Photo at right

BATTERY OF LOUDSPEAKERS

Drives exponential horn for tests, p 48

INSPECTING TV RATINGS

Flying-spot scans film records, p 31

TELEMETRY BEACON

Uses transistor self-reactance, p 35

PRACTICAL PARAMP

For 5,000-Mc tropo scatter system, p 38
SPECIAL PULSE TRANSFORMERS TO YOUR REQUIREMENTS

The pulse units illustrated below show a few of the thousands of special types designed and produced by UTC to customers' requirements. Range covered on special pulse units from a few microwatts to 10 megawatts. Rectangular pulse shapes are deliberately shown exaggerated to clarify parameters.

Almost thirty years of pioneering in the design and production of transformers plus exhaustive life testing programs and rigid quality control measures guarantee components of the highest reliability in the industry. . . . You can stake YOUR reputation on UTC products.

25 kc pulse transformer, DO-T or DI-T configuration. Pulse width 60 μsec. Rise time less than 0.5 μsec. Secondary C.T. balance each side to within 1% to ground. MIL-T-27A, GR 4. Size: DOT, \( \frac{3}{4} \) dia. x \( \frac{5}{8} \) wt. 1/10 oz., DOT, \( \frac{3}{8} \) dia. x \( \frac{1}{2} \) wt. 1/20 oz.

Special precision miniature pulse transformers. Designed in our standard stock mold to your specs. Checked and precisely adjusted in your tube or transistor blocking oscillator circuit. Sizes: \( \frac{3}{8} \) dia. x \( \frac{1}{8} \) 1gram, \( \frac{3}{8} \) dia. x \( \frac{1}{4} \) 4 grams, \( \frac{1}{4} \) dia. x \( \frac{1}{4} \) 6 grams.

Ferrite core blocking oscillator transformer. 0.1 μsec. +10% @ 200 kc PPS. 2 windings, rise time 0.01 sec. Epoxy case MIL-T-27A, \( \frac{3}{4} \) dia. x \( \frac{1}{4} \), .07 oz.

600 μsec. coupling transformer for printed circuit application. 2 windings, \( \frac{3}{8} \) μmetal case for extreme shielding, Z = 20 μsec. 10 V MIL-T-27A, standard UTC ML case; \( \frac{3}{8} \) x \( \frac{1}{2} \) x \( \frac{3}{2} \) x 2 oz.

Toroidal pulse transformer, 120 V, 200 μsec. @ 400 PPS. Molded in epoxy, 3 windings, low leakage, less than 1% Sec. rise time. -40 °C, 150 °F, 85°C, output voltage within 1%. MIL-T-27A; \( \frac{3}{4} \) sq. x \( \frac{3}{4} \) 1.5 oz.

Output to 244.2 magnetic input. 1300 V-50 ohms. Output 6.5 V to 1000 ohms and 6A filament winding. 15 μsec. 1000 PPS. Trigger winding, MIL-T-27A GR 5, \( \frac{1}{2} \) x \( \frac{3}{4} \) x \( \frac{3}{4} \), 10 oz.

Output to Klystron, 5 μsec. pulses in groups of pulse trains at high rep rate. Drop 1% over pulse trains. 30 KV W.V., 43 KV input, -53°C to +85°C; MIL-T-27A, 4½ x 5 x 6½", 11½ lbs.

Sonar sine wave pulse output transformer. 3-65A's, 11-14 kc flat. Pri. 11 KV, 28 KV input. Spark gap protected. Sec. 1500 V-50 ohms. 60 A mil spec. MIL-T-27A, -53°C to +85°C; 6 x 6 x 8½", 13 lbs.

**UNITED TRANSFORMER CORP.**

150 VARICK STREET, NEW YORK 13, N. Y.

PACIFIC MFG. DIVISION: 3630 EASTHAM DRIVE, CULVER CITY, CALIF.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y.

CABLE: “ARLAB”
BATTERY OF LOUDSPEAKERS. 49 in all, feeds an exponential horn that tapers down to a 3-in. tube. Purpose is to study sound-absorbing properties of materials for aerospace use. This horn may produce 160 db of sound intensity (1 w/cm²). See p 48 COVER

SOLID-STATE CIRCUITS. Sessions on low-noise amplifiers and microwave power sources are featured at Philadelphia conference. One of the devices newly reported is a 40-Gc maser that requires a pump frequency of only 13 Ge.

OPTICAL MASERS: Looking Ahead. A pioneer in the maser field discusses engineering problems that must be solved. Effect of environmental acoustic vibrations is one of the unknowns.

TWO PIPELINE SYSTEMS. Introduced are analog simulator to help advance scheduling of shipments and digital remote control and telemetering system. Latter can work with control computer.

FLUID LOGIC Proposed for Space Computers. Switching theory symposium is told that hydraulic systems using gas and ceramic parts would resist high temperature and radiation. Fluid logic devices are slow, but inexpensive.

EARTH SCIENTISTS Plan Use of Remote Sensors. Data could be rapidly gathered by aerial surveys. Big problem: lack of information on spectral characteristics of materials.

SPACE PROBES Will Be Tested in Big Simulator. Huge vacuum chamber with arc light system provides a Venus-to-Mars environment. First guinea pig, for three weeks, is Mariner.

INSPECTING TV RATINGS RECORDS With a Flying-Spot Scanner. Viewing preferences in sample homes are recorded as black marks on 16-mm film. Scanner and phototube read records at 700 recorded minutes each second. Load switching controls phototube frequency response. A. C. Lewis Brown.

SELF-REACTANCE MODULATION in Telemetry Oscillators. Variation of common-base output capacitance produces f-m in vhf transistor when collector-base voltage is varied. This idea creates a simple telemetry oscillator for a biological satellite. T. M. Conrad.
CONTENTS continued

PARAMETRIC AMPLIFIER Improves Troposcatter System. Preamplifier for 4,400 to 5,000-Mc military system has 23 db gain, noise figure is 2.5 to 3 db. It is a one-port negative-resistance device using a circulator to separate input and output. W. L. Smoot and H. C. Leahy 38

BIONICS—Part III: Brain Models and Neural Nets. Computer simulation, building randomly wired networks conditioned for learning and mathematical formulation of neurophysiological functions are all part of the work. One clue was found by studying what makes a beetle follow a changing light pattern. N. A. Lindgren 41

REVERSIBLE DECADE COUNTER. Uses one sign-determining signal to handle rapid reversal of count direction. Add and subtract signals are fed to separate inputs; count time is long relative to circuit delay. L. C. Burnett 46

DEPARTMENTS

Crosstalk. Good Going, Glenn. IRE Preview Coming Up 3

Comment. Parametric Amplifier. Laser References 4

Electronics Newsletter. Glenn’s Flight Scores Point for Manual Control 7

Washington Outlook. EIA Opposes To Bill 12

Meetings Ahead. Engineering Writing and Speech Symposium 28

Research and Development. Electric Field Changes Viscosity of Fluid 48

Components and Materials. Ceramic Stacks Form Miniature Circuits 54

Production Techniques. Scheduling Projects by Critical Path 56

New Products Design and Application. Strain Gage Amplifier Uses Variable Gain Circuit 58

Literature of the Week 62

People and Plants. Lambda Setsles in New Plant 64

Index to Advertisers 68
GOOD JOB, GLENN. We didn't get much work done Tuesday before last. Like most Americans, we kept an ear to the news broadcasts, following the final countdown, waiting out the three long orbits and that agonizingly slow twenty minutes for recovery from the sea.

Our congratulations to NASA for its iron-pants determination to wait until launch conditions were right, to the industry for building a system that worked well when the chips were down, and above all to Col John H. Glenn, Jr.

Certainly the Mercury program and system had its flaws, but they overshadow the event no more than a pebble on a pyramid. Mistakes are what people learn by. If the Mercury program was going to be flawless, NASA could have skipped it and gone directly on to Gemini and Apollo.

No program that has gone so far so fast could be flawless. It has gone fast, even if the U.S. did get a late start and we spectators become impatient.

We took time to leaf back through the many news articles and technical reports we have printed during the past several years on Mercury, and its predecessors and successors. As recently as early 1958, in those pre-NASA days, the government was still ruminating over the best way to get the space program organized. Contrast our special report, "The Challenge of Space," April 24, 1959, with "Missile and Space Electronics," published last November 17. The first was long on what might be done; the second was packed with information on what is being done and the hardware doing it.

Hardly a week goes by now without a new achievement being planned or consummated. What happened last week was one of the most magnificent—yet.

LUCKY US. We can go to the IRE International Convention three weeks hence and spend at least part of the time socializing with old friends from out of town. We can do this with a clear conscience because half our job will be done when we put our IRE Special Issue to bed next week.

The staff has spent the last month or so extracting information on what's new and interesting in the technical papers and exhibits, plus some general information on how to find your way around.

We don't guarantee next week's issue will report everything worth seeing and hearing. There are bound to be a few last-minute surprises. Finding out about them will be the other half of our job. But the preview should save at least as much time as a pair of roller skates, leaving you more time for socializing, too.

THE FIVE W'S. One of our assistant editors finds a shortcoming in this week's article by A. C. Lewis Brown. Brown describes an A. C. Nielsen Co. machine that automatically processes reports on the habits of tv viewers.

It is a reporter's rule of thumb that a good story tells the "who, what, when, where and why." The editor ruefully comments that "why" is the only information the machine does not give. He is vociferously dissatisfied with tv program fare, thinks it a pity that what he usually finds on his tv screen matches neither the inside of the set, nor Nielsen's machine, in ingenuity.

After all the effort that engineers have put into designing a national network of visual communications channels, he says, programmers "sadly let the side down and give the lie to engineers being second to artists in public doing-good."

Oh, well. As somebody once said, you can't please everybody. We still think it is a good article on a good system.
**NEW JERROLD 900B SWEEP SIGNAL GENERATOR**

The new Jerrold 900B is the last word in versatility and precision, the ultimate instrument for all your IF, VHF, and UHF sweep requirements. Bench space requirements and test set-up time are drastically cut because so much is already built in:
- Built-in crystal-controlled harmonic markers at 1,10, and 100mc intervals.
- Built-in variable-gain dc or ac-coupled scope preamplifier with 200X maximum gain.
- Built-in precision attenuator from zero to 50db in 10db steps.

Generating sweeps with center frequencies ranging from 500kc to 1200mc, the 900B offers unusual stability with sweep widths as narrow as 10kc and as wide as 400mc. Write for complete technical data.

$1,980.00 (f.o.b. Philadelphia)

*Typical communication receiver IF (selectivity approx. 6 kc).

**Frequency response of typical wide-band distributed amplifier [4-216 mc].

---

**COMMENT**

**Laser References**

Please tell me how to reach three of the references in your recent laser series (p 39, Oct. 27, 1961; p 40, Nov. 3; p 81, Nov. 10; and p 64, Nov. 24).

I am particularly interested in the proceedings of the Second International Conference on Quantum Electronics, which was held on March 21, 1961, in Berkeley, California.

Apparently the Wescan Proceedings were not published this year and I am anxious to see the abstracts or to reach the authors in the symposium there.

The last item is L. M. Vallee on the generation of coherent light sources, presented at the International Congress of Electronics in Rome, June 19, 1961.

Editors Vogel and Dulberger are to be congratulated on an unusually fine series.

**BLANTON C. WIGGIN**

Advanced Instruments, Inc.

Newton Highlands, Massachusetts

**Editor Vogel replies:**


As for the WESCON Proceedings, write to WEMA (Western Electronic Manufacturers’ Association), 1435 South La Cienega Boulevard, Los Angeles 35, California, for information on obtaining abstracts or papers presented at the 1961 WESCOn.

For a copy of Dr. L. M. Vallee’s paper, write to him at IT&T Federal Laboratories, 500 Washington Avenue, Nutley 10, New Jersey.

**Parametric Amplifier**

Can you supply reprints of the two articles referenced by Denes Roveti in his article, Diode Amplifier Has Ten-Gigohm Input Impedance (p 38, Dec. 22, 1961)? There seems to be a typographical error, as I am unable to locate these references in our library copies of Electronics.

W. A. Peterson, Jr.
Tektronix, Inc.
Beaverton, Oregon

**Author Roveti replies:**

The references quoted in my article should have read, Communication and Electronics, instead of Electronics.

Other references pertaining to this article may be of interest:


Another item about the parametric amplifier in my article: with some minor modifications, it can also be used as a d-e amplifier with input impedance levels of 10 ohms and close to unity voltage gain. With feedback techniques, the input impedance of this amplifier on a-c and d-e can be further improved with auxiliary transistor circuits.

Since the article was written, the noise level of this parametric amplifier has been reduced considerably. We are now making unity voltage gain amplifiers with an input impedance of 10,000 megohms and an output impedance of 10 kilohms with a typical noise level of 50 microvolts (with input open, over a bandwidth of 3 cycles to 200 kilocycles). These units are operated from a 6.75-volt mercury battery with a one-milliamp drain. By lowering the input impedance, noise levels as low as 20 microvolts can be obtained with a 2,000-megohm input impedance.

Denes Roveti

Denro Lab
Washington, D. C.

**Laser Dangers**

Please grant us permission to reproduce the article entitled Laser Dangers (p. 27, Jan. 26). We are desirous of distributing this article to our field engineers.

C. M. E. Hoffman
Maryland Casualty Company
Baltimore, Maryland
GROWTH has many dimensions

...it can be measured by pure statistics:
Employment up 40% in 1 year
Plant space up 900% in 3 years
Sales up 100% in 2 years

...it can be measured by product development:
3 capacitor designs — 1955
12 capacitor designs — 1958
20 capacitor designs — 1961

...it can be measured by the utilization of human resources:
Sales management increased 30% in 1 year
Engineering management increased 50% in 1 year
Production management increased 60% in 1 year

If interested in knowing more about product lines circle number below on reader service card.

If interested in knowing more about a growth company send resume to: Personnel Department, Vitramon, Inc. Box 544, Bridgeport 1, Connecticut. Inquiries receive immediate attention in strict confidence.
FAIRCHILD ANNOUNCES
A NEW TECHNOLOGY:

**μPLANAR**

AND TWO
MICROPLANAR DEVICES:
2N2368  2N2369

- ultra-high speed, high current switching
- ideal for reliable computer logic applications
- now available in volume
- practical in cost

μPLANAR is the first technology ever to combine the Planar process, metalizing over oxide, the Epitaxial process and interdigitated geometries.

The combination of the Planar process with metalizing over the oxide makes possible a device which is electrically small, but at the same time physically large enough for normal, reliable lead bonding techniques. Protected junctions provide for lower leakage and noise, wider hfe ranges, and stability for all surface dependent parameters.

Large metalized lead bond areas are evaporated over the oxide protected junctions (a Fairchild patent), allowing for normal lead bonding to micro-size devices.

The Epitaxial process results in lower saturation voltage and greater breakdown voltage. Optimized interdigitated geometries provide faster switching speeds and higher frequency response without severe current limitations.

FAIRCHILD SEMICONDUCTOR
545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. • YORKSHIRE 8161 • TWX: MN WY CAL 853
A DIVISION OF FAIRCHILD CAMER AND INSTRUMENT CORPORATION
Glenn Scores Point for Manual Controls

SPACE FLIGHT should be possible with less automation, Lt. Col. John H. Glenn, Jr., said at his press conference last Friday. He also saw a good prognosis for visual rendezvous in the ease with which he used retrorockets to maneuver his Mercury capsule.

Glenn used manual controls for two orbits after his automatic stabilization and control system functioned improperly. At one point, he turned the Mercury capsule 180 deg to observe the illuminated particles, which appeared after each sunrise.

Meanwhile, Roger Pierce, technical director for Apollo deep space programs at Collins Radio, said Glenn's flight indicates that high-frequency radio gives satisfactory transmission over a very long distance.

H-f transmission was used from the upper layer of the ionosphere. There had been doubts whether this could be done without a direct line-of-sight. The results will help design telecommunications for Gemini, the two-man orbit, and Apollo.

Any specific recommendations for changes in the next orbital capsule will wait on analysis of telemetry data received from Glenn's capsule at 18 Mercury ground stations. Processing will take about two weeks.

Change in Resistance Is Basis for Memory

MEMISTOR memory element that permanently switches resistance 1,000:1 in nanoseconds when driven by a milliamper square wave in the 10-μsec range, is reported by Trionics Corp., Madison, Wis. In latest developed models, a 2 or 3-v pulse will switch from 1 megohm to 10 or 100 ohms.

Resistance states, considered as 1 and 0, can be nondestructively read out by an ohmometer whose applied voltage is below the switching level. Trionics says elements are unaffected by 10,000-gauss fields, need no holding voltage and operate from -50 to 450 C. However, resistance ratios decrease with higher temperatures, becoming 10:1 at 250 C.

Element is formed with ceramic-type button of processed nickel oxide. These may be individually sealed in transistor can or fabricated in a matrix.

Paraplegic's Muscles Stimulated by Signals

MAIMONIDES HOSPITAL, Brooklyn, N. Y., is conducting experiments in the artificial stimulation of a paraplegic's muscles with programmed electrical signals.

Dr. Adrian Kantrowitz described the work to medical researchers at Brookhaven National Laboratory last week. He showed in a motion picture how a man, paralyzed from the waist down, stood up and sat down when signals were applied externally to leg muscles. Films also showed how electrodes implanted in a dog's leg made the leg perform walking motions.

Programs were prepared with an electromechanical simulator. Signals generated by potentiometers corresponding to flexor and extensor muscle actions at hip and knee joints were recorded on tape. Recent report from Moscow indicates similar work is being done at a bioelectrostimulation laborato-

tory in the Ukrainian Academy of Sciences, Kiev. Development of techniques to record "biocurrents" of a healthy donor are claimed. Expectations are the techniques may also be applied to heart and respiratory stimulation.

Goto Logic Makes Space Computer Resist Radiation

GUIDANCE AND CONTROL computer that can operate next to nuclear propulsion systems is being developed by IBM for Air Force. It uses Goto, or majority logic type circuits.

IBM says tests show that Goto circuits using only tunnel diodes and resistors tolerate steady-state radiation exceeding 10^8 nvt and weapon burst radiation of 10^7 rad /tissue per sec.

In Goto circuits, state is determined by the algebraic sum of input currents. Output voltages have the same polarity as the majority of input voltages.

The computer will have a 12,000-word memory, can carry out 70,000 operations a second, will weigh about 100 lb, occupy 2 cu ft and draw 150 w.

See 25-Percent Efficiency For Thermionic Converters

DEVELOPMENT model of a solar thermionic converter built for satellite communications power supplies operates at 13 percent efficiency, reports Thermo Electron Engineering Corp., Watham, Mass. A 200-w cesium generator has been made for the Air Force. A 135-w system being developed for Jet

USSR Ready to Invent Steller-Inertial Guidance

MOSCOW—Autonomous navigation system based on a combination of inertial and astronomical measurements is described in Aviation and Cosmonautics as the most reliable means of guiding a spaceship to the moon or planets.

The inertial system would act as a memory between astronomical fixes. The article goes on to say that development of a system able to take fixes and determine acceleration and speed is one of the "cardinal problems."

(See ELECTRONICS, p 95, Nov. 17, 1961)
Propulsion Lab weighs less than 8 oz, the company says. It expects fully-developed solar thermionic power systems to have lifetimes of a year or more, efficiencies to 25 percent and power levels of 100 w to 10 Kw. Isotope, nuclear reactor, gas and gasoline-fueled systems are in development, it was reported.

