles and intended to perform only one kind of test sequence do not have to be adaptable; in these applications the equipment is expendable and space and weight must be saved.

**MAKING TEST GEAR ADAPTABLE**—The ideal automatic tester, of course, would have no limitations. Since voltages, currents, time phenomena and other physical quantities occur in all electronic equipment, with proper programming the ideal tester could test almost anything. For each piece of new equipment a new program tape would be inserted, connections made, and a test run immediately.

In practice this is not so simple, because universality carries with it certain penalties. Several basic approaches have been developed toward making automatic checkout equipment adaptable.

* Basic-unit-plus-adapter system. This approach to automatic testing equipment uses one basic unit, comprising the elements that are common to all intended applications, and an adapter that completes the test system. The adapter is custom-built for each kind of equipment to be tested.

An example of this approach is Nortronics’ Datico (Digital Automatic Tape Intelligence Checkout) test system, which has been applied to monitoring the readiness of submarine-based Polaris missiles (see Fig. 5), as well as other systems ranging from system checkout to component fault isolation on the Nike-Hercules missile and on automatic pilots.

The basic Datico is unchanged in different applications, except for physical characteristics to conform to the different armed services’ specifications. The equipment includes the program board, test-point selector, control
scanner, comparator, indicator and control, programmer-timer and printer circuits. Figure 6 is a block diagram of Datico.

To this package is added the adapter, which includes the signal (stimuli) generators, measuring devices and displays, as well as connection hardware. Thus units that are common to all testing schemes need not be duplicated, while the specialized features whose requirements vary from system to system can be designed for each, without compromise in measurement accuracies.

DEE, by RCA, is a flexible universal test system. Equipment is shown in its high-speed automatic configuration, block

DEE SYSTEM before delivery to Signal Corps. This is a magnetic-tape system with electric-typewriter printout. Other configurations are available for other applications of the same system—Fig. 9
The Polaris Datico operates on three levels: watch mode, for continuous monitoring of the readiness of the missile circuits; test mode, a periodic maintenance check to ensure readiness; and operate mode, for the final countdown sequence before launching. The system

is controlled by punched Mylar tape.

The basic-unit-plus-adapter system is also used in the Martin Denver Company's Martac 420 system, a solid-state, high-speed automatic checkout system. Martac has the additional feature of one central unit controlling a number of remote units located at the equipment sites. A system is illustrated in Fig. 7.

- Erector-set approach. Called also the functional building-block principle, this approach uses an assortment of physical modules each of which has only one function, such as tape reader, voltmeter, counter or printer. The modules have standardized physical dimensions; electrical characteristics can be also standardized.

For any automatic testing program, only the relevant functional modules are selected and assembled. A programming unit is selected according to the speed and complexity of the test, and connection made to the equipment. This approach is illustrated by RCA's DEE (Digital Evaluation Equipment) system. The basic DEE has 108 different modules, built in five standard module sizes. Fielddata code is the program language.

This system assumes that the basic physical measurements will recur in different systems to be tested, and that measuring units will not be made obsolete by new equipment or increased accuracy requirements. Its advantage is that in any testing program only the necessary units are carried, thus saving space and weight, and that modules can be interchanged to accommodate changing requirements. Obsolescence of individual modules does not necessitate redesign of the system, and expansion capability is maximum.

Thus the DEE open-end system makes possible a variety of testing programs, ranging from semi automated punched-card-programmed units, suitable for production testing and component grading, to computer-controlled research and development evaluation systems, see Fig. 8 and 9. An interface converter available with DEE makes it possible to control the DEE equipment with a external digital computer, so that the testing program can time-share the computer with other activities.

Here automatic checkout equipment becomes an extension of a computer, a tool that enables the controlling computer to perform checking and analytic functions on other electronic equipment without human intermediaries.

Another modern automatic checkout system that illustrates some of the points mentioned above is Sperry's Race (Rapid Automatic Checkout Equipment), a computer-controlled dynamic test system that uses a 1-mega-cycle digital computer with a half-million-bit memory, a computing capacity equivalent to a conventional digital business-type computer. The system is adaptable to radar system testing, data processing stations, bombing-navigation systems and countermeasures systems, and is self-adapting to system design variations.

Race, shown in Fig. 10, performs about 1,500 test cycles in 30 minutes, completing the equivalent of six man-weeks of testing. Without relay switching-time and human-response delays, the system could complete the 1,500 tests in one minute.

The Race checkout systems use a human operator as part of the checkout loop, to cover all modes of operation in the shortest possible time. The operator has a small box by which he can communicate with the control unit: the control unit requests the operator by a flashing-
light code to select switch positions, verify scope patterns and make adjustments. Operator acknowledges orders and replies by pressing buttons, Fig. 11.

Programming of the Race system is by magnetic-drum memory. The logic circuits operate at a one-megacycle clock rate; the drum runs asynchronously slightly slower, and the system under test has its own clock frequency; thus the entire testing system operates on three simultaneous time scales.

An example of an industrial automatic tester is Datronics' Automatic Continuity and Leakage Tester shown in Fig. 12. This unit can be used in production tests, computer checkout and troubleshooting. It tests a circuit's continuity, with go limits 0.4 and 5.0 ohms at 10-milliampere d-c test current, and leakage resistance from 20 to 200 megohms at 500 volts d-c test voltage. The tester has a capacity of 1,000 circuits, each being assigned a three-digit decimal code, and will test these in predetermined sequence at 100 circuits a minute.

The readout indicates the number of the tested circuit, continuity and leakage NO GO lights, test-cycle-complete light, and a fault alarm is sounded in NO GO cases. Programming is by patchboard. Sequence stops when a NO GO reading is obtained. The fault reading can then be repeated or bypassed at the operator's option. Switching is done by stepping switches and relays.

An example of an industrial on-line automatic tester is the DIT-MCO company's model 720 logic-module tester. Programmed by punched Mylar tape in endless loop, the model 720 performs static and dynamic tests on active or passive logic modules, such as memory boards, computer logic cards and component cards. The testing is GO-NO GO, measurements are made of resistance, voltage and current. Marginal tests can be programmed to evaluate a logic module under conditions of lowered or raised supply levels, combined with lowered or raised signal levels. Passive logic circuits can be checked against logical outputs conforming to the logic equation.

TRENDS IN DESIGN—Several trends are emerging in the development of automatic testing systems. They are for the most part in the direction of increased automation, increased speed and smaller physical size.

Computer-controlled checkout systems, capable of analyzing the performance of a unit under test from only a limited number of measurements, will be able to isolate and identify the smallest replaceable component and instruct the operator to that effect. From logical analysis of operation, future systems will probably be able to predict the remaining useful life of any piece of equipment, and also to determine tolerance limits of operation for selected portions of a system where they are contingent on actual performance values measured in other portions of the system. Through computer-controlled checkout equipment, interconnecting cables will be kept to a minimum.

Other features recently appearing in checkout systems are all-solid-state circuits, fully digital circuits, expandable modular design, flat-wire cabling, wire-wrapped connections, use of standard logic modules, photocell rather than electromechanical punched-tape readers, and less reliance on operating technicians.

A major part of the automatic checkout equipment made today is designed in conformance with USAF specification MIL-D-9412, covering data for aerospace ground equipment (AGE).
FIRST CIRCUIT DETAILS
Paramp that Tracked Pioneer IV
Deep-Space Probe

Rapid tuning over a broad frequency range at low noise is made possible by a unique three-cavity design and varactor-diode mount

By A. P. HEYMANN
Specialty Devices Operation,
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THREE CAVITIES, tightly coupled at the varactor diode, but tuned separately, overcome tuning-range limitations of the usual parametric amplifier. This negative-resistance amplifier tunes from 375 to 1,200 Mc with a noise figure of less than 2.5 db. Frequency-selective filters in all the tuning circuits allow independent tuning. The filters and cavities are arranged around the diode so that there is no spurious resonance or interaction between tuning controls.

A rectangular waveguide H-plane cross is used for the pump and idler circuits with the diode at the center of the cross. Pump frequency, fixed at 10 Gc, is supplied by a 100-milliwatt reflex klystron.

Mounted directly on the cross assembly, the coaxial cavity is tuned to the signal frequency. The signal cavity is a modified ¼ or ½ wavelength shorted line capacitively loaded by the diode. A coaxial low-pass filter keeps out X-band frequencies.

The cross design is mechanically simple and lends itself ideally to the electrical requirements.

The physical size of the common frequency area containing the diode is small and of a shape that blends perfectly with the three cavity structures. This simplifies theoretical design.

This configuration permits the use of up to six filter and cavity tuning elements, which are coupled closely to the diode. This relatively large number of independent tuning and matching adjustments results in the unusually wide tuning range.

Two idler-frequency filters and two idler tuning adjustments are arranged in a line with the diode in the center, Fig. 1. The complete circuit may be viewed as a multiwavelength waveguide cavity loaded in the center by the diode.

Two idler adjustments prevent a voltage standing wave minimum from falling at the diode position and decoupling the idler circuit at spot frequencies.

Because both filters are tuned in the same frequency, the two tuning
adjustments interact with each other, providing a tuning adjustment and a diode coupling adjustment for the circuit. The two filters prevent interaction with the pump circuit adjustments.

Band-pass idler filters cover the idler tuning range of 8,800 to 9,625 Mc and have over 30 db attenuation at the pump (10 Gc) and upper sideband frequencies. The filters are a Tchebyscheff design with maximum passband attenuation of 3 db and sharp cutoff slope.

The pump circuit is similar to the idler circuit except that, because of fixed-frequency operation, the filters are narrow band-pass units. With the source at one end of the pump circuit, a sliding short is a matching device at the other end. The sliding short matches the diode to the pump to conserve pump power.

SIGNAL CAVITY—Because of the wide-band tuning requirement plus the requirements of the antenna and post-receiver coupling, the signal cavity (Fig. 2) is the most critical portion of the amplifier. The cavity operates as a coaxial quarter-wave resonant line, which is foreshortened by the diode capacitance, for frequencies up to 550 Mc. The three-quarter mode is used above 550 Mc because its length is more convenient.

The filter section of the signal cavity, a two-section constant-K filter of coaxial design with a cutoff frequency of 4 Gc, is designed for high attenuation in the pump and sideband region (8 to 12 Gc) and the pump second harmonic region (20 Gc). High attenuation at these frequencies assures their absence from the signal cavity resonant circuits, simplifying the design of the signal cavity and providing independence for quick and easy adjustment.

A unique split-conductor construction is used in which both inner and outer conductors are divided for the full length of the cavity to permit the insertion of an adjustable shorting bar. This bar controls both the signal frequency tuning of the amplifier and the coupling between the signal cavity and the signal input and output circuits.

To adjust the signal frequency, the bar is moved to vary the length of the resonant portion of the cavity, which lies between the bar and the varactor diode. The remainder of the cavity acts as a coaxial line to connect the resonant portion to the signal input and output circuits.

The shorting bar is a leaky short that permits energy to couple into and out of the resonant cavity. Coupling is controlled by varying the cross-section of the shorting bar. By making the bar with a lengthwise taper, its effective cross-section is adjusted by moving it into or out of the split signal cavity.

The bar makes contact at all times to both halves of the center and outer portions of the signal cavity. Six rhodium-plated beryllium-copper contact strips make high-pressure contact with the rhodium-plated shorting bar. The split-center conductor is supported by a low-loss foamed-in-place plastic that is almost completely transparent to the signal-frequency energy. This construction makes the signal cavity a rugged structure, practically immune to shock, vibration or moisture and dirt contamination.

A phasing adjustment, Fig. 3, allows optimum matching between the antenna and the signal cavity. This is a trombone-type constant-impedance coaxial line stretcher.

COUPLER—A wide-band directional coupler couples signal input and output lines to the amplifier. A circulator would be better but no circulator covers more than a small fraction of the tuning range of the amplifier. It may be possible to cover the 825 Mc tuning range using two circulators with coaxial switching. These devices have not yet been developed but their use would double the bandwidth of the amplifier and increase its stability.

Any conventional circulator can be used with the amplifier over a tuning range determined by the passband of the circulator. Such a circulator could either directly replace the directional coupler or be installed external to the amplifier and the directional coupler left in place.
A loop coupler introduces a test signal into the amplifier for adjusting and verifying operation.

In the pump circuit a 20-db cross-guide coupler diverts 1 percent of the pump power to a crystal detector. The rectified current goes to a 0-1 milliammeter that monitors pump power. An attenuator diode across the pump waveguide acts as an electrically-operated control of the pump power reaching the varactor diode. This controls amplifier gain which is a function of pump power. A low-noise high-stability power supply furnishes bias voltage to the attenuator diode.

The varactor diode is operated with a fixed bias of 1.35 volts from a Mallory PX13 mercury battery.

As shown in Fig. 3 five servo motors in the amplifier operate the adjustments. These are conventional a-c servos with carbon-film stepless reference and feedback potentiometers.

MOUNTING—The amplifier is mounted on, but thermally isolated from, a round aluminum base plate. The cylindrical aluminum cover is double walled with a foamed-in-place plastic thermal insulation. To reduce radiant heat pickup from sunlight, the outer surface is polished and bright anodized. The cover bolts to the base plate with an O-ring seal to provide a weather-tight joint.

To avoid artificial cooling, the amplifier is operated at an internal temperature of 125 F. The temperature control system consists of four thermoswitches and a number of heater units distributed over the amplifier structure.

For wide-range operation on a parabolic antenna, a broadband feed must be used. A log periodic structure would meet this requirement.

