A McGRAW-HILL WEEKLY 75 CENTS NOVEMBER 15, 1963

electronics

BEAM DISCHARGE THROUGH SCREEN

Collimates beam for hot welding

(photo right)

PHASED-ARRAY RADAR SYSTEMS

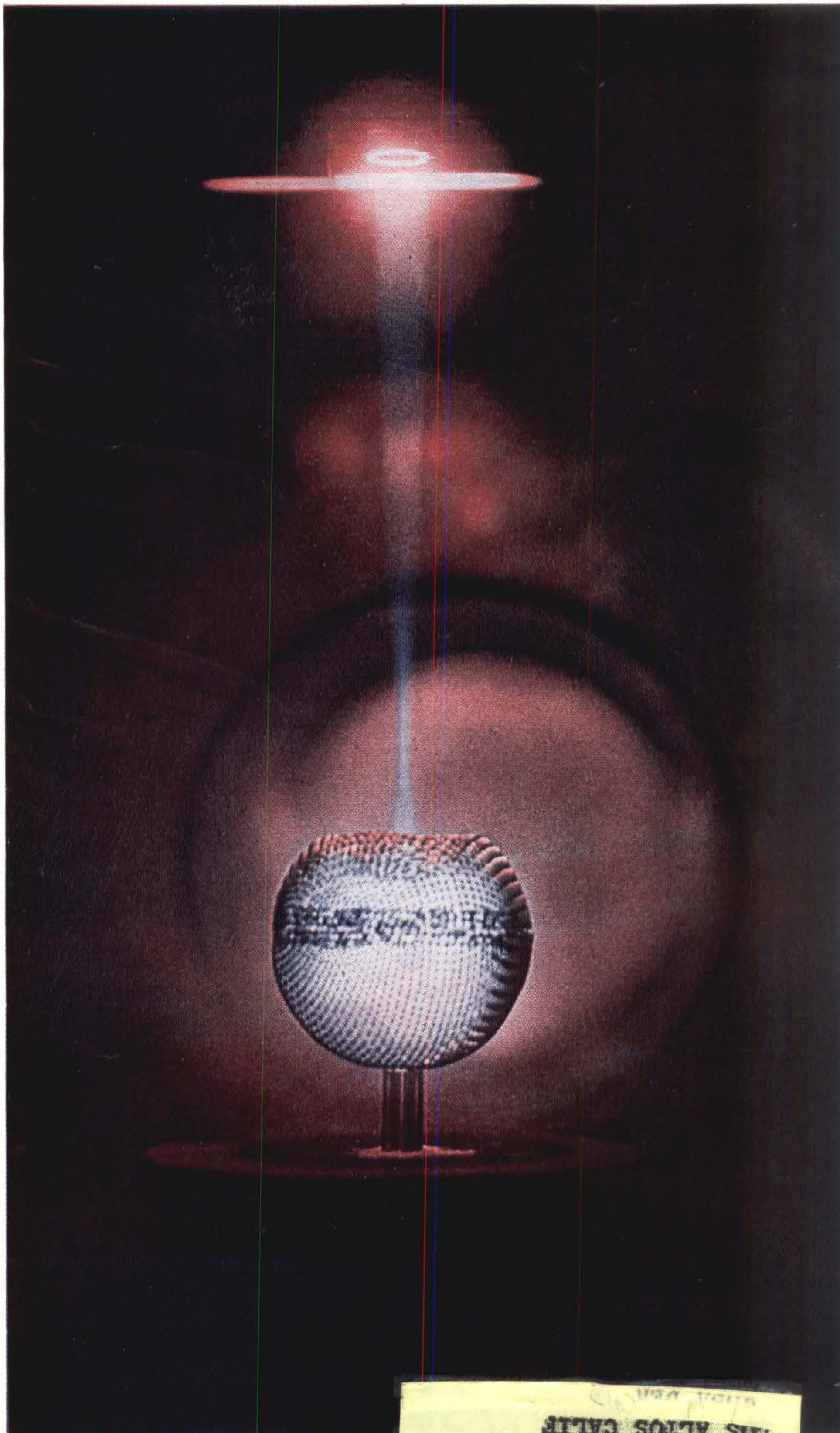
Computers help solve alignment problems

ASSOCIATIVE MEMORY

Uses multi-aperture logic elements

COLOR CODE

FOLDOUT CHART



The versatile new hp 310A High Frequency Wave Analyzer separates an input signal so that the fundamental, harmonics or intermodulation products can be determined and analyzed. Any signal component between 1 kc and 1.5 mc may be selected for measurement. Additionally, a front panel Mode switch lets the 310A function as an efficient tuned voltmeter for accurately measuring relative or absolute signal levels, as a signal source for selective response measurements, and as either an AM receiver or carrier reinsertion oscillator for demodulating sideband signals.

High sensitivity of 10 μv full scale, and the wide dynamic range of 75 db allows measurements of weak harmonic components down to 1 μv or strong signals up to 100 v. A switch above the input attenuator can be flipped from Absolute to Relative to permit signal readings at any arbitrary point on the meter for simplifying relative-strength measurements for harmonic components.

Three passbands, selected with a front panel control, increase the versatility of the 310A even more. The 200 cps passband discriminates between harmonics for exact identification. The 1 kc passband simplifies calculations of noise power per cycle bandwidth. The 3 kc passband admits carrier channel signals for evaluation and is wide enough to pass intelligible voice signals, but contributes so little noise that even the 10 μv range can be used. Rapid drop-off of 24 db per octave on either side of the band's cutoff frequency assures accurate readings.

The 310A is extremely easy to use. To prevent ambiguity of reading, proper voltage range, corresponding to full scale sensitivity, is automatically shown on an illuminated display on a 15-place front panel range scale indicator. Frequency tuning is continuous and linear over the entire range with no bandswitching. Frequency can be easily read from a 4-place digital type dial which has a resolution of better than 200 cps over the entire band, any setting being accurate to ± (1% + 300 cps).

An AFC control has a dynamic hold-in range of ±3 kc (at 100 kc) with response rapid enough to lock signals with drift rates in excess of 100 cps/second.

Outputs include restored frequency, which permits accurate measurement of the input frequency of the signal to which the 310A is tuned, plus a dc output for driving a recorder.

The output from the BFO is a derived sine wave that corresponds to the tuning indicator's setting, and it can be used effectively to make selective or narrow-band response tests on such as filter circuits and transmission systems. The BFO and tuned voltmeter are simultaneously controlled by the frequency indicator, tracking together, and can be conveniently used as a self-contained measuring system—the BFO output fed through a device under test, then back to the tuned voltmeter input for comparative analysis.

A carrier reinsertion oscillator is included to provide for the demodulation of single sideband signals, either normal or inverted. The demodulated signal is available for aural or recording purposes.

Call your nearby Hewlett-Packard representative today for a demonstration of this remarkable new instrument.

ANALYZER

SPECIFICATIONS

Frequency Range:	1 kc to 1.5 mc (200-cps passband); 5 kc to 1.5 mc (1,000-cps passband); 10 kc to 1.5 mc (3,000-cps passband)
Frequency Accuracy:	± (1% + 300 cps)
Frequency Calibration:	Linear graduation, 1 division per 200 cps
Selectivity:	Three IF passbands; 3 db points at ±100 cps for 200 cps passband; ±500 cps for 1,000 cps passband; ±1,500 cps for 3,000 cps passband. Drop off is 24 db/octave from 3 db points. Mid-passband indicated by rejection 1 cps wide
Voltage Range:	10 μv to 100 volts full scale
Voltage Accuracy:	±6% full scale
Dynamic Range:	Greater than 75 db
Input Resistance:	Determined by input attenuator; 10K ohms on most sensitive range; 30K ohms on next range; 100K ohms on other ranges
Automatic Frequency Control:	Dynamic hold-in range is ±3 kc, minimum, at 100 kc. Tracking speed is approximately 100 cps/sec for signal as low as 70 db below zero db reference on range attenuator
Restored Frequency Output:	Restored signal frequency maximum output is at least 0.25 volts across 135 ohms with approximately 30 db of level control provided. Output impedance, approximately 135 ohms
BFO Output:	0.5 volt across 135 ohms with approximately 30 db of level control provided
Recorder Output:	1 ma dc into 1,500 ohms or less for single-ended recorders
Receiver Function (Aural or Recording Provision):	Internal carrier reinsertion oscillator is provided for demodulation of either normal or inverted single sideband signals. AM signal also can be detected
Power:	115 or 230 volts ±10%, 50 to 1,000 cps; approx. 16 watts
Dimensions:	16¾" wide, 10½" high, 18⅜" deep. Hardware furnished converts panel to 10¼" x 19" rack mount. 44 lbs.
Price:	$2,000.00

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

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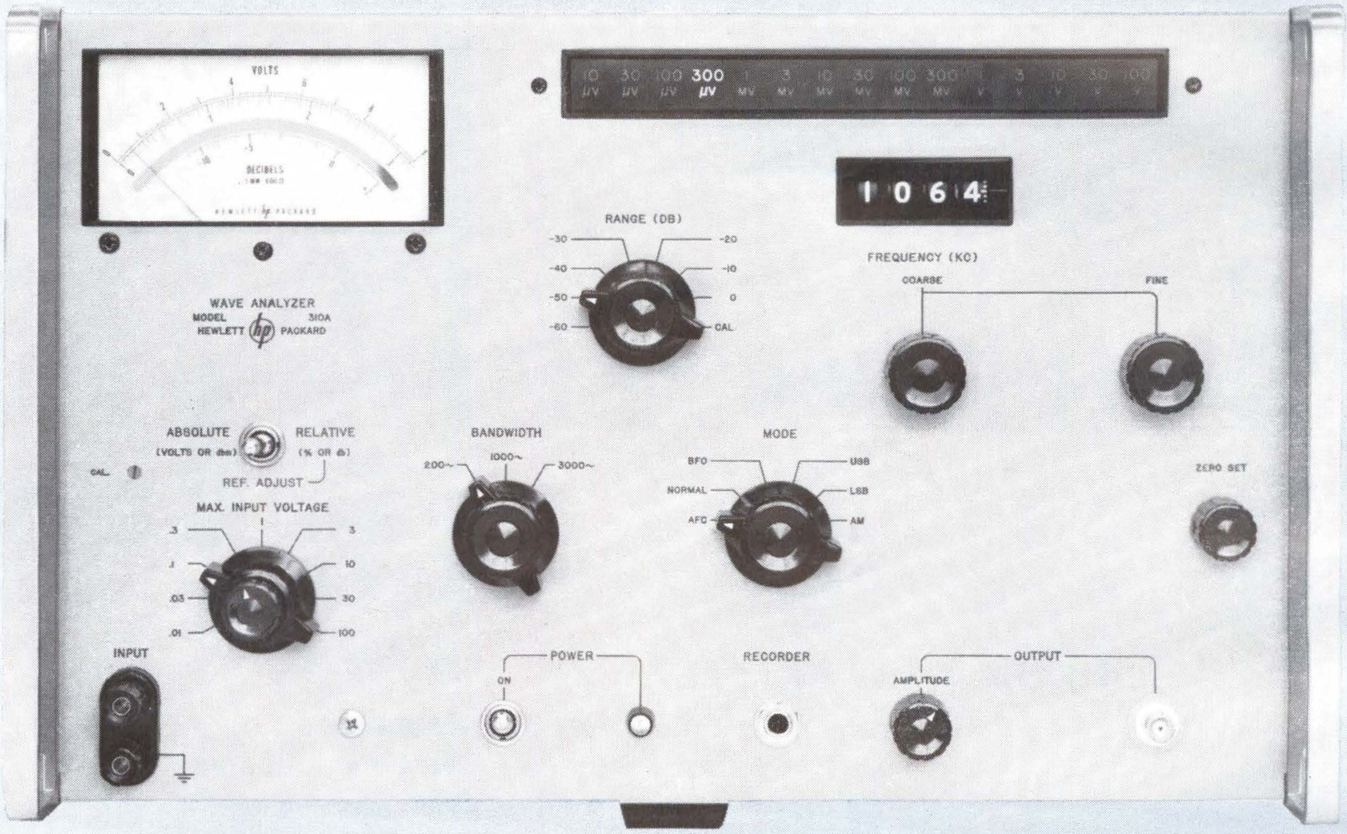
ver·sa·tile

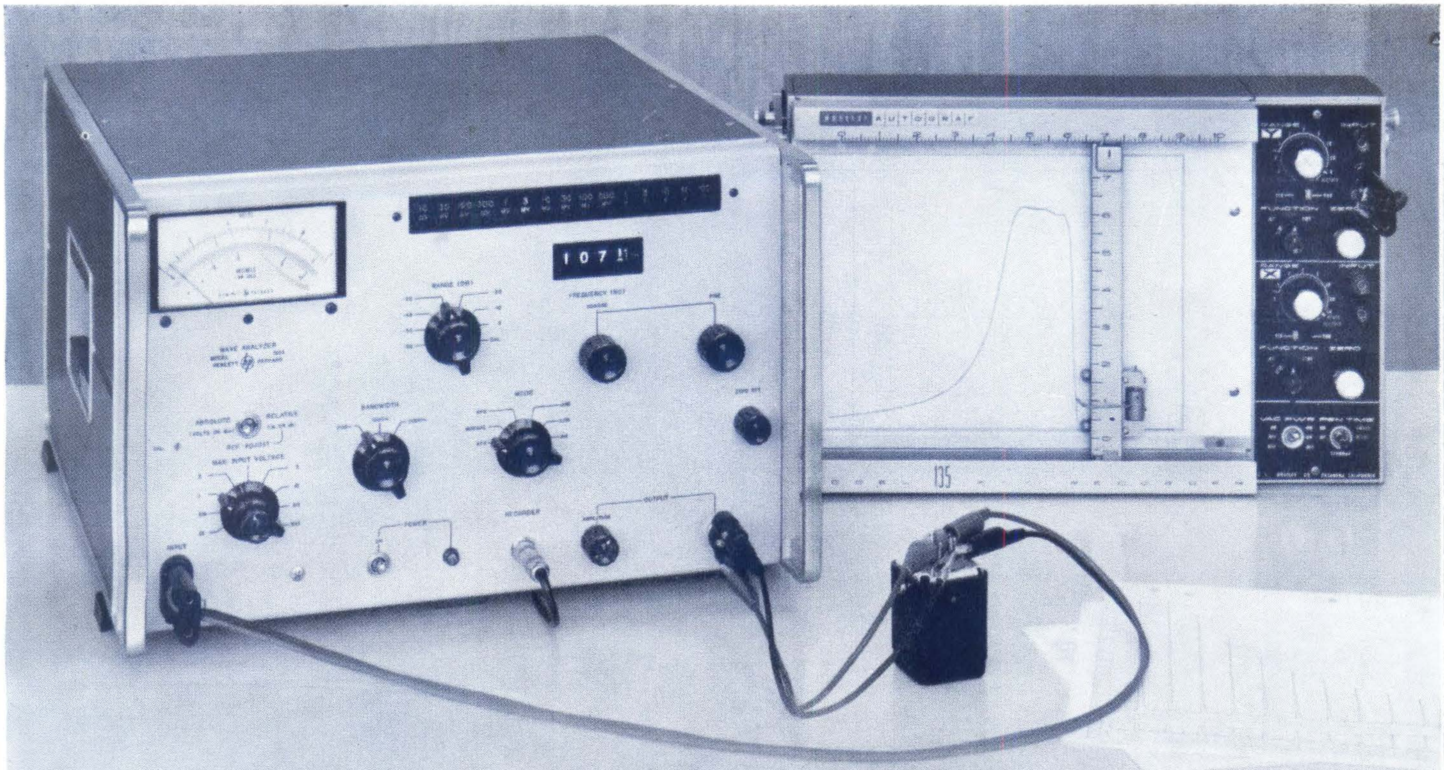
(vûr′sətĭl), *adj.* 1. capable of or adapted for turning with ease from one to another of various tasks, subjects, etc.; many-sided in abilities.



Count the capabilities of this high sensitivity, high frequency

New hp 310A Wave Analyzer

TURN THE PAGE for details on the usefulness of the 310A for analyzing complex audio and rf waveforms—measuring frequency response of filters and amplifiers—making multi-channel carrier measurements—making long line telephone measurements—analyzing transmission line characteristics—analyzing sonar signals...



VERSATILE

Curve on recorder shows frequency response of filter under test in 1 mc range; recording on table shows odd order harmonics of square wave.

With the NEW hp 310A:

Analyze complex audio and rf waveforms
Measure frequency response of filters and amplifiers
Measure multi-channel carrier waves
Make long line telephone measurements
Measure transmission line characteristics
Analyze sonar signals

Check these features:

Covers 1 kc to 1.5 mc, three passbands
High sensitivity of 10 microvolts full scale
Wide dynamic range, over 75 db
Continuous linear tuning, no frequency range switching
Digital frequency readout
Automatically tracks drifting signal
Restored frequency output
Carrier reinsertion oscillator
All solid state with plug-in board construction
High input resistance

NOVEMBER 15, 1963

electronics

A McGRAW-HILL WEEKLY 75 CENTS

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electronics

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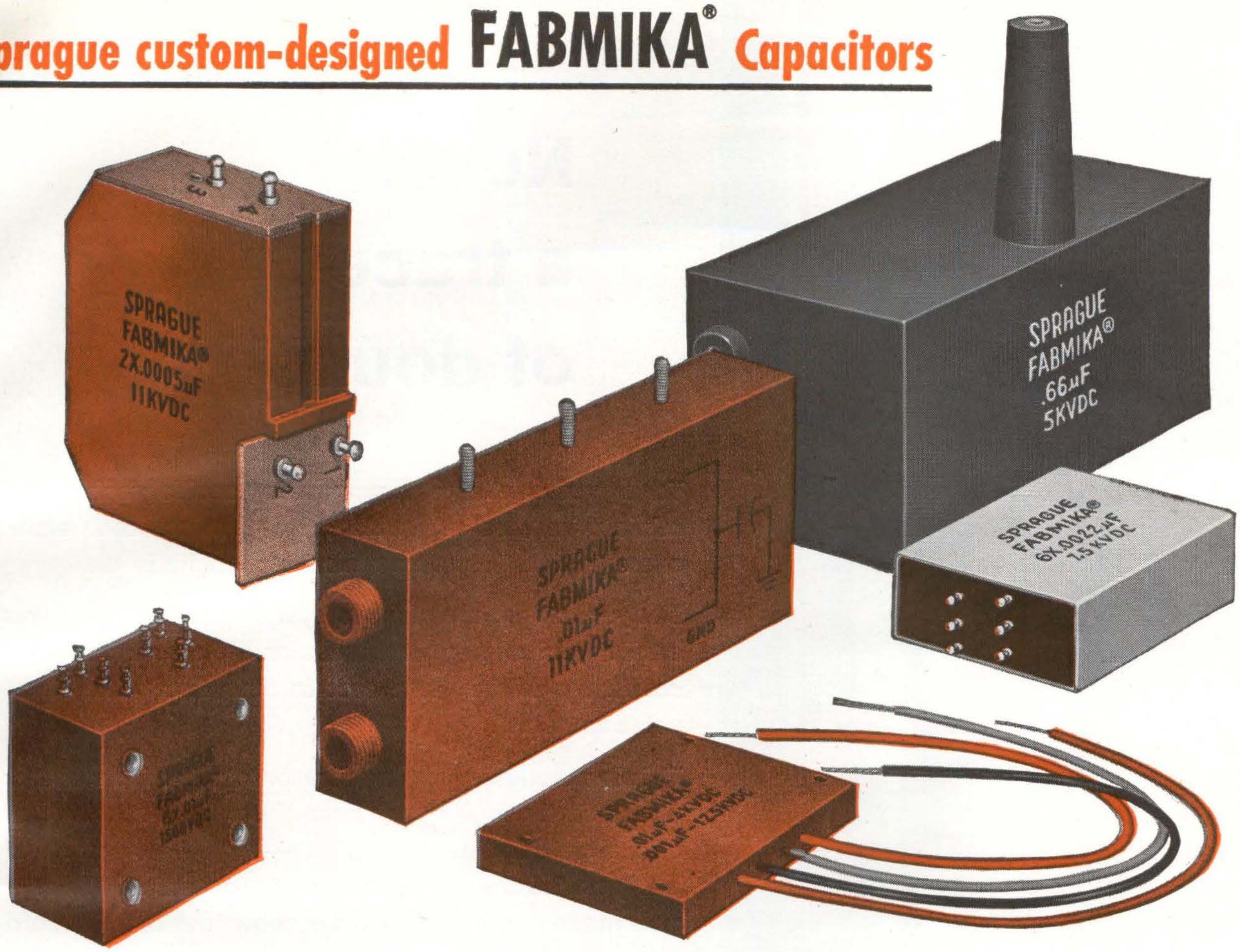
DEPARTMENTS

Sprague custom-designed FABMIKA® Capacitors



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7

Man's Military Role in Space

AS ANOTHER AUTUMN moves into winter, and 1963 into 1964, the Administration moves into a new round in the effort to decide what, if any, man's military role in space should be. "It's a very tough problem, but we intend to face it, and we intend to face it right away."

This promise was made by Harold Brown, Director of Defense Research and Engineering, at the United Aircraft Corporate Systems Center, Farmington, Conn., Oct. 17.

Outcome of the long-awaited tangle with the reality of "near-earth orbit" will be of great interest to us, some hundred or so miles below, and to industry, whose efforts in this segment of defense work have been curtailed for the past two years.

The administration's decision could be positive, depending on military strategy, political pressure in an election year, or a casual statement by Khrushchev at a press conference that the Soviets are building a manned earth-orbiting laboratory—a system with obvious military potential.

At present, however, there is no indication that the decision will reflect any more enthusiasm for advanced weapon development than Brown and Secretary of Defense Robert McNamara have expressed in the past.

"We've been looking at this question (of man's military role in space) for six years now and we have not come up with very many more things than . . . (surveillance, repair of complex electronic equipment, and the return of recoverable boosters)," Brown said in Farmington.

Because of this scarcity of ideas, Brown sees doubtful military benefit in Gemini and Dynasoar. Both projects "are very limited in being able to answer the question of what man can do in space." Main value of the projects, he explained, would be to test requirements of a follow-on system, but unfortunately there *are* no well-thought-out plans for a follow-on system.

Others *do* see a military role for man in space. Khrushchev said after Titov's flight: "If you want to threaten us from a position of strength we will show you our strength. You do not have 50-and-100-megaton bombs. We have stronger than 100-megatons. We placed Gagarin and Titov in space, and we can replace them with other loads that can be directed to any place on earth."

Soviet Marshal Sokolovskiy has also spoken of orbiting nuclear weapons and military aerospace vehicles. Khrushchev has said they could knock our missiles down, and in October, 1960, Dr. Zhukov, a Soviet military analyst, wrote in *International Life,* that they can destroy our satellites.

The U.S. Air Force has responded to Soviet threats by proposing that manned satellite systems could provide command and control, and that satellite-based bombardment missiles could provide global coverage. Radiation weapons installed on orbiting platforms are also possibilities; while such devices may seem far out, ICBM's were also discounted a few years ago.

Jerome Wiesner, the President's Scientific Advisor, expressed this same viewpoint in the very statement in which he proposed emphasis on *non*-military research effort because "the scientific-military revolution has stabilized. . . ." Wiesner told the House Subcommittee on Science, Research and Development, Oct. 16: "At the beginning of the 1950's many wise men did not foresee the wholly new military potentialities of development in rocket propulsion, guidance, communications, and nuclear technology. . . ."