Voice and Teleprinter Transmitted Simultaneously

MARTIN MARIETTA says its Racep communications system will now transmit as many as 70 voice and teletype messages at one time. Added capability is achieved by plugging in a single printed circuit card and printers. Data rate is 100 wpm.

Racep (Random Access and Correlation for Extended Performance) is a wideband radio system that breaks signals into microsecond pulses and combines them randomly for transmission. Receivers accept messages with a preassigned code and reconstruct the message. The system can have up to 700 subscribers. It is being tested by the Army and Air Force.

Vocoder Development Is Ordered by Air Force

TEXAS INSTRUMENTS has been awarded a $370,000 Air Force contract for development and manufacture of a full duplex digital vocoder system. It will be used for secure voice transmission at 1,200, 2,400 or 9,600 bits a second. The digital output of the system may be used as an input to automatic speech pattern recognition equipment being developed at Air Force Cambridge Research Laboratory. A voice-excited or hybrid technique makes voice quality in the 9,600-bit mode as good as toll telephone quality, TI says.

Sensitive Microphone Detects Earthquakes

GEOTECHNICAL CORP. is making a microphone which could presumably be used to detect nuclear blasts (p 9, Oct. 13, 1961, and p 28, Feb. 23, 1962). The company says it will detect small, low-frequency atmospheric pressure fluctuations caused by geomagnetic storms, tornadoes and earthquakes. It can detect barometric pressure anomalies as low as 0.03 dyne/cm² in a pass band of 1 to 0.025 cps. The transducer, which uses a metal diaphragm in a balanced barometric environment, is patterned after an NBS design. It is part of an f-m system for recording.

Film Memories’ Cost Cut to 4 Bits a Bit

BURROUGHS announced this week that it is producing 3,072-bit, thin-film memory planes costing 50 cents a bit, a price reduction of 100 percent. The planes will store 128 24-bit words. Techniques are essentially an extension of those previously reported (p 39, March 3, 1961).

Orbiting Solar Observatory Uses Its Spin as Gyroscope

NASA SAID last week that “within a week or so” it would launch the first Orbiting Solar Observatory. It has a wheel-shaped section rotating at 30 rpm to act as a gyro and provide comparative data on radiation from the sun and the rest of the sky. Connected to the wheel is a stabilized, contrarotating, fan-shaped section with experiments that will continually point at the sun.

There are 13 experiments in all, five in the fan and eight in the wheel (ELECTRONICS, p 102, Nov. 17, 1961). The wheel also contains data storage, command, telemetry and battery compartments. Gas jets and a photodetector-servo system are used for attitude control. OSO has a six-month life, will be followed by other OSO’s to study the sun at least one solar-cycle. Funding in 1962 is $4.2 million.

OSO (S-16) is a refined and enlarged cousin of S-15, which spun but did not lock on the sun (p 32, April 14, 1961). The attitude system is like one developed for pointing rocket experiments (p 48, Dec. 23, 1961) by Ball Brothers and AFCLR. Ball Brothers is prime contractor for OSO.

In Brief...

VOICE OF AMERICA is planning three more overseas radio transmitters as part of its $50 million expansion program.

TOSHIBA plans to export to the U.S. this spring a 15-tube, 10-inch portable tv costing under $130.

SYLVANIA has a $47,000 contract from Air Force for feasibility and design studies of high-speed digital computers for flight training simulators.

FEASIBILITY of using tunnel emission in thin-film, transistor-like devices is to be determined by Electro-Optical Systems under $89,056 Air Force contract.

OTHER R&D awards include $3.9 million to Raytheon for further work on Project Arpat; $236,000 to Microwave Associates for microwave semiconductor devices; $100,000 to Clausen Technology, for gas masers and magnetometer temperature sensor.

GRANGER ASSOCIATES has a $883,000 Army order for ionospheric sounder and other h-f gear.

SPACE AND MISSILE GSE contracts include $1.5 million to Radiation, Inc., for telemetry antenna systems; $800,000 to Miratel for tv monitors; $368,195 to American Concertone for miniature tape recorder; $301,000 to Dynatronics for pcm telemetry playback station. Rohr has a fourth NASA order for an 85-ft antenna.

ETELE-MCCULLOUGH is supplying $600,000 in high-power klystrons for Air Force troposcatter systems.

WEATHER BUREAU is installing 55 Alden facsimile recorders for cloud analysis at airports with AN/QMC-13 rotating beam ceilometers.

ARGONNE National Lab has ordered a digital computer from Advanced Scientific Instruments.

MARTIN, Denver, is installing two Titan telemetry checkout systems made by Telemetrics, Inc.

PM ELECTRONICS has acquired assets of California Instruments Corp.
New from Sprague!

NO30 MONOLYTHIC® Ceramic Capacitors offer unparalleled size and circuit stability

Here is a new kind of capacitor... with a combination of stability, weight, and size advantages never before achieved in a "compact" capacitor!

Layer-built by a unique automated process, MONOLYTHIC Ceramic Capacitors exhibit extremely low capacitance change with temperature (about one-fourth that of comparable capacitors using other dielectrics). Their special construction also permits a new order of compactness—MONOLYTHICS pack more capacitance per unit volume, resulting in substantial reductions in size and weight.

In addition to single-section capacitors, MONOLYTHICS can also be obtained as multiple-section units, allowing circuit designers to replace several conventional capacitors with a single compact device. The availability of these tiny yet highly stable units with either axial or radial leads offers further flexibility to the circuit design engineer.

Cumulative test data prove the low failure rate of these epoxy or phenolic coated capacitors in service—established by thousands of life, moisture resistance, shock, and vibration tests.

For application engineering assistance without obligation, write to Commercial Engineering Section. For complete technical data, write for Engineering Bulletins to Technical Literature Section.

New asynchronous model offers high reliability, quality

*Start-Stop operation under the command of input da
The S-C 3070 message printer utilizes an electrostatic process to produce highly legible, permanent copy. The printer is designed to operate at speeds up to 3000 words per minute using standard computer or communications codes over telephone, telegraph and microwave links. Compact dimensions and quiet operation make the S-C 3070 ideal for offices and communications or command centers. Multiple copies of S-C 3070 printer output can be easily obtained by using the original as a litho offset master or by standard office copying methods. Reliable, unattended operation in the S-C 3070 results from the unit’s non-impact printing concept and field proven electronic circuitry. Ease of maintenance is assured through modular design and readily replaceable printed circuit boards. Replacement paper rolls can be loaded into the S-C 3070 without interrupting operation or interfering with message transmission. The S-C 3070 finds many applications in military, government, and commercial communications systems—and in the data processing field. For additional information on the S-C 3070, write to Department C-25, General Dynamics Electronics, P.O. Box 2449, San Diego 12, Calif.
WASHINGTON OUTLOOK

EIA'S OPPOSITION to S.2109, the FCC-sponsored bill requiring production of only all-channel uhf-vhf tv receivers (p 12, Feb. 23), was delivered to the Senate Communications Subcommittee last week.

L. M. Sandwick, staff director of EIA's consumer products division, claimed the bill would penalize set manufacturers and consumers with "dubious" results. Buyers would have to pay an average of $30 a set, plus antenna costs. Set sales might plunge as much as 14 percent.

The industry will produce all the uhf-equipped sets the public wants, Sandwick said. Shortage of buyers caused uhf set output to drop to a new low, 370,000 last year, against 1.5 million in 1953, he said.

Sandwick cited examples to indicate that uhf station failures were not due to lack of uhf receivers but to programming and other difficulties. Among examples were a uhf station that couldn't compete with vhf networks, uhf stations that succeeded with network programs, and one that made the grade through "salesmanship" and vigorous competition with vhf programs in the same area.

As an alternative to legislation, he offered the industry's voluntary cooperation in promoting uhf and in solving technical problems. The bill, he protested, could lead to further FCC regulation of set design and might logically be extended to a requirement for f-m in all radio sets.

GOVERNMENT SALARIES under President Kennedy's proposed new scales would range up to $28,000—almost $10,000 more than top government scientists and engineers get now. Increases would be most significant in top and near-top levels, where turnover is greatest now. The four top pay grades ($15,030, $16,295, $17,570 and $18,500) are 20 to 50 percent below comparable private levels.

Proposed increases range from $6,000 to $6,500 by 1965, plus two new top classifications which would add another $3,500 to potential top annual pay. Object is to attract more trained men into government service.

ELECTRONICS INDUSTRY interest in the trade expansion bill will probably focus on the "zero list." The President could reduce to zero the tariffs on all product categories on the list. Products go on the list if the U.S. and European Common Market Countries control 80 percent of world trade.

Computers, for example, will likely be among electronic products on the list. The administration maintains that if Americans and Europeans drop computer tariffs, U.S. manufacturers would be faced with increased imports, but exporters of some lines would have a field day.

Key to the President's trading authority is what base year is selected for exports and imports. The year chosen could put as many as 50 products and categories on or off the list. This question will probably be cleared up after the House Ways and Means Committee begins hearing March 12.

LATEST LABOR DEPARTMENT survey shows employment in aircraft and missile plants rose 3.4 percent in the year ending August, 1961. Employment totaled 982,400. Moderate increases were expected through this February. Employment was up 9.9 percent in the missiles sector of the aircraft industry and up nine percent among missile producers in the electrical machinery (including electronics), ordnance and other industry groups. Missile contractors in industries other than aircraft were expected to account for three-fourths of the additional hiring through this February.
Don't just drop any "can" over an electronic component and expect complete protection from stray magnetic fields. Completely protect tubes and transformers with carefully engineered, high-permeability shielding, fabricated to the exact requirements of your components. You get this complete protection with Magnetic Metals shielding. For highest permeability and full effectiveness, Magnetic Metals shielding is made of carefully annealed molybdenum permalloy or magnetic equivalent, and fabricated to provide the layer of magnetic or electrostatic shielding you require.

For a discussion of your shielding needs, write or call today. MAGNETIC METALS COMPANY, Hayes Avenue at 21st Street, Camden 1, New Jersey.

COMPLETE SHIELDING PROTECTION!

...fully engineered for full effectiveness
NEW!

ANSCO SUPERAY H-D
Ultra-High Definition X-ray Film...

from tiny transistors... to giant jets...

Be "Ansco-sure"...

With the first American X-ray film for ultra-high definition radiography! If you require critical definition of correspondingly minute defects, be "Ansco-sure" with this new film. The extremely fine grain characteristics of Superay® H-D film provide the ultimate in image sharpness and maintain high definition throughout the entire 65-250 KVP range.

For radiography—it's Ansco best by definition.

Ansco—America's first manufacturer of photographic materials... since 1842.
Today OGO hovers above a crater on earth

Soon a new space chamber 30 feet in diameter will fill this deepening bowl of earth. Here OGO (NASA's Orbiting Geophysical Observatory) will be subjected to conditions of solar heating, vacuum, and vehicle radiation to the cold of outer space. The new space chamber will be the sixth at STL. It will enable engineers and scientists working on OGO, Vela Hotel and other STL projects to test large, complete spacecraft as well as major subsystems. And along with other advanced facilities at STL's Space Technology Center, it will provide unusual scope for engineers and scientists to verify and apply new techniques in design, development and fabrication of spacecraft. STL's expanding space programs have created new opportunities for engineers and scientists in the following fields: Aerodynamics, spacecraft heat transfer; Communication Systems; Electronic Ground Systems; Power Systems; Propellant Utilization; Propulsion Controls; Re-entry Body Evaluation; Systems Analysis; Thermal Radiation; and Trajectory Analysis. All qualified applicants are invited to write Dr. R. C. Potter, Manager of Professional Placement and Development, for opportunities with STL in Southern California or at Cape Canaveral. STL is an equal opportunity employer.

SPACE TECHNOLOGY LABORATORIES, INC.

P.O. Box 95005-J, One Space Park, Redondo Beach, California • P.O. Box 4277, Patrick AFB, Florida

Los Angeles • Vandenberg AFB • Norton AFB, San Bernardino • Dayton • Cape Canaveral • Washington, D.C. • Boston • Huntsville

IRE Delegates: NYC Interviews March 26-29. Call F. C. Nagel, Plaza 2-8968. Visit STL Booth 1435

March 2, 1962
Super-Conductors

Columbium-Tin
Columbium-Zirconium
Columbium-Titanium
Vanadium-X

These alloys are produced from our electron-beam refined, ultra-purity materials. Experimental quantities of various compositions in rod, wire, and sheet form are immediately available.

MRC has just moved to a new plant, built to our specifications, on route 303 in Orangeburg, New York. The Advanced Materials Division has an atmosphere-controlled section, equipped with the newest quality control instruments and production tools. This care in production is reflected in the purity of our materials and the true homogeneity of our alloys.

Seen the new IDEA INDEX IN EBG?

The INDEX to the editorial articles in electronics magazine, previously published annually in a December issue, now appears ONLY in the EBG. Another original EBG idea that saves time and trouble for users! Keep your EBG copy on your desk!

EXTRA!
Also in the EBG are condensed ABSTRACTS of all the editorial feature articles which have appeared to date in 1961. Another reason why EBG is used more by all four - men in research, design, production and management.
Moving air is easy... controlling it takes an expert

All the brawn in the world won't help this glass blower unless he has the ability to control it with the deft touch, the precise move that comes only with experience. Cooling and moving air can be tricky. We know because that's our business. Doing it efficiently, quietly and economically is our stock in trade. Over the years we have learned to control our production strength with creative design and imaginative engineering. You'll find the whole story in Brochure 102. Get a copy now from the Torrington Manufacturing Company, Torrington, Connecticut.
This one solid tantalum capacitor replaces 12 standards

New high-capacitance STA's, a recent Fansteel Development, deliver up to 4000 μf in a single package. A dozen standard 330 μf solid tantalum capacitors are replaced with one compact 4000 μf unit—and you require only two connections instead of twenty-four! High-capacitance solid tantalum capacitors are supplied in units from 300 to 4000 μf polar, and 150 to 2000 μf non-polar. Solid or wet, general purpose, high capacity, straight sided, polar, non-polar, feed-thru, military—whatever your tantalum capacitor requirements, Fansteel offers a complete range of sizes and types. Reliability ratings start at 0.003% per 1000 hrs. @ 85° rated voltage for standard production tantalum capacitors. For complete specifications, write the Rectifier-Capacitor Division, North Chicago, Illinois.
Advanced-program openings at Boeing for

STRUCTURAL AND ELECTRONIC/ELECTRICAL ENGINEERS

Boeing's Aero-Space Division, holder of major contracts on such advanced space programs as SATURN, DYNA-SoAR and MINKETMAN, has a number of immediate, long-range openings offering professional challenge, and in many instances, unique ground-floor opportunities in newly-formed divisional organizations.

STRUCTURAL engineering openings require knowledge of the air loads, high heating rates, extreme differential temperatures, material oxidation and creep associated with advanced vehicles designed for flight regimes ranging from orbital to normal landing speeds.

ELECTRONIC/ELECTRICAL engineering assignments are available in many areas, including the design of electronic equipment, the development of improved design techniques, electronic parts, electronic packaging techniques and the design and development of improved electronic systems.

Salaries are commensurate with all levels of education and experience. Minimum requirements are a B.S. degree in any applicable scientific discipline. Most of the assignments are in the uncongested Pacific Northwest, offering outstanding family living and recreational advantages.

Send your resume, today, to Mr. Carl Anderson, The Boeing Company, P. O. Box 3707-ECE, Seattle 24, Washington. The Boeing Company is an equal opportunity employer.
Low-noise amplifiers and microwave power sources using solid-state masers, tunnel diodes and varactors are featured at Solid-State Circuits Conference

By SAMUEL WEBER
Senior Editor

PHILADELPHIA—Marked progress in masers and parametric amplifiers, the possibility of cryotron linear amplifiers, advances in microwave power sources and other circuit and component improvements were reported at the Solid-State Circuits Conference late last month.

During a session on low-noise amplification, F. Arams and B. Peyton, of Airborne Instruments, described a solid-state maser that requires a pump frequency only slightly higher than the signal frequency. It uses four-level operation with push-pull pumping.

The prototype has a signal frequency around 40 Gc, a pump frequency of 43 Gc and applied field of 700 oersteds. Stable operation has been obtained over large ranges in the K" band. Tuning range can be varied with orientation of the active crystal, chromium-doped titania at a temperature of 4.2 K. Arams and Peyton expect the technique will be applicable at frequency of 150 Gc or higher.

M. Uenohara, of Bell Telephone Labs, reported a nondegenerate parametric amplifier believed to have the lowest-noise performance—0.9 db system noise figure—yet achieved. It has motor-controlled trimmers (see sketch) to compensate for impedance changes in the diode. The diode is a gallium arsenide, point-contact varactor.

Operating frequency is 6 Gc, pump frequency 23 Gc, and pump power 5 mw. A dewar which keeps the amplifier from contacting the liquid nitrogen is used for refrigeration.

Thin-film cryotrons, long experimental computer switches, were
Applications of Solid-State Devices

proposed as small signal, high-frequency, linear amplifiers, by N. D. Richards, of Mullard Research Labs. Experiments indicate low-noise cryotron amplifiers may have considerable utility.

Bandwidth-gain squared products around 200 Mc may be obtainable from present cryotrons. Richards thinks this figure can be raised to several Gc with new techniques and materials. One problem to be overcome is the low impedance (on the order of 10^4 ohm) of such devices, which must be matched to 50 ohms in practical applications.

Microwave Power Sources

Two major solid-state devices, varactors and tunnel diodes, were discussed by a panel on microwave power sources.

F. Sterzer, of RCA, disclosed that 1-mw power has been achieved with tunnel diodes at about 10 Gc. He also discussed a unit that gives an output of 1 mw over its tuning range of 350 Mc to 1 Gc. In contrast, varactors employed as harmonic generators give 2-w outputs at 2 Gc and 1-w at 10 Gc.

Although tunnel diode output is low at microwave frequencies, inherent stability makes the devices suitable for local oscillator service; D-e to r-f efficiency is high (30 percent compared to a few percent for harmonic generators) and they are easily tuned over a wide range.

Tunnel-diode development is aimed at increasing the basic output limit. Tunnel-diode oscillators at X band are possible, the panelists said, but they are limited by shot-noise problems. At X band, noise level is around 6 db because of the device's series resistance.

In a session on tunnel-diode applications, P. M. Thompson, of the Plessey Co., cited uses such as specialized computer logic circuits (hybrid counters and shift registers), computer storers and level detectors, as well as microwave sources.

Tunnel diodes are good microwave power sources, he said, because they can be used in harmonic generators with gain, the oscillators lock well and power output can be obtained with multiple tunnel-diode circuits (see diagrams).

Thompson feels tunnel diodes make good superregenerative receivers. They have the right type of negative resistance and the frequency is not sensitive to bias changes. He said several 1-Gc receivers gave performance close to that predicted by theory.

D. W. Murphy, of IBM, described a tunnel-diode power driver (see diagram) designed to pass a 5-nsec pulse while preserving its waveform. The driver's rise time is less than 1 nsec and its dissipation is approximately 80 mw. The circuit family has been used in designing a computer that could process two 64-bit words with eight adds, three multiplies and one divide at 5 Mc.

A semiconductor switching assembly capable of providing switching for a modulator producing more than 300 Kw was reported by F. A. Gateka and M. L. Embree, of Bell Telephone Labs. An assembly of 20 ppm transistors switched from 8 Kv (off) to 80 amp in 125 nsec. Two in series switched 16 Kv.

P. R. Low, of Stanford, described a two-core magnetic adaptive component that could serve as an analog memory for an adaptive logic system. It takes about 10 nsec to change gain from normalized +1 to −1, which could probably be speeded up by a factor of 100. A 50-mv r-f input gives 5 mv per turn on the output.