Since this is a regenerative amplifier, its gain is limited only by self oscillation. In laboratory tests it operated with gains as high as 50 db. However, stability, bandwidth and system noise usually limit the paramp gain to 20 db or less. At 20-db gain the bandwidth is between 100 Kc and 300 Kc at 400 Mc and between 250 Kc and 700 Kc at 1,000 Mc. Bandwidth is determined by the antenna phasing control. Use of a circulator will result in the doubling of the bandwidth. With 20-db gain the noise figure is approximately 1.3 db at 375 Mc and 2 db at 1,200 Mc using a Microwave Associates MA-460H varactor diode.

In spite of the apparent complexity of its controls, the amplifier can be tuned to any frequency within its range in less than 30 seconds by an unskilled operator using calibration curves and checking equipment.

Although the paramp was designed to enhance the capabilities of space tracking and space communication facilities it is a general-purpose, signal-frequency, low-noise, 50-ohm amplifier, which can be used with any radar, radio-astronomy or noise-measuring equipment. A developmental prototype of this amplifier was used in March 1959 to track the Pioneer IV deep-space probe to a range of 407,000 miles. An 18-foot parabolic antenna was used with a phase-lock receiver. Signal frequency was 960 Mc.

Although this unit was specifically designed for a tuning range of 375 to 1,200 Mc it can be made to operate at any frequency up to about 2,500 Mc by change in the passband of the idler filters. With a redesign of the waveguide cross to accommodate a higher frequency pump, the amplifier can be made to operate at signal frequencies up to 5,000 Mc.

REFERENCES


NEW WAY TO MULTIPLY Q

Negative-impedance converter increases Q by a factor of 4 or more, by reducing circuit losses. Transistor matching is not necessary, and component tolerances are not critical.


TUNED CIRCUITS in the audio range seldom achieve a high circuit Q. The difficulty is a combination of low operating frequency and high series losses with inductors. This article presents a method for reducing circuit losses, thereby increasing over-all circuit Q.

Consider a tank circuit composed of a lossless capacitor in parallel with a lossy inductor, Fig. 1A. Figure 1B also represents the circuit, and the analysis lends itself more readily to this representation. For Fig. 1B, Q is given by

\[ Q = \frac{R_p}{\omega L} \]  

\[(A)\]  

\[(B)\]  

TANK CIRCUIT (A) is also represented as (B); tank circuit with negative resistance added (C) — Fig. 1

Multiplication of Q can be obtained by raising the value of \( R_x \). This is most easily accomplished by adding some negative resistance to the circuit as shown in Fig. 1C (the tank circuit losses are represented by resistance \( R_p \)). The new circuit Q will be

\[ Q = \frac{R_x}{\omega L}, \text{ where } R_x = \frac{R_p R_N}{R_p - R_N} \]  

\[(2)\]  

Since \( R_x \) must be positive to prevent oscillation, the magnitude of \( R_x \) must be greater than \( R_p \). Referring to Fig. 1C,

\[ V_{in} = V_g - i_x R_p \]

\[ i_x = \frac{V_{in}}{R_p} \]

and \( i_x = \frac{V_e}{v + R_p} \)

The equation for \( V_{in} \) can be rewritten as

\[ V_{in} = R_x (i_x + i_{in}) \]  

\[(3)\]  

Solving Eq. 3 for \( i_{in} \)

\[ i_{in} = \frac{V_{in} - i_x R_p}{R_x} \]  

\[(4)\]  

Defining a multiplication factor \( M \), such that \( R_x = \)
WITH TRANSISTORS

\[ MR_p, \text{ then} \]
\[ i_{in} = \frac{V_{in} - M R_p R_p}{M R_p} = \frac{V_{in} (1 - M)}{M R_p} \]  \hfill (5)
\[ \frac{V_{in}}{i_{in}} = R_M = \frac{M R_p}{1 - M} \]  \hfill (6)

The designer will have all the information necessary to solve Eq. 5 and 6.

Figure 2A is a schematic of a negative impedance converter. It consists of an emitter follower and grounded base amplifier, with positive feedback from the collector of Q, to the base of Q. The circuit of Fig. 2A may be reduced to that shown in Fig. 2B. Resistance \( R_b \) represents the parallel combination of \( R \) and \( R_\text{r} \), \( R_b \) represents the parallel combination of \( R_\text{r} \) and \( R_\text{p} \), and all capacitances have been omitted since their reactances can be made negligible at the operating frequency. Referring to Fig. 2B, and using only magnitudes for \( a \) and \( \beta \)

\[ i_b = K \beta, \text{ where } K = \frac{R_b}{R_b + (\beta + 1) R_L} \]
\[ i_{ib} = (\beta + 1) i_b = K (\beta + 1) i_b \]
\[ i_{z} = R_L + R', \text{ and } i_{za} = \frac{R_L}{R_L + R'} i_{za} \]

where \( R' \) equals \( R_L \) in parallel with the input resistance of \( Q \).

\[ i_b = K R_L (\beta + 1) i_b \]
\[ i_{za} = \frac{R_L}{R_L + R'} i_{za} \]

Since \( R' \) will be much smaller than \( R_L \) and can be neglected, and \( \beta + 1 \) is essentially \( \beta \),

\[ i_b = K \beta \]

Neglecting the small current that will flow in \( R_\text{p} \),

\[ i_{za} = a_2 K \beta \]
\[ i_{za} = \frac{R_L}{R_L + R'} i_{za} = \frac{a_2 K \beta i_b R_L}{R_L + R'} \]

At the input

\[ i_{in} = i_b - i_f \]
\[ i_{in} = i_b - a_2 K \beta i_b R_L \]
\[ i_{in} = \frac{(R_L + R_f - a_2 K \beta R_L)}{R_L + R_f} \]

Solving for \( R_f \) yields

\[ R_f = i_{ib} (1 - a_2 K \beta) R_L - \frac{i_{in} R_L}{i_{in} - i_b} \]

Assume \( a_2 = 1 \) and

\[ R_f = i_{ib} (1 - K) R_L - \frac{i_{in} R_L}{i_{in} - i_b} \] \hfill (7)

Conventional biasing techniques will determine the values of the biasing resistors shown in Fig. 3 (\( R_\text{r}, R_\text{n}, R_\text{i}, R_e, R_n, R_r \)). The original circuit conditions give values of \( V_{in} \) and \( R_p \). With these two values and the desired multiplication factor \( M \), Eq. 5 can be solved for \( i_{in} \). Current \( i_b \) can be found from

\[ i_b = \frac{V_{in}}{R_b (1 - K)} \]

Equation 7 can be solved for \( R_f \). Making \( R_f \) variable will allow for any corrections that may be necessary due to assumptions made in the analysis.

Figure 3 shows the multiplication capabilities of the circuit. Transistor matching is not necessary and component tolerances are not critical. Lead lengths could become critical when large multiplication factors are desired, so good wiring practice should be observed. Figure 2A gives component values of a circuit built in the lab to demonstrate Q multiplication. The tank circuit Q was multiplied by 4, giving an overall circuit Q of 20. As shown in Fig. 3, much higher multiplication may be obtained, the limit being the condition where \( |R_f| = R_e \) and oscillations result.

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Steering Radar Antenna Beams

Made from passive microwave elements, beam-forming matrix can be placed next to antenna array, is theoretically lossless and forms as many simultaneous beams as there are antenna elements in the array

By WILLIAM P. DELANEY
MIT Lincoln Laboratory, Lexington, Mass.

MANY PRESENT and future radar systems require a rapid and flexible means of steering the antenna beam. Some of the limitations inherent in mechanical steering methods can be overcome by the phased array radar, which uses electronic beam-forming and beam-scanning.

All phased array receivers combine the outputs of discrete antenna elements to form one or more antenna beams. This combining process can take place in the r-f or i-f portions of the receiver. One major disadvantage of forming the beam in the lower frequency portions of the receiver is the need for amplitude- and phase-stable mixing and amplifying circuits between the antennas and the low-frequency beam former.

A theoretically lossless multiple-beam forming technique can be used to form $n$ simultaneous beams from an $n$ element linear array. The beam-forming matrix operates directly at the r-f carrier frequency and thus can be located directly behind the antenna elements. All the beams formed by this technique have the full gain of the array aperture. Since the technique uses a matrix of passive microwave devices, it can be rugged and reliable, and is not susceptible to the phase and amplitude instabilities common in active r-f devices.

COUPLERS & PHASE SHIFTERS
—Basic components of the matrix are 3-db directional couplers or hybrid rings and fixed phase shifters. Conventions concerning the phase shift through hybrids and directional couplers are shown in Fig. 1A. When the input voltages have the amplitudes and relative phase angles shown in Fig. 1A, all the input signal power will appear at the indicated terminal.

The simplest multibeam array is formed with two antenna elements plus one hybrid ring or one 3-db directional coupler. Figure 1B shows a two-beam, two-element array using a 3-db directional coupler.

A certain incident wavefront will excite antenna element currents that are 90 degrees out of phase, and therefore all the received signal energy will appear at one terminal of the directional coupler. Thus, a beam right and a beam left are formed. If a hybrid ring is used, the two-element array has a broadside beam and an endfire beam, assuming an antenna element spacing close to one-half wavelength.

A four-beam matrix can be built by interlacing two two-beam matrices and then providing a second level of directional couplers or hybrid rings to combine the outputs. Fixed phase shifters are required between the upper and lower levels of couplers. Figure 2A shows a four-element, four-beam array using directional couplers. The amplitudes and phases of an incident beam-1-left signal are shown at various points in the matrix. Figure 2B shows the amplitudes and phases of an incident beam-2-left signal. The directional couplers shown shaded are used to form...
With a Lossless R-F Matrix

The particular beam. Thus, the beam-forming matrix behaves like a multiple port feed structure that routes a signal originating at a particular point in space to a particular output port of the matrix. Since the matrix is symmetrical about a vertical line through the center, the 1-right and 2-right beams can be found by using the same approach.

**SIXTEEN-ELEMENT MATRIX**

—This can be thought of as four interleaved four-element matrices. Two extra levels of phase shifters and combining elements (directional couplers or hybrid rings) are required. Figure 3 is a diagram of the 16-element matrix used to obtain the experimental measurements presented here.

The beam-forming technique can be used in planar arrays by first combining the columns of antenna elements in matrices and then combining the outputs of the column matrices in a group of row matrices. Some of the fundamental characteristics of the r-f beam-forming matrix are given in Table I.

The basic antenna beams formed using the r-f matrix will have the same beam shape as a uniformly illuminated antenna array. Thus first sidelobe levels of -13 db are to be expected for arrays of eight elements or more. The beams formed by this technique occupy fixed positions in space for fixed values of antenna element spacing and frequency. When the frequency is changed the beam positions will shift. Typically, a 10 percent frequency change will shift the positions of the beams near broadside by 10 percent and the beams furthest removed from broadside by as much as 28 percent.

The adjacent beams formed by this technique overlap each other with the cross-overs at the $2\pi$ (at -4 db) points. The top portion of Fig. 4 shows three typical beams: 1R = first beam to the right of broadside, 2R = second beam to right.

Figure 4 also shows how two adjacent beams (1R and 2R for example) can be added to form a new beam (1R + 2R), which is somewhat broader than the component beams but has lower sidelobe levels. This addition of two adjacent beams changes the array illumination from a uniform distribution to a cosine distribution and thus first sidelobe levels of -23 db are to be expected in a large array. These reduced sidelobe levels are
achieved at the expense of a 0.9-db decrease in antenna gain and a 35 percent increase in half-power beamwidth. Adjacent cosine illumination beams shown at the bottom of Fig. 5 cannot be realized both simultaneously and without loss.

Three uniform illumination beams can be added to form a cosine-squared illumination of the aperture; in general, \( n + 1 \) beams can be added to give a (cosine)\(^n\) illumination. Directional couplers in the matrix are of the coupled strip type. This type of coupler, shown schematically in Fig. 5A, has broadband characteristics.

Input power to port 1 is split equally between ports 2 and 4, with no power coupled to port 3. Power transfer from port 1 to 2 is accomplished by electromagnetic coupling between the two center conductor strips. Figure 5B shows a cross section of this coupler in strip transmission line.

**EXPERIMENTAL RESULTS—**The couplers used in the matrix coupled 3 db \( \pm 1/4 \) db over the 880 to 1,160 Mc range, with good isolation (26 db minimum) and low vswr (1.10 to 1 maximum). The phase shifters in the matrix also utilize a coupled-line technique to obtain a broadband phase characteristic.

Figure 5C shows a network with close to constant differential phase shift between the output ports for a wide range of frequencies. The phase shift, \( \phi \), from input to output port 1 is a linear function of frequency since this path contains a straight piece of transmission line. Phase shifts \( \phi \), from input to output port 3, has a different characteristic because of the coupled line in this path. Differential phase shift \( \Delta \phi \) is reasonably constant from 0.67 \( f \) to 1.33 \( f \).

The technique was fully explored using broadband couplers and phase shifters (see Table II). The beam-forming matrix was tested in a 16-element linear array of parallel dipoles 0.58 wavelength apart. Figure 6A shows the major lobes of all 16 beams. Beam peaks occur close to theoretical positions, with a worst case error of 1.2 degrees in beam-7-right. The envelope of the beam peaks follows the antenna element pattern closely, as would be expected from the principle of pattern multiplications. The near-in beam, (1-right, Fig. 6B) has first sidelobes of -13 db.

The antenna element spacing of 0.58 \( \lambda \) in this test allows grating lobes to form for beams further than 45 degrees off broadside. The start of this grating lobe structure is evident in beam-7-right.

A cosine illumination of the aperture can be achieved by adding two adjacent beams. Figure 6D shows a cosine illumination beam obtained by adding beams 4-right and 5-right in a hybrid ring. The first sidelobe in this beam is about 22 db down, which is close to the theoretical value of -23 db for a cosine illumination on a 16-element array. The hybrid ring also provides the difference of the two adjacent beams corresponding to a sine illumination. The difference pattern has a sharp null at the same position as the peak of the sum pattern and may be useful for amplitude-comparison monopulse applications.