Although Wiesner was not advancing the need for a military role for man in space, his point is applicable and timely. We, today, do not foresee all the military applications of space. And we *will* not unless we build and experiment with prototype, adaptable systems in the near-earth region, such as Dynasoar, Gemini, and a permanent, manned, orbiting laboratory.

Why are we not going ahead with such a program? And what can we hope for from the Administration's promise for new evaluation?

The answer lies in the Administration's stipulation to every advanced weapon proposal that it "fill a military requirement." This is as it should be. But to understand the import of this stipulation it is important to recall the Administration's views on military needs.

Last January 30, McNamara revealed the nuclear stalemate theory to Congress and backed it up by placing emphasis on conventional, limited-war arms, and only token enthusiasm for advances in strategic weapons. He also stressed the need for curtailing development of "deadly weapons." Confidence in the power of nuclear stalemate prompted McNamara to express satisfaction when told the Soviets were developing a second strike capability. "It will put less pressure on them to carry out a preemptive strike," he explained to Congress.

Faith that the stalemate will be maintained is apparently based on belief that Soviet initiative is geared to what the U.S. does. In a two-part article in *The New Yorker,* January 19 and 26, 1963, Wiesner was quoted as saying that part of his job is to keep an eye on the Defense Department so he can veto development of weapons the President might feel the enemy would consider "too hostile." Wiesner also said: "Suppose one country holds down the manufacture of a type of missile that another country thinks is specially tailored for its destruction. That might just make the other fellow a little less nervous, and he might then follow suit." Harold Brown was quoted in the same article: "the more powerful the weapons that a nation possesses, the more insecure it feels."

Until these viewpoints are changed, sizable effort in aerospace work can not be expected.

LATE QUOTE FROM MOSCOW

"We have never said that we are going to give up our lunar project. You're the ones who said that . . . you keep expecting us to give up."

Khrushchev, Nov. 6, 1963

COMMENT

INFORMATION RETRIEVAL

I have read with interest your editorial, A Huge Amorphous Mass (p 5, Oct. 11).

Fortunately, you have answered your own question in the first sentence of the second paragraph when, in referring to my proposal for a National Research Data Retrieval System, you stated, "if we understand it correctly."

Obviously, you have been misled on the basic concept of HR 1946. If you had covered the hearings of my committee, you would have learned that it is not the purpose of HR 1946 to concentrate on scientific research data retrieval in any one single place, but rather to develop a national system with a central clearing house which would maintain a running inventory on what is being done and where, for the immediate information of scientists.

In fairness to my committee and your readers, and since I personally highly respect your publication, I would indeed be grateful if you could find space for the speech which I delivered on this subject at the University of Maryland. It is my hope that through publication of these views, we can once and for all dispose of the erroneous impression that HR 1946 proposes to isolate the scientific community from all other cultural influence by lumping it into a single intellectual compound.

I agree with you, nothing could be more disastrous to American scientific achievement than to try to place all of their scientists under one regimen.

I do wish to thank you, however, for the rest of the editorial, which appears to support my basic proposal for a greater national effort to develop a more effective means of communication between our various research establishments.

I think you will find from reading my speech that your editorial board and I are in effect recommending pretty much the same course of action.

ROMAN C. PUCINSKI
Member of Congress

House of Representatives
Congress of the United States
Washington, D. C.

• Here are some excerpts from the address of Mr. Pucinski (D.-Ill.) to the Association for Computing Machinery, at the University of Maryland, on Oct. 17:

". . . First of all, my responsibilities to my constituents make it imperative that the mounting government costs in research are, in fact, spent for new and expanded research and not for a duplicate effort contained in some document drowned in an ocean of inaccessible information.

Secondly, it is my firm belief that unless our scientists are given better, faster and more accurate information wherever and whenever needed, their valuable training and creative energies will be diluted to the level of insignificance.

Thirdly, the emergence and advancement of scientific and technological competition from many countries make it crystal clear that this nation, in order to insure its economic survival, no longer can afford to ignore the development of its most important national asset: scientific information. . . ."

". . . As I see it, this country will sooner or later have to establish a giant network of research information services throughout the United States, each dealing with its own particular scientific discipline, and each tied together by coaxial cable, closed-circuit television, facsimile and other electronic devices to one central command post which, through the use of electronic computers and retrieval machines, will keep a constant inventory of what is being done, where and by whom, in this nation's widespread scientific community. This command post quickly would provide to any scientist a complete record of the scientific research being sought so that he would have at his fingertips all the work previously done in a given field. . . ."

". . . It is not the purpose of the proposed national information center to carry out under one roof all the operations of collecting, processing, abstracting and coding of scientific information. Clearly, this is physically impossible and operationally impractical at the present time. . . ."

". . . I wish to stress that the purpose of the national information center is not to eliminate any of the existing indexing, abstracting and translating services, but rather to obtain their final work products in coded or other formalized form and make them available to the technical and business community. . . ."

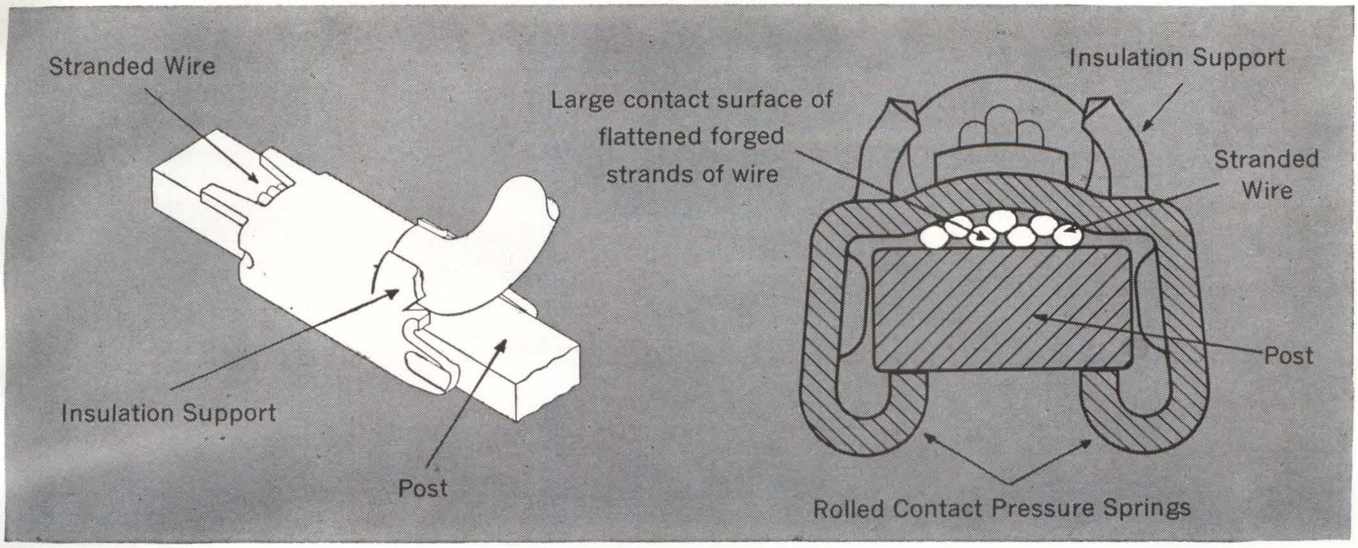
CHELATE COVER

Your Oct. 25 cover strangely reminds me of some sort of glowing, living organism that has crawled up from the ocean depths.

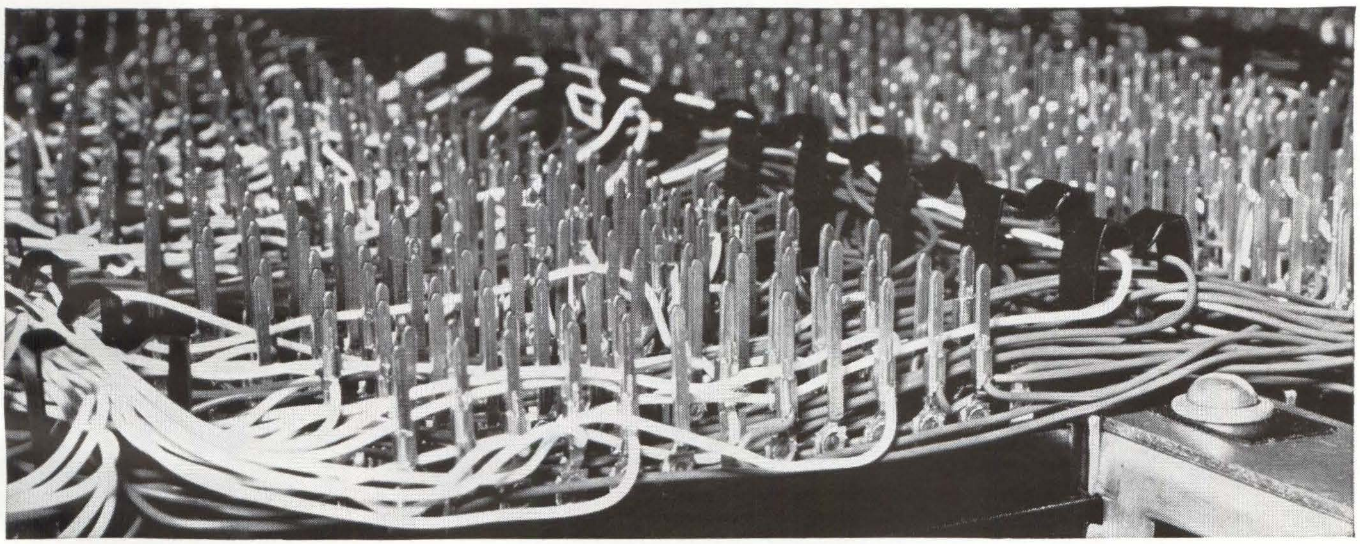
JOHN FINKBINER

New York, New York

• The European chelate molecule shown on that cover is a compound that attaches itself to a central atom to form a ring. The word chelate is from the Greek *chele*, meaning a claw. Part of the molecule is somewhat like the claw of a crab, and chelate means "having claws." For more on chelates, see p 67 of this issue.



See what's happened to stranded wire



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Serviceability, despite the close spacing of posts, is extremely easy. A simple extraction tool removes TERMI-POINT terminals—any terminal from any position on the post without electrically disturbing others—and leaves the conductor ready to be used again, if necessary.

There's more . . . a lot more to tell about this new technique and how you can benefit in your point-to-point wiring program. Find out how you can achieve greater density, even modular design; gain higher production levels at lower applied costs; eliminate stocking various pre-cut wire lengths; and service with an ease unknown in other point-to-point wiring techniques. It's all in our booklet, TERMI-POINT Tools and Terminals For A New Point-To-Point Wiring Technique. Send for your copy today.

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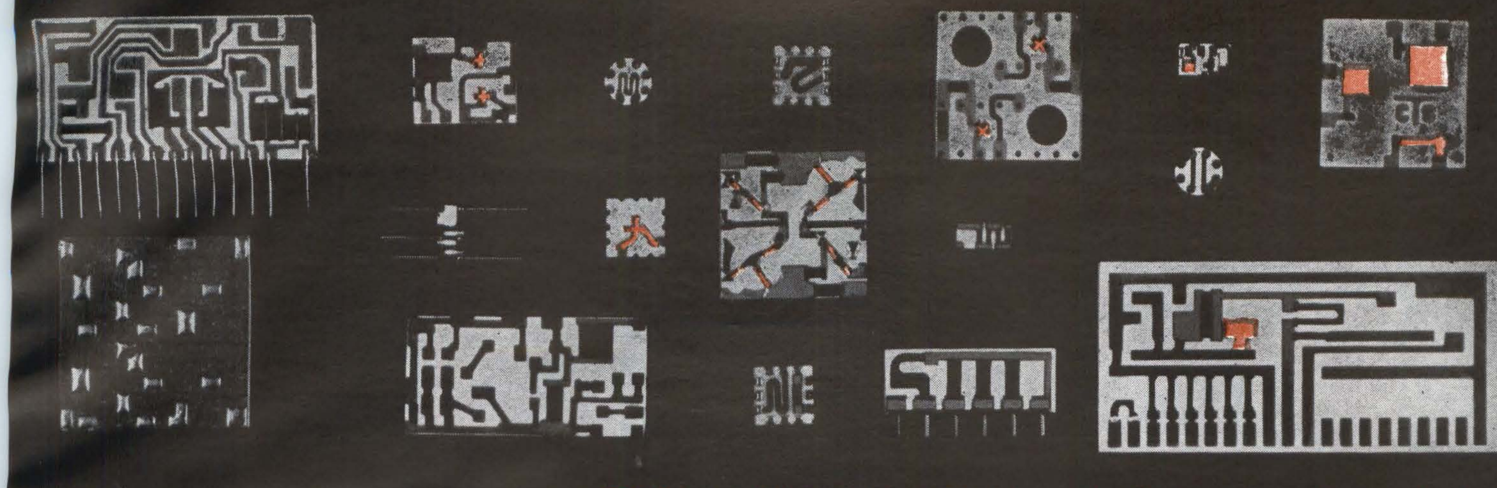

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- **Elements can't separate from substrate** during varying environmental conditions. Cermet resistors and capacitors are thermally bonded.
- **Perfect termination** due to similarity of compositions. Pt-Au conductor composition diffuses with the cermet compositions and becomes part of the substrate after firing.
- **Migration dangers eliminated** because no silver is used.
- **No cermet resistance element failures** after 36,000,000 element hours of extended load life reliability tests. Only 0.172% average resistance change at full rated load.
- **Extremely tight quality control** in purchased materials inspection, in-process control of production procedures, step-by-step product inspection, and quality assurance program on completed product.
- **Fired at temperatures exceeding 650°C** so cermet resistors, capacitors and conductive circuit take excessive overloads without failure. Cermet resistors and capacitors operate continuously at 275°C; take short periods of 500°C.

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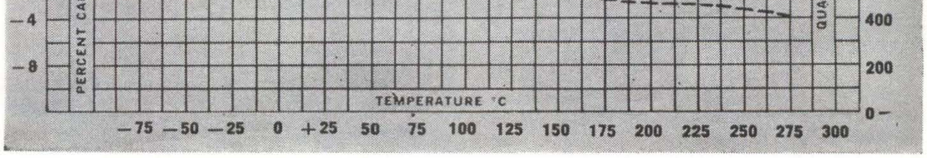

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New Twist in Space Tracking: The Vehicle Tracks the Ground

Reversal of usual doppler method to add flexibility to Saturn instrumentation

By **JOEL A. STRASSER**
Assistant Editor

HUNTSVILLE, ALA. — A new type of doppler tracking system will be used on Saturn V, the giant rocket that is slated to boost the three-man Apollo ship to the moon by 1970.

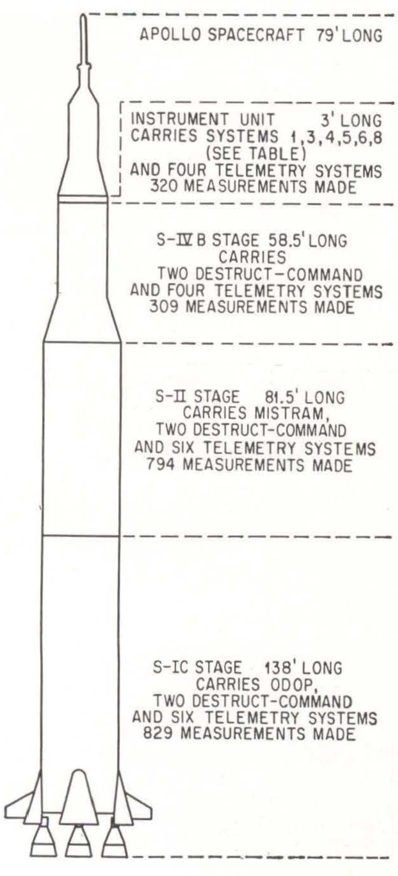
Normally, doppler transmitters and receivers are on the ground and the transponder is in the space vehicle. In the system under study, this would be reversed. The transmitter and receiver would go aboard the vehicle and transponders would be on the ground at various points around the earth. This arrangement provides onboard tracking to measure range and range rate from the multiple ground stations.

The system, called AROD (Airborne Range and Orbit Determination), will add significantly to the flexibility of Saturn V instrumentation.

Many other developments are being incorporated into the booster's instrumentation system, key project officials at NASA's Marshall Space Flight Center told ELECTRONICS.

Saturn V instrumentation will be highly flexible, to meet the Apollo launch vehicle's varying mission requirements and still give the flight-parameter measurements required, according to Sherman M. Seltzer, deputy chief of systems engineering, and Andrew L. Bratcher, chief of Instrumentation Development Branch's technical data unit, both of Marshall's Astrionics division.

A typical Saturn V mission, estimated to be about seven hours long, will require about 2,252 measurements (see diagram).



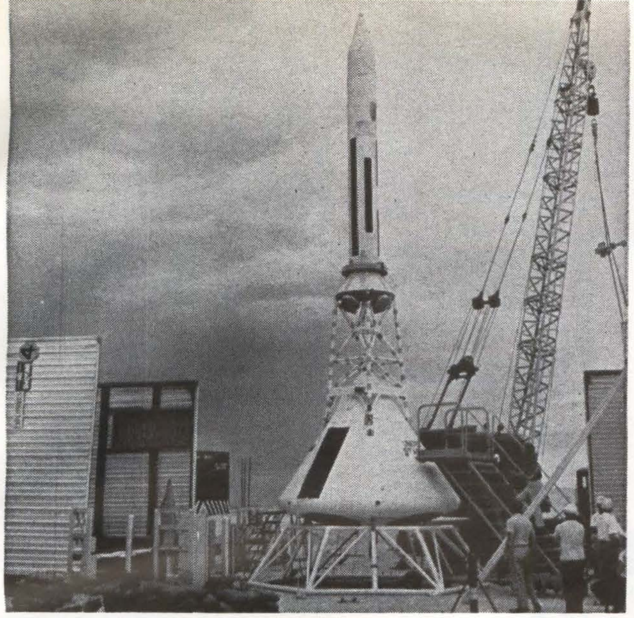
SATURN VEHICLE stands 360 feet high with Apollo spacecraft attached. Most of the 2,252 measurements made during a typical mission monitor physical performance and fuel consumption of the vehicle. The 103 guidance, control, r-f and telemetry measurements required are made only in the instrument unit. Table details equipment

Performance Parameters of Saturn I/IB R-F Equipment*

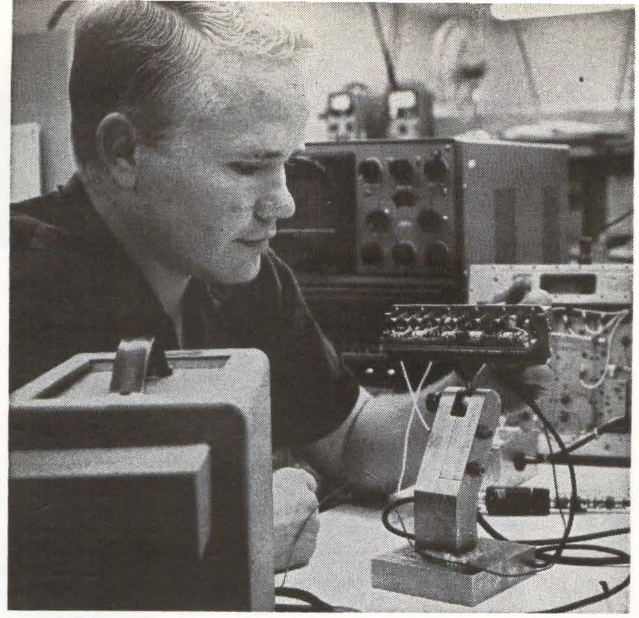
1) **C-BAND RADAR**: manufacturer, Motorola; bandwidth, 10 Mc; frequency, tunable from 5,400 to 5,900 Mc; input power, 24 w; radiated power, 400 w; effective range, 1,000 mi
2) **MISTRAM**: manufacturer, General Electric and Motorola; bandwidth, major loop closed—6 kc, major loop open—40 kc, minor loop closed—100 kc, minor loop open—1 Mc; frequency of range channel, receiver—8,148 Mc, Transmitter—8,216 Mc; frequency of calibrate channel, receiver sweeping frequency—7,884 to 7,892 Mc, transmitter sweeping frequency—7,952 to 7,960 Mc; input power, 154 w; radiated power, 200 to 500 mw per channel; effective range, 1,000 n mi
3) **AZUSA GLOTRAC (Type C)**: manufacturer, Convair; bandwidth, f-m noise bandwidth of 2 kc; frequency, receive—5,060.194 Mc, transmit—5,000 Mc; input power, 134 w (transponder only), 149 w (with filter); radiated power, 2.5 w min; effective range, 1,500 mi
4) **RADAR ALTIMETER**: manufacturer, Ryan Electronics; bandwidth, 3 Mc; frequency, 1,610 Mc; input power, 75 w; radiated power, 5,000 w peak; effective range, 250 mi max
5) **MINITRACK**: manufacturer, Space Craft, Inc; bandwidth, Modulation index up to 1 radian; modulation frequency, 200 cps to 100 kc; frequency, 136.65 Mc; input power, 364 mw; radiated power, 50 mw; effective range, 1,000 mi
6) **AROD**: feasibility studies are incomplete at this time; first flight test will probably be on the first Saturn IB vehicles
7) **ODOP**: manufacturer, Motorola; bandwidth (phase-lock loop), 600 cps; frequency—Ground-to-air 890 Mc, air-to-ground 960 Mc; input power 40 w; radiated power, 1 w; effective range, 200 mi
8) **GUIDANCE COMMAND**: under development
9) **DESTRUCT COMMAND**: secure digital code, under development

* Performance information is based on presently known requirements and state of the art developments as applied to the earlier Saturn I and IB vehicles. As requirements for the Saturn V become more clearly defined, developments will be advanced accordingly and contracts let

Other Tracking Systems — Saturn V's C-band radar transponder is designed to work with the newly modified AN/FPS-16 radar planned as part of the orbital Apollo ground net. Resulting range and azimuth and elevation angle information in real time will permit rapid determination of Saturn V's position. Differentiation of this data will provide vehicle velocities.



APOLLO BOILERPLATE model was mated with ecape tower for abort test last week at White Sands Missile Range. The mission, first powered flight of Apollo hardware, checked escape mechanism during a pad abort



L-BAND offset doppler (ODOP) phase-locked transponder for Saturn is checked out at Motorola. Receiver threshhold sensitivity is —130 dbm; transmitter power output is 1 w min

Mistram (Missile Trajectory Measuring System) transponder onboard the operational Saturn V will be located in the S-II stage. During early R&D flights, it may be located in the instrument unit.

Azusa system on Saturn V consists of a ground station and onboard transponder. The transponder, located in the instrument unit, measures the range used to determine vehicle's position and velocity by continually comparing the phase between signals transmitted to and from the vehicle. Azusa will be used with Glotrac, the USAF global tracking system.

ODOP (Offset Doppler) c-w radar system will have its transponder in the S-IC stage. ODOP receives the signal at 890 Mc and offsets it to 960 Mc for transmission. The system is designed to check velocity and position by measuring the doppler shift between the ground-station and vehicle signals. During the critical first portion of the flight, it provides very precise tracking data.

To supplement the range, azimuth and elevation data of the other tracking systems, a radar altimeter will be used to obtain more complete tracking coverage at high altitudes. Ryan Electronics built the unit that flew aboard the SA-4 earlier this year.