What's Ahead for Optical Masers?

By THOMAS MAGUIRE
New England Editor

AS POTENTIAL APPLICATIONS of the optical maser multiple, some of the hard-core engineering problems are also coming into focus, says Charles H. Townes, a maser pioneer now provost of MIT.

In a Lincoln Laboratory Decennial Lecture at MIT, Townes cited the need for more information about variations in atmospheric optical properties affecting maser communications. To work in atmosphere, a carefully controlled optical system will have to operate under conditions of high power, hot lenses and hot mirror surfaces.

Townes pointed out that acoustic vibrations in a normal environment can cause frequency vibrations of tens of Kc—or one part in 10^15—which could be troublesome in some of the precision applications now contemplated. Townes plans to tackle this problem with tests in a super-quiet laboratory.

A great deal of engineering will be needed also, said Townes, to take advantage, in space communications and radar applications, of the optical maser's directivity and super-intensity focusing.

Extensive work on doppler effects at optical wavelengths is required. Optical masers promise to achieve interference patterns at distances of thousands of miles. But it is not yet clear whether remote detection of these patterns will have important applications.

Changes in doppler shifts will be important if interstellar and interplanetary communications are explored, such as the Ozma-type experiments proposed by Townes and R. N. Schwartz. (Nature, p 205, Apr. 15, 1961). They point out that another civilization might be trying to communicate with the earth by optical or infrared masers.

With maser techniques, signals between planets one light year apart could be detected by the human eye, says Townes. Telescopes could be used to signal between planets 10 light years apart.

Monochromaticity, or frequency purity, of optical masers will make them extremely valuable as oscillators. Townes said the hydrogen maser under development at Harv-
ard by Ramsey promises to be the most precise clock ever devised—accurate to one part in 10⁹.

Townes also added an historical footnote. "We still don't have a good oscillator in the No Man's Land between 300 Ge and 3,000 Ge." Searching for such an oscillator led to masers and lasers, but the hunt still goes on in the region between microwave and infrared.

Among fields yet to be explored, Townes cited molecular resonance at the other end of the spectrum—very high intensity acoustic oscillations that might someday make possible a maser-like device.

The optical technology gradually being built around the maser, Towne said, includes amplification and oscillation techniques, antenna properties of lenses, frequency multiplication, heterodyning, and information on attenuation properties. Two maser beams, he pointed out, can be put through the same photocell and a difference frequency produced as modulation.

Other applications he thought interesting include:

- Communications: Optical masers can dispel the bandwidth problem. The entire radio-microwave range is equivalent to only 0.1 percent of the bandwidth available in the optical frequency range. Work is now underway on methods of powering an optical maser by solar radiation alone.

- Measuring distance and time: Possible measurement of the frequency of oscillation of light may eventually result in the velocity of light being made the standard of time.

- Surface measurements: Surface accuracies of large radiotelescopes will be measurable within one wavelength of light, a precision not yet reached in such antennas.

- Energy intensity: At focus point, the optical maser can concentrate 100 million watts per cm². It may be used for evaporating refractory materials, producing nonlinear effects on materials, etching, chemically pure welding, microsurgery, microscopy and perhaps precise control of machinery in factories by optical beams.

- Power transmission: Ten Kw could be beamed to a spot of 6-in. diameter 1,000 miles away. Light pressure could possibly be used to position or maneuver satellites.

PIECE OPERATORS were offered two systems last month. One is an analog simulator that helps dispatchers schedule shipments. The other is a solid-state digital supervisory system.

The simulator, introduced by General Precision, evaluates in a few minutes shipment schedules and pump operations for periods up to two weeks in advance. Electrical circuits simulate pipe, pumping stations and other pipeline parts.

Outputs and pipeline parameters are set up in a pinboard. Flow rates and other data outputs are recorded on strip charts.

The digital supervisory control and telemetering system was announced by Transitel International Corp, of Paramus, N. J. One of its features is a digital setpoint capability which allows direct transmission of manual or computer-fed numeric commands to an unattended remote facility.

Control instructions are sent to remote stations after message loops have been selected and verified. Telemetering can be selective, continuous, monitor alarm limits, or automatically engage associated control functions. One alarm bank will scan up to 400 points at 10 Kc. Eight basic circuits comprise 90 percent of the system.

Lasers’ Future: Bright or Cloudy?

PHILADELPHIA—Optimistic reports on the future of optical masers clashed with cautious reservations at a panel discussion on lasers at the Solid-State Circuits Conference.

H. Scharfman, of Raytheon, predicted mounting power outputs. Outputs would be raised from 20 to 30 joules now to somewhere between 100 and 1,000 joules by the end of the year, he said. Efficiency would double, to two percent.

Outputs will later be raised to the 1,000 to 10,000-joule range, he thought. After that, though, a substantial improvement in technical knowledge will be needed to break through to higher outputs.

M. L. Stitch, of Hughes, remarked that "remarkable advances" in output of optical ranging equipment had been achieved since he reported one delivering over 600 Kw, six months ago. Stitch declined to reveal the new figure.

The note of caution was injected by P. Franken, of the University of Michigan. He said it has not yet been determined whether the laser is a major development. It can make a unique and lasting contribution, particularly in research, he said, but he now foresees small application in industry.

Scharfman argued that lasers should be regarded as something completely new and unique, with ramifications still unrealized. A. E. Siegman, of Stanford, felt the laser has an important future in the generation of millimeter waves with down-conversion techniques.
10MC COUNTER INTRODUCES ELECTRO-LUMINESCENT READOUT

The Beckman® 8370 Universal EPUT® and Timer—the most widely accepted 10MC counter-timer—now offers a totally new concept in digital readout. ...Electroluminescent display.

EL digits are in-line and in the same plane—assuring fast, accurate readings from extreme angles without the confusion of "stacked" digits. The soft green illumination is uniform and highly legible—no glare to cause eye fatigue.

The 8370 also offers the plus features of automatic decimal point and MC, KC, mSEC, or SEC in the EL display for complete recognition of measurements even at a distance.

Beckman's application of solid-state EL follows 2½ years of close collaboration with Sylvania Electric Products, Inc. during which Beckman research engineers perfected a digital configuration and logic circuitry that capitalize fully on the significant advantages of Sylvania Panelescent® electroluminescence.

This EL feature is also available in other Beckman digital counters.

Beckman® INSTRUMENTS, INC.
BERKELEY DIVISION
RICHMOND, CALIFORNIA

See Us At IRE Booths 3515-17

March 2, 1962
Propose Fluid Logic Space Computers

By HAROLD C. HOOD
Pacific Coast Editor

SUNNYVALE, CALIF.—Computer scientists from throughout the Free World gathered here this week for what was believed to be the first symposium on the application of switching theory to space technology. It was jointly sponsored by Air Force Systems Command and Office of Aerospace Research with Lockheed Missile and Space Co.

Some two dozen papers were delivered in sessions on circuit logics, systems and new switching and storage devices. Emphasis was split between theoretical considerations and new hardware.

Uses of hydraulic switching devices in space-born logic networks were outlined by A. P. Speiser, of IBM's Zurich Research Lab. Binary counters, or gates, multivibrators and shift registers have been successfully tested, he said.

He described two types of systems, one using spool valves as switches and the other employing dynamic phenomena involving no moving or deformable solid parts. Both may be operated with liquid or gas. Systems could be used by themselves or combined with electronic systems. Speiser said speed and power requirements are about that of electrical relay circuits.

Fluid logic is highly insensitive to nuclear radiation. Another advantage in space applications, he said, is that fluid amplifiers built of ceramic and using gas could operate at temperatures of many hundred degrees Centigrade.

Speiser does not expect fluid logic to replace high-speed solid-state circuits. But, he pointed out, many computers use such circuits at speeds far below their potential. Fluid circuits would have a cost advantage here. Elements can be made inexpensively of molded plastic. Miniature fluid circuits are now being designed. The minimum practical bore of spool valves used is about 1 mm.

Speiser drew some analogies between operation of fluid and semiconductor devices in logic systems. Fluid inertia in power lines and connecting channels, for example, creates a problem akin to large electrical inductances.

Among other new devices described were an electron spin echo storage, by M. E. Browne, of Lockheed; nonlinear resonance switching elements, by J. C. Santosmasas, of the University of Madrid, and superconductive switches and storages, by A. E. Slade, of Arthur D. Little.

Eiichi Goto, of the University of Tokyo, surveyed majority, threshold and bilateral switching devices. He stressed the importance of complementing practical approaches to threshold logic with mathematical or idealistic approaches. Some of the most promising applications for this logic in the near future, he feels, are neuron-like or adaptive systems.

Practical approaches resulted in development of such computer components as parametrons, magnetic core switches and Esaki diode circuits. But, Goto said, if too much emphasis is placed on practical considerations, fruitful mathematical theories may not be fully developed.

D. G. Willis, of Lockheed, also discussed threshold switching theory. He said the meeting was organized to focus on theoretical problems. Digital design problems are compounded in space, he pointed out, and design engineers will be hard-pressed to keep hardware abreast of theoretical concepts that are developing.

The general chairman, Howard Aiken, of Harvard University, also stressed the importance of theory. He called it the basis for all digital computers. Without digital techniques utilizing discrete variable circuits, space exploration as we know it would be impossible, he said.

The main objective of the fast-growing field of digital network theory, according to W. H. Kautz, of Stanford Research Institute, is development of analysis and synthesis procedures for networks composed of digital elements. He feels development hangs on understanding how network terminal be-
Behavior is related to internal structure or wiring.

In a paper on totally sequential switching circuits, Kautz outlined relationships between the structure of the state graph, which exhibits network behavior, and network equations which describe internal structure. Prime justification for studying totally sequential networks, he said, is their theoretical value in developing analysis and synthesis techniques for families of sequential digital networks.

Sensors Seen as Boon
To the Earth Sciences

THREE-DAY SYMPOSIUM on the applications of electronic sensors in the earth sciences was held two weeks ago at the University of Michigan's Institute of Science and Technology, under a tri-service contract administered by the Office of Naval Research.

It gave some 70 oceanographers, geologists, meteorologists, biologists, botanists and other specialists an opportunity to discuss sensors largely developed under military programs. Specific research programs will be proposed at a followup symposium in May.

Among suggested applications were measuring sea temperatures, determining water content of soils, assessing agricultural diseases. Sensors might also be used to count the different kinds of animals or plants in a large area, or predict earthquakes and volcanic eruptions.

A number of agricultural scientists thought that great economic benefits could come from rapid aerial surveys of crops (ELECTRONICS, p 7, Feb. 2).

The full gamut of remote sensors could be used, including radar, infrared and microwave detectors, aerial photography, gravimeters, and magnetometers. Aboard aircraft or satellites, they could rapidly survey large areas.

But first, it was pointed out, there is a fundamental problem to be solved. There has been little cataloguing of spectral characteristics of natural and man-made materials. The problem is made more complex by variations in meteorological environments.

Frequency Stabilization

ML-7855

Special anode design of ML-7855 permits frequency stable operation within 10-15 seconds after application of high voltage. (Frequency change during this initial period is less than 1 mc).

ML-7855 provides frequency stable operation with unregulated supply — change in plate dissipation has no effect upon frequency.

CW operation to 2500 mc, with 1000 V Ebb, 100 ma la.
Plate-pulsed to 3000 mc, with 3500 v eb, 3.0 a lb, with a tp of 3 usec at 0.0025 Du.

Send for UHF brochure

The Machlett Laboratories, Inc.
A division of Raytheon
Springdale, Connecticut

March 2, 1962 CIRCLE 25 ON READER SERVICE CARD
Big Simulator Tests Space Probes

Environmental simulator that cost $4 million is now being used by Jet Propulsion Laboratory to aid design of lunar and planetary probes. JPL is developing for National Aeronautics and Space Administration. First to go in it, for a three-week period, is Mariner, a Venus probe.

Built by Consolidated Vacuum Corp., the simulator is 80 ft tall, has a chamber 47 ft high and 25 ft in diameter. The evacuation systems, comprising seven compressors, three blowers and 10 oil diffusion pumps, can produce a vacuum of 10^-6 mm of mercury. Spacecraft performance is monitored by electrical connections through the chamber walls.

The optical system was designed by Bausch & Lomb to simulate solar intensity as close to the sun as Venus and as far as Mars. The optical sun is an array of 2.5-Kw mercury-xenon arc lamps, each with a 16-ft reflector.

Light is reflected in zig-zag fashion by parabolic and hyperbolic mirrors into the chamber. In the chamber, the 3-ft beam is widened to 25 ft by a reflector consisting of hundreds of small stainless steel pebbles. Another parabolic mirror makes the beam almost parallel in the test plane.

Heat is prevented from radiating back from the chamber walls by an aluminum shroud made of 200 black plates cooled to -310 F.

Four Computer Centers to Control Defense Network

Department of Defense will install a computer and electronic wall displays in each of its area communications control centers in Europe, Alaska, Hawaii and Colorado. The systems, designed to prevent delays in message routing and transmission, will give a detailed picture or printout of congestion or trouble in each area.

The Defense Communications System includes 6,300 circuits in 73 countries, the majority of long-haul point-to-point circuits used by military departments and DOD.

IBM Federal Systems Division will equip the centers, which will use 1410 computers. IBM is also to train operators and turn the centers over to the Defense Communications Agency by March, 1963.

Electronic Systems Office Gets Another Commander

Command of Air Force Electronic Systems Division, Hanscom Field, Bedford, Mass., was taken over last month by Brig. Gen. Charles H. Terhune, Jr. He succeeds Maj. Gen. Kenneth P. Bergquist, now chief of AF Communications Service, Scott Field, Ill. Air Force also announced Rome Air Development Center is now assigned administratively to Systems Command Headquarters, no longer part of the Hanscom complex. RADC mission remains the same, principally developer and purchaser of hardware for command and control systems designed and managed by ESD.
JANCO EXTERNAL AMMETER SHUNTS

Designed and Built to MIL-S-61B

QUALIFIED SERIES
MS 91586 (MSA Style)
MS 91587 (MSB Style)
MS 91588 (MSC Style)

Also manufacturers of a complete range of non-standard shunts from 0.1 amp to 3000 amps.

Write today for complete detailed specifications.

JANCO CORPORATION
3111 Winona Avenue, Burbank, California

CIRCLE 201 ON READER SERVICE CARD

NEW HIGH SPEED TAPE PERFORATOR

SPEEDS UP TO 60 CPS
NON-SYNCHRONOUS DRIVE
PAPER OR MYLAR TAPE
5 TO 8 CODE CHANNELS
VARIABLE TAPE WIDTH UP TO 1"
COMPACT DESIGN 10 1/2" x 19"
PRECISE HOLE SPACING
HARMONIC TAPE ADVANCE

Write today for complete detailed information.

Anadex INSTRUMENTS INC.
7617 HAYVENHURST AVENUE • VAN NUYS, CALIFORNIA

CIRCLE 203 ON READER SERVICE CARD

MINIATURE INDUCTORS STILL TOO BIG?

try the new WEE-WEE DUCTOR for size — the smallest inductor immediately available to the engineer with a complete set of values from 0.10 µh to 1000 µh. Meets Mil Spec. MIL-C-15305 B.

For complete engineering data, write to Dept. WL-7, or phone 464-9300.

NYTRONICS, INC.
550 SPRINGFIELD AVENUE, BERKELEY HEIGHTS, N. J.
CIRCLE 202 ON READER SERVICE CARD

50 amp power supplies
0.1% regulation

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Voltage</th>
<th>Ripple</th>
<th>Delivery</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>115/60-BER-12/600</td>
<td>12</td>
<td>1 mv, rms</td>
<td>From stock</td>
<td>$945</td>
</tr>
<tr>
<td>230/60-BER-28/1400</td>
<td>28</td>
<td>2 mv, rms</td>
<td>Less than 30 days</td>
<td>$1750</td>
</tr>
</tbody>
</table>

*Output voltage adjustable over ±17% range.

These supplies have magnetic circuit breakers for overload protection, metered outputs, and remote sensing capability. Optional features include modifications for parallel operation and remote programming. Available for 19-inch racks or in case mountings.

Write for complete specifications on these and many other EIC power supplies.

ELECTRODYNAMIC INSTRUMENT CORPORATION
Subsidiary of Reed Roller Bit Company
JA 6-3761 • 1841 Old Spanish Trail • Houston 25, Texas

CIRCLE 27 ON READER SERVICE CARD
MEETINGS AHEAD

MISSILES & ROCKET TESTING SYMPOSIUM, Armed Forces Communications & Electronics Association; Cocoa Beach, Fla., Mar. 6-8.


IRON & STEEL INDUSTRY INSTRUMENTATION CONFERENCE, Instrument Soc. of America; Hotel Roosevelt, Pittsburgh, Pa., Mar. 14-16.

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


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

QUALITY CONTROL CLINIC, Rochester Soc. for Q.C.; University of Rochester, Rochester, N.Y., Mar. 27.

ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, AIEE, IAS, IRE, University of Rochester; at the University, Rochester, N.Y., Mar. 28-29.

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

PLASMA PHYSICS SYMPOSIUM, American Physical Society; Hilton Inn, Tarrytown, N.Y., April 13-14.

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

HUMAN FACTORS IN ELECTRONICS, PEOC of IRE; Los Angeles, Calif., May 3-4.

ELECTRONIC COMPONENTS CONFERENCE, PEOC of IRE, AIEE, EIA; Marriott Twin Bridges Hotel, Washington, D.C., May 8-10.

NATIONAL AEROSPACE ELECTRONICS CONFERENCE, PEOC of IRE; Biltmore Hotel, Dayton, Ohio, May 22-24.


ADVANCE REPORT

ENGINEERING WRITING & SPEECH SYMPOSIUM, PGREWS of IRE; at Mayflower Hotel Washington D.C., Sept. 12-14. Five copies of titles (not more than 50 letters and spaces) and abstracts of papers (not more than 750 words) should be sent by Mar. 15 to: J. E. Durkobin, Program Chairman PGREWS, 900 ARINC, 1700 K Street, N.W., Washington 6, D.C. Papers should not have been presented elsewhere except at local meetings. Conference theme is "Engineering Writing and Speech An Art or a Science?" Suggested topics include: writing proposals that pay, better reading for better writing, visual communication, tutorial material, economics in writing and government regulations.
electronics is specially edited to keep you informed about the entire industry. With special issues on Electronic Markets, Modern Microwaves, Search and Probe Systems, and other reports you'll want to file and keep

subscribe today to electronics

Every Friday, electronics gives you the latest engineering developments and technically interpreted market trends. So don't wait till everyone on the routing slip has read it. Subscribe now and read electronics first. Mail the reader service card (postpaid) to electronics, the magazine that helps you to know and to grow! Rates: three years for $12, one year for $6; Canadian, one year for $10; foreign, one year for $20. Annual electronics Buyers' Guide (single issue price $3.00) included with every subscription.
A replacement is not a replacement, if it offers only some of the original product's benefits. Philco MADT's give you MORE device per dollar than any germanium "replacement" transistor:  
- MADT delivers higher $h_{FE}$;  
- MADT offers better emitter-base diode stability;  
- MADT types offer higher frequency capability;  
- MADT types offer higher current capability;  
- MADT process-controlled geometry assures tighter parameters;  
- MADT types are optimized for specific applications;  
- MADT is inherently avalanche-free in practical switching circuits.

For top switching capability, use the world's most popular germanium transistor, with uniformity assured by industry's only fully-automatic transistor production. Insist on Philco MADT. For complete data on MADT circuit benefits, write Dept. E2262.