Acknowledgement is due J. Blass, J. Butler and R. Lowe, and J. Shelton and K. Kelleher; the matrix was designed and built by Sanders Associates.

**REFERENCES**

MEASUREMENTS OF 16-ELEMENT AT 900 MC—TABLE II

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<td>Maximum Input or Output Vswr</td>
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<td>Minimum Isolation Between Beam Terminals</td>
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<tr>
<td>Minimum Isolation Between Antenna terminals</td>
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<td>Average of Rms Phase Errors in Output</td>
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THREE MATRIX BEAMS and the formation of cosine illumination beams—Fig. 4

COUPLED-STRIP directional coupler (A); cross section of a 3-db coupler (B). Broadband differential phase-shift network (C) and its phase characteristics (D)—Fig. 5

MAJOR LOBES of all 16 beams (A), beam-1-right (B), beam-7-right (C), and cosine illumination beam (beam-4-right plus beam-5-right) (D)—Fig. 6

July 13, 1962
THE NEED for a high-performance high-voltage power supply has led to the design of a unit 2½ in. high by 1¼ in. square with an output of 5,000 v d-c at 50mA. Input is 26 volt d-c with a current drain of 44 ma for the military model and 26 v d-c at 60 ma for the commercial model.

The circuit uses a voltage-doubler rectifier output, although more expensive transistors used in experimental models have permitted the use of a single silicon rectifier at full voltage to achieve the same output characteristics.

OPERATION — The transformer acts as a voltage step-up and oscillator section and the transformer core is the transistor heat sink. The 0.01μf capacitors in the voltage-doubler section provide sufficient filtering for most applications. However, in the military unit additional filter capacitance has been added to attenuate a-c ripple to less than 0.01 percent over the range. The transformer secondary loading characteristics require silicon rectifiers having piv (peak inverse voltage) ratings of not less than 3,000 volt d-c, permitting 1μa to flow at 3,000 volts for the 1N3286 rectifier. Leakage in inexpensive diodes causes high loading and distortion of the sine wave.

The design characteristics of the coil are rigid, yet it can be wound on multiple winding machines in production. The ferrite core is a Q type used in tv flyback transformers and is hollow in the center, thus permitting the core to be used as the transistor heat sink. The transformer primary was wound with No. 38 Mylar wire to determine empirically the best oscillatory characteristic of an inexpensive 2N217 transistor. After checking of 2N217s in various circuits, it was determined that 175 turns either side of the center tap was optimal disregarding the inductance of the secondary. The No. 38 wire was selected to give 40 ohms total d-c winding resistance of the transformer primary to match the collector-to-base voltage ratio (BV_{ce}) of the 2N217 transistor in series with its base resistor. This design resulted in 8 volts rms from the primary winding on the ferrite core. Using 20,000 secondary turns gave 2,500 volts output, which when doubled gave the necessary 5,000 volts d-c.

INEXPENSIVE Converter Gives 5,000 Volts D-C

Converter uses sinusoidal oscillator rather than relaxation type; voltage-doubling capacitors provide smoothing with less than 0.01-percent ripple

By R. D. MORROW Morrow Products Inc., Baltimore, Md.
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Do Field-Effect Transistors Resist Nuclear Radiation?

Semiconductor majority carrier characteristics may determine resistance

By ALVIN B. KAUFMAN
Litton Systems, Inc.,
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IRRADIATION of field-effect transistors indicates that majority-carrier characteristics may be the limiting factor in obtaining nuclear-resistant semiconductors. This implication results from tests in which degradation of gain to a predetermined value required about the same level of exposure as with high alpha cutoff frequency transistors.

The tests also indicate that majority-carrier properties may be improved by lowering semiconductor resistivity and possibly by better surface passivation. Use of germanium rather than silicon may also improve nuclear resistance.

The field-effect transistor at the top of Fig. 1 consists of an n-type silicon bar with an ohmic cathode contact at one end and an anode contact at the other. Positive voltage is applied to the anode or drain electrode. Two pn junctions built into the middle of the bar and connected in parallel serve as the grid or gate. Negative bias applied to the grid projects the depletion layers shown by broken lines into the silicon, increasing effective anode-to-cathode resistance.

OPERATION—As anode voltage increases, the voltage drop resulting from anode current reverse biases the grid junctions so that the depletion layers are extended and finally meet in the bulk material. Increasing anode voltage further does not increase anode current appreciably. Pinch-off voltage is the anode potential at which anode current reaches saturation, and pinch-off current is anode current after pinch-off voltage has been reached. With zero grid bias, pinch-off current is maximum specified anode current. The field-effect transistor is said to be in the triode region before pinch-off and in the pentode region after pinch-off has been reached. Interchanging anode and cathode terminals results in little or no change in operating parameters.

Since there are no junctions in the output current path, the major source of noise is the thermal noise of the anode-to-cathode resistance, which is typically 1,000 to 10,000 ohms. In transistors, emitter and a collector junctions change contact potential and leakage resistance under irradiation, shifting operating characteristics. These junctions are lacking in the field-effect transistor, which also depends on majority-carrier characteristics instead of the majority-minority properties used in transistor operation.

During irradiation in the General Dynamics reactor at Fort Worth, mutual gain was measured dynamically. The observed change in anode current was divided by the variation in gate voltage using the circuit at the bottom of Fig. 1 to compute mutual conductance.

Radiation exposure was determined by the Litton microfoil technique. It is estimated from previous experiments that the gamma-ray exposure, measured in ergs/gm (C), was $2.7 \times 10^{12}$ as intense as the epithermal neutron exposure, measured in neutrons/cm², with $E_x$ greater than 0.48 ev. Irradiation was carried out at 17.5 degrees C.

TEST RESULTS—Mutual conductance of the Crystalonics C652 silicon npn field-effect devices before and during irradiation is shown at the top of Fig. 2. Resistivity of units A and B is about 10 ohms/cm and of the remaining units is 3 to 5 ohms/cm. The same data, normalized by dividing observed values by baseline values is shown at the bottom of the figure.

Although the number of samples was small, apparently low-resistance devices might withstand exposure twice as great as high-resistance devices. This interpretation requires that devices A and E be neglected, performance of A being questionable at any rate.

Exposure needed to degrade gain to 0.7 of baseline value was about $2 \times 10^9$ epithermal neutrons per cm² (mv,t), about the same as required to damage high alpha cutoff
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NO VOLTAGE OVERSHOOT from turn-on, turn-off or power failure.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>DC OUTPUT RANGE</th>
<th>AMPS</th>
<th>REGULATION %</th>
<th>STABILITY %</th>
<th>OUTPUT IMPEDANCE 0-1KC</th>
<th>RIPPLE RMS</th>
<th>INPUT WATTS MAX</th>
<th>INPUT AMPS MAX</th>
<th>PRICE</th>
</tr>
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<tbody>
<tr>
<td>KS 8-100M</td>
<td>0-8</td>
<td>100</td>
<td>0.01</td>
<td>0.01</td>
<td>0.0002</td>
<td>1 mv</td>
<td>1400</td>
<td>24</td>
<td>$1,395.00</td>
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<tr>
<td>KS 18-50M</td>
<td>0-18</td>
<td>50</td>
<td>0.01</td>
<td>0.01</td>
<td>0.0004</td>
<td>1 mv</td>
<td>1400</td>
<td>24</td>
<td>$1,295.00</td>
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<tr>
<td>KS 36-30M</td>
<td>0-36</td>
<td>30</td>
<td>0.01</td>
<td>0.01</td>
<td>0.0006</td>
<td>1 mv</td>
<td>1400</td>
<td>24</td>
<td>$1,195.00</td>
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<tr>
<td>KS 60-20M</td>
<td>0-60</td>
<td>20</td>
<td>0.01</td>
<td>0.01</td>
<td>0.001</td>
<td>1 mv</td>
<td>1500</td>
<td>26</td>
<td>$1,295.00</td>
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</tbody>
</table>

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frequency transistors. Thus majority-carrier characteristics may be the significant factor in nuclear resistance and might be improved by lowering semiconductor resistivity and by better surface passivation.

Degradation for specified exposure does not appear to be the same at different nuclear facilities. Basically these differences result from differences in reactor neutron energy spectra and energy above which neutron flux is specified and from differences among specimens.

For exposures that could be compared, the energy point above which all neutrons are reported should include all neutrons producing damage and exclude all neutrons not producing damage. This point is not easily selected, particularly in a device containing materials of different atomic weights and with widely varying operational requirements.

Lattice displacements occur with a transfer of 25 ev kinetic energy to the typical atom, and their magnitude and effect on components or hardware may differ. Seitz has shown that maximum energy imparted to a target atom in perfect collision is \( E_{\text{max}} = E_0 \left(1 - \left( \frac{m-1}{m+1} \right)^2 \right) \), where \( E_0 \) is initial neutron energy and \( m \) is target atom mass. Thus for germanium semiconductors, minimum energy of the neutron is 450 ev if 25 ev is transferred to its target atom and if the secondary neutron recoils straight back. Otherwise initial energy must be higher.

For silicon, the value is 175 ev. This difference in threshold energy for damage might account for the difference in radiation sensitivity between silicon and germanium.

NEUTRON ENERGY—If all factors are equal, degradation of a given semiconductor for the same exposure should be invariant in different neutron environments if the neutrons measured are those above the threshold damage point. Presently the epicadmium point \((n,\gamma)\) is the closest to the desired energy threshold. With improved resonant-coil techniques, measurement of \(n,\gamma\) at \( E_0 \) greater than 450 or 175 ev may show closer correlation of component performance in different reactors. Semiconductor data reported at \(n,\gamma\) exposures with various energies should be converted (by multiplication of ratio values of differential flux for reactor used) to \( n,\gamma \) for correlation.

Gate current, which reflects input impedance, was not measured and may be an important parameter. Severe increase in gate leakage current has been reported, probably induced by the high level of ionization. Considering the high input resistance, the leakage might have been induced in the instrumentation rather than in the test specimen.

Degradation of normalized gain to about 0.9 at 10⁶ \( n,\gamma \) shown in Fig. 2 has been reported for other field-effect transistors.

REFERENCES

Laser-Pumped Maser Shows Way to Fill Spectrum Gap

RUBY CRYSTAL pumped by coherent optical radiation from a ruby laser has generated and amplified microwaves at 22.4 Gc. The optically pumped maser extends the frequency range over which maser devices can be pumped by three orders of magnitude.

The laser-pumped maser was developed at the research laboratories of Hughes Aircraft Co. under a one-year contract with the U. S. Army Signal Corps, Fort Monmouth, N. J.

The maser cavity consisted of a section of 0.05 by 0.13 inch waveguide that was beyond cutoff at 22.4 Gc. The waveguide was loaded with a 0.078-inch length of 0.05-percent ruby. The structure functioned as a ruby-loaded reflection cavity that was resonant in a perturbed TE_01 mode at 22.4 Gc. Optical pumping was effected through the waveguide.

The ruby cavity structure was oriented so that the crystalline C axis was at 67 degrees to a magnetic field of 6,700 oersteds. This arrangement split the ground and
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Wind-Tunnel Models Are Magnetically Supported

BOSTON—Magnetic suspension and balance system eliminates the interference caused by supports of models in a wind tunnel. The system is being used at the Naval supersonic facility at Massachusetts Institute of Technology.

The technique developed at MIT is a modification of the method first successfully used by French aeronautics researchers in 1957. At the MIT wind tunnel, a half-inch diameter, 20-ounce brass model containing a ferromagnetic cylinder is magnetically suspended and controlled by lift, drag and lateral coils.

The control system for the magnetic suspension equipment includes position-sensing light beams. Thyratons are connected in a six-phase, half-wave star configuration to form the basic power supply.

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Red Bank Division

July 13, 1962
New Magnetic Rods Simplify Circuits

Major advances also offer increased stability with temperature change

By T. A. O. GROSS, President
Spectran Electronics Corp., Maynard, Massachusetts

EFFICIENCY and dynamic range of magnetostrictive filters have improved at least several dB in recent months, but the big step forward has been improved stability with variations in ambient temperature. New high-efficiency rods now offer opportunity for simplified and more reliable circuit design.

Improvements in transfer efficiency is illustrated by a simple circuit adopted for Spectran’s own use, Fig. 1. This circuit takes advantage of these new high-efficiency rods, and permits oscillation with a single transistor stage.

A temperature coefficient of 2 ppm per deg C is now representative. Much of the advance is due to the introduction of modified Elinvar constant modulus materials, but small refinements in the many steps of manufacture have been major contributions to the performance and reliability of magnetostrictive rods.

The rods are now cut to lengths accurate to $2 \times 10^{-5}$ inches. This precision minimizes the amount of final tailoring necessary which contributes to the stability of the resonator.

Magneostrictive rods are now the principal type of filter used in multiple-filter spectrum analyzers, and resonant rods are rapidly assuming a dominant position in telemetry and command systems.

New applications of resonant rods in space programs account for some of the increased activity in magnetostrictive filters, just as the closely related magnetostrictive delay lines have benefitted by the recent upsurge in digital equipment. More important, however, has been the increased acceptance of magnetostrictive devices in established applications—in transducers, magnetostrictive oscillators, filters and storage delay lines—representing a method of converting an electrical pulse into a mechanical pulse or conversely. This upsurge in activity has been due to improvement of the rod elements themselves.

