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ANALOG CONVERTERS
Give nanosecond resolution, p 55

HIGHLY STABLE 400-CPS SOURCE
Uses magnetic multiplier, p 58

SPECIAL
Latest innovations in CONSUMER ELECTRONICS
SPECIFICATIONS

SWEEP GENERATOR
Internal Sweep: 21 ranges, 1 μsec/cm to 5 sec/cm, accuracy within ±3%. Vernier extends slowest sweep to at least 12.5 sec/cm
Magnification: X2, X5, X10, X20, X50, accuracy within ±5% of sweep rates not exceeding a maximum rate of 0.2 μsec/cm
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Trigger Point Selection: From +10 volts to —10 volts, positive or negative slope of external signal or internally from any point of the vertical waveform presented on screen. Internal, 0.5 cm or more vertical deflection. External, dc or ac coupled 15 volts p-p or more
Single Sweep: Front panel switch

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Bandwidth: DC Coupled: dc to 500 KC
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AC Coupled (in amplifiers for trace stabilization): 25 cps to 500 KC at 0.2 mv/cm sensitivity. Lower cut-off is reduced proportional to sensitivity down to 20 mv/cm where it is 0.25 cps
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External Calibrator: Approx. 350 cps, 500 mv ±2%, front panel input
Cathode Ray Tube: 10 x 10 cm internal graticule type, P31 phosphor standard, P-2, P-7 and P-11 available, same cost
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One instrument for rack and bench

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low-level signals directly

with the new hp

130C 500 KC Oscilloscope!

With the new HP 130C Oscilloscope you get a full 10 x 10 cm picture of low-level signals without external preamplification. The 130C is ideal for viewing output from low-level transducers, strain gauges, small signals in solid state devices, detected RF, medical, physical phenomena, phase shift, and X-Y plots.

Identical horizontal and vertical amplifiers have 200 µv/cm sensitivity and 500 KC passbands, with balanced input for rejection of common mode signals. Near identical phase characteristics of the amplifiers (less than 1° up to 100 KC) permit highly accurate phase measurements.

Automatic, versatile sweep circuitry makes the 130C fast and easy for even inexperienced personnel to use. Automatic triggering eliminates complicated trigger adjustments. The push button beam finder brings the trace onto the screen regardless of control settings. To further aid in locating the trace, a base line automatically appears on the CRT in the absence of an input signal. The automatic feature may be locked out, and a front panel control set to select trigger level and slope for special applications. A single sweep switch allows viewing of transients.

The 130C is equipped with the HP internal graticule CRT that eliminates viewing and photographic parallax error. An etched safety glass faceplate cuts glare making the scope easy to read in high ambient light. Easy access modular construction allows both rack mounting and bench use.

The specifications tell the detailed story. Check them out... and then call your Hewlett-Packard representative for a demonstration on your own bench.
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Low-Level Signals Directly

VERTICAL SENSITIVITY / VERNIER

VOLTS/CM

.1
.2
.5
1
2
5
10
20

MV/CM

50
20
10
5
2
1
.5
.2

200 \mu v/cm sensitivity... 500 KC
New hp 130C Oscilloscope
BANK OF MIRRORS lining darkroom helps in final adjustment of RCA color television receiver. Color tv will be a pace setter among new consumer products. See p 49

ANTI-ICBM LASERS: Can They Be Developed? Yes, say laser experts, but it will require the solution of many thorny engineering problems. Solar-pumped systems operating in spacecraft are feasible

3-D BATTLEFIELD RADAR Uses V-Beam Antenna. Two feed horns produce vertical and slant beams. This air defense radar for the Marines gives altitude, azimuth and range information directly

TWO MORE LASER ADVANCES. Nonlinear effects now make possible conversion of a laser beam to any frequency and light amplification. Another team of physicists reports on a low-current technique for energizing superconducting magnets

MICROCIRCUITS GO ALOFT. Integrated circuits will soon be operational in Navy's airborne systems. In June or July, they'll be introduced into airborne digital computers

TV TEST Uses Two Colors. Mexican system puts color picture tube in black-and-white set. Inventor thinks a low-cost system like this will open up the Latin American market

JAPANESE EXPORTS Keep Climbing. Another gain of 16 percent in electronics exports is expected in 1963. Production is also rising; an increase of 171 percent is planned by 1967

SPECIAL—CONSUMER ELECTRONICS: First of a Series. New home-entertainment developments include small-screen transistor tv sets, build-it-yourself electric organs, stereo tape recorders and f-m multiplex receivers. This may be the first really big year for color tv.

ANALOG-TO-DIGITAL CONVERSION: New Method Provides Nanosecond Resolution. Parallel sampling at predetermined levels and time intervals requires a bank of eight circuits. Sampling circuit outputs are fed to fast tunnel-diode switching circuits.

MAGNETIC FREQUENCY SEPTUPLER Gives Stable Output Voltage. A master of magnetic-amplifier design tells how to run 400-cps equipment from a 60-cps line using only this static frequency multiplier. Square-wave output voltage is stable against large variations in three-phase supply.

By W. A. Geyger, U. S. Naval Ordnance Lab

Contents Continued
CONTENTS continued

PULSE MODULATION Using Three New Approaches. These three different modulators can control high power traveling-wave tubes, some of which put out 10 Kw or more. One modulator uses four-layer diodes, another diodes and transistors while the third uses vacuum tubes and semiconductors.

By E. H. Heckman, Westinghouse Electric 62

D-C LEVEL SHIFTER Affords High Precision, Reduces Output Impedance. The output signal appears at a lower impedance and shifted in d-c voltage level by a predetermined amount. Zener diodes in balanced bridge circuits give high linearity and low drift.

By J. Willis, Southern Instruments, Ltd., England 65

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CONGRESS is again considering legislation to require employers to pay women wages equal to men if they do equal work. Whether HR 3861 or S 910 or some combination of the two is adopted is of great concern to the electronics industry. We depend heavily on women to staff our production lines.

Of course we favor equal pay for equal work, just as we oppose sin and defend motherhood. But does everything have to be written into law and draped with red tape? Laws that tell an employer how to treat his employees should be adopted only when flagrant and socially unacceptable abuses need correction, as was the case with child labor.

We defy any lawyer to draft a formula that will tell an employer when his male and female employees are of equal value to him. Men are men and women are women and the two sexes have different—different, not greater or lesser—abilities. That's not male chauvinism, that's biology.

There are jobs in the electronics industry that are usually done by women and rarely done by men. For example, some of the fine hand work required in semiconductor device assembly. This kind of work cannot be equated against work that requires broader technical experience and judgment.

There is no denying that the average woman is paid less than the average man in the electronics industry, but the average male employee is generally worth more, long term, to an employer than the average female employee. That is also a result of biology. Most men are committed to industry as a career, because of their role as breadwinners. Most women can and many frequently do exercise the option of becoming homemakers rather than factory employees.

It is the rare employer who has not invested substantial training costs in an employee. An employee most likely to stick with the company is a more valuable employee. Further, if an employee invests his or her own time and money in technical education that also makes the employee more valuable. Men frequently do this, women infrequently.

So much for the average.

In a minority are women who don't fit into the general pattern. We mean women who make a career of industrial employment and who leap the biological barriers because of exceptional talent or ambition. These women are of greater value than the average male employee, should be paid accordingly, and usually are. The employer who cannot appreciate the worth of an exceptional woman is a dolt, but equal pay legislation won't correct his stupidity.

ELECTRONICS AND THE CONSUMER. If, like many electronics engineers, your contact with consumer electronics is now limited to adjusting your tv set or fiddling with a hi-fi, you'll be pleasantly surprised to find just how sophisticated consumer electronics is becoming.

The design of consumer products has kept up well with recent advances in electronics. In a three-part series on consumer electronics, beginning in this issue on p 49, Assistant Editor Gray reports, for instance, on a tiny hearing aid with an integrated amplifier circuit, a doppler security alarm the size of two table-model radio receivers, a microwave oven that heats in six seconds, and a model train control that uses silicon controlled rectifiers to separate the controlling r-f frequency from the a-c track voltage.

This week, the subject is entertainment, from tv receivers to f-m multiplex. Next week, we get into electroluminescence, silicon controlled rectifiers and their many applications, and auto ignition. In the third article, the topic is appliances and housewares, from thermoelectric cooling to an electronic telephone dialer. We think you'll be interested, not just as a consumer, but as an engineer.
Dynamic Null

In reference to the article, New Method for Measuring Equipment Performance (p 78, March 15), I do not believe that the method outlined by the author can be said to be a new one. An examination of p 280 of the 1962 Radio Amateur's Handbook will reveal that author Haynes has modified a well-known and widely used method which differs but little from the one discussed in the article.

Richard R. Slater
Oklahoma State University
Stillwater, Oklahoma

Author Haynes replies:

I was unable to locate a 1962 Radio Amateur's Handbook, but did find a 1963 edition. The method therein described (pp 283-4) is, as Mr. Slater states, well known and probably adequate for checking out ham gear. It would be virtually useless, however, for evaluating instrumentation equipment. Even assuming the oscilloscope vertical and horizontal amplifiers to have identical (or negligible) distortion and phase shift, the measurement is limited by the resolution of the scope trace to about two percent. Using the Dynamic Null method, measurement of errors is limited only by the sensitivity of the vertical amplifier. Errors of 0.02 percent are easily measured in a 10-volt signal. This is the essence of a null form of measurement.

John L. Haynes
Redwood City, California

Government Patent Policy

I note with renewed frustration and alarm, under Washington This Week (p 12, March 29) that presidential adviser Jerome Wiesner, in a message to Congress, has struck a middle ground between NASA's and the Defense Department's policy relative to "who gets the patents."

Here, as in the past, the intellectual and creative rights of employed inventors are given not the slightest consideration, yet only they can create the innovations which both the government and corporate contractors would claim. All the gold in Ft. Knox cannot create anything; neither can the great governmental or corporate showplace laboratories, or their project teams. Creativity, wherever one finds it, in science, in engineering, or in the arts, always has been and must still be the product of a single human mind. But present patent practices, and those now proposed, can only strangle its productivity for the very simple and obvious reason that no incentives or rewards exist for it.

The patent productivity in Europe and Russia, per million of population, exceeds our own by factors as high as ten or more. The obvious reason for this lies in their laws, even now being strengthened, which provide compulsory, realistic remuneration for employed inventors.

Benjamin F. Miessler
Miami Shores, Florida

Thermocouple Circuit Tester

In my Research and Development article, Tester Checks Out Thermocouple Circuits (p 102, March 15), two slight editor's revisions were made in the original which I feel should be corrected in the interest of complete clarity and accuracy.

The third sentence, as it appeared, states "The resistance, per 100 feet, of 28-gauge wire at 68 deg F varies from 6.489 ohms for copper to 266 ohms for Chromel-P." The inference here is that copper and Chromel-P are used together, which is not the case. The various combinations of wires used, and their resistance differences, should be expressed as "copper, 6.489 ohms and constantan, 184.0 ohms; iron, 37.63 ohms and constantan, 184.0 ohms; Chromel-P, 266 ohms and alumen, 110.8 ohms.

Sigmund Meieran
Aero-Space Division
The Boeing Company
Seattle, Washington
These P-channel diffused silicon transistors embody all the desirable characteristics inherent in the field effect design—low input capacitance and high impedance. Use of an S-shaped gate configuration contributes to the exceptionally low capacitance. Tung-Sol's wide application experience with injection transistors and vacuum tubes—features of which are combined in the field effect transistor—is an important consideration for anyone seeking a competent source of this advanced semiconductor device. Write for complete technical information. Tung-Sol Electric Inc., Newark 4, N. J. TWX: 201-621-7977

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**New Development.** Here is a unique combination of low cost and high reliability. Featuring all silicon semiconductors throughout, these supplies are priced as much as 35% lower than comparable germanium supplies.

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CIRCLE 6 ON READER SERVICE CARD
SAC Head Wants Space Command Station

DALLAS — Renewed charges that the military's space program is floundering were made last week at the Manned Space Flight meeting here, cosponsored by NASA and the American Institute of Aeronautics and Astronautics.

Gen. Thomas S. Power, commander of the Strategic Air Command, warned that the nation's survival would be at stake if the U.S. is confronted with a "space Cuba." He said men should be trained to operate a deep-space command station.

Courtland D. Perkins, of Princeton's aeronautical engineering department, said the "rambling and largely unsupported" R&D program of the Air Force needs to be brought into focus. He urged support of the X-20 Dyna-Soar and Blue Gemini programs, with the possible addition of a manned military space station and dual-launch space plane system.

The military is "groping around for better state-of-the-art, better concepts, and better arguments" to develop military space missions in all fields except surveillance, Perkins charged.

Other officials warned that "go" decisions must be made now if systems and techniques are to be developed in time to land men on Mars during 1973-75. Mars will be in a favorable position then for interplanetary travel. It won't be again until 1984.

NASA reported that the arc jet, resistojet, contact ionization and electron bombardment ion engines are moving into engineering phases. Snap-10A, a 500-w nuclear system, has shown "some success" and is "expected to be integrated with the nuclear system this year, with flight tests within two years."

California Site Bounces Microwaves to England

THE MOON was the middle link last week in what is believed to be the longest direct microwave hook-up ever achieved—5,333 miles from Camp Parks, Pleasanton, Calif., to the Royal Aircraft Establishment at Farnborough, England. Camp Parks, point of origin for the X-band transmissions, is a MIT Lincoln Laboratory field site. Its cassegrainian antenna system, using a 60-foot paraboloidal reflector, was designed primarily for Project West Ford. Transmission was at the standard 60 wpm teletype rate. Special design features of the receiver combat smearing in the doppler shift and in relay.

How Do Missiles Affect Radiation?

CAPE CANAVERAL—The Air Force wants to find out if the presence of missiles affects the amount of radiation found at high altitudes. Under Project Hi-Tab, it will launch a large number of Aerobee rockets from Walker Cay in the Bahamas to get a thorough mapping of natural background radiation.

Launches will be made under all weather conditions. Flight altitudes will be about 135 miles. When this program is completed, similar rockets will be fired in conjunction with missile launchings here to measure any differences in background radiation. This part of the project is known as Tabstone, for Target and Background Signal-To-Noise Experiment.

Japan Starting to Make 16-Inch Color Tv Sets

TOKYO—Japanese tv makers hope to popularize color tv by October, 1964—in time for the Olympics here. Unable to agree on a standard 16-inch color tube, the size they think is most likely to win wide acceptance, manufacturers will soon start production of 16-inch color sets using three different types of 3-gun shadow mask tubes.

The main differences between the tubes will be in deflection angle and size of front faceplate. First sets using these tubes are expected to go on sale around the end of August. EIA-Japan was unsuccessful in its attempts to persuade set makers to settle on a standard tube and now hopes that the customers will display a marked preference for one type, forcing the others to adopt it.
Space Tracker

48-INCH spectrometric telescope built by MIT Lincoln Laboratory will probe the thermal, electrical and aerodynamic phenomena that occur when a space vehicle reenters the earth's atmosphere. Located at Arbuckle Neck, Va., the telescope can look onto the faint tiny glow from a fast-moving target. The radiometer (right), measures light intensity in the near infrared region.

announced it will waive commodity taxes on transistor tv sets until March 31, 1966. This is expected to cut domestic prices about 10 percent. The resulting increase in production should mean an eventual cut in export prices too.

Long-Life Plasma

Claimed by Russians

MOSCOW—The Kurchatov Atomic Energy Institute has produced a plasma with a period of retention of “hundredths of parts of a second,” Pravda claims. A “magnetic field of an intricate geometric form” was used. The temperature was said to have been 40 million C and density approximately 10 billion particles per cc.

Reportedly, the installation was built on the principle that “one of the peculiarities of employing a magnetic system is that the power of the field increases on all sides from the sphere occupied by the plasma.”

“Plasma occupying a volume of several dozen liters in a vacuum chamber does not reveal those ordinary types of instability which were earlier considered irremovable,” the newspaper said. Soviet scientists now hope to raise plasma temperature to 200 million degrees and increase density a thousand-fold, Pravda said.

A-Blast Detection Puzzle:

Where’s the Epicenter?

WASHINGTON—Epicenter location is still the bugaboo of scientists trying to identify nuclear tests by remote instrumentation. Locating the depth of a disturbance is little better than two years ago when instruments were “recording” explosions 1,300 feet underground as being as much as 30 miles in the air. Since most earthquakes occur 3 to 12 miles down, where nuclear tests are not feasible, epicenter location within a 1,000-yard tolerance is seen as a crucial factor to identifying tests.

DOD Aide Urges Use

Of Microcircuits

DALLAS—The space industry should use microelectronic circuits wherever possible, James Bridges, director of electronics in the DOD’s Office of Defense Research, said at the Manned Space Flight meeting here last week. He said that microcircuits offer the best hope for obtaining the reliability levels needed for manned space flights.

Tunnel Diode Used

In Computer Memory

IBM has installed for study purposes a tunnel-diode memory unit in the Stretch computer at its Poughkeepsie development labs. Company says this is the first time such a unit has been used in an operating computer. One possible application is as a buffer.

In Stretch, the memory has a storage-retrieval cycle time of 600 nsec and has reached 200 nsec in tests—three times the speed required by any existing computer, IBM says. Capacity is 17 words of 74 bits each.

In Brief . . .

NATIONAL ACADEMY OF SCIENCE gave its backing last week to a proposal that would establish a National Academy of Engineering (p 3, Oct. 5, 1962).

NATIONAL BUREAU OF STANDARDS has obtained interference fringes over a 200-meter path using a laser light source. Work is now under way to stabilize the laser for interferometric calibrations of length-measuring devices.

TOP EXECUTIVES of the nation’s space projects deserve higher salaries, says Charles W. Frick. He resigned from his $20,000-a-year job as head of Project Apollo to return to private industry.

STOCKHOLDERS of Beck’s, Inc. have been asked to approve the sale of the firm to Control Data Corp.

AIR REDUCTION CO. sees future uses in welding of light gauge metals and chemical synthesis for its new 9-w, c-w laser.

TOSHIBA will supply tv sets to Sears Roebuck for sale under Sears’ trade names.

GE IS ADDING a new computer, the GE-235, to its medium-range line. Typical cost is $475,000.

YOKOGAWA will form a joint venture company in Japan with Hewlett-Packard to produce instruments.

GOVERNMENT MARKET for simulation systems totaled $250 million in fiscal year 1962, according to Smith, Winters, Mabuchi.

Solinon Tetrode produced by Self-Organizing Systems, Inc. is used as the analog memory element in a machine called Child (for Chemical Hybrid Intelligent Learning Device) being built by the Air Force.

PROPOSED MERGER of Baird-Atomic and Allied Research Associates, Inc. has been called off.

A TITAN II launched from an underground silo last week hit a target more than 4,000 miles away.

30 RCA 301 computers will be installed at 10 key sites of the Air Force Logistics Command to replace over 500 pieces of punched card equipment.

May 3, 1963 • electronics
FOIL TANTALUM CAPACITORS for satellites and other high-vacuum environments are now available from Sprague Electric.

The new Type 142D and 143D hermetically-sealed Tantalex® Capacitors utilize a true glass-to-metal seal for these applications. The seals on these new capacitors will not diffuse more than three cubic centimeters of helium in ten years*, enabling them to survive the extreme vacuums of outer space!

Type 142D and 143D Tantalex Capacitors are beyond the pilot production stage. They’re available now in plain-foil or etched-foil, polarized or non-polarized construction, with voltage ratings up to 450 VDC.

*by mass spectrometer test at one atmosphere

If you have need for this premium product, write for further information (on your letterhead, please) to Tantalum Capacitor Section, Field Engineering Department, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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SPRAGUE COMPONENTS

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Aircraft & missiles can now fly automatic, ground-

Terrain Following Radar now enables air-to-ground missiles, drones and aircraft to fly automatically at selected low altitudes permitting penetration below early warning radar. This new on-the-deck mission capability and many others can be added to all types of aircraft by the General Dynamics-Electronics Terrain Following Radar. The system, which detects all terrain obstacles and transmits continuous instructions to pilot or autopilot, is suitable for both military and commercial aircraft.

*THOROUGHLY TESTED — More than 25,000 miles of actual low level flight tests and 200,000 miles of computer simulation have proven the system’s capability and reliability. In one test an aircraft flew at 400 feet from San Diego, California, to Las Vegas, Nevada, over some of the roughest terrain in the United States without the pilot having touched the controls. Available now, the versatile General Dynamics-Electronics unit is suitable for manual or automatic blind flying at speeds from 100 knots to well in excess of Mach 2.5.

COMPACT, LIGHTWEIGHT — The General Dynamics-Electronics Terrain Following Radar is the only thoroughly and successfully tested system compact enough to fit in any aircraft and is readily adaptable to air-to-ground missiles. The low-powered, lightweight system weighs only 40 lbs. and occupies 1/2 cubic foot. The design is so simple that preflight calibration and alignment are not necessary.

APPLICATIONS — Besides adding all-weather, low-level mission capabilities, the system permits safe, automatic let down through cloud cover to non-instrumented air fields. It also protects aircraft flying through unfamiliar mountainous terrain in periods of poor visibility. During any ground-hugging flight the radar system frees the pilot to observe or operate navigation and other equipment.
hugging missions with compact, proven* radar

**RELIABILITY** — As a result of simplicity of design the system is highly reliable and requires an absolute minimum of maintenance. This factor is enhanced because there is no scanning antenna and no requirement for a radar scope. For further information on Terrain Following Radar, write to Department D-21, General Dynamics/Electronics — San Diego, P.O. Box 127, San Diego 12, California.

**SPECIFICATIONS:**

- **FREQUENCY:** Ku Band
- **POWER IN:** 1 amp, 28v d-c, 2 amps, 115v a-c, 400 cycles
- **POWER OUT:** 10 KW peak
- **WEIGHT:** 40 pounds
- **CIRCUITRY:** transistorized
DEFENSE DEPARTMENT proposes wide-ranging changes in the Armed Services Procurement Regulations dealing with proprietary data—long a source of controversy. Industry complains of excessive military demands for contractors' trade secrets and inadequate protection of proprietary data from commercial competitors.

On May 7, industry representatives will discuss with Pentagon officials proposed changes that are both liberalized and more restrictive. On one hand, they would allow acquisition of unlimited proprietary data in formally advertised contracts. This would primarily involve follow-on production contracts for items developed at military expense and "broken out" for competitive bidding. EIA opposes this change.

On the other hand, DOD also proposed to broaden its recognition of proprietary data. Aim is to discourage so-called "reverse engineering" by protecting proprietary data "not readily disclosed by inspection or analysis." In effect, the change in definition expands the volume of protected proprietary data.

DEFENSE COMMUNICATIONS AGENCY will award contracts soon for program definition of a military communications satellite system. The time goal to get an R&D system in orbit is two years following contract awards, roughly around 1965.

DCA has decided to proceed with a system based on present state of the art—several satellites at altitudes from 4,000 to 6,000 miles in polar orbit. Synchronous satellites were rejected for the first system because of the research still required and vulnerability to enemy jamming and interference.

DCA will also modernize and expand its world-wide communications facilities to provide automatic switching for voice, teletypewriter and data communications among overseas bases and between U.S. and foreign sites. Two networks are involved: Autovon, for voice, and Autodin, for data and teletypewriter communications. Both jobs will be under contract this fall and operational sometime in 1965.

ELECTRONICS is getting new emphasis in Department of Commerce efforts to improve the overseas position of U.S. products. Officials are conferring with industry to identify possible areas of concentration. Trade center shows of advanced components are being planned for London and Frankfort this winter. In light of European competition, advanced components are seen as the best initial area of emphasis. Also, the instrument and lab apparatus promotion now in Tokyo will go to England and Germany later.

SENATE CONFIRMATION of the 14 board members of the new Communications Satellite Corporation frees the group to get on with the job of establishing a commercial satellite communications system. The next big step for the corporation is to issue stock to the public and communications carriers, probably within another year. Manpower requirements, R&D needs and anticipated use by carriers, which will determine amount of stock issued, are now being studied.
We produced the world's thinnest (.005 diam.) flux-core solder

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Less than twice the size of a human hair, this new Kester wire solder they're looking for is just .005" in overall diameter. Try to find that on a tweed carpet!

This new Kester solder has a hollow core filled with flux. To produce this takes ingenuity. It requires the most precise manufacturing standards to conform to the rigid specifications of the electronics industry. Can you visualize using this .005" diam. Kester Solder in your manufacturing operation? Perhaps this is just what you need to solve your most difficult precision soldering problem. Kester will offer engineering assistance if you will state briefly your application situation. Write today.

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Special skills are important in the wiring of today's sophisticated assemblies for electronic and telemetry systems. Klein has developed special pliers to assist in solving difficult assembly problems.

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THE BOURNS ULTRA-RELIABILITY CONCEPT
—a method now producing potentiometers with statistically verified reliability

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**Element:** Wirewound  
**Resistances:** 100Ω to 20K  
**Power Rating @ 70°C:** 0.5 watt  
**Max. Op. Temp.:** 150°C  
**Humidity:** Meets MIL-STD-202, Method 106

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**MAX. FAILURE RATE: 0.01% PER 1000 HOURS (60% CONFIDENCE LEVEL)**

Curves are based on a constant failure rate (Poisson distribution)

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electronics • May 3, 1963

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Contemporary design
Straight sides and square corners, plus color styling of the cover, give the “MS” Series a distinctive appearance. The clean, functional design blends with the square and rectangular shapes of modern electronic and process equipment.

Clear, uncluttered dial
All extraneous data has been removed from the dial face—the unit of measurement is hot-stamped on the inner surface of the cover.

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Concave face improves readout by minimizing shadows and glare. Whereas light is reflected over the entire area of a flat surface, a concave surface reduces the effect and localizes it to a much smaller area.

Full light reaches the dial through the sides and top as well as the front of the crystal-clear Plexiglas cover.

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Scale is as much as 50% longer than conventional meters of same size. For instance, the MS1 meter has greater scale length than some 2½-inch meters—a real saving in valuable panel space without sacrificing reading accuracy.

For complete information, write Honeywell, Precision Meter Division, Manchester, N. H. In Canada, Toronto 17, Ontario.