**THESE PHILCO MADT's OFFER OPTIMUM VALUE FOR SPECIFIC NEEDS**

**2N768:** Optimum performance at low power. $f_t = 170$ mc at 1v, 1 ma.  
**2N1499A, 2N2048:** High frequency performance at low cost. $V_{CES} = -20$V.  
**2N501A, 2N1500, 2N799B:** High speed logic transistors.  
**2N976:** World's fastest switch. $f_t = 900$ mc.  
**2N1204A:** High power, low speed. Max. $I_c = 500$ ma. $f_t = 400$ mc. $P_I = 200$ mw.  
**2N1494A:** High power, low speed. Max. $I_c = 500$ ma. $f_t = 400$ mc. $P_I = 400$ mw.

*Micro Alloy Diffused-base Transistors.  
†Military types.
Flying Spot Inspects TV Rating Records

Load switching controls phototube frequency response. Simultaneous switching of phototube load and intensity of spot in flying-spot scanner eliminates burning from quiescent spot and gives usable signal-to-noise ratio.

By A. C. LEWIS BROWN
A. C. Nielsen Co., Evanston, Illinois

ONE SYSTEM for producing national tv ratings records minute by minute station tuning in a sample of homes on 16-mm microfilm. Described here is a machine designed for fast inspection of these records.

A previous article describes the general system. A representative 16-mm film record is shown in Fig. 1A. A black minute mark is recorded by a synchronous motor for each elapsed minute. A day mark occurs each 6:00 a.m. under control of an electrically wound mechanical clock. Thus a home power outage, which interrupts the recording, can be compensated by using the known time of the mechanical-clock day mark. Power outage is indicated on the film after power returns by exposing all columns for three minutes. Viewing is recorded in five columns for each receiver as shown in Fig. 1A.

The inspection machine automatically finds the start of each film and reads the film at a rate of 700 recorded minutes per second without stopping. For each film minute, it scans the recorded information and makes logical entries into electronic accumulators. At each day mark or power outage, the accumulators read one line of characters to an output printer. This printed line shows the number of electrically recorded minutes since the previous day mark, whether a power outage occurred, plus indications of improper code patterns and of film faults.

The number of electrically recorded minutes between day marks must be $24 \times 60 = 1,440$ unless a power outage mark explains missing minutes. The clock times at beginning and ending of a power outage can be computed knowing the minute counts from and to the adjacent 6:00 a.m. day marks.

After inspecting a two-week film in about 30 seconds, the machine stops the film, prints totals of viewing for four receivers and then automatically searches for the beginning of the next record.

The output record for a four-day film is shown in Fig. 1B. The first interval is 720 minutes. The film was changed 12 hours after a day mark or at 6:00 p.m. Then there is a perfect day having a count of 1,440 minutes. During the next day a power outage occurs 280 minutes after the day mark, or at 10:40 a.m. Since the first count following the power outage shows 1,100 minutes, the power outage must have been an hour long, and must have ended at 11:40 a.m. The next day is a perfect one showing 1,440 minutes, but has an improper code pattern in receiver 1. The last interval, 240 minutes long, shows the film was changed about 10:00 a.m.

The film is read by phototubes with a flying-spot scanner as the light source (Fig. 2). Phototubes pass signals through a video amplifier that generates sequential sig-
nals to drive the serial input of a shift register. The shift register has a position for each film column, and stores all the information from one minute of film for 350 microseconds. During the storage interval, the shift register is interrogated by a set of enabling pulses that cause readout if any patterns of interest are present. Readout is in pulses that are stored in flip flops or counters for later printing. A time mark or power outage causes the readout selector to advance and read from the storage that has just filled. Meanwhile, a new storage accepts information being read while printing is completed.

The machine uses a 5ZP16 flying-spot scanner tube. A quiescent spot on the scanner tube is imaged by a lens system through the film onto the photocathode of a 931A multiplier phototube. Voltage output of this phototube is amplified and monitored by a Schmitt trigger circuit. When, due to film motion, a black minute mark interrupts the light path from cathode-ray tube to cell, the Schmitt trigger senses the voltage change to recognize the minute mark. When this happens the flying spot is swept from the minute mark column sequentially across all film columns. During this sweep, the phototube output will be pulsed dependent on the number and placement of black and white film columns.

A mechanical grating on the face of the flying-spot tube causes a gate phototube to generate a sequence of 21 gating pulses. These pulses define the center third of each film column, and occur whether or not the film column is exposed. By gating the gating pulses with the signal from the reading phototube, a series of direct and shift pulses is generated for input to the shift register. Thus, the shift register is continuously loaded and shifted in synchronism with the flying-spot image movement across the film. When the sweep is completed in 450 microseconds, the shift register is loaded with all of the information of one film minute.

The logic circuits that examine the shift-register contents are gated and output pulses for code combinations are produced. These output pulses are stored in flip flops and counters for later printing. Meanwhile the flying spot has retraced to quiescent sensing, awaiting the next minute mark.

For the film speed of 700 minute marks per second, or about 1,400 microseconds per film minute, a sweep and shift-register loading time of 450 microseconds is used. If 21 film columns were alternately white and black, output pulses occur at a 50-Kc rate.

Measurements show that a 22,000-ohm phototube load is maximum to give good 50-Kc response. Sufficient light was obtainable from the moving spot to give good output signal-to-noise ratio. However, the light obtainable from a quiescent spot without screen burning was too low to give usable signal-to-noise ratio.

Because the required frequency response for the signal due to film motion (minute-mark sensing) is only about 2 Kc, switching is used to overcome burning. By switching the load of the reading phototube, its sensitivity and frequency response can be changed, and by simultaneously switching the spot intensity, the comparative system characteristics shown in the table are obtained. Since the spot intensity and phototube load resistor are simultaneously switched, the reading phototube voltage output remains constant for both minute sensing and sweep.

The circuit for phototube load switching is shown in Fig. 3A. Diode V2 is normally conducting, holding V1 at cutoff. The phototube sees a 470,000-ohm load resistor (R2) that gives good sensitivity with poor frequency response. Circuits following the video amplifiers respond to the signal from the 931A phototube and trip the sweep when a black minute mark covers the quiescent spot. As soon as the sweep starts, a positive load switching waveform is applied to the cathode of V2 to cut it off. Immediately, the photo currents developed by the 931A multiplier phototube effectively see a 22,000-ohm load by the connection of V1. This lower load resistor gives the frequency response necessary to correctly reproduce the 50-Kc square wave generated by the read phototube as the spot traverses the film.

So that the video amplifier circuits will see equal voltage waveforms during both load periods, the spot is intensified as soon as sweep starts. The circuit of Fig. 3B accomplishes spot intensification and also acts to hold spot intensity constant as it moves across the phos-

### SYSTEM CHARACTERISTICS

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>TIME DURATION</th>
<th>BRIGHTNESS</th>
<th>LOAD RESISTOR</th>
<th>SENSITIVITY</th>
<th>FREQUENCY RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINUTE SENSING (SPOT QUAESCIENT)</td>
<td>600 μsec</td>
<td>LOW</td>
<td>470,000 ohms</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
<tr>
<td>SPOT SWEEP</td>
<td>450 μsec</td>
<td>HIGH</td>
<td>22,000 ohms</td>
<td>LOW</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

![CHANNEL NUMBERS](image)

**FIG. 1—Typical record (A) shows receiver 1 in on and tuned to station 6 (4 plus 2). Output record obtained from microfilm (B)**
In this circuit a 931A phototube views the spot at all times without interruption by a lens system or film. While the spot is at rest the output signal of this automatic brightness control (abc) phototube is applied to a cathode follower. Output of the cathode follower determines the bias on the flying spot 5ZP16. This feedback loop compensates for any changes that occur in spot intensity.

Load switching similar to that employed for the read phototube is used for the abc phototube. While the spot is resting, the abc phototube sees only a 10-megohm load resistor since diode $V_4$ is cut off. This high value of load resistor develops a large negative voltage which biases the crt to prevent screen burning. As soon as a minute mark is sensed and the sweep starts, a load switching wave is applied to the cathode of $V_4$. This cuts off $V_4$ and allows $V_5$ to conduct. The abc phototube load is switched from 10-megohms to 120,000 ohms.

Since the phototube is a constant current generator this reduces the phototube output voltage, which acts through the feedback loop to...
cause the intensification of the spot.

By adjusting $R$, the increase in light intensity can be made to balance the decrease in read phototube sensitivity caused by going from a 470,000-ohm to a 22,000-ohm load. Thus, a usable signal is obtained from the read phototube both with the spot stopped and moving. In addition, good frequency response is provided when it is necessary while allowing relatively poor frequency response during the slow process of minute-mark sensing.

The video amplifier circuits are conventional and direct coupled. The supply voltages used by the video amplifier, cathode-ray tube and phototubes must be well regulated because of varying repetition rates. This is because film speeds anywhere from 0 to 700 minute marks per second must be accepted.

Figure 4 shows how the read phototube and gate phototube signals are gated together to produce digit and shift pulses for the shift register.

Once the shift register is loaded, the sweep circuits issue commands for the logic to examine the stored pattern of the register. Diode gating circuits are used.

A printer capable of printing 3 lines of 11 digits each per second is used. Assuming that one line of printing could contain all the information for one film interval, in one third of a second approximately 500 minute marks or 8 film hours would be read. In this long film time that there might be occurrences of power outages and thus additional print orders.

Since the printer does not print instantaneously, unless the film is to be stopped more than one storage will be required to avoid loss of information. Since film stoppage is undesirable a minimum of 2 storage positions is required. The machine accumulates the first interval in storage $A$ (see Fig. 2). At the end of the first interval, all storages are electronically switched to accumulate in $B$ position. The selector circuits now read out from $A$ to the printer. If the printer finishes its operation before the next print order, the $A$ storage is available to take the next film information and contents of the $B$ storage could be printed. However, if a print order occurs before printing of storage $A$ is finished, the storage circuits switch to $C$.

Studies show that 3 storage positions would care for 95 percent of all encountered films. Accordingly, the machine is designed so that it normally progresses through $A$, $B$ and $C$ storage, both accumulating and printing. Two storages are normally in use while the third is held in reserve. Serial switching between storages is accomplished by the readout selector.

When the film calls for more storage while a previous printing is still continuing, a lag cycle transfers control of the readout selector from the film to the printer. This means that as long as the printer is no more than two positions behind the accumulators, it will continue printing, and if possible catch up. To provide additional time for the printer the film is automatically slowed whenever the machine goes into this lag cycle. If the printer falls more than two positions behind the accumulators, the film stops.

The readout selector of Fig. 2 uses a 30-level, 26-position switch. Four levels are used for control and the other 26 are sequentially switched to read out 26 binary variables from $A$, $B$ or $C$ storage. After switching, these binary voltages are fed to a matrix that drives a set of relays through amplifiers. Contact matrices operated by the relays convert the binary quantities for decimal input to the printer.

A binary counter circuit senses the end of the film. It compares mechanical motion of the film drive unit with the flying-spot sweeps. Film end is defined as film motion without sweep of the spot. The counter uses pulses from a generator on the film drive shaft as the count input. The counter tries to advance but is continually reset at each sweep occurrence. When the sweep no longer occurs the counter advances to a full count signaling the end.

At the film start, relay logic circuits advance the film until minute marks are sensed. As soon as minute mark sensing occurs the film is reversed and the end-of-film circuit looks for the end of minute marks. As soon as this is found, the film stops, all machine circuits are cleared and a start order issued. In automatic running of a number of films the machine begins to search for the start of the following film whenever the end of the previous film is sensed.

The author acknowledges the assistance of W. A. Marggraf particularly in designing the control circuits and in debugging the machine. Other contributions were made by D. W. Holbrook, C. Prisekin, J. Schweins, A. Reska, E. O. Ross, L. Scholten, R. L. Freeman and C. H. Currey.
Self-Reactance Modulation in
TELEMETRY
OSCILLATORS

Design formulas for predicting the frequency characteristics of vhf-uhf transistor oscillators using self-reactance modulation techniques

By THOMAS M. CONRAD
Flight Electronics, Wayne, Pa.

SIMPLE frequency-modulation techniques for common-base transistor oscillators operating in the vhf-uhf range are of interest in the design of satellite telemetry beacons and similar equipment. This article considers the self-reactance frequency modulation of such oscillators. Although self-reactance modulation techniques have been known and used for some time in such circuits, the modulation characteristics have been largely determined by experiment. Given here are analytic expressions for the modulation characteristics based on a new and more exact expression for the common-base parallel-output capacitance.

Consider the equivalent circuit of a drift transistor at vhf shown in Fig. 1. The capacitance at the output port is composed of the collector transition capacitance $C_a$, in parallel with the collector diffusion capacitance $C_d$

Experience has shown $C_d$ to be negligible at the frequencies and operating points of interest here. The parallel output capacitance $C_{cap}$, hereafter simply called $C_a$, is then equal to the collector transition capacitance $C_a$. Capacitance $C_a$ is a function of the externally impressed voltage across the collector depletion layer and the constant contact potential $\phi$ of the base-collector diode. Since $r_v << r_c$ and $r_v << r_a$ at d-c and low-to-medium frequencies such that $X(C_a) >> r_v$, the voltage across the collector depletion layer is simply the collector-to-base voltage $V_a$, with sufficient accuracy for this analysis.

The boundaries of the collector depletion layer adjust to a changed $V_a$ rapidly. For modulation frequencies in the usable range the adjustment of $C_a$ to a change in $V_a$ is essentially instantaneous, meaning that $C_a$ is a function only of the instantaneous value of $V_a$.

Earlier analyses have derived the transition capacitance for planar diodes as a function of $V$. Where $V$ is the absolute magnitude of the reverse bias voltage and $C(0)$ is the measured capacitance of the junction at zero bias, excluding the stray capacitance of the mounting arrangement

$$C(V) = C(0) \left(1 + \frac{V}{\phi}\right)^n$$

$$C(V) = C(0) V^{-n}$$

The exponent $n$ is $\frac{1}{2}$ for diodes having a linear impurity density gradient. Equation 2 is a more accurate approximation to Eq. 1 at high $V$ for silicon junctions than for germanium ones, since $\phi$ for silicon is about 1.12; for germanium it is about 0.72 v. However, Eq. 2 may be used for simplicity without losing accuracy, due to the method of evaluation.

Experiment has verified that both Eq. 1 and 2 are not accurate enough descriptions of empirical data to be useful in the present design problem without modification. By artificially casting the experimental results in the form of Eq. 2, but allowing $n$ to be a nonconstant function of $V$, this deviation from theory may be shown. Solving Eq. 2 for $n(V_a)$

$$n(V_a) = \frac{\log C_a(0) - \log C_a(V_a)}{\log V_a}$$

for $V_a > 1$.

The resulting plot of $n(V_a)$ for a typical measurement of $C_a(V_a)$, together with the graph of $C_a$, itself, is shown in Fig. 1. There is a region extending over almost all quiescent $V_a$'s of interest in which $n(V_a)$ is approximately a linear function.

The deviation of $C_a$ from theory for both Eq. 1
and 2 appears to be due to several previously ignored factors: variation of the true impurity density function from a linear one along the axis of the junction as the depletion layer extends into both the non-linearly doped base region and the constant-impurity-density collector region; skin effect at high frequencies (change of effective geometry with frequency); change of effective junction area with the position of the depletion layer boundaries due to a deviation from the cylindrical model for the junction; and variation of the effective dielectric constant of the depletion layer material due to variation in impurity density as the depletion layer boundaries extend. Exact theoretical consideration of these factors is in progress.

For the present, however, an empirically fitted curve will be used. The quiescent \( V_{ab} \) of the oscillator is chosen and \( C_{ab}(V_{ab}) \) is measured at zero bias and at reasonable intervals of perhaps 0.25 v around the quiescent voltage for about 1 v in each direction. Then \( n(V_{ab}) \) is plotted and fitted with a linear curve of the form

\[
n(V_{ab}) = a + b V_{ab}
\]  

Then

\[
C_{ab}(V_{ab}) = C_{ab}(0) V_{ab}^{-(a+bV_{ab})}
\]  

the accuracy of which depends solely upon the accuracy of measuring \( C_{ab} \) and the closeness of fit of the linear curve, since \( n \) was originally derived from Eq. 2. The reason for using \( n(V_{ab}) \) rather than the plot of \( C_{ab}(V_{ab}) \) directly is that since \( n(V_{ab}) \) is closely linear in many cases, the error in interpolation is less in using Eq. 5 in most cases.

For later derivations it will be convenient to express Eq. 5 as

\[
C_{ab}(V_{ab}) = C_{ab}(0) e^{-(a+bV_{ab})}
\]  

Consider the basic oscillator circuit of Fig. 2A. If a modulation current \( i_m \) is injected at the emitter, the presence of \( R_e \) causes the collector-to-base voltage to vary. This in turn varies the output capacitance, the tank resonant frequency, and ultimately the oscillation frequency.

In Fig. 2A, \( I_e = 10 \) ma, \( V_{cb} = 11.5 \) v, \( C_{ab} = 1.97 \) pf, \( C_n = 3 \) pf total, \( h_{fe} = 0.98 \), \( f_a = 200 \) Mc, and \( L_s = 0.127 \) \( \mu \)h with three turns of No. 12 wire, inside diameter one-half inch, pitch 8 turns per inch. Transistor \( Q \) is the unit whose \( C_{ab}(V_{ce}) \) curves are shown in Fig. 1. Capacitance \( C_e \) includes stray capacitance. The \( L_s \) and \( C_e \) resonate at \( f_a \). The \( Q \) of the loaded tuned input is not critical, but must sufficiently attenuate the 400-Mc harmonic. Coils \( L_s \) and \( L_e \) must be loosely coupled. The buffer output tank values will depend on the next stage.

Defining \( C_{esy} \) to be the output capacitance at the d-c quiescent voltage \( V_{ces} \) (lumping the header capacitance with external circuit elements), and \( h_{fe} \) as the common-base short-circuit current transfer ratio, constant over the modulation frequency band down to d-c, and evaluated at the operating point \( I_{es} \), \( V_{ces} \), then

\[
\frac{d V_{ces}}{d i_e} = -\frac{R_e h_{fe}}{R_e + h_{fe}}
\]

Then taking \( C_{esy}(V_{ces}) \) to find the first derivative, evaluated at \( V_{ces} \)

\[
\frac{d C_{esy}}{d V_{ces}} = -C_{esy}\left[\frac{a}{V_{ces}^2} + b (1 + \ln V_{ces})\right]
\]

Using a first-order Taylor polynomial in differential form

\[
\delta C_{esy} \approx \delta V_{ces} \frac{d C_{esy}}{d V_{ces}} \bigg|_{V_{ces}}
\]

This converges nicely to the differential of \( C_{esy} \) for small increments of \( V_{ces} \) and \( V_{ces} \) in the normal range.

---

**Fig. 1**—Equivalent vhf circuit (inset); typical plot of \( C_{ab}(V_{ces}) \) and \( n(V_{ces}) \), based on 2N706 transistor, measured at 300 Mc in a transfer function bridge, and omitting the \( C_e \) header capacitance of 0.6 pf.
since $C_{aa}(V_a)$ has small curvature at $V_a$ greater than about 10 v, in general, meaning that higher-order derivatives are small.