IMPROVED MATERIALS—Present studies includes work with ferromagnetics having greater magnetostrictive effects. The most promising materials are variations on the nickel-zinc ferrites which have been modified to improve their frequency versus temperature characteristics. The coupling coefficient of these materials is much higher than for the Elinvar and their higher resistivity permits operation with much lower losses.

The assembly shown in Fig. 2 shows a bank of filters used to separate subcarrier modulation tones in satellite and rocket command-control and command-destruct receivers. Important design consideration was to minimize weight. Excess material was drilled out of base plate to keep weight of entire assembly down to two ounces—Fig. 2.

FILTER BANK assembly, shown actual size, separates subcarrier modulation tones in satellite and rocket command-control and command-destruct receivers. Important design consideration was to minimize weight. Excess material was drilled out of base plate to keep weight of entire assembly down to two ounces—Fig. 2.

trol and command-destruct receivers. Great pains were taken to minimize weight. Excess material has been drilled out of the base plate so that the weight of the entire assembly is two ounces.

Present day magnetostrictive filters have a Q range of 2,000 to 20,000 and a resonant frequency range of 10 Kc to 500 Kc. Not all Q's can be obtained over the entire frequency range so that the practicable range in half-power bandwidth is about one cps to 200 cps.

This article discusses only four-terminal resonant devices used as filters and as frequency standards. The nonresonant devices are used in different fields of application. Intriguing possibilities of the two-
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Low boiling points of 3M Inert Liquids (see “profile”) permit exceptional rates of heat transfer by evaporation. Boiling FC-75, for instance, removes up to 10 times more heat than standard transformer oil does by convection. And inert fluids remove 30 to 40 times more heat than many less volatile organic coolants.

FC-75 and FC-43 are compatible with most materials, remain chemically inert, dielectrically strong. Both are non-explosive, non-flammable, non-toxic, odorless and provide great thermal stability. Write for further details.

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terminal devices must await more development to make them practical.

The resonant element, Fig. 3A, in a typical 100 Kc/s magnetostrictive resonator is a nickel-iron alloy rod or tube supported by two or more node washers—so named because they are located at the motional nodes. At no other point may the rod touch coils or other objects lest the motion become damped. The vibratory motion of the rod is longitudinal; it becomes alternately longer and shorter by about 200 microinches at resonance with a strong signal. This motion is small to the engineer who would use it to actuate some sort of readout, but it is large to the metallurgist concerned with the elastic limit of the material. The enormous stresses cause no permanent damage but the Q falls off during excitation with excessively large signals.

The rod is driven by a coil accurately positioned so as not to interfere with its motion. This coil produces an axial field which alternates with the signal to add or subtract from the flux produced by the bias magnet.

Magnetostriction causes the rod to change its length-diameter ratio with changes in the magnetic flux. The rod can be driven without the bias magnet, but the device then becomes nonlinear with small signals and there are two mechanical cycles for each electrical cycle. There are applications where this frequency multiplication is desirable. The difference in frequency between input and output can be exploited to improve off-resonance isolation and the higher mechanical frequency reduces the length of the filter.

DRIVE AND PICKUP—The output or pickup configuration is similar and often identical to the drive end. The bias magnet, however, now has an essential role because the pickoff signal is generated by its flux. The alternating stress produced by the mechanical vibration produces a corresponding variation in the rod permeability. As the reluctance of the flux path through the coil varies, so does the distribution of the bias magnet flux vary between external leakage and the
path linking with the coil.

The resonant frequency of the rod is equal to

\[ \frac{N}{2L} V \]

where \( N \) is an integer, \( L \) is the length, and \( V \) is the velocity of sound in the rod—about \( 2 \times 10^5 \) in./sec.

Simple low frequency filters operate in the second order \((N = 2)\) which is the lowest that can be used with two or more node washers. The second order motion diagram is given in Fig. 3B. Higher orders are often used to obtain larger spacing between drive and pickoff coils which improves off-resonance isolation.

The resonant frequency is adjusted within 0.05 percent of the desired value by manipulation of the length alone. Final tailoring is accomplished by removing minute amounts of material from region B in Fig. 3B, if it is desired to raise the frequency, or from region of A or C if it is desired to lower frequency.

If desired, it is practicable to adjust a filter or frequency standard to within 0.1 cycles per second at 200 Kc per second. Interestingly enough, the only difficulty is the time required to read a frequency to the requisite accuracy.

It is the usual practice to multiply the rod frequency by a factor of ten before feeding into the

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counter, so that the tailoring process can be accomplished rapidly.

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New Phosphor Screen
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HIGH-RESOLUTION cathode ray tube, now available from Westinghouse, has a screen deposited on the faceplate by electrolysis before it is mounted on the tube. The new deposition technique results in a compact and exceptionally smooth screen. Coating uniformity of deposit results in low screen noise levels and the P16 phosphor provides rapid image decay.

The new tube's precision electrostatically focused electron gun produces a line of light energy that is 0.001 inch in diam at its one-half amplitude level. The five-inch diam tube, WX-4647P16 is designed for use as a high-information-content flying-spot scanner, and as a photographic recorder.

New Microwave Tube
Produced in Japan

NEW MICROWAVE tube, the Laddertron, is now being commercially produced at Oki's new Tokyo factory, built exclusively for the production of millimeter and submillimeter tubes.

The new tube was invented at Kobe University by Kazuo Fujiwara. Oki financed research and holds exclusive patent license. Fujiwara transferred to Osaka University.

Three to 15 millimeter range versions of the Laddertron are now in production. Other tubes to be produced initially include magnetrons and klystrons in the same frequency range as the Laddertron. Future plans include production of twt and bwo tubes, also extension of frequency range of tubes produced to submillimeter and production of higher power tubes.
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July 13, 1962
Making New Production Ideas Work

Systematic effort to find and put best ideas to work pays off

By C. J. GEATING
Westinghouse Air Arm Div.,
Baltimore, Md.

To obtain maximum production efficiency, this division has set up a special methods engineering department. Much of the production in the plant is highly complex electronic equipment, but produced in relatively small lots. As a result, highly automated production techniques are not generally economical and thus manual methods are extensively used.

Since the labor costs in manual assembly are relatively high, the Methods Engineering Group was established to determine best practices and to get them accepted throughout the plant. Since, in many cases, past practice has become habitual and is assumed to be best practice, new methods are often criticized and resisted as being too refined or too theoretical; thus special attention is needed in getting acceptance.

One of the first steps in the program was to set up monthly meetings of the members of the line and staff groups immediately concerned with production, including production line supervisors, manufacturing engineers, methods engineers, industrial engineers and quality control. Because of the size of the staff, four meetings, each one and one-half hours long, are held each month; but a given supervisor, for example, will attend only one of the meetings.

At each meeting, six presentations of various ideas for improving production are made, using samples, charts, drawings, slides, etc., as required by the idea. In addition, each person attending the meeting is required to present, in writing, an idea that he or one of the people in his group has come up with. An incentive is provided to each member of the group, not only to generate new ideas, but to put those that others thought of to work in their own department if they are suitable. Thus, a total of 24 production ideas are presented each month. After the formal presentations, the meeting considers problems raised by those attending.

Movies are made of each presentation and are shown the following month at each of the four sessions, thereby, making possible a complete interchange of ideas. In addition, ten to fifteen minutes are allotted at each session to representatives of outside companies who present ideas using samples or film. Representatives from the engineering department also will occasionally discuss equipment or a process still in development stage.

Production Lab—Besides providing a forum for airing produc-
HOW FREON® SOLVENTS SAVE YOU MONEY
AT $7.50*
PER GALLON

Clean entire assemblies at one time. "Freon" seeks out and removes oil, grease and soils but does not harm metals, plastics or electrical components. Example: An Eastern manufacturer cleans complete office machines by immersion in "Freon" solvents.

Cut rejects from contamination. "Freon" cleans effectively, dries quickly, and leaves no residue. Example: One Midwest maker of electronic relays cut his reject rate to less than 1% by using "Freon".

Reduce need for safety facilities because "Freon" is non-flammable, virtually nontoxic. Your cleaning facility requires no expensive modifications to protect workers. Example: A Midwest missile component manufacturer saved $250,000 in air handling and refrigeration facilities by designing his White Room Complex to use "Freon".

Eliminate employee time loss and complaints due to headaches and related problems. There is not a single recorded case of an employee complaint caused by using "Freon". In fact, chronic complaints have stopped when "Freon" replaced ordinary solvents.

Cut solvent losses because "Freon" is stable. It does not contain or require additives. "Freon" doesn't turn acid. Both vapors and liquid can be recovered easily and used over and over again. Example: Hundreds of enthusiastic users.

Now back to that $7.50 per gallon! You know that, compared to labor and equipment, the solvent is normally only a small part of the cost of your cleaning operation. And compared to the expensive parts being cleaned, solvent cost is negligible. In fact, you can't afford not to use "Freon" for parts damageable by harsh solvents!

For any cleaning problem, it can pay you to investigate "Freon" cleaning agents. Write Du Pont for detailed technical information; or if you wish, we'll arrange a visit by a technical man to analyze your particular problem. Address: Du Pont Co., N-2420-E7, Wilmington 98, Delaware.

July 13, 1962

*Price is for "Freon" TF solvent delivered in 55-gallon drums. Price subject to change without notice.

**Du Pont's registered trademark for its fluorocarbon solvents.
Wide Bandwidth Multiplier-Divider

for highest speed and dynamic accuracy in analog computation, data correlation or reduction and automatic control

**FEATURING**

- D-C to 400,000 cps operation; less than 2 µsecs. response.
- Less than 1° phase shift at 12,000 cps.
- Four-quadrant operation.
- High gain minimizes need for external amplifiers.
- Instantaneous recovery from overloads.
- Positive-negative switch — no inverter needed

Write for Technical Bulletin MU500F

**NEW! FROM**

**GPS INSTRUMENT CO., Inc.**

180 NEEDHAM ST., NEWTON 64, MASS.

---

Bench, with lighting fixture variable both in height and candlepower, before installation in production laboratory. From studies conducted under conditions similar to actual production area, lighting to 200 candlepower was found desirable for some jobs.

**Problem Description:**

With the rapid increase in the use of electronic equipment for the solution of complicated problems, the methods engineering department also operates a special production laboratory, where systematic attention to production problems of larger scope can be applied, and where special machines can be built.

One of the first ideas for improving production was an investigation into the effect of operator comfort on output. The conventional workbench and highchair, for example, allows the operator to put her feet either on the rung of the chair or on the rail under the bench. But the rail under the bench is sometimes used for storage, in which case only the rung of the chair is available.

Two types of adjustable workbenches and adjustable stools were purchased so that the effects of varying workbench height could be studied. For small work, such as printed circuit boards and small chassis, the benches were set at normal desk height and the operator has his or her feet on the floor, with consequent freedom of movement. For heavier work, a bench height of 35 inches was found more suitable.

During the study of bench height it was realized that much space was wasted with conventional tables, since workspace 18 inches deep and three feet long was found to be adequate for many operations.

From the studies on workbenches made to date, new low benches and chairs have been installed in part of the production area and more will be installed. The workbenches are 30 inches high, 18 inches deep and six feet long, and provide space for two operators. On the back of the benches are six shelves, 12 inches deep; when the benches are arranged in rows, these shelves are storage space for the operator at the bench in front. Table tops are gray Micarta but pastel greens and blues should also be suitable. For some work, however, a less polished surface is desirable.

Instead of large lazy susan type component storage racks on the tops of the tables, which were on the older type tables, racks of component holding trays are provided each operator in the new arrangement; these racks swivel to allow access to the back tier of components. Tops of the new tables are detachable, so that a work space can be moved easily without disturbing the setup of the job in progress.

Lighting studies have also been carried out on a systematic basis and one of the photographs shows an adjustable lighting fixture. As a result of the experiments, lighting is being increased for some types of work up to 180 candle power and up to 200 candle power for printed circuit work. Comments from operators indicate a reduction in headache, eyestrain and fatigue.

Production increases as a result
You will find career excitement in many of the challenging programs at Boeing's Aero-Space Division. Some of these programs—the advanced Saturn S-IC first-stage booster, for example—are under the management of newly-formed divisional organizations that can offer you unique ground-floor opportunities.

Other openings with rapid-advancement potential are immediately available on the Dyna-Soar space glider program and the solid-fuel Minuteman ICBM. Assignments are available in many fields of activity, including Research and Development, Design, Manufacturing and Test.

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Salaries are commensurate with education and experience. Minimum requirements are a B.S. degree in any applicable scientific discipline. Boeing pays liberal moving allowances for newly-hired engineers.

Send your resume today to Mr. Lawrence W. Blakeley, The Boeing Company, P. O. Box 3822-ECI, Seattle 24, Washington. Boeing is an equal opportunity employer.
of board can be placed on one tape. of changes in bench and chair height are estimated at about four percent, without taking reduction of rework or increased space utilization into account. It is estimated the improved lighting will increase production an additional four to six percent.

Automatic Tester for Computer Logic Boards

AUTOMATIC EQUIPMENT to test computer logic boards in one-twentieth the time formerly needed has been developed by Autonetics, a division of North American Aviation, Inc.

The machine is being used for functional tests of logic circuit and diode matrix boards for the Air Force Minuteman's airborne digital computer.

Major advantages of the tester are speed, accuracy and versatility; the functional test of a logic board takes 12 minutes instead of the approximately four hours required previously.

Errors have been located that previously were almost impossible to find. Trouble-shooting of finished boards assembled in the computer has been drastically reduced.

If a logic board error is discovered during test, the error is displayed visually and printed out on paper tape. The test continues until the complete board is fully checked. By referring to the tape the operator can immediately locate the error and determine its cause.

Programming is comparatively simple. Schematics are translated onto punched cards and the cards are then fed into a tape converter. Programs for more than one type of board can be placed on one tape.