SPECIFICATIONS
Sizes and Types — MS1 (1½-inch), MS2 (2½-inch) and MS3 (3½-inch). DC meters in all sizes to measure volts, millivolts, milliamperes, amperes and microamperes. AC rectifier-type voltmeters in all sizes; AC iron-vane types in 2½-inch and 3½-inch sizes to measure milliamperes, amperes and volts. VU meters with buff dial, “A” or “B” scales in all sizes. Null indicator types available in 1½-inch and 2½-inch sizes.

Ranges — All standard ranges. Special ranges and customized dials also available on request.

Accuracy — ±2% of full scale for all DC ranges. For AC ranges, ±3% of full scale.

Mechanism — Model MS1 has self-shielded, core-magnet mechanism. MS2 and MS3 models require special calibration for use on steel panels.

Mounting — MS1—single-hole mounting. Gasket and mounting ring provided. MS2, MS3 — to ASA mounting dimensions.

Cover Dimensions — MS1 — 1.750” square; MS2 — 2.178” high x 3.140” wide; MS3 — 3.500” high x 4.100” wide.

Cover Colors — Normally furnished in onyx black. Available in 15 other standard colors. Any custom color to order.

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Less than 0.0015% / 1000 hours.

CORNING has failure rate data based on continuous life testing for periods up to 50,000 hours; nearly six years. This test is for 1800 resistors that have been on continuous life test for 60,000,000 unit hours at powers up to 140% of rated. The confidence level is 60%.

Less than 0.0012% / 1000 hours.

This one is based on 75,000,000 unit hours at 250% of rated power and 25°C.

CORNING resistors live through high-stress reliability programs like these because of the inherent reliability of the tin oxide and glass that go into them. They demonstrate flat load-life characteristics for the same reason.

High-reliability CORNING resistors are available in general purpose C-style, precision RN-type, and hermetically sealed precision NF-type. A bulletin on CORNING "Resistor Reliability" is now available. Write for your copy.

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A DIVISION OF CORNING GLASS WORKS
3901 ELECTRONICS DR., RALEIGH, N.C.
Will Lasers Protect Our Cities Against ICBM’s?

Laser experts find radiation weapon possible, but difficult

By LEON H. DULBERGER
Associate Editor

DEVELOPMENT OF a laser radiation weapon for use in anti-missile defense is possible, according to laser experts interviewed by ELECTRONICS. But they say that many thorny engineering problems must be surmounted to produce a working system. Materials research is one area requiring much investigation—both for laser operation and target damage knowledge.

DOD will only say that it is investigating the possibility of anti-ICBM lasers, along with other avenues of ICBM defense, in an orderly scientific fashion. Details are classified.

Scientists at Raytheon’s Surface Radar and Navigation Operation are doing analysis and experimental work on a definition of laser weapon system design parameters. Raytheon acknowledges that the small beamwidth and possibility of high target-spot energy density suggest weapons possibilities. Raytheon has a commercial 350-joule ruby laser that can cut through ½-inch steel.

A Russian military publication has alluded to possible use of lasers for locating and destroying space vehicles. But while it mentioned U.S. work on this, it did not mention any Soviet efforts. Khrushchev, however, has said he believes his scientists are ahead of the U.S. in general laser work. Last year, he showed a visiting American a steel ruler supposedly perforated by a laser beam.

Major Gen. D. F. Ostrander, Commander, Air Force Office of Aerospace Research, said this at a laser symposium: “As a professional military man, I am naturally excited about the practical applications of these revolutionary devices (lasers) in the fields of military communications, and possible disruption of matter by high energy density of radiation, and so on.”

Laser beam attenuation studies are being made for Air Force at Ohio State University. A 50-foot chamber is fitted with reflectors to simulate approximately a 1-mile path. Propagation and attenuation of beams from various lasers is explored under varying atmospheric conditions. Effects of altitude and space are included. Air Force won’t comment on specific goals for this research beyond saying it is designed to study the atmosphere in relation to laser beams.

WEAPONS POSSIBILITIES — Some of the possibilities, problems,
and progress are:

- One laser could attack many targets. Discrimination against decoys should be unnecessary since slewing speeds could be high and laser bursts should be readily repeatable. However, at present high-power lasers usually require four or five minutes between bursts to allow energy storage and cooling the laser.

- One possible ICBM-defense system is an orbiting space station equipped with detecting and tracking radar, and lasers pumped by direct sunlight. One big problem would be making the platform stable enough for accurate target tracking. Also the laser would have to focus on the target long enough to destroy it, implying an extremely fast slewing servo. Techniques to focus enough energy density on the target pose formidable problems.

- An interceptor rocket could be launched to areas not protected by space stations. Its laser weapon could be controlled from earth and chemical flash powders used to pump the laser.

- A space platform would not be needed to field-test laser weapons concepts. Testing could be done in the thin air on mountain peaks in clear weather. Helicopters with ceilings of 25,000 ft are available to supply test teams. Mountains in the continental U. S. reach heights of over 14,000 feet in the western portion of the nation and some exceed 6,000 feet in the east. Alaska has peaks to 20,000 feet.

- Countermeasures against laser radiation weapons might include laying smoke screens in beam's path to disperse and attenuate it. Or, the beam could be deflected by highly reflective surfaces on targets such as nuclear warheads. Reflection techniques now being researched to protect men and equipment against nuclear bomb blast temperatures up to 3,000 °F may lead to protective devices against laser beams. However, any tarnishing on the surface of a polished reflector would soon be cumulative and destroy protective qualities finally allowing damage.

SOLAR PUMPING—Energy levels in the millions or even billions of joules will be required for anti-ICBM lasers. These high-energy, high-power lasers might be directly pumped with sunlight. A large tracking reflector could gather solar energy and direct it through a mirror system to the laser material—whether it be crystal, gas, liquid, plastic or glass. Direct sun pumping would eliminate conversion to electricity and back again to light, to pump the laser.

Some of the work now being done in industry and at universities may lead to extremely high-power lasers. Nuclear Research Associates, Inc., of New York, is working on a laser intended to deliver 1 billion joules of energy from a laboratory-size generator. The firm has at least one Air Force contract for high-energy laser development. They plan to use unorthodox pumping and lasing techniques in a solid-state laser. While the exact quantum mechanical operation to be employed in such lasers is not easily spelled out scientists do not preclude their final development.

HOW DO LASERS BURN?— Burning or destroying material with a laser beam at great range is a real problem. In space it is many times more difficult than in a lab. A study of the interaction between energy and materials is required.

One scientist believes that laser cutting action resembles a localized explosion. For example, if a 1-joule laser beam is focused on carbon paper, the laser only chars the paper when the pulse width is long. When a 1-microsecond pulse is employed, a distinct snap—caused by gases trying to escape—is heard as the beam strikes the carbon paper. In metal cutting, long pulse widths allow heat dissipation on the target surface, reducing cutting action. A rapid, high-peak-power pulse vaporizes part of the target surface in an explosive fashion.

Therefore, it may be possible to damage a reentry warhead by relying on the shock wave effect to extend the initial destructive effect.

Thin-film deposition technique work at the University of Rochester has posed this question about laser action in heating: Is material actually vaporized by a laser or does it come off as finely divided debris from a miniature explosion? Clearly, laser damage demands much research and even the concept of “radiation pressure” is suggested as the active effect.
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**Systems and Sub-Systems Design** • antenna and microwave design, integrated circuit applications, stress analysis and heat transfer, digital and voice communications, command and control, telemetry and tracking systems design, data processing and display, ultrareliability design techniques, radar and guidance equipment.

We are particularly interested in programs on which this experience was obtained, and the extent of your technical responsibility. Address information to our Manager of Engineering at the location of your choice for immediate attention.
**MARINES TO GET**

Air defense radar gives altitude, azimuth, range information directly

**SINGLE PHYSICAL** antenna generates two sheet beams, oriented in space to form the required V configuration, in a new three-dimensional military air defense radar. The transportable equipment, designed by Sperry Gyroscope Co., begins operation with the U.S. Marine Corps this spring. The Corps will receive twenty systems—two every month.

A compact single physical antenna is achieved by superimposing two electrically separate antenna reflectors on a single backup structure. Tactical mobility is thus implemented. A plastic honeycomb sandwich supports the reflectors which are created of flat metallic strips to provide polarization.

**V-BEAM** — Two independent microwave horns produce separate vertically oriented and slant oriented sheet beams which rotate as a unit and afford V-beam coverage. The vertical sheet beam, aided by the slant beam, searches. The slant, combined with the vertical beam, affords altitude information.

Solution of the V-beam geometry provides altitude information. The angle of rotation between the vertical and slant sheet echoes are measured electronically as an angle identified as the turn angle. Along with target range it is used to solve for target height. Dual modulators couple through high-voltage-pulse slip rings to dual transmitters mounted on the rotating antenna assembly, and then to the antenna reflector feed horns.

Targets are isolated by gating the receiver channels of the two beams. Measurement to vertical and slant beam centers provides turn-angle accuracy. Angular interval is measured by digitally counting pulses obtained with a magnetic pickoff which senses teeth on a ferromagnetic gear rotating with the antenna.

**V-BEAM spatial coverage, and the geometry that is solved for altitude**

**HEIGHT COMPUTER** solves V-beam equation. **PPI operator marks target's range and azimuth coordinates to orient acquisition gate**
3-D RADAR

...tion-generator technique solves the height equation by approximating straight-line segments. The height-finding operation may use height-smoothing equipment to improve output data through averaging a series of height readings and rejecting spurious signals.

COMPUTER—An automatic computer solves the V-beam equation and computes target heights after an operator manually selects the target. An automatic digital computer system may be added to provide 3-D coordinate data on all targets within the illumination and detection area.

The radar, designated AN/TPS-34 and developed by Sperry's Surface Armament division, is reportedly a quarter of the size of a two-radar installation. It can be transported by helicopter, cargo aircraft, truck and amphibious vehicle and be ready for operation in eight hours. An inflatable radome with dual walls eliminates entrance air locks and protects the antenna and equipment from weather. Possible application to air-traffic control and long-range 3-D air-route surveillance is envisioned. Additionally, 3-D air-corridor safety surveillance for missile test ranges is possible using the radar.

High-Resolution Scope Reported Easier to Work

CLEVELAND — Time-sharing digital oscilloscope was introduced by Fred Katzman, of Du Mont, at the Cleveland Electronics Conference last month. The cro has realizable resolution of over 1,000 lines and readout precision to half percent. Improvements reduce training time, permit less skilled technicians to achieve optimum use of the instrument, Katzman said. One control allows operator to choose desired display, method of signal correction and time-base synchronization. A calibration marker system permits the scope to magnify reference calibration off screen.

From the DD Line of data transmission equipment

“SEPATH”

Rixon DD 1002 SEPATH data terminals, operating in conjunction with existing frequency division multiplexing equipment, provide an excellent means for transmitting high-speed digital data via hf radio circuits. Serial binary data is converted into parallel low-speed data streams at the transmit terminal to permit propagation through multipath conditions. These are simultaneously transmitted on TTY channels. At the receive station, the parallel information is regenerated and reassembled into the original serial format.

Other systems available which use the SEPATH principle are the SEPATH/Teletype system [SEP 589-1(A)] for bulk encryption, and the DD 3005 30 Channel time division multiplexer for 60 and 100 wpm TTY signals. For further information, contact ...
British Report Latest Measuring Techniques

One new instrument is a frequency meter that needs no sampling period

SOUTHAMPTON, ENGLAND—Several measuring techniques—including one for continually displaying frequencies—were introduced at a British IRE conference April 16 to 20.

The dynamic frequency meter, described by P. Wood, of Plessy, Ltd., gives a continuous 6-digit display of frequencies between 250 cps and 16 Kc without the normal sampling period.

The unknown frequency input is converted to a pulse train that is fed to the add input of a reversible counter. The subtract input is obtained from a binary rate multiplier comprising a binary scaler to which is applied a fixed-frequency pulse train. Scaler outputs are fed to gates controlled by the counter stages. Combined, the gate outputs give a pulse train whose mean rate equals the product of the fixed frequency and the contents of the counter. When the mean rates applied to the add and subtract inputs become equal, the number held by the counter represents the input frequency. Jitter is eliminated by a digital filter.

E. Harrison and P. F. Roach, of the United Kingdom Atomic Energy Authority, reported on a system that continuously measures conductivity of radioactive liquids without electrodes and with 1-per-cent accuracy. A liquid loop couples two toroidal transformers (see diagram). A second coupling induces an antiphase signal that is adjusted by a servo-driven series potentiometer to null the transformer output. At balance the potentiometer value is proportional to the liquid conductance.

A simple three-dimensional numerically controlled die-making machine has been designed by P. Burgess, of Wickman Ltd., and R. Duthia, of Parmeko Ltd. A magnetic tape programmer records movements of a zero pressure stylus over a model. Stylus position is determined by the onset of a spark discharge between the stylus and the model's conductive material.

What Happened to Project Bambi?

AIR FORCE project to intercept enemy ballistic missiles during their boost phase from a rocket-carrying satellite seems dead.

Testimony released last month from the Senate Armed Services Committee hearings during February quote Defense Secretary McNamara:

“(Bambi) was an Air Force project, but it was never developed with any effectiveness up to the present time. We spent practically nothing on it. It has been a study project phase. We have not held it back for lack of expenditures, but we have not found a way to expend funds effectively on that project.”

Clue to one of the major problems encountered was contained in another statement: “I think we found that the sky was bigger, perhaps, than we had anticipated.”
Tom:

Here's the list you wanted of systems now using Paktron's MR-330 & MR-700 capacitors. Pardon my loose drawings but I thought they might aid recognition.

- Airplane Navigational Equipment (Doplar)
- Undersea Detection Equipment (Sonar)
- Bullup Missile
- Missile Fuses
- Electronic Teaching Equipment
- Tachometers
- Field Communication's Equipment (PRC-35)
- Laboratory Test Equipment
- Telephone Switchboard Equipment
- Manned & Unmanned Spacecraft

Fundamentally, they like the size, cost and needless to say - proven reliability.

I've listed the Durez capacitor users on the other side. Incidentally, sales on the molded were up over 1000% last year.
These manufacturers are the biggest and best in the business, so track records are good. Complete spec information is available on each so why don’t you drop their office a note and they’ll rush the material to you. As one engineer to another, you’ll be doing your boss a favor. See you at the next engineering seminar.

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All now available with d.c. isolation between output terminal and slow wave structure to permit grounded cathode operation.

All fitted with grids for amplitude modulation or feedback to obtain smooth output with swept frequency.

<table>
<thead>
<tr>
<th>Frequency (Gc/s)</th>
<th>Band</th>
<th>Type</th>
<th>Line Voltage (kV)</th>
<th>Focusing</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 7.5</td>
<td>C</td>
<td>Y257/4E</td>
<td>0.27 to 1.25</td>
<td>Magnet</td>
<td>Coaxial</td>
</tr>
<tr>
<td>18 to 26.5</td>
<td>K</td>
<td>Y322/1E</td>
<td>0.7 to 2.8</td>
<td>Solenoid</td>
<td>W.G.</td>
</tr>
<tr>
<td>26.5 to 40</td>
<td>Q</td>
<td>Y333/1E</td>
<td>0.7 to 2.8</td>
<td>Solenoid</td>
<td>W.G.</td>
</tr>
</tbody>
</table>

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Nonlinear Effects Convert Laser Beam, Amplify Light

Physicists also report low-current energizer of superconducting magnets

By WARREN KORNBERG
McGraw-Hill World News

WASHINGTON—Laser beams can now be tailor made in any frequency from the infrared through the long-sought blue-green into the far ultraviolet.

A series of breakthroughs in exploiting the nonlinear effects of molecularly symmetrical liquids and piezoelectric crystals on coherent light culminated in two developments reported at last week's American Physical Society meeting—both by a team from Ford Motor Company Scientific Laboratory.

Robert W. Terhune, a leader in the rapid development of laser harmonics since 1961, reported both the tailor-making of laser frequencies almost without limit and the development of a parametric amplifier for light—both the result of the nonlinear optical effects.

He said the nonlinear effects make it possible to do with light anything that can now be done in the microwave frequency ranges.

Terhune's results are being called "remarkable" and "unexpected" by other laser scientists at the APS meeting and the simultaneous National Academy of Sciences meeting.

CONVERSION—Several laboratory teams have harmonically stepped laser beams into previously unavailable frequencies.

But the emissions in the harmonic multiples of the 7,000-A ruby emission were weak.

Terhune this year applied megawatt power. Rather than the expected 100 watts of power in the "second harmonic" blue beam, he got 200 Kw—20 percent.

Even more recently, scientists at the University of Michigan are getting 10 Kw of green light out of a 300-Kw neodymium laser.

Others are reportedly exploring other green and blue-green frequencies applicable to highly classified Navy work in submarine detection and communication areas. Terhune's contribution, said one scientist, "is raising a number of naval personnel to a highly excited state."

Terhune says that, by proper selection of nonlinear materials—molecularly symmetrical liquids like benzene or nitrogen in which to focus the red beam and ADP or calcite crystals to pass the resulting beams through—he can add or subtract frequencies to get results anywhere in the visible spectrum.

The liquid has the effect of creating beams at two relatively close frequencies—6,940 and 8,000 A for example. The crystal's nonlinear effect then is to recombine them in a predetermined way—either to add them or subtract them into the desired frequency, up to the second or third harmonic of the input.

The new light loses none of the coherence of the original beam.

AMPLIFICATION—The second nonlinear effect Terhune reported—and this work is less than two weeks old—is that suggestive of parametric amplification.

Laser light passing through liquid nitrogen, he said, results in a series of rings of coherent light on multiples of the laser frequency, surrounding the core of original red light. The rings around the red run from yellow to blue.

He explained the effect as a four-photon process in which two photons of the laser beam are annihilated and simultaneously two new photons are created—displaced equally above and below the laser frequency by some multiple of the molecular vibration frequency of the liquid nitrogen.

The liquid, he explained, can serve as the parametric amplifier
for a light signal passing through it and drawing amplifying power from a selected "displaced" photon from the laser beam.

"As with microwave parametric amplifiers," he said, "the insertion of energy at either the signal or idler frequencies triggers the creation of additional photons in both frequencies."

MAGNETICS—A method of energizing superconducting tape-wound magnets without massive hot leads and high currents—by hemstitching normal "holes" in the material's superconductivity—was described by Avco Everett Research Laboratory scientists at the APS meeting.

Ethan D. Hoag and Z. J. J. Stekly say the electromagnetic "energizer" "is especially adapted to superconducting magnets using large currents, since it eliminates the large power supply required to energize such magnets."

Using an inch-wide niobium-zirconium superconducting strip and a 20-amp input to the energizer, they built a 4,000-gauss field in 90 minutes in the experimental model. They expect to be able next to build a 33-kilogauss field in 10 minutes in a magnet of 5-inch i.d.

The energizer is essentially a small C-shaped electromagnet, wound with either normal or superconducting wire. The superconducting strip is placed, in its liquid hydrogen bath, between the cusps.

The magnetic field creates an eddy current at the edge of the superconductor, normalizing a small region and looping a line of force through the normal region.

"Walking" the field across the strip creates a series of normal regions through which the field lines pass, until the field is looped around the entire superconducting strip. There it is self-sustaining.

Beginning over again at the edge, additional lines are "walked" across the strip until the superconductor...
has accumulated the desired field. Reversing the process removes field force.

By arraying electromagnets across the strip and triggering them in sequence, Hoag says, he can link the force rings around the strip without any moving parts.

**THERMOELECTRICS**—In another development out of the Ford lab, L. L. Van Zandt and A. W. Overhauser reported on a theoretical explanation of giant thermoelectric effects in dilute paramagnetic alloys. This contributes to understanding of a variety of apparent anomalies in alloys containing impurities of chromium, manganese, titanium, cobalt, nickel and the like, and may open thermocouples and other thermoelectric devices to greater control.

Van Zandt built on Overhauser's earlier description of spin density waves—periodic areas of "up" and "down" spinning electrons.

The introduction of the impurities to create the dilute alloys, Van Zandt told an APS session, intensifies the wave effect in the region of the impurity, creating anomalies of temperature and magnetism.

He said the effect was one of unbalancing the electron drift in the metal carrying an electric current. Impurity atoms can act as a "bank" for electron energy.

Since thermoelectric power is very sensitive to slight changes in the energy current, he said, at low temperatures the "change in the thermoelectric power can be as much as a thousand times what would be expected if there were no spin density wave present."

---

**School for Key Engineers**

The plan is to begin in the fall of 1964 offering specialized and broad courses, ranging from a week to a year in length. During the first three years, the center will be experimenting with the programs offered.

Since one of the major purposes is to make engineering managers more effective in directing the applications of new scientific advances in industry, the center's sponsors are hopeful that employers will underwrite the expenses of those attending the Center.

**Flight Computer**

**RESERVATIONS computer installed at New York International Airport by Teleregister for TWA will process overseas bookings received by teletypewriter**

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How To Select An RI/FI Meter

In noise-and-field-intensity measurement, Polarad has three major competitors. They are all competent. They build good equipment. Give or take an adjective, they describe and rate their equipment accurately. We respect their designs, their equipment, and their integrity as manufacturers. We believe they return that respect.

As an engineer, you know that no two design groups ever produce exactly the same instrument for a specific purpose. Experience and backgrounds differ. Approaches differ. Even basic concepts differ. Then, too, each group has its own view of the needs of the user. In a complex design, one approach will favor sensitivity over bandwidth, or, perhaps, cost over durability. We all must draw the line somewhere, in reaching each design decision. In an RI/FI meter, there are dozens of such decisions. The final "mix" of characteristics is, at best, an intelligent compromise...never the ultimate.

We believe that the two instruments described on this page represent by far the best "mix" of performance, economy, and versatility for the majority of applications.

You don't buy an RI/FI meter every day. Once you buy it, however, you may use it every day, for many years. Therefore, we urge you to consider the "mix" carefully. Limited range or restricted utility may seem tolerable now, but what about next month, or next year? Initial cost may dominate your thinking now, but how much does an extra man-hour a day (or one questionable result a week) cost...over five years?

Consider the "mix". We think you'll choose Polarad.

We can't resist listing the outstanding features of our "mixes", below — but don't decide until you have the complete technical data in front of you.

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- Battery and AC Operation
- Direct Reading without Charts
- Directly Calibrated Long-Life Impulse Calibrator
- Digital Frequency Display
- -85 db Minimum Sensitivity
- 70 db Dynamic Range
- Standard Calibrated Horn Antennas
- Air Force Approved

Which one is just right for you?

Polarad's new "Project Mohammed" will be bringing the "Mountain" (our new Mobile Microwave Calibration Laboratory) to "Modern" (your microwave instruments) starting next month. Be sure to take advantage of this opportunity to have your gear checked — at your doorstep. Save weeks, off-delay and needless expense. Call your Polarad field engineer for details and schedules!
“OUR Panoramic* ANALYZERS ARE AN ABSOLUTE NECESSITY...”

GPL Division engineers study recording of spectrum distribution of test signals from Doppler Radar Signal Simulator. The instrument is a PANORAMIC Ultrasonic Spectrum Analyzer Model SB-15 with optional PANORAMIC Recorder Model RC-3a/15.

*A Trademark of THE SINGER MANUFACTURING COMPANY.
INTERVIEW WITH GPL DIVISION, GENERAL PRECISION AEROSPACE, ON TESTING OF AN/ASQ-28 DOPPLER RADAR EQUIPMENT

“We have one chronic complaint about spectrum analyzers,” said the project engineer. “There aren’t enough of them.”

We were standing in a busy corner of GPL’s test section in Pleasantville, N. Y., where this Division of General Precision Aerospace produces, among other electronic gear, advanced Doppler Radar Systems under Navy and Air Force contracts.

“Take this set-up,” he continued, indicating a test in which one of the Model SB-15 PANORAMIC Ultrasonic Spectrum Analyzers was connected to a GPL-designed Doppler Radar Signal Simulator. “There’s really no other way to do it. It’s interesting that the accuracy of the simulator signal we’re testing here must be at least an order of magnitude greater than the airborne system we will test with it.”

He switched out the sweep rate derived from the RC-3a Recorder and selected the more rapid sweep rate of the SB-15 for a “quick-look” analysis.

“That’s a complicated audio signal,” said our host, pointing to the screen trace. “It’s generated and then shaped to simulate the signal received by our airborne navigation system. Right now we’re measuring signal-to-noise ratio. However, at any time we may want to run a whole program of qualitative tests on the same signal. PANORAMIC analyzers give us the needed flexibility and resolution.”

He demonstrated this point with a series of quick manipulations of the continuously variable center frequency and scan-width controls.

“We use the analyzer for trouble shooting, too,” he continued. “If a Simulator signal looks wrong, we work back through its audio circuitry with the SB-15 and find the cause.”

We asked about reliability.

“Very rugged,” was the answer. “This particular PANORAMIC unit was here four years ago when I joined the section. We have several. Some are the newer Model SB-15a. This one is a special 400-cycle power line job that’s been pulled out of the lab and used in a number of actual flight tests. Aside from our own checks and routine trips to our calibration lab, it’s almost constantly in use.”

We commented on what seemed a large amount of gear for an air navigation project.

“Oh, this is all test equipment,” our guide explained. “For instance, our AN/APN-153 Doppler Navigation unit itself is only one cubic foot in size and weighs under 50 pounds. We’re very proud of that.”

Had he any general comments about the equipment?

“Well….” He thought a moment. “In my judgment, for anyone requiring rapid analysis of sonic or ultrasonic signals, the spectrum analyzer is an absolute necessity.”

DESCRIPTION

Model SB-15a PANORAMIC Ultrasonic Spectrum Analyzer automatically and repetitively scans spectrum segments from 1 kc to 200 kc wide through the entire range (100 cps to 600 kc) with a 60 db dynamic range. It plots frequency and amplitude along the calibrated X and Y axes of a long-persistence 5” CRT or also on a 12” x 4½” chart with optional RC-3b. Sweep rates are adjustable from 1 to 60 cps. Adjustable resolution permits selection and detailed examination of signals as little as 100 cps apart. Self-checking internal frequency markers are provided at every 10 kc. The unit has an internal amplitude reference at 100 kc. The compact SB-15a, only 8⅞” high, needs no external power supply or regulator. The optional recorder RC-3b permits very slow scans for high resolution at broad sweep widths and statistical analysis of complex signals. The recorder is compatible with a wide variety of PANORAMIC instruments.