Then, chaining backward to $i_m$,

$$\delta C_{aa} = (-i_m h_{f_a} R_c) \cdot \frac{d C_{aa}}{d V_{vo}} \cdot V_{vo}, \quad \text{or}$$

$$\delta C_{aa} = i_m h_{f_a} R_c C_{aa} \left[ \frac{a}{V_{vo}} + b (1 + \ln V_{vo}) \right]$$

Checking this result physically, it is seen that if $i_m$ decreases the total magnitude of the emitter current, the collector current increases, collector voltage $V_a$ decreases, and capacitance $C_{aa}$ increases as expected. This is in fact the definition of the sign convention for $i_m$; if $i_m$ tends to increase the absolute magnitude of total emitter current, $i_m$ is positive; if $i_m$ tends to decrease the emitter current magnitude, $i_m$ is negative.

Examining the oscillating circuit, the frequency of oscillation of the circuit is nearly the resonant frequency of the tank. Thus the frequency of operation $f_o$ is

$$f_o = \frac{1}{2\pi \sqrt{L_1 (C_i + C_{aa})}}$$

Capacitor $C_i$ merely provides a feedback path to sustain oscillation. In some cases, the stray wiring and case capacitances between emitter and collector are sufficient alone. Now the deviation of $f_o$, due to modulation is

$$\delta f_o = \frac{1}{2\pi \sqrt{L_1 (C_i + C_{aa} + \delta C_{aa})}} - f_o$$

where $f_o$ is the center frequency given by

$$f_o = \frac{1}{2\pi \sqrt{L_1 (C_i + C_{aa})}}$$

This result for $\delta f_o$, may then be used to generate curves of frequency shift versus modulation current for a given center frequency and $h_{f_a} R_c$ product (Fig. 2b). Note that in the equation for $\delta C_{aa}$ (Eq. 12) nowhere does $h_{f_a}$ appear except in the product with $R_c$, thus allowing $R_c$ to be adjusted to accommodate for differences in $h_{f_a}$ in a batch of transistors to be used for producing a group of identical oscillators. Actually, as Eq. 12 shows, the product $h_{f_a} R_c C_{aa}$ is the pivotal quantity that allows adjusting of a group of oscillators to compensate for differences in all transistor parameters used in the design method. The constants in the equation for $n(V_a)$ can be expected to be nearly invariant over a batch of transistors of a given type.

Since the variation of $C_{aa}$ encountered in normal modulation is of the order of 0.001 picofarad, careful electrostatic shielding of the entire oscillator is needed to ensure the oscillator is operated with stray capacitances the same as those present when center frequency was calibrated.

Thermal drift of the oscillator frequency will largely depend upon variation of $h_{f_a}$ with temperature when the $I_{ac}$ is small (as in planar mesa) compared with $I_{ac}$ and when the total variation of $l_{ac}$ is small compared to $h_{f_a} R_c$. One method of ensuring reasonable thermal stability is to use a small $R_c$ and large $i_m$, but this leads to problems.

The best way of determining $C_{aa}$ is by experiment, using the values of $C_{aa}(V_a)$ and $L_1$ known and the measurement of $f_o$ for a given $V_{vo}$. Capacitance $C_{aa}$ includes all appropriate stray capacitances, the transistor head capacitance between base and collector leads, and any capacitance reflected into the tank by the load.

An analytic expression for residual a-m in the oscillator would require an accurate and general expression for oscillator efficiency as a function of operating point. Such a function is apparently not known at present. However, empirical curves for oscillator efficiency indicate that for usual cases the residual a-m should be small. However, if either $R_c$ or the modulation current or both are unusually large, the modulation of the operating point may be sufficient to vary efficiency enough to cause problems with amplitude modulation.

The design analysis presented leads to accurate prediction of the frequency-modulation characteristics of a vhf-uhf transistor oscillator with low-to-medium frequency modulation current injected at the emitter. Methods for accommodating parameter differences in the transistors have been suggested. Residual amplitude modulation is very small in most cases.

The author expresses his appreciation to Robert L. Pritchard of Texas Instruments and Rainer Zuleeg of Hughes Semiconductor Division for helpful experimental data and theoretical discussions.
Parametric Amplifier

Design details of a production-type parametric amplifier for

By W. L. SMOTT
H. C. LEAHY
Electronics Division,
Westinghouse Electric Corp.,
Baltimore, Md.

PARAMETRIC AMPLIFIERS designed to improve performance of existing tropo scatter equipment must meet requirements for compatibility. Among the factors to be considered are: sufficient gain by the amplifier to overcome receiver noise, bandwidth, sufficient pump power for a dual diversity receiving system, amplifier isolation from the preselector and the antenna, and simplicity in operation and maintenance.

An amplifier to improve performance of a 4,400 to 5,000 Mc military tropo scatter communication set was developed under contract with the Air Force Rome Air Development Center. This article discusses the factors relating to the initial design concept through the laboratory phase and production of the final unit.

The requirement of compatibility with the receiver necessitated use of a noninverting amplifier, more commonly known as a reflection amplifier. This is a one-port negative-resistance device that relies on a circulator to separate the input and output. The system has a number of advantages over other types of parametric amplifiers. It provides better noise figures and permits fail-safe operation by allowing the signal to pass through the system with only the insertion loss of the circulator whenever the amplifier is off.

The primary factors in developing the pump system were r-f, pump power requirements, power supply and theoretical attainable noise figure. A system using a pump frequency of 13.5 Gc was chosen over one operating at 25 Gc. The lower frequency system was chosen because diodes were available, tubes to operate in this range were available, and the power supply could be made small. Pump power requirement is only 600 v at 60 ma as compared to an estimated 1,500 v at 230 ma for the higher frequency unit.

The approximate expression for the noise figure of the reflection amplifier, assuming a lossless diode and near oscillatory pump power is

\[ F = \left(1 + \frac{Q_e}{Q_i}\right) \left(1 + \frac{j_f}{f_i}\right) \]

where \( F \) = noise figure, \( Q_e \) = external Q of signal circuit, \( Q_i \) = internal Q of signal circuit, \( f_s \) = signal frequency, and \( f_i \) = idler frequency. \( Q_i \) may not be much larger than diode Q at signal frequency due to the large physical size of conventional diode cartridges and the necessity of obtain-
Improves Tropo-Scatter System

improving an existing beyond-the-horizon military communications set

large affective capacitance variation in the signal circuit. Varactor Q is about 14, and is tightly coupled to the signal circuit, the internal Q of the cavity must be of the same order and the external Q close to unity for good noise figure. The amplifier design problem was that of achieving a series of extremely tight couplings, diode to signal cavity, diode to idler cavity, and signal cavity to line and maintaining these coupleings over a large tuning range while simultaneously attempting to isolate tuning mechanisms functions. Knowledge of the fields in the immediate vicinity of the varactor was vague; the cartridge design is not directly controlled by the amplifier designer and the required Q's are so low that description of the signal cavity by conventional analysis by circuit theory of lumped equivalents is impractical. These factors increased the amount of laboratory work but use of a wideband sweep technique and a flexible test setup allowing measurements to be conducted without involved assembly and disassembly of waveguide components allowed rapid optimization of the great number of variables.

These experiments led to the building of two prototype models that were completely different in tuning. One was a waveguide cavity tuned by a capacitance plunger that was simple in construction but provided only 75 percent of the required tuning range due to the large change in field distribution as the plunger position was varied. The other, more complex in construction, was a short section of line, tuning being accomplished by varying its width. The amplifier may be represented by the equivalent circuit as shown in Fig. 1 and is the configuration used in the final design. In Fig. 1, $Y$, is the input line characteristic, $B$, is the tuning susceptance, $L$, is the junction inductance, and $Y_0$ is the diode admittance. $Y_0$, can be resonated by adding susceptance at the junction. This makes the structure easily tuneable, since by varying the line section width and the susceptance, numerous impedance transformations of $Z_0$ occur similar to those of E-H waveguide and triple stub coaxial tuners. The flexibility of this mechanism is the factor producing the required large external loadings.

The pump signal is introduced into the idler cavity by a waveguide beyond cutoff and pump power into the diode was accomplished more efficiently by locating the diode as close to the pump feed line as possible. The diode acts as an attenuator between the pump feed and reactive idler cavity reducing the effect of the idler cavity tuning on the pump circuit. The amplifier structure is represented in the outline drawing, Fig. 2.

The system developed for control of frequency and pump signal level is shown in the block diagram, Fig. 3. Frequency control is accomplished by an equal-arm system that provides a large pull-in range thus allowing operating personnel to operate the pump system without test equipment. The amount of reflector voltage controlled is limited so that the klystron always operates on the desired mode and corrective mechanical tuning is accomplished in

![Block Diagram](image)

**FIG. 3**—Frequency control system at right controls the amount of reflector voltage to the klystron; pump signal level control at left operates the variable attenuator

March 2, 1962

39
FIG. 4—Low level d-c from the detector modulates the high frequency from the oscillator to give stable d-c to operate the attenuator.

FIG. 5—Effect of amplifier adjustments on frequency and noise figure.

A straightforward approach. A meter provides indication of whether the frequency is high or low. The AFC feedback loop required high gain to lock with the desired accuracy and stability. This was accomplished by placing most of the gain in the i-f amplifier followed by a relatively low-gain d-c amplifier. The reference frequency is obtained by a resonant cavity constructed from invar material which was then mounted in a relatively simple temperature controlled oven.

The automatic level-control system consists of a detector crystal driving a d-c amplifier which in turn drives a ferrite variable attenuator. At room temperature an initial attenuation is placed in the system; then as klystron output drops due to thermal detuning over temperature extremes, the system is able to maintain constant amplitude of output over the entire klystron mode by removing attenuation.

The control system circuit was solid-state, using transistors and varicaps, mounted on plug-in printed boards. The major problem in the design was achievement of stable operation over the required temperature range, minus 26 C to plus 70 C, and a circuit was developed especially to attain this stability. This consisted of modulating a relatively high-frequency signal by the low-level d-c obtained by rectification of the high-frequency loop signal, amplifying and again rectifying to magnify the small d-c voltage. This circuit, Fig. 4 was called a magnified d-c amplifier.

Lack of proper means of specifying varactor diode parameters arose as a major problem during the engineering development phase. Specifications on the basis of Q or cut-off frequency proved inadequate. Grading diodes on the basis of performance in an amplifier, allowed analysis of diode parameters to discover roots of the performance variations. Diode Q, C, Cmin, C operating, operating bias, and d-c leakage had to be restricted to achieve reproducible results.

Much of the early development was done using the Microwave Associates 460 series diodes. As the program progressed, type 450 HR diodes became available. They were evaluated and it was found that by obtaining diodes within specified C, range, excellent and consistent results were obtained. The amplifier is provided with easily read precalibrated dials for adjustment of the signal cavity, idle cavity and the iris coupling. Frequency change and adjustment is accomplished simply by setting the three dial readings for any desired frequency in the 4400 to 5000 Mc range, then increasing pump power for a specified increase of receiver thermal noise as indicated on a meter in the receiver. The variation of the iris, signal and idler adjustments plus the variation of noise figure over the frequency range is shown by Fig. 5. These curves show a relative insensitivity of the iris and signal adjustment, and over a frequency shift of approximately 100 Mc, adjustment of the idle cavity only is required. The discontinuity at 4.8 Gc is due to diode self-resonance.
BIONICS
Part III:
Brain Models and Neural Nets

Simulation of nervous functioning requires design of complex nets of neuron-like elements. Many approaches are being taken, but the difficult problems have only begun to be tackled.

By NILO LINDGREN, Assistant Editor

The approaches to understanding and to design of neural-like nets include build-up of neuron-like elements into physical networks; simulation of neural-like structures by computer; mathematical formulation of redundant nets of formal neurons; mathematical synthesis of neurophysiological functions; design of adaptive networks by inductive methods, then comparing their behavior with animal systems; and construction of randomly wired networks that are conditioned for memory and learning.

Such approaches differ in direction and intention as well as in method. One investigator develops nets of increasing complexity and aptitude to discover how the central nervous system is structured, while another takes off from known biological facts about a neural subsystem and synthesizes a network that will perform useful tasks. One commentator remarks that the first investigator, Rosenblatt of Cornell Univ. and Cornell Aero Labs, has contributed more to the design of intelligent machines than he has to the understanding of neural nets.\(^3\)

In psychological theory, emphasis has shifted from stimulus-response conditioning models to problemsolving models. Rosenblatt, for instance, sees the methodology of his perceptron studies merging with the heuristic program approach of A. Newell, J. C. Shaw, (Rand Corp.) and H. A. Simon (Carnegie Institute of Technology), whose General Problem Solver or GPS incorporates in a computer program means for solving problems, such as discovering proofs for theorems in logic. Simon concludes a present need is for programs to explain long-term memory.\(^4\)

The problem of understanding both long and short-term memory and locating the residence of long-term memory traces in the brain are both unresolved, although a number of theories have some experimental support. These theories say that the residual effects of learning or memory traces are widely dispersed throughout the nervous tissue (distributed memory); that memory traces reside in the glial cells, which are found between cerebral neurons and outnumber them ten to one; that short-term memory may be based on reverberatory activity in nerve loops or in modification of neuron firing...
threshold, etc.

Many other basic physiological questions are still open: how the organism exercises selective attention, how it sets itself to work toward a specific goal, how it makes choices, how it performs complex behavioral sequences and how it perceives.

There has been considerable controversy over whether the brain is highly prestructured in its functions. It is known that the sensory inputs to the brain are mapped in a precise, orderly fashion on the cerebral cortex—hearing is mapped according to pitch, touch according to body location, motor areas on the cortex are topologically similar to body muscle organization.

Whether the fine organization of the brain is highly structured is an open question. One view sees highly specific preorganization, another believes that the preorganization of the brain functions exists as biases and directional preferences, that the fine detail allows for a degree of randomness, which may be modified in learning. This latter view has led Rosenblatt and others of the perceptron approach to build brain mechanisms that start with randomly wired nets and then they introduce constraints one by one while observing results.

In general, bionics is working toward: (1) understanding individual neurons including sensory neurons, motor neurons that transmit signals to muscles and glands and associative neurons that connect sensory and motor neurons; (2) understanding of neural nets and their relation to motivation and memory; (3) understanding the physiochemistry of attention and intelligence; (4) understanding the data processing throughout the nervous system; and (5) invention of a new mathematics to deal with unreliable elements and subjective probabilities.

Armour Research Foundation is doing mathematical studies on how concepts are formed and tied in with perception in man. These studies cover: (1) how concepts are formed; (2) how perceptrons are randomized; (3) and design of a specific learning machine. It consists of a full retina based on sets of slides on which are deposited photosensitive material whose density changes on exposure to light. By a Pavlovian training procedure, the machine is taught to remember all the patterned slides it sees.

George Jacobi of ARF remarks, "We will be dealing with highly specialized learning machines for a long time."

Studies, by Scott Cameron and others at ARF, of the human perceptive system lead them to conclude that the human is highly specialized in the relations he perceives in his environment. Other workers have also stressed, in discussions of pattern recognition problems, that no pattern recognition scheme is universal. Reference to general-purpose pattern recognition devices may be misleading.

Another program has recently been announced by the Librascope div. of General Precision, under two contracts by the Air Force Office of Scientific Research. They are part of a five-year program of studies of intelligent machines and self-adaptive mechanisms. The program will cover hypothetical nerve nets, analogical simulation of neural behavior, relation of classical association psychology to data processing and digital computers, behavior of mutually inhibiting nerve nets and simulation of the lobster cardiac ganglia.

Rand Corp. reports that in addition to computer simulation of human problem solving and using computers to build and test theories in psychology, they are doing physiological modeling, attempting to make a mathematical model of the human external respiratory system and simulating neural nets. They are modeling the cortical neuron as closely as possible and are designing an artificial neural net that has learning properties.

Heinz von Foerster and his colleagues at the Biological Computer Laboratory, University of Illinois are emphasizing, in their studies, methods of property filtration, taking as a basis the various kinds of property filtering found in living systems—such as in the frog's eye.

The U. of I. work has resulted in an object counter, called Numa-rete, a retinal device that counts, using...
a sequential method of interrogation, as many as 40 separate objects in 0.2 second. It is not confused by intricate shapes or by objects appearing in holes in other objects. They have also developed a topological counter that is based on a parallel technique.

Their information-processing networks rely chiefly on layers of active elements that perform mathematical or logical operations on input stimuli. Figure 1 shows a two-level array of elements. The first layer is an extensive array of photocells, the second of neurons that carry out logical operations. Loops about the stems of the neurons indicate inhibitory inputs (-1), and T connections to the sides of the neurons indicate excitatory inputs (+1). A neuron in the second layer shows no response as long as the two neighbors of its overlying photocell are both stimulated. For uniform lighting over the photocell array, there is no output. However, the edge of an obstruction will be detected since the photocell under the obstruction provides no inhibition to its neighboring photocell exposed to the light. This photocell thus has an output (+1) that indicates the edge. By extensions of such strategies, it is possible to perform complex operations on various kinds of inputs.

Most recently, von Förster and M. Babcock have developed a dynamic signal analyzer (photo) that, through banks of filters, analyzes the frequencies in an aural spectrum, and reproduces the action of the ear. The analyzer depends on a double differentiation of sound inputs. This artificial ear exhibits extremely sharp frequency discriminations, recalling the resonance theory by Helmholtz, which assumes that the transverse fibers of the basilar membrane act as tiny resonators, each tuned to a different frequency.

Using neuromimes, Harman and van Bergeijk at Bell Labs have turned up functions that suggest explanations for hearing phenomena and nerve responses of the skin.

In the cochlea of the inner ear there are four groups of nerve fibers, of which the least is known about the external spiral fibers which cross what is called the arch of Corti (Fig. 2A), and connect to external hair cells. These external hair cells respond through the basilar membrane to pressure changes from sounds impinging on the ear and form part of a convergent neural arbor (Fig. 2B). Impulses stimulated in these nerves conduct inwards towards the brain (afferent innervation). The function of this spiral innervation is unknown, but because of their length (these external spiral nerves cover a quarter to a third of a cochlear turn), there has been speculation about their role in preprocessing aural information.

A neuron is refractory for a short time after it fires. Observing Fig. 2C, it is seen that if a hair cell triggers branch 1, the spike will travel down 1, into 3, 5, 7. As the pulse travels along the nerve, it leaves the nerve and the junctions (A, B, C) refractory. If an impulse has also been triggered in branch 2, it will be stopped at the A junction. For low firing rates and randomly distributed firing, few pulses are blocked; as firing rate goes up the probability of blockade goes up. With high stimulus on the ear, and with much agitation of the nerve hairs, fewer pulses are transmitted towards the central nervous system.

An artificial spiral nerve was made with 19 neuromimes (Fig. 2D); this chain was connected to an electrical analog of the cochlea, which was excited with a one-Kc sine wave. The outputs (see Fig. 2D) from neurons in the chain show that the slopes of the plots of sine-wave attenuation in db against neuromime output in pps decrease as the chains grow longer. Thus, a long chain of neurons can cover a much larger dynamic range than a single neuron can cover.

There is some physiological evidence to support this view; psycho-physical studies of the effect of varying density of innervation in the skin, by von Bekésy, show similar results in dynamic range. Although it is not certain that this model explains the spiral nerve function, it shows how electronic modeling of neural events give rise to viewpoints that may prove fruitful.

Unusual experimental studies by Werner Reichardt on how a beetle (Chlorophanus) responds to moving periodic patterns has led to a mathematical model of the beetle's perception processes. The model allows predictions of how the beetle moves his whole body in response to light stimulus.

The beetle is glued to a stand that holds in suspended inside a hollow cylinder composed of vertical dark and light stripes of various patterns, and he is given a Y-maze globe which he carries (see Fig.
neurons fire continuously."