PREVENT THERMAL RUNAWAY—GET MAXIMUM SEMICONDUCTOR PERFORMANCE

Semiconductor devices derate rapidly when operated at temperatures above those recommended by the manufacturer. Destructive heat rise can be controlled, even when solid state devices are operated at maximum rated load, by using Birtcher 3-B Series Heat Radiators. The exclusive, compact, patented stacked fin design provides up to 12 square inches of radiating surface... permits maximum density packaging. Sizes IN STOCK for every popular semiconductor device.

Available from authorized distributors coast-to-coast

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PRODUCTS OF PROVEN RELIABILITY

Gorham Electronics has established a reputation of supplying complex precision castings, microwave devices and slip ring assemblies of proven reliability to the country's major contractors. Completely integrated facilities covering design, precision casting, close tolerance machining and assembly, plus final electrical test—all at one location—are your assurance of a quality product, at lowest cost.

Hidden costs associated with vendor liaison, incoming inspection, divided technical responsibilities, and multiple profits are eliminated by placing a single order for timely delivery of a final tested product with an "Integrated Facility of Proven Reliability"—Gorham Electronics. Write today for our brochure.

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BY DELTA DESIGN

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CIRCLE 75 ON READER SERVICE CARD

July 13, 1962
**NEW PRODUCTS**

**DESIGN AND APPLICATION**

**Oscillator Ages Less Than 2 Parts in 10⁹**

*Solid-state device has accurate outputs at 100 Kc, 1 Mc and 5 Mc*

Manufactured by Manson Laboratories, 375 Fairfield Ave., Stamford, Conn., the model RD-180A transistorized frequency standard has outputs at 100 Kc and 1 Mc of 0.75 v rms into a 50-ohm load and 5 Mc at 0.25 v rms into a 1,000-ohm load. Frequency stability is 1 to 2 parts in 10⁹ per day after six months continuous operation. Frequency adjustments can be made to 500 parts in 10⁹ total. The standard consists of a high-stability Pierce oscillator using a ruggedized plano-convex 5th overtone precision AT-cut crystal with a three-point mount. The oscillator is enclosed in a glass flask within a temperature-regulated oven. Fine temperature control is by a temperature-sensitive bridge and proportional amplifier. Coarse temperature regulation is by a mercury switch oven. The crystal is nominally operated at the point where oscillations are sustained with minimum current flow and any tendency for the crystal current to increase is cancelled by feedback from the age amplifier.

Two locked dividers convert the 5 Mc to 1 Mc and 100 Kc and buffers isolate the oscillator from load variations. The oscillator can be finely tuned by a front panel control. A self-contained 50-hour battery supply is switched on in the event of line failure.

*CIRCLE 301, READER SERVICE CARD*

**Temperature Programmer Uses Power Proportioning**

Announced by F & M Scientific Corp., Starr Rd. and Rt 41, Avondale, Pa., the model 240 power proportioning temperature programmer is a lightweight unit in which the amount of power supplied to a heater is increased continuously by silicon controlled rectifier phase control rather than full power being applied intermittently. Heating rates between 0.5, 1, 2, 3, 4, 5, 7.5, 10, 15, 20, 25 and 30 degrees C per minute between 0 and 500 C with power up to 1,500 watts are provided. Phase control of the scr is through a unijunction firing circuit and by controlling the scr firing phase, power applied to the load is controlled. Temperature detection is by a thermocouple reference bridge and microsignal amplifier. Proportional bandwidth is adjustable between 2 and 20 C and temperature control is ±0.1 C or better. The thermocouple bridge is stabilized by a two-stage zener diode regulator. Applications include DTA units, hotstage microscope studies, heated cells for IR, ovens for crystal growing or wherever precise temperature control is needed. (302)

**Low-Frequency Oscillator**

Recently announced by Grafix Inc., POB 3296, Albuquerque, New Mexico, the new line of solid-state low-frequency oscillators supply fixed tones or timing frequencies comparable to tuning-fork oscillators and are very rugged, have superior reliability and cost less. Frequencies can be supplied between 400 cps and 100 Kc ±0.01 percent. Output is 4 v rms into a 2,000-ohm load. Harmonic distortion is less than 5 percent and can be ordered to essentially zero per-
In a single envelope, ITT's new backward wave converter provides a complete microwave receiver front end, amplifier/pre-selector, a local oscillator and mixer. The BWC operates as a swept superheterodyne receiver with octave coverage without the use of an external local oscillator or external mixer. This design eliminates crystal detectors and their burn-out problems and virtually eliminates blocking by strong signals at the pass band. Seven frequency ranges from 500 to 12,000 MC in seven bands are now available. BWA tubes for use as pre-selectors with the converters are also in production. The ITT microwave tube line includes BWC, BWA and BWO types as well as TWT's for L, S, C and X band.

Replaces a 3-unit microwave front end

RF TO IF IN ONE ENVELOPE

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Write for information on the complete line of ITT traveling wave tubes. Application assistance is available for your specific requirements.

ITT ELECTRON TUBE DEPARTMENT

ITT COMPONENTS DIVISION PRODUCTS: POWER TUBES • IATRON STORAGE TUBES • HYDROGEN THYRATRONS TRAVELING WAVE TUBES • SELENIUM RECTIFIERS • SILICON DIODES AND RECTIFIERS • TANTALUM CAPACITORS

July 13, 1962

CIRCLE 77 ON READER SERVICE CARD 77
Electro Development Corporation, Seattle, Wash., uses a Model 1108 Honeywell Visicorder Oscillograph to prove the linearity and resolution of signal conditioner-event markers which they supply to the Boeing Company.

A missile telemetering system samples each channel only once every 30 milliseconds, but missile engineers want to know when some events occur to an accuracy of better than one millisecond.

The event marker (the small cube atop the Visicorder) produces a highly-linear ramp output that starts exactly when the marker is triggered by the event in question. This ramp continues for about 100 milliseconds... enough time so that the telemeter system can sample the ramp at least three times. A straight line drawn through these points will accurately determine the occurrence of the event.

To check event marker linearity, the ramp is recorded at the very high record speed of 80'/sec. It's this high speed, the .01-second timing lines, the ease of operation, and the wide deflection capabilities of Honeywell galvanometers (approx. 7" in this application) that caused the Electro Development Corporation to select the Model 1108 Honeywell Visicorder.

Honeywell

electronics
cent. The oscillator (sketch p 76) uses two transistors, one for power regulation and the other for the oscillator. A transformer feedback loop, loosely coupled to the tank circuit, minimizes effects of collector capacitance change with temperature. Collector and base windings have much lower impedance than the tank circuit thus allowing output levels as low as 2,000 ohms without significant change in output or frequency. The tank circuit core provides a change of inductance with temperature to compensate changes in tuning capacitor used. By matching these two components, it is practical to achieve stabilities of better than 0.001 percent. The regulator makes output and frequency virtually independent of supply voltage.

CIRCLE 303, READER SERVICE CARD

Coax Connectors
Feature Low VSWR

GREMAR MFG. CO., INC., 7 North Ave., Wakefield, Mass., offers a series of modified series N precision coax connectors for use with microwave components such as twt’s, amplifiers and bwo’s. The TWT series connectors feature a low vswr. They are available for X-band and S-band uses and for either RG-55/U flexible cable or 0.140 in.-diameter 50-ohm rigid cable.

Connectors

GARDE MFG. CO., 53 John St., Cumberland, R. I. The 630 series of right angle pin and socket connectors for dip soldering to p-c boards meets all requirements of MIL-C-8384 specifications.

Sampling Plug-Ins
Extend Scope Range

TEKTRONIX, INC., P. O. Box 500, Beaverton, Ore. Two new sampling plug-ins will extend the range of 4 Mc scopes to 875 Mc. Type 3876 dual-trace sampling unit and type 3177 sampling sweep unit, when combined with a 561 crt indicator, permit observation of recurrent
MIDGET TOOLS FOR MINIATURIZED WORK!

Midget tools for work on miniature assemblies are another Utica specialty. We have designed and stock the industry's broadest line of midget pliers and other special hand tools for working with ease in the most confined places. All are precision, finely finished tools. All are backed by famous full guarantee. See for yourself! Contact your Utica distributor or write for our latest hand tool catalog.

Utica Tool Division
Kelsey-Hayes Company
Utica 4, New York

tools the experts use!

Converters Accept Various Inputs

HOWARD INSTRUMENT CO., Red Bank, N. J. The C series binary-decimal converters are available in capacities up to 7 decimal digits. Model 1007-C, illustrated, accepts 21 bit serial binary inputs, and converts the data in 210 μsec, to 7 digit binary-coded-decimal. Other models accept parallel inputs in true binary, or serial, or parallel reflected binary. (309)

C-R Tubes Use Spiral Acceleration

SYLVANIA ELECTRIC PRODUCTS INC., 1100 Main St., Buffalo 9, N. Y., announces the SC-3377 and SC-3511 high sensitivity crt's, employing spiral acceleration and designed for use with transistor deflection circuits. Overall tube length is only 13½ in., making the units suitable for compact, efficient scope designs. Pressed faceplates provide good quality and strength. (310)

Plug & Socket Connector Designed for P-C Boards

CONTINENTAL CONNECTOR CORP., 34-63 56th St., Woodside 77, N. Y.,
Noise Filter Translates White Output to Pink

GENERAL RADIO CO., West Concord, Mass. Type 1390-P2 translates the white-noise output of an a-f random-noise generator into pink noise, that is noise with constant energy per octave. Although designed to plug directly into the GR type 1390-B random-noise generator, the pink-noise filter can be used in any circuit where such a characteristic is desired, providing the source impedance is less than 1,000 ohms and the load impedance is at least 20 kilohms.

Flangeless Diode Operates From —65 to +200 C

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., Clifton, N. J., announces a flangeless 1-w Zener voltage-regulator diode. The regulators will operate over a temperature range of —65 to +200 C. They feature low dynamic impedance with a sharp Zener knee, 100 percent tested, and have controlled forward characteristics. The diodes

Data-Processing Systems, Inc.
Instrumentation for Research
Los Angeles • Santa Clara • Wash., D. C. • Cape Canaveral
Home Office: E. Liberty St., Danbury, Conn. • Pioneering 3-9241

Now! Capture transient events like never before!

• Virtually no overshoot • Fastest rise time attainable

Want to capture transients that have eluded you up to now? Or, if you are getting them, want them more faithfully? The photo above proves it can be done—providing you use DCS high-frequency FM subcarrier oscillators and discriminators. These new DCS components are based on a high-frequency current switching device, operating with unsaturated transistors in a manner that permits very long recovery periods. Result: faster rise time than ever before possible, with virtually no overshoot!

Components now available for immediate, off-the-shelf delivery:

DCS High-Frequency VCO (UNIDAP Configuration)

High-frequency VCO plug-in modules for all standard DCS UNIDAP systems. Standard frequencies available: 250, 400, 550, 700 and 850 kc, all ±40 kc. Also 800 kc, ±300 kc. Others available on request. Permits analog intelligence frequencies to 300 kc to be converted to FM subcarriers for both direct tape recording and multiplexing.

DCS High-Frequency Discriminator

High-frequency, phase-lock playback discriminator for use with standard DCS UNIDAP and telemetry data systems. Recovers data from all DCS airborne and ground high-frequency VCO's. Also with standard DCS predetection telemetry recording and standard DCS frequency translation systems. Output intelligence frequencies up to 300 kc.

For more information, complete specifications, etc., write to Dept. E-2-3.
Making Room at the Top

EICO creates a new, professional lab quality test instrument series at moderate prices.

AC VTVM & AMPLIFIER #250

Kit $45.95, Wired $79.95

VTVM: 12 ranges from 1mv to 300v rms; response absolutely flat from 10 cps to 600 kc; Input Impedance 10MΩ, shunted by 15μF; accuracy ±3% of full scale.

Note: Average responding meter calibrated in rms; Linear 0-1, 0-3 scales. Decibel scales based on 0db=1mw in 600Ω with 10db interval between ranges.

AMPLIFIER: 60db gain on 1mv range; response 4-db to 3-db from 6cps to 800kc; output to 5v rms undistorted, variable down to zero by attenuator control at output; Input Impedance 10MΩ, output impedance 5KΩ; hum & noise ~40db for signal inputs above 2mv.

DESIGN QUALITY: All frame-grid tubes; 60db frequency-compensated input attenuator ahead of cathode follower with 10db/step attenuator following. Two-stage R-C coupled amplifier and full-bridge meter circuit in one overall feedback loop no response adjustment required in amplifier circuit; single sensitivity adjustment; voltage-regulated power supply; 50/60 cycle operation.

EICO MODEL 255 AC VTVM Identical to Model 250 described above, but less amplifier facility. 50/60 cycle operation. Kit $44.95 Wired $72.95

CIRCLE 206 ON READER SERVICE CARD

R-F Converter Utilizes Nuvistors

TAPETONE ELECTRONICS LAB., INC., 99 Elm St., West Newton 55, Mass. Model 100-A is designed for telemetry and satellite tracking applications. Available at frequencies from 200 to 500 Mc, with i-f outputs of 5 to 100 Mc. Utilizing Nuvistors as the r-f amplifiers and mixer, this converter has a noise figure of 5 db at 400 Mc, with an overall gain of 25 db. Design incorporates high gain with very high overload resistance. (314)

Precision Clock Has Square Wave Output

TECH SERV, INC., 4911 College Ave., College Park, Md. Precision clock with frequencies of 1000, 100, 10, and 1 pps utilizes tuning fork device as basic generator deriving tolerances of ±0.10 percent. Output pulse trains are symmetrical square waves having a voltage excursion from 0 to −10 v and rise time of less than 1 μsec. (315)

Solid State Converter Offered in Four Models

SOLID STATE ELECTRONICS CO., 15321 Rayen St., Sepulveda, Calif. The Freqmeter is a completely solid state unit which will linearly convert frequency or repetition rate of signals to a proportional d-c volt-
Northrop Space Laboratories needs uncompromising men

It takes dedicated men to breathe life into a new undertaking. Determined men, to guide and guard its goals through the formative years.