APPLICATIONS

• Ultrasonic noise and vibration analysis
• Communications system analysis
• VLF radio and carrier channel analysis
• General Fourier analysis
• FM telemetry subcarrier channel analysis

SPECIFICATION HIGHLIGHTS

• Frequency Range: 100 cps to 600 kc
• Sweep Width: Adjustable, calibrated from 1 kc to 200 kc
• Center Frequency: Adjustable, calibrated from 0 to 500 kc
• Markers: Crystal controlled, 10 kc and 100 kc plus harmonics, usable throughout band, also provides amplitude reference
• IF Bandwidth: Adjustable, 100 cps to 4 kc
• Sweep Rate: Continuously adjustable, 1 cps to 60 cps (30 seconds to 16 hours in steps with the RC-3b PANORAMIC Recorder)
• Amplitude Scales: Linear, 40 db log (extendable to 60 db) and 2.5 db expanded
• Sensitivity: 200 µv to 200 v full scale deflection
• Accuracy: ±0.5 db
• Input Impedance: 50,000 ohms

GPL Division of General Precision Aerospace is just one of hundreds of users who find PANORAMIC Spectrum Analyzers indispensable for monitoring, testing, and trouble-shooting in the audio, ultrasonic, and low rf frequency bands. Our applications engineers will be glad to discuss your requirements at your convenience and without obligation. Write today, outlining your application, for literature and prompt recommendations.
Now — an easy-to-use, portable calibration pressure system

CEC’s 6-201 Primary Pressure Standard combined with new 6-003 Calibration Pressure Controller

In field or lab, CEC’s great new calibration answer saves you time and money... the first factory-made system on the market. It’s highly accurate, highly reliable, and highly portable.

CEC’s Type 6-003 Pressure Controller makes this calibration pressure system possible. All essential controls are included: pressure volume regulator, input and output connections, coarse control, gage, feed and vent valves to control pressure to the pressure standard and built-in filter. Portability allows you to take it from field to field... plug it in and get faster, precise answers. Type 6-003 fits a 19” rack with all connections and controls on a single panel, comes in a hardwood carrying case.

Other part of the calibration pressure system is CEC’s Type 6-201 Primary Pressure Standard, lightweight, easy to operate and portable. Why not investigate? Call your nearby CEC office, or write for detailed specifications contained in Bulletins CEC 6201-XB and 6003-XB.

CONSOLIDATED ELECTRODYNAMICS
A Subsidiary of Bell & Howell • Pasadena, California
Microcircuits Go Aloft

Integrated circuits will soon be operational in Navy’s airborne systems

WASHINGTON — Introduction of microcircuits into Naval avionics equipment appears to be moving ahead rapidly, Col. Arthur C. Lowell, director of the Bureau of Naval Weapons’ Avionics Division, told ELECTRONICS last week that most microelectronics fabrication problems have been solved and 1-Mc digital circuits can be implemented now with existing devices, while 3 to 5-Mc circuits will be achievable with off-the-shelf microelectronic devices by December.

Production of h-f communications sets with no moving parts and Mtbf's greater than 1,000 hours also appears feasible, he said.

MEETA T—All phases of Navy’s MEETA T (Maximum Improvement Through Advanced Techniques) program are presently being implemented.

Under phase I significant numbers of silicon integrated circuits will be introduced in June or July into airborne digital computer that Litton is building for BuWeps, Col. Lowell said.

Phase 1 calls for substituting microcircuits directly for conventional circuits, while phase II has the development of a maintenance module as its object (ELECTRONICS, p 18, Dec. 7, 1962).

In phase III, which calls for developing complete equipments using microelectronic circuits, Col. Lowell cited the following developments:
- Sperry’s Loran-C receiver has now been adequately demonstrated. Hardware fabrication is 60 percent complete and a qualified receiver will be delivered to BuWeps in December.
- Naval Air Development Center has a functioning breadboard of a one-way microelectronic data link that will be test flown this month.
- Westinghouse has built a working ecm receiver.

(continued on page 38)

INDUSTRY OPTIMISTIC ABOUT FUTURE

Electronics industry this year will be spending less but expecting more than U. S. manufacturers as a whole.

Electronics producers have earmarked 8 percent more for new plants and equipment this year than they spent on these items last year. But the increase is 1 percent less than the increase for manufacturers generally.

Other manufacturers see unit sales rising only 4 percent this year while electronics firms are predicting an 8 percent jump. Between now and 1966 firms generally are hopeful of an 18 percent increase but those in electronics are expecting a whopping 29 percent.

Electrical machinery manufacturers, with whom some electronics firms are grouped, are anticipating a 7 percent climb in sales this year and a 23 percent rise by 1966, according to the annual survey of business plans conducted by the McGraw-Hill Department of Economics.

Manufacturers generally said they consider 22 percent of their stock of plants and equipment technologically outmoded. The figure was only 11 percent for the electrical machinery industry.

All business now plans to spend a record $40 billion on new plants and equipment this year, a 7 percent increase over 1962. Of this amount, manufacturing firms alone account for $16 billion.
StereoZoom® helps build 20-year reliability in this Western Electric undersea rigid repeater

Talk about reliability! Each of these 36” x 13” diameter repeater amplifiers contains more than 5000 precision parts ... and each is rated for a minimum of 20 maintenance-free years on the ocean floor. Spaced every 20 miles in Bell Telephone’s new single-cable transoceanic system, these repeaters help transmit 128 two-way messages simultaneously.

To make sure, Bell System’s Western Electric Company uses StereoZoom Microscopes for the assembly and inspection of the high-voltage capacitors. StereoZoom’s big, bright, natural, 3-dimensional views make sure of alignment, bond, and freedom from flaws or foreign particles. Its shockproof, dustproof optical system shrugs off punishing industrial use.

Have you got big problems with tiny parts? Call your dealer, or write for an on-the-job demonstration of StereoZoom Microscopes. Bausch & Lomb Incorporated, 61441 Bausch Street, Rochester 2, New York.

BAUSCH & LOMB

Polaris Navigator

ADVANCED inertial navigation system for Polaris submarines uses electrically suspended gyros (see p 29, Nov. 17, 1961). New system built by Honeywell will monitor present Polaris systems. Installation above is on test ship USS Compass Island.

These equipments use silicon integrated circuits. Hybrid thin-film circuits are being used in a personnel transceiver being built by Sylvania.

SYSTEMS — Complete microelectronic systems currently envisioned (phase IV) are an integrated helicopter/VTOL avionics system and an integrated light attack system. Request for bidders for seven items that make up a communications and navigation IFF package for naval aircraft went out last week.

As emphasis turns to applying microcircuits to operational hardware, Col. Lowell said the major problem now lies in making the design engineer aware of the new design techniques and how to apply them. Some pitfalls he warned against: putting pnp and npn characteristics into a single chip in cases where it would be better to separate them, trying to put too many functions into a single chip, and attempting to get components in a silicon chip that should be in discrete or thin-film form.

Overall MEET AT program encompasses use of microcircuits, digital data processing, visual fault location, modular construction, majority-type redundancy, and reliability and maintainability testing.
Programming reliability starts here...

This new A-MP* Twin Detent Patchcord offers positive retaining action with a unique spring member which makes insertion-extraction easy and accidental dislodgement next to impossible. When seated, patchcords stay put even through the roughest handling. Force applied to the patchcord tip causes displacement of a plunger which acts on the Twin Detent spring. In addition, the force is distributed evenly over a larger patchboard area eliminating board chipping usually caused by application of excessive pressures. The contact area of the pin is unaffected by accumulated dust, oil, grime, or other contaminants.

Leads are better, too. AMP uses fine stranded wire and more of it (41 strands per conductor), for a more flexible lead and greater flex life. Polyvinyl chloride insulation withstands temperatures up to 105°C; and because PVC only is used, color coding won't wear off, fade or discolor.

Check these reliability features:
- Pins are precision crimped to leads.
- Twin Detent action assures retention of pins in board.
- Nickel plating on pins for ordinary applications—hard gold alloy for dry circuit requirements.
- Extended moulded shroud for larger wire bending radius, easier handling and longer flex life.
- PVC insulation withstands temperatures up to 105°C and 1,000 V.D.C. operation.
- Cords are color coded by length.

Write today for the full story on the new Twin Detent Patchcord.

---

AMP products and engineering assistance available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

electronics • May 3, 1963

CIRCLE 39 ON READER SERVICE CARD 39
We’ve already solved scores of unique

You’ll probably never need any of these three cables. But somebody did. And the same versatility and reliability control which fit these special cables to special needs are now available to solve your cable problems.

These are products of Rome’s Special Products Facility, where unique cable constructions are everyday products.

Cables like these can’t afford to fail—there often isn’t a second chance. So Rome assures reliability with a quality control program second to none. It tests each cable construction continuously throughout construction and inspection.

The program has been so successful that we recently won the first aerospace reliability contract ever awarded to a cable manufacturer. Its goal is to
cable problems ... can we help you?

prevent cable assembly malfunctions in the Minuteman missile.

Other cable constructions from Rome's Special Products Facility have proved themselves reliable on such projects as Hound Dog, Atlas, Mercury, and Sergeant.

Our Special Products Facility brochure explains how you can fit Rome's unique experience, skills and equipment to your specific problems. Just send the coupon.

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ALCOA ROME CABLE DIVISION

electronics • May 3, 1963

CIRCLE 41 ON READER SERVICE CARD 41
SIMPLE TWO-COLOR camera uses a double-speed sweep to pick up both
Two-tube camera picks up both colors and transmits them alternately
presents red and blue-green images to color picture tube in black-and-

**TV TEST Uses**

**Mexican system puts**
color picture tube in
black-and-white set

By WESLEY PERRY, JR.
McGraw-Hill World News

MEXICO CITY—For an hour each
weekday evening during the past
two months, curious viewers have
crowded around 28 storefronts here
to peer at the first color-television
broadcasts south of the border.

The experimental receivers pro-
tect two primary colors instead of
the three of the NTSC system.

According to the inventor, Mexi-
can station XHGC-TV owner Guili-
mero Gonzalez Camarena, color tv's
success in Latin America will be de-
termined more by the availability
of low-cost receivers than by equal-
ing the NTSC color capacity.

Color quality of his system is
around 9 percent below the U.S.
set. MEXICO CITY—For an hour each
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success in Latin America will be de-
termined more by the availability
of low-cost receivers than by equal-
ing the NTSC color capacity.

Color quality of his system is
around 9 percent below the U.S.
system, but he feels they have equal
entertainment value. He says re-
ceiver cost is half of U.S. set.

In the receiver, the color r-f
mixing tubes are switched by a
square-wave multivibrator. Time
base is adjusted to 30 cps, 60
polarity changes per second.

**Camera**—Three interchangeable
techniques are being used in experi-
mental broadcasts.

In one, two optical filters and
image-splitting mirrors (see dia-
agram A) project two images onto a vidicon or image orthicon.

The vertical-sweep speed is dou-
bled so that both red and blue-green
images are displaced alternately
during one normal sweep time.

Second, (diagram B) the camera
has two image pick-up tubes that
operate with simultaneous horizon-
tal and vertical sweeps. The optics
direct the images through comple-
mentary color filters. One tube is
set back further from the aperture,
so the images match.

The switching circuits alter-
nately amplify each video signal.
Mixing tubes are switched by a
square-wave multivibrator. Time
base is adjusted to 30 cps, 60
polarity changes per second.

---

**IN AMPLIFIERS:**

**MICROVOLT DRIFT WITHOUT CHOPPERS!**

**SA-112 DC Amplifier**
The SA-112 employs
tetrodes to achieve low drift rates
comparable to that of chopper stabilized
amplifiers. Unlike chopper
amplifiers, two small
batteries will provide
power for over one
month of continuous
operation. The SA-112 is ideal for use
with thermocouples, strain-gauges, pyrhel-
ometers, and other low-level sources.

Price $295.00, FOB Dallas. Available from stock.

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**IN MEASURING INSTRUMENTS:**

**INTEGRATION WITH VOLTAGE MEASUREMENT EASE!**

**SI-100 General Purpose Integrator**
A versatile, battery-powered
integrator for general laboratory use. Integral
ranges of 10, 30, 100, 300, 1000 and
3000 volt-seconds are provided to permit
a wide variety of input signals. The integral
of the input is displayed on a meter
 calibrated in volt-seconds. An auxiliary
electrical output is provided. Highly linear
ramp functions can be generated with
durations of 10 seconds to one hour.
Input 1-100 volts, impedance 30K to 10
megohms. Accuracy within 3%. Current
integration shunts optional.


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**SELF-ORGANIZING SYSTEMS, INC.**
6612 Denton Drive, Dallas 35, Texas, FL 2-4514
(formerly R&D Division of Texas Research & Electronic Corporation)
Two Colors

RECEIVER—The receiver can be either the common NTSC three-gun type, or black and white sets with a three-gun chromatic kinescope. A synchronized key-pulse generator (diagram C) produces alternate square waves of negative polarity. One output eliminates red brilliancy of the screen with each key pulse. The other dulls green and blue.

The system's persistence-flicker problem was solved by selecting a picture tube with relatively long red and green persistence. The type preferred is 21CYP22.

The time base of the input for vertical sync pulses is adjusted so that each pulse coincides with each field. When the key pulses are alternated the complete frames in color are integrated.

The generator is composed of two sections: a conventional multivibrator that gives the time base synchronized to the vertical synchronism pulse, and an amplifying section that elevates the potential of the key pulses, for required polarity.

The two-color-disk concept can also be used. One disk spins in front of a camera lens in synchronization with complete changes of the frame. Another whirls before the receiver in sync with vertical pulses.
HOW TO BREADBOARD A 10 MC DIGITAL SYSTEM—FAST

Your fastest, surest means is EECo's new high-speed system breadboard. This transistor unit lets you: (1) patch up trial circuit combinations with the same catalog modules that go into the final system, (2) perform tests at operating frequencies by pushbutton and (3) get a "stop-action" look at the over-all logic flow.

Using patchcords, you can hook up, take down or change circuitry at will to study the effects of wiring, propagation delay, clock duty cycle and alternative design approaches. And, because you use field-proven modules in the breadboard, you know that the final system will work.

EECo equipment has no equal for practicality or versatility. It is completely self-contained, but has provision for external test equipment. The built-in clock source lets you apply pulses singly or in pairs. You may operate the system slowly to watch individual operations or at high speeds to simulate end-system performance. To help you patch your circuits together, EECo provides handy symbol cards — cards that indicate module circuitry, part numbers and input-output pin connections to give you a road map of the system as you assemble it.

The more you value your time and ability, the more you can benefit by using EECo breadboard equipment. Write today for the full story.
JAPANESE EXPORTS
Keep Climbing
By CHARLES COHEN, McGraw-Hill World News

One-fifth of country's electronics production is shipped overseas

TOKYO—Electronics exports from Japan rose much faster than production during 1962. This year, the trend will be the same but exports will not rise so rapidly, according to statistics from the Finance Ministry and the Ministry of International Trade and Industry.

Exports in 1962 increased 26 percent over 1961 to $317 million. During 1962 production totaled $1,607 billion, an increase of 14 percent. Japan's Electronics Industries Association predicts that this year's exports will increase about 16 percent. Production will again increase about 14 percent.

EIA-J estimates that in 1963 Japanese electronics plants will produce 16.75 million radios, 5 million tv sets, 1.77 million tape recorders, 237.6 million receiving tubes and 270 million transistors.

In 1962, entertainment electronics such as radios, tv sets and tape recorders, made up 54 percent of all electronics production. Largest single item was tv sets—4.89 million sets—worth $527 million. Next to the U.S., this is the largest such production figure in the world.

But growth has leveled off and efforts are being made to develop new types that will stimulate sales. Last year many companies concentrated on expanding their production of transistor tv. Production will continue to expand this year.

This year, there is a concerted effort to make color tv a paying proposition in Japan. Major effort is development of inexpensive receivers using square-corner 16-inch 70 or 70-degree) would help achieve lower costs, but sets using both types have been announced. It will be difficult now to achieve standardization because the companies using the rejected size will lose face.

Production of components for both entertainment and industrial electronics also increased in 1962. Increases in production of tubes and semiconductor devices ranged from 20 to 23 percent; production of components rose over 16 percent.

INDUSTRIAL ELECTRONICS—Many companies feel that the future of the Japanese electronics industry lies in the industrial electronics field. Biggest gain in the group in 1962 was in computers, whose production was twice that of 1961. Production of most other items went up 20 to 30 percent.

There is great hope for a rapid rise in industrial electronics exports.

In the charts, miscellaneous wireless equipment is wireless equipment not used for communications. Miscellaneous electronic equipment includes nonwireless electronic equipment not included in the other categories, such as computers.

Detailed production statistics for 1960 and 1961 were reported in ELECTRONICS, p 18, June 22, 1962.

PLAN FOR 1967—Electronics production will total 1,146,280 million yen (approximately $3.2 billion) in 1967, according to MITI's new five-year plan. This is 171 percent of the value of 1962 production. Production increased 300 percent during the previous five-year period, from 1957 to 1962.

MITI says electronics here will change from primarily a consumer-oriented business to an industry-oriented one. Consumer production is expected to increase only 32 percent in value, mainly because of the leveling off of the demand for tv sets. Commercial and industrial production is seen rising 184 percent.

The plan envisions 1967 production as: entertainment electronics, $1.16 billion; communications equipment and noncommunications wireless equipment, $770 million; miscellaneous electronic equipment, $248 million; electric measuring and industrial instruments, $155 million; electron tubes and semiconductor devices, $341 million; other components, $508 million.
MICROTHERN, microwave power source for electronic food preparation units, featuring a CW magnetron from our line of microwave tubes and display devices. San Carlos, California. In Europe, Box 110, Zurich 50, Switzerland.

Litton Industries
Electron Tube Division

Here is the world's smallest motor
Yet it's so powerful...

Mitsumi Micro Motor

Less than 20mm in diameter, the new Mitsumi Micromotor provides a startling efficiency of over 50%, the barrier which miniature motors are not allowed to pass. A novel construction principle helped to make this accomplishment possible. The form is more simplified by setting all the terminals at one position. Because the entire mechanism is given full protection against irregular revolution and above all, electrical noise is entirely eliminated, you may call this the most perfect micromotor yet devised. Please write for complete information on Mitsumi Micromotor, and we will send you specifications and data.

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Tokyo • Osaka • New York

Meetings Ahead


National Aerospace Instrumentation Symposium, ISA; Jack Tar Hotel, San Francisco, California, May 6-9.


East Central & Alleghany Ohio Valley District Meeting IEEE; Commodore Perry Hotel, Toledo, Ohio; May 8-10.

Pulp & Paper Instrumentation Symposium, ISA; Peabody Hotel, Memphis, Tenn., May 8-10.


Electronic Parts Distributors Show, Electronic Industry Show Corporation; Conrad Hilton Hotel, Chicago, May 20-22.


Advance Reports

Canadian Electronics Conference, IEEE; Exhibition Park, Toronto, Sept. 30-Oct. 2. May 15 is the deadline for submitting a 100-word abstract and a 300-1,000-word summary to: Dr. J. L. Yen, Chairman, Technical Program Committee, Canadian Electronics Conference, 1819 Yonge Street, Toronto 7, Canada. Papers in electronics and related areas are looked-for. Authors need not be members of IEEE.

National Electronics Conference, National Electronics Conference, Inc.; McCormick Place, Chicago, Oct. 28-30. May 15 is the deadline for submitting 4 copies of a 50-word abstract and 2 copies of completed paper or 700-word summary to: Dr. R. W. Farris, IEEE Department, University of Michigan, Ann Arbor, Mich. All scientific and engineering aspects of entire technical range of electronics are of interest.

Northeastern Electronics Research & Engineering Meeting, IEEE; Commonwealth Armory and Somerest Hotel, Boston, Nov. 4-6. June 7 is deadline for submitting 600-1,000-word condensed versions of paper in triplate and 25-50-word abstract to: Arthur O. McCoubrey, Boston Section, IEEE, 133 Washington Street, Newton 58, Mass. Papers should describe significant original advancements in the various electronic fields.

May 3, 1963 • Electronics
Smaller diameter for complex hook-ups with Beldfoil* shielded cables

Where shielding is required you can reduce the size and weight of your cable with Beldfoil shielding. This new development can greatly reduce the diameter of multi-conductor cables. Multi-cable hook-ups can also be confined to less area. In many applications Beldfoil shielded cables can replace combined and complex hook-ups of twisted pairs and individual conductors laced together.

Beldfoil is a lamination of aluminum foil with Mylar† which provides a high dielectric strength insulation that is small in diameter, light in weight and low in cost. Its superior characteristics give 100% isolation between shields and adjacent pairs.

For audio and radio frequency applications, it eliminates cross-talk and is ideal for stationary or limited flexing.

The cable cross sections shown below (outer jacket not shown) are just a few of the many intricate and diverse ways Beldfoil has been used to solve a specific shielding problem for a customer.

If you have a space or design problem on shielded cables Belden engineering can help you.
Hammond engineers — through tough tests — sold themselves on A-B Hot Molded Variable Resistors

In selecting components for the swell control pedal, which is in constant use, Hammond Organ Company exercised traditional care to make certain their new spinet will remain a lifelong companion. Therefore, Hammond engineers conducted extensive tests to determine the control that would provide the longest life in this quite abusive application. Because of the wide degree of amplification, an extremely low noise level is tremendously important. Based on such tests, the Hammond engineers selected the Allen-Bradley hot molded Type J variable control as their No. 1 choice. The special tapers necessary for this type of application are easily accomplished in the Type J control.

Hammond Organ Company’s new spinet also uses A-B hot molded fixed resistors, which are world famous for their consistently uniform characteristics, low noise level, and complete freedom from catastrophic failures.

You can be certain of protecting the reputation of your equipment by always insisting on A-B fixed and variable resistors. For more complete information on the entire line of A-B quality electronic components, please write for Publication 6024.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wisconsin  
In Canada: Allen-Bradley Canada Ltd., Galt Ontario
Small-screen tv is back with vigor, color tv sets will be smaller and imported ones will be sold here, a new type of electronic organ is coming out, and this year should be the best yet for tv, radios, phonographs and tape recorders.

By STEPHEN B. GRAY,
Assistant Editor

ELECTRONICS FOR ENTERTAINMENT will have its biggest year in 1963, even if only half the predictions come true. The makers of color sets are sure that tinted tv will bring down the house this year, and U.S. black-and-white receiver makers are getting in on the small-screen money. Also, rapidly decreasing microelectronics prices may soon permit using thin-film and integrated-circuit electronics for tv, radio and phonographs.

TINYVISION—Several tv companies are predicting that 6 million black-and-white sets will be sold this year. Estimates on how many small-screen sets will be sold run from 100 to 200 thousand. The Japanese small sets are selling well, despite the fact that U.S.-made small-screen tv, from 8 to 14-inch, got a lukewarm reception in 1956 and 1957. However, those sets were vacuum-tube types, and although the screen was small, the set was not. The size of the Japanese sets has made them popular for their novelty and portability, and some of the more expensive ones have become status symbols. If it were not for the competition, the pioneering Sony Corporation might well have left the price of their 5½-inch 8-pound transistor model at $290, instead of bringing it down to $190.

Not to miss out on the microtelevision market, General Electric and Admiral will bring out 11-inch vacuum-tube models this summer for $100.

THE LATEST TV RECEIVER by Zenith is a 16-inch portable which, to provide a rugged assembly, has a superstructure attached to the chassis for mounting the tuner and loudspeaker at the top (see photo). According to Zenith, the chassis is "horizontal, handwired, handsoldered and handcrafted."

The circuits are almost identical to those of Zenith's 19-inch 114-degree table model sets, except that the power transformer has been eliminated to reduce weight. A 13J10 tube, which combines the 6BN6 audio detector and an audio pentode similar to the 6AQ5, was used to save space.

This receiver uses a 16AVP4 picture tube incorporating the new low-drive high-γ gun developed by the Rauland Corporation, a Zenith subsidiary, which provides a much higher brightness for a
given amount of video drive, by designing for a
greater amount of available beam current when the
grid-to-cathode voltage approaches zero during peak
white video information.

Even though a much larger amount of beam cur-
crent is available when it is needed (during high-
lights), the design provides that the beam current
is greatly restricted when the tube accidently loses
its bias or the set is turned off. This eliminates the
hazard of screen spot burn without complicated ex-
ternal circuits. The new gun is also used in all Zenith
19-inch tubes and most of the 23-inchers.

The 16-inch portable tv receiver has the automatic
fringe-lock circuit that is on all Zenith tv sets. On
previous receivers, the degree of noise immunity was
determined by the adjustment of a fringe-lock con-
trol in the noise-gating grid of the age and sync
clipper tube, which was set by the serviceman to
suit local signal conditions. In some instances, where
both strong and weak signals exist, the noise pro-
tection of the weak signal had to be compromised so
that a “paralysis” or “split-phase” condition would
not occur when switching to a strong-signal channel.

The automatic fringe-lock circuit uses a varistor
instead of an adjustable control (Fig. 1). As the
signal level to the detector decreases, the video screen
decreases in potential. Since the varistor is con-
ected to the video screen, less potential is applied
across the varistor. This action is the same as adjust-
ing the fringe-lock control.

THE “COOL CHASSIS” contruction that Philco
has featured for the last three years in their black-
and-white console tv sets was extended last year to
their 19-inch portables, and is now used in the 16-inch
Courier portable.

This ventilation design features extra openings in
the chassis, all components mounted on top of the
chassis, heat barriers to isolate high-heat components,
and elimination of heat traps. Philco claims a heat
reduction of, for instance, as much as 24 percent in
operating temperature in the sync separator area,
equivalent to 15 deg C.