Consideration of such nets, which von Neumann called circuits logically stable under common shift of threshold, has led Warren S. McCulloch and his group in Neurophysiology at the Research Lab. of Electronics, MIT, into the mathematical construction of redundant nets of formal neurons that are logically stable even when the component neurons and their connections are unreliable.

A formal neuron is defined as an all-or-none threshold device with many input lines and one output line. Each line can be in one of two possible states, on or off. A finite unit of time elapses between consecutive states. Input lines in the on state excite the formal neuron with a strength +1 or −1, and in the off state with a strength 0. If the algebraic sum of the excitation of the input lines equals or exceeds a given value, the threshold θ, the formal neuron fires, giving rise to the on state of its output line. Such a formal neuron is capable of logical computation."

Although early work on these nets has dealt with performing simple logical functions, McCulloch's group would like eventually to study more complex phenomena such as learning."

Various disturbances to the neurons and to the nets composed of them have been studied, including failures in the input and output lines to individual neurons, fluctuations of signal strength and variations in neuron firing threshold. Various types of redundancy have been considered to produce networks that will operate reliably. Says McCulloch, "It is only out of redundancy that one can buy security." One way to introduce redundancy into the nets is by a bundling technique in which single-line automata are replaced by multiple-line automata, as shown in Fig. 4A and 4B. Bundles of lines in Fig. 4B carry the same amount of information as individual lines in Fig. 4A. More sophisticated schemes have recently been under consideration. McCulloch distinguishes redundancy of coding, redundancy of channels, redundancy of calculation and redundancy of potential command.

Computer simulations of neuron-like nets that show promising relationships to electrophysiological findings are being carried out by Belmont Farley at Lincoln Laboratory, MIT, on Lincoln's TX-2 digital computer. Associated physiological studies may be made by Charles Molnar, of Air Force CRC and the Communications Biophysics Group at MIT. Computer simulations are interesting, since the analysis of the behavior of large numbers of interacting neurons appears impossible at this time.

Farley's nets are composed of 1,296 elements, in 36 × 36 array. Each element possesses many of the characteristics of biological neurons: both spatial and temporal summation of excitation, analog and digital qualities, definite thresholds, refractory periods when threshold rises to infinity, holds and then decays exponentially to normal threshold.

Connections between these neurons can be given any desired probability distribution. Both tightly coupled and loosely coupled nets have been studied, the first tending to produce well-defined wave fronts, the second tending to oscillate diffusely.

The number of connections to the
various elements can be varied, and all element parameters can be changed to study their effects. Oscillations in these nets have been set up by stimulus to small groups of elements, and have also been driven by repeated stimuli. Study of these large nets has revealed simple oscillations, amplitude-modulated burst-like rhythmic activity as well as irregular waves of all kinds, especially in loosely coupled nets. These are suggestive of so-called slow-wave phenomena. Farley suggests that these slow-wave phenomena may arise chiefly from dendritic interactions. He stresses, however, that these suggestions are open to question and must be pursued experimentally.

One of the most popular approaches to learning machines has been the perceptron (ELECTRONICS, July 22, 1960, p 56). This approach, originated by Frank Rosenblatt in 1957, has grown to such an extent that a perceptron symposium was held in Washington in December to consider recent progress. At least 21 companies have constructed some form of perceptron.

Rosenblatt stresses that a perceptron is a brain model, not an invention for pattern recognition. However, opponents generally attack the lack of physiological evidence in support of this view.

Despite such controversies, perceptrons may find many applications. They may be trained to detect targets of military interest in aerial photographs, diagnose medical symptoms and recognize events in a bubble chamber. At the December conference, Rosenblatt reported that an audio perceptron is being built, under ONR sponsorship, that will learn to recognize spoken words and develop a vocabulary of several hundred words. Called Tobermory, it will be completed within a year.

One of the many companies engaged in perceptron work is Aeronutronic, a div. of Ford Motor Co. They report that their work has taken the form of mechanizing basic biological learning models with low-cost, high-speed hardware. One component they have developed is called mind (magnetic integrator, neuron duplicator), shown in Fig. 5. It is a magnetic element whose flux can be changed in approximately 50 discrete steps, having nondestructive readout, and suitable for perceptron-type memory elements. Two systems have been built using these components. The first is equivalent to a single-neuron model. The second is equivalent to 32 neurons. It contains about 200 mind components and was completed late last year.

This perceptron shown in Fig. 6, will test a variety of neural-net learning processes. Both systems were sponsored by ONR and Rome Air Dev. Center. Aeronutronic expects that its present program in new computing concepts will overcome component-cost limitations that presently confront builders of neural-model recognition systems.

Another machine that operates by networks of adaptive elements, employing associative storage and retrieval methods, is the Madalone, designed by Bernard Widrow and Marcian Hoff, Jr. of Stanford Electronics Labs. Madalone is being used to investigate learning and various types of memories. Interest in this type of adaptive system has also been expressed by Westinghouse, which has recently instituted a bionics program.

REFERENCES

(4) Conversation with George Jacoby, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.
(5) Private communication from M. E. Maron, The RAND Corp., Santa Monica, Calif.
(14) B. G. Farley, Some Results of Computer Simulation of Neuron-Like Nets, Symp. on Computer Techniques in Physiology, Atlantic City, April 1961.

March 2, 1962

45
Reversible Decade Counter

Multidecade counter uses one sign-determining signal to handle rapid reversal of count direction in this simplified circuit.

By L. C. BURNETT
Etoloc Ltd., Beeston, Nottingham, England

COMPLEXITY in conventional counter circuits arises from the requirement to produce an add carry when the count changes from 9 to 0, but not for a 1 to 0 change, and similarly a subtract carry must be generated by a 0 to 9 change, but not by 8 to 9. Each decade stage is normally equipped with memory and coincidence circuits to give the required performance.

When add and subtract signals, separated by the normal resolution time, are fed to separate inputs, and where the time of one count is greater than that required for a carry to pass right through the counter from the units to the most significant decade, then considerable simplification of circuits is possible.

An add input signal applied to the units stage may, or may not, lead to an add carry between the hundreds and thousands stages, but it can never lead to a subtract carry in any stage. Therefore one sign-determining circuit prior to the input to the tens stage can provide gating signals for every decade.

The circuit uses glow transfer tubes, but the principle can be applied to any multidecade counter. A pulse applied to the add input steps the units counter clockwise, say from 7 to 8. It is also connected to one of the inputs of a bistable multivibrator to produce +40 v on the add bus and 0 v on the subtract bus. Each counter cathode 9 is clamped to the sub bus, and each cathode 0 is clamped to the add bus, so that although another add pulse steps the glow in the units tube on to cathode 9, the output is clamped at 0 v, therefore no output signal is generated. A further add pulse steps the discharge to cathode 0, which rises from ground to +35 v. The leading transient is fed through a capacitor to the trigger of the trigger tube driving the tens stage clockwise, and so this counter steps. Should this cause a transfer from 9 to 0, a signal will fire the hundreds driver tube, and so on through all decades.

This design will handle rapid reversals of count direction, such as 8,9,0,9,8 because the charge on the coupling capacitors is not required to change; the only capacitance on the buses is that of the wiring and the clamping diodes.

The only critical value in the circuit is the ±165 v trigger tube bias, which must be held to ±5 v.
ASSURES PROTECTION from Severe Mechanical Shock

- **Positive protection** against retaining-ring slippage is now yours with Texas Instruments 2N332A series grown-junction transistors.

  The retaining ring stays put in TI's exclusive CRIMP-LOCK design, preventing short circuiting and assuring fail-safe performance under extreme mechanical abuse.

- **Guaranteed high-temperature stability** plus added mechanical reliability is provided with TI's ceramic base feature.

- **Immediate delivery in production quantities** . . . applications assistance . . . data sheets . . . complete statistical reliability data . . . all are yours for the asking. Call your local TI sales office or authorized TI distributor today.


**Improve Your Circuit Reliability with Long-term Proven Performance of TI Grown-junction Transistors.**

- *Only TI offers over five years of life test data, from lots that have been continuously on test for over 5 years, showing an extremely low average failure rate of less than 5 x 10^-6!*

- *Over six-million life test hours provide your greatest source for predicting transistor reliability.*

- *Thousands of successful circuit applications over the years testify to the consistent high performance of TI devices.*

*All at low cost,* because industry's wide acceptance and use of these units enables TI to provide fast, cost-saving production in large quantities.
Electric Field Changes Viscosity of Fluid

LOUDSPEAKERS are among a number of devices being investigated that use an electro-viscous fluid. An impressed electric field changes viscosity of the newly developed fluid. Armour Research Foundation, which has verified the properties of the fluid, reports that changes in viscosity have been achieved at levels much greater than any previously recorded phenomena.

The magnitude of the viscosity change is dependent on field strength and is thus readily controllable. Relative changes in viscosity of more than 200 to 1 have been measured at a maximum field intensity of 75 volts per mil. And present indications are that the range of viscosity changes can be greatly increased.

Testing and further development is continuing at ARF and at Colorado Dynamics Corp., which is the developer of the electro-viscous fluid.

Possible areas of application of the fluid include various types of mechanical transmission and control devices, brakes, transducers, valves and hydraulic equipment. Armour scientists are working on use of the fluid to replace the conventional speaker used in radio and tv receivers. By placing the amplifier output leads in the fluid, the fluid acts as a nondirectional speaker and bounces the sound waves off the walls of the room, from which the sound will emanate. An ultrasonic washing machine is also being investigated through which the vibrations of molecules will clean and even dry clothes in one machine.

Viscous Fluid Clutch

A small experimental clutch 2 inches in diameter and 2 inches long is currently being constructed at Colorado Dynamics. Limited information so far available indicates that a number of desirable characteristics are feasible in such a clutch. It should have extremely short response times and should provide 20 ounce-inches minimum energized torque with de-energized torque of less than 0.1 ounce-inch. Excitation power at 330 volts a-c should be less than 10 watts at any frequency from 30 to 1,000 cycles per second, and life of the clutch should be well in excess of 1,000 hours. For a service life limited to 1,000 hours, the clutch could be produced with the same external size and consuming the same amount of power but with an energized torque of 200 ounce-inches and a de-energized torque of less than 0.2 ounce-inch.

The clutch, according to its developers, may be less expensive when in production than existing electromagnetic clutches having comparable torque ratings. The capabilities of the electro-viscous fluid clutch could range from miniature instrument clutches to large industrial units capable of transmitting hundreds of horsepower.

The electro-viscous clutch has the same potential applications as conventional electromagnetic dry powder, fluid and friction-disk clutches. However, it is believed to be a more practical and economical solution to clutcher problems. Typical current applications of electromagnetic clutches include rotary indexing, positioning, rapid cycling and synchronization, torque and tension control, controlled acceleration, inching and jogging, and overload protection.

Materials Testing Sound Source

THE FRONT COVER. Sonic fatigue in materials will be investigated using exponential horn made by Illinois Institute of Technology. Goal is to produce sound intensity of 160 db in 8 inch tube at distance of 13 feet from 49-speaker array

Preventing Burnout
In Resistor Tests

By B. ERLICHMAN
Rego Park, New York

Using a Wheatstone bridge to measure resistances of low-wattage precision potentiometers and resistors can result in burning out these components. Measuring current supplied by the bridge may exceed the maximum current rating of the unknown resistance. However, the measuring current can be determined before such tests, avoiding
As of now Heinemann gives you a FIVE-YEAR guarantee. From here on out, every Heinemann circuit breaker, time-delay relay or overload relay you buy will carry a five-year "repair-or-replace" guarantee against manufacturing or material defects. Sound like a good deal? It is. Only you'll probably never have reason to take advantage of it. This, after all, is the real point of the five-year warranty. You might give that some thought the next time you're batting around the reliability question.
destruction of the component.

In the typical Wheatstone bridge in Fig. 1, current through the unknown resistance is \( I = \frac{E(R_1 + R_3)}{[R_1(R_a + R_v) + R_2(R_3 + R_v) + R_w]} \), where \( R_1 = R_a R_0/(R_a + R_v + R_0) + R_v \), \( R_2 = R_a R_0/(R_a + R_v + R_0) + R_v \), and \( R_0 = R_a R_0/(R_a + R_v + R_0) + R_v \).

With the galvanometer switch open, \( R_0 \) is infinite and \( R_v = R_v \) and \( R_r = R_v = R_v \).

**Practical Example**

Determining measuring current can be demonstrated using as an example 100 specially wound 0.3-watt, 1500-ohm potentiometers that are to be checked during incoming inspection. Resistance between the wiper arm and one end of the resistance winding is to be measured at 30-degree increments of shaft rotation. Maximum rated current of the test potentiometer is \( I = (0.3/1500)^1 = 0.001 \) ma.

With the bridge set to measure 30 ohms (zero degrees rotation of the potentiometer), \( R_0 = 9.9 \) ohms, \( R_v = 990 \) ohms, \( R_v/R_0 = 0.01 \), \( R_v = 250 \) ohms, \( R_0 = 10 \) ohms, \( R_v = 30 \) ohms, \( R_v = 3,000 \) ohms, \( R_0/R_v = 0.01 \) and \( E = 4.5 \) volts.

Substituting, \( R_v = 990(250)/1250 + 3000 = 3198 \) ohms, \( R_0 = 9.9(250)/1250 + 30 = 32 \) ohms and \( R_0 = 9.9(900)/1250 + 10 = 17.8 \) ohms. Thus \( I = 4.5(3198 + 32)/3.98(32 + 17.8) + 1024 = 90 \) ma. In this case, measuring current with the galvanometer switch open is also 90 ma.

If an attempt were made to measure resistance of a potentiometer at
Innovations in high density packaging have compressed the performance of large room-sized computers to "briefcase" dimensions at Univac. Example—a new Univac computer which measures just one cubic foot! Its thin film memory unit is an 8" cube, storing nearly 160,000 bits of memory. All other circuit components are commercially available items, ingeniously packaged and connected.

Univac continues to meet the challenge of the increasing demands for reliable miniaturization. Qualified personnel interested in both personal and professional advancement are invited to investigate the career opportunities now available on such programs.

**Immediate openings include:**

- **RESEARCH ENGINEERS**
  Attractive positions are now available for Research Engineers. These permanent assignments include circuit development work and the logical design of high speed computer elements.

- **TRANSISTOR CIRCUIT DESIGNERS**
- **ELECTRONIC PACKAGING ENGINEERS**
- **SERVO ENGINEERS**
- **ELECTROMECHANICAL ENGINEERS**
- **QUALITY CONTROL ENGINEERS**
- **PRODUCTION ENGINEERS**
- **RELIABILITY ENGINEERS**
- **STANDARDS & SPECIFICATIONS ENGINEERS**

Send resume of education and experience to:

**R. K. PATTERTON, DEPT. T-1**

**REMEMTTON RAND**

**UNIVAC**

**DIVISION OF SPERRY RAND CORPORATION**

2750 West Seventh St., St. Paul 15, Minn.

There are also immediate openings in all areas of digital computer development at our other laboratories. Inquiries should be addressed to:

F. E. NAGLE, Dept. T-1
REMEMTTON RAND UNIVAC
P.O. Box 506
Blue Bell, Pa.

D. CLAVERDUX, Dept. T-1
REMEMTTON RAND UNIVAC
Wilson Avenue
South Norwalk, Conn.

(An equal opportunities employer)

---

**Soft Landing System**

**Stems From Bionics**

INVESTIGATIONS of how the eye judges distances and speeds of approach has led to development of an electronic system that aids pilots in determining distance above the ground, speed of approach and attitude by adding a computer to the system, it could enable soft landings on the moon.

The bionics group at the GE Advanced Electronics Center, Light Military Electronics Dept., found that the eye judges distances by calculating density of the texture of a surface. The rate of change in the surface texture indicates speed of approach. The angle to the surface is determined by comparing the density of near texture to that farther away.

The pilot aid is a contact analog. A grid pattern on a tv screen moves toward the pilot, as though he were looking down a runway on which the grid had been painted. As distance to the ground decreases, the pattern gets larger. As distance to the ground increases, the squares in the pattern diminish in size.

The grid moves faster when the plane nears the ground and slower as altitude increases. Also, the pattern is stabilized relative to the ground so that the stable pattern gives and indication of attitude.

To make possible unmanned landings on the moon, a computer has been added. It can operate landing controls based on information from the contact analog.

---

**Labac,**

**a solid-state, variable, a-c power regulator . . .**

. . . can be used to smoothly proportion the a-c voltage from a 315-230-v. power line into a resistive load either by manually turning a knob . . .

... or in response to a low level control current from an external source.

A 1-ma. CONTROL CURRENT into Labac's 200-ohm input impedance effectively controls its full rated power—up to 40a. in some models. Thus, power gain up to 40 million is achieved. (Input can be matched to commonly used control currents, e.g. 1-5 ma.)

**NO VACUUM TUBES—NO MOVING PARTS**

LABAC uses two silicon controlled rectifiers pulsed by a magnetic amplifier for instantaneous (one cycle) power regulation by either manual or remote control.

**REPLACES** bulky saturable core reactors or thyristors.

**REPLACES** mechanical contractors in ON-OFF applications.

**REPLACES** motor-driven variable transformers in applications involving resistive loads.

**APPLICATIONS:** May be connected to set-point meters, recorder-controllers, or thermistor devices for closed loop temperature control to heaters, laboratory ovens, kilns, . . . for theatre light dimming, operation of sales demonstrators and experimental apparatus.

---

**R I RESEARCH**

**INCORPORATED**

P.O. BOX 6164L, MINNEAPOLIS 24, MINN.
CERAMIC CIRCUITS that will compete on an economic basis with conventional circuits and that offer equivalent technical performance are scheduled to be in pilot production at RCA by the end of this year. Described as solid ceramic circuits, the devices are compatible with the micromodule and some other approaches to system miniaturization.

Solid ceramic circuits can be visualized as a group of very thin micromodule wafers that have been stacked one on top of another and fused together. Actually, the first step in making these circuits is to print patterns for resistors, interconnections, and capacitors on ceramic sheets of a few mils thickness. These sheets, after being cut, punched, and stacked, are pressed and fired until they become a solid hermetically sealed unit.

A well at the top of the stack is used to mound active devices in pellet form. A circuit containing four resistors, a capacitor, a diode and a transistor measures 0.3 in. square by 30 mils thick. This size will be reduced further should experimental work of thin film transistors lead to deposition of active devices on the ceramic.

A wide range of resistors and capacitors can be incorporated in these devices. Resistors ranging from a few ohms to megohms have been fabricated. General duty capacitors with values up to 1 μf and precision capacitors with values to 2,500 pf have been developed. Voltage rating for the capacitors go to 50 volts. Dissipation factor for the precision capacitors (which have a temperature coefficient of 0 ± 60 ppm/°C) is less than 0.3 percent, for general purpose capacitors less than 1.5 percent.

Experiments with ferrites indicate inductors of a few millihenries and with fairly high Q's are possible. With reasonable values of inductance available, solid ceramic circuits can be used in communication and linear amplifier applications, in addition to digital circuits.

Since the components can be built to close tolerances, power dissipation can be decreased to increase reliability for a given parts density. According to RCA, when these components with narrow tolerances are combined with low-power semi-
conductors at low power levels they give more effective operation than now possible. Complex interconnection of parts can be obtained by using multiple interconnection wafers. One experimental unit has provisions for interconnecting 10 active devices in the well at the top of the present ceramic circuits.

The passive elements are self packing because they are fused into a hermetically sealed unit during manufacturing. Transistors and diodes, after being mounted in the top of the units, are protected by a metal hermetic seal.