An on-board orbital tracking beacon transmitter operates on a fixed frequency. It may be either unmodulated c-w or phase modulated with measuring data. To permit long-duration missions, transmitter power requirements are extremely low. Minitrack ground stations require extremely sensitive receivers and precise angle-determination with highly directional antennas. Data from three or more stations would permit precise orbit determination.

Telemetry—Three types of telemetry will be used on Saturn V.

Pam/f-m/f-m will be used for some continuous data transmission and for the usual types of telemetry where time-division techniques are advantageous.

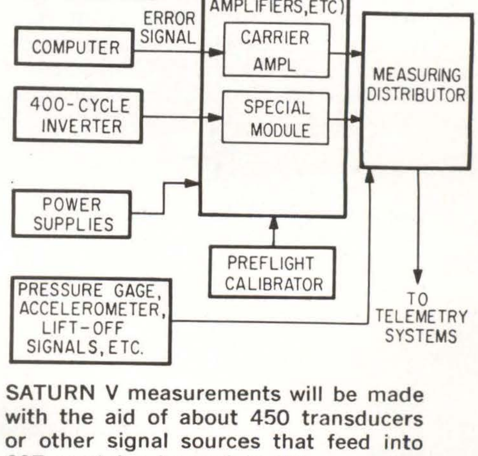
Digital data will be transmitted by pcm/f-m since much of the information is in quantized form before it is transmitted.

Vibration data will be transmitted by ssb telemetry in which the f-m carrier is modulated with an ssb, a-m subcarrier. This wideband capability is ideal for such data. Bandwidth efficiency of the ssb/f-m system is about 10 times that of standard f-m.

Command System — Command signals from the ground to the instrument unit will be transmitted with the aid of Saturn V's guidance-command system. On-board, the signals are received by the command receiver and fed into the digital computer to initiate various functions.

Saturn V's command-destruct system permits explosives to be activated from the ground if the vehicle veers off-course. Each stage has its own safety digital command system. Each has a coded circuit designed to resist natural and man-made interference. The Apollo spacecraft, of course, would be separated from the launch vehicle prior to a command destruct signal.

Saturn V will also have recoverable film cameras and on-board tv cameras to monitor staging, internal tank conditions and the engine area. Locations and the numbers of cameras have not yet been decided upon.



SATURN V measurements will be made with the aid of about 450 transducers or other signal sources that feed into 297 modules housed in 37 measuring racks

MONEL alloy 400
What is it?
What does it offer?
How is it used?
Can you use it?

MONEL* alloy 400 contains 66% nickel and 31.5% copper (nominal). It offers high strength and toughness, plus good corrosion resistance. And it may be the answer to your electronic design problem.

Here's what you should know about MONEL alloy 400, as well as the other MONEL nickel copper alloys.

Nominal Mechanical and Physical Properties. At 70°F the electrical resistivity of MONEL alloy 400 is about 307 ohms per circular mil foot. Tensile strength in the annealed condition is 70-85,000 psi, yield strength is 25-45,000 psi, elongation is 50-35%.

Corrosion Resistance. MONEL alloy 400 is remarkably resistant to corrosion caused by practically all alkalies, most acids, salts, organic substances.

Fabrication. MONEL alloy 400 is easily worked—hot or cold. It is available in sheets, strips, seamless tubes, rods, bars, plates, angles, wire, clad plates.

Uses. MONEL alloy 400 is typically used for electrical connectors, sliding contacts, plugs, jacks, magneto and rotor distributor fingers, transformer cases, resistor caps, diaphragms.

Other MONEL Nickel-Copper Alloys

MONEL alloy 404. Similar to MONEL alloy 400 but with a lower nickel content, it is virtually non-magnetic at or above room temperature. Its magnetic properties are not appreciably influenced by working or heat treatment. This alloy was especially designed for applications where it is necessary to make multiple brazes in wet hydrogen.

It is typically used in structural parts for power tubes, traveling wave tubes, klystrons, wave guides, magnetrons, and in cathode supports.

MONEL alloy R-405. This alloy has the same composition as MONEL alloy 400 except that a controlled amount of sulfur is added to enhance machinability. It was designed for machining on automatic screw machines.

MONEL alloy K-500. This age-hardenable alloy is virtually non-magnetic down to minus 150°F and is thus very useful where a strong non-magnetic material is required. It is typically used in special electronic tubes, magnet frames, Bourdon tubes, gyroscopes.

MONEL alloy 501. This alloy was developed to have improved machining characteristics. Parts may be machined in the annealed or cold drawn condition and subsequently age-hardened. Its properties are otherwise similar to MONEL alloy K-500.

Could one of these MONEL nickel-copper alloys be the material you're looking for?

For additional information on compositions, physical constants and mechanical properties, write for copies of bulletins T-5, Engineering Properties of MONEL nickel-copper alloys and T-9, Engineering Properties of MONEL alloys K-500 and 501.

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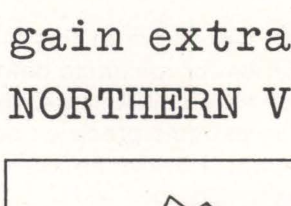
You're looking at one compelling business reason why America's first 500,000-volt power line will soon feed Northern Virginia. Research centers and light, technical industries are multiplying in this key area just across the Potomac from Washington. And they can make good use of the million new kilowatts VEPCO's line will bring.

If you have such a research or technical plant in mind, ask VEPCO about available sites. You'll find here a high concentration of specially trained



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VIRGINIA ELECTRIC and POWER COMPANY

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Serving the Top-of-the-South with 2,540,000 kilowatts—due to reach 3,500,000 kilowatts by 1965.

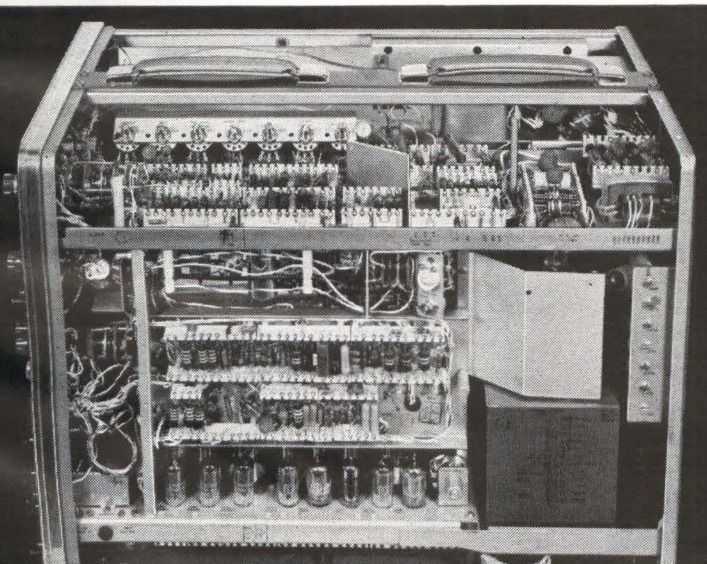
Many years ago Lavoie Laboratories started using Allen-Bradley hot molded resistors... ***time has endorsed their decision***

To insure the highest degree of accuracy and dependability in their laboratory-type oscilloscope, Lavoie engineers demanded the ultimate in performance from every component used. In fixed and variable resistors, the choice was Allen-Bradley . . . and for good reasons.

In the field of fixed composition resistors, none can even approach the proven performance record established by the more than ten billion Allen-Bradley hot molded resistors—now in service—*without a single known instance of catastrophic failure!* Furthermore, their conservative ratings, stable characteristics, and uniformity—which are possible only with Allen-Bradley's *exclusive* hot molding process—permit accurate prediction of long term resistor performance.

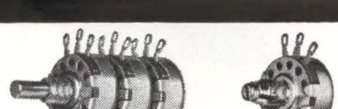
Allen-Bradley's famous Type J variable resistors—also made by the exclusive hot molding process—have a solid resistance element that provides smooth, quiet control. The "noise factor"—low as it is to start with—becomes even better with use. On accelerated tests, the Allen-Bradley Type J control has repeatedly demonstrated the life of over 100,000 operations—with less than a 10% resistance change.

Why not follow the Lavoie Laboratories' example? You, too, can benefit by standardizing on Allen-Bradley hot molded fixed and variable resistors. For more detailed information on these and other A-B electronic components, please write for Publication 6024: **Allen-Bradley Co., 110 West Greenfield Avenue, Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.**



Lavoie oscilloscope LA-265A with cover removed, showing extensive use of Allen-Bradley fixed and variable resistors.

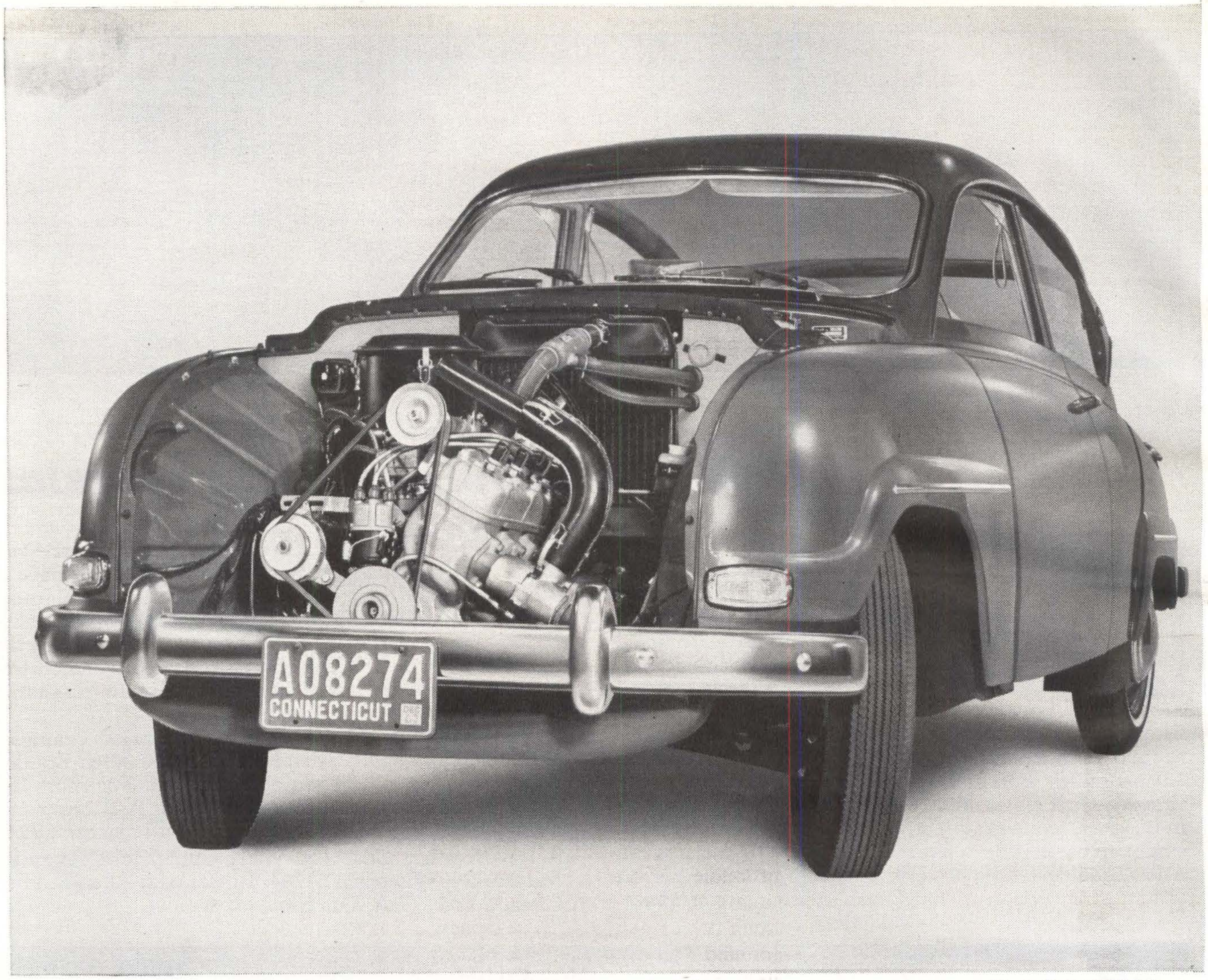
HOT MOLDED FIXED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits.



A-B Type J controls are rated 2.25 watts at 70°C and are available in standard tapers and standard total resistance values up to 5 megohms. Special tapers and special, as well as higher, resistance values are also available.

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS



White sidewalls optional at extra cost.

Bonneville Nationals: 103.56 mph. Yet a SAAB engine has only 3 cylinders and takes oil in the gas tank. Strange.

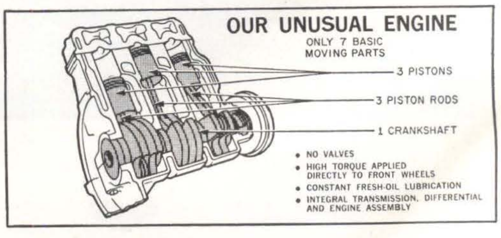
All cars that race at Bonneville have specially prepared engines. So did SAAB. Basically, though, the engine is the same. It is a 2-stroke engine with no valves and only 7 basic moving parts. That's hundreds fewer than conventional engines have; and hundreds fewer sources of friction, wear and potential trouble.

And because SAAB's 3-cylinder engine delivers a power stroke for every revolution, it is comparable to a 6-cylinder engine in torque, pickup and hill climb. But unlike a "6", it gets 28 to 38 mpg. It also grows old gracefully, with a minimum of maintenance. Strange powerplant. But very sensible.*

With a SAAB, you put oil right in the gas tank (there is no crankcase). And no problem. The engine likes it that way because it continually receives a fresh bath of uncontaminated oil. There are fewer things to worry about: No oil pump. No oil filter. No clogged oil lines. No acids. No sludge. And, of course, no oil change. Strange powerplant? Ingenious powerplant! If you've never driven a car with a 2-stroke engine, see your SAAB dealer. And test-drive a 1964 SAAB. Only **$1895,** P.O.E. Shopping imports? Write for full descriptive literature on SAAB. SAAB Overseas, Inc., Department 411, 405 Park Ave., New York, N.Y.

*Engine, transmission and differential warranted for 2 years or 24,000 miles.

Bonneville Salt Flats 1963: Modified SAAB 96 hits 103.56 mph.



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CIRCLE 299 ON READER SERVICE CARD

ITU Agrees on Space Allocations

GENEVA—ITU conference sources here report agreement on two important issues: the allocation of 136-137 Mc for space research, and measures to ensure compatibility between space and terrestrial services sharing the same part of the spectrum, notably in the 1-10 Gc range. Intricate standards for signal strength and geographical distance coordination have been worked out.

Observers stress the generally satisfactory compromise reached between U.S. and Soviet proposals. It is believed at least 60 percent of the original U.S. proposals will come out in the final allocations, possibly as much as 90 percent. (In Washington, the State Department said "the results of the conference were satisfactory and did on the whole meet our requirements." The allocations for communications satellites "should be sufficient to accommodate anticipated traffic growth until the period 1975-80," a spokesman said.)

Here are other preliminary space allocations granted on an exclusive basis—

Space research, 15.25-15.35, Gc; telemetering, 401-402 Mc, 420-450 Mc, 1.525-1.540 Mc; radioastronomy, 2.690-2.700 Mc, 73.00-74.60 Mc, 31.3-31.5 Gc, 15.35-15.4 Gc; radio-navigation-satellites, 149.9-150.05 Mc, 399.9-400.05 Mc, 14.3-14.4 Gc.

Allocations assigned on a nonexclusive basis: space research, 30.005-30.010 Mc, 174-216 Mc, 2.290-2.300 Mc, 5.250-5.350 Mc, 8.400-8.500 Mc, 400.05-401 Mc, 31-31.3 Gc, 31.5-31.8 Gc, 31.8-32.3 Gc, 34.2-35.2 Gc, 15,762-15,768 kc, 18,020-18,035 kc, 143.6-143.65 Mc; telemetering, 136-137 Mc, 143.6-143.65 Mc; tracking, 136-137 Mc, 143.6-143.65 Mc.

Radioastronomy, 4.990-5.000 Mc, 37.75-38.25 Mc, 33-33.4 Gc, 1,660-1.700 Mc, 460-470 Mc; radionavigation, 33-33.4 Gc, 31.8-32.3 Gc; meteorological satellites, 400.05-401 Mc, 1,660-1,700 Mc, 460-470 Mc, 1,770-1,790 Mc; communication satellites (satellite-to-earth), 3.400-4,200 Mc, 4.400-4.700 Mc, 5.725-6.425 Mc, 7.250-7.750 Mc, 7.900-7.975 Mc; communications satellites (earth-to-satellite) 5,725-6,425 Mc; telecommand, 1.427-1.429 Mc; satellite identification, 30.005-30.010 Mc, 174-216 Mc.

Sonar Steers Ship

BOSTON—A four-headed nautical navigator that automatically and continually plots position while a ship is underway has been developed by Raytheon for the Navy. The sonar navigator can not only "see" in front and behind but takes in port and starboard as well.

In development for five years, the device bounces four signals simultaneously off the ocean's bottom. Echoes are compared with transmitted signals and the results written in ink on the ship's navigational chart.

As the navigator gives the position at all times, a skipper can pilot his ship through fog or a blinding storm. The track displayed is more easily interpreted than ship-centered radar information, Raytheon says. In a recent trial aboard Raytheon test boat Alan on Narragansett Bay, the navigator recorded the vessel's point-to-point progress with an exactness rarely achieved by conventional methods, the firm said.

Airborne Infrared Unit Will Detect Submarines

INFRARED SYSTEM for ASW detection and monitoring has been designed for the Navy by Ehrenreich Photo-Optical Industries. Now being studied by the Navy's weapons bureau, the unit employs a closed-circuit tv photographic pulse camera mounted in a pod under a plane's wing, along with associated infrared sensor and servo tracking equipment. Entire lens display, registered through an 85-mm to 250-mm motorized zoom lens, is transmitted to an 800-line scan tv monitor.

Electronic Bookie

FAST ON THE HEELS of the vote in New York favoring off-track betting, Electronic Assistance Corp. says it has an electronic betting system ready for citywide horse parlors if and when the state legislature makes them legal. EAC predicts that the equipment could handle more than 1 million bets daily, and could be applied to other sports. It combines push-button ticket issuing and cashing machines with conventional data recording-processing equipment, the firm says. With it, a bet could be placed in seven-tenths of a second, recorded, and later verified before payoff

Metal-Base Transistor Developed at SRI

MENLO PARK, CALIF.—A transistor with a low-resistance metal base developed by D. V. Geppert, of Stanford Research Institute, can be used in microwave circuits, but because of low gain cannot be used at low frequencies. Metal base layer is about 100 Å thick and can be copper, gold or molybdenum, but molybdenum is preferred.

SRI is also working on large-area emitter structures, using an all-vapor-deposition technique. Structure is silicon-molybdenum-silicon. Units with alphas up to 0.7 and betas just over 1.0 have been built. SRI expects to get betas over 10 by better control of vapor deposition.

Poor Workmanship Means Shutdowns—NASA

BOSTON—NASA will "shut down the production line" in Apollo contractors' plants whenever workmanship and quality control become substandard. That's the word from

Apollo spacecraft program manager J. F. Shea. Speaking last week at a NEREM session, Shea said that in the Mercury program, "some spacecraft were accepted with waivers at the McDonnell plant, and defects corrected at Cape Canaveral." He added: "The Cape people were not very happy about it" (p 20, Oct. 11, p 11 and 20, Oct. 18). "You have to make some tradeoffs," he said, "but at times in the Mercury program we should have shut down the production line. There's nothing like shutting down the production line to shake people up. And in Apollo, we will do it."

2,300-Å Laser Beams Called Boon to Chemists

BOSTON — One-megawatt laser beams at 2,300 Å should be available soon and will provide important tools for chemists, according to a research scientist from one of the principal centers pursuing nonlinear optics. In a NEREM talk last week, R. W. Minck of Ford Motor Co. Scientific Lab said the high-power output at 2,300 Å will be achievable by generating the third harmonic of a ruby laser output for 10 to 20-nanosecond pulses. The resulting photon energy, he said, would be comparable to electron bonding energy and will cause uv-excited chains of molecules to recombine. Minck said ruby rods under development at Linde Co. may open the way for much better conversion efficiency for second and third harmonic generation and to a wider range of frequencies.

FAA Gets Quasi-Doppler Radio Direction Finder

QUASI-DOPPLER radio direction finder system, developed by Servo Corp. of America for the FAA, has largely overcome errors due to site location and ambiguities, according to a Servo spokesman. The quasi-doppler system impresses a phase modulation on a signal received from an aircraft. The phase modulation is generated by sampling a circular array of antennas. The envelope of the phase modulation is compared to a known, fixed reference to establish the direction from which the received signal came. Volume production of the direction finders has been started under a $2.7-million FAA contract. The systems will be used as back-up equipment at large, busy airports, and for primary aircraft identification and position determination at smaller airports.

France Seen Building An Electronics Giant

PARIS—Efforts to build France's electronics-computer industry into an international monolith—a government objective for some time—took a big step ahead last week with the announcement of a high-level personnel move. Jean Bigard, still number-two man at the country's leading electronics house, CSF (Compagnie de Telegraphie Sans Fil), has also become general manager of the top French computer firm, Compagnie des Machines Bull.

Insiders say it means the two outfits will coordinate R&D programs. Although both plan to retain fiscal autonomy, they are in fact linked through the Banque de Paris et des Pays-Bas which controls CSF and holds high stakes in Bull's financing. Besides these interests, the Banque has wired into a loose but real network a number of other French computer-electronics moneymakers.

Stress Tests Devised For Encapsulated Units

SAN FRANCISCO—Lockheed Missiles and Space Co. is developing a technique to measure stresses imposed on electronic components in encapsulated assemblies. Tiny 50-mil ferrite cores are imbedded into the epoxy at time of encapsulation, and the magnetostriction principle allows measurements of output differential which can be calibrated into stress parameters. Lockheed says it has measured stresses up to 20,000 psi with the technique, and considers the development a step toward solution of cracked resins causing component failures or changes in voltage outputs.

MEETINGS AHEAD

DIGITAL COMPUTER EQUIPMENT USERS SOCIETY MEETING, DECUS, Lawrence Radiation Laboratory; Livermore, Calif., **Nov. 18-19.**

ENGINEERING IN MEDICINE AND BIOLOGY ANNUAL CONFERENCE, IEEE, ISA; Lord Baltimore Hotel, Baltimore, Md., **Nov. 18-20.**

NUCLEAR ELECTRONICS INTERNATIONAL SYMPOSIUM, SFDERE; Unesco Headquarters, Paris, France, **Nov. 25-27.**

ULTRASONICS ENGINEERING SYMPOSIUM, IEEE-PTGUE; Marriott Motor Hotel, Washington, D. C., **Dec. 4-6.**

VEHICULAR COMMUNICATIONS NATIONAL CONFERENCE, IEEE-PTGVC; Adolphus Hotel, Dallas, Texas, **Dec. 5-6.**

FALL URSI MEETING, IEEE Seattle Section, URSI, Boeing Scientific Research Laboratories; University of Washington, Seattle, Wash., **Dec. 9-12.**

FIRST MICROELECTRONICS CONFERENCE, EIA; Irvine Auditorium, University of Pennsylvania, Philadelphia, Penna., **Dec. 10-11.**

NON-LINEAR PROCESSES IN THE IONOSPHERE MEETING, NBS; Central Radio Propagation Laboratory, Boulder, Colo., **Dec. 16-17.**

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE MEETING, AAAS; Cleveland, Ohio, **Dec. 26-30.**

RELIABILITY-QUALITY CONTROL NATIONAL SYMPOSIUM, IEEE, ASQC, ASME, EIA; Statler Hilton Hotel, Washington, D. C., **Jan. 7-9.**

INSTRUMENTATION SYMPOSIUM, ISA North Central Area; New Sheraton-Ritz Hotel, Minneapolis, Minn., **Jan. 30-31.**

WINTER POWER MEETING, IEEE; Statler Hilton Hotel, New York, N.Y., **Feb. 2-7.**

ADVANCE REPORT

NATIONAL SYMPOSIUM, SID; *El Cortez Hotel, San Diego, Calif., Feb. 26-27, 1964; Dec. 10 is deadline for sending four copies of 250-word abstracts and summaries, plus affiliation and resume, to Mr. Sherman H. Boyd, 4281 View Place, San Diego 15, Calif. Some topics include systems development, human factors, techniques and devices, software, standardization.*

Laser Dispute: Was There Action?