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Solid state physicists, to conduct fundamental research on many-body problems as applied to an ultra high pressure program. The goals of this program are to study the electrical and physical behavior of materials under ultra high pressure, to investigate the origin, history and structure of the moon and planets, and to find ways to utilize their natural resources.

Scientists, to perform research in nuclear and radio chemistry, and to conceive and carry out investigations in the fields of activation analysis, dosimetry, gamma ray spectrometry, surface phenomena, and numerous other areas.

Stress analysts, to develop fresh analytical techniques and apply them to new space structural concepts; to do stress analysis and design optimization studies on advanced space vehicle structures.

A plasma physicist, to join our growing program in the measurement of plasma properties, spectroscopy, diagnostics, accelerators, and power conversion devices.

A mathematician-physicist, to concentrate on systems analysis and operations research applied to military and non-military space systems.

Physicists experienced in electro-optical imaging devices and laser theory; engineering mathematicians interested in detection theory, reconnaissance and tracking; electronic engineers who know their way around statistical communications theory and noise phenomena; for new and original work in satellite detection systems.

For more information about these and other opportunities, write to W. E. Propst, Space Personnel Office, IIII East Broadway, Hawthorne, California. You will receive a prompt reply.

Northrop
AN EQUAL OPPORTUNITY EMPLOYER

July 13, 1962
First develop a size 23 resolver for naval fire control computers. Next develop one for the B-58's navigational system. Then combine the best features of both, add a couple of new ideas, and produce the Size 23, 0.01% Resolver. That's what Ford Instrument did. With the result that this new resolver has a maximum variation of transformation ratio (with input voltage from 0.3 to 6 volts) that is only 0.02% of 6 volts. Far as we know, this is the most accurate resolver made today. Most durable and trouble-free. Priced right, too. Conforms to Mil-E 5272A. Specify this resolver for application in analog computers, automatic control systems, and data transmission systems for coordinate conversion, precision phase shifting, and similar operations. Bulletin 23TR-61-1 gives full specifications. It's yours for the asking. Write:

FORD INSTRUMENT CO.
Division of Sperry Rand Corporation
31-10 Thomson Ave., Long Island City 1, N.Y.

units available from 30 Kv up to 80 Kv (insteps of 10 Kv) and current up to 5 ma. They are designed for single phase, 115 v, 60 cycle input and output is continuously variable from zero to max voltage. Polarity is reversible. Typical applications include laboratory use; maintenance, such as dielectric testing; industrial, such as power supply for electrostatic painting, flocking, etc.

CIRCLE 318, READER SERVICE CARD

UHF Coax Isolator Features Broad Band

E & M LABORATORIES, 15145 Califa St., Van Nuys, Calif. Model U112LC1 exhibits these characteristics over the entire 600 to 1,000 Mc range: 10 db minimum isolation, 1.0 db max insertion loss, and 1.20 max vswr. Uses include standards and microwave laboratories as well as radar, communications, and telemetry systems and ground support equipment. (319)

Spectrum Analyzers Have Variety of Uses

SPECTRAN ELECTRONICS CORP., 146 Main St., Maynard, Mass. The 480 series spectrum analyzers are now available in a rack mounted assembly providing readout on an ITT model 1735D oscilloscope. The 480-WS assembly provides substantially instantaneous 480 line reso-
olution analysis of both steady state and transient phenomena. Uses include signature studies of sonar signals and doppler radar echoes, mis-distance indication, speech studies, shock and vibration analysis. (320)

Pinch-Off Presses Reach Inaccessible Areas
CHARBON PRECISION GAGE & TOOL CORP., 821 Washington St., Lynn, Mass., offers pinch-off presses primarily used for pinching off tubing after the exhaust period in the electronic and transistor industry. They are powerful, yet small and compact, which enables them to reach inaccessible areas. Presses, made for either automatic or semi-automatic installations, are manufactured in 2, 4, 10 and 20 ton capacities. (321)

Electronic Weatherstrip
METEX ELECTRONICS CORP., Clark, N. J., announces Metalex, a knitted wire mesh, electronic weatherstrip that is mechanically joined to a solid aluminum extrusion. (322)

Battery Chargers Sell in $2 to $5 Range
MILLI-SWITCH CORP., 1400 Mill Creek Rd., Gladwyne, Pa., offers nickel-cadmium battery chargers for portable battery operated equipment. They sell in the range of $2 to $5 depending on rating, terminals and quantity desired. Il-

We're looking for men who can't let well enough alone

Northrop-Norair needs men who ask questions; men who aren't afraid to rock the boat. In the advanced areas we're exploring at Norair, you don't dare take anything for granted. If this kind of challenge appeals to you, put down the magazine now, while it's on your mind, and write us a letter. Positions are immediately available for:

Engineers in electronic checkout systems who have worked with advanced design and program development.
Engineers whose background is in supersonic aerodynamics, stability and control, inlet design, ducting, and performance analysis.
Engineers familiar with airframe structural analysis.
Scientists specializing in infrared, optics, and electronic research.
Engineers to work in data reduction.
Scientists who know structures research and dynamics.
Scientists who have done supersonic aerodynamic research.
Scientists experienced in working with information and sensing systems, platforms, infrared, sensors, flight controls, airborne computing and data handling systems.
Engineers familiar with programming, operations, and instrumentation for ballistic missile flight test.
Reliability Engineers to assess the reliability and to optimize the configurations and mission profiles of space systems.
Chemical Engineers to work on the development and applications of structural adhesives for aerospace vehicles.
Metallurgical Engineers for research and development on materials and joining.

If you'd like more information about these opportunities and others that may be available by the time you read this, write and tell us about yourself. Contact Roy L. Pool, Engineering Center Personnel Office, 1001 East Broadway, Hawthorne, California.

NORTHROP
AN EQUAL OPPORTUNITY EMPLOYER

July 13, 1962
GIANT PLOTTING

New, ultra compact 30" x 30" X-Y Plotter
with the quality, convenience and functions you expect in a Moseley recorder

The Moseley Model 7 Autograf Recorder combines in one 6" deep instrument all the facilities needed for rapid, accurate 30" x 30" plotting of two variables in ranges from 30 mv to 300 v full scale. Accuracy is better than ±0.1% of full scale, and maximum pen speed is 20"/second for each axis. The instrument may be rack mounted or used in table position.

Its large recording area makes the Model 7 ideal for point plotting of digital data with Moseley digital-to-analog conversion accessories. Modular construction makes it easy to adapt for time base operation, ac input, logarithmic conversion, or curve follower operation with either magnetic or optical followers.

Selector switches provide 13 voltage ranges, 1 millivolt/inch to 10 volts/inch. Dual drive cables assure accurate X and Y alignment, with X and Y servo systems completely independent and isolated from ground.

Model 7 uses either individual sheets of graph paper or 50-yard roll charts. Price, $6500.

Call your Moseley representative today or write direct for detailed information.

AUTOGRAF recorders

F. L. MOSELEY CO.
409 N. Fair Oaks Avenue, Pasadena, California

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Illustrated is a charger for a 1.25 v cell. It is housed in a 1 ¼ by 1 ¾ by 13 in. plastic box and encapsulated in a thermosetting plastic.

CIRCLE 323, READER SERVICE CARD

Servo Amplifier
Priced at $272

M. TEN BOSCH, INC., Pleasantville, N. Y., offers a 400-cycle servo amplifier capable of yielding 6 w over a temperature range of -55 to +125 C. Hermetically sealed unit is transistorized and weighs 7 oz. Power gain at 2 w output with a 20,000 ohms input impedance is 2,400. Phase shift is adjusted internally to 0 deg. Model 1800-4700 is unit priced at $272 (for orders of 10 to 99). (324)

Shielding Material

METEX ELECTRONICS CORP., Clark, N. J., offers a spring-type, formed rfi gasketing material that can be installed or replaced quickly and easily by snapping it into a channel that is either attached to or is an integral part of the unit to be shielded. (325)

Power Supply
Packaged for Bench Mount

PERKIN ELECTRONICS CORP., 345 Kansas St., El Segundo, Calif. Model 28-10WXA is a magnetic amplifier regulated 28 v at 10 amp d-c power supply for inclusion in ground support systems. It provides 24 to 32 v at 10 amp with automatic voltage regulation of ±0.5
percent and ripple of 1 percent rms. Unit is contained within a 5\frac{1}{2} in. high by 16\frac{1}{4} in. wide by 14\frac{3}{4} in. deep package for bench mount. Price is $375. (326)

**Blowers Offered in Four Models**

**PREMIER METAL PRODUCTS CO., INC.,**
337 Manida St., New York 59, N. Y.
The PMB series of Prem-O-Kool panel mounted blowers, designed for low noise level with minimum of vibration and space, have permanent type washable filters and are available in four models having 150, 285, 410 and 750 cfm. Motors are permanently lubricated with lubricant temperature range from —29 to +148 C. (327)

**H-V Static Inverter Uses No Moving Parts**

**MICRODOT INC.,** 220 Pasadena Ave., S. Pasadena, Calif. A 5 Kva static inverter, operating from a wide range d-c battery source, supplies up to 5,000 w of a-c power. Conversion system allows an adjustable output frequency over the range of 380 to 2,000 cps. No moving parts are employed in the unit which measures 17 in. by 17 in. by 42 in. and weighs 200 lb. Power conversion system inherently provides excellent voltage regulation

**ULTAMAG\textsuperscript{®} instrument type magnetic amplifiers are practically invulnerable to shock, vibration, moisture, and radiation. All solid state construction! Easily withstand 1000\% overload or can be operated into dead short without damage. Applications — where vacuum tubes or transistors are used!**

**PERFORMANCE:**

- Stability ~ ~ ~ under 1%
- Sensitivity ~ ~ microamperes
- Output ~ ~ ~ 7.5 to 10 volts

**20 Line Miniature in full military configuration**

$139.50 each
1 to 5 units

**100 Line in 50 or 60 cps**

$69.50 each
1 to 5 units

**MACE**

**WESCON BOOTH 3016**

**CIRCLE 87 ON READER SERVICE CARD**
THINNER THAN EVER!

is the thermo module newly developed by Sanyo Electric Co. The technique evolved by Sanyo eliminates high cost and brittle nature of the bismuth telluride alloys used in production of thermoelements. Our exhaustive study reveals possibilities of still reducing its thinness, resulting in wider and more economical applications to scientific and electronic equipment.

SPECIFICATIONS

<table>
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<tr>
<th>Type</th>
<th>Thermo Couple</th>
<th>Optimum Current (mA)</th>
<th>Voltage (V)</th>
<th>Temperature Range (°C)</th>
<th>Dimension (mm)</th>
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SUBSIDIARY OF SANYO ELECTRIC CO., LTD., OSAKA, JAPAN

MAKERS OF RADIO, TV, STEREOPHONOGRAPH, ROOM AIR CONDITIONER, REFRIGERATOR, WASHING MACHINE, SEMICONDUCTOR, THERMOELEMENT.

H-V Delay Line Operates From -55 to +125 C

COLUMBIA TECHNICAL CORP., Woodside 77, N.Y. Type CTC-1411 has an operating input signal level in excess of 200 v. Operating temperature range, from -55 C to +125 C; total delay, 50 μsec (multiple taps); rise time, 0.5 μsec max; delay to rise time ratio over 100:1; impedance, 500 ohms; accuracy of delay, 0.1 percent or 0.05 μsec whichever is larger; attenuation, less than 2 dB; total volume, approximately 200 cu in. (329)

Memory Drum Has Over 10 Year Life

DIGITAL DEVELOPMENT CORP., 7541 Eads Ave., LaJolla, Calif., announces a 5.5 million bit magnetic memory drum for industrial process-control computers. The 1100 track drum has a design life in excess of 10 years, and may be operated in an oxygen purged nitrogen atmosphere at 1 psi N₂ to extend bearing life further. Integral selection diode matrices are designed as an additional feature. All read-write amplifiers and selection drivers are mounted in the housing cover. (330)
PRODUCT BRIEFS

D-C CAPACITORS for laser applications. General Electric Co., Hudson Falls, N. Y. (331)

PACKAGED CENTRIFUGAL BLOWERS, eight models. McLean Engineering Laboratories, Princeton, N. J. (332)

MASS SPECTROMETER LEAK DETECTOR has high sensitivity. Vacuum Instrument Corp., Stepar Place, Hunting- 
ton Station, N. Y. (333)

SPOT WELDERS are small, ultraprecise. Wells Electronics, Inc., 1701 S. Main St., South Bend 25, Ind. (334)

MULTIPLE CONNECTOR takes 6 wires. Conolex Corp., Box 468, Silver Spring, Md. (335)

RATE Gyro eliminates gimbal. Humphrey, Inc., 2805 Canon St., San Diego 6, Calif. (336)

CUSTOMIZED RECORDERS, low-cost. Texas Instruments Inc., 3609 Buffalo Speedway, Houston, Texas. (337)

SATURABLE REACTOR PACKAGES offer high-gain. Instrument Systems Corp., 129-07 18th Ave., College Point 56, L. I., N. Y. (338)

X-BAND T-W AMPLIFIER, ultra-broad bandwidth. Sperry Electronic Tube Division, Gainesville, Fla. (339)