The Courier black-level circuit (Fig. 2A) d-c
couples a signal reference level from the video out-
put stage to the crt cathode. This reestablishes a
uniform d-c signal level, which is relatively un-
affected by the changing picture information. The
d-c reference level is taken from the plate of the
video output stage, and is applied to the crt cathode
through peaking coil $L_1$ and resistor $R_1$. With the
d-c level once established, the video information is
then fed to the cathode through the contrast con-
trol and capacitor $C_1$.

In the Courier, a varistor limits the maximum
vertical pulse amplitude before applying it to the
vertical output transformer (Fig. 2B) and adjusts
vertical drive in compensation for slight compo-
nent-value changes that occur as the set warms up.
Pulse limiting is required to prevent damage to the
vertical output transformer by the high-amplitude
vertical spike. During pulse time, capacitor $C_1$, which
is connected to the plate of the vertical output stage,
charges through varistor $R_1$, causing a high potential
to appear across the varistor. Varistor resistance
decreases, causing $C_1$ charging current to increase.
Thus, the amplitude of the vertical pulse is reduced
or damped by the $C_1$ and $R_1$ shunt load. However,
during the time between pulses, the reverse situa-
tion exists. The potential across $C_1$ and $R_1$ is low,
which increases the varistor resistance, and thus the
effect of the $C_1R_1$ shunt path is lessened, resulting
in no appreciable loading or damping of the sweep
voltage during line time.

PAST PERFORMANCE

Last year was the best since 1956 for tv, and the best
ever for radio sales, according to EIA. Nearly 5 mil-
lion phonographs were sold in 1962, almost a million
more than previous year, with stereo outselling mon-
aural almost 3 to 1.
For regulation of the vertical output-stage bias, a negative potential is developed across the varistor in proportion to the pulse amplitude. The bias path is from the junction of $R_1$ and $C_1$, through the vertical size control to the grid of the vertical output stage. If there is an increase in yoke impedance during warm-up of the set, the vertical sweep decreases, and the resulting lower-amplitude vertical pulse that appears across $C_1$ and $R_1$, causes the varistor resistance to increase, the charging current through $C_1$ to decrease, the negative potential across the varistor to decrease, the negative potential at the $R_1$ end of the vertical size potentiometer to decrease, and the negative grid bias on the vertical output stage to decrease. Thus, vertical output conduction is increased, which increases vertical scan.

Among the latest innovations in Philco tv receivers is the extended use of frame-grid tubes in tuners, i-f and video stages. A new circuit often requires that changes be made elsewhere: the reduction of B-plus voltages for longer life of, and less stress on, components required the development of low-voltage, high-efficiency sweep tubes, high-$G_m$ picture tubes and a frame-grid video tube. The use of high-$G_m$ picture tubes necessitated new production techniques for gun alignment and spacing jigs. The introduction of modular construction for i-f circuits required development of a system to provide built-in capacitances and inductances in etched-circuit subassemblies. The use of d-c coupling in video stages required new developments in contrast controls. Other recent innovations are: introduction of toroid vertical deflection coils in the yoke, for greater efficiency in the vertical circuit, and use of varistors as regulating devices for sweep circuits.

COLOR TELEVISION—Predictions on 1963 sales of color tv run from 250 to 700 thousand sets. Last year, 400,000 color receivers were made, but only half that many ended up in homes, mainly because of price. The GE base price for a color set is $495, unchanged from last year. RCA is so optimistic over the color market that after this year they will no longer supply their color chassis to other users, claiming they will need the entire production for their own sets.

The current producer of all picture tubes for color sets, RCA, will have competition shortly. This fall, National Video Corporation plans to market a 23-inch 90-degree rectangular color picture tube, which will permit color tv sets to be reduced more than 20 percent in depth from the present 27-inch front-to-rear bulk. A Zenith subsidiary, Rauland Corporation, will shortly begin production of a 21-inch 70-degree color tube, the same size as the RCA tube.

A Japanese 14-inch color set that weighs 70 pounds will be sold here in June for $369 by Delmonico International, along with a 17-inch color receiver for $429. Unlike previous Delmonico receivers, which had a U.S.-made color tube on a Japanese chassis, both these sets feature Japanese color tubes.

TAPE RECORDERS—Over half a million tape recorders were sold in 1962, with a rising rate of increase that may result in 50 percent more sales for
AMPLIFIER, one of five in multichannel chassis for do-it-yourself Artisan organ—Fig. 3

F-M MULTIPLEX receiver, partial schematic, by Admiral—Fig. 4

REAR VIEW of Artisan build-it-yourself organ, Imperial model, with over 250 independent oscillators and 30 preamplifiers
1963 over last year. It is expected that an increasing number of manufacturers will incorporate tape decks in consoles, one reason being that a tape recorder goes well with f-m stereo in a console. The current mixture of recorders sold is 50 to 60 percent complete monaural; 30 percent stereo playback and monaural record; 15 percent full stereo; and about 5 percent component decks.

The 44-pound Concertone model 605 stereo recorder (see p 50) has a double-gap ferrite-core erase head. With a bias frequency of 100 Kc, nickel alloys get hot due to eddy-current losses, but ferrite at that frequency operates with virtually no heat. Thus the tape can remain stationary while the machine is in record mode without burning or warping. The double gap erases the tape twice, in effect, and permits an erasure of 65 to 70 db. The play head is completely shielded with Mu-metal to help eliminate reverse-channel crosstalk when four-track heads are used: the flux on the tracks not being played is shorted across the Mu-metal front. By holding the play head gap to 0.0001 inch, a 15-Kc response at 7½ ips results. The entire head assembly can be unplugged and replaced with other head combinations, for full-track, two-track or four-track recording.

The Norelco 4-track stereo recorder, model Continental 401, features four speeds, including 1/2 ips for up to 32 hours of recording on a 7-inch reel, using half-mil tape and one track at a time. Using a 0.0001-inch head-gap, the reported frequency at ±3 db at this speed is 60 to 4,500 cycles.

**ELECTRONIC ORGANS**—A new type of organ will be introduced by Electro-Voice in the latter part of this year, based on electrostatic pickup of organ tones from physical analogs of the complex waveforms.

Pipe organs of outstanding timbre were recorded, and the recordings converted to circular waveform patterns (Fig. 2C) on a six-inch stator plate. The organ contains 24 of these plates, two for each different note of the octave, with each pair providing all the various voices in the different octaves for that note. The outer waveforms are for the top octave; pedal notes are in the center. A synchronous motor rotates over the waveform plates, producing a variable capacitance that is fed to a stator connector which carries only that one waveform signal.

The Electro-Voice organ has only four basic units: stator-plate tone generator, key switches, power amplifier and loudspeakers. The amplifier of the integral audio system has three tubes, and three more are in the power supply. Tone cabinets have been developed that will include loudspeakers such as the 30-inch woofer, to produce fundamental base frequencies down to 15 cps. These low frequencies are felt physically as well as heard.

The Wurlitzer Company introduced their first all-transistor organ this year. Previously, their organs were either of the vacuum-tube or amplified-reed types. The new organ uses 87 diodes and 84 transistors, in a two-keyboard configuration with a 13-note pedalboard and 22 tone-controls tabs. An earphone plug permits silent playing. Twelve transistor oscillators and a divider chain produce square waves for such organ voices as the woodwinds, stepped flute and tibias. Diode keying and shaping circuits produce a sawtooth pattern, for voices such as the strings, open flutes, reeds, brass and diapason. By pressing the volume control to the right with the foot, all the organ frequencies slide up in a half-tone for creating such effects as the Hawaiian guitar, slide trombone, and the portamento of bowed instruments. This feature was used on the Lowery organ several years ago.

A recent Artisan build-it-yourself vacuum-tube organ is the three-manual Imperial model (see p 52), with a 32-note radiating pedalboard. It features the theater-type horseshoe console, which is becoming more and more popular. The Allen Organ Company is now building four theater-type models.

Optional accessories for the Artisan organs include chimes, glockenspiel and band box. The Imperial has booth theater and concert-type voices. Artisan feels that "although several organ firms have gone over to transistor oscillators, the tone quality of the transistor does not compare with that of the vacuum tube, and the cost factor offers no advantage either."

The latest Artisan transistor 5-channel amplifier has a varistor control circuit that allows one or more amplifiers to be controlled by a single line from the volume pedal. Each channel (Fig. 3) has its own volume, bass and treble controls, for flexibility in voicing the stops with which each amplifier is used.

The two-transistor preamplifier circuit was chosen because of its inherent low-noise characteristics, temperature stability and economy. The driver circuit, which uses full negative feedback and therefore has no effective voltage gain, supplies the base currents to the output transistors with the required phase relationships to drive the power-output half-bridge circuit.

The half-bridge varistor circuit was chosen because it introduces the least noise into the amplifier circuit and can provide the desired level control. The shot noise produced by a thyrite seems to be most active during the period when the bias voltage is applied, and is usually reduced noticeably within 15 or 20 seconds.

**F-M STEREO**—A transistor f-m multiplex receiver will be introduced this month by Admiral, with noise squelch, automatic stereomonaual switching and an incandescent-lamp multiplex beacon.

Noise squelch is obtained between stations by using transistor Q, (Fig. 4) as an r-f controlled 19-Kc amplifier. With no signal to the receiver, Q, is cut off by a small positive voltage from the ratio detector, developed by noise. The combination of capacitor C, and diode D, senses the presence of a signal and develops a bucking voltage sufficient to turn on Q, activating the subcarrier regenerating channel. Because this activating point is at a level approaching quieting, effective noise squelch between stations is accomplished.

The Q, circuit is a switched 38-Kc amplifier. In the absence of 19-Kc information to D, and D, no bias is developed between the base and emitter of Q, thus.
cutting off the amplification of this stage. When 19-Kc signal is applied to these diodes, they act as a full-wave rectifier, doubling the frequency and developing a d-c component that turns on $Q_s$.

Simultaneously, resistors $R_s$ and $R_a$ adjust the operating conditions for the multiplex decoding diodes $D_s$ and $D_a$. When $Q_s$ is not amplifying (in the absence of a 19-Kc multiplex sub-carrier), there is no voltage drop across $R_s$, as a result of $Q_s$, collector current, and thus $D_s$ and $D_a$ are forward-biased through $R_s$ to allow undistorted transfer of the monaural signal through the diodes. When $Q_s$ receives subcarrier information, it passes current through $R_a$, which in turn lowers the voltage at the junction of $B_s$ and $R_a$, to reduce the bias for $D_s$ and $D_a$ for proper stereo operation.

The d-c current change through $Q_s$ is also passed through $R_s$ to control the stereo indicator light. Transistor $Q_s$ acts as an emitter follower, turning the light on when voltage is developed at the base of $Q_s$, and turning it off when there is no voltage.

Supplementary carrier authorization (SCA) rejection is performed by a filter network that attenuates the entire SCA service band while passing the sum and difference information and adjusting the delay between the two for proper detection at $D_s$ and $D_a$. This removes commercial f-m services.

SPEAKERS—The recently developed Matsushita MF-800 loudspeaker and amplifier combination features what the manufacturer calls a variable acceleration-velocity type of motional feedback (MFB) system. This system obtains adjustable damping and frequency response in the low-frequency range.

Motional feedback refers to feedback of a voltage in proportion to the vibration of the MFB speaker cone, to the driver stage of the amplifier (Fig. 5A). The source of the voltage pickup is an electromechanical device in the loudspeaker. Previous systems fed back the voltage in proportion to the velocity of the loudspeaker cone; this system feeds it back in proportion to the acceleration of the loudspeaker cone, to the driver stage of the audio amplifier. The results are, according to Matsushita, an extended reproduction range and reduced distortion.

When the velocity-type MFB is applied to a cone-type loudspeaker mounted in an infinite baffle or in an enclosed box, the response characteristics will change as shown in Fig. 5B. The lowest response frequency does not change; rather, the sharpness $Q$ of the resonant point of the loudspeaker movement changes. Therefore, as the velocity feedback increases, the low-range response will be lowered proportionally and tends to become overdamped, requiring preemphasis in the preamplifier circuit.

When acceleration-type MFB is applied to a cone-type loudspeaker, the axis of the frequency response changes, as shown in Fig. 5C. The apparent lowest resonance frequency will be lowered and the resonance sharpness is increased, resulting in an expansion of the reproduction range at low frequencies. There is less distortion in the acceleration-type MFB than in the velocity type, according to Matsushita, because there is no decrease of feedback even in the high-frequency range. When the feedback of the acceleration type increases, the sharpness of the resonance $Q$ at the lowest resonance frequency becomes wider, and the value of $Q$ changes. Therefore, the combination of velocity and acceleration types gives a more flexible method of changing the response at the low-frequency range.

The MF-800 picks up the voltage in proportion to the velocity of the loudspeaker cone by a pickup coil moving in the magnetic field, and feeds back this voltage change in proportion to the acceleration, through a differential circuit. The phase shift of the feedback voltage increases in the high-frequency range, and unless acceleration feedback is reduced, an unstable feedback system may result. Also, less acceleration feedback will cause an increase in gain.

MOTIONAL FEEDBACK: feedback loop, with partial schematic of amplifier (A); effect of velocity-type MFB (B) and of acceleration-type MFB (C) in loudspeaker-amplifier system by Matsushita—Fig. 5
New Digital Conversion Method Provides Nanosecond Resolution

This analog-to-digital converter uses a bank of 8 sampling circuits that simultaneously receive a signal but fire at different levels to quantize the signal.

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ANALOG-TO-DIGITAL conversion systems usually consist of an analog storage device (delay line, capacitor, pulse-stretcher) ramp generator, coincidence circuits, and digital clock or scaler. These circuits record the number of clock pulses between a start pulse and the coincidence between the height of a ramp function and the unknown stored analog signal. The delays inherent in such systems (Scaler resolution, data address, etc.) usually limit time response to $10^{-6}$ to $10^{-4}$ sec. Faster time response may be achieved by using one analog storage device per data point.

A new method of analog-to-digital conversion that lends itself to much shorter resolving times is the parallel sampling of an unknown input signal at predetermined levels and time intervals. Figure 1A is a block diagram of a system that employs parallel sampling to provide nanosecond analog-to-digital conversion. A signal source such as a scintillator-photodiode converts a nuclear signal to its electrical analog and transmits it to the height sampler. The number of height samplers determines the number of binary bits per digital word. The input voltage signal is sampled and digitized by comparing it with known discrete levels. It is then coupled to a gating circuit (time quantizer) where time information is added which results in an output of digital-pulse-height per unit of time. The sampling and gating circuits, contained on one circuit board, consist of eight 4-transistor difference amplifiers and 8 tunnel diode gating circuits.

SAMPLING CIRCUIT—One of the sampling circuits is shown in Fig. 1B. The input impedance of this
circuit is 50 ohms; however, the use of balanced emitter followers $Q_1$ and $Q_2$ increases the apparent input impedance seen by the input and reference signals to greater than 10,000 ohms. The input signal is compared to the reference signal in the emitters of $Q_1$ and $Q_2$. In the quiescent condition $Q_1$ is conducting and generates a current $I_1$. The voltage $I_1$, $R_1$ keeps $Q_1$ cutoff until the emitter current $I_1$ through $Q_1$ is greater than $I_n$. Then $Q_1$ is driven to cutoff and $Q_2$ is turned on. Between cutoff and saturation both $Q_1$ and $Q_2$ act as amplifiers whose voltage gain is a function of $R_2$, $R_3$, $R_4$, and the beta of $Q_1$ and $Q_2$. A positive output signal is generated across $R_2$. These currents have 1-nanosecond switching and 4-nanosecond delay time.

Eight of these sampling circuits are connected in parallel and divide the input signal at each point in time into eight basic levels. A change in the absolute value of the reference voltages does not effect the ratio between any two levels. Sampling may be accomplished on input signals ranging from millivolts to 10 v and in a linear (2 decades) or logarithmic manner (3 decades). Figure 2 shows the results of sampling a fast rising pulse.

**GATING CIRCUIT**—The signals from the sampling circuits are connected to one input of the fast tunnel diode gating circuits (Fig. 3).

A 100-Mc clock pulse is connected to the other input and a coincidence between the signals occurring at the two inputs quantizes the signal being analyzed in time. A pulse occurring at the same rate as the clock pulse but delayed by 4 nanoseconds resets the tunnel diodes. This type of tunnel diode gating circuit is also referred to as analog threshold logic circuit. The current through $R_1$ holds tunnel diode $D_5$ in the low voltage state. An input to $E_1$ from the height samplers causes the current through $D_5$ to increase from 5 to 8 ma. If this input is coincident with a clock pulse at $E_0$, an additional 3-ma current flows through $D_4$, causing $D_4$ to switch from the low voltage state to a high voltage state. Low voltage state is 60 mv, high voltage is 400 mv. Diodes $D_1$ and $D_2$ isolate the inputs from each other and $R_3$ limits the current through $D_4$, when $D_4$ is in the high voltage state. $D_2$ passes current when $D_4$ is in the high voltage state. The switching time of this circuit is better than 1 nanosecond. The output of the gating circuits is digital-pulse-height per unit of time.

Amplifier circuits (Fig. 4) provide sufficient current gain to store the digital information from the gating circuits in the memory. This wideband amplifier consists of four class A common emitter a-c coupled cascaded amplifiers with negative feedback at every second stage. The amplifier has a voltage gain of 12 and a bandwidth of 100 Mc (upper 3 db point). The rise time of the circuit is 3 nanoseconds; pulse pair resolution is 5 nanoseconds. The signal-to-noise ratio is better than 100 to 1 for input voltages from 0 to 200 mv. The drive circuits produce current in the word and information lines of the memory during the read or write mode and develop 4 and 2 amp in their associated lines.

**MEMORY**—The memory package (see photo) has a storage capacity of 160 eight-bit words. It is connected for parallel input and access. It consists of a work-oriented, current-coincident, thin, magnetic film memory. Each 8 by 20 memory plane is fabricated by vacuum deposition of the thin film in a strong magnetic field. The work lines are parallel to the hard direction and generate a field parallel to the preferred direction. The sense lines are located between the information conductors and reduce the capacity between the sense and information lines. Pulses of 5 nanoseconds width with 1-nanosecond rise time occur-

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**A/D CONVERTER USES**

Extremely fast analog-to-digital conversion of singly occurring transients or randomly occurring pulses can be achieved with this analyzer. It can also sense a zero slope per unit time and in this mode it can be used as a multichannel pulse height analyzer with a dead-time dependent only on the rise of pulses it is analyzing.
ring at a 100 Mc rate have been stored in the existing memory.

Sense amplifiers have been developed to read the information stored in the memory. An amplifier (Fig. 5) amplifies the small signals stored in a desired memory location while simultaneously rejecting noise appearing from partially selected bits on the same sense line. It consists of a completely isolated differential amplifier operating from a low impedance source.

If the converter is to be used as a pulse height analyzer for rapidly occurring random voltage pulses, a height logic card is provided. This logic circuit senses the maximum pulse height of incoming signals and causes the information to be stored in the memory as a function of pulse height.

Temporary storage circuits provide buffer operation and circuit time compatibility between the fast memory and a slower digital-to-

analog converter and furnish binary-to-decimal data to Nixie tubes for visual readout. The parallel-to-serial converter transfers serial word data to a telemetry unit for space and field operation.

CONCLUSION — This analyzer provides extremely fast analog-to-digital conversion of singly occurring transients or randomly occurring pulses. It senses a zero slope per unit time and in this mode can be used as a multichannel pulse height analyzer with a dead-time which is dependent only on the rise of pulses it is analyzing (pulse pair resolution of 10^-7 sec for random pulses with a 0.1 μsec time is possible).

It has a 160 eight-bit word storage capacity and is limited to 10 nanosecond sampling time by the available memory devices. Silicon transistors and a thin film memory in modular design provide temperature stability and physical rigidity of the entire system.

BIBLIOGRAPHY


Standard 400-cps equipment can be operated from either single-phase or three-phase 60-cps lines. This frequency multiplier requires fewer transformers, and output voltage remains constant despite large variations in supply voltage.

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STATIC 60-to-420 cps frequency multiplier provides constant square-wave voltage despite large variations in supply voltage. The highly reliable septupler can be used to operate 400-cps equipment from either single-phase or three-phase 60-cps lines. Since the output terminals can be permanently short-circuited, the multiplier protects itself and the equipment it supplies from overloads.

Seven saturable transformers are used in the frequency multiplier. The multiple primary windings are series-star connected and the secondaries are series-aiding connected. The use of capacitors and linear reactors in the primary circuit permits operation from a single-phase source as well as providing excellent stability in the output voltage.

The possibility of using saturable-core transformers as static frequency multipliers has attracted interest since the beginning of the century. Recent developments, particularly in the fields of magnetic amplifiers and flux-gate magnetometers, have revived interest in methods of producing even or odd-harmonic multiples of power supply frequency. The phase-multiplier type stabilized 60-to-420 cps frequency transformer has increased in importance for operation of standard 400-cps equipment from 60-cps lines.

Conventional frequency multipliers operating from three-phase supplies at frequency ratios of $n = \frac{T}{f_p}$...
Stable 420-Cps Voltage

5, 7 or 9 require additional transformers for deriving $n$ saturable-reactor supply voltages. By providing multiple primary windings in this multiplier, the need for these additional phase-changing transformers is eliminated. By combining the primary circuits of the seven saturable transformers with three power-factor correcting shunt capacitors and three series-connected linear reactors, excellent stability of the output voltage is obtained. Thus this magnetic frequency multiplier has the properties of ordinary ferroresonant constant-voltage transformers.

Only minor modifications are needed to operate this three-phase frequency multiplier from a single-phase supply. By using a single linear reactor instead of three separate linear reactors, the seven saturable-core transformers with three shunt capacitors function as a phase converter, establishing a substantially symmetrical three-phase system.

A stabilized 60-to-420 cps frequency multiplier providing output power up to about 40 watts was required for several laboratory projects. Two similar prototype designs have been developed using these basic concepts. The three-phase design operates from a source in the range of 180 to 220 volts, while the single-phase design operates in the range of 100 to 140 volts. Measured total efficiency (watts out divided by watts in) of both multipliers is about 60 to 70 percent with a purely resistive load.

PRINCIPLE—The magnetic frequency septupler in Fig. 1A is a special form of the phase-multiplier frequency transformer. With an odd-harmonic frequency ratio, $n$, a substantially sinusoidal magnetizing current is produced by suitably interconnecting $n$ saturable transformers into an $n$-phase group from which the $n$th harmonic voltage is filtered by a polygon-winding connection. Frequency multiplication ratio $n$ may be an odd number, generally 5, 7 or 9.

Actual magnitude of the square-wave output voltage of a frequency $n$ times supply frequency $f$, can be maintained nearly constant by the saturated magnetic cores. Thus, the circuit also serves as a constant-voltage transformer. Power-factor correction is achieved by shunt capacitors and series-connected linear reactors. Also, capacitive compensation of the inductive impedance of the multiplier can be used.

The frequency septupler in Fig. 1A has $n = 7$ saturable transformers with the indicated percentage of turns in the multiple primary windings and series-connected secondary windings. The corresponding star-connected groups of primary windings are supplied with three substantially sinusoidal currents $I_s, I_n, I_r$ displaced 120 degrees apart and derived from the three-phase, three-wire supply $R, S, T$.

In the three-phase circuit in Fig. 1A, shunt capacitors $C_s, C_n$ and $C_r$ and series-connected linear reactors $L_s, L_n, L_r$ are used to obtain constant output voltage $E_r$. Despite large variations in power supply voltage $E_r$, these stabilizing and power-factor correcting components are connected between power supply terminals $R, S, T$ and inner terminals $R', S', T'$ of the frequency-transforming system.

In the single-phase version in Fig. 1B, only linear reactor $L_r$ is required. Power supply voltage $E_r$ is injected to only two of the inner group terminals (such as $R'$ and $S'$). The saturable transformers function as phase converters, establishing a symmetrical three-phase system. The three line-to-line voltages across inner terminals $R', S', T'$ are made equal by the same voltage-controlling process that stabilizes output voltage against variations in power supply voltage.

A small voltage at the fundamental frequency appearing in output voltage $E_r$ can practically be eliminated by suitable adjustment of capacitors $C_s, C_n$ and $C_r$. In the two branches not connected directly across the single-phase supply leads,
phase angle must lead by 60 degrees in one branch and lag 60 degrees in the other. To obtain these phase angles, it is necessary only to overcorrect phase angle slightly in one branch and undercorrect it in the other.

CURRENT VECTORS—To derive seven primary ampere-turns, AT₁ through AT₇, displaced 360/7 degrees apart from the three 120-degree displaced supply currents, several properly rated ampere-turn components are added or subtracted vectorially. The relationship between the currents is shown in Fig. 2. In the phase-transforming circuit in Fig. 1A, the three currents are used to produce seven ampere-turns displaced 51.4 degrees apart to excite the seven transformers. The phase relationship between the seven-legged star that forms the seven-phase magnetic-flux system and the three-phase primary-current system is irrelevant in principle. However, some circuit symmetry is desirable.

The preferred distribution of the multiple primary windings over the three star-connected phases is that which results in the most suitable phase range of ampere-turns that can be produced with the greatest economy (least copper resistance of primary windings) by each pair of 120-degree displaced phase currents. In the actual arrangement corresponding to Fig. 2, circuit symmetry is achieved by choosing saturable transformer 1 in the axis of current Iₕ so that it is excited by only one phase current. In the remaining six transformers, two currents contribute to the exciting ampere turns. The number of primary turns in transformer 1, associated with phase current Iₕ", serves as a reference for designing the other units. The relationship among the primary ampere-turns is indicated in Fig. 1 and 2.

Series-connected secondary windings N₁ through N₇ have the same number of turns. By selecting this number in accordance with the actual load impedance, optimum operating conditions can be obtained. A capacitor can be connected in series with the load to obtain capacitive compensation of the inductive internal impedance of the multiplier.

WAVEFORMS — Generally, any phase-symmetrical distribution of n distorting elements connected to a three-phase system of sinusoidal supply voltage eliminates from the three-phase input current all harmonics of any order below 2n ± 1. This elimination of harmonics occurs because of mutual cancellation of harmonic currents in parallel-connected branches or by mutual cancellation of harmonic voltages in series-connected branches. For this reason, the series-star connection to guide the nearly sinusoidal phase currents through the multiple windings is essential.