Operating temperature range of solid ceramic units is limited by the semiconductor used for the active device. The passive components can be operated to 500 °C. Using gallium arsenide devices, unit operation to 350 °C is possible.

Because ceramic technology is not new, it's felt that no new breakthrough in materials is required to make ceramic circuitry practical. In addition, RCA officials feel the approach is flexible enough to incorporate future developments in such areas as active device and miniature memory cells.

Designers can breadboard circuits with conventional components and microelements made of the same basic material as the ceramic solid circuits prior to making pilot line production runs. Although compatible with the micromodule, the shape of the ceramic circuit is not fixed. Because the ceramic is bendable prior to firing, wrap around circuits are possible.

These new circuits are the result of work started four years ago to develop capacitors for the micromodule program. In experimental counter using two solid ceramic inverters has been operating since June, 1961. Present laboratory facilities at RCA can fire up to 1,000 units per hour.

Because many micromodule components (micro elements) are made from the same materials employed in the solid ceramic circuits, it is expected the new circuits will have reliability characteristics similar to those of microelements.—MMP

Sensors for the Middle Infrared Band

Germanium crystals, doped with gold, zinc, copper, cadmium and mercury, are processed in the Martin Marietta Infrared Laboratory, Baltimore. Materials will be used in infrared sensors for the difficult middle infrared radiation frequency band, and beyond. Devices detect heat emitted by moving objects in the form of infrared radiation.

Acoustical Components of Superior Quality

JAPAN PIEZO supplies 80% of Japan's crystal product requirements.

PHONOGRAPH MOTOR — DC
PM — 31-1
9V, 2,500RPM: No-load current, 35 mA; load current, 80 mA. Starting torque, 13 g-cm; load torque, 5 g-m. Size: 2.4 cm × 4.6 cm. Weight: 100 gm.

Write for detailed catalog on our complete line of acoustical products including pickups, cartridges, microphones, record players and many associated products.

JAPAN PIEZO
ELECTRIC CO., LTD.
Kami-renjaku, Mitaka, Tokyo, Japan

March 2, 1962
Scheduling Projects by Critical Path

By C. B. STEGNER
Weston Instruments Div.,
Daystrom Inc., Newark, N. J.

PLANNING AND CONTROL of development projects is as important to a company as production planning and quality assurance. Schedules of tooling, parts, production, and product availability are all in vain if the expected release date of the project from engineering is not attained.

The control of all the engineering work scheduled simultaneously is a complex problem requiring a comprehensive knowledge of the individual phases of each project and a means of determining inter-relationships between projects. The Gantt chart, Fig. 1, has often been used to indicate the time necessary to complete projects. The technique shows the duration of various phases and gives a certain amount of information with regard to the inter-relationship of the various jobs. It is not, however, immediately apparent from a Gantt chart which jobs follow any particular phase of the entire project.

Also, due to the simplicity of scheduling by the Gantt chart method, various phases of the project are often unintentionally overlooked and corrections are not projected with relation to the completion date. As a result, the fact that the project is behind schedule is sometimes not evident until shortly before the release date.

Critical path scheduling offers an improved method of planning projects. The technique provides a detailed analysis of the phases of the project with respect to function, time and manpower. Inter-relationships of the phases form a composite picture, showing when each phase of the project requires special attention.

At Weston, critical path scheduling has been employed to relate

FIG. 1—Gantt chart shows when a project should be completed

FIG. 2—Critical path is indicated by the dashed line. Any delay along this path delays the entire project. Conversely, any improvement over the estimates speeds the project, but only to where another path becomes critical
all phases of engineering projects, including design, prototype fabrication, quotations, purchase parts, testing, redesign, retesting and evaluation. The phases are sequentially connected in a network diagram and programmed through a node system.

Phase or task completion is designated by circles or nodes, as shown in Fig. 2. The rule for assigning node numbers is that each node is reached from a lower numbered node. Thus node 10 is reached from nodes 8 and 9. Jobs are defined by arrows whose direction indicate the proper sequence, with the estimated time for each job placed below the arrow.

Using the expected time for each job, all the paths through the network are calculated; the longest path is defined as the critical path and shorter ones are called slack paths. The critical path drawing, Fig. 2, illustrates a typical network of a recent development project for a ruggedized d-c panel meter. The critical path for the project is indicated by a dashed line.

In exercising control, attention is focused on those tasks that lie along the critical path. But since the other paths can be delayed, or estimates proved wrong, the diagram must be reviewed to determine whether the critical path has been changed. For example, in Fig. 2, ten weeks was estimated between nodes 4 and 16, which is along the critical path. From node 4 to 19, a 9 week period was allocated; if the time between 4 and 19 extended beyond 10 weeks, this would become the critical path. The drawing is revised as necessary and sometimes is redrawn.

When a number of projects are scheduled, the determination of which path is critical is sometimes not too apparent. When this happens, a computer can be programmed to solve the problem. Programming initially involves tabulating the phases of the projects for punched cards in the following manner:

<table>
<thead>
<tr>
<th>From Node</th>
<th>To Node</th>
<th>Duration (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>002</td>
<td>001</td>
</tr>
<tr>
<td>002</td>
<td>003</td>
<td>003</td>
</tr>
<tr>
<td>003</td>
<td>004</td>
<td>001</td>
</tr>
<tr>
<td>004</td>
<td>011</td>
<td>003</td>
</tr>
<tr>
<td>004</td>
<td>005</td>
<td>003</td>
</tr>
<tr>
<td>004</td>
<td>009</td>
<td>001</td>
</tr>
</tbody>
</table>

Program cards are then used to convert the punch card information into computer language. Readout will provide the following information: earliest starting date; latest starting date (latest finishing time — shortest duration); latest finishing date (earliest starting date + shortest duration); latest finishing date; total float or amount of delay possible between phases without affecting completion date; free float, or the amount of delay of a phase without affecting the earliest starting date of subsequent phases.

Several node points in Fig. 2 are natural project review points; these occur primarily where cost estimates have become reasonably firm for particular phases. If cost estimates are found to be greatly out of line, for example, a general review by management might lead to project cancellation before too great an investment has been made.

Slanted and curved lines are used in making the drawing for convenience only; they have no other significance. From node 29 to node 38, only one critical path is shown on the drawing, although 3 paths are actually critical.

Automatic Diode Test

Diode testers and classifiers are designed to measure and sort diodes at temperatures up to 200 C. Testing is around 3,000 units per hour. Three different models have been made and the manufacturer, Transistor Automation Corp., Cambridge, Mass., states that the machines can be adapted to test other types of axial lead components.
**DESIGN AND APPLICATION**

**Strain Gage Amplifier**

**USES VARIABLE-GAIN CIRCUIT**

RECENTLY introduced by Natel Engineering Co., Inc., 15022 Strathern St., Van Nuys, California, is the model 9036 strain gage amplifier. The transistorized unit has a 0 to 5 v d-c output which can be zero-shifted for telemetering applications. It operates from zero to 2.5, 50, or 500 mv with the gain being controlled remotely or internally set. The unit provides 5 v sine wave excitation signal to a 300-ohm Wheatstone bridge circuit which is completed by the external transducer. The sealed unit, shown in the sketch, includes a subcarrier oscillator, negative-feedback amplifier and a phase-sensitive demodulator. Gain is adjustable over 20:1 dynamic range and the frequency response is ±3 percent to 600 cps. The amplifier is critically damped and linearity is ±1 percent over the operating temperatures of -55 C to +71 C.

**CIRCLE 301 ON READER SERVICE CARD**

**RFI Measurement Meter**

**FROM 150 KC TO 400 MC**

RECENTLY announced by Interference Testing and Research Laboratory, Inc., 150 Causeway Street, Boston 14, Massachusetts, is the model BYD-552 Radio Interference Measurement Meter. Designed specifically for optimum pulse reception with associated high image rejection and low-noise figure, the device features plug-in head tuning between 150 Kc and 50 Mc with tangential sensitivity of 0.2 μv, between 50 Mc and 400 Mc the tangential sensitivity is 2 μv. Another head, tuning to 1,000 Mc, is under development. The i-f amplifiers are six synchronously-tuned stages with agc compensated to eliminate center frequency changes and bandwidth as agc voltage varies. Each amplifier has 10° gain into a 50-ohm load, noise figure is less than 4 db and output dynamic range is over 6 v. I-f output is applied to weighting circuits with accurately controlled charge and discharge time constants. Audio output can be derived from metering circuits. An impulse noise generator having a flat spectral response over entire receiver range permits gain calibration at any frequency. Step attenuation is by a 50-ohm input circuit and the meter can measure between 1 μv and 1 v. The meter has a low-impedance input and can be used as a two-terminal voltmeter for measurement of r-f.

**CIRCLE 302 ON READER SERVICE CARD**

**NOR Logic Circuit**

**IN WELDED TO-5 CASE**

MANUFACTURED by Kearfott Semiconductor Corp., 437 Cherry Street, West Newton, Massachusetts, this pnp germanium NOR Logic Micro Function Circuit combines the functions of five individual components in a single lightweight package. Designed for application in digital computers and other data handling systems, the device features delay time of 60 nsec, rise time of 140 nsec and storage time of 175 nsec all with a 1 Mc pulse repetition rate, 50-percent duty cycle. The fall time is 140 nsec and the input signal for A and B input is -10 v.

**CIRCLE 303 ON READER SERVICE CARD**

**Sync Generator**

**FOR C-C TV SYSTEMS**

COHU ELECTRONICS, INC., 5725 Kearny Villa Road, San Diego 12,
New
Corning TY capacitor

gives you glass stability in a
new package

Check the TY from every angle against what you need in a printed circuit capacitor:

High stability—You get the same type basic capacitive element of fused glass and foil that we put in the hi rel Minuteman and all other Corning capacitors.

Small size—The "T" in TY is for tiny. See the table.

No shorts—The case and potting compound prevent inter-component, wire, or chassis short circuits.

Easy mounting—Parallel leads are symmetrical with the case, spaced uniformly on 1/16" grids. The standard gold-flashed Dumet leads are welded to the conductive plates for greater strength, and are easier for you to weld or solder. No "pants" on the TY—it sits flat on your board—and its dimensions are stable.

Try the TY06 now, with a capacitance range of 1 to 560 pf, and the TY07, with a range of 560 to 1000 pf. These values hold at 300 volts from -55°C to +125°C with no derating. Corning

TY capacitors retain the electrical performance inherent in glass capacitor construction as evidenced by their stability, life performance, and TC.

Check these TY dimensions for your application:

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>W</th>
<th>S</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>TY06</td>
<td>.300&quot;</td>
<td>.200&quot;</td>
<td>.200&quot;</td>
<td>.115&quot;</td>
</tr>
<tr>
<td>TY07</td>
<td>.300&quot;</td>
<td>.300&quot;</td>
<td>.200&quot;</td>
<td>.115&quot;</td>
</tr>
</tbody>
</table>

For more information, write Corning Glass Works, 539 High St., Bradford, Pa.

CORNING
Electronic Components

March 2, 1962

CIRCLE 59 ON READER SERVICE CARD 59
For years, Lapp has been a major supplier of stand-off insulators to radio, television and electronics industries. Wide knowledge of electrical porcelain application, combined with excellent engineering and production facilities, makes possible design and manufacture of units to almost any performance specification. The insulators shown on this page are representative of catalog items—usually available from stock—and certain examples of special stand-offs. The ceramic used is the same porcelain and steatite of which larger Lapp radio and transmission insulators are made. Hardware is brass or bronze; brush nickel plating is standard.

Write for Bulletin 301 with complete description and specification data. Lapp Insulator Co., Inc., Radio Specialties Division, 189 Sumner St., Le Roy, N. Y.
PRODUCT BRIEFS

STATIC CONVERTER high voltage. Jordan Electronics, 121 S. Palm Ave., Alhambra, Calif. (308)


RARE EARTH FLUORIDES 15 types. Kleber Laboratories, Inc., 2530 N. Ontario St., Burbank, Calif. (310)


TRANSISTORIZED DIGITAL CLOCK two models. Non-Linear Systems, Inc., Del Mar, Calif. (312)

TOROID INDUCTORS hermetically sealed. Microtran Co., Inc., Valley Stream, N. Y. (313)

INDUSTRIAL LAMINATES six new Textolite types. General Electric Co., Coshocton, O. (314)

TEST EQUIPMENT for microwave industry. Westinghouse Electronic Tube Division, Box 284, Elmira, N. Y. (315)

SILICON RECTIFIERS for close-quarter mounting. Universal Rectifier Corp., 2055 Pontius Ave., Los Angeles 25, Calif. (316)

PULSE GENERATOR wide operating range. Lavoie Laboratories, Inc., Morganville, N. J. (317)

REGULATED POWER SUPPLIES portable. 100 amp. Chatham Electronics Division of Tung-Sol Electric Inc., Livingston, N. J. (318)

TEMPERATURE SENSORS platinum resistance. Trum-Sonic's, Inc., Box 328, Lexington 73, Mass. (319)


THERMAL TRANSFER METER rapid switching time. Tensor Electric Development Co., Inc., 1873 Eastern Pkway., Brooklyn, N. Y. (321)

MODULAR POWER SUPPLIES for klystrons. Micro-Power 20-21 Steinway St., L. I. C. 5, N. Y. (322)


THINK DEEP

You're looking at the natural habitat of the PI tape recorder. Beneath the surface, you'll find PI tape machines at work in conventional and nuclear submarines, in exploration of the ocean floor, in ASW sounding and detection buoys, and in oceanographic research. You'll find them wherever there's an exceptional premium on reliability—cruising under the polar ice cap, probing the darkest depths aboard the Trieste bathyscaph, handling important Polaris telemetry and computer assignments.

You needn't go very deep to discover why PI recorders need very little of man's most valuable undersea commodity—space. They pack far more performance into far less space than conventional recorders, require less power, generate less heat, need less maintenance. Their rugged, lightweight, all-solid-state design offers simpler installation, easier mobility.

PI recorders aren't all beneath the surface. They're veterans of orbital satellite flight, and are familiar equipment in hundreds of laboratory, scientific, and industrial applications. They're made in numerous configurations, for analog or digital recording on 1 to 16 or more tracks, in standard speed ranges push-button controlled from 15/16 to 60 ips, with frequency response from 0 to over 200 kc.

Whether your recording applications are under the sea or above it, we'd like to demonstrate PI's approach-in-depth. And whether you are presently using strip charts, punched tape, or pad and pencil to gather data, you may find that upgrading to magnetic tape not only provides increased flexibility and reliability, it may also cost less for itself through savings in time and money. Ask your PI representative for our current brochure, or write direct.

PRECISION INSTRUMENT COMPANY
1011 Commercial Street • San Carlos • California
Phone LYT 1-4441 • TWX: SCAR BEL 30
Representatives in principal cities throughout the world

PI invites inquiries from design, application, and sales engineers.
Literature of the Week

**DIODE ENCLOSES** National Transistor Mfg., Inc., 500 Broadway, Lawrence, Mass., has available a bulletin entitled "Reliable Glass Enclosures for Diodes." (324)

**STATOR YOKES** Syntronic Instruments, Inc., 100 Industrial Road, Addison, Ill. Catalog covers stator type magnetic deflection yokes for 11" neck diameter CRT's in transistor or tube circuits. (325)

**ELECTRON TUBES** Litton Industries, 960 Industrial Road, San Carlos, Calif. A 24-page 1962 Electron Tube Condensed Catalog features 65 new products. (326)

**TIME DELAY SWITCH** Leesona Moos Laboratories, 90-28 Van Wyck Expressway, Jamaica 18, N. Y. Data sheet describes model 5419, which provides a time delay of from 2 to 12 hr between actuation and switch operation. (327)

**SILICON TRANSISTORS** Silicon Transistor Corp., Carle Place, N.Y. The 2N2034 series of miniaturized high power silicon transistors are discussed in a bulletin. (328)

**PLASTIC FOLDER** Liquid Nitrogen Processing Corp., Malvern, Pa. Six-page bulletin describes use of plastics as molding compounds, lubricants and coatings. (329)

**DELAY LINE DESIGN DATA** Allen Avionics, Inc., 255 E. 2nd St., Mineola, N.Y. A 10-page technical booklet describes how to design a delay line that can be delivered in 24 hours. (330)

**WIREWOUND RESISTORS** Aerovox Corp., 1110 Chestnut St., Burbank, Calif. Bulletin presents specifications on Hi-Q microminiature Aerohm 600 high-reliability wire-wound resistors. (331)

**TRANSISTOR TRANSFORMERS** Stancor Electronics, Inc., 3501 Addison St., Chicago 18, Ill. Three transistor transformers—a driver, an output, and a power unit—are described in bulletin 606. (332)

**INSULATING MATERIAL** Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. Bulletin No. 43 contains descriptions and...
NEW opportunities in MISSILE ENGINEERING for:

PHYSICISTS
MECHANICAL &
ELECTRICAL
DESIGN ENGINEERS
SYSTEMS
ENGINEERS

The Hughes Tucson Engineering Laboratory is again expanding its scope of operations. Challenging new opportunities have been created with state of the art advances in missile & space engineering.

The scope of engineering effort at Hughes Tucson includes operational as well as advanced missiles and subsystem designs for space programs.

Specific areas of immediate needs include:

- Circuit Design
- Transistor Techniques
- Electromechanical Design
- Infrared Theory
- Microwave Antenna Design
- Miniaturization
- Hydraulics
- Controls

Engineers and Physicists who like to work on important problems will find this dynamic organization an ideal environment in which to exercise creative talents.

If your goals include — work on vital projects with recognized leaders in the field — to live in the heart of the year-round, healthful southwestern vacation land — to continue advanced studies (at the University of Arizona) — and to contribute to our Nation’s Defense while securing your own future — send your resume to MR. W. A. BARNES.

NEW! HIGH CAPACITY!

TWO-STAGE WELCH
“DUO-SEAL”
VACUUM PUMP No. 1398
50 CFM (1400 LITERS/MINUTE)

1 x 10⁻⁴ mm Hg
(0.1 MICRONS)

The Youngest, But Largest
Member of the Welch family of “Duo-Seal” oil sealed rotary vacuum pumps makes its appearance as the No. 1398. This new pump offers very high capacity and excellent ultimate vacuum characteristics with no sacrifice of long life, low maintenance, freedom from vibration and minimum noise level. These features have long made Welch “Duo-Seal” pumps the most widely used of all rotary vacuum pumps. 1398’s, like all Welch “Duo-Seal” Pumps, are thoroughly run-in at the factory and tested until they exceed their vacuum guarantee.

The new 1398 is highly recommended for all industrial and laboratory applications requiring high pumping capacities and low pressures. Typical uses are electron tube evacuation, vacuum distillation, dehydration, reduction, sublimation, metalizing, metal processing, leak detection, hermetic sealing and back-filling, impregnation and general scientific studies.

IMPORTANT FEATURES:

- High pumping speed — 50 CFM (1400 liters/minute)
- Low ultimate pressure — 1 x 10⁻⁴ mm Hg (McLeod)
- Quiet, vibration-free operation
- Compact, rugged design
- Air-cooled
- Vented Exhaust Valve
- Flanged, O-Ring-Sealed Intake Port
- Totally Enclosed Belt Guard
- Air Intake Screen
- Exhaust Filter
- Trouble-free, low maintenance

WELCH “DUO-SEAL” PUMPS ARE CARRIED IN STOCK BY AUTHORIZED DEALERS.

Welch Duo-Seal Vacuum Pumps are manufactured in wide variety of capacities and ultimate vacuum characteristics. They range in capacities from 21 to 1400 liters/minute and ultimates from 2 x 10⁻⁴ mm Hg down to 1 x 10⁻⁶ mm Rg.