DIGITAL ASPECT SYSTEM for rockets and satellites. Adeco Corp., 186 Massachusetts Ave., Cambridge 39, Mass. (340)

DUAL ADAPTER simplifies line voltage connectors. The Superior Electric Co., Bristol, Conn. (341)

COAXIAL BAND PASS FILTERS for operation from 1,000 Mc to 10 Gc. RLC Electronics, Inc., 25 Martin Place, Port Chester, N. Y. (342)

ULTRA-HIGH VACUUM EVAPORATOR for laboratory use. General Vacuum Corp., 81 Hicks Ave., Medford 55, Mass. (343)

CROSS FLOW BLOWERS provide high pressure, low noise. The Torrington Mfg. Co., Torrington, Conn. (344)

SUPER-THIN FOIL for capacitors. Republic Foil Inc., 55 Triangle St., Danbury, Conn. (345)

POWER SUPPLY, constant current and voltage. NJE Corp., 20 Boright Ave., Kenilworth, N. J. (346)

TOGGLE SWITCHES are panel mounted devices. Mill-Switch Corp., Gladwyne, Pa. (347)

DIGITAL INDICATOR, end-fire-illuminated display. General Radio Co., West Concord, Mass. (348)

P-V-P-N SWITCH, light actuated. International Rectifier Corp., 223 Kansas St., El Segundo, Calif. (349)

AUDIO CONNECTORS, three circuit contacts. Switchcraft, Inc., 5555 N. Elston Ave., Chicago, Ill. (350)

---

AIRPAEX

Electronic Tachometer

Converts signal information frequency into a directly proportional DC output

TYPICAL SIGNAL SOURCES

The Airpax Tach-Pak solid state electronic tachometer employs a combination of transistor and magnetic circuits to produce a device of exceptional accuracy and versatility. Other than its common use as a speed indicator, present applications include: ★ Propeller shaft rotation indicator on atomic submarines ★ Starter cut-off on jet aircraft engines ★ Turbine overspeed warning system ★ Speed recorder on railway rolling stock ★ Impact tool frequency recorder. The Tach-Pak is available in a hermetically sealed case, explosion proof housing or cast aluminum or NEMA enclosure with barrier strip or plug connectors.

Write, wire or phone for descriptive literature

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SEMINOLE DIVISION
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July 13, 1962
now...high accuracy synchro and resolver testing

— GERTSCH STANDARDS REPLACE COSTLY ELECTRO-MECHANICAL METHODS

Gertsch Synchro Standards simulate the output of a master Synchro Transmitter (CX), with better than 2 seconds of arc accuracy. Ideal for checking Synchro Control Transformers (CTs), or complete systems. Units feature a low effective unbalance impedance which permits loading the output without introducing stator output errors.

When driven by a suitable signal source, unit provides stator outputs $S_x, S_y, S_z$ corresponding to the outputs of a master Synchro Transmitter as the shaft is rotated in 5° increments. Quadrant switching simulates operation over a full 360°. Series SS.

Gertsch Resolver Standards simulate the output of a master Resolver Transmitter (RX). Checks Resolver Control Transformer (RCT). Unit features low effective unbalance impedance, hence negligible loading error.

Driven by a suitable signal source, unit produces 2 isolated output voltages corresponding to the sine and cosine output voltages of a master Resolver Transmitter as the shaft is rotated in 5° increments. Full 360° operation. Series RS.

Synchro and Resolver Standards rotate throughout a full 360°, in 5° increments. Accuracy is better than 2 seconds of arc. Both single-switch and 2-switch models are available to cover all standard voltages and frequencies. Bulletins SS and RS on request.

Gertsch Divider Heads—for checking angular measurements on all types of rotary components. Accuracy is ±15 seconds. Repeatability: ±5 seconds. Large dial indicator provides direct readings with 3-second resolution. Unit rotates in 5° steps through a full 360° in either direction . . . is quickly set up, easy to operate, and fully portable. Bulletin DH-5.

Literature of the Week


TEMPERATURE PROBE Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J., has issued a bulletin on the Glennite cryogenic temperature probe. (352)

DIODE RELIABILITY PROGRAM Sperry Semiconductor, division of Sperry Rand Corp., Norwalk, Conn. Booklet describes company facilities for testing and sorting high reliability silicon diodes. (353)

MICROWAVE TEST EQUIPMENT PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N.Y. Bulletin 801 illustrates and describes precision microwave test equipment. (354)

P-C DRAFTING AIDS By-Buk Co., 4314 W. Pico Blvd., Los Angeles 19, Calif. New shapes and sizes of pre-cut pressure sensitive drafting aids appear in bulletin P-40. (355)

X-Y PLOTTER The Gerber Scientific Instrument Co., P.O. Box 305, Hartford, Conn. An 8-page booklet illustrates and describes the GP-30-D digital X-Y plotter. (356)

FERRITES Ferroxcube Corp. of America, Saugerties, N. Y. Bulletin details the company's ferrite materials and applications. (357)

SUBCARRIER OSCILLATOR Telemet Co., 185 Dixon Ave., Amityville, N. Y. Single sheet covers subcarrier oscillator that features 11 standard IRIG channels. (358)

SPECTROMETER SYSTEM Varian Associates, 611 Hansen Way, Palo Alto, Calif. Brochure describes the high resolution 100 Mc NMR spectrometer system. (359)

RELATIVE HUMIDITY INDICATOR Cybernetics, Inc., 136 Washington St., Paterson 1, N. J. Bulletin illustrates and describes the Rhindicator portable relative humidity indicator. (360)

SOLID STATE CHOPPERS Airpax Electronics Inc., Cambridge, Md., has available a 2-page article on solid state chopper design. (361)

SEMICONDUCTOR PRODUCT GUIDE Radio Corp. of America, Somerville, N. J., offers a 12-page semiconductor product guide which includes a by-application classification. (362)

ROTARY EQUIPMENT Beau Electronics, Inc., P.O. Box 624, Waterbury, Conn., announces a catalog illustrating and describing a line of precision rotary equipment. (363)

POWER SOURCE Amulex Electronics Inc., 467 Connecticut Ave., S. Norwalk, Conn., announces availability of a power source catalog. (364)
We'll prove it! Send us small parts you find difficult to clean for test cleaning in our laboratory. We will do the job and return the cleaned parts to you, together with a recommendation for the right L & R cleaning solution which you can use in your ultrasonic cleaning equipment. For over 30 years L & R has been a world leader in precision cleaning for the watch and instrument fields. This experience is at your disposal. Or write for a copy of our latest catalog describing L & R's ultrasonic cleaning and rinsing solutions and ultrasonic cleaning equipment.

**New Modular Concept in Preselectors**

REL can provide you with the preselector you require for use in the 400 mc, 1 kmc and 2 kmc frequency bands. Basic units with an exceptionally low insertion loss and VSWR are available for use in filter configurations of one to six sections. Tell us your requirements for:

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C. Attenuation band characteristics
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E. VSWR
F. Tunability
G. Other special requirements

We will provide you with the solution to your preselector problem. WRITE or CALL for our Preselector Technical Data Bulletin.

**Editorial Opportunity**

IT DOESN'T HAPPEN OFTEN, but electronics, "bible of the industry" and a McGraw-Hill publication, has an opening for an Assistant Editor.

Ideally, the man we are looking for and to whom a post on our New York staff could be a long-term challenge, would have an electrical engineering degree or technical equivalent, practical experience in our field and a demonstrated aptitude for editing, writing, reporting. He probably lives somewhere in the metropolitan area and therefore would have no relocation problem.

Write The Editor, electronics, 330 W. 42nd St., New York 36, stating experience, aspirations and past earnings. Mark the envelope "Confidential" and it will be kept that way.
FULL-SIZE PERFORMANCE IN A MINIATURE TELEMETRY DISCRIMINATOR

Now you can install 9 IRIG discriminator channels in only 7" of rack space. Advanced solid-state design has packed essential accuracy and reliability into a small package without crowding out the operating refinements that become so important in actual use. The indicators, controls and test points you need are all there — right up front. The output signal is tailored to give you good, clean graphic recordings, with a squelch circuit to eliminate noise traces when no signal is present, and output limiting to protect sensitive recorders. And with zero drift less than 0.2% in 12 hours, you won't be bothered with incessant adjustment.

Accuracy? We can sum it up by saying that data error contributed by the discriminator is so small that you can't detect it on the graphic record. For detailed performance specs — and a look at the superior construction features — send for our new 6-page brochure on TD-109.

NEW BOOKS

The Encyclopedia of Electronics
Edited by CHARLES SUSSKIND
Reinhold Publishing Corporation, New York, 1962, 974 p, $22.50

About 500 selected topics in electronics are covered by short articles in alphabetical order. The articles are for the most part state-of-the-art summaries, limited by space requirements to general terms; this makes it difficult to look up a particular specialized term. The book will serve as a fine introduction to topics outside one's own specialty; however, because of the state-of-the-art approach, there will be danger of obsolescence.—G.V.N.

Superconductive Devices
By JOHN W. BREMER

A fairly complete introduction to the basic phenomena, theory and applications of superconductivity up to date. Several chapters are devoted to the cryotron and croytron circuits applied to digital computers. Superconductive magnets, a fast-moving subject of research, are mentioned only briefly. The closing section is devoted to low-temperature techniques.

No book can hope to remain up-to-date for long in this fast moving area, or to cover all existing developments; however, "Superconductive Devices" gives the reader a good grounding in the fundamen-
Switching Circuits
For Engineers
By MITCHELL P. MARCUS

This excellent book is highly useful to the logic design engineer, both for study and reference. Its clear, step-by-step explanations also make it valuable as a school text. Applications as well as theory are stressed, and the author goes into detail seldom seen elsewhere. An original method is given for obtaining flip-flop excitation expressions.—S.B.G.

Redundancy Techniques for Computing Systems
Edited by RICHARD H. WILCOX and WILLIAM C. MANN

A collection of 23 papers presented at the Symposium on Redundancy Techniques in February. The papers range in subject matter from very basic to speculative, and indicate well the present state of the art. A bibliography on redundancy techniques is included and should prove very useful.

Elements of Electronic Circuits
By J. M. PETERS

These building bricks for circuit design are taken from a feature in British Wireless World magazine. The articles are noted for their clear and highly instructive diagrams, most of which are input and output waveforms, and for the easily understood text.

The chapter headings are general principles, two-state circuits, timebases, electronic markers, the logarithmic amplifier, gates and coincidence circuits, and waveforms operated on mathematically.—S.B.G. continued
Analysis and Design of Non-linear Feedback Control Systems
By GEORGE J. THALER and MARVIN P. PASTEL

A graduate-level text that presupposes an elementary knowledge of the subject, the book has two parts. The first is devoted to analysis, the second to design. Among the topics included are analysis with random inputs, dual-mode servos, self-adaptive control systems and analog simulation. A brief introduction to the Second Method of Lyapunov closes the book.

A Survey of Switching Circuit Theory
Edited by E. J. McCLUSKEY, Jr. and T. C. BARTEE

This book contains a group of tutorial papers presented at the 1959 Fall and 1960 Winter General Meetings of the AIEE, at sessions sponsored by the Subcommittee on Logic and Switching Theory.

As a short introduction to switching theory, the book covers the field very well. Divided equally between combinational and sequential switching circuits, the chapters deal with such subjects as switching algebra, binary numbers, map methods, minimization theory, and state tables.—S.B.G.

Radiation and Waves in Plasmas
Edited by MORTON MITCHNER
Stanford University Press, Stanford, Calif., 156 p, $4.50.

Seven papers presented at the Fifth Lockheed Symposium of magnetohydrodynamics cover experimental and theoretical work in this field.

The first five papers deal with theoretical problems, valuable primarily to those actively engaged in research in this field.

The last two papers on experiments are general enough to be of interest to those not expert in the field.
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for long-distance point-to-point communications

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TELEGRAPH TERMINAL TYPE 235 MODEL 3
MIL DESIGNATION AN/FGC-61A

... All units militarized: components and design approved by U.S. Military.
... Converters have equalized gain and adjustable time delay in each channel for better diversity performance and interchangeability.
... Switching Panels provide "local" or "remote" selection of 2-channel or 4-channel diversity modes.
... Combiners have adjustable gains in each channel, for complete switching flexibility, and the combining follows an ideally modified square law function for both 2-channel space or frequency and 4-channel space plus frequency diversity.
... Keyers have adjustable "threshold" sensitivity control and simplified input circuit selection.
... Optical and Delay Indicator provides test keying signal source for keyers and delay equalizers in all channels.
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WITH THE NEW DI-ACRO* SPRING WINDER

This unique machine eliminates costly special spring orders, saves valuable waiting time. Winds compression and extension springs to 1½ O.D. Handles round, flat and rectangular wire to 1½ dimension. Note exclusive features in the hand operated Di-Acro Spring Winder which assure accurate tension and fast operation without special experience or skill.

TENSION CONTROL—Simply adjust to desired tension—the control keeps it uniform, for winding one spring or hundred, and releases when each spring is wound.
WIRE CUT-OFF—After spring is wound, release tension and use cut-off lever to quickly cut end of spring to desired length.
CAM LOCK—Simply feed wire under cam, turn handle and wire is securely locked to arbor while spring is wound. No threading required.

FREE ENGINEERING SERVICE

Send us your spring forming problems—sample prints or dimension sketches—together with set-up data and size of spring desired, or actual parts for quick evaluation. We will then supply you with a concise evaluation of the possibilities. No obligation.

DI-ACRO CORPORATION
(formerly O'Hall-Irwin Mfg. Co.)
247 8th Ave., Lake City, Minn.