Analysis of this type frequency multiplier shows that with n series-excited cores in symmetrical phase sequence, only one core is taken out of saturation at any time. Also, at this instant, the core taken out of saturation generates a counter emf opposing the instantaneous values of any of the three line-to-line voltages in its primary windings. Conversely, any one of the three line-to-line voltages can be considered as cut up in block sec-

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tions that are displaced 180/n degrees in phase and that vary in height by a sine-law distribution depending on the numbers of turns involved.

All of these sections must be approximately rectangular so that a counter emf is always generated in at least one core at a time and so that the counter emf fits into the pattern of all three line-to-line voltages at the same instant. Because of the deviation between applied voltage and the generated counter emf, it also follows that ripple currents of the predominating order, 2n = 1, are generated in the three-phase input current. With n = 7, the resulting deviations from the precise sine wave therefore consist of the 18th and 15th harmonics.

Since the voltage waveform is cut up into approximately rectangular blocks of the same width (180/n degrees), the voltage per turn generated during each zero passage of primary ampere-turns is the same in all cores. The idealized waveform of the individual secondary voltages, appearing across winding N2 through Nn, corresponding to the zero passage of primary ampere-turns is shown in Fig. 3. The individual contributions of the seven transformer units to square-wave output voltage Ew at frequency 7f may is also shown.

WINDING DATA—The three-phase design in Fig. 1A provides up to 40 watts output power with a 60-cps input of 180 to 220 volts. The toroidal transformer cores are made of 2-mil Orthonol tape in 180 wraps. Tape width is 1 inch, inside diameter is 1.5 inches and outside diameter is 2.5 inches. The number of ampere-turns in the primary windings corresponding to the vector diagram in Fig. 2 is shown in the table.

Secondary windings N1 through N7 are each made of 230 turns of No. 25 wire. Linear reactors L1, L2, and L3 have MoPermalloy powder cores and are Arnold type A-459,-281-2 with an inside diameter of 0.95 inches, outside diameter of 1.84 inches and 0.71 inch high. Each reactor has 1,000 turns of No. 26 wire (9 ohms). Nominal permeability is 125 and nominal inductance is 0.281 henry.

The same toroidal transformer cores are used in the single-phase design in Fig. 1B, which operates from a 60-cps input of 100 to 140 volts. The primary windings are made of No. 18 wire, and the number of ampere-turns for the single-phase system is also shown in the table. The secondary windings are again formed of 230 turns of No. 25 wire.

Linear reactor Lx, has two stacked MoPermalloy powder cores and are Arnold type A-899.142-2 with an inside diameter of 1.93 inches, outside diameter of 3.063 inches and are each 0.5 inch high. The reactor has 600 to 1,200 turns of No. 20 wire (2 to 4 ohms) and is adjustable with taps. Nominal permeability of these cores is 125, and nominal inductance of the two stacked cores with a 1,000-turn winding is 0.284 henry.

RESULTS—The three-phase system in Fig. 1A with the symmetrical input circuit has been designed for a nominal supply voltage of 208 volts and requires three relatively small capacitors. The single-phase system in Fig. 1B requires considerably larger capacitors. However, this system can be used where a three-phase, 208-volt supply is not available. For example, this frequency multiplier can be used with small 400-cycle magnetic amplifiers operating from single-phase, 120-volt, 60-cycle supplies.

The satisfactory stabilization achieved is indicated by the performance characteristics obtained in the three-phase system and shown in Fig. 4. The rms values are shown of primary winding current Ix (one of the phase currents Ix, Iy, or Iz), capacitor current Ir, and linear reactor current Iz. Also, output voltage is shown across resistive loads of 300, 500 and 10,000 ohms.

Similar characteristics in Fig. 4B for the single-phase system are for the special case of a load consisting of two magnetic instrument amplifiers connected in parallel. These push-pull type two-stage amplifiers, which supply a two-channel ink recorder, present a substantially constant inductive load of about 40 volt-amperes. In this application, a 3-microfarad capacitor was connected in series with the load for capacitive compensation of the inductive impedance in the output circuit. The measured rms values shown in Fig. 4B are primary current Ir, input current Ix, through linear reactor Lx, and load voltage Ew, which is the 420-cps power supply voltage of the magnetic amplifiers.

The output voltage waveform of the three-phase system with a purely resistive load of 300 ohms is shown at the top of Fig. 5. Output of the single-phase system with the magnetic amplifier load is considerably distorted from the rectangular waveform, as shown at the bottom of Fig. 5. However, this distortion was found not to affect operation of the magnetic amplifiers.

A breadboard model of the single-phase system is shown in the photograph. All the components can be contained in a portable case about 12 by 10 by 6 inches. This system, which offers the advantages of ordinary constant-voltage transformers such as ruggedness, reliability and almost unlimited life, does not require servicing.

REFERENCES

(2) E. Friedlander, "Prüfenzwandler (Frequency Transformer)," German patent No. 679,577, August 9, 1939.
(4) E. Friedlander, "Principle and Analysis of a Stabilized Phase Multiplier Type of Magnetic Frequency Converter, Electrical Energy, 1, p 55, October 1956.
Four-layer diodes alone, or with transistors or vacuum tubes, form a pulse-modulation technique to produce variable pulse lengths at high repetition rates with rapid rise and fall times.

**SERIES-resistor modulator uses four-layer diodes to produce 350-v 1-ampere pulses—Fig. 1**

**TRANSISTOR and diode modulator can produce up to 5 µsec pulse width at high prf—Fig. 2**

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**THREE NEW APPROACHES**

By E. H. Heckman
Systems Management Department,
Westinghouse Defense Center,
Baltimore, Maryland

**PULSE MODULATION THE NEW WAY**

The three circuits covered in this article use various combinations of four-layer diodes, transistors and vacuum tubes to produce low prf pulses with any length, high prf pulses with widths up to 5 µsec and pulses of any length with close spacing between pulses. They can be used to modulate a twt or in any application where fast-rise, flat, variable-width, ampere-pulses are required for repetition rates to 300 Kc.

**MANY** high-power traveling wave tubes are gridded, enabling the output to be controlled by a relatively low-power modulator. Some of these have an over 10 Kw output, yet are controlled by grid pulses of 500 v with grid interception of 0.6 amperes or less.

The three modulators described here can modulate two tubes in parallel, or may be used in other applications wherever fast-rise, flat, variable-width, ampere-pulses are required at repetition rates up to 300 Kc. Pulse width is variable from 0.1 to 5 µsec for all circuits, and two circuits will produce millisecond pulses at low prf. The circuits were designed to operate between -250 volts and +250 volts, but may be altered to operate between other limits.

The circuits described are on-off types in which the B+ is switched on by a trigger to charge the inherent load capacitance (twt grid to-cathode plus strays) of up to 50 pf in less than 20 nsec. The pulse remains flat until a second trigger returns the load to the negative bias, discharging circuit capacitance in 15 to 50 nsec, depending upon the circuit design chosen.

Triggers required to pulse the modulators may be obtained by differentiating the output of a commercial low-voltage pulse generator, except in the third design where a higher voltage is required.

**SERIES RESISTOR MODULATOR**—A combination of four-layer (pnpm) diodes and a series resistance makes a simple modulator that will produce an excellent pulse shape at low repetition rates. Figure 1 shows an experimental circuit that produces 350-v, 1-ampere pulses. A negative trigger produces an over-voltage on the top four-layer diode of the ON circuit causing it to avalanche and apply full voltage across the rest of the load, minus the IR drop through \( R_e \). Diode \( D \), in series with resistance \( R_e \), paralleled by capacitor \( C \), simulates the...
TO PULSE MODULATION

load of a twt grid for test purposes. In the test setup, a 5687 was diode-connected to handle the one ampere pulses. The resistance and capacitance values were determined from the characteristics listed by the twt manufacturer to duplicate the grids of two tubes in parallel. When the positive spike triggers the off string of four-layer diodes, the voltage at the lower end of $R$, is depressed to $B^-$. The current reverses in the on string so the diodes turn off (recover). When capacitor $C$, charges, current through the off circuit is limited by $R$, to a value below the holding current of the off string of four-layer diodes, and they recover. Then $C$, discharges through $R$, and the cycle is repeated. This circuit produces the pulses shown at the bottom in Fig. 1.

The Shockley 4G200 diodes used in the circuit require several microseconds to recover so that $C$, must be relatively large and $R$, must be a high resistance to turn off diodes that have low holding current. Thus, the circuit produces only one or two hundred pulses a second. The prf can be increased by selecting diodes for fast response and high holding currents and by replacing $R$, and $C$, with an LC network. Pulse voltage can be raised to 500 v by using an additional diode in each string.

TRANSISTOR AND DIODE MODULATOR—High prf may be realized by replacing the series resistor of Fig. 1 with transistors. To obtain rise times faster than the turn-on time of transistors, four-layer diodes are again used in series in an on circuit (Fig. 2). The transistors are pulsed on and when the lower end of the string reaches a voltage near $B^+$, the two on four-layer diodes avalanche, applying a fast rise pulse to the load. The pulse to the transistor bases must be maintained to hold the transistors on. At the end of the pulse, they turn off but continue to conduct due to internal delay. At the end of the delay period, the off string of four-layer diodes is triggered and the load is brought rapidly to $B^-$. Heavy surge current through the transistors reduces their turn-off fall time and when transistor current ceases, the four-layer diodes recover and the circuit is ready for another pulse. Diodes can be selected from 4G200 units that will permit 100-Kc repetition rate. Special experimental Shockley diodes, manufactured by a gold-diffusion technique resulting in faster recovery, allow three-microsecond pulse spacing.

The 2N1508 transistors were used for experimental tests under overvoltage conditions. The bases were pulsed by a special transformer with five secondaries with each secondary rated at 8 v for 80-ohms load and would hold up a 5-µsec pulse. The off trigger can be provided from the trailing edge of the on pulse by reversing the transformer to work with negative
pulses and by using a 50-nsec delay line to connect to the off circuit.

Figure 2 also shows the pulse obtained with this circuit. Note that rise time is about 20 nsec, fall is 40 nsec and the top of the pulse is virtually flat.

HYBRID MODULATOR—Voltage limitations of fast-response transistors available during this development required an impractically large number of expensive transistors. Accordingly, a hybrid circuit was developed to combine the flat pulse obtained with four-layer diodes and the current handling capabilities of tubes.

The hybrid modulator is shown in Fig. 3. Both on and off triggers determine pulse width. However, both on and off triggers must be about 250-v amplitude. The method of triggering the four-layer diodes is unconventional, but turns on a string of diodes faster than methods previously reported.

Tube V1 is normally on, operating self-biased through Rn, and current is returned to the reference supply to hold the cathode at about 400 volts. The four-layer diodes are switched on by a positive pulse across diodes D1 and D2 supplied from 1:1 isolating transformer T1. These avalanche, follow immediately by avalanche of the rest of the string. Increased current through V1 drops the cathode about 100 v, supplying the load (twt grid) at +300 volts. The grid of V1 is held at approximately zero bias during the pulse by resistor Rn. Current from the +350-v supply is limited by R, during the pulse. The result is a pulse that will remain flat indefinitely. The off trigger turns on V1, and pulls down the grid of V1, to cut it off, terminate the pulse and discharge the capacitance of the load. The grid of V1 is recharged to the self-biased state through the L-R, series combination. The inductance holds off the grid rise to allow time for recovery of the special four-layer diodes. Closest pulse spacing with this circuit is about 3 µsec. The L-R, circuit must be changed to increase recovery time to about 10 µsec if 4G200 diodes are used.

The hybrid modulator produces the pulse shown in Fig. 3. Rise and fall times are about 15 nsec for a 550-v, 1.4-ampere pulse. A minor dip near the leading edge can possibly be reduced with minor circuit changes. An extra clamp may be required in some applications since the output pulse voltage is determined by the 400-volt drop through output tube V1. Extensive tests of clamp circuits were conducted. Semiconductor diodes were found to be superior to thermionic types in clamping the initial 100 nsec of a pulse. A string of 1N697 diodes to a positive reference will provide an excellent clamp. A series resistance of about 50 ohms should be inserted ahead of the clamp. Without the additional pulse clamp, changes over the tube life will change the pulse voltage.

All three modulators described have turn-on and turn-off delays on the order of 50 to 100 nsec. Such a delay is also inherent in vacuum-tube circuits. However, extreme care is required for four-layer diode circuits to insure that the delay remains constant. Changes may occur due to variations of trigger voltage, B+ or B—voltage, ambient temperature and aging.

The first circuit (Fig. 1) presented is preferred for low prf pulses of any length. The second (Fig. 2) is preferred for high prf and pulses up to 5 µsec while the hybrid circuit (Fig. 3) will produce pulses of any length with close spacing subject to component duty cycle.

The circuits are unique in their ability to produce fast rise time, flat pulses at high power levels. This is accomplished with a minimum of components in an efficient compact package. Newer types of semiconductors which are becoming available will allow even higher pulse repetition rates and higher power outputs. Until semiconductor breakthroughs are made, it is probable that the circuits will find application when high power, variable width pulses are required for twt modulator or similar applications.

The author is indebted to M. L. Jones for suggestions regarding the circuit designs.

May 3, 1963 • electronics
HIGH PRECISION

D-C Level Shifter
Reduces Output Impedance

Circuit uses balanced bridge techniques to maintain constant current through reference zeners; only one d-c supply source is needed.

By JOHN WILLIS, Southern Instruments Limited, Camberley, England

THE OUTPUT SIGNAL of this circuit is a replica of the input signal but it appears at lower impedance, and shifted in d-c voltage level by a predetermined amount. The circuit is a precision one, giving high linearity and low drift. The basic circuit uses only two transistors, two zener diodes and three resistors, plus one supply line which need not be stabilized.

The circuit may be used to shift the output level from any voltage source having a moderately low internal resistance. Originally the circuit was developed as an output stage for a frequency-voltage converter of the saturating-core type, the combined circuit being used as a precision frequency discriminator. Here the output circuit was used to back-off the steady output produced by the carrier frequency, so that the demodulated sidebands produced output voltages varying about ground potential.

SIMPLE CIRCUIT—Consider the conventional solution to the problem shown in Fig. 1A. The backing-off (level shifting) voltage is provided by a chain of zener diodes D1-Dn biased by a constant current I supplied by transistor Q. The input, V_in, is applied at the lower end of the chain and the output voltage V_out, taken from the top through an isolating stage Q. Transistor Q is needed partly to reduce the output resistance, but mainly to ensure that changes of load current do not modify the value of I, otherwise the resulting change in Zener diode working point would result in a nonlinear relationship between $V_{in}$ and $V_{out}$.

This basic circuit, Fig. 1A, has a number of disadvantages. Both...
positive and negative supply lines are needed. The positive line voltage \( V_p \) must be high enough to accommodate maximum positive signal voltage swing on the output, plus bias requirements for zener diode \( D_n \), which may be an extra six volts. The single emitter-follower \( Q_1 \) has only a moderate performance. Noise on the supply bus can reach the output terminals through \( R_c \) for the positive line and through the collector capacitance of \( Q_1 \) for the negative line. The constant current \( I \) from \( Q_1 \) may vary with temperature, resulting in output drift if the source resistance \( R_s \) is appreciable. Also, the output resistance of \( Q_1 \) is finite, so that \( I \) may vary with output voltage, giving rise to nonlinearity.

**IMPROVED CIRCUIT**—The alternative circuit of Fig. 1B uses fewer components but gives a better performance. This circuit maintains a constant voltage between input and output terminals; it also provides an impedance transformation between these terminals.

Transistors \( Q_1 \) and \( Q_n \), Fig. 1B, are connected in a d-c negative-feedback loop. Transistor \( Q_1 \) supplies the current demanded by the bridge network \( R_i-D_i-R-D_n \), while \( Q_n \) detects any unbalance in the bridge and corrects it by changing the bias on \( Q_n \) thus modifying the bridge input current. The current out of the bridge is made up of two components, \( I_1 = (V_p - V_n)/R_c \) and \( I_2 = (V_n - V_i)/R_c \), neglecting \( Q_n \) base current. The zener diodes \( D_1 \) and \( D_n \) are biased by currents \( I_1 \) and \( (I_2 - I_1) \); \( I_2 \) and \( I_1 \) are fixed while \( I_2 \) is small and near-constant, as will be shown shortly. The voltage between the input and output terminals of the circuit is \( V_+ = V_n - V_i \), and will thus be constant, apart from temperature effects. The temperature coefficient of the whole backing-off voltage is the sum of the coefficients of \( D_1, D_n \) and \( Q_n \) emitter-base voltage. By choice of diodes, this may be set to near zero, or to a small positive or negative value.

The impedance transformation occurs as follows. Input signals are applied to \( Q_1 \) base through \( D_i \) and taken from \( Q_n \) emitter through \( D_n \). Transistors \( Q_1 \) and \( Q_n \) are connected as a compound emitter follower². Any change in the collector current of \( Q_1 \) changes the bias on \( Q_n \) so that \( Q_n \) collector feeds back into \( Q_1 \) emitter a current which reduces the original change by a factor \( B_1 \), where \( B_1 \) is somewhat less than the grounded emitter current gain of \( Q_n \). Transistor \( Q_n \) thus behaves as if its current gain were not its normal value (say \( \beta_n \)), but rather \( B_1\beta_n \) giving an impedance transformation of this magnitude between input and output.

The circuit can deliver an appreciable current into a load resistor. Current fed into the load is supplied directly from the collector of \( Q_n \) and can be large assuming adequate precautions against over-load. Current drawn from the load flows into the bridge network, the current supplied by \( Q_n \) being reduced by the same amount. The maximum swing in this direction is thus limited to less than \((I_1 + I_2)\). For a current \( I_1 \) into the load, the working point of \( Q_n \) and the zener diode \( D_n \) change by \((I_2)/B_1\). The resulting change in backing-off voltage can be calculated on this basis and can be made small.

The minimum backing-off voltage available is that developed across two zener diodes in series. Larger voltages can be obtained by adding more such diodes in series with the input lead. The backing-off voltage can be made variable by including a variable resistor \( R_v \), Fig. 2A, in series with the input lead. The current \((I_1 + I_2)\) in this resistor is defined, so the voltage across it will be virtually constant, and the increase in resistance seen at the output terminals will only be \( R_v/B_1 \). However the temperature coefficient of the total current through \( R_v \) is slightly different from that of the backing-off voltage, since \( V_n \) (for \( Q_n \)) occurs once in the equations for \( I_1 \) and \( I_2 \) but only once in the equation for the backing-off voltage.

Incidental advantages of the circuit are that it requires no separate negative supply line, and the positive line voltage need be only slightly higher than the most positive output voltage excursion. The circuit is largely insensitive to changes of supply line voltage at d-c or low frequencies. The small residual effect, which arises from the finite output resistance of \( Q_n \) can be cancelled by inverse feedback through a resistor \( R \) into \( Q_n \) emitter circuit (Fig. 2A). The optimum value for \( R \) is best found experimentally. Figure 2A also gives circuit values.

**DESIGN DETAILS**—This level-changing circuit has, in addition to its normal operating state, a second stable condition in which both transistors are cut off and no current flows. This cut off condition, which can be mistaken for circuit failure, is avoided by ensuring that the circuit output is always connected to some finite value of load resistor.

The circuit must also be pro-
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SPECIFICATIONS

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F. L. MOSELEY CO.
409 N. Fair Oaks Ave., Pasadena, California
an affiliate of Hewlett-Packard
tected against damage by short circuit across the output. If the output voltage is positive when the short circuit is applied, \( Q \) (Fig. 2A) will be turned fully on, so its maximum current must be limited by a resistor \( R_s \) in the collector circuit. Current through \( Q \) is limited to a safe value by \( R_s \). Alternatively, if the output is negative, a short-circuit cuts transistors \( Q \) and \( Q \) off, and the emitter-base junction of \( Q \) becomes reverse-biased. The reverse voltage rating of this junction should preferably be large enough to withstand the largest expected reverse voltage; if this is not possible, the junction should be protected by a shunt diode \( D \) (a series diode would be better, but would increase the temperature coefficient of the backing-off voltage). The maximum current flowing through \( D \) and \( D \) is then limited only by the characteristics of the source, which must be chosen appropriately.

**TEMPERATURE EFFECTS**—The major effect of temperature change on the circuit performance is a change in backing-off voltage resulting from the temperature coefficients of \( D \), \( D \), and \( V_o \) of \( Q \). Variation of temperature will also change other parameters of \( Q \) and \( Q \); the resulting changes in circuit performance can be deduced from the current-flow diagram of Fig. 2B. First consider transistor \( Q \). Feedback action holds the collector current of \( Q \) at an \( I \), value sufficient to turn-on current \(( I_1 + I_2 \approx I_3 \approx 2 A)\) will be turned fully on, so its maximum current must be limited by a resistor \( R_s \) in the collector circuit. Current through \( Q \) is limited to a safe value by \( R_s \). Alternatively, if the output is negative, a short-circuit cuts transistors \( Q \) and \( Q \) off, and the emitter-base junction of \( Q \) becomes reverse-biased. The reverse voltage rating of this junction should preferably be large enough to withstand the largest expected reverse voltage; if this is not possible, the junction should be protected by a shunt diode \( D \) (a series diode would be better, but would increase the temperature coefficient of the backing-off voltage). The maximum current flowing through \( D \) and \( D \) is then limited only by the characteristics of the source, which must be chosen appropriately.

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**small signals**—The circuit constitutes a negative feedback amplifier, so for loop stability the Nyquist criterion must be satisfied. The bridge \( R \), \( D \), \( D \), and \( V_o \) has been discussed; changes in \( D \), and \( V_o \), hardly affect the backing-off voltage, but modify the current flowing out of the bridge circuit as shown in Fig. 2A.

**References**

Varian's low-noise X-band klystron oscillators for CW-doppler or pulse-doppler systems are available with several power ratings and a wide selection of tuning and cooling arrangements. These two-cavity klystrons can be used to meet your requirements for drivers or power oscillators. Improved manufacturing techniques provide a long life of low-noise performance which is guaranteed for at least 500 hours. Frequency stability: excellent. Write for additional information.
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Optical Computers Approach Reality

By JAMES T. TIPPETT and HAROLD E. PUTHOFF
Department of Defense, Washington, D. C.

Subnanosecond computing elements may use fiber optics, glass lasers

A MAJOR BARRIER in speeding up the operation of computers from submicrosecond to subnanosecond range is the demarcation between circuits whose speed is limited primarily by the active component speed, and those whose speed is limited by transmission delays between elements and stray effects surrounding the elements.

New devices are needed that will have faster active elements, that will be substantially reduced in size, and that will have a minimum of energy stored in stray effects.

Promising developments are taking place in optical and optoelectronic devices. These include the invention of the laser, use of fiber optics as both passive and active transmission lines, recent advances in high-speed photodetection, and both incoherent and coherent light-emitting semiconductor diodes.

Many photon processes are inherently fast: the natural lifetime of an isolated nonmetastable atom is in the nanosecond and subnanosecond range for photons at optical frequencies (2 e.v.) and higher. Such processes are the basis of fluorescence phenomena in activated solids. Laser processes also occur at nanosecond speeds.

The size of light generators, detectors and transmission lines is competitive with today's electronic circuits. Whereas the smallest coaxial cables in use are about 30 mils in diameter, optical fibers in the micron range have been used successfully, and ones in the 1 to 5-mil range are commonplace. Their loss characteristics are better than those of smallest coaxial cables, and crosstalk can be either enhanced for coupling or reduced to negligible amounts for isolation.

THE STRAY REACTANCE problem does not play a significant role in the optical elements, which are photon-controlled, rather than charge-controlled as conventional electronic devices. In a laser, for instance, the bulk movement of charge has been replaced by a bulk movement of photons, thus eliminating the need for a major redistribution of relatively large-scale fields.

The ability of optical systems to process information in parallel is well known, beginning with the simple lens and including fiber optic bundles. In the slower (millisecond) optical and optoelectronic systems already developed, fan-in factors of 1,000 have been obtained.

Some of the engineering considerations and advantages of new optical devices are:

- Light frequencies, of the order of $10^9$ cps, potentially provide larger bandwidth and higher information-handling rates, if suitable modulation techniques are found.

- Because photons can be treated both as waves (interference effects) and as particles (quantum interactions), it may be possible to obtain circuits and utilize effects not possible in electronic circuits.

- The higher frequencies are a natural research candidate for faster computers. Although research has been performed with microwave computer circuits, the complexity of metallic waveguide structures has made microwave
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In an area 10 microns square, 100 closely packed optical fibers of 1 micron diameter can be contained, offering a substantial size reduction over the typical 30-mil diameter coaxial cables used in some advanced tunnel-diode circuits. Also, an optical fiber connection requires no ground wire. Several effects not found in microwave waveguides can be exploited: for instance, optical fibers have a propagation mode that has no lower optical frequency cutoff. Energy can be carried on the outside as well as the inside of the fiber.

Nanosecond phenomena have been found in the last year or so in optical devices, but have not been applied to higher speed computers. The neuristor is an example of a continuous type of device which may be more easily obtainable in optical fibers than with electronic devices.

Glass fiber lasers, which make the active transmission line a reality for optics, have been demonstrated and could be used to overcome any undesirable loss of signal.

There are three types of computer circuits possible using optics. The first one is the optoelectronic type circuit, which uses a combination of photons and electrons as carriers of information, such as the light-emitting diode and photodetector. Then there is the purely optical type in which photons control photons, such as the glass laser. The other type of optical logic element is the hybrid combination of purely optical and optoelectronic circuits.

The frequency spectrum of the optical elements is in the visible (4,000 to 7,500 Å) and the near infrared (7,500 to 20,000 Å), where most optical devices and components developed to date operate.

OPTICAL ELEMENTS—The principal all-optical element is the active or passive optical fiber (sometimes referred to as the dielectric waveguide). Such fibers...