BOSTON—Dispute over laser action in silicon carbide (p 17, Sept. 6) came into sharp focus last week when a paper on the room-temperature c-w laser, at 4,560 Å in the blue, was scratched from a NEREM post-deadline session by its author, Arthur J. Rosenberg of Tyco Laboratories.

He told NEREM officials he did so because there was no more to report. The previous week, GE's Robert N. Hall, disputed Tyco's claim. And the same day the paper was withdrawn, Robert H. Rediker, of MIT Lincoln Lab, told the NEREM conferees:

"Tyco will agree that they have not at this point furnished conclusive proof of laser action." He added that "with the exception of the controversial silicon carbide, all diode lasers announced to date have direct-gap transitions. The possibility of laser action is at least three orders of magnitude larger for direct-gap materials than for indirect." A mode pattern in spiking, he said, is the "proof of the pudding" of laser action.

Charles E. Ryan, chief of the Solid State Division of Air Force Cambridge Research Labs, commented that Tyco's claim has not been clearly established nor clearly disproved. The mode of lasing is not the same mode as has been observed in, say, gallium arsenide, he said. AFCRL has for years been sponsoring development of the traveling-solvent method of crystal growing, employed by Tyco. AFCRL also sponsors Hall's diode-laser investigations

Phone Companies Test Electronic Switching

ELECTRONIC telephone switching is moving out of the labs and into the field. The concept will receive two more major trials next year by two different companies. GT&E will try out its exchange at the 2,400-line Portage, Ind., telephone network and the Stromberg-Carlson division of General Dynamics will install its 10,000-line system for Delhi Telephone Co. in Delhi, N. Y.

Railroad Introduces Data Transmission Device

NEW YORK CENTRAL System has devised an Intercoupler that automatically translates data from punch cards and teletypewriter, eliminating manual code conversion before and after each TTY transmission. Output is on punch cards. Designed and built by Navigation Computer Corp. to specifications of the Central, the device can select and delete specific unwanted data and introduce spaces between data for easier readability. Data transmission time will be cut in half, saving more than $300,000 a year.

Ultra-Fast Memory Called 'New-Generation' Device

NEWPORT BEACH, CALIF.—Philco unveiled a computer memory last week that it says represents a "new generation" of devices. The 10-Mc biax unit stores 50,000 bits of information in 1,024 words and is capable of reading out 48 bits of data in 0.1 microsecond. Stored data is secured in a maximum of 85 nanoseconds, with words extracted randomly or sequentially at any rate up to 10 Mc or every 100 nanoseconds. Read/write cycle time is 10 μsec and writing is accomplished in 3.5 μsec. The unit, developed for $500,000, will sell for $135,000 each.

IN BRIEF

ELECTRO-OPTICAL Systems Inc. says it has achieved chelate laser oscillation from a new five-ligand europium compound in liquid solution that could possibly go c-w (see p 67). Higher quantum efficiencies near room temperature are gained through a new method the firm calls inter-intra-molecular energy transfer.

WESTERN PACIFIC Railroad will install a coast-to-coast management information and control system. GE will provide the real-time computer equipment and systems engineering support.

OWENS-ILLINOIS and Bendix are planning to build plants in Mexico. Owens-Illinois will manufacture tv tubes and Bendix auto and boat radios and navigation aids.

JOINT COMPANY will be formed by Xerox and P. R. Mallory to produce adaptable microcircuit boards. First of the thin-film, multilayer devices will be a two-layer type.

COMPANY PURCHASES — Electronic Devices Inc. bought Raytheon's Trans-Sil Corp. Geo Space Corp. bought Electrodynamics Instrument Corp. Ampex bought Allegri-Tech's Western Division. National Aeronautical Corp. bought Electro-Nuclear Apparatus Co. Litton plans to buy Clifton Precision. United Electrodynamics has agreed to purchase Allied Research Associates.

SPERRY RAND has been named by the Air Force to fill a $37-million order for electronic data processing equipment (p 7, June 14). It will facilitate base-level inventory accounting at 152 sites.

STEPS TAKEN by the Defense Electronics Supply Center to simplify procedures for vendors will be discussed at a seminar Dec. 3 at Fort Jay, N. Y.

FAIRCHILD Semiconductor has reportedly developed silicon planar diodes for use as low-power microwave signal sources.

11 STATES have contributed $247,000 to help Michigan continue advanced studies of electronic highway control outside Detroit (p 14, Dec. 28, 1962). Tests employ 14 closed-circuit tv cameras with wide-angle and telescopic lenses.

Advisor Change Won't Overturn Science Policy

Indications are that the new presidential science advisor, Donald F. Honig, was handpicked by Jerome B. Wiesner, the retiring advisor. The choice of Honig, Princeton University professor of chemistry, will therefore leave hardly a ripple on the face of White House science and technology policy. Wiesner is expected to return to teaching at Massachusetts Institute of Technology by early spring.

Honig and Wiesner have worked together off and on since they were group leaders at the Los Alamos Scientific Laboratory in the mid-1940's. Honig joined the President's Science Advisory Committee shortly after Wiesner came to Washington in 1960. Their views are much alike on the need for balanced support for science and technology as a general stimulus to the economy as military demands on R&D level off and phase out. Honig has served as chairman of the PSAC panels on space sciences and space vehicles, and has been a supporter of military space programs in a single service.

UHF Tv Facing Another Battle For Key Cities

This week, FCC will again try to decide the crucial vhf-tv drop-in issue. Tv set makers and broadcasters will watch the outcome closely. They can be expected to come up with some bearish views on the prospects for all-channel television if the Federal Communications Commission goes ahead with its proposal to put vhf assignments in seven big markets, instead of preserving them for uhf development (ELECTRONICS, p 7, March 1; p 12, March 15; p 10, June 14). Commissioner Lee Loevinger will cast the deciding vote, for the other members are split three to three. Already, there are sour reactions over FCC's failure to put a commercial uhf assignment in New York City, in the recently proposed new table of uhf allocations. Some savvy marketers are insisting that uhf can never be revived without a strong, pacesetting commercial uhf station in New York.

Congressman Says FAA Pays Too Much for Navaids

FAA's long-time critic, Rep. Henry Gonzalez (D-Tex.), has renewed his charges that the Federal Aviation Agency pays five or six times more for electronics navigation aids than airlines and state governments. The congressman lays this to the "poor judgment" of FAA Administrator Najeeb E. Halaby. The charge stems from complaints earlier this year by the Air Transport Association. But FAA contends that most of the deficiencies in its buying practices have been corrected, and ATA agrees. The overspending resulted mainly because procurement was divided among various groups, rather than being centralized, with the result that specifications were set so high that "gold-plated" purchases were being made.

Space Race Renewed Too Late To Help Apollo

The crossfire of high-level chatter over the moon race has left Project Apollo badly wounded. President Kennedy dealt the heaviest blow with his suggestion for U.S.-USSR moon-shot cooperation. This took the urgency out of the program, possibly permanently. The confusion was compounded by Premier Khrushchev's remarks, widely interpreted to mean Russia had quit the race. Kennedy then said Khrushchev meant no such thing, and Khrushchev agreed (see p 5). Since little was known about the Russian moon effort to start with, the statements did little more than increase the confusion. The best estimate of the situation now is that the manned space platform before long will succeed the man-on-the-moon effort as NASA's glamor program, and that space spending will level off at $5 billion a year or a little less.

Now!

permanent magnet torquers and motor synchronism indicators

Reeves

12IG

the Reeves 12IG is the smallest (1.2 inch diameter) miniature inertial-type floated gyro to offer these advanced design features

PERMANENT MAGNET TORQUER

Permanent Magnet series are adaptable to pulse torquing techniques, and are ideally suited for digital computer applications and strap-down inertial navigation systems. P.M. models are supplied with two coils which may be wired in series or parallel, or used independently.

SIMPLIFIED SYSTEM CHECK-OUT

The second coil, when used independently, permits ready "end-to-end" check-out of an entire system.

MOTOR SYNCHRONISM INDICATOR

A built-in circuit provides positive remote indication of spin-motor operation and synchronism.

In addition to the Permanent Magnet torquer models, the 12IG can also be supplied with conventional microsyn torquers. Reeves has designed a companion rate gyro employing torsion bar restraint (Model 12RG) with equally high performance characteristics.

A complete line of servo amplifiers, including pre-amplifiers, power amplifiers and proportional temperature control amplifiers, is available, designed especially to be used in conjunction with the 12IG. The gyros can be supplied in either beryllium or aluminum.

For the ultimate in inertial reference and stabilization systems, specify the ultimate in Miniature Gyros — The Reeves 12IG Floated Gyro. Write for Data File 111.

typical specifications

PARAMETER	UNITS	MICROSYN TORQUER	P.M. TORQUER
Wheel Speed	r.p.m.	24,000/12,000	24,000/12,000
Angular Momentum	c.g.s.	30,000/15,000	30,000/15,000
Torquing Rates (max)	deg/sec	20/40	12/24 (one coil) 24/48 (two coils)
Damping Constant (1)	dyne-cm sec/rad	60,000	60,000
Gimbal Angle	degrees	±5	±5
Mom. of Inertia	gm-cm²	30	30
T.G. Sensitivity	dyne-cm	2/ma²	60/ma
S.G. Sensitivity (2)	mv/mr	5	5
Mass Unbalance	deg/hr/g	<1	<1
Anisoelasticity	deg/hr/g²	.01	.01
Trimmed Drift Rate	deg/hr	<0.1	<0.1
Wheel Power	watts	1.5	1.5
Wheel Excitation	line-to-line	26v,3Ø,400 cps	26v,3Ø,400 cps
Torque Linearity	%	0.5	0.01
Size	inches	1.2 x 2.5	1.2 x 2.56
Weight	ounces	6	6

NOTES:
(1) Gyros can be supplied for any value of damping constant from 15,000 to 120,000.
(2) At 400 cps, 50 ma input. This parameter is directly proportional to current and frequency. Range is to 5,000 cps, and 100 ma input. Tuning the output will increase sensitivity by a factor of 5.

Qualified engineers seeking opportunities in these fields are invited to get in touch with us.

Reeves

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Division of Dynamics Corporation of America, Roosevelt Field, Garden City, N. Y.

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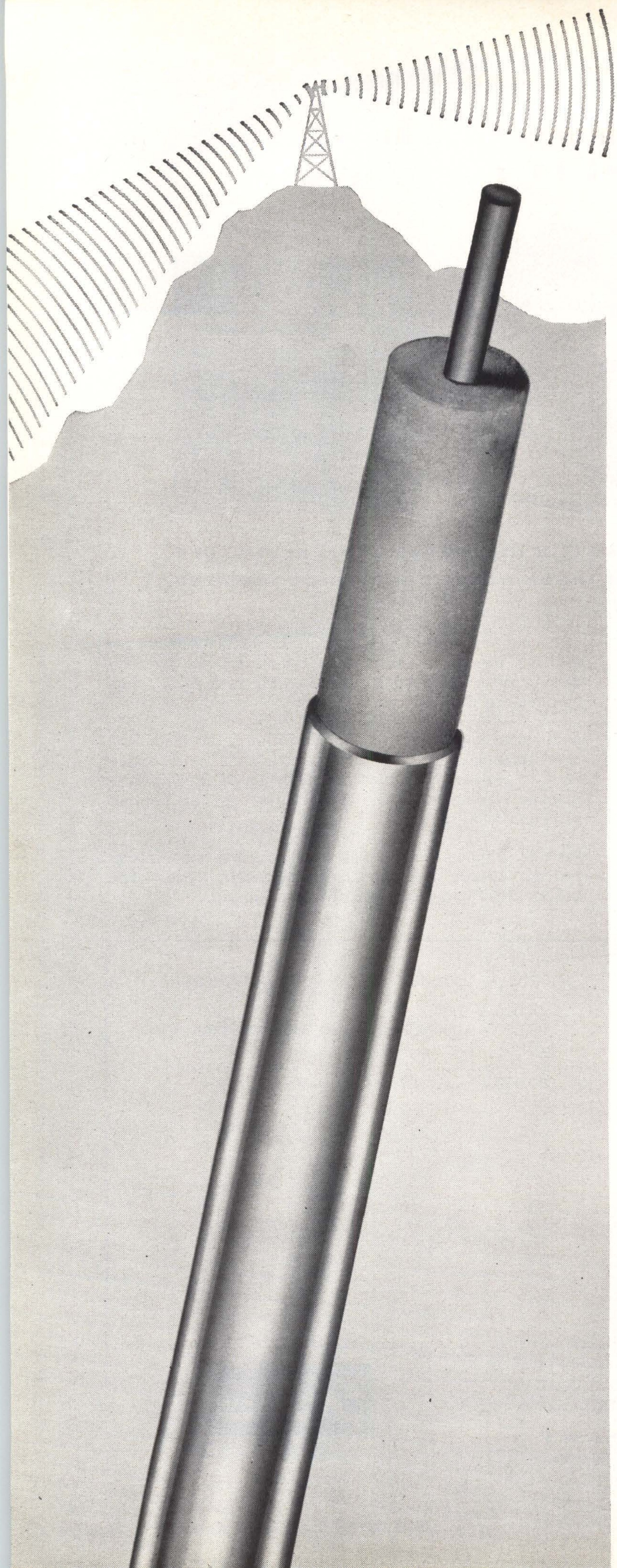
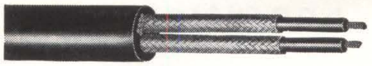




NOW AVAILABLE FROM STOCK!

FM-AM SIGNAL GENERATOR

TYPE 202-H

SPECIFICATIONS:

RADIO FREQUENCY CHARACTERISTICS
- RF RANGE: 54-216 MC
- RF ACCURACY: $\pm 0.5\%$
- RF OUTPUT RANGE: 0.1 μv to 0.2 volts*
- *Across external 50 ohm load at panel jack
- ACCURACY: $\pm 10\%$, 0.1 μv to 50 K μv; $\pm 20\%$, 50 K μv to 0.2 volts
- AUTO LEVEL SET: Holds RF monitor meter to "red line" over band
- IMPEDANCE: 50 ohms
- VSWR: <1.2

AMPLITUDE MODULATION CHARACTERISTICS
- AM RANGE: Internal: 0-50%; External: 0-100%
- AM ACCURACY: $\pm$ 10% at 30% and 50% AM
- AM DISTORTION: $\leq 5\%$ at 30% $\leq 20\%$ at 100%; $\leq 8\%$ at 50%
- AM FIDELITY: ± 1 db, 30 cps to 200 KC

FREQUENCY MODULATION CHARACTERISTICS
- FM RANGE: Internal: 0-250 KC in 4 ranges; External: 0-250 KC in 4 ranges
- FM ACCURACY: $\pm 5\%$ of full-scale*
- *For sine-wave
- FM DISTORTION: $<0.5\%$ at 75 KC (100 MC and 400 cps modulation only); $\leq 1\%$ at 75 KC (54-216 MC); $\leq 10\%$ at 240 KC (54-216 MC)
- FM FIDELITY: ± 1 db, 5 cps to 200 KC
- SIGNAL-TO-NOISE RATIO: >60 db below 10 KC

PULSE MODULATION CHARACTERISTICS
- PM SOURCE: External
- PM RISE TIME: <0.25 μsec
- PM DECAY TIME: <0.8 μsec

MODULATING OSCILLATOR CHARACTERISTICS
- OSC FREQUENCY:

50 cps	7.5 KC	1000 cps	15 KC
400 cps	10 KC	3000 cps	25 KC

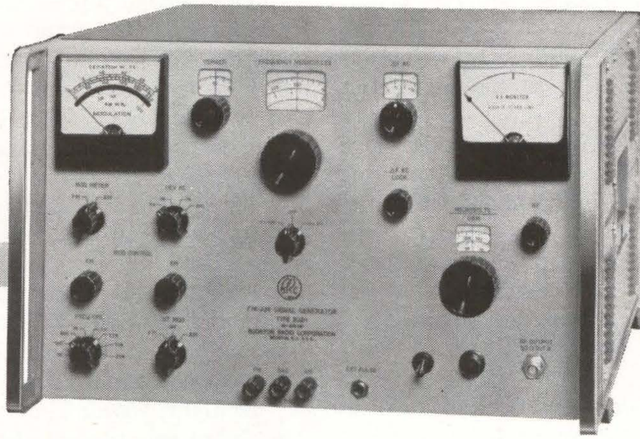
- OSC ACCURACY: $\pm 5\%$
- OSC DISTORTION: $<0.5\%$

PHYSICAL CHARACTERISTICS
- MOUNTING: Cabinet for bench use; readily adaptable for 19" rack
- FINISH: Gray engraved panel; green cabinet (other finishes available on special order)
- DIMENSIONS:

Height:	Width:	Depth:
10⅜"	16¾"	18⅜"

POWER REQUIREMENTS
- 202-H: 105-125/210-250 volts, 50-60 cps, 100 watts

PRICE — 202-H: $1365.00
F.O.B. Rockaway, N. J.



The Type 202-H FM-AM Signal Generator covers the frequency range from 54 to 216 MC and is designed for the testing and calibration of FM receiving systems in the areas of broadcast FM, VHF-TV, mobile, and general communications. The generator consists of a three-stage RF unit, together with a modulating oscillator and power supply, all housed in a single cabinet which may be adapted for rack mounting.

The RF unit consists of a variable oscillator, a reactance tube modulator, a doubler, and an output stage. The modulator is specially designed for minimum distortion and operated in conjunction with the electronic vernier to provide incremental changes in RF output frequency as small as 1 KC. The RF output is fed through a precision, waveguide-below-cutoff variable attenuator; automatic RF level set is incorporated which maintains "red line" on the RF monitor meter over the entire band. The entire RF unit is shock-mounted for minimum microphonism.

An internal audio oscillator provides a choice of eight frequencies which may be used for either FM or AM modulation. A modulation meter indicates either FM deviation or % AM and is calibrated for sine-wave modulation.

A completely solid-state power supply furnishes all necessary operating voltages and may be switched for inputs of either 105-125 or 210-250 volts, 50-60 cps.

Model 202-J is also available for the 215-260 MC telemetering band.

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Electronics for the SST—What's Ahead?

Designers will try to lower operating costs, don't want exotic systems

By **LAURENCE D. SHERGALIS**
Regional Editor, San Francisco

SEATTLE — Supersonic airliners will need more reliable electronics and easier maintenance. Exotic control and guidance systems and microminiature equipment will probably not be seen in the first series of these mach-2 to mach-3 aircraft.

Most airliner equipment development is aimed at lowering operating cost. Easy replacement of faulty equipment and very short turn-around time is vital for profitable operation. Supersonic transport planes (SST) must meet schedules or become too expensive to fly.

Maintenance—Two approaches to this problem are to be used. The first is complete redundancy of aircraft systems, including inertial navigation, control, engine monitoring, radio and landing. If one of the dual systems should fail, the other will go into operation.

In military operations, no redundancy is provided, but equipment is replaced before the statistical mtbf (mean time before failure). Commercial airline operators wait until equipment fails, then replace it. They feel that redundant systems are less costly.

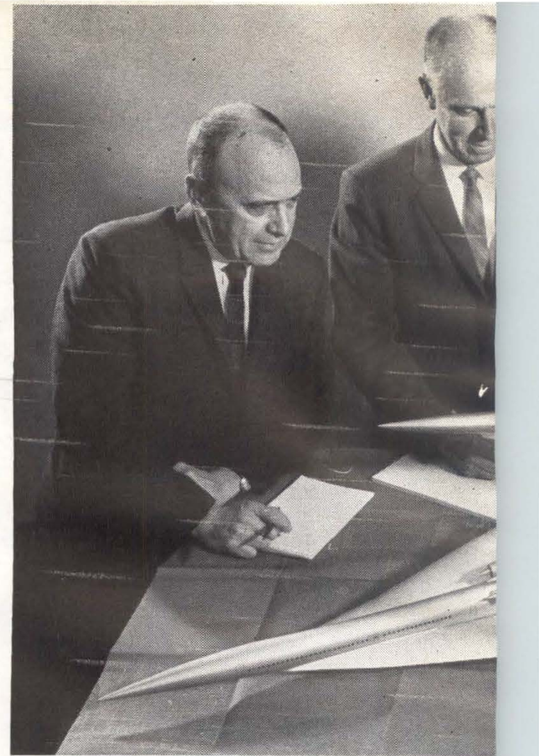
The second approach to maintainability is the trend toward self-testing. Each equipment will use a built-in test circuit for quick checks of its operation. This is to eliminate the variety of "suitcase" testers needed to check out aircraft systems. The military is trending toward the mobile test van for flight-line testing, but airlines haven't time to wheel out a mobile test van loaded with test equipment. Often, commercial airliner turn-around time is only an hour.

In-flight monitoring is another means of maintaining aircraft. Trans World and Trans Canada airlines have been testing a system called the Airborne Maintenance Recorder, made by Royston of England. It records on paper tape inputs from engines, electrical and hydraulic systems. Data from these several hundred points show the airplane's performance trend. Objective is to anticipate failure. Preliminary tests indicate engines may not have to be pulled every 2,000 hours. Also, the engineer can crank performance tolerances into the associated computer. For example, TWA reports, a jet flying with an improperly trimmed stabilizer could lose about 2 percent efficiency, raising operating cost $18,000 a year.

These systems, say the airlines, could be a boon to the SST; performance data could be telemetered ahead to speed necessary repairs.

Reliability — Most aircraft electronics equipment is solid-state, reducing weight and heat, but box size has stayed about the same. New military aircraft equipment specifications call for microelectronics, but commercial operators prefer conventional construction with proven reliability.