WRITE FOR DUO-SEAL CATALOG No. 1398 for full description and prices.

1507 N. Sedgwick St. • Chicago 10, Ill.

CIRCLE 63 ON READER SERVICE CARD 63

March 2, 1962

A-C MOTORS Kearfott Division, General Precision, Inc., Little Falls, N J. Four-page folder completely describes a line of general purpose a-c motors. (334)

DELAY LINES Kenyon Transformer Co., Inc., 1057 Summit Ave., Jersey City, N J. Catalog D-621 covers a wide line of delay lines with time delays from 1 nsec to 5,000 usec. (335)

SERVO AMPLIFIER Diehl Mfg. Co., Findorne Plant, Somerville, N J., offers catalog sheets describing its 75-w vacuum tube servo amplifier and associated solid state power supply. (336)

POTTING COMPOUND Mereco Products, 530 Wellington Ave., Cranston 10, R. I. Bulletin describes the use of Mereco No. 4583, an epoxy resin compound that utilizes an intrinsic dispersion method, which produces a permanently suspended filler/resin system. (337)

L-F OSCILLATORS Bulova Watch Co., Inc., Electronics Div., 40-10 61st St., Woodside 77, N Y. Catalog sheet covers a number of l-f crystal-controlled oscillators. (338)

ROTARY SWITCHES Markite Corp., 155 Waverly Place, New York 14, N Y. Brochure covers conductive plastic rotary switches for controls and instrumentation. (339)

TEST PORT STATION Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Two-page bulletin describes the 24-025A test port station. (340)

SOLID STATE COMPONENT Diodes, Inc., 7303 Canoga Ave., Canoga Park, Calif. A one-page bulletin describes the Stabistor which is used in transistorized or tube circuits where a high current non-linear resistor is needed. (311)

SERVOMOTOR Helipot Division of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. Data sheet describes a 26-V, 100-cycle size 5 servomotor. (342)

IGNITRONS General Electric Co., Schenectady 5, N. Y. Bulletin PT-57 contains complete information on ignitrons in capacitor discharge and crowbar service. To obtain a copy request on company letterhead.
Lambda Settles in New Plant

LAMBDA ELECTRONICS CORP. recently opened a 76,000-sq-ft air-conditioned plant on a 14-acre site in Huntington, L. I., N. Y., as part of a program of expansion to meet increased demand for its products.

Capable of tripling previous production capacity and providing ample space for increased product R&D, the one-story plant accommodates assembly-line production, transformer manufacturing, sheet metal fabrication and design and prototype development.

Lambda power supplies are used in the Tiros and Mercury programs, Sage and digital computer intervention and display systems, and other major projects. Full production of seven new solid-state regulated power supply models is underway.

Matcovich Moves Up

At Bulova Labs

PHILIP A. MATCOVICH has been named to a new position as director of manufacturing for the Bulova Research and Development Laboratories division of Bulova Watch Co., Inc., Woodside, N. Y.

Before this new assignment Matcovich has been chief design engineer.

Continental Connector

Expands Facilities

CONTINENTAL CONNECTOR CORP., manufacturer of precision electronic connectors for commercial and military applications, has purchased a 23,000 sq ft building adjoining its main plant in Woodside, N. Y., as part of an expansion program.

The company recently terminated its exclusive sales agreement with DeJur-Amsco Corp. for the sale of Continental connectors, and will now handle all sales activities through its own direct sales force and manufacturers' reps throughout the country. The firm's sales department will occupy a portion of the new building.

Arrance Advances

At Centralab

FRANK C. ARRANCE has been promoted to general manager, technical ceramics department of Centralab, The Electronics Div. of Globe-Union Inc., Milwaukee, Wis.

Arrance will be in charge of R&D, production engineering and manufacturing engineering. He will also be responsible for the manufacturing of all steatite and high alumina products.

Texas Instruments

Renames Division

TEXAS INSTRUMENTS, INC., Dallas, Texas, has changed the name of its Geosciences Division to Science Services Division to reflect the broadened scope of its activities, president P. E. Haggerty recently announced.

The division's activities now include geophysical exploration, earth sciences research and development, and scientific data collection, data processing and data interpretation.

Its organization remains unchanged, Haggerty said, with vice president Robert C. Dunlap, Jr., as division general manager.

Myers Accepts Post

At Martin Marietta

APPOINTMENT of Peter B. Myers as manager of a new research and advanced technology department at Martin Marietta Electronic Systems & Products division, Baltimore, Md., is announced.

Myers formerly was staff scientist in the semiconductor products division of Motorola.

Electronics Company

Opens in Dallas

SCIENTIFIC DALLAS, INC., recently started operations in Dallas, Texas, according to R. E. Cormier, presi-
How to File a Card in

For the busy scientist, engineer, teacher, busi-
nessman or student who has to keep basic infor-
mation on file for use in a variety of capacities.
The Genie PMU (Portable Memory Unit) is spe-
cially designed.

Information retrieval systems for small card files (1000 to 10,000 cards) with absolute
convenience, economy and out of the question for
small budgets is the GENIE PMU. It is a low cost infor-
mation retrieval system that is as fast or faster
than manual filing systems.

Low initial cost, only $39.95 for the basic kit
and two hundred cards, puncher, sorting rods, and
ranging instructions, low maintenance with new
your costs running $4.00 per year or $20.00 per 100.
It is economical with ready access to thousands of
information. No electrical switches or mechanical
pushers are needed. No posts to slow up operation.
Sorting is done easily and is automatically performed.
Sorting rates are conservatively one per second
and this is for maximum sorting at least 25 per
minute.

Information is stored on the cards by machin-
ing alphabetical holes around the edge of the card.
These holes have no previous knowledge of filing
and can thus be used in any categories as is necessary.
You can prepare an abstract on the card or
usually made on small articles, invoices, etc.
and each card is fited at random and will
automatically appear during sorts for the various
categories. The possibilities of the PMU informa-
tion retrieval are unlimited and enable the
mail to medium size information file to commers-
ialize with extremely expensive electronic
sorting devices. It serves as a useful adjunct to
many important information retrieval
functions.

Information retrieval system is innumerable products de-
cided. The GENIE PMU contains a number
hand punch, opening hole, 25 cards and is only
$4.50. Add the punch and tangents to the
United States, $1.00 abroad in NYC and $2.00
elsewhere. Additional cards are 4.00 for 250.

Make check or money order to Dept. E-32A
or telephone 6-3372
OLIVER GARFIELD CO., INC.
17 St Marks Place
New York 3, N. Y.

CIRCLE 210 ON READER SERVICE CARD

Operational guidance for buyers

That's what your 1961 electronics
Buyers' Guide and Reference Issue

gives you ... this year more than
ever before.

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

Temco Promotes
Campbell

AARON R. CAMPBELL has been pro-
moted to manufacturing manager of
Temco Electronics division of
Temco Electronics & Missiles Co.,
subsidiary of Ling-Temco-Vought,
Inc.

He will direct all of the division's
manufacturing operations in
Garland, Alpine and Grand Prairie,
Texas. His chief offices will be at
the Garland headquarters of the
division.

PEOPLE IN BRIEF

Bruce A. Winner is new v-p and
g-m of Welton V. Johnson Engi-
gening Co., Inc. C. B. Lou, ex-
North American Autonetics, ap-
pointed to engineering staff of
California Computer Products,
Inc. Edward T. Butler, senior v-p
of Electro Instruments, Inc., is
named g-m of its San Diego sub-
sidiary. Jack D. Rowley, previously
with Melabs, joins Pulse Engine-
nering Inc. as mgr. of quality
assurance. Warren T. O'Brien, from
General Electric to Philco Corp.
as mgr. of operations of the
Communications and Weapons div.
Kenneth M. Miller, formerly
with Daystrom, Inc., new g-m of Singer-
Bridgeport. Walter A. Schwalm
moves up at TELvision Laborator-
ies, Inc., to president and chair-
man of the board. Guy E. Inshaw
leaves Northrop Corp. to take post
of senior staff engineer and head
up the western engineering office
of Dunn Engineering Corp. Bruce
Emonson is elevated from v-p to
president of TelePrompter of
Canada Ltd. Uno Hedin, previ-
ously with Allied Control Co.,
appointed project engineer for
Washash Magnetics, Inc. David Zeheb
advances to chief engineer of elec-
tronics at Weston Instruments
div., Daystrom, Inc. William H.
Reinholtz, ex-Librascope and Mar-
chant Research, joins Datex Corp.
as product engineering mgr.
ATTENTION:
ENGINEERS, SCIENTISTS, PHYSICISTS

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

STRICTLY CONFIDENTIAL

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

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. Please print clearly.

(Continued on opposite page)

#3262

### FIELDS OF EXPERIENCE (Please Check)

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

### CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

<table>
<thead>
<tr>
<th>RESEARCH (pure, fundamental, basic)</th>
<th>Technical Experience</th>
<th>Supervisory Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESEARCH (Applied)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEMS (New Concepts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEVELOPMENT (Model)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DESIGN (Product)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MANUFACTURING (Product)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIELD (Service)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SALES (Proposals &amp; Products)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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

The advertisements in this section include all employment opportunities—executive, managerial, technical, selling, office, skilled, manual, etc. Look in the forward section of the magazine for additional Employment Opportunities advertising.

RATES

DISPLAYED: The advertising rate is $8.17 per inch for all advertisements appearing on or after January 1, 1962. (Dealers are subject to published contracts.)

An advertising inch is measured by verticals on a 1/4-inch column—30 inches equals 1 line.

Box numbers—use 1 line.

Discount of 10% if full payment is made in advance for a consecutive 3 issues.

Not subject to Agency Commission.

ELECTRONIC DEVELOPMENT ENGINEERS

Immediate openings for EEs experienced in original semiconductor circuit and component design. Positions require problem definition, system design and prototype evaluation. Salary open.

See openings to Mr. J. E. McShane.

UNION SWITCH & SIGNAL

Division of NABCO

Pittsburgh 18, Pa.

SELLING OPPORTUNITY WANTED


MANUFACTURERS’ REPRESENTATIVES

IN THE ELECTRONIC INDUSTRY

SAMUEL K. MACDONALD, INC.

1531 SPRUCE STREET, PHILA. 2, PA.

Territory: Pennsylvania & New Jersey New York Maryland Virginia & West Virginia District of Columbia

Sikorsky Aircraft

DIVISION OF UNITED AIRCRAFT CORP.

STRATFORD, CONNECTICUT

An Equal Opportunity Employer

FOR MORE INFORMATION about Classified Advertising contact the McGraw-Hill nearest you.

ATLANTA, 9 D. Hicks
1375 Peachtree St., N.E.
Trinity 5-0523

BOSTON, 10 Shouvilin
Capleey Square
Congress 2-1160

CHICAGO, 11 W. J. Higgins
645 N. Michigan Avenue
MOhawk 4-5800

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

DALLAS, 7 B. Wood
1712 Commerce St., Vaughn Bldg.
Riverside 7-5117

DENVER, 2
1700 Broadway — Tower Bldg.
Alpine 5-2981

DETROIT, 26 Wm. H. Ginder, Jr.
856 Penobscot Bldg.
WOodward 2-1793

HOUSTON, 25 J. Page
Prudential Bldg., Holcombe Blvd.
JACKson 6-1281

LOS ANGELES, 17 Wm. C. Gries
1125 W. 6th Street
HUnley 2-5450

NEW YORK, 36 H. T. Buchanan - T. W. Bender
500 Fifth Avenue
OXford 5-5959

PHILADELPHIA, 3 Wm. B. Sullivan - F. W. McCarthy
Six Penn Center Plaza
LCOust 8-4330

PITTSBURGH, 22
4 Gateway Center
EExpres 1-1314

ST. LOUIS, 8
7751 Carondelet Avenue
PArkview 5-7285

SAN FRANCISCO, 11 J. A. Hartley
255 California Street
DOuglas 2-4600

March 2, 1962
INDEX TO ADVERTISERS

A-M-E ........................................... 65
Adax Instruments Inc. .................. 27
Ameco ........................................... 32
Beckman Instruments, Inc. .......... 24
Berkeley Division ....................... 22
Billing Electric Co. ..................... 26
Budelman ........................................ 39
Burnell & Co., Inc. ...................... 3rd cover
Clarex Corp. .................................... 37
Cohn Corp., Simonds .................... 28
Corning Electronic Components ...... 59
Electrodynamic Instrument .......... 27
Corporation Emerson & Cuming Inc. ............................................. 27
Fairchild Semiconductor Corp. ...... 6
Farnell Metallurgical Corp. .......... 18
Garfield Co., Inc., Oliver .......... 25
Globe Dynamics Electronics ........ 16
Gould National Batteries Inc. ...... 39
Heinemann Electric Co. ............... 49
Hughes Aircraft Co., Tucson Engi- 
neering Laboratory ...................... 63
Institute of Radio Engineers ... 28, 50, 62
Janel Corp. ......................................... 27
Japan Precision Electric Co., Ltd. 55
Jerrold Electronics Corp. ............. 4
Lapp Insulator Co., Inc. ..........  68
Machlett Laboratories, Inc. ......... 25
Magnetic Metals Company .......... 12
Materials Research Corp. .......... 16
Nytronics Inc. ................................... 27
Philco Corporation ..................... 30
Precision Instrument Co. ............ 61
Radio Corporation of America ... 4th cover
Ramming Rand Environ ................ 53
Research Inc. ................................. 53
Space Technology Laboratories, Inc. 15
Sprague Electric Co. .................. 24
Texas Instruments Incorporated . 17
Transistor Products Division .......... 47
Torrington Mfg. Co. ................. 17
United Transformer Corp. .......... 3rd cover
Vitronix, Inc. ................................. 5
Welch Scientific Co., The .......... 63

MANUFACTURERS’ REPRESENTATIVES
MacDonald Inc., Samuel K. ....... 67
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES ....... 67
INDEX TO CLASSIFIED ADVERTISERS

Silkorsky Aircraft ......................... 67
Div. of United Aircraft Corp. ........ 67
Union Switch & Signal, Div. of 
WABCO ........................................... 67

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

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

INDEX TO ADVERTISERS

NEW YORK (36):
Donald H. Miller, Henry M. Shaw,
George F. Weyner
505 Fifth Avenue, OXFORD 3-5959

BOSTON (16):
William S. Hodgkinson, Donald R. Furth
McGraw-Hill Building, Copely Square,
Cone 2-1160

PHILADELPHIA (3):
Warren H. Gardner, William J. Boyle
6 Penn Center Plaza, LOCUST 8-4330

CHICAGO (11):
Harvey W. Weneske, Robert M. Dennead
455 North Michigan Avenue, Mohawk 4-3500

CLEVELAND (13):
Paul T. Fegley
55 Public Square, Superior 1-7000

SAN FRANCISCO (11):
R. C. Alcain
255 California Street, Douglas 2-6600

LOS ANGELES (17):
Peter E. Conaway, Ashley F. Hartman
1125 W. 6th St., Huntley 2-3450

DENVER (2):
J. W. Popyen
Tower Bldg., 1700 Broadway,
Alpine 5-2981

ATLANTA (9):
Michael H. Miller, Robert C. Johnson
1375 Peachtree St. N.E., Trinity 5-0253

HOUSTON (25):
Joseph C. Page, Jr.
Prudential Bldg., Halcomb Blvd.,
Jackson 6-1281

DALLAS (1):
Frank Le Beau
The Vought Bldg., 2172 Commerce St.
Riverside 7-9721

LONDON W1:
Dennis McDonald
34 Dover St.

FRANKFURT/Main:
Stanley K. Kimes
85 Westendstrasse

GENEVA:
Michael R. Zeynel
2 Place du Port

"Headquarters for Business Information"

McGraw-Hill Technical and Business Publications

American Machinist-Metalworking Manufacturing
Aviation Week and Space
Technology
Business Week
Chemical Engineering
Chemical Week
Coal Age
Construction Methods and Equipment
Construction Daily
Control Engineering
Electrical Construction
and Maintenance
Electrical Merchandising Week
Electrical Wholesaling
Electrical West

Product Engineering
Electrical World
Electronics
Engineering Digest
Engineering and Mining Journal
E & Mj Metal and Mineral
Markets
Engineering News-Record
Factory
Fleet Owner
Industrial Distribution
National Petroleum News
Nucieconomics
Nucleonics Week
Platt’s Oilgram News
Platt’s Oilgram Price Service
Power

Overseas only:
Automobile International
(English, Spanish)
International Construction (Spanish)
International Management
(English, Spanish, Portuguese)

Available by subscription only — to qualified persons actively engaged in the field of the publica-
tion. For subscription rates and information describing the editorial coverage of any of the
above publications, write to: Subscription Manager, Circulation Department, McGraw-Hill Pub-
lishing Company, 330 West 42nd Street, New York 36, N. Y.
Imagine having access to an unlimited inventory of waveforms of every conceivable shape; some so radical that they could previously only be described graphically and attained only through complex active element circuitry.

Furthering the state of the art to suit the complexities of modern electronic systems, Burnell is now prepared to design networks through the use of the Fourth Dimension of Time Domain Synthesis.

These passive networks may be designed to produce low ringing, constant delay filters, or to produce a functional wave shaping characteristic with or without specific attenuation requirements. Examples of a low pass characteristic pulse forming network are shown above, where the networks precisely resolve the constituents of a time function to produce a variety of wave forms, with unique properties now available as a tool for new and imaginative applications.

Break the chains of conventional design, unnecessarily complex circuitry, and wasted space by contacting your Burnell sales engineer today, with your wave form application problems.
Higher Circuit Performance
Lower Component Cost

Major Manufacturers of TV, Audio and Hi-Fi Equipment Are Switching to NOVAR... what about you?

8 LEADING MANUFACTURERS HAVE ALREADY USED HALF A MILLION NOVAR TUBES IN TV, AUDIO AND HIGH-FIDELITY EQUIPMENT

14 MORE LEADING MANUFACTURERS WILL USE NOVAR TUBES IN THEIR NEW SET MODELS

Why? Because the 9-pin, integral-base novar design offers better performance at lower cost than comparable tubes, regardless of base configuration, previously manufactured with octal base and T-9 or T-12 envelopes. With so many important manufacturers swinging over to low-cost, high-performance novar, you won't want to miss out on the unique advantages of novar design, namely:

Larger internal lead diameter—provides strong cage support and high thermal conductivity for very effective heat dissipation.

Wider spacing between pins (0.172")—minimizes the possibility of voltage breakdown; hence greater reliability.

Pin length of 0.335"—assures firm retention of tube in socket.

Pin circle diameter of 0.687"—large enough to permit use of both T-9 and T-12 envelopes.

RCA “Dark Heater”—operating about 350°K below the temperature of conventional heaters, “Dark Heater” assures longer tube life and improved stability and reliability.

These novar tube types are commercially available:

For TV damper service: RCA-6AY3, 12AY3, 17AY3; RCA-6BH3, 17BH3, and 22BH3; RCA-6DW4 (color and black-and-white).

For TV horizontal-deflection amplifier service: RCA-6GT5, 12GT5 and 17GT5; RCA-6GJ5, 12GJ5 and 17GJ5.

For use in hi-fi amplifiers: RCA-7868.

For rectifier use in TV sets, hi-fi audio equipment and radio power supplies: RCA-5BC3.

For additional information on any novar tube type, call your RCA Field Representative or write Commercial Engineering, RCA Electron Tube Division, Section C-19-DE-1, Harrison, N.J.

The Most Trusted Name in Electronics