---

**Inverse Pinch Plasma Generator**

**PLASMAS** can be expanded at rates up to 10^7 cm/sec into magnetic fields as strong as 2 kilogauss with this generator developed by Aracon Laboratories, division of Allied Research Associates, Inc., in Concord, Mass. The generator is complete with vacuum chamber and electrodes, Helmholtz coil, vacuum system, high-voltage capacitor bank and operating console. Various gases can be quickly injected into the chamber; the expanding plasma can be observed visually or by electronic methods.
The passive optical fiber is an excellent means of interconnecting optical circuits where gain is not needed to overcome losses. Typical passive fibers have a loss of about 1.1 db per meter; this compares with 1.8 db per meter at 1 Ghz for a specially made 35-mil diameter coaxial cable. Losses in fibers are due to line losses and end losses. Line losses are caused along the fiber by absorption in the material and scattering at the core-cladding interface, and are analogous to attenuation losses in electrical transmission lines. End losses are a measure of the amount of light that can be injected into and removed from the fiber, and are analogous to the impedance-matching losses in electrical transmission lines.

Velocity of propagation in optical fibers is about 8 inches per nanosecond, about the same as the propagation velocity of electrical signals along coaxial cables.

ACTIVE FIBERS—If the optical fiber is doped to provide laser action, it can act as an active transmission line; it then shows a net gain. This may overcome device loss in signal transmission paths thereby becoming an extremely valuable adjunct to lumped active devices.

NEURISTOR FIBERS—It has been shown (Walter Kisonocky, RCA) that an optical computer system is possible, using only optical lasers as active elements, operating as a laser neuristor computer. Kisonocky discussed the realizability of neuristors as active transmission lines in the form of optical fibers containing active-emissive ions and saturable-absorptive ions. Analysis has shown that optical logic devices are realizable; for example, using a one-micron-diameter optical fiber with a pulse duration of 100 picoseconds at a frequency of 1 Ghz, a logic device can be realized that operates at a 10-milliwatt power level.

Two problems must be solved before the attractive neuristor laser concept can be realized. They are (1) to find a suitable combination of emissive and absorptive ions in an appropriate transmission me-
In January of 1963, a scientist at Spectra-Physics' laboratories in Mountain View pushed a button and turned on a light. It was no ordinary light; the yellow-orange beam was the first 6118Å continuous-wave gas laser transition ever seen by human eye.

In producing this transition, the shortest laser wavelength yet observed, Spectra-Physics employed a novel technique — use of an intra-cavity prism to remove all competing wavelengths from the cavity resonator except for the one of interest.1

By demonstrated ability to conceive and carry through advanced ideas in laser technology, Spectra-Physics has become identified as a leader in bringing the laser to practical reality. Further evidence of Spectra-Physics' leadership in gas laser technology includes many more original contributions, such as:

- discovery of the first high-gain CW gas laser transition — 3.39 microns, helium-neon;2
- achievement of the highest power CW gas laser output yet observed — over 0.1 watt

Over 70% of all commercial CW gas lasers in use today were developed and produced by Spectra-Physics

Spectra-Physics offers, in addition to its off-the-shelf gas laser product line, competent application-oriented research services for systems developers interested in the exploration and application of laser techniques. Write for details.

---

Integration into an all-semiconductor package.

The best type of logic to be used in nanosecond computing systems has yet to be settled. Majority or threshold logic may be found convenient, or possibly multilevel or parallel logical circuits will be indicated.

Precise Pointing Control

Development of a new pointing control for orientation of scientific instruments in rockets has been announced by Ball Brothers Research Corporation, Boulder, Colorado.

In a recent flight the new control, called the SPC 400, pointed a spectrographic monochromator biaxially at the center of the sun and held it there within 15 seconds of arc, for a period of about 5 minutes.

The instrument has two servos, operating in the azimuth and the transverse axes. In each axis, coarse and fine light-sensitive detectors provide the error signal.

Used with the Aerobee rocket, the pointing instrument can be recovered by locking in a stowing position and landing by parachute. A standard Aerobee ogive-shaped nosecone assembly is used, allowing space for instrumentation.

Largest Neutron Monitor
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DALLAS—A new instrument to observe cosmic radiation and its variations with time is being planned at

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Current production models of high-precision laboratory gas lasers include:

Model 115 (upper photo) — lightweight (8 lbs.) source of continuous-wave, highly monochromatic light from a helium-neon plasma; visible and infra-red; 6328Å, 11,523Å, and 33,912Å; interchangeable confocal and hemispherical resonators; plane-parallel resonator option.

Model 112 — advanced research model; provides, in addition to capabilities of Model 115, stable operation in plane-parallel resonator configuration; capacity for precision experiments such as optical heterodyning.

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Range, dc: 0.01 to 1,500v; 100 µa to 1.5 amperes. True RMS response is provided in ac measurements: 1 to 1,200v; and 0.01 to 12 amperes. Frequency span: dc and 50 to 2,500cps (5,000cps to 120v). Input power: 105/130v, 50/440cps. Write for details on Model 1572 Portalab.

Maser Telescope Probes

Planetary Radiation

LINEAR polarization of microwave radiation received from Saturn indicates that the planet has an extensive Van Allen belt.

This was announced by a U.S. Naval Research Observatory research team, which used an 84-foot radio telescope with a maser amplifier designed at the Columbia Radiation Laboratory. The telescope was used to measure each of the vibration components of microwave radiation. It was found that polarization in one plane was much stronger than in the other.

It is thought that Jupiter's radiation is polarized by very fast electrons spinning above its equator. Jupiter's polarization would therefore be in its equatorial plane; however, radiation from Saturn is polarized in the plane of the planet's axis. This is explained by two alternative hypotheses: that Saturn's rings have modified its Van Allen belt, or that the magnetic poles of Saturn are close to the equator.

When the full-scale instrument is completed, it will weigh 40 tons, and will be placed in operation by next January 1 somewhere in the North American polar cap, close to the North magnetic pole.

Fluctuations of cosmic rays will be monitored on a minute-to-minute, hour-to-hour and day-to-day basis. Eventually a complete network of neutron monitoring stations will permit measurements from different angles.

McCracken said that the new monitor, the biggest one built, will increase by a factor of 20 the amount of neutrons counted, compared to present-day instruments.

Work on the station is supported by a $111,100 National Science Foundation grant. The Science Research Center is temporarily housed in facilities of the Southern Methodist University; permanent facilities are being raised on a 1,400-acre campus north of Dallas.
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At Lockheed Missiles & Space Company, a dedicated team of scientists devotes its entire attention to problems in interplanetary navigation. Of particular interest are problems attendant to the guidance of a manned vehicle to another planet. With many successful accomplishments to their credit (such as the Polaris and various Agena missions), this group faces every new challenge with confidence.

A promising means for manned spacecraft guidance includes taking celestial and planetary optical sightings, feeding that information into an onboard computer, and computing the spacecraft’s position and velocity to predict its future course. The computer will then calculate the predicted destination planet error, decide if a correction is necessary, and compute its value. These procedures would be repeated continually until the planet is reached. The optimum timing and magnitude of correction, in view of the information obtained from the observations, is the subject of continuing study.

Even before work on hardware for an interplanetary mission is begun, orbit characteristics must be determined to set the requirements to be built into the spacecraft. An optimum trajectory must be shaped for the specific mission, in order to realize ultimate effectiveness. An outstanding accomplishment by Lockheed scientists is the computation of some 250,000 different orbits to Mars and a similar number to Venus. Each orbit varies as to speed, fuel, departure, arrival, and elapsed time.

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COMPONENTS AND MATERIALS

Compatible Techniques for Integrated Circuits

Combined thin-film and silicon block techniques improve performance

PROGRAM to develop compatible techniques for fabrication of complete integrated circuit functions utilizing semiconductor, thin film and other solid-state technologies as required was discussed at Electrochemical Society meeting, April 17 in Pittsburgh.

J. R. Black of Motorola discussed techniques for successful integration of thin film and semiconductor techniques to produce useful circuit functions which are inherently reliable and reproducible. Main point brought out in this talk was that utilization of a wide variety of materials to construct circuit elements provides wider range of component values to closer tolerances than can be presently achieved if only one technology and material is used.

BETTER CONTROL—Black said that the component parasitic parameters such as temperature coefficients, voltage sensitivity and loss factors can be better controlled if more than one material is available to construct components. Of great importance is the electrical isolation of critical circuit elements which is achievable when thin films are combined with silicon elements. Possibility also exists of reduced manufacturing costs due to design flexibility.

A partial list of some of the bounds placed upon materials selection and processing which have been identified to date were outlined. Silicon is the initial substrate material. Final functions shall be capable of being stored for long periods at 300 C without degradation. Diffusion temperatures are near 1,000 C. Silicon dioxide can be thermally formed at 900 C. To provide organic free contact areas, the semiconductor block must be heated in oxygen to 550 C. After metalization of contact areas the block should not be subjected to temperatures exceeding 500 C. Due to migration, diffusion and alloying problems, use of gold shall be avoided. Aluminum metal is used for the interconnection due to its electrical conductivity and excellent adherence to metals and glass. Minimum sealing temperature should be 440 C for 15 minutes. And the use of physical masks for the delineation of thin film components should be avoided.

Black said that effort was made to modify the material and processing parameters of the thin-film components to assure compatibility. Thin film components and processes which have received attention at Motorola were outlined.

RESISTOR FILMS — Desirable characteristics for thin film resistor elements include materials having relatively low temperature coefficients, absence of reverse leakage parasite and reduced distributed capacitance. Tin oxide films receive attention for large value resistors by gas plating. Nichrome films are used for moderate to low valued resistors. These are deposited by vacuum evaporation.

DIELECTRIC FILMS — Capacitor considerations include materials which can provide low loss, voltage stability, and are isolated devices. Materials used are alumina silicate glass, silicon oxide, tantalum oxide and alumina. Processes for the alumina compounds are by gas plating. The others are deposited by vacuum evaporation, and also wet.

Kiln Speeds Ferrite Production

HUGE electric kiln, 155 feet long, is used exclusively for the manufacture of ferrites. Indiana General facility is part of company's manufacturing and research complex. Last year company's progress in memory field produced organized memory system with read-restore time of one microsecond. Products extend from digital computer memory systems to lifting magnets.

May 3, 1963 • electronics
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This economical new 30-channel operations monitor provides immediate, permanent recording of on-off events on dry, electrosensitive charts — using "pulsed writing" for maximum clarity, stylus life and economy of power. Six different interchangeable, plug-in 10-channel solid-state Writing Control cards are available to match your signal voltage and recording requirements. Included are types which operate with logic levels between +6 and +40 volts or −6 and −40 volts. Also, "precision types" for monitoring low level signals are available with adjustable threshold or balanced input (with respect to signal return). Model 361 system, for rack mounting or portable case, is 8¾" x 19" wide x 14½" deep, weighs approx. 50 lbs. Complete 30-channel system, with either +6 v to +40 v or −6 v to −40 v Writing Control, is $2050 F.O.B. Waltham, Mass. Prices with other Writing Controls on request.

FOR UP TO 120 CHANNELS of on-off recording, Model 360 uses 16" wide, 450-foot charts; has 9 standard and 9 optional additional speeds; takes only 14" of panel space complete with integral cooling system. Solid-state plug-in Writing Control cards described above are optional. Model 360 120-channel Recorder alone, $3900; prices with various Writing Controls on request.

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chemistry in the case of tantalum oxide.

Conductor films use aluminum, for metallizing around corners and also for interconnection patterns on ceramic or plastic for interconnecting functional electronic blocks. Black also discussed techniques for reduction of pinholes in thermally-grown silicon dioxide.

**TIN OXIDE** can provide high valued resistors which can be readily etched to fine patterns using KMER, according to Black. This can make stable electrical contact to silicon. At elevated temperatures, the tin oxide reacts with aluminum and can form an insulating aluminum oxide interface resulting in an open contact. A film of nickel, approximately 1,000 Å thick can provide a satisfactory stable interface between the tin oxide and aluminum.

Present effort is being devoted at Motorola to develop a 300-350°C deposition process which uses phosphorus, silicon or aluminum as a dopant. Resulting films are said to show promise in obtaining lower temperature coefficients for a given sheet resistance than do films deposited by the older processes. Furthermore, it is believed that improved aging characteristics can be achieved and better control obtained over thin film properties than is available with the higher temperature process.

The Nichrome films are seen to possess excellent long term aging characteristics as well as low and reproducible temperature coefficients. Nichrome maintains good electrical contact to silicon as well as aluminum and adhere well to silicon dioxide. Methods presently developed to accurately etch Nichrome patterns 0.001-inch wide used photoresist techniques.

Work is now directed towards improvement of reproducibility for depositing a stable mixed oxide glass system of higher dielectric strength and volume resistivity than either thermally-grown or reactively-sputtered quartz films.

Organo-aluminum compounds are being investigated which pyrolyze at lower temperatures for the deposition of conductors for multilayered printed wiring interconnect boards.

Work at Motorola shows that capacitors of tantalum oxide possess a voltage-capacitance of 2.5 microfarad volts per sq cm when rated at one-fourth breakdown potential. Films are formed by vacuum deposition.
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(3 db bandwidth is 2 cps to 7 Mc)
Measures signals with Crest Factor...5 full scale to 15 down scale.
Accuracy above 300 µV, in % of READING AT ANY POINT ON SCALE, 2%, 20 cps to 400 kc; 3%, 10 cps to 2 Mc; 4%, 5 cps to 4 Mc
Input Impedance ....... 10 megohms in parallel with 11 or 27 pF
Amplifier ... Choice of balanced or single ended, 5 cps to 4 Mc, up to 90 db gain, 50 V into 20K load
DC Output ...... Proportional to mean square of ac input, for connection to recorder; output 1V, source resistance 1000 ohms
Power requirements .............. 115/230 V, 50-420 cps, 90W
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evaporation of tantalum followed by an electrochemical process which converts the outer layer of tantalum to tantalum oxide. Pinhole problems are said to be avoided by removing the tantalum metal behind a pinhole by a reverse-etch process prior to the addition of the second electrode.

LOW RESISTIVITY — Effort is being devoted to reducing the dissipation factor of such capacitors at moderate frequency due to the series resistance of the somewhat resistive tantalum electrode, and such efforts are reported as successful. An aluminum film is deposited onto the substrate just prior to the evaporation of the tantalum film. The highly conducting aluminum is said to provide the desired low sheet resistivity for the tantalum electrode.

Problems are being worked on to provide compatibility with silicon substrates. These include development of the second electrode which is stable with the oxide dielectric and aluminum metal. Also, development of a technique to provide a low resistance contact to the tantalum and aluminum electrode after anodization.

Work at Motorola on compatible techniques for integrated circuits was written up by J. R. Black and C. R. Madland. Program was sponsored by Wright Field.

Carrier Transport Through Thin Organic Films

UNIQUE properties of organic materials may open up a whole new range of basic insulating materials for electronic applications, according to L. C. Scala of Westinghouse Research Laboratories.

Using special techniques, organic insulating films may be prepared under conditions such that their thickness, structure and composition are subject to careful experimental control. Well defined layers of organic materials, and their ordered organic structures, facilitate analysis of thin insulating layers, less than 500 Å thick.

Scala discussed carrier transport mechanisms through thin organic films at Electrochemical Society meeting, April 18, in Pittsburgh. Metal-insulator-metal sandwich
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Now there's a microwave filter that's virtually maintenance-free and reliable to a degree once unattainable. Why? No moving parts. Loral YIG (Yttrium-Iron-Garnet) Filters are all solid state . . . replacing electromechanical preselector mechanisms consisting of cams, drives, follower arms and other moving parts—they sweep over wide bandwidths at high speeds, making possible substantial savings in weight as well as in improved performance.

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**Representative Performance Specifications**

For Four Cavity Units

Specifications are for tuned YIG and gallium-substituted YIG filters. All can be supplied with transistor driver circuits and, where required, temperature control circuits.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Bandwidth at 3 db points</th>
<th>Maximum insertion loss across band</th>
</tr>
</thead>
<tbody>
<tr>
<td>500-1,000 mc</td>
<td>10 mc</td>
<td>12 db</td>
</tr>
<tr>
<td>1-2 gc</td>
<td>15 mc</td>
<td>10 db</td>
</tr>
<tr>
<td>2-4 gc</td>
<td>25 mc</td>
<td>8 db</td>
</tr>
<tr>
<td>4-6 gc</td>
<td>30 mc</td>
<td>6 db</td>
</tr>
<tr>
<td>8-12 gc</td>
<td>35 mc</td>
<td>6 db</td>
</tr>
</tbody>
</table>

Scan rate: 0-100 cycles
Operating temperature range: $-55^\circ$ to $+71^\circ$C
Weight: 29 1/2 oz.
Environmental: meets shock and vibration requirements of MIL-E-5400

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electronics • May 3, 1963

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Example: take two critical tests (of the 22 run)—moisture resistance and temperature cycling.

Here's the MIL Spec and the Ward Leonard Result—

<table>
<thead>
<tr>
<th>Test</th>
<th>MIL-R-10509D Maximum Deviation</th>
<th>METOHM Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture Resistance</td>
<td>±0.5%</td>
<td>-0.04 to +0.32</td>
</tr>
<tr>
<td>Temperature Cycling</td>
<td>±0.25%</td>
<td>-0.04 to +0.10</td>
</tr>
</tbody>
</table>

Other rigorous tests such as vibration, load life and shock show equally impressive results. In addition, each METOHM® resistor logs 7 inspections, 8 quality-control checks, and 7 tests prescribed by MIL-R-10509D and MIL-STD 202B specifications.

Write for Bulletin 50A and ask for samples—available in these ratings: RN55-1/10 W; RN60-1/8 W; RN65-1/4 W; RN70-1/2 W. For Stock Orders call your nearest Authorized Industrial Distributor. Ward Leonard Electric Co., Metal Film Division, 30 South Street, Mount Vernon, N. Y. 2.28

Powdered Silicon Forms

Solid Electrolyte Capacitor

CONTROLLED purity silicon has been studied as a basic material for the production of a solid electrolytic capacitor both by Texas Instruments and Nippon Electric.

J. H. Van Tassel and R. R. Habrecht of TI described their development at Electrochemical Society meeting on April 17 in Pittsburgh. Y. Ishikawa and S. Inowaki will present a paper on what is believed to be a similar development at the Electronic Components Conference

Star Spotting Elements

Set Course to Moon

NETWORK above is part of an experimental electronic computer developed by Republic Aviation to record the lunar vehicle's trajectory and velocity from continuous star sightings. If vehicle is off course, the computer will initiate the firing of course-corrected rockets.
ONLY
In Mincom’s CM-100 instrumentation recorder/reproducer, the series elements before data
storage have been reduced to receiver and mixer, only one step from the antenna. With the
CM-100’s 1.5-megacycle response and linear phase equalization at all speeds, an original
OPERATIONAL
IF signal thus can be heterodyned so that the carrier swing and its sidebands fall within the
PREDETECTION RECORDING
Mincom CM-100’s frequency range—in FM, FM/FM modulation, PCM and PCM/FM.
...and actually doing it at defense facilities as you read this page.

5.0 mc IF carrier heterodyned down to 750 kc. Random-spaced pulses,
20 μs on-20 μs off-type information. Sweep rate: 50 μs/cm.

Mincom Division
2049 South Barrington Avenue, Los Angeles 25,
425 13th Street N.W., Washington 4, D.C.

Write for brochure.
NRC's Model 3176 Vacuum Coater is a unique vacuum evaporation system for thin film deposition in R&D and production programs. Unmatched for versatility, reliability and ease of operation, the Model 3176 is used in the areas of solid state electronics, optics, magnetic films, memory planes and solar cells.

Exclusive features include: • Fastest Useful Pumping Speed . . . with high performance, lowest backstreaming NRC diffusion pump rated at 1500 liters/sec. • Highest Conductance/ Lowest Outgassing . . . with the new NRC Slide Valve which was specifically developed for maximum pump efficiency. • More Efficient Baffling . . . with single circular chevron cold trap-baffle combination. • Easy, Fast Operation . . . with all controls (manual or automatic) conveniently mounted on front panel. • Maximum Versatility . . . used with 18'' or 24'' work chambers — electrical and mechanical feed-throughs interchangeable.

The Model 3176 has a new sophisticated appearance and is ready to operate. Merely connect power and water supply. Write or call for data sheet.

NRC EQUIPMENT CORPORATION
A Subsidiary of National Research Corporation
160 Charlemont Street
Newton 61, Massachusetts
Area Code 617 DEcatur 2-5800
to be held in Washington on May 7. Texas Instrument reported on the effect of particle size, particle shape, resistivity and nature of impurities.

PELLETS—At TI, anode bodies of silicon are fabricated by pressing powdered silicon. The body is hardened by sintering in a vacuum between 1,350 C and 1,400 C or in inert atmospheres at somewhat higher temperatures. The authors discussed the effects of pressure, powder size fraction and sintering conditions upon the density of the anode body. During the entire anode fabrication procedure, the pellet is maintained in an oxygen-free atmosphere to prevent oxide doping during sintering and to insure the electrical integrity of the sintered anode.

The TI paper outlined the influence of resistivity of the starting silicon material upon the electrochemical processing steps and gave final device characteristics. The dissipation factor measured on the system was found to vary directly with the base material resistivity. Rate of anodization also increases with increasing material resistivity for equal surface areas. P-type silicon, ranging in resistivity from 0.001 ohm cm to 213 ohm cm was used in this portion of the study. Electrolytes evaluated included N-methyl acetamide made 0.04 N in potassium nitrate, water-phosphoric acid, monoalcohol-phosphoric acid and polyalcohol-phosphoric acid.

The influence of the accepter impurity of the base material upon the dielectric film was investigated at Texas Instrument by radio-tracer techniques.

Various power application programs were discussed by TI. The current densities used were considerably higher than those normally used in the formation of anodic tantalum oxide films because of the relatively low current efficiency for the anodization of silicon.

Anodized silicon pellets are processed at TI in a manner similar to that used in fabricating solid electrolytic tantalum capacitors. Finished device operating parameters, as related to starting material characteristics were discussed and compared to those of other solid electrolytic capacitor systems.
Ravenous Tiger

It's late evening. All the Tiger pickup trucks are empty. In five minutes, the last shipment will be fed into the huge cargo hold of the Swingtail-44 and the dock will be clear. Three minutes later, everybody's shipment will be on its way. Everybody's.

That's the beauty of the Swingtail-44. It has a big appetite—33 tons. It carries off every package on the dock. Nothing waits to go out. Nothing gets left behind.

And when you've got a whole fleet of 44's... and a fleet of trucks for door-to-door service... and a gang of detail-minded people to expedite your shipment all along the way... then you've really got airfreight service. The fast kind. The kind you can depend on. The Flying Tiger kind.
Notation Language Speeds Production Changes

By R. P. PREISS and L. C. VARUZZO
Data Systems Division, International Business Machines Corp., Poughkeepsie, N. Y.

Softens impact of specification changes on production schedule

HANG-UP conditions in production schedules caused by specification changes may be a thing of the past when a special notation language is used to transcribe designs and design changes on magnetic tape. In this discussion, specific reference is made to design and production of computer products. However, basic technique may be applied to design and production of other electronic equipment.

When carried out manually, changes and re-changes require hundreds of man-hours. The magnetic-tape recording technique, used in a “design automation” system at IBM produces a new computer printout for every design change and provides designers with clean, original sheets for their work in a matter of minutes.

New technique and computer language developed for it are based on the applications concept of taking partial designs and combining them into bigger ones, thus being able to add more details on existing designs.

CRITERIA—Just as algebra can describe certain static conditions while calculus must be used to describe more dynamic conditions, notation language or coding for recording designs and changes is tailored to perform these recording functions. Four requirements met:

- Language can be understood by man and machines without intermediary translation
- All design information necessary for building, testing and servicing the manufactured product can be summarized on one diagram
- Language permits grouping of

CONVENTIONAL block-diagram approach for implementing simple Boolean expression (A) and functional notation (B) provide basis for listing notation (C)—Fig. 1

May 3, 1963 • electronics
1. **Faster writing speeds.** Supersonic radar targets require superfast writing speeds. Only ITT offers writing speeds up to 500,000 ips.

2. **Slower writing speeds.** Narrow bandwidth picture transmission requires slow writing speeds. ITT provides the slowest: less than 1.0 ips.

3. **Erase time.** Fast erase time is essential to high-speed multiple target tracking and for TV presentation at TV rates. ITT storage tubes have erase times as low as 1 millisecond—the fastest available.

4. **Resolution.** Resolution is the key limiting factor on virtually all display systems. At 50% brightness, conventional ITT storage tubes provide up to 70 raster lines/inch.

5. **Brightness.** High ambient light conditions demand maximum brightness capability. ITT tubes are unsurpassed in average brightness of saturated display. The F-7174 is capable of 22,000 foot lamberts.

6. **Optimum display diameter.** For every application there is one "best" size storage tube. ITT makes the broadest range: 2½, 4, 5, 6, 7, 7½, 10 and 11 inch. Available with electromagnetic or electrostatic focus and deflection.

7. **Distortion.** Accurate readout calls for the elimination of distortion. Only ITT positions writing and flood guns concentrically to eliminate trapezoidal distortion.

8. **Direct vs. projection readout.** Direct readout tubes have their limitations in very large display applications. ITT's exclusive projection type tubes provide the high resolution and brightness needed to do the job.

Write for comprehensive brochure.

**ITT**

ELECTRON TUBE DIVISION
CLIFTON, NEW JERSEY
International Telephone and Telegraph Corporation

CIRCLE 93 ON READER SERVICE CARD
Even the cleanest of hands carry minute traces of moisture and contaminants that can eventually wreck a tantalum capacitor. That’s why “no hands” is the order of the day at the Mallory capacitor plant at Greencastle, Ind. Only freshly laundered cotton or sterile rubber gloves are ever permitted to touch assemblies during critical manufacturing operations.

Surgical cleanliness is routine at our ultra-modern tantalum capacitor facility, where every possible means of assuring quality was engineered into the production line when it was built. All this extra care pays off in the product; Mallory tantalum capacitors consistently equal or exceed MIL specs for electrical parameters and resistance to environmental conditions. Mallory Capacitor Company, Indianapolis 6, Indiana... a division of P. R. Mallory & Co. Inc.
Mallory tantalum capacitors delivered from stock at factory prices by these distributors:

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700 turns
No. 37 Single Enamel Wire
Insulation on Both Leads Stripped
Finished Coil Taped

800 coils per hour

Leesona No. 116 Automatic
Bachi Bobbin Winder
automatically:
• Closes the tail stock.
• Insulates starting lead with tape.
• Winds coil.
• Stops winding at ±2 turns.
• Strips insulation from start and finish leads.
• Tapes finished coil.
• Waxes finished coil.
• Indexes wire guide.
• Cuts wire.
• Ejects finished coil.
• Sorts coils of two different specifications.
• Counts number of coils produced.