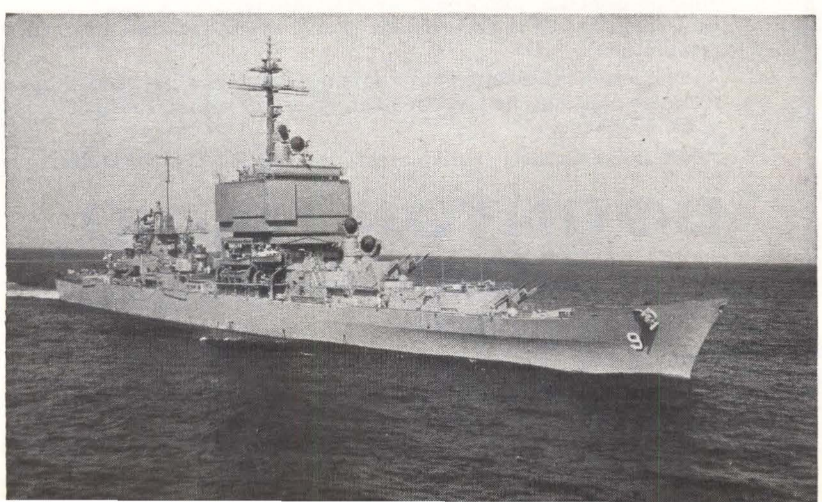
Boeing's new 727, three-engine jet, is getting equipment considered a new family developed since the 707. Boeing engineers see another new family of solid-state equipment, suitable for the SST, coming on the market in 1964-65 period. Normal development in the industry will

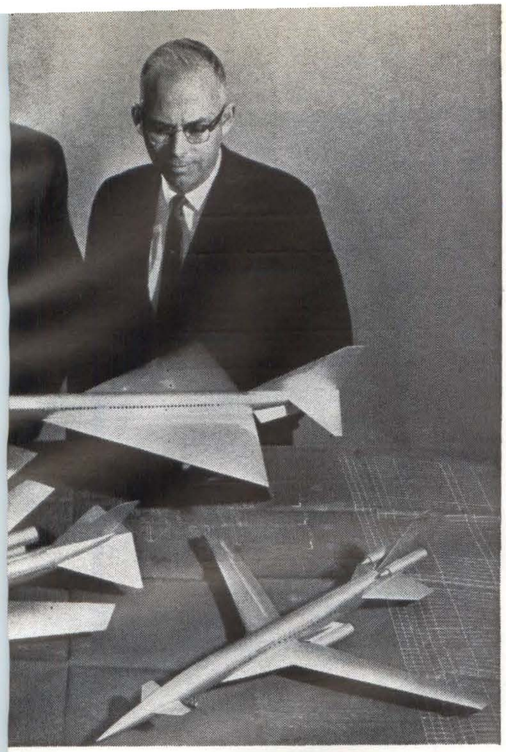


AMONG MANY DESIGNS for the SST are Lower right is Boeing's 733 variable-sweep concept called Scat 16 and behind that is

Computer-Radar Systems Hunt Targets

FLAT SIDES of bridge on USS Long Beach, first guided-missile cruiser, are antennas of four Hughes Aircraft Scanfar 3-D radars. Computer-controlled, inertialess rapid electronic scanning finds range, height and bearing of multiple targets. Targets are located by fan beams scanned in azimuth, and are tracked by pencil beams scanned in azimuth and elevation





these being inspected by Boeing officials. model, center is a NASA variable-sweep NASA's delta-wing Scat 17

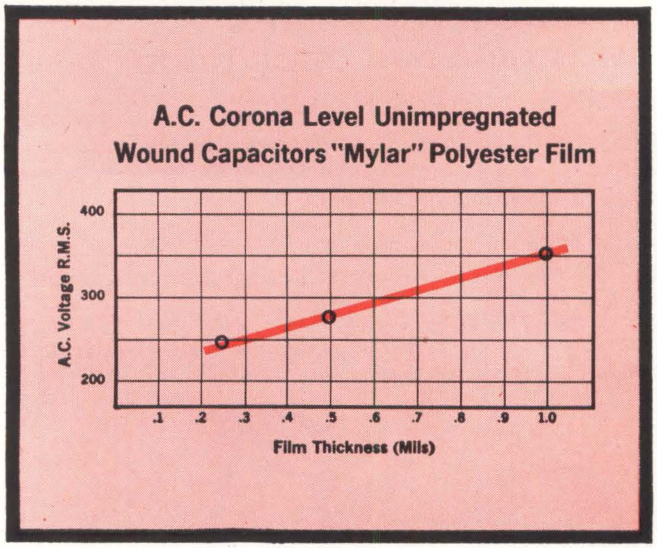
bring this about, they say.

Antennas—Two problems confront the aircraft-antenna engineer—temperature-resistant materials and mounting. In mach-3 aircraft, weight will be critical. A radome material that will withstand up to about 650 F must be found. Glass fiber will probably be used, but a better binder must be found. Present radomes go to about 400 F.

Automatic direction finders require large antennas. Where to put them becomes a problem on the SST. Cavities in an airplane cost money. The answer may be to improve adf performance so that performance will remain the same with lower antenna requirements.

Control Systems—Adaptive controls will not be necessary, say Boeing engineers, since programmed systems will probably give the required performance. A probable requirement is a stability-augmentation system (SAS), operating around all three axes because of the SST's low damping factor. The system will be similar to the SAS used in helicopters (ELECTRONICS, p 20, Oct. 5, 1962).

Boeing's SST work has aimed mostly at variable-sweep aircraft using different combinations of surfaces for control. This adds a new dimension to the control problem.



Unimpregnated Single Layer 25 Gauge Capacitors of "Mylar"

D.C. Bias (Volts)	0	100	300
A.C. Volts R.M.S. necessary to produce corona at 25°C	290	290	290
at 125°C	285	285	280

Unimpregnated Single Layer 50 Gauge Capacitors of "Mylar"

D.C. Bias (Volts)	0	200	400
A.C. Volts R.M.S. necessary to produce corona at 25°C	345	350	350
at 125°C	315	320	310

AC CORONA LEVEL

Corona levels for various gauges of "Mylar"* in capacitors were determined in life tests and are shown above. AC corona level is defined as the r.m.s. voltage below which corona does not exist.

AC/DC CORONA LEVEL

Corona is a function of AC voltage only. Table shows full AC voltage must be applied before corona can exist, whatever the DC bias may be.

AC/DC Capacitor study... New tests show compatible in

Now designers can apply the high reliability and low cost of capacitors of "Mylar" to AC and AC/DC circuits. Capacitors with "Mylar"* polyester film as the dielectric are completely compatible in these circuits in home entertainment equipment and similar circuits in other equipment. Data proving compatibility was developed in Du Pont's test at the Film Department Sales-Service Laboratory and at Inland Testing Laboratory.

Briefly, the tests showed that for a capacitor with a dielectric of dry "Mylar" it does not matter whether the voltage is DC, or AC, or combinations of these voltages. There are only two limitations: (1) the AC voltage or AC component in an AC/DC situation should not exceed the corona level, and (2) the total of the DC voltage plus the r.m.s. AC should not exceed the rated DC working voltage.

Now that it's assured that these capacitors are completely functional in such circuits, designers can utilize the other advantages of "Mylar"—over-all reliability, high IR, small size, moisture resistance, capacitance stability. Remember, too—capacitors of "Mylar" cost about the same as paper.

*Du Pont's registered trademark for its polyester film.

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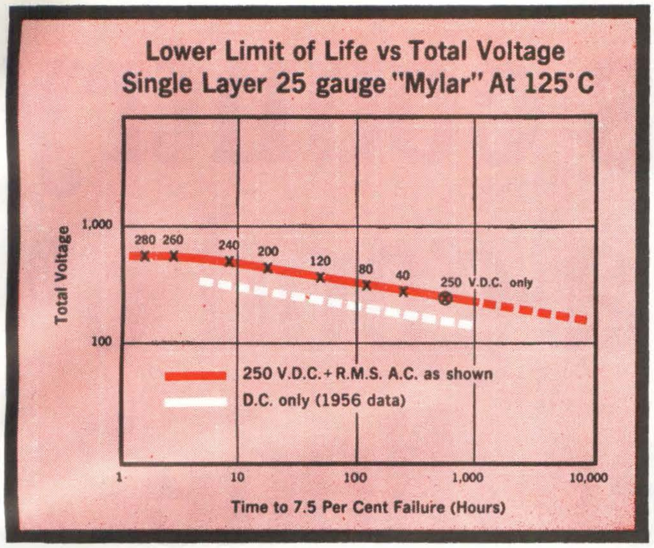

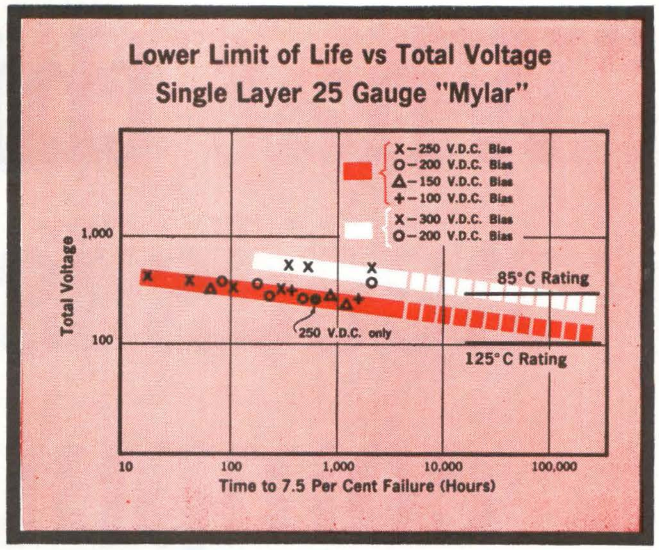

AC/DC LIFE

Below AC corona level, life is a function of total voltage. AC/DC total voltage life performance is identical to DC life performance.

Regardless of AC/DC combinations, the basic voltage-life law is maintained, and the law applies to various operating temperatures as shown.

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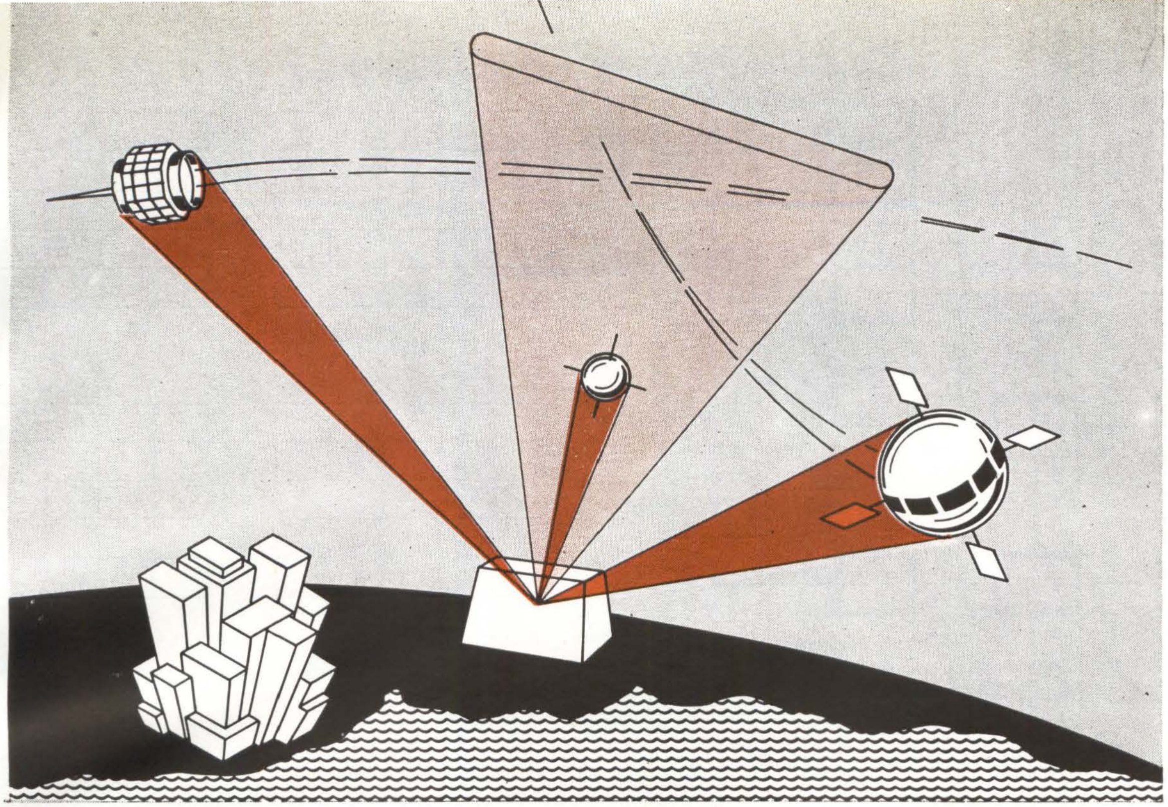


OPERATING MODES of a phased-array radar, in artist's interpretation, showing a search fence detecting a satellite, which would then be tracked as are the other two satellites

HOW COMPUTERS ALIGN PHASED-ARRAY RADARS

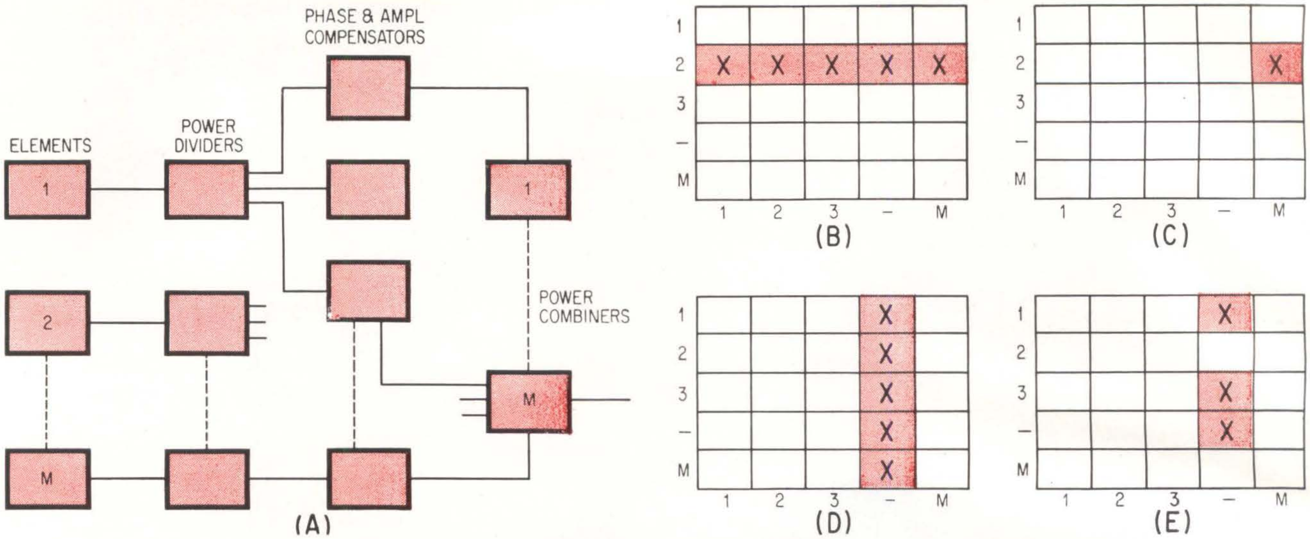
By **ARNOLD GUY KRAMER** and **ALLAN SLOCUM,** Sylvania Electronic Systems, Waltham, Mass.

WITHIN the past few years the use of phased-array antennas as sensor elements for advanced radar systems has steadily increased. These antennas provide rapid and inertialess electronic-beam steering, using the same physical aperture to form many beams, and to perform many functions. However, from a maintenance point of view, the phased-array antenna system differs markedly from a conventional antenna. A phased-array antenna system is typically made up of a large number of components, both passive and active, interconnected in a multiterminal matrix. These components, both individually and also in particular groups, must have their transfer functions controlled within exacting limits to realize the design performance level of the array—hence the alignment and maintenance problem.

The nature of the phased-array alignment and maintenance problem is illustrated by the following example: The antenna aperture under consideration is a relatively simple one—a ten-by-ten square receiving array of elements from which ten different beams are to be formed with each beam, utilizing the entire aperture. The pattern characteristics of each beam can be related to the phase and amplitude performance of each element channel in the aperture. In our example, the illumination function is assumed to be achieved by placing suitable time delays and attenuation in each signal channel between the individual antenna element and the beam output using parallel r-f beam-forming techniques. Since the output of each element is used in many beams, channels leading from each element must branch. The mini-

CHALLENGE

The optimum selection of a monitoring system for the modern phased array is a carefully considered compromise involving many factors. As array systems grow in size and complexity, methods of fault location and monitoring must also evolve toward automation and system simplification. This will be in many senses an engineering challenge equal to that of the array itself



LINEAR ARRAY (A). Failure patterns, with signal channel number in the first column of each, for input (B), channel component (C), beam combiner (D) and for probable beam combiner (E)—Fig. 1

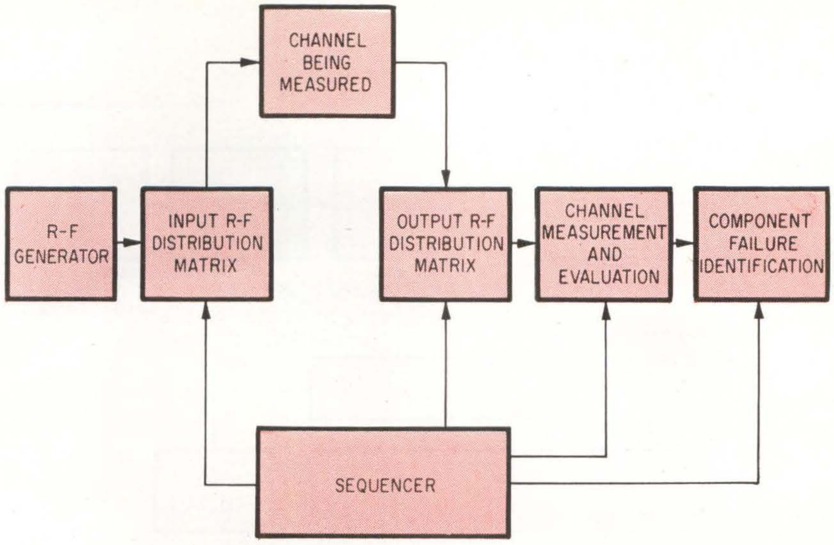
mal number of components in a signal channel consists of an element, power divider, time-delay unit, attenuator, and a beam-power combiner with interconnecting cables. The array, therefore, consists of some 1,000 different signal channels (ports of a single signal channel are an antenna element and a beam output) containing some 5,310 components, many of which are assemblies containing numerous parts. Some components are common to all beams, some to only one beam, and some lie wholly within only one signal channel. Yet all components in the matrix must have their transfer functions aligned and maintained within some specified tolerance of the no-error design value. To measure all of the individual channels is a tedious task. To measure all of the individual components is indeed a formidable task. To identify out-of-tolerance components and to correct or replace them without a carefully designed alignment-and-monitor system is difficult and inefficient, if not impossible. At the present state of the phased-array art, a ten-by-ten array is relatively small and simple. Arrays containing in excess of one hundred thousand signal channels are presently feasible. Problems relating to the design of alignment and monitor systems for the modern phased array are the subject of the following discussion.

General Considerations — Certain general performance criteria for the phased-array antenna maintenance system must be derived from the mission requirements of the overall weapons or reconnaissance system. The following discussing resolves the interrelationship between mission requirements, quantities being measured, measurement techniques, degree of automation, and measurement philosophy. Two examples of working systems will then be described which are illustrative of solutions to the design problem. Briefly, the maintenance system requirements can be summarized as follows: (a) operate without interfering with the operational effectiveness of the basic system; (b) determine the presence of faults within the array matrix and locate these faults; (c) cost—reasonably consistent with the cost of the basic array; (d) use should not require highly skilled maintenance personnel.

The first requirement of noninterference places considerale constraint on the design. If the monitoring function must be performed while the main system is in operation, then measuring techniques which require removal of major components from the array for measurement are unacceptable. Also the measuring signal must pass through the component while it is operationally connected within the system.

The monitoring system basically performs its function by inserting measurement signals into individual signal channels and measuring their transfer functions. Those which lie outside of prescribed limits with respect to the *average* for each individual beam or function are selected as outages. Allowable channel tolerances are usually based on the work of Ruze[1] and of Rondinelli[2] and others that relate the allowable deviations from a predetermined aperture excitation function to a given performance degradation. The component requiring corrective action is then identified from the pattern of measured channel failures. Figure 1A is a block diagram of a multibeam phased array. To illustrate the logical process of locating component failures from channel measurements, several examples of failure patterns for a linear array are shown in Fig. 1B through 1E. Each signal channel consists of the element, power divider, time-delay unit, attenuator, beam-power combiner, and their associated interconnecting cables. In Fig. 1B, the signal channel of each beam that includes one particular element shows an out-of-tolerance condition; the trouble may be localized to either the element, the power divider, or the cable connecting them. Figure 1C shows the characteristic failure pattern attributable to components common to only one signal channel; that is, the attenuator, time-delay unit, or the interconnecting cables. In Fig. 1D, a catastrophic failure of an entire beam can usually be traced to difficulties within the beam-power combiner. The type of pattern shown in Fig 1E is more typical of that generally encountered in operating systems. Since some but not all the channels contributing to one beam are faulty, the difficulty cannot be unequivocally attributed to one cause. Diagnosis in these cases must be on a "most probable" basis. In the example, the difficulty probably lies in the beam-power combiner.

The types of failure patterns that will be observed in the signal channels of a two-dimensional switched-delay-type phased array will be more complex. Nevertheless, each type of failure will still involve a characteristic pattern that will permit it to be localized and subsequently corrected.



FUNCTIONAL essentials of any monitoring system—Fig. 2

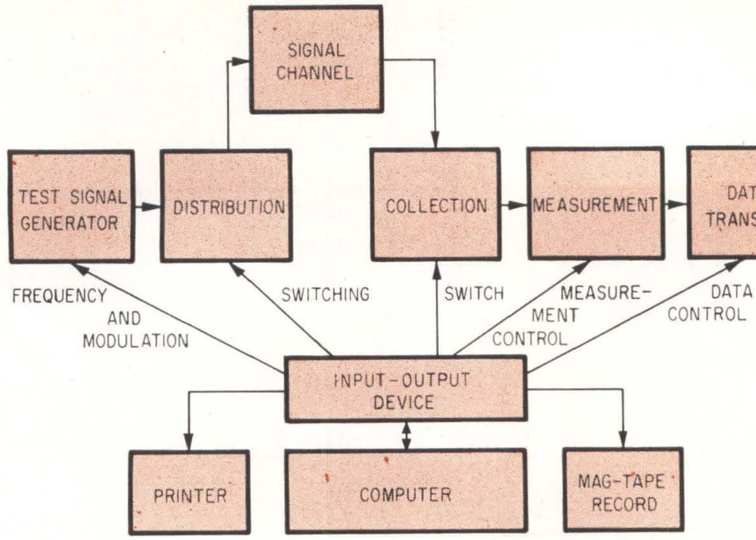
Figure 2 is a block diagram showing the functional essentials of any monitoring system. It should be noted that some functions need not be performed electronically. The r-f generator supplies a suitable measurement signal at a frequency (or frequencies) within the band of interest at a specific power level and with a required degree of amplitude and phase stability. An input r-f distribution section, typically a matrix of power dividers and switches, supplies a signal of constant phase and amplitude to the input of the channel being measured. An output r-f collection system samples the signal at the output of the channel being measured and routes it to the measurement equipment. The channel measuring and evaluating equipment measures the transfer functions of the channels in the beam under consideration, computes the appropriate phase and amplitude averages, compares individual transfer functions with the average, decides if an out-of-tolerance condition exists, and records the beam number, channel number, and degree of tolerance variation in the faulty channels. The component failure identification unit processes the data associatively to locate the faulty component. The sequencer coordinates the functions of all other blocks.

The degree of automation designed into the operation of each of the various functional blocks shown in Fig. 2 is dependent on such factors as cost, overall complexity of the antenna system, estimated failure rates and mean time between failures of the various components involved, and allowable degree of degradation of performance of the main system. For complex systems, complete automation using a computer may be required.