CIRCLE 95 ON READER SERVICE CARD
Wilson: Take the initiative

Using his qualities of quiet determination to see the job through is a key characteristic of Webster H. Wilson, chairman and president of Hazeltine Corporation. The effectiveness of the Wilson approach was recently made evident in the form of a contract award to a five-company team headed by his firm, for a second phase study of the coordination of electronics into a guided-missile destroyer escort class of ships.

Since World War II when he was in charge of Bureau of Ships installations and maintenance of electronic identification equipment, "Web" has been interested in the concept of merging electronics and architectural functions of ship design. The studies in which Hazeltine is now engaged, in association with Newport News Shipbuilding and Dry Dock, Sperry Rand, DECO Electronics and Nortronics, represent the fruition of Wilson's initial planning.

"Sure, ideas like this have been around for years", says Wilson with his almost shy smile. "But someone has to have the incentive to push and push hard to implement them. So many days are afraid to try new approaches." Navy's Bureau of Ships has taken the initiative in this case.

Since graduation from Phillips Andover, Wilson, who was born in Wollaston, Mass., has always had a double-barreled approach to his work. Majoring in aeronautical engineering and business administration at Massachusetts Institute of Technology from which he was graduated in 1936, he approaches his corporate decisions with the combined outlook of a businessman and an engineer.

He has been with Hazeltine since leaving the Navy in 1946. Starting then as a project administrator, he soon became a chief project administrator and a vice president in charge of the Government and Commercial Sales department. In 1958 he became executive vice president of the Electronics division and a director of the corporation. He was elected president of Hazeltine in 1960 and last year succeeded the late William A. MacDonald as chairman of the board. In 1961, he was also elected a director of the Western Union Telegraph Company.

His associates appreciate Wilson's friendly, warm good humor and his wide interests. He is a ham radio addict and an avid baseball and football fan. He tempers this with interest in the writings of C. P. Snow, and has developed a green thumb in the garden of his Locust Valley, Long Island home.

This flexibility of character is reflected in some of his actions since taking over the helm at Hazeltine. He feels strongly that the successful company in today's ever-shifting electronics industry must remain flexible both technically and in business methods. One of his recent moves was the formation of the company's International division under which reciprocal technical and sales agreements will be concluded with overseas companies.

A member of many organizations, including IRE, AFCEA, National Security Industrial Association, American Society of Naval Engineers, Air Forces Association, and American Ordnance Association, he served as a member of the U.S. delegation to the First International Meeting on Radio Aids to Marine Navigation held in London in 1946.

Elect J. L. Sprague
Senior V-P

John L. Sprague was recently elected a senior vice president of the Sprague Electric Co., North Adams, Mass., and named co-director of the firm's engineering laboratories.

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before rectifying to d-c. this new
Reliance D-C Power Supply brings
you these major advantages:
1. High frequency A-c. distribution — multiple rectifiers at point
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2. Low cost, compact, high frequency components.
3. Maximum protection against
   line voltage and frequency disturbance.
4. Simplicity in maintaining high
density D-c. voltages.

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dian Division: Toronto, Ontario.

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Sample and Hold
Multiplex
Digitize

HIGH SPEED
HIGH ACCURACY
HIGH RELIABILITY

The above instruments are typical of ADC's
wide selection of modular data units. Each
instrument is completely integrated, with its
own power supply and operating controls.
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second-aperture sampling of high-frequency
analog data.
Multiplexors, for programmed and sequen-
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High-Speed Analog-to-Digital Converters,
for continuous or peak digitizing.

All ADC instruments use plug-in solid-state
circuits to simplify future expansion.
The ADC Systems Division can supply
complete data-acquisition, data-processing and
computing systems.

Write for complete information.

Other ADC Products — card files • equipment drawers
  • cabinet sections • logic modules
March of this year, Sprague has most recently been head of the Transistor Research department of Sprague Electric's research laboratories.

Applied Dynamics Promotes Three

PROMOTION of three engineering staff members has been announced by Applied Dynamics, Inc., Ann Arbor, Mich., manufacturer of electronic analog computers and components.

The three are: Peter W. Barhydt, named quality control department manager; Jay B. King, advanced to chief designer and staff advisor; and Charles W. Kleekamp, appointed engineering department manager.

![General Electric Hires Schulz](image)

**General Electric Hires Schulz**

**John E. Schulz** has joined the traveling-wave tube product section of GE's Power Tube Dept. as a senior engineer for advanced high-power electronic devices.

His appointment was announced by S. E. Webber, manager-engineering of the Product Section in Palo Alto, Calif.

Schulz was formerly manager of the superpower klystron group for Eitel McCullough, San Bruno, Calif.

**Elco Erecting New Plants**

**Elco Corp.**, Philadelphia, Pa., manufacturer of connectors and components, announces that expanding operation has necessitated construction of two new plants.

One is a 111,000 sq ft facility in
NOW!
Optically Corrected
Single Crystal
Laser Rods

Meller offers optically corrected laser rods in ruby or sapphire-doped ruby, doped calcium fluoride, calcium tungstate, sapphire and other single crystals. Only Meller offers these outstanding guarantees: all faces flat to 1/1000 wave or better... ends optically parallel within 2 seconds of arc. Chisel right angle correct within 3 seconds of arc... apex of angle parallel to flat end within 4 seconds of arc so that maximum TIR (total internal reflection) will be attained. Guarantees apply to ruby rods from 1/16" to 1/2"... and up to 2" lengths on other single crystals.

Meller offers round, square, triangular, and other configurations. Also white sapphire tubes for any size ruby rod—piston fit. Trumpet shaped ruby—sapphire completely lapped and silvered available for less than $1,000.00.

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Phone (401) 331-3717

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PRODUCTS

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Alumina Powder

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Your EBG is bigger and better this year than ever... and more helpful than ever... with more new exclusive features than ever. Keep it close at hand, you'll find it's useful day in and day out.

electronics
BUYERS' GUIDE
and Reference Issue
The Basic Buying Guide
in Electronics since 1941

Willow Grove, Pa., which will take the place of the company's present Philadelphia plant. The second is a 52,000 sq ft building in Huntingdon, Pa. Both are expected to be ready for occupancy in September of this year.

Varian Associates Appoints Miller

SOLOMON L. MILLER has joined the central research staff at Varian Associates, Palo Alto, Calif., as a senior research scientist. He formerly headed research at Rheem Semiconductor Corp. in Mountain View, Calif.

John Royan Joins National Transistor

JOHN ROYAN recently joined the R&D department of National Transistor Mfg., Inc., Lawrence, Mass.

Before joining the firm, Royan was employed by Farranti, Ltd., in Manchester, England, where he specialized in semiconductor devices.

Hi-G, Inc., Continues Facilities Expansion

HI-G, INC., Windsor Locks, Conn., recently announced the completion of a 22,000 sq ft addition to its

CIRCLE 99 ON READER SERVICE CARD
main production facilities, and the start of a second addition of 9,000 sq ft as an advanced research and engineering center.

Company manufactures components for many switching functions and control circuits in the current space vehicle and computer programs.


Electro-Optical
Appoints Munk

ROBERT MUNK has joined the technical staff of Electro-Optical Systems, Inc., Pasadena, Calif., as chief scientist of the company's Advanced Electronics and Information Systems division. He will be responsible for systems research and analysis activities for space vehicles and weapon systems.

Prior to joining EOS, Munk was with Ryan Aeronautical Corp. in San Diego.

Granger Associates
Elects Pappenfus

THE BOARD of directors of Granger Associates, Palo Alto, Calif., has elected E. W. Pappenfus vice president, engineering. He will assume wide responsibilities for development of the company's programs in radio communications systems and devices.

Pappenfus spent 19 years with
Collins Radio Co., where he was at the last director of development of the firm's largest design division.

Ford Instrument Names Montani

ANGELO MONTANI has been appointed assistant to the president of Ford Instrument Co., a division of Sperry Rand Corp., Long Island City, N. Y.

He was formerly research manager for Philco Corp.

PEOPLE IN BRIEF


ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

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

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1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
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(SEE PAGE KEY #)

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103 1

BRISTOL COMPANY

Waterbury, Connecticut

104 2

COLLINS RADIO COMPANY

Dallas, Texas

18 3

DOUGLAS AIRCRAFT CO.

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97 4

ESQUIRE PERSONNEL SERVICE INC.

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103 5

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102 6

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69 8

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Classified Advertising Division


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

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Universal Relay Corp., 42 White St., New York 13, N. Y. announces the publication of their 52 page Spring 1962 catalog. With publication of the catalog, they inform their customers that "normal inventory includes over 1,500,000 relays in approximately 30,000 types. In most cases stock is sufficient to give immediate delivery of production quantities.

This catalog is, therefore, not just a listing of items available 'on order' but, by and large, it is an indication of in-stock items (either as complete units or as ready to assembly components).

The average shipment is made within 48 hours. Where coils and frames require assembly, or relays require special testing or adjustment, shipments are made within one week to ten days.

Universal is completely equipped to assemble, adjust and thoroughly test any type of relay. Assembly and test facilities have been imitated by some relay manufacturers.

A personal interest is taken in every order. This interest is maintained as the order is processed. And, it continues even after the customer receives the merchandise until he makes sure that it satisfies his needs.

All merchandise is guaranteed, subject to customers' inspection and approval, and may be returned within 30 days for replacement or credit.

The catalog is full of items to fill everyday relay requirements".

Catalog E-162 may be obtained by writing directly to:

UNIVERSAL RELAY CORP.

42 White Street, New York 13, N. Y.

W. Walker 5-6900
SEARCHLIGHT Equipment Locating Service

NO COST OR OBLIGATION

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components not currently advertised. (This service is for USER-BUYERS only).

How to Use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Locating Service
c/o ELECTRONICS, P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

_________________________________________________________________

Searchlight Equipment Locating Service
c/o ELECTRONICS, P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following equipment components.

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NAME .................................................. TITLE .................. 7/13/62

COMPANY .............................................. STREET .............. CITY ..................
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Audited Paid Circulation

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F. J. Eberle, Business Mgr.

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Double Pulse Generator Recommended For Semi-Automatic Checkpoint Systems

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Compact, Medium-Power Pulse Generator Features Modular Adaptability

Model 3350A Pulse Generator

Fast rise time pulses are fully controllable in a variety of parameters—Model 3350A Pulse Generator offers broad performance range in a unit designed for console mounting. Uses include pulse circuit design and testing of radar, navigational systems, digital computers, and control systems. It may be operated from the internal oscillator, slaved to an external trigger, or used single shot by pushbutton for transient testing. SERVPULSE™ Model 3350A has 2 nsec-2 cps, regulated 10 nanosecond rise time.

For complete details, write:

SERVPULSE™ PRODUCTS
SERVO CORPORATION OF AMERICA

111 New South Road
Hicksville, L. I., N. Y.

WEIlS 8-9700

July 13, 1962
TRANS-PAK!
A New Concept for making Printed Circuit Masters

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- 40% Faster
- 100% Accuracy

With new Trans-Pak, you POSITION, PRESS, PEEL for fast, accurate, distortion-free die-cut symbol placement. It's a strictly HANDS OFF APPLICATION. No fumbling, no picking off, no eye strain, no tools needed.

Trans-Pak symbols are packaged 250 to a roll, in pressure sensitive ruby red translucent or black crepe paper. 18 outside diameter sizes range from .100" to .500". We furnish both standard and special shapes and sizes. NO ADDED DIE CHARGES.

Write today for full details and samples of the new Trans-Pak printed circuit method.

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"Headquarters for Business Information"
Sperry offers 60-day delivery on a low-cost K band reflex klystron

The SRK-291, a new low-cost K band reflex klystron oscillator offering dramatic cost savings in microwave systems, is now available from Sperry Electronic Tube Division within 60 days from receipt of your order! Sperry's new tube operates at frequencies ranging from 21 to 24.5 Gc. Within these frequency limits, it offers a 11/4 Gc mechanical tuning range and a low temperature coefficient. The SRK-291 is priced at only $1495.

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The SRK-291 is specially suited to the requirements of parametric amplifier pumping, since its power output—80 mW minimum—is more than adequate for parametric amplifier pumping demands. Its low price, wide bandwidth, and inherent stability remove the technical and economic limitations that formerly hindered the use of parametric amplifiers in many systems.

OTHER APPLICATIONS

Sperry's versatile new tube also shows great desirability for application in short range communications systems, beacons, and microwave links. Extreme mechanical ruggedness, light weight (only 3 1/2 oz.), and small size, make the tube ideal for airborne as well as ground-based installations.

NEW, FREE BROCHURE

A new, free brochure describes the capabilities of the SRK-291 in greater detail. For your copy, write to Sperry Electronic Tube Division, Sec. 141, Gainesville, Florida.

Since the SRK-291 is available within 60 days, it represents an immediate solution to your present problems, whether you are designing a new system or concentrating on improved performance for an operational one. Cain & Co., which represents Sperry nationally, has a sales engineer near you. He'll be happy to help you work out specification details. Call him today.
Integral Cavity Design Means Greater Reliability Over Broader Bandwidth

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Operation of RCA A15038 over this bandwidth is made possible by integrating the radio-frequency input and output circuitry, high-voltage blocking circuit and the gridded tube structure within a common vacuum envelope. The tube is suited to a variety of modulation techniques—amplifying at any frequency within the passband at which it is driven.

Developed by RCA for the Rome Air Development Center, A15038 Coaxitron also features a low temperature matrix-oxide filamentary cathode to provide high emission, long life, and economical operation. These and other features combine to provide greater power output, broader bandwidth, higher power gain, better stability and greater reliability.

For further information contact your RCA Industrial Tube Representative or write: Marketing Manager, Industrial Tube Products, RCA Electron Tube Division, Lancaster, Pennsylvania.