At 7250 turns, No. 39 single formex wire, 585 coils per hour is a typical production rate reported by prominent manufacturers who use the No. 116. Operator merely loads bobbin on arbor of individual head as table rotates, and clips starting lead. Production can be cycled to operator’s loading time by controlling clockwise table rotation from 1/4 to 2 rpm. Winding speed of each head can be set according to number of turns desired. Write Leesona Corporation, Warwick, Rhode Island.

Leesona Corporation, Warwick, Rhode Island.

Or call Leesona at 5700 W. Diversey Ave., Chicago 39, TU 9-5735; 1500 Walnut St., Phila. 2, KI 6-1720, or A. R. Campman & Co., 1762 W. Vernon Ave., Los Angeles, AX 3-6265.
Mighty Micropot® for close quarters

Tighten up your parameters all you want because some good things still come in small packages.

7/8" DIAMETER, +2 MILLION REVOLUTIONS
Like the new, miniaturized (7/8" diameter) 2150 Micropot. Here is a tiny, 10-turn precision potentiometer that delivers over 2 million revolutions with high accuracy and good resolution. Independent linearity holds to ±0.25%.

In fact, the only modest thing about this Micropot is its price (under $10—and much less in production quantities).

GANG IT, HEAT IT TO 105°C
Looking for component versatility? The 2150 ignores heat up to 105°C. You can gang it (2 units). Tap it. Even add rear-shaft extensions, if you want to. Torque and noise are extremely low.

Compare specs and prices. We believe you won’t match our 2150 Micropot anywhere for either commercial or military applications.

NEED SPECIALS?
Take advantage of the Borg Quick Reaction Facility. Get fast delivery of prototypes built exactly to your specifications.

Call your nearby Borg representative or distributor. Or a letter to R. K. Johnson will put the 2150 story on your desk in short order.

2150-2160 SERIES TEN-TURN MICROPOT®
Mechanical rotation..... 3600° +10° —0°
Electrical rotation..... 3600° +10° —0°
Resistance range, ohms.....100 to 100 K
Resistance tolerance, ............ ±3%
Standard linearity, ............ ±0.25%
Power rating.................. 3 watts at 40°C
Noise.........................100Ω equiv. noise resist. max.
Temperature range...........—55°C to +105°C
Resolution, ............ from .054% at 100Ω to .0088% at 100 K
Torque...................... Start 0.5 oz/in; Run 0.4 oz/in
Shaft dia. ............. ¼" (2150) and ⅛" (2160)
Weight......................1 oz
Life......................... 2,000,000 revolutions

BORG EQUIPMENT
A Division of Amphenol-Borg Electronics Corporation
Janesville, Wisconsin

CIRCLE 97 ON READER SERVICE CARD
ence is made showing that w comes from line 15.1.

TRANSCRIPTION — Coded notation listing is designated as “original document” or “changed document” and, as mentioned before, lends itself readily to furnishing keypunched data that can be recorded on magnetic tape. Thus, the design-recording-change system shown schematically in Fig. 3 was developed to facilitate design and design changes during production.

Handle Test Probes Like Chopsticks

By CHARLES L. COHEN
McGraw-Hill World News

CHOPSTICK technique with test probes is demonstrated by Japanese technician

TIME for aligning radio receiver is greatly reduced by girl operator using two hands—use of both hands simultaneously is not easy for some operators

TOKYO—Handling two test probes in one hand while checking-out circuits is done easily by Japanese technicians. They often find it convenient to perform in this way and can work many test operations faster than with two hands. Lifelong use of chopsticks prepares them for it—no special training is given.

Management at Toshiba’s Yanagicho Works takes this ability for granted. They are really proud, however, of girl operators’ ability
to align radios—using two hands: simultaneously, a trimmer is adjusted with a screwdriver in one hand while the other hand adjusts signal generator frequency or output.

Vapor Pressure Sprays
Two-Part Encapsulants

TWO-PART EPOXY, URETHANE and other viscous materials can be applied with a spray system using vapor pressure as propellant rather than air pressure. Reportedly, such materials could not be sprayed using air pressure because of tendency to coagulate. With Chemtronic Vapor System developed by Zicon Corp., highly viscous materials are atomized and sprayed by action of hot water vapor having a molecular weight 3 times that of air —this supplies "pushing" effect. Application of materials on circuitboard assemblies is claimed to be much more efficient and effective than hand brushing, dipping or flow coating. Mil thickesses can be controlled easily with solid fillets obtained around and under components.

Evaporator Doesn't Use Nitrogen Cold Trap

FOUR MINUTE production vacuum coating is provided by a new Vacuum Evaporator developed by Vacuum Specialties. Pressure of $5 \times 10^{-3}$ is normally used with ultimate pressures of $5 \times 10^{-5}$ attainable without use of a liquid nitrogen cold trap.
HITACHI TRANSISTORS

SPECIFY "MESA" TYPE TRANSISTORS FOR HIGH FREQUENCY USE

2SA233, 2SA234, 2SA235

Hitachi PNP germanium diffused "Mesa" type transistors provide outstanding high frequency characteristics compared with conventional alloy junction or drift transistors.

Exclusive "Mesa" type transistors are indispensable for FM receivers used in tuner circuits and intermediate frequency amplifiers and also in TV receivers in intermediate frequency amplifiers. They can be used effectively in short-wave converters, medium wave converters and all high frequency applications.

For superior performance, specify Hitachi "Mesa" type transistors ... another engineering achievement from one of the world leaders in electronics.

| Maximum Ratings  
<table>
<thead>
<tr>
<th>(Ta = 25°C)</th>
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<tbody>
<tr>
<td>Items</td>
</tr>
<tr>
<td>Collector Voltage</td>
</tr>
<tr>
<td>Emitter Voltage</td>
</tr>
<tr>
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<tr>
<td>Emitter Current</td>
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<tr>
<td>Junction Temperature</td>
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<tr>
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<tr>
<td>Ambient Temperature</td>
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| Characteristics  
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<tr>
<td>Max. Emitter Cut-off-Current</td>
</tr>
<tr>
<td>Current Amplification Factor</td>
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<tr>
<td>Alpha Cut-off Frequency</td>
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| Typical Operation  
<table>
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<tr>
<th>(Ta = 25°C)</th>
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<tbody>
<tr>
<td>Items</td>
</tr>
<tr>
<td>Power Gain at FM Radio Frequency</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Mixer Gain at FM Radio Frequency</td>
</tr>
</tbody>
</table>

10.7 Mc Intermediate Frequency Amplifier Circuit
LIKE HAPPY ENDINGS?

Here's one from the Saturn program about a new telemetry technique — and a Collins Mechanical Filter.

The Saturn missile brought up a tough telemetry question: How to provide adequate transmission capacity for wideband data such as vibration measurements. Bandwidth capacity of available telemetry systems was too low. A new kind of transmission, using single sideband modulation of an AM subcarrier and providing 10 times the equivalent bandwidth, had been proposed. Filters were key factors in the system's operation. In addition to the extreme selectivity demanded of the bandpass filters, they had to be tough enough to operate under 20 G's vibration from 50 cps to 200 cps without modulation and spurious signals. They had to withstand a 100 G shock. And they would have to reduce insertion loss and passband ripple to new minimums. Because of these rigorous requirements, the logical answer was a Collins Mechanical Filter, but with significant state-of-the-art improvements. For the transducer, Collins developed a new ferrite material, increasing the mechanical strength of the filter and reducing insertion loss. Another benefit of the ferrite transducer was a 3 db to 1 db drop in passband ripple. Specs for frequency stability of the filters under radical temperature changes sounded impossible at first. But with new heat treatment techniques for the nickel-alloy discs that are the filter's resonant elements drift was held to within 1 ppm/C temperature change. This Collins Mechanical Filter, packaged in less than 1/3 cubic inch, was a key to development of this new SS-FM telemetry technique at NASA's George Marshall Space Flight Center. The new technique has been invaluable in transmitting the avalanche of vibration data and other wideband information through two successful Saturn launchings. More than 100 standard mechanical filters for the 60 kc to 600 kc range are in the Collins catalog today, and if one of these won't do, the industry's only mechanical filter design staff is ready to help you with special designs. Call Collins today or write for Data File 202. COLLINS RADIO COMPANY • Components Division, 19700 San Joaquin Road, Newport Beach, California, Phone: Kimberly 9-2911 • International Division, Dallas, Texas.
NEW PRODUCTS

Aging Correction Stabilizes Frequency

Crystal oscillator has time accuracy within 8 milliseconds per year

LONG-TERM frequency stability using a corrected crystal oscillator to produce an independent frequency standard accurate to within 5 parts in 10¹⁰ per year is featured in the BRAVO (best rate of aging verified oscillator) manufactured by Manson Laboratories Inc., 375 Fairfield Ave., Stamford, Connecticut. Output frequency is 100 Kc and 1 Mc at 0.75 V into a 50-ohm load. Time accuracy is within 8 milliseconds per year. Corrected stability is within 5 parts in 10¹⁰ per year and uncorrected is 1 to 2 parts in 10¹⁰ per day. Frequency settability is better than 1 part in 10¹¹ and the internal oscillator can be fine adjusted. Operating from conventional power sources, the unit also has internal batteries for 35 hours emergency operation. Size is approximately 10 x 17 x 19 inches and weight, including batteries, is 100 lb. The device uses a 5 Mc crystal oscillator whose output is divided by 5 to produce 1 Mc at 1 to 2 parts in 10¹⁰ per day. The 100 Kc output of the 10:1 divider is uncorrected and represents 10 Kc + Δf(t) where Δf(t) is frequency change due to aging. This is reduced to zero in the correction circuit. A variable rate device anticipates required aging reduction with time and compensates accordingly. The remainder of the circuit drives a synthesizer whose output is compared with a low-frequency standards transmission. Any difference between synthesized and received signals is recorded on a strip chart.

CIRCLE 301, READER SERVICE CARD

Breaker Saves Components

PROTECTING solid-state components from overvoltage and overcurrent is the purpose of the Circuit-Saver developed by Siltronics, Inc., 2231 Saw Mill Run Blvd., Pittsburgh 10, Pennsylvania. A visual trip indicator calls attention to the excesses, and resetting is by depressing the illuminated trip indicator. Designed for 28-v operation, the device has trip currents from 250 mA to 5 amperes, overvoltage protection occurs at 125-percent of rated voltage and voltages up to 45 V can be blocked in the tripped condition. Series impedance varies from approximately 5 ohms at 250 mA to 0.25 ohm at 5 amperes. (302)

Step-Frequency Generator Tests Chart Recorders

CALIBRATING frequency measuring equipment such as doppler data and strip-chart and other recorders is the purpose of the model 1104 step frequency generator made by the EDP Corp., 3501 South Orange Blossom Trail, Orlando, Florida. The unit generates a program of output frequencies linearly spaced over the spectrum of interest. Ten sequential frequencies, in increments of 10-percent full-scale frequency are generated at a rate variable from one per second to one per thirty seconds. Only one setting is necessary to select full-scale output in the range from 5 to 50 Kc. The program of sequential output frequencies is initiated by pressing a front-panel button. All operations are automatic. Full-scale frequencies are continuously adjustable from 5 to 50 Kc, incremental frequencies are generated in 10-percent steps of full-scale setting, dwell time on each frequency is 1
NOW THE CRADLE RELAY IS AVAILABLE with bifurcated contacts

NEW ALLIED T-163 RELAY • PROVIDES GREATER SWITCHING RELIABILITY STAYS IN SERVICE FOR MILLIONS OF OPERATIONS • HAS GOLD PLATED TERMINALS AND CONTACTS FOR LONGER SHELF LIFE.

The versatile T-163 "cradle" relay also offers simplicity of design—it has no internal wiring, contact arms are extended to form combination solder and plug-in terminals along with ease of installation—it mates with easy-to-plug-in solder and printed circuit type sockets.

On every count—bifurcated contacts, exceptionally long life, quality design—Allied's T-163 gives you relay value. For quick service, call your nearest Allied representative. Also, write for Allied's T-163 Catalog Sheet.

OPERATING CONDITIONS
(at +25°C)

<table>
<thead>
<tr>
<th>Contact Rating:</th>
<th>Available with low level or 2 amperes contacts for resistive loads up to 29 volts d-c.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Arrangement:</td>
<td>Up to four pole double throw</td>
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<tr>
<td>Ambient Temperature:</td>
<td>-55°C to +71°C Higher temperature available</td>
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<tr>
<td>Operate Time:</td>
<td>15 milliseconds maximum</td>
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<tr>
<td>Release Time:</td>
<td>8 milliseconds maximum</td>
</tr>
<tr>
<td>Weight:</td>
<td>From 0.80 to 1.0 ounces maximum</td>
</tr>
</tbody>
</table>

AVAILABLE FROM YOUR ALLIED DISTRIBUTOR

ALLIED CONTROL COMPANY, INC. 2 EAST END AVENUE, NEW YORK 21, N. Y.

OUR 25TH YEAR IN THE RELAY INDUSTRY

CIRCLE 103 ON READER SERVICE CARD 103
through 30 seconds adjustable, switching time between consecutive frequencies is less than 30 ms without signal interruption and repetitiveness is 0.1 percent. Accuracy is 1 percent, output voltage is zero to 1 v rms at 600 ohms. The device contains an RC oscillator that generates the selected output frequency. The highest (100-percent) frequency is selected by manually adjusting the capacitance of the RC time constant and the 10-percent increments are generated by automatically switching the resistive elements. The 10 discrete steps are programmed by a very low frequency (1 pps to 2 ppm) pulse oscillator driving a counter and switching matrix.

CIRCLE 303, READER SERVICE CARD

Amplifier Drifts 10 µv per Day

SOLION TETRODES eliminate the need for mechanical choppers in the SA-112 amplifier from Self-Organizing Systems, Inc., 6612 Denton Drive, Dallas 35, Texas. Voltage gain is 500 to 10,000, rise time is 0.5 second, drift is less than 10 µv per day and noise is 3 µv rms. Input impedance is infinite at d-c and 25,000 ohms at 0.1 cps. Power requirement is 60 mw and the device can be operated continuously for one month from two batteries. It will also drive a galvanometer-type recorder. The sketch shows use for thermocouple signal recording with compensation for the non-linearity of the thermocouple curve. Voltage-temperature curve for the copper-constantan thermocouple is approximately three straight-line segments. The circuits with the battery, diode and resistor change amplifier gain at upper and lower temperatures. The circuit using $D_1$ introduces a little positive feedback to increase gain at low temperatures while the $D_2$ circuit provides negative feedback to reduce gain at high temperatures. Gain changeover points are adjusted by varying the voltage in series with the diodes while the value of gain is changed by varying the resistors in series with the diodes. (304)

Tunable YIG Filter For Microwave Receivers

YTTRIUM iron garnet microwave tunable filter, manufactured by Physical Electronics Laboratories, 2493 Pulgas Ave., E. Palo Alto, California, operates between 2.0 and 4.0 Ge with low sensitivity to temperature changes. Frequency drift between $-30$ and $+80^\circ C$ is less than 15 Kc per degree C and tuning sensitivity is 22.2 Mc per ma with the internal electromagnet. D-c tuning power is 2.5 w and a-c sweep is 0.25 w for sweeping ±1 Ge at 3 Gc at a 1 Kc rate. For 10 Kc sweep, power is 0.63 w. Bandwidth at 3 db point is 18 to 20 Mc over entire tuning range at $-30$ db point is 100 Mc. Insertion loss is less than 1 db over most of the range increasing to 3 db from 2.1 to 2 Gc. Off-resonance isolation is greater than 40 db and strongest spurious response, 700 Mc
Kinney Evaporators are designed for laboratory, pilot plant or production applications where versatility, dependability, and speed are required. These evaporators offer rapid evacuation and ultimate pressures as low as $5 \times 10^{-7}$ torr when using liquid nitrogen. They are furnished complete with filament power supplies and vacuum gauges. Utilizing dependable Kinney components, each system is housed in a compact, functionally designed cabinet finished in hammertone grey enamel and topped with a durable formica work surface. All electrical controls and meters are grouped on a sloping console for optimum operator control and visibility. Its versatility is enhanced by a complete line of Kinney accessories. Kinney's standard models include 2" to 6", single and double evaporators; custom-designed systems can be built to your specifications.
below main response is down 24 db. Sketch shows receiver circuit using 2 YIG filters for stalo discriminator operation and a third as a preselector for elimination of spurious radiation and image rejection. The dual filter can be swept at a high rate of speed by modulating the electromagnetic current control. Simultaneously, the two can be made to track accurately with desired sweep rate as well as tracking the input filter unit. Use of YIG filters eliminates slow tuning speed and mechanical complexity of the usual stalo cavity pair.

CIRCLE 305, READER SERVICE CARD

F-M Broadcast Monitor
For Professional Use

designed for critical professional applications, the 4310R is a wide band f-m multiplex tuner with provision for diversity reception and automatic selection of mono-stereo performance depending on signal conditions. Overall signal strength tuning meter and separate VU meters for each channel provided. Sensitivity is 1.9 µV; signal to noise, 60 db; harmonic distortion, 0.5 percent; tubes and solid state devices, 27; selectivity, 50 db. H. H. Scott, 111 Powder Mill Road, Maynard, Mass. (306)

D-C Servo Amplifier
Uses No Relays

completely transistorized model 1465 d-c servo amplifier can be used as part of a closed loop position control. High accuracy and fast response time make it suited for rapid cycling, manual positioning, or modulating systems. It is designed...
new low cost precision
THERMISTORS
match standard curves
-40° to 150° C.

Low Noise Choppers
Have High Reliability

CHOPPERS designed to give high
performance over a minimum of
13,000 hr of continuous operation,
with low noise level and freedom
from pickup, are announced. Both
electrostatic and magnetic shielding
isolate the low-level circuit from the
a-c driving coil. Contact materials
are chosen to reduce parasitic emf's
at the contacts to a minimum; con­
tact points themselves are gold.
Contact rating is 10 v d-c, at 1 ma.
Dissymetry of closure (dwell) time
is 3 percent max; bounce, 2 percent
max during closing and opening
contact; operating temperature, 0
to 70 C; storage temperature, down
to -60 C. Leeds & Northrup Co.,
4901 Stenton Avenue, Philadelphia
44, Pa. (308)

Spectrometer Uses
Solid-State Circuits

GAMMA RAY spectrometer using
solid-state circuits has been intro­
duced. The SC-530T enables accurate
detection of the individual radiation
properties unique to each isotope
through a combination of a pulse-
Now Electronics Engineers can expect more from a molded coil. Delevan's new Molded Shielded Fixed Coil reaches out to high inductance values in a miniature size. Electromagnetic shielding, feature of Series 1537-700 parts, is fully effective not only along the body but also at the ends of the coil guaranteeing efficient shielding regardless of your packaging configuration. The length of the molded body permits lead mounting of .400" PC hole spacing.

Series 1537-700 is a high quality product with reliability built into every design feature and manufacturing process. You will find it worthy of the Delevan name.

**SPECIFICATIONS:**
- Size: 0.157" Diameter; 0.375" Length
- Shielding: Less than 2% coupling
- Inductance: 0.1 uh thru 120,000 uh (74 values)
- Environment: Grade 1, Class B, MIL-C-15305

**Delevan Electronics Corporation**
A Subsidiary of American Precision Industries, Inc.
270 QUAKER RD • E5 • EAST AURORA, N.Y.

Write for further information on 1537-700 Molded "Shielded" Fixed Coils Today.

**CIRCLE 108 ON READER SERVICE CARD**

**HELP YOUR POST OFFICE TO SERVE YOU BETTER**
BY
MAILING EARLY IN THE DAY
NATIONWIDE IMPROVED MAIL SERVICE PROGRAM

---

Tiny Feed-Through Features Long Lug

TURRET TOP microminiature Press-Fit feed-through Teflon terminal features a long lug for easier soldering access in extremely tight space applications. Type FT-MM50 TUR incorporates a brass, gold flash over silver plate lug measuring 2 in. long. The Teflon bushing measures 0.140 in. overall with 0.093 in. as the minor diameter and 0.125 in. as the seating diameter. The Teflon bushing is pure virgin Teflon and is available in all ten standard EIA colors. Seallectro Corp., 139 Hoyt St., Mamaroneck, N. Y. (310)

Capstan Motors for Tape Recording Use

SERIES 43H precision, direct drive capstan motors for use in the tape recording industry are available in one, two and three-speed models with speed combinations available between 300 rpm and 1,800 rpm.
The Honeywell 1612 Visicorder Oscillograph is a completely new 36-channel instrument. It was designed from the base up for systems use. Features such as a built-in heated platen, modular electronics, and push-button controls make it the most versatile oscillograph ever built by Honeywell, pioneer in direct writing oscillography using light beam galvanometers.

The built-in heated platen, a factory-installed option, serves as a standard platen until heat is desired, at which time the operator simply pushes a button. Platen heat improves the quality of the record and gives better contrast. In conjunction with the two latensifier lamps, it provides immediate read-out of records at speeds up to 16 inches per second.

Other examples of the 1612's functional design are:
- 15 forward recording speeds (from 0.1 to 160 ips) and 10 reverse speeds—all pushbutton controlled.
- All controls on front surface.
- Paper loading accomplished in seconds.

Instrument may be operated in the rack, pulled out on slides, or bench-mounted.

Uses Type M miniature galvanometers, interchangeable among other Honeywell oscillographs.

For full details on all Visicorder Oscillographs, tape systems, and signal conditioning equipment, write to Honeywell, Denver Division, Denver, 10, Colo., or phone 303-794-4311.
NO STRIPPED THREADS

METER MANUFACTURER CHOOSES CLECOMATIC® BECAUSE . . .

(1) Previous fastener driving methods proved inadequate for precise Quality Assurance Standards.

(2) SERIES 3 and 6 CLECOMATICS provided the precise control required to meet those quality standards.

(3) Automatic shut-off prevents fracturing of meter box coatings, stripping of threads and damaging of screws resulting in dramatic reduction in the number of rejects.

What the precision torque, fully automatic CLECOMATIC has done for this manufacturer, it can do for you. Call your CLECO Representative, he will be glad to help you with your production line problems.

*Fully warranted for one year by the GOLDEN CIRCLE guarantee

Conductive Paint
For P-C Boards

A SILVER conductive paint is available for applications where a temporary common conductive path is required for the precious metal plating of "fingers" on a printed-circuit board. The silver paint is applied with an artist's pen or draftsman's ruling pen, air dried, and can later be removed, when necessary, by wiping with xylene. Price: $8 for a 2-oz kit. Etchomatic Inc., Newton St., Waltham, Mass. (312)

Disk Thermistors Are Epoxy Encapsulated

DESIGNED for mounting on p-c boards, these epoxy-encapsulated disk thermistors (measuring approximately 1/8 in. by 3/16 in. by 3/16 in.) are provided with 0.025 diameter stiffened nickel leads, and facilitate both automated and manual mounting. Molded construction serves to extend the vibration, shock, acceleration and humidity characteristics of the units. A broad range of resistance values are available in the new configuration. Fenwal Electronics, Inc., 63 Fountain St., Framingham, Mass. (313)

Static Relays Offer Ultrasensitivity

SERIES 650 Mag relay combines a magnetic amplifier and silicon con-

synchronous speeds. Shaft run-out is 150 µin. max. A typical motor will provide direct drive tape speeds of 33, 7 1/2, and 15 ips at shaft speeds of 300, 600 and 1200 rpm, respectively. Windings are for 115 v, 60-cycle excitation; 50-cycle motors available on special order. Typical torque values range from 6.0 to 12.0 in.-oz. Motors measure 4 7/8 in. diameter by 4 7/8 in. length to the mounting flange. Beau Electronics, Inc., 41 Haig St., Hamden 14, Conn.
In determinations of acceleration factors for metal and carbon film resistors for the high reliability MINUTEMAN Program, Electra Manufacturing Company uses an Automatic Resistor Data Logging System designed and built by Electro Instruments.

This system, in conjunction with other test equipment, has accumulated over 60 million resistor hours of data in the last 18 months. Without this accelerated testing system, \(7\frac{1}{2}\) years of test time would have been required! Most important, the EI system gives Electra the confidence that their products meet stringent government specifications.

As in this EI system created for Electra, EI all solid state Digital Multimeters are the basis for better measuring at greater speed, higher reliability, significant cost savings and a much lower investment.

Whether your interest lies in spacecraft, electronic components or industrial processes, we can demonstrate to you the advantages of EI digital instruments in measuring DC volts, AC volts, DC ratios, resistance, capacitance, inductance and impedance. Let EI all solid state Digital Multimeters or Complete Systems provide swift, accurate, low cost solutions to your measurement and display problems!

For full details on EI's individual digital instruments, or our complete capabilities in the field of measurement, display and recording—write direct to Electro Instruments, Inc.

Electro Instruments, Inc.
8611 Balboa Avenue, San Diego 12, California
New, complete catalog describes full line of Standard precision timers. Various models have scale divisions from 1/1000 sec. to 1/5 sec., totalize from .360 sec. to 60 min., are available in accuracy range from ±.0002 sec. to ±.1 sec.

REQUEST Catalog No. 257

THE STANDARD ELECTRIC TIME COMPANY
89 LOGAN STREET • SPRINGFIELD, MASSACHUSETTS

NEW BETTER-THAN-EVER RELIABILITY
for long-distance point-to-point communications

NORTHERN RADIO

NEW 16-CHANNEL TRANSISTORIZED VOICE FREQUENCY DIVERSITY CARRIER TELEGRAPH TERMINAL TYPE 235 MODEL 3
MIL DESIGNATION AN/FGC-61A

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

Write for complete literature.