Complete automation of the system described in Fig. 2 would include automating the sequencer, the channel measuring and evaluating equipment, and the component failure identification equipment. For the beam being measured, the sequencer selects a particular channel input and output and, if real-time channel measuring and evaluation is being performed, synchronizes the measurement and the evaluation. The required minimum speed of measurement sequencing is determined by the probable accumulation of component failures. The fault accumulation depends upon the failure rate, the ease of component adjustment or replacement, and the time required to verify fault correction. Automation of the component failure identification equipmentment may also be necessary depending on the data volume. The fault-location process must be fast enough to keep up with the average fault occurrence rate; otherwise degradation will be continuous and monotonic. However, if fault location is at least that rapid, the level of operating degradation (steady-state degradation) is not a rapid function of the fault-location rate. The speed of a measurement cycle must also be sufficiently high to insure that errors due to measurement equipment drift are negligible compared to the channel tolerances.

Monitoring Systems — The design principles previously discussed have been successfully applied to phased-array systems now in use. Two such systems will be discussed. The degree of automaticity of function, the speed of sequencing, and the techniques used in the instrumentation of each monitoring system differ in these two examples, showing in some degree the flexibility required to adapt to various systems.

Semi-automatic — Following is an example of a semiautomatic monitoring system that was designed and fabricated for a multifunction array antenna. The total number of signal channels involved in this array is less than 10,000; there are comparatively few individual components, the expected mean time between failures is relatively long, hence a fully automatic monitoring system is not required. An automatic sequencer controlled the operation of the input and output r-f matrices. Real-time automatic measurement and channel-error detection controlled by the sequencer shortened the duration of the measurement cycle. Amplifiers used in the array had a much higher failure rate than any other system components. These were monitored separately, as components. Failures among the remainder of the system components could be easily located



AUTOMATED monitoring system—Fig. 3

by simple associative failure plots performed by the operator. The design rate of sequencing was bounded by two extremes: an upper bound determined by the necessity of minimizing the frequency spectrum occupied by the measuring signal; a lower bound determined by the desire to minimize the effect of long-term drift upon the measurement without the necessity of instrumenting corrective techniques. Since manufacturing tolerances on individual array components were set and controlled at a level consistent with achieving the predicted operational performance, no array-trimming adjustments and consequently no adjustment facility in the monitoring system were required. If a component drifts out of tolerance, it is simply replaced.

The system-design economics justified a method of measurement that reduced the dynamic range linearity requirement upon the transfer function measuring circuits. Prior to measurement, a phase delay and an attenuation complementary to the proper value for each signal channel forming a beam is added to its output. This makes the adjusted output of all signal channels within a particular beam identical. For the limited dynamic range necessary to encompass the allowable phase and amplitude deviations within a beam, a simple phase detector and amplitude detector i-f circuit are accurate and adequate. This method adds some complexity to the required switch sequence and thus to the sequencer.

Other design features of this system are conventional. The required phase and amplitude tracking of the transfer function in input and output matrices is maintained through extremely tight component specifications. Large ensembles of individual components such as switches, power dividers, and directional couplers were in fact successfully produced to transfer-function tracking tolerances significantly tighter than those imposed on the "state of the art" components used in the array. The use of a low-noise dual-channel receiver insures a signal-to-noise ratio in the measurement equipment that is adequate for high-accuracy measurements. The monitoring system has proven itself in the field to be a highly accurate installation and maintenance tool. Operational experience has shown it to be capable of maintaining the antenna array to within its design specifications.

Larger Array—As an example of a larger, more complex monitoring system, consider a radar with a 5,000 element receiving array with 50 beam outputs. This array certainly has greater monitoring complexity than the previous example. The number of signal channels is 50×5000 or 250,000. The monitoring system cycles through all channels within one hour. One hour allows the measurements to be made on a noninterfering basis with the antenna system and is short enough so that component drift is small. Two hours would have been acceptable from failure or drift-rate considerations, except that this was considered to be too long to wait for a fault correction verification.

The monitoring function must be performed without interfering with the array's operation. In this array, as in most, a small percentage of channel failures, say 5 percent, in any beam, will not appreciably affect the antenna beam performance, hence the design objective of the monitoring system is to prevent the number of channel failures from exceeding this percentage. The monitoring equipment must then repeatedly measure these failures, each time updating the outage list by printing out new information.

Automation is necessary in this system. To check all channels without a completely automated system would be an unacceptably lengthy process. A computer therefore performs a number of functions for the basic system. The monitoring system takes overall direction from the computer, which controls all switching and timing functions involved in each channel measurement process. The computer also receives raw data from the measurement equipment, and processes it, making decisions concerning channel failures, or trim adjustments where these are provided. Associative processing is also performed within the computer, whereby components (such as a power supply) whose failure causes failures in several channels are identified. Outages are printed out with data indicating fault location and the corrective action required.

In the resulting monitoring equipment, the computer directs measurements, receives and corrects data, processes it, and indicates element failures that are beyond design tolerances. Organization of the test sequence along the lines of array network interconnections assists the computer in making the calculations in real time. For example, assume that the column elements are combined directly in any beam. If measurements were made sequentially down the column, this would enable the data to be processed directly, thereby minimizing the amount of raw data storage required within the computer. This type of reasoning, applied extensively, results in the formulation of the complete detailed test sequence. Use of this type of organization is absolutely essential, since computer data storage must be minimized economically. An unacceptable alternative would be to measure all 250,000 signal channels and then solve 250,000 simultaneous equations, a sizable task for any present-day computer.

Figure 3 shows the basic system of Fig. 2 adapted to computer use for the illustrative system under discussion.

The monitoring signal distribution system is simply a 1-to-5,000 divider with switches in each output branch to enable sequential connections of the signal to one signal channel at a time. Switches use fast-acting, stable diodes. The long-term stability requirement of this switch and distribution system is a small fraction of the signal channel tolerance permitted. Transfer-function tolerances required of the divider network are, as in the previous system, derivable directly from the array channel tolerances.

The collection subsystem samples the signal at a beam output and conveys it to the measuring equipment. Three requirements are of interest in this subsystem; inter-channel isolation, tracking of the transfer function from beam output to measurement equipment, and insertion loss. The isolation between the ON and OFF channels of the collection system must be sufficient to avoid ambiguities in measurement. Beam-to-beam tracking of transfer functions in the collection system is required only where beam outputs are related, as in a monopulse tracking system. Insertion loss in the collection system should not cause excessive deterioration of the signal-to-noise ratio which would degrade the measurement accuracy.

Achieving the required signal-to-noise ratio may be a problem. The signals coming through signal channels are considerably lower in level than the normal array output, and as a result narrow measurement bandwidths are used to reduce the noise. To avoid time interference with the array operation, a pulsed, sampled measurement technique is used. The use of pulsing introduces transients that must decay sufficiently to allow sampling with limited error. This sets a lower bound on the measurement bandwidth.

Measurement equipment performance must be effective. Sufficient monitoring speed and the required resolution must be provided at the same time. A well-designed limiter is an essential part of the phase monitoring equipment — output phase variation as a function of input amplitude must be controlled.

Amplitude measurement is preferably performed at a frequency where a good rectified i-f output can be obtained, free from ripple uncertainties. Wide dynamic range in the detector is desired so that the linear range of the antenna taper losses can be accurately measured without an expensive and difficult switched taper-loss equalization arrangement.

The choice of a measurement frequency involves a trade-off between the desired phase resolution and the number of cycles in a sample pulse required to provide the desired accuracy. The phase-measurement resolution is the number of degrees at the particular frequency that is contained in the counting interval. The measurement receiver consists of a low-noise preamplifier, a double superheterodyne type of receiver and a device to produce the required i-f frequencies. Mixer errors from spurious cross products in the local oscillator device are minimized and the source should have the required i-f stability.

The data transfer into the computer involves conversion from analog to digital. Gating and storage circuits accomplish the data transfer. The computer requires a real-time input-output device to receive data and to send out properly timed control pulses for all the equipment functions of switching and measurement. A printer and magnetic tape are used for recording the status and outage information of the monitoring system.

Before proceeding further, mention of basic measurement philosophy should be made. The absolute measurement of transfer characteristic does not provide the necessary accuracy for signal channel measurements. Since there is gain and many circuits prior to the measurement equipment that can drift, it is necessary to use comparison switching. Within several milliseconds of any measurement, a standardization path is switched in between the test-signal generator and the measurement equipment to provide a drift-free reference. Thus the changes in the equipment common to the path of both the standardizing and measurement signal are nullified, and the required measurement accuracy has been achieved without the need for long periods of stability in the measurement equipment.

An obvious remaining engineering problem is the design of the computer program. The test sequence leads directly to program requirements. The details of data storage would be a predominant consideration used in the example under discussion. Computer capacity is assumed to be limited. An "agenda" tape is programmed containing the following information: (a) all constants required for steering correction, calibration data, component location, etc; (b) constants covering the proper switching and measuring sequencing; (c) computational data required as the test sequencing progresses through the monitor cycle.

In this system under discussion a method is presented to assist the maintenance man in making the adjustment or replacement related to a failure. One approach would have been to stop the automatic sequencing and place the channel under adjustment on continuous monitor. Then the element adjustment could be talked in by intercom between a man reading the output of the computer and the man making the adjustment. This method is impractical. The overall failure rate is so high that the monitoring equipment would have to be on repair adjustment much of the time, leaving little time for monitoring.

The workable solution however makes use of the inherent flexibility of the computer. The computer can be addressed directly for each failure and be cycled repeatedly through the channel needing adjustment along with the normal monitor measurements. The results of this measurement can be presented on a portable meter which can be located conveniently near the adjustment. This same device is used to address the computer to measure each failure. Thus the maintenance adjustments, in fact many of them simultaneously, can be made without materially affecting the main monitor function.

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(1) J. Ruze, *Supple. al Nuovo Cimento*, 8, pp 364-380, 1952.
(2) L. A. Rondinelli, *IRE Nat Conv Record 7*, Part 1, pp 174-187, 1959.

BI-QUINARY SCALING: Accuracy

Practical 500-Mc counting circuit avoids speed limitation imposed by the feedback required in decade scalers. Both bi-quinary and qui-binary count division are described

By **RUDOLPH ENGELMANN,** Consultant, Manchester, N. H.

500-MC BARRIER BREACHED

Top scaling speeds of practical high-frequency decades are 150 to 200 Mc. Problems inhibiting 500-Mc binary decade counting are feedback, required in binary to decimal conversion for BCD-input readout equipment, and binary drive limitations. The bi-quinary scaler needs no feedback, no differentiated input and counts in excess of 500-Mc

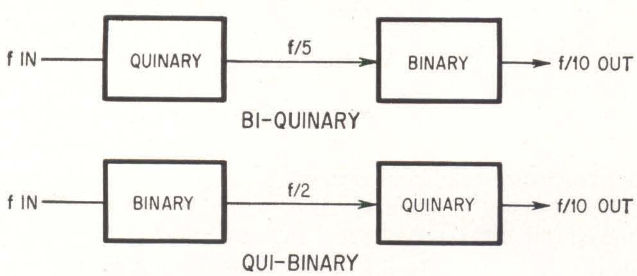
Counting Sequence TABLE I

Q_1 on	Q_2 off
Q_3 off	Q_4 on
Q_5 on	Q_6 off
Q_7 off	Q_8 on
Q_9 on	Q_{10} off

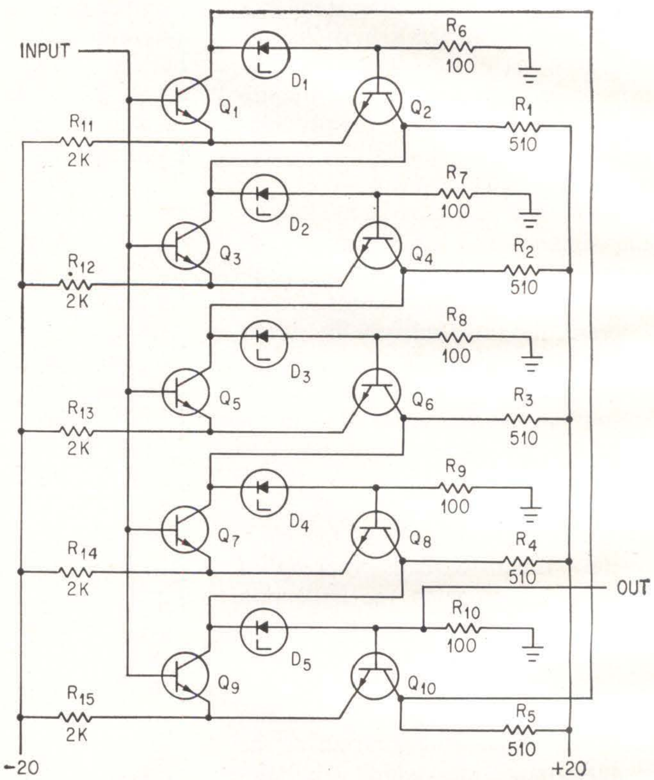
Counting Sequence TABLE II

After One Complete Negative Going Pulse

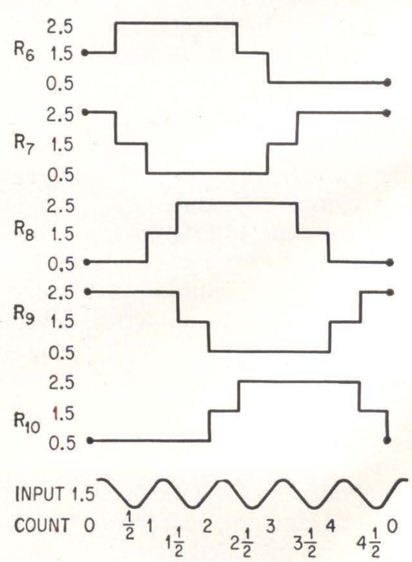
Q_1 off	Q_2 on
Q_3 on	Q_4 off
Q_5 on	Q_6 off
Q_7 off	Q_8 on
Q_9 on	Q_{10} off



BI-QUINARY DIVISION is fast. Qui-binary converts easily to BCD—Fig. 1



(A)



(B)

QUINARY DIVIDER is ring-counter of 5 current-mode ▶ switches (A), needing no feedback, with undifferentiated input signals. Bias relationships of load resistors (B) during a complete 5-sine wave scaler input cycle—Fig. 2

and Simplicity at 500 Mc

INCREASING SPEED requirements in digital counters has placed a strain on conventional counting techniques, especially in systems requiring decimal presentation. At present, counting rates in excess of 300 megacycles have been achieved in a number of laboratories using binary dividers. However, since binary division does not lend itself readily to decimal conversion, practical systems operating above 100-Mc in decimal mode are scarce and uneconomical.

The following describes a counting circuit (patent pending) which operates in excess of 500-Mc, and is economical of space, components and cost. Other economies, such as power requirements, input drive requirements and peripheral circuits enhance the desirability of this approach to digital measurement, even at low frequencies.

In Figure 1, two forms of count division are shown. The first is bi-quinary division and the second is qui-binary division. Each has its advantage and disadvantage. In bi-quinary division, the quinary divides the events at the input by five, and the binary divides the number at the quinary output by two, to give a total division by ten. Bi-quinary has the advantage, presently, of high speed, but is more difficult to convert to binary coded decimal (BCD) than qui-binary, which at a sacrifice in speed, converts readily to BCD. Both methods present decimal information with no difficulty.

Quinary Divider—Figure 2A shows a counting ring consisting of five current-mode switches. The input is common to the bases of the switch input transistors. Each switch has emitter current supplied by an individual resistor, from the negative voltage supply to the common emitters of the transistor-pair in the switch. The collector supply resistors (R_1—R_5) each connect to: the collector of the output transistor of one switching stage; the collector of the input transistor of a second stage; a zener diode, which leads to the base of the second stage output transistor, and to a load resistor to ground.

Operation—Current passing through R_1, for example, has a choice of three return paths; the collector of Q_2, the collector of Q_3, and zener diode D_2. If 25 milliamperes passes through R_1 at all times and both Q_2 and Q_3 are turned off, then the entire 25 ma passes through zener diode D_2 and load resistor R_7. The voltage across R_7 is 2.5 volts, which the base of Q_4 sees as a bias. Since Q_3 is turned off, Q_4 must be turned on, and for this to be true the voltage on the base of Q_3 must be less than 2.5 volts. Since the base of Q_3 is common to the bases of Q_1, Q_5, Q_7 and Q_9, the bases of these transistors are also biased at some value less than 2.5 volts.

Collector resistor R_2 supplies Q_4 and Q_5. At this point Q_5 is turned on. Since the values of the emitter supply resistors (R_{11}—R_{15}) provide a current of 10 ma to their respective stages, Q_4 will draw 10 ma from R_2, as will Q_5. Only 5 ma is left to flow through D_3 and R_8. The voltage across R_8 is therefore 0.5 volt, which is the bias on the base of Q_6 which is turned off (Q_5 is on). Therefore, the voltage on the base of Q_5 and the other four input transistors must be greater than 0.5 volt.

It is established that the bias on the bases on the input transistors is greater than 0.5 volt and less than 2.5 volts. Table I shows the order of transistors turned on and off.

With Q_{10} turned off and Q_1 on, a total of 15 ma flows through zener diode D_1 and load resistor R_6. The bias on the base of Q_2 is 1.5 volts. So that Q_2 be turned off, the bias on the base of Q_1 must be greater than 1.5 volts. It is now established that the bias on the bases of the input transistors is greater than 1.5 volts and less than 2.5 volts.

Counting Sequence—From this point a counting sequence can be established. If the input bias moves to a value less than 1.5 volts, Q_1 will be turned off and Q_2 on. With Q_1 off, a total of 25 ma flows through D_1 and R_6. The base of Q_2 is now biased at 2.5 volts. With Q_2 turned on, only 15 ma flows through the diode-resistor combination (D_2, R_7). The bias on the base of Q_4 is 1.5 volts. This set of conditions will be retained until the input bias rises to a value greater than 1.5 volts at which time Q_3 will turn on and Q_4 off as its base bias drops to 0.5 volt. This new order (Table II) of on and off transistors is the condition of the circuit after one complete negative going pulse has been applied to the input. The width of the pulse is of no consequence.

Prime Advantage—Herein lies the primary advantage of this scaling technique. It is not necessary to differentiate the input signal. The quinary divider remains stable as long as the input signal does not cross the switching reference, which in this illustration is 1.5 volts. The d-c bias on the input may thus be set either above or below the reference, and pulses of either polarity, or any type of alternating signal will be accepted and correctly counted. However, if the upper and lower bias values of 2.5 and 0.5 volts are exceeded at the input, false triggering will occur. The input levels must be limited in amplitude. This is a minor consideration since a driving amplitude on the order of 200 millivolts is sufficient for error-free counting.

Components—For 500-Mc operation this circuit uses 2N2708 transistors. Actually any transistor with F_t of 2 or 3 times the top frequency expected to be counted can be used (typically $F_t = 1.2, 1.3, 1.5$-Gc). The switching current is that value at which the transistors are specified for maximum performance as amplifiers. The dominant factor in selecting the 2N2708 was cost, as several other types, such as the 2N2809 or 2810, perform as well in the quinary.

The zener diodes are 5.6-volt, 400-milliwatt types (typical is the 1N752A). Circuit sensitivity can be increased by matching the voltage drops of the zeners, and even further increases can be had by matching the resistors, and the base-emitter forward drop of the transistors. As is, 5-percent resistors, and zener matching will accomplish the sensitivity claimed here.

Output—Figure 2B demonstrates the bias relationships between the load resistors of each stage during a complete scaler cycle of five complete sine waves applied to the input. In this instance an output may be taken from across R_{10} to drive a shaper and a binary to complete a bi-quinary decade.

Figures 3A and B demonstrate means for displaying the count contained in bi-quinary and qui-binary decades respectively. The Nixie indicators are driven directly without need of buffers. Figure 3C demonstrates the conversion of qui-binary to BCD.

Bi-quinary to BCD conversion requires the bi-quinary be converted first to ten line code; BCD then is derived by normal 10-to-4 line conversion. A multiple decade counter will use bi-quinary decades in only the first one or two decades to take advantage of their greater speed and ease of driving. The qui-binary decade would be used in the lower-frequency decades to take advantage of the easier conversion to BCD which is required for most hard-copy readout systems.

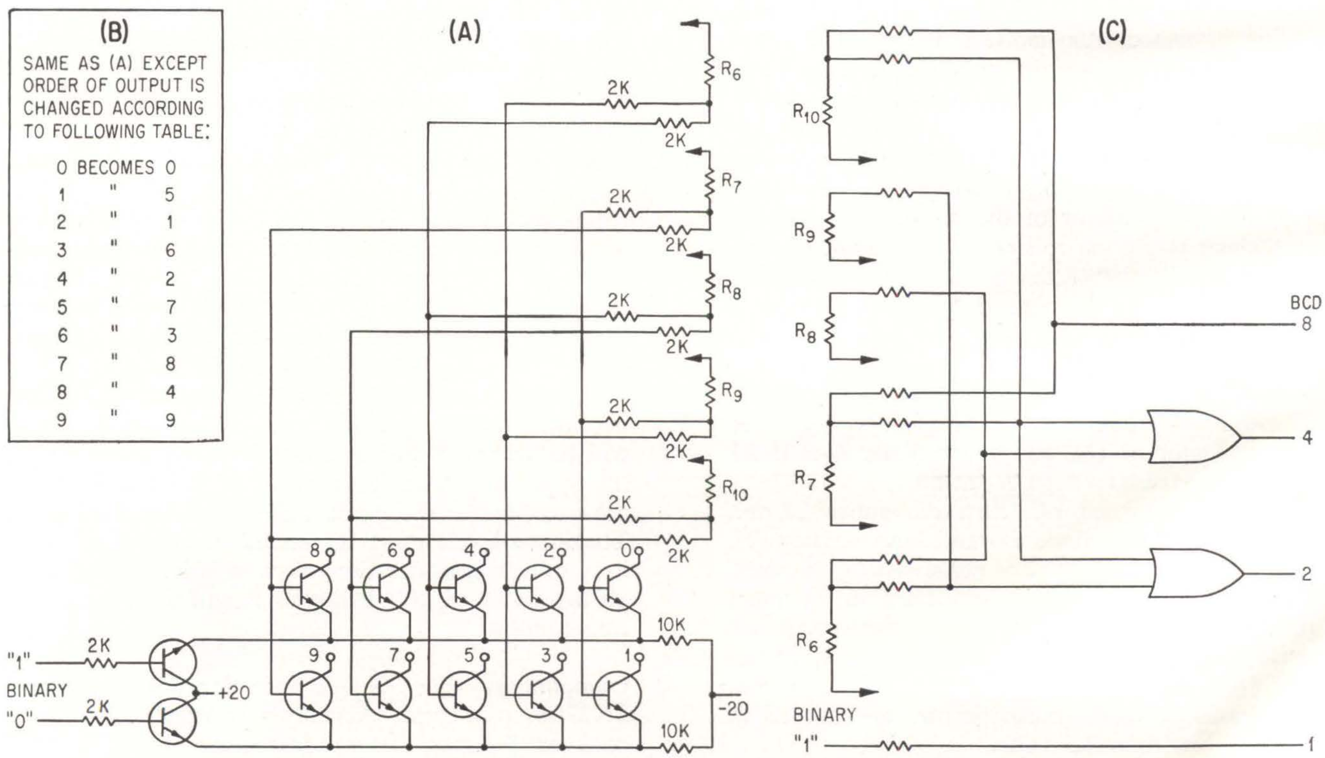
With better transistors becoming available and with more advanced physical layout of the circuit components, scaling speeds in excess of 1-Gc will be obtained in the near future. Under rigid conditions, speeds of 750-Mc have already been obtained in the lab. At this time however, practical instruments which must operate in extremes of environment will be limited to top specified speeds of 500-Mc.