Northern Radio Products Corp., Box 438, Highland Park, Ill. (315)

Northern Radio

Snap-Action Switch
For Slow Actuation Use

SNAP-ACTION switch series E14 is UL approved, 25 amp 125/250 v a-c, 1 h-p 125 v a-c, 2 h-p 250 v a-c. Designed with new tease-proof mechanism that assures simultaneous electrical and mechanical action regardless of rate of actuation, this series is available in both momentary and reset action types. Featuring coil spring construction it has a contact carrying blade that maintains full contact pressure as actuator approaches operate and reset points. Cherry Electrical Products Corp., Box 438, Highland Park, Ill. (315)

Solder Remover for Component Rework

DESIGNATED Soldapullt, this portable hand tool provides a convenient method of desoldering components on p-c boards. It features a high impulse of 25 in. of Hg vacuum and a self-cleaning tip. It reduces solder splash and overheating of solder connections. Also it simplifies re-
cut your identification costs with modern methods like these

Print top and side together at 3200/hour

Identify products with inks that meet government specs

Print 1500 hard-to-hold items per hour with complete uniformity — change to new imprint in seconds

Save purchase, inventory and obsolescence costs by making your own labels exactly as needed

Get sharp, durable imprints on extremely irregular shapes or rough surfaces

Color-band and/or print economically by machine — in sample lots or up to 6000/hour

Looking for faster identification . . . imprints that meet government specs . . . flexibility to meet changing requirements . . . a practical way to mark prototype or sample lots? Would direct printing or making your own labels cut costs, give higher print quality? Ask Markem to analyze your identification needs now — without obligation — and show you how and where you can save money. Frequently, a Markem in-plant identification system pays for itself in a few months. Contact the Markem Technical Representative near you, or write Markem Machine Co., Keene 5, New Hampshire.

New 12-page Catalog describes Electrical/Electronic Identification Methods and Equipment. Copy on request.

MARKEM
TECHNICAL ASSISTANCE AND INDUSTRY-PROVEN EQUIPMENT WORLDWIDE . . . TO HELP YOUR PRODUCT SPEAK FOR ITSELF

electronics • May 3, 1963

CIRCLE 113 ON READER SERVICE CARD 113
TRIMMING POTENTIOMETERS

NEW ATOHM HCL PROGRAM GIVES ASSURANCE OF ULTRA-HIGH RELIABILITY AT NO EXTRA COST!

Tired of paying the high, extra cost of so-called, ultra-high-reliability trimmer pot programs and putting up with delivery delays? Then, here's good news. The Atohm High-Confidence-Level reliability program, which meets and exceeds testing required by MIL-R-27208A, is now available at no extra charge.

Specifically, the new Atohm HCL program provides:

1. Quality assurance testing to paragraph 4.5 and sub-paragraphs 4.5.1.3, 4.5.1.4, and 4.5.1.5 of MIL-R-27208A.
2. Units which have been conditioned by temperature cycling in the process of manufacturing: 1 cold cycle (−65°C) and 8 heat cycles (over 200°C); a total of 18 hours of hot and cold cycling.
3. Units which have been tested and inspected for a total of 88 electrical, mechanical and functional tests.
4. Three additional tests in the Group A or final inspection tests above that required by MIL-R-27208A: (1) Insulation resistance; (2) Immersion; (3) Operational cycling (20 cycles under power).
5. Units that have been subjected to full military requirements, not watered down screening tests which specify lower ambient temperatures and reduced loads.
6. Quality assurance testing and scheduled testing and test reporting performed under surveillance of the U.S. Navy Quality Control Representatives. Documentation upon request.

This program of testing is performed continuously at the Atohm plant on all military units as a standard production technique. Such testing is not limited to special orders or lots, and is available without extra cost. Your Atohm representative can answer any specific question you may have regarding the HCL program. Call him today.

ATOHM ELECTRONICS
7648 San Fernando Road, Sun Valley, California • TR 7-9873

CIRCLE 211 ON READER SERVICE CARD

MARK II MODULATED BEAM PHOTOMETER

The "Speedivac" Modulated Beam Photometer provides a method of controlling the optical thickness of films deposited by evaporation or sputtering by indicating the changing optical characteristics of the films as their thickness increases. The instrument measures the reflection from or the transmission through coated glass surfaces as a function of wave-length. Both these quantities can be measured alternately if two light sensing elements are used.

SPEEDIVAC MULTIPLE VAPOR SOURCE VACUUM COATING UNITS

EDWARDS HIGH VACUUM has pioneered the design and development of evaporation systems and accessory equipment from small versatile laboratory units to high capacity production plants.

CIRCLE 316, READER SERVICE CARD

Counter-Timer Has Plug-In Design

NEW 10 Mc counter-timer, model 1034, is a general purpose digital test instrument featuring front-panel plug-in design, transistorized plug-in construction, and a wide range of selectable modifications to satisfy specific customer requirements. Standard features include a seven digit readout with blanking of display during count cycle, and an oscillator with a stability of ±3 parts in 10⁹ per week. Also provided in the universal input plug-in model 1926 are variable controls for each input amplifier and convenient front panel jacks for setting trigger levels on an oscilloscope. Systron-Donner Corp., 888 Galindo St., Concord, Calif. (317)

Instrument Stand For Plastic Welding

INSTRUMENT stand for use with plastic welding torches has an integral torch rest for operator convenience and features a new combination gas regulator and filter unit. The compact, lightweight regulator-filter provides accurate flow control for precise temperature regulation and assures a clean gas supply for consistent weld integrity. Stand has an aluminum heat shield to confine the hot gas. The instruments, filter and regulatory assembly, are
This is a uniquely versatile, factory-calibrated instrument for making pulsed-light measurements in the visible and near-infrared spectrum. Average power readings are indicated directly on a built-in meter; waveshape, rise time, fall time, duration and energy measurements are easily displayed on a fast oscilloscope. Utilizing EG&G's new ultrafast, SD-100, silicon photodiode, the LITE-MIKE detector head is swivel-mounted for ease of alignment with the light source to be measured. Compact (only 10" high) and lightweight, the LITE-MIKE incorporates built-in controls for sensitivity selection and balancing of ambient light.

For data sheets and further information, contact:
Marketing Dept., 176 Brookline Avenue, Boston 15, Massachusetts

EGERTON, GERMESHAUSEN & GRIER, INC.
BOSTON • LAS VEGAS • SANTA BARBARA

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>MONOCHROMATIC SPECTRUM</th>
<th>CHROMATIC SPECTRUM</th>
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<td>WAVELENGTH</td>
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*Can be calculated within spectral response capabilities.

**Chain of Thought**

The document describes a new instrument called the LITE-MIKE, which is used for making pulsed-light measurements in the visible and near-infrared spectrum. It provides detailed measurements such as waveshape, rise time, fall time, duration, and energy, which can be displayed on an oscilloscope. The instrument incorporates a built-in silicon photodiode and has features like a swivel-mounted detector head for ease of alignment and built-in controls for sensitivity selection and balancing of ambient light. It is compact and lightweight, making it versatile for various applications.

**Table:**

<table>
<thead>
<tr>
<th>ANGSTROMS</th>
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<tr>
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</tbody>
</table>
BARKER AND WILLIAMSON

BARKER & WILLIAMSON, Inc.
Radio Communication Equipment Since 1932
BRISTOL, PENNSYLVANIA • STILLWELL 8-5581

HARMONIC AND SPURIOUS TOTALIZER

B&W Harmonic and Spurious Totalizer, Model HST, measures total harmonic and spurious radiation from radio transmitters.

Frequency Range:
for transmitters operating from 2-32 mc, measures harmonics and spurious to 90 mc.
Total spurious and harmonic levels as low as 65 db below the carrier can be measured.
A measurement can be made in a matter of minutes.

Ideal for:
Periodic check of spurious emissions at radio transmitting stations.
Development of transmitter equipment.
Production testing of radio transmitters.

Write for Sales Bulletin #106 for description and specification.

Power Transistor for High-Speed Switching

DEVELOPMENT of an epitaxial-base germanium power transistor series for high-speed, high-voltage switching applications is announced. Internal construction of the devices, types MP721A, B and C, gives rise to extremely fast switching characteristics particularly applicable to flyback circuits in transistorized TV circuits and similar applications. Pertinent specifications for TV flyback circuits include a fall time of 0.7 µsec at 8 amperes of collector current. Motorola Semiconductor Products Inc., P.O. Box 955, Phoenix, 1, Ariz. (319)

H-V Test Set Is Portable Unit

A PORTABLE Hi-Pot Tester has been developed which supplies high potential voltage up to 5 Kv for testing such items as cables, connectors and other devices and components subjected to high potential insulation. Unit incorporates fixed and variable sensing circuits which automatically remove high potential voltage when current exceeds pre-
General Electric has completed a silicon transistor reliability improvement program for the MINUTEMAN airborne guidance and control system where data on a single product has been accumulated for over 100,000,000 life test hours... unsurpassed in the semiconductor industry. The result is reliability without parallel. For instance, final phase testing of 4,650 G.E. MINUTEMAN transistors to approximately 24,000,000 transistor hours at 288 mw resulted in ZERO failures. The MINUTEMAN Part transistor made by General Electric substantially exceeds the MINUTEMAN objective of an average failure rate of 0.001%/1000 hours in continuous operation at 87 mw (25°C ambient) (see graph).

You can have this kind of reliability in your military and commercial applications. Just check the chart for MINUTEMAN Part Numbers, similar EIA Types, and additional MINUTEMAN Types, all produced simultaneously on the same production lines and under the same exacting conditions.

**NEW HIGH VOLTAGE POWER SUPPLIES**

PSR Series, pictured above offer these important features: Range 5 to 30 KV, 2 to 30 MA • Regulation ± .05% • Ripple .1% RMS • Completely Solid State Circuitry • Light Weight • Rack Height 8¼" maximum • Dry Insulation • Overload Protection • Reversible Polarity • Simplified Controls; coarse and fine voltage, ON-OFF meter reversing switch • Triple-Range Kilovoltmeter and Milliammeter.


ELECTRONICS DIVISION
RESEARCH-COTTRELL, INC., BOUND BROOK, NEW JERSEY

REMOTE DATA RETRIEVERS, EVENT AND DATA RECORDERS

HOGAN FAXimile recorders are available with up to 2000 individual styli for simultaneous recording. A wide range of stylus spacings is offered – up to 100 to the inch for high-speed facsimile, television and radar recorders and high resolution printers and plotters. Chart widths to 30" and feed rates to 50" per second.

Hogan specializes in electrolytic techniques for event, spectrum analysis, oscillograph and facsimile recording, frequency time analysis and special purpose binary and gray scale record applications. Hogan electrolytic fax-papers provide a permanent high contrast black on white record which is reproducible on most conventional office duplicators.

Whatever your recording problem may be – contact HOGAN FAXimile, a subsidiary of TELautograph Corporation, 635 Greenwich Street, New York 14, N.Y.

B-W Oscillator Can Be Ambient Cooled

FEATURED in the SYB-4403 backward wave oscillator is a novel packaging which makes external cooling unnecessary. Tube is tunable over the 2.0 Ge to 4.0 Ge range, with a power output of 100 mw, and a power variation of less than 2 db from a straight line. It contains a control electrode to facilitate low-voltage pulsed or amplitude modulation. Unit is used in test equipment and as a local oscillator for frequency-diversity systems. Sylvania Electric Products Inc., Williamsport, Pa. (322)
NEW DESIGN PRINCIPLE PERMITS MEASUREMENTS ACCURATE TO 0.2 db OF AC OR DC VOLTAGES OR VOLTAGE RATIOS ON TRUE LOGARITHMIC SCALE OVER 3160:1 OR 70 db CONTINUOUS RANGE  □ DC OUTPUT FOR RECORDING □ 60 db/sec SLEWING SPEED □ MODEL HLVC150 $1450.

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Literature of the Week

BEARINGLESS TACHOMETER GENERATOR
Vibrac Corp., Route 129, Alpha Industrial Park, Chelmsford, Mass. A 4-page brochure describes an inexpensive means to precise measurement of shaft speeds. CIRCLE 323, READER SERVICE CARD

POWER SUPPLIES Kepco Inc., 131-38 Sanford Ave., Flushing 52, N. Y. Catalog B-631 provides a convenient guide to the selection of a wide variety of high-reliability, d-c regulated power supplies. (324)

LASER MICROPHONE Jarrell-Ash, 26 Farrell St., Newtonville, Mass. Preliminary bulletin 45-600 describes an optical ruby laser for exciting spectral emission from analytical samples. (325)

WIRE AND CABLES Standard Wire and Cable Co., 3440 Overland Ave., Los Angeles 34, Calif. Publication entitled "Comparison Chart" shows major characteristics of aircraft and electronic wires and cables covered by military specifications. Copies are available upon letterhead request. (326)


ULTRAPURE ELEMENTS L. Light & Co. Ltd., Colnbrook, Bucks, England. Over 700 forms and compounds of 84 elements are listed in catalog M-4 now available. (328)

WIRE AND CABLE INSULATIONS Radiation Materials Inc., 36-32 37th St., Long Island City 1, N. Y. A 20-page catalog describes the company's irradiated polyolefin wire and cable insulations. (329)

ELECTRON TUBES General Electric Co., Owensboro, Ky. A 16-page booklet contains details of 22 recent developments in Compactrons, receiving tubes, ceramic tubes, photoconductive cells, and reed switches. (330)

POWER WIREWOUND RESISTORS International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. High temperature power wirewound resistors featuring fireproof construction are described in bulletin P-7b. (331)

R-F INDUCTORS Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J. Ultrareliable shielded subminiature r-f inductors with inductances from 0.11 H to 180,000 H in 76 values are offered in a catalog sheet. (332)

MILITARY COMPONENTS Ohmite Mfg. Co., 3640 Howard St., Skokie, Ill. Catalog of military components (50C) contains information on new rheostats and resistor styles and expanded listings of hat shape tantalum slug capacitors. (333)

May 3, 1963 - electronics
PROTECTIVE COATING Columbia Technical Corp., 24-30 Brooklyn-Queens Expressway West, Woodside 77, N. Y., offers a data sheet on Humiseal type 1B25, a fast drying coil dope for applications over a wide range of frequencies. (333)

PREAMPLIFIERS Brush Instruments, division of Clevite Corp., 37th and Perkins, Cleveland 14, O. Five data sheets describe the 4200 series of interchangeable solid-state preamplifiers for use with oscillograph recording systems. (334)

FIXED DELAY LINE Helipot Division of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif., has available data sheet 63437 on a miniature fixed delay line. (335)

EXTRUSIONS Mideast Aluminum Corp., U. S. 130, Dayton, N. J. Brochure describes the company and its services for the extrusion of shapes for the electronic and electrical industries. (336)

PRINTED CIRCUIT PROTOTYPES Rowe, Inc., 68 Union Ave., Clifton, N. J. Brochure describes the company's special facilities for printed circuit prototype development and short run production. (337)

TELEGRAPH REKEYER Ortronix Inc., P.O. Drawer 8217, Orlando, Fla., offers a short form catalog on a transistorized, solid state telegraph rekeyer that is a 10th the size of conventional vacuum tube types. (338)


TUNNEL DIODE AMPLIFIERS Aertech, 1074 Alma, Mountain View, Calif. A technical data sheet describes S-band and C-band low noise, high gain tunnel diode amplifiers. (340)

PRECISION MOLDINGS Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y. Brochure 1018 describes the design advantages of automatically-molded small precision thermoplastic parts. (341)

X-Y RECORDER Varian Associates, 611 Hansen Way, Palo Alto, Calif. The all-transistor model F-80 X-Y recorder is illustrated and described in a new folder. (342)

LINE FAULT ANALYZER Sierra Electronic Division of Philco, 3899A Bohannon Drive, Menlo Park, Calif. Model 371A line fault analyzer with its 200 mile ranging capability is covered in a 4-page folder. (343)

DEFLECTION YOKE Constantine Engineering Laboratories Co., Mahwah, N. J. Celco bulletin Y18 details technical information concerning a new deflection yoke for direct display storage tubes. (344)

DIGITAL DELAY LINES Microsonics, Inc., 60 Winter St., Weymouth 88, Mass., has published a bulletin dealing with digital delay lines. (345)
H-P To Build $2-Million Plant

DAVID PACKARD, president of Hewlett-Packard Co., has announced the company will build a new plant in Colorado Springs, Colo., for the design and manufacture of oscilloscopes.

Construction of the $2-million plant will begin about June 15, according to Packard. He said the new facility, a single 137,500-sq-ft building on a 30-acre site, is expected to be completed within a year, and eventually employ about 650 people.

"According to our long-range plans, this building will be only the first unit of a four-building complex which will provide some 400,000 sq ft and employ more than 2,000 people," he added.

Hewlett-Packard, headquartered in Palo Alto, Calif., is one of the largest manufacturers of electronic measuring instruments. The company already has two facilities in Colorado—a 140,000-sq-ft plant in Loveland, and a 20,000-sq-ft leased plant in Colorado Springs.

Packard pointed out that H-P has been producing oscilloscopes for only the past six years. During that time the company's oscilloscope sales have increased at an average rate of 30 percent per year.

"We anticipate that this growth will continue, and for this reason are moving as quickly as possible to expand our productive capacity," Packard said.

At present the bulk of Hewlett-Packard oscilloscopes are produced in Palo Alto, Calif. However, Packard stated that over the next 18 months the company will transfer its entire Oscilloscope division to Colorado Springs.

Hewlett-Packard and its subsidiaries now produce more than 900 different types of precision instruments which are distributed throughout the U.S. and in some 70 foreign countries. The company has a dozen manufacturing plants, including two in Western Europe. Total employment, including subsidiaries, is approximately 6,000.

Activity at its Beverly, Mass., facility.

Under the direction of Arthur McCoubrey, the new activity will be located at the Beverly site together with the Bomac division of Varian.

McCoubrey's group will take over development and production of Varactor subminiature diodes formerly produced by the Bomac division. It will also develop and introduce a new line of microwave devices useful for the generation and amplification of microwave energy, and for other purposes. The group will function as a unit of Varian's Microwave Tube Group, reporting to group vice president Emmet G. Cameron.

McCoubrey has been with Varian since 1960.

Piland Takes Over Key NASA Post

ROBERT R. GILRUTH, director of NASA's Manned Spacecraft Center, Houston, Texas, has named Robert O. Piland to be acting manager of the Apollo program, with the additional responsibility as chief, Command and Service Module.

Piland was formerly chief, Lunar Excursion Module, and is being replaced in that position by James Decker.

General Capacitor Elects Biesele

R. L. BIESELE, JR., formerly manager of operations of the Palo Alto plant of the Clevite Corp., has been elected president and chief executive officer of General Capacitor Co. of Palo Alto, Calif. He has also been elected to the board of directors of the company.

General Capacitor manufactures a line of high voltage capacitors and pulse forming networks for use in high power search radars, linear accelerators, and pulsed laser applications.

Kolste Takes New Management Post

LOREN KOLSTE has been appointed manager of operations of Good-All
The all-new CUBIC V-85 is your best buy in a 5-digit voltmeter! The new V-85 five-digit reed relay voltmeter has more unique quality features inside and out than any other instrument. New lifetime, encapsulated, sub-miniature reed relays in the bridge switching circuit are good for more than a billion cycles of maintenance-free operation. These reed relays are virtually noiseless! The precision Julie Research Lab resistors in the bridge circuit are the best and most expensive obtainable—and they yield unparalleled accuracy.

MILITARY GRADE CIRCUIT BOARDS: Cubic uses extra thick epoxy-glass circuit boards of military grade. All etched circuits are on one side of the boards and all components on the other to simplify maintenance. For rapid repairs, a new board may be slipped into place within seconds. Boards fit into molded connectors mounted on the mother board. This construction technique is much more substantial and eliminates the mis-alignment problems common to many plug-in board designs. Extender boards are furnished to bring circuit boards out into the open to provide external test points for checking.

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The new Welch 1377A Turbo-Molecular Pumping System produces an ultimate vacuum of $1 \times 10^{-6}$ mm Hg (Torr) and better; constant speed of 140 liters per second, over a range of $1 \times 10^{-2}$ to $1 \times 10^{-8}$ mm Hg (Torr).

The clean, vapor-free Turbo-Molecular Pump is combined with the well known Welch Duo-Seal 1397 two-stage mechanical pump, providing a completely assembled and tested pumping system, ready for use.

Advance design of the Turbo-Molecular Pump permits the use of an air slit ten times the size of previous designs and greatly reduces risk of damage by impact, heat expansion and dirt particles.

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- Purification of metals.
- Optic coating.

The Welch 1377A is particularly useful in processes involving separation of materials or isotopes with different molecular weights, as in particle acceleration work.

**Honeywell Announces Management Changes**

HONEYWELL has announced key management changes at two company divisions in the Boston area.

John W. Anderson, formerly vice president of engineering for the Electronic Data Processing division, was named general manager of the newly expanded Aeronautical division facility in Boston.

Succeeding Anderson at EDP is J. Chuan Chu who was named vice president for planning and engineering. Chu had been director of product planning for EDP.

Also, Robert J. Keeler was appointed director of engineering for the Boston Aeronautical facility. He had been head of the advanced product planning departments for both Boston and Florida operations.

**Transitron Names Division Managers**

Two major divisional appointments have been announced by Transitron Electronic Corp., Wakefield, Mass.

Roderic E. Hall, who has served as division manager-special products since 1961, has been appointed division manager-transistors.

Appointed division manager-special products was William Edgar who had previously been associated with Raytheon Company for some 15 years in semiconductor and tube departments.

Both men will report to the president.

**Ford Instrument Appoints Simon**

SIDNEY L. SIMON has been named vice president-engineering of Ford Instrument Company, division of Sperry Rand Corporation, Long Island City, N. Y. He was formerly chief engineer of RCA's Aerospace Communications and Controls division.

For more than 12 years, Simon was associated with the National Advisory Committee for Aeronautics (predecessor of NASA), earning promotion to chief, Physics of Solids Branch, Lewis Laboratory, Cleveland, O.

**Announce Formation of New Company**

A new firm, Micro-Beta Laboratories, Inc., has opened in Chicago,
and is offering prototype and consulting services in (1) radar, navigation, and communication components and systems; (2) special consumer electronic products.

In addition to these services the company manufactures a line of r-f and microwave products.

President of Micro-Beta Labs is R. B. MacAskill, and director of engineering is H. H. Sandgathe.

Fancher Assumes New Post

H. BRAINARD FANCHER, formerly general manager of General Electric's Semiconductor Products Department in Syracuse, N.Y., has been named general manager of GE's Apollo Support Department of the Command Systems Division.

His new headquarters will be in Daytona Beach, Fla.

Polytronics Labs Names Doremus

JOHN A. DOREMUS has been named chairman of the board and chief executive officer of Polytronics Laboratories, Inc., Clifton, N.J.

Before joining Polytronics, Doremus was vice president and general manager of the Westrex division of Litton Systems, Inc.

Established in 1958, Polytronics produces a complete line of citizens band communications equipment.

Beckman/Berkeley Hires Stalker

APPOINTMENT of James I. Stalker, formerly with Thompson Ramo Wooldridge, Inc., as manager of manufacturing engineering for the Berkeley division of Beckman In-
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**DC Digital Voltmeter (Model 501BZ).** Similar to Model 501B (see above). Circuit is automatically and continually calibrated against a Zener diode reference source instead of against an unsaturated mercury-cadmium standard cell. For submarine and other special environment applications. Price: $3160.

**AC/DC Digital Voltmeter (Model 502B).** Gives you AC accuracy within 0.1% of reading; over-ranging on both AC and DC; automatic ranging and remote (programmable) control. Measures DC between ±100 microvolts and ±1000 volts, AC from 30 cps to 10 kc between 1 millivolt and 1000 volts. Five-digit readout. Stepping switches guaranteed for 2 years. Price: $1245.

**AC/DC Digital Voltmeter (Model 502BZ).** Similar to the Model 502B (see above). Circuit is automatically and continually calibrated against a Zener diode reference source instead of against an unsaturated mercury-cadmium standard cell. Price: $4110.

Write for detailed literature or a demonstration of any of these exceptional instruments. Representatives in all major cities. All prices FOB, San Diego, Calif. Additional export charge.
For electronic equipment that must perform dependably in the presence of nuclear radiation fields

SPECIFY RCA NUVISTORS

The RCA nuvistor is in the class of active electronic-circuit components least susceptible to catastrophic failure from nuclear radiation.

Tests have demonstrated the rapid recovery and dependable performance of the RCA-7586 triode and the RCA-7587 tetrode after these nuvistors were subjected to both pulse and steady-state nuclear radiation as specified in the Neutron Radiation Damage Test, Military Standard MIL-STD-446A, November 25, 1960.

Specific test exposure levels and results for commercially available nuvistors are:

Pulse Nuclear Radiation. Nuvistor types 7586 and 7587 were operated in a 15-kc amplifier circuit and monitored during exposure to pulse nuclear radiation under the following conditions: neutron flux intensity, $\geq 10^{14}$ neutrons per square centimeter per second; energy level, $\geq 2.5$ million electron volts; pulse duration, 65 microseconds; integrated total neutron flux, $2 \times 10^{12}$ neutrons per square centimeter. In both the 7586 and 7587, recovery of the output signal was achieved in less than 0.5 millisecond after the end of the radiation pulse.

Steady-State Nuclear Radiation. Samples of the 7586 nuvistor tube were exposed to steady-state nuclear radiation under the following conditions: neutron flux intensity, $\leq 10^{13}$ neutrons per square centimeter per second; energy level, $\leq 1$ million electron volts; integrated total neutron flux, $10.8 \times 10^{14}$ neutrons per square centimeter. After exposure, all of the 7586 nuvistor tubes remained operable and exhibited an average change in transconductance of less than one percent compared to the initial reading.

These facts, plus the already established advantages of nuvistor, are of vital importance to the designer of electronic equipment for use in the presence of nuclear-radiation fields.

Whatever your specialty in the field of electronics, it will be to your advantage to know more about nuvistors. Call the RCA Electron Tube Division Field Office nearest you for information on specific nuvistor types or write Commercial Engineering, Section E-19-DE-1, RCA Electron Tube Division, Harrison, N. J.

FIELD OFFICES