Low Frequencies—The lower the frequency a given decade is expected to scale, the lower the switching current required to maintain the operation of the decade. At 50-Mc, a switching current of 3 or 4 ma is sufficient. At frequencies below 1-Mc, switching currents of 200 or 300 μa are sufficient to maintain operation and avoid complications due to semiconductor leakage in high-temperature environments.

Below 50-Mc, the zener diode, employed as a low dynamic impedance-coupling device, is unnecessary. A resistor will replace the zener diode. There is no case in which a coupling capacitor will be used. But, at very-low-frequency operation, a bypass capacitor across the load resistor of each stage may be desirable to reduce noise sensitivity when a low-amplitude drive is desired.

As example of the wide range of practical uses for the quinary circuit: a 50-Mc counter; 100-Mc and 200-Mc plug-in decade counting units; a nanosecond time interval meter; and a 500-Mc frequency meter.

With all the advantages of this approach to frequency division, the appearance of a low-cost, battery-operated, coat-pocket counter, paralleling in every respect the performance of present laboratory counters, becomes imminent. Complete low-frequency decades the size of a nickel are being constructed and versions much smaller than this are possible if applications become known.



COUNT of bi-quinary decade is displayed by Nixie indicators (small numbered circles) which require no buffers (A). Outputs are reversed for qui-binary decade (B); conversion of q ui-binary to BCD (C)—Fig. 3

CHASSIS WIRING

PRESENT STANDARD	PROPOSED*	
Gray		A-C power lines
Black (K)		Grounded elements and returns
K-N		Grounded heater or fil.
K-R		Grounded B minus
K-Y		Grounded cathode
K-G		Grounded grid
Brown (N)		Heaters or filaments
N-R		Rectifier htr. or fil.
N-Y		Auxiliary htr. or fil.
N-G		Auxiliary htr. or fil.
N-W		Htr. or fil. c.t. (not grounded)
Red		Main stem B plus
R-W		Unfiltered B+ from fil.
R-B		B+ above main stem
R-Y		B+ below main stem
R-G		B+ intermediate
R-K		B+ intermediate
R-B-Y		B+ intermediate
White		B or C minus, main stem
W-R	(Detailed differentiation not included in new proposal)	B— below ground (max)
W-O		C— intermediate, fixed
W-Y		C— intermediate, fixed
W-G		C— (preferred for avc bias)
W-N		C— (intermediate avc bias)
W-K		Alternate ground or off-ground connection
W-B		Internal antenna or to antenna coil
W-R-B		Universal substitute wire
Green		Control grids and diode plates (and first base on transistors*)
G-W		Diode plate (if identified from control grid)
G-R		Identified grid (as thyratron grid)
G-Y		Identified grid (as oscillator grid)
Blue		Plates, except diode plates (and transistor collectors*)
B-R		Identified plate
B-Y		Identified plate
Yellow		Cathodes (and transistor emitters*)
Y-R		Identified cathode
Y-G		Identified cathode
Orange		Screen grids (and second base on transistors*)

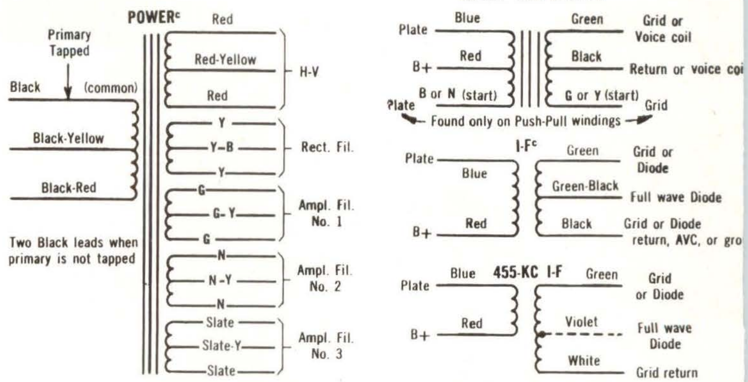
*EIA proposed new standard: not formally approved as of date of publication

TRAVELLING WAVE TUBE

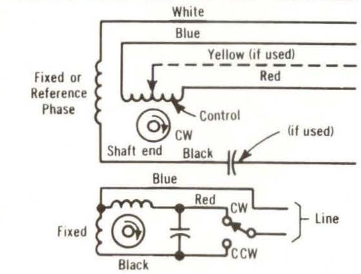
K	Grounds, grounded elements
N	Heaters or filament off ground
Y	Cathode, also heater-cathode lead if common
R	Collector
O	Helix 1
O-G	Helix 2
O-B	Helix 3
O-A	Helix 4
G	Grid 1
B	Grid 2
A	Grid 3
W	Grid 4
G-K	Grid 5
B-K	Grid 6
A-K	Grid 7
W-K	Grid 8

ELECTRONICS COL

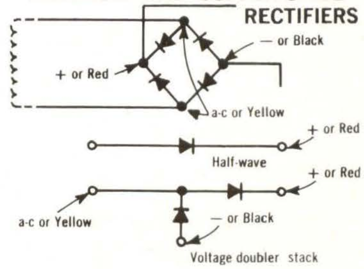
TRANSFORMERS



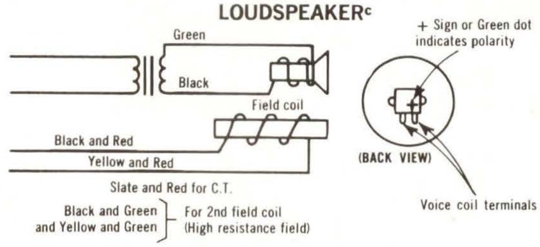
SERVO AND CAPACITOR MOTORS



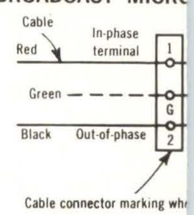
SELENIUM AND COPPER-OXIDE RECTIFIERS



LOUDSPEAKER[c]



BROADCAST MICRO



COLOR KEY

COLOR	Abbreviations STD.	ALT.	① Number	② Suffix Letter	③ Standard Multiplier
blacK	Blk	K	0	—	10^0
browN	Brn	N	1	A	10^1
Red	Red	R	2	B	10^2
Orange	Orn	O	3	C	10^3
Yellow	Yel	Y	4	D	10^4
Green	Grn	G	5	E	10^5
Blue	Blu	B	6	F	10^6
Violet	Vio	V	7	G	10^7
Gray	Gra	A	8	H	10^{-2} (alt.)
White	Wht	W	9	J	10^{-1} (alt.)
Silver	Sil	—	—	—	10^{-2} (preferred)
Gold	Gld	—	—	—	10^{-1} (preferred)
None	—	—	—	—	—

[a] Guaranteed Minimum Value [b] Optional when metallic pigment is undesirable [c] Widely used but not a standard

Re

OR CODES

COLOR CODES shown here are from the main standards for electronics of EIA and NEMA. Standards for semiconductor devices are formulated by JEDEC committees and are now issued jointly by EIA and NEMA. Neither EIA nor NEMA members are required to follow the color codes shown here but it is industry practice to do so where practical.

HALL-EFFECT GENERATOR

(MIL Std. 681A)

Black—Negative side, control current
Red—Positive side, control current
Yellow—Negative side, output voltage
Blue—Positive side, output voltage

PREFERRED SECONDARY COLORS

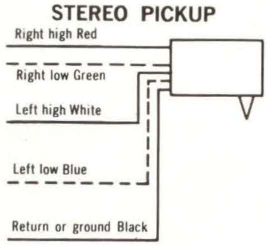
Light brown—use Tan
Light red—use Pink
Dark red—use Maroon
Light orange—use Peach
Dark yellow—use Mustard
Light green—use Lime
Dark green—use Jade
Light blue—use Aqua
Dark violet—use Purple
Dark gray—use Slate

INDUSTRIAL CONTROL WIRING

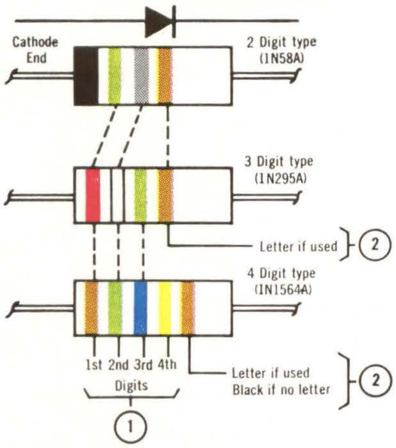
Black or Gray—a-c and d-c power and line
Red—a-c control circuits
Blue—d-c control circuits
Green—(usually equipment grounding)
White—(usually grounded neutral)

)PHONE

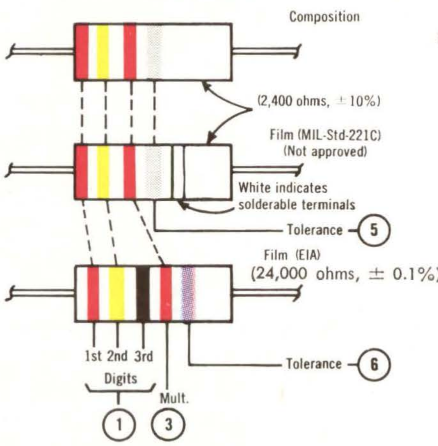
STEREO PICKUP



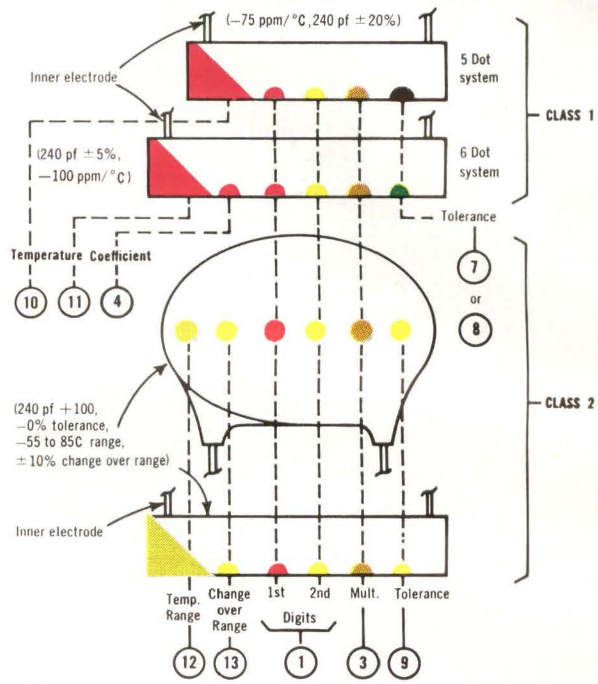
DIODES



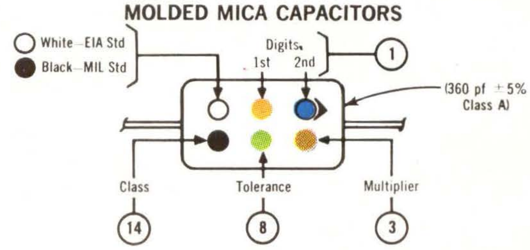
RESISTORS



CERAMIC DIELECTRIC CAPACITORS



MOLDED MICA CAPACITORS



(4) Temp. Coeff. Multiplier	(5) Tolerance in percent	(6) film resistor only	(7) Capacitor Tolerance < 10pf	(8) > 10pf (in percent)	(9) (in percent)	(10) Temperature Coefficient (Parts per 10⁶ per deg. C) (5 dot system)	(11) (6 dot system)	(12) Temp. Range (deg. C)	(13) Capacitance Change over Range (in percent)	(14) Capacitor Class (molded mica)
−1	± 20	—	± 2pf	± 20	± 20	0	0	—	± 2.2	A
−10	± 1	± 1	± 0.1pf	± 1	—	−33	—	+10 to +85	± 3.3	B
-10^2	± 2	± 2	—	± 2	—	−75	1	—	± 4.7	C
-10^3	± 3	—	—	± 3	—	−150	1.5	—	± 7.5	D
-10^4	GMV[a]	—	—	—	+100, −0	−220	2.2	—	± 10	E
+1	± 5[b]	± 0.5	± 0.5pf	± 5	± 5	−330	3.3	—	± 15	—
+10	± 6	± 0.25	—	—	—	−470	4.7	—	± 22	—
$+10^2$	± 12.5	± 0.1	—	—	—	−750	7.5	—	+22, −33	—
$+10^3$	± 30	± 0.05	± 0.25pf	—	+80, −20	+150 to −1,500	−1,000 to −5,200[d]	—	+22, −56	—
$+10^4$	± 10[ab]	—	± 1pf	± 10	± 10	+100 to −750	—	—	+22, −82	—
—	± 10	± 10	—	—	—	—	—	−30 to +85	± 1.5	—
—	± 5	± 5	—	—	—	—	—	−55 to +85	± 1	—
—	± 20	—	—	—	—	—	—	—	—	—

[d] Multiplier dot for this coefficient is black

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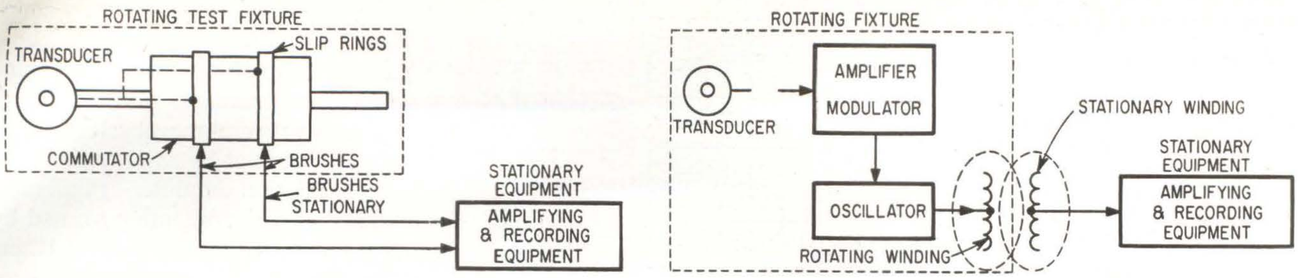


(A) (B)

CONVENTIONAL spin-measurement system with mechanical contacts (A), and inductive telemetry scheme (B)—Fig. 1

INDUCTIVE TELEMETRY Improves Spin-System Measurements

Brush contact pressure and mechanical alignment cause varying amounts of noise in mechanical systems. Here is a technique for transmitting transducer signals to test gear by telemetry

By **H. BAUMANN**
Instrumentation Section,
Picatinny Arsenal, Dover, N. J.

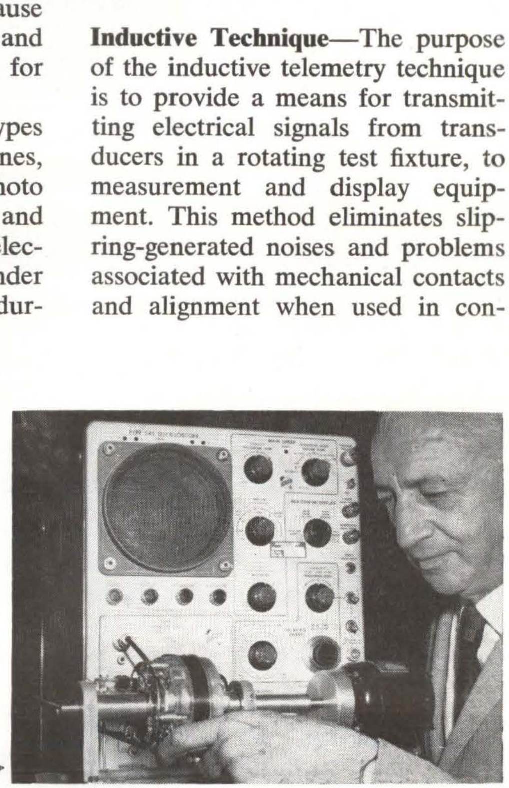
CONVENTIONAL methods for telemetering data from rotating test fixtures utilize a commutator-slip-ring unit to connect the transducer output signal to indicating and display equipment for analysis as shown in Fig. 1A. While this method may often be satisfactory, it has some objectionable characteristics such as slip-ring-generated noise and the problems associated with mechanical contacts subject to high rpm. Brush contacts on a commutator revolving at 5,000-15,000 rpm will generate some level of contact noise. If the transducer output signal is of low amplitude, the contact noise may completely obscure the transducer signal. Brush contact pressure and mechanical alignment are variable factors that can cause changes in contact noise levels and therefore must be maintained for optimum performance.

Some of the more common types of transducers include microphones, accelerometers, strain gages, photo electric cells, magnetometers and blast gages. Many of the non-electrical signals are generated under conditions of rotating motion, during a test. This means that the transducer output signal must be transmitted from the moving device to a stationary system which displays the transducer output signal for observation and analysis as shown in Fig. 1B.

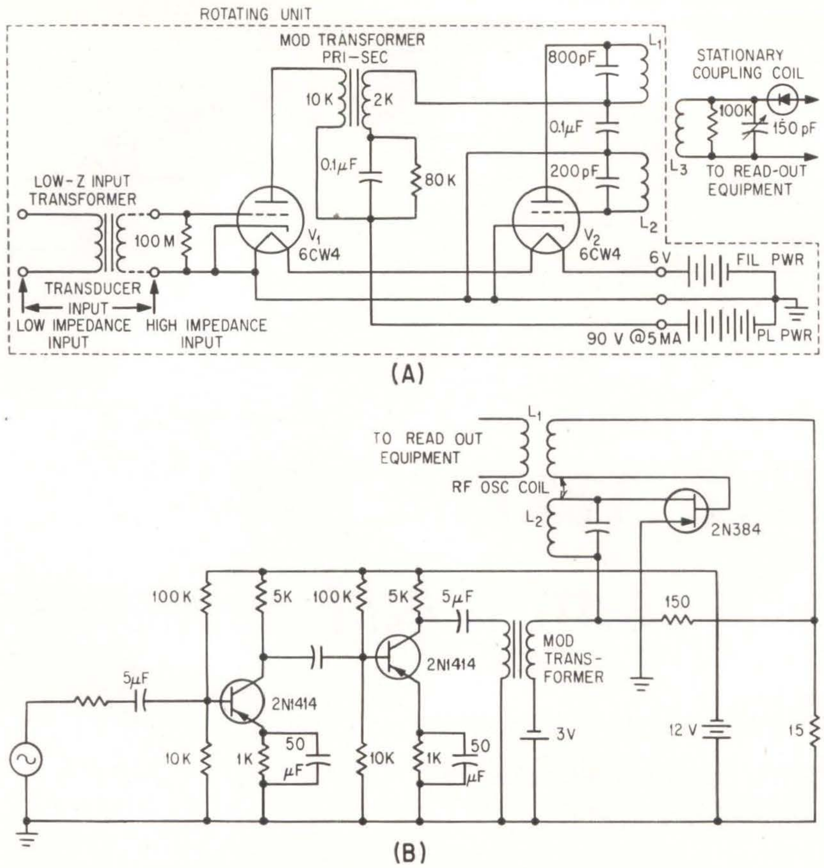
Inductive Technique—The purpose of the inductive telemetry technique is to provide a means for transmitting electrical signals from transducers in a rotating test fixture, to measurement and display equipment. This method eliminates slip-ring-generated noises and problems associated with mechanical contacts and alignment when used in con-

BETTER SPIN-SYSTEM MEASUREMENTS

Conventional spin-measurement techniques require the use of a commutator-slip-ring assembly to couple an output signal to various pieces of laboratory test equipment. The method discussed in this article uses an inductive coupling scheme to do away with physical connections between the spun device under test and the analysis gear. In so doing, the technique eliminates noise problems normally associated with brush-contact devices and increases life by eliminating physical wear and tear



AUTHOR adjusts the spun device prior to a working test at Picatinny Arsenal ▶



ROTATING unit and inductive coupling used by the author (A), and suggested circuit for its transistor equivalent (B)—Fig. 2

junction with a commutator at high revolutions.

A spin-test unit has been developed at Picatinny Arsenal that makes use of radio frequency inductive coupling. Briefly, the system functions as follows: The transducer output signal instead of passing through slip-ring contacts, is connected to the input of a modulation amplifier, which in turn modulates a radio-frequency oscillator. This unit spins with the system to be analyzed. The radio frequency modulated signal from the rotating oscillator coil is then inductively coupled to a tuned circuit consisting of an inductance coil, tuning capacitor and diode. This tuned circuit connected to the input of a wide-band, high-gain oscilloscope. The r-f carrier is eliminated by the diode and the display on the oscilloscope is the electrical analog of the transducer output signal. The transducer, modulator and oscillator are packaged in a cylindrical unit that rotates with the spin system. As long as the spacing between the rotating oscillator coil and the fixed coil connected to the oscilloscope are constant, the behavior is similar to an r-f transformer with fixed coupling between primary and secondary as illustrated in Fig. 2A.

The prototype unit that has been developed uses nuvistors in conventional circuits. The entire package including battery supply is contained in a cylindrical configuration that is considerably smaller than a slip-ring commutator assembly.

The r-f oscillator frequency for this unit is approximately 1 Mc. Sufficient stability is obtainable in this range without crystal oscillator circuits; however, their use is recommended as they would introduce no additional problems. Output signals are not affected by the coupling factor if the spacing between the rotating and stationary transformer coils is constant.

Design of the oscillator and coupling coil are determined by the carrier frequency selected and the required transmission bandwidth. The carrier frequency should be approximately ten times the required bandwidth of the system to be analyzed. For bandwidths of 10 Kc and greater at the half-power points, it may be necessary to reduce the coupling coil Q by means of a shunt resistor or to use a coupling coil with a degraded Q. There is a limit to the degree of damping which is practical and for bandwidths of several megacycles, simple circuits can not be employed.

Modulation-amplifier gain-bandwidth requirements are governed by transducer sensitivity and the determinable parameters. For most applications, a voltage gain of 10^3 and uniform response of 200 to 10,000 cycles will be adequate.

Nuvistors were used initially because of the inherently high input impedance characteristics that make them ideally suited for use in conjunction with high-impedance crystal transducers. For spin measuring systems using strain gages and relatively low-impedance transducers transistor circuits such as that in Fig. 2B can be utilized.

The linearity of the system is such that saturation or nonlinearity occurs beyond the signal level that causes 100-percent modulation of the carrier. The unit must be calibrated with the associated transducer, and some knowledge of the expected level of the input signal to be analyzed is necessary to remain within the limits of linear response.

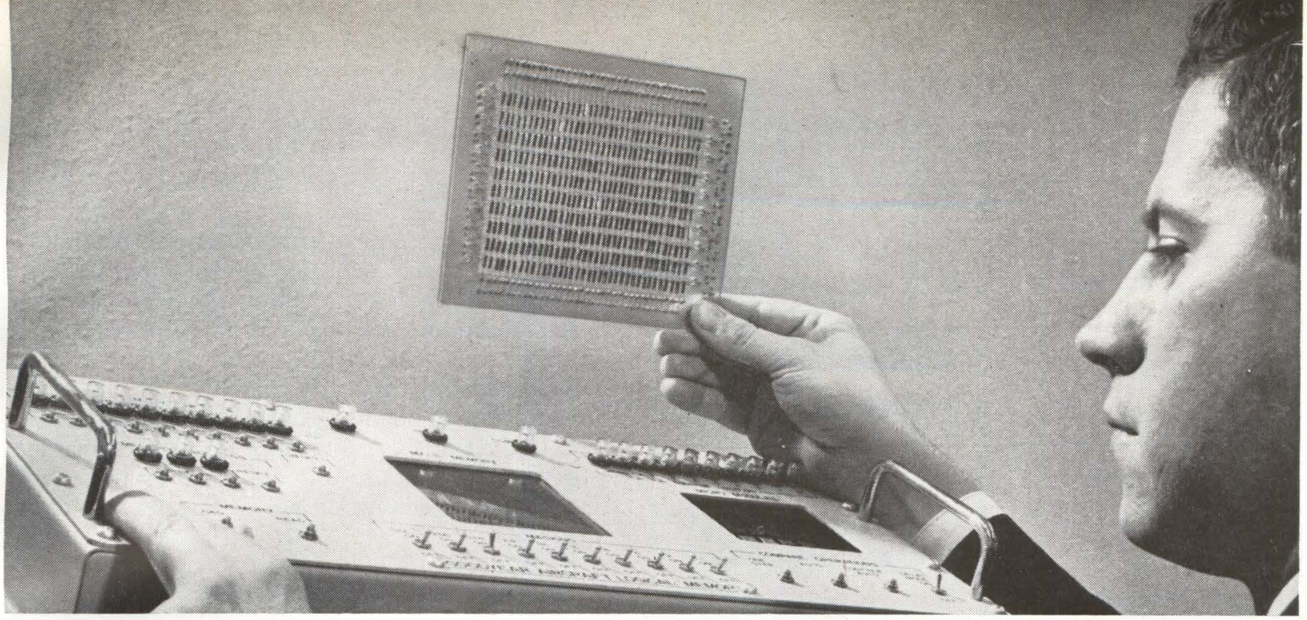
All components should be mounted symmetrically to maintain dynamic balance with a minimum of counterbalancing.

Speed Limitations — Electrically, speed limitations of the system will be governed by the acceleration or g level which the components can withstand.

Tests with nuvistors indicate they can tolerate up to 10,000 g for limited intervals. Transistors, condensers and resistors, have been subjected to accelerations of 20,000 to 30,000 g without apparent damage.

The test unit has been rotated at 6,000 rpm, which is an acceleration level of 2,000 g. Output indications have been observed with inputs in the order of several millivolts over a frequency range of 200 to 10,000 cycles.

The a-m system described transmits only one channel of information. However, by using f-m techniques, multiplexing of a number of channels can be achieved. It is also possible to operate a number of a-m channels simultaneously providing there is adequate frequency separation to eliminate crossover.



PORTABLE FEASIBILITY MODEL of an associative memory con aining a memory plane of eight 10-bit words. Front-panel controls enter information into memory—masking, reading and comparing. Lights are provided for the load-and-compare-word and the compare-location registers

HOW to Quiz a Whole Memory At Once

Associative memory queries all the memory of a computer in one cycle instead of word by word. Memory read-write operations are random-access, with nondestructive read-out

By **G. T. TUTTLE**
Goodyear Aerospace's Computer Systems Dept.,
Akron, Ohio

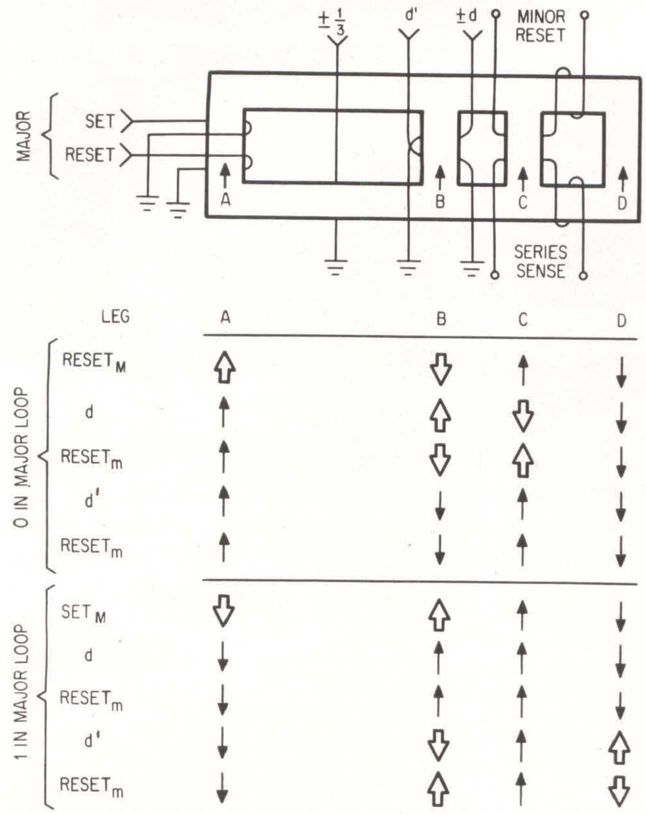
WHAT IS AN ASSOCIATIVE MEMORY?

Present-day digital computers are word-oriented. Arithmetic and memory operations are sequenced by function and the computer solves all problems word-by-word. However, computation is still relatively fast. Standard logical operations such as encoding-decoding, table look-up, or memory search routine all take time. Such operations are usually performed by sequencing through all or part of the memory until a desired logical operation is achieved. In each case, the data contained in some definite but unknown memory location is desired. With increasingly larger memories, memory searching time becomes prohibitively long. The total time depends upon the logic and memory speeds plus the size of the memory. Frequently the programmer must abandon the luxury of memory-search routines. Unfortunately this cannot always be done.

A solution would be to interrogate all of memory at one time. A logical operation such as a compare function would be accomplished in one memory-cycle time. While reading out an entire digital memory into a logical unit is possible, the equipment required and the resultant cost would be prohibitive. An ideal solution is a logical operation inherent in the memory system itself

THE MAIN FUNCTION of an associative memory is to compare a data word to the entire contents of memory. Occasionally, such memories are called search memories or content address memories. Then, for such a memory system to be useful, some method must be provided to handle the responses resulting from the compare operation. An additional feature often desired is the ability to limit the compare operation to certain bit locations in the data word. This is usually accomplished by using a masking word.

Memory Element—The basic memory element in Goodyear Aerospace Corporation's associative memory is the Male (Multi-aperture logic element), which has one major and two minor apertures. The major aperture is for storage and the minor apertures provide the exclusive OR logical function, thus combining both memory and logic in a single device. A unique method of wiring is used with the Male,



MALE flux-state diagram—Fig. 1

resulting in an extremely high signal-to-noise ratio for ferrite devices. The high signal-to-noise ratio allows the Male to be used in word lengths exceeding one hundred bits.

A wiring and flux-state diagram of the Male is shown in Fig. 1. The large arrows indicate which legs change state. Operation is:

(1) A ONE or a ZERO is set into the major loop by causing a constant current to flow into either the SET or RESET lines. The resulting mmf is just enough to fully switch around legs *A* and *B* and not affect legs *C* or *D*.

(2) A ONE or a ZERO may then be compared to the information stored in the major loop by causing a constant current to flow into either the *d* or *d'* lines. In either case, only legs *B* and *C* or *B* and *D* may change. The current and resulting mmf is limited so that no switching can occur in leg *A*.

Then by causing a constant current to flow into the minor-reset line, and at this time monitoring the series-sense line, a pulse will be observed if the digital information set into either of the digit lines differs from that set into the major loop. If we let the information stored in the major loop equal X and the information stored in the minor loops equal Y, the following relationship is observed: series sense line $= XY'$ or $X'Y$ (exclusive OR).

Referring again to Fig. 1, note that if the information stored in the major loop is desired, it can easily be obtained by causing constant current flow into the *d'* line and a true indication of the stored bit will be obtained by monitoring the series-sense line when resetting the minor loop. It is this feature that gives the device its nondestructive read operation.

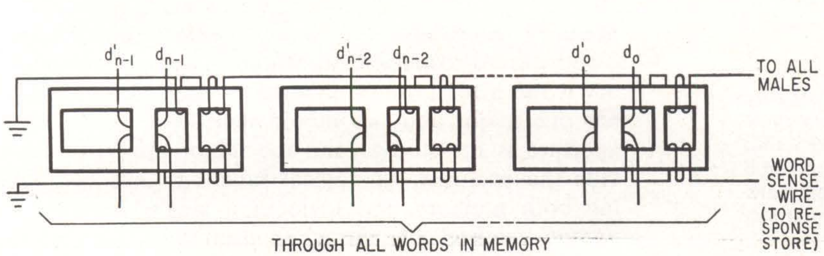
One additional line is required to use the Male in an associative memory system and that is the $\pm 1/3$ line located in the major loop and shown in Fig. 1. After resetting the major loop, the $\pm 1/3$ line provides the choice of setting or not setting the major loop to a ONE.

System Operation—A typical memory word is shown in Fig. 2, and a block diagram of the associative memory system in Fig. 3.

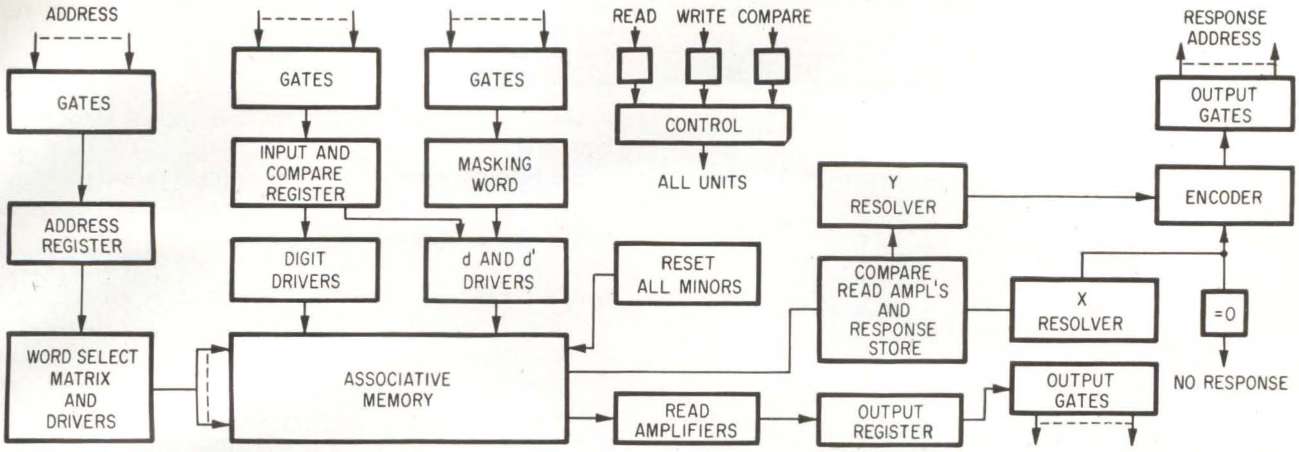
Writing into memory is done as in a linear select memory with one exception: the basic storage element is now the major aperture of the Male. A certain word is selected by the word-select matrix, and the contents of the input register determine which bits (major apertures) in the selected word are set to a ONE. This is the only memory operation that affects the major aperture.

A nondestructive read operation is performed by interrogating the minor loops in the Male. To read a particular word from memory, the digit-oriented *d'* drivers are turned on. Each respective minor loop will switch only if the major loop contained a ONE (Fig. 1). Since parallel (bit-by-bit) sensing is required, the series sense is not used during the read-memory operation. After the *d'* lines have been pulsed, the desired word is selected by the word-select matrix and the reset-minor line for that particular word is turned on. There are two reset-minor lines in the system; one is used for the read-memory operation, and the other is used during the associative operation. For readout sensing, the *d* wires are used and by appropriate gating via the control circuits are fed to the read amplifiers during the reset-minor pulse. Notice that all of the minor loops in memory may have changed state by turning on the *d'* lines, but this is of no consequence, as readout was sensed on a word basis (by turning on only one reset-minor line). Also if succeeding read operations on additional words are required, the *d'* drivers need not be turned on again.

Compare Operation—The associative function of comparing a word stored in the Input and Compare Register (ICR) (Fig. 3) to all of memory at one time is accomplished as follows:



TYPICAL memory word. For clarity, the write wires are omitted and only the wires used for the associative function are shown—Fig. 2



ASSOCIATIVE MEMORY—Fig. 3

The contents of the ICR determine which *d* driver is gated ON. For every ZERO in the ICR, the *d'* driver is gated on, and for every ONE the *d* driver is gated on. Thus for each bit location, either a *d* or *d'* driver is turned on. Immediately following the *d* drivers (gated off) the minor loops of every word in memory are reset to ZERO. At this time each word-sense wire for each word in memory is gated into the compare read amplifiers.

Previously, it was shown that if the digital information set into the minor loops by the *d* drivers differs from that stored in the major loop, an output pulse will be observed on the word-sense line upon resetting the minor loops. The word-sense line of all Males making up a memory word are wired in series (Fig. 2), thus providing the means of detecting if one or more of the minor loops changed states during the compare operations. In practice the signal appearing on the word sense line is the complement of what is desired; that is, a signal for non-compare. The compare-read amplifier complements the input signal, which sends the correct logic level to the response store.

Masking Word—The power of an associative memory is greatly increased if some method is provided to select certain bits in the ICR for the compare operation. This is particularly true for any encoding or decoding operation. A typical example would be a table look-up operation such as finding the sine of a given angle. Conventional digital computers usually solve this problem by some iterative process such as a power series; that is

$$\sin x = x - \frac{1}{6}x^3 + \frac{1}{120}x^5 - \frac{1}{5040}x^7 + \cdots\cdots$$

Here a number of add, subtract, multiply and divide operations are required, which is time-consuming. With an associative memory, a $\sin x = y$ table could be used. Each word in the table would contain the following information

ANGLE	SINE	INTERPOLATION VALUE

To obtain the sine value, the compare operation would be performed on the data bits representing the angle. The sine value and the interpolation values are masked out of the compare operation. Masking is done in the associative memory by simply inhibiting both the *d* and the *d'* drivers in selected bit positions. The selected bits then appear as don't-care bits in the compare operations. Regardless of the information contained in the major loop, no signal can appear on the series-sense line during the reset-minor pulse unless preceded by a *d* or *d'* current pulse. Which bits are selected are determined by ONE's in the masking register which has a bit-by-bit correspondence with the ICR.

In the example, suppose the table consisted of 90 words, one for each degree and the sine of 43.17 deg is desired. The input to the system for the compare operation would be 43 deg and the contents of the ICR and the masking register is

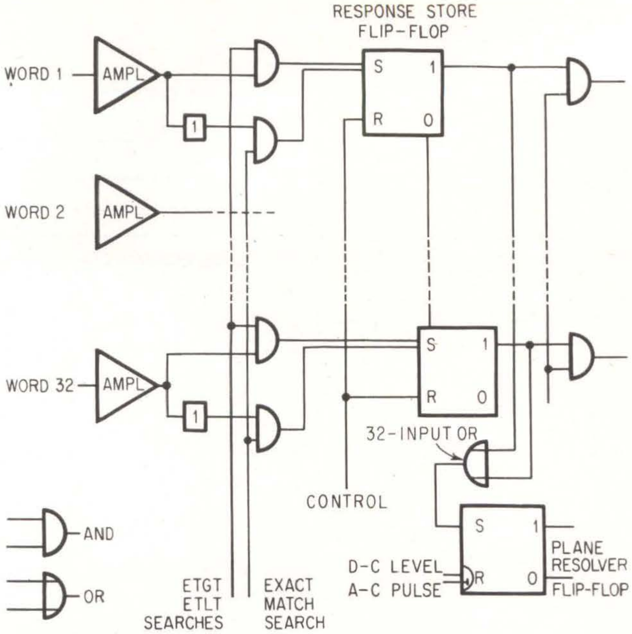
4 3 1 7 0 0 0 — — — 0 0 0 0 0 0		ICR
1 1 0 0 0 0 — — — 0 0 0 0 0 0 0		MASK REGISTER

The resulting search in the associative memory would be on

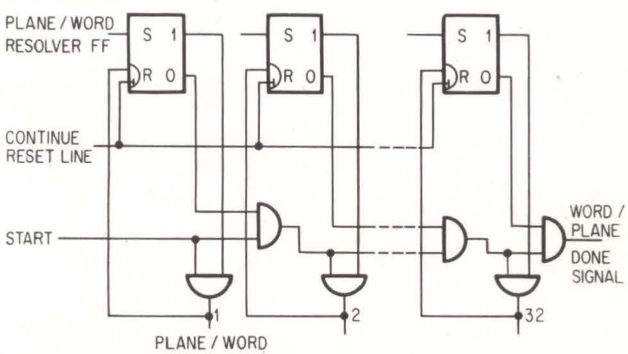
4 3 X X X X X X X — — — X X X X X

where the *X*'s indicate don't-care bits. Immediately following the compare operation, a read-memory operation is performed using the address indicated by the response store. Now the sine value and the sine interpolation value are transferred to a standard arithmetic unit for one multiplication and add operation to obtain the sine of 43.17 deg.

Response Store—Two methods are currently used to resolve the multiple responses resulting from the compare operation. Both are similar in operation and differ only in the actual storage element used. For small associative memory systems, solid-state devices (flip-flops) are used and for large systems, two-core planes are used. Both methods divide the memory into zones, with each zone containing a number of words. The contents of the zone and word resolver, denoted in Fig. 3 as the *x* and *y* resolver, are then fed



RESPONSE store—Fig. 4



PLANE and word-resolver circuit—Fig. 5

to a diode encoder, which generates a binary number for the first least significant word position that compared to the data word used in the compare operation. The *x* and *y* resolvers are sequential in operation and generate response addresses at a one-mc rate. The lack of a response to a compare operation is indicated by all zeroes in the *x* resolver, which activates the no-response line shown in Fig. 3.

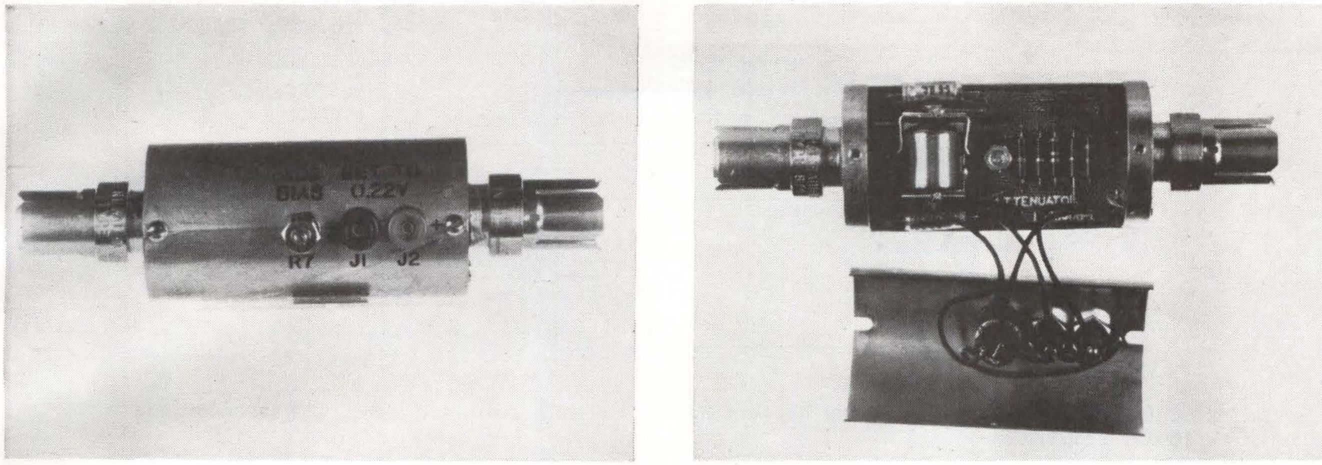
To describe the operation of the response store and associated circuits, a 1,024-word associative memory consisting of 32 planes will be used. Each plane contains 32 words and straightforward noninverting logic circuits are shown instead of the actual circuits developed for the system to better illustrate system operation. Each word in memory has associated with it (see Fig. 4) one amplifier with both the true and an inverted output plus three AND gates and a flip-flop (FF). The AND gates feeding the response-store FF discriminate between the exact match search and the compound searches of Equal to and Greater Than (ETGT), and Equal to and Less Than (ETLT). At this time only the exact match or compare operation will be considered. During the compare operation the control circuitry gates the inverted signal from the word amplifier into the response store FF's. If one or more of the response store FF's are set to a ONE, the plane resolver FF is also set to a ONE by the 32-input OR gate. The remaining 31 planes are identical and are set or not set during the compare operation. The circuit that determines which words met the search criteria is now activated (Fig. 5). The plane-resolver FF for each plane is shown along with two additional AND gates per stage. To start the plane-resolver circuit, a ONE is applied to the start line at the end of the compare operation and begins to ripple down through the top AND gate structure as long as each plane-resolver FF is reset. If any plane-resolver FF is set to a ONE, the chain is broken, and the lower AND gate associated with that particular FF is turned on. Notice that one, and only one, of the lower AND gates will generate a ONE at any one time. This signal is used to transfer the contents of the response-store FF's associated with the plane-resolver FF into a word-resolver circuit that is identical to the plane-resolver circuit just described. A ONE is now started down the word-resolver circuit and stops at the first word FF that contains a ONE. These are the *x* and *y* resolvers shown in Fig. 3. At this time there is a signal from one AND gate in both the word resolver and plane resolver. These two signals are then fed into a standard diode-encoding matrix that generates, in binary form, the address of the first word meeting the search criteria in the compare operation. To obtain the additional addresses that may exist (which would indicate that more than one word met the search criteria) the continue-reset line in the word resolver in Fig. 5 is activated with a short-duration pulse. Each FF has a gated a-c reset so that only one of the resolver FF's will be reset at one time, which allows the start signal to continue rippling down the top AND gate structure until stopped by another FF that contains a ONE. This process continues until a completion signal appears in the last AND gate in both the word and the plane resolver, which indicates that no additional responses exist in the system. In practice the rippling process is speeded up by using conventional look-ahead circuits[1]. Worst-case-time timing for the response store, the word and plane resolvers and the diode encoding matrix is one microsecond for a 4,000-word memory so that addresses can be generated at a one-mc rate.

Additional Functions—Other useful functions performed by the associative memory are finding all words in memory that are less than, or greater than, some specified value. A between-limits search is obtained by combining a greater-than search with a less-than search.

System Functional Speed—The read, write and compare operations are determined by the switching speed of the ferrite material used in constructing the Male. Two different types of materials are used in making the Males. The faster of the two results in a 2.5-μsec function time for the read and compare operations and a 5-μsec write time. The slower material requires 5 μsec for the read and compare operation and 7 μsec for the write operation.

REFERENCE

(1) O. L. MacSorely, *High Speed Arithmetic in Binary Computers*, *Proc IRE*, Vol. 49, No. 1, Jan. 1961.



THREE-DECADE attenuator for logarithmic pulse compression

ATTENUATOR SPECS

This passive attenuator of simple construction will logarithmically compress positive or negative pulses having an amplitude range of three orders of magnitude. The output is proportional to the logarithm of input voltages between 0.1 and 100 volts. The range of the output is between 0.1 and 0.9 volt and the log-linear relationship is achieved with an accuracy of better than ± 4 percent. The corresponding attenuation varies from 1:1 at an input of 0.1 volt, to 111:1 at 100 volts

LOGARITHMIC ATTENUATOR SPANS THREE DECADES

Passive circuit attenuates positive or negative pulses, has output proportional to the logarithm of input voltages between 0.1 and 100 volts. Output ranges between 0.1 and 0.9 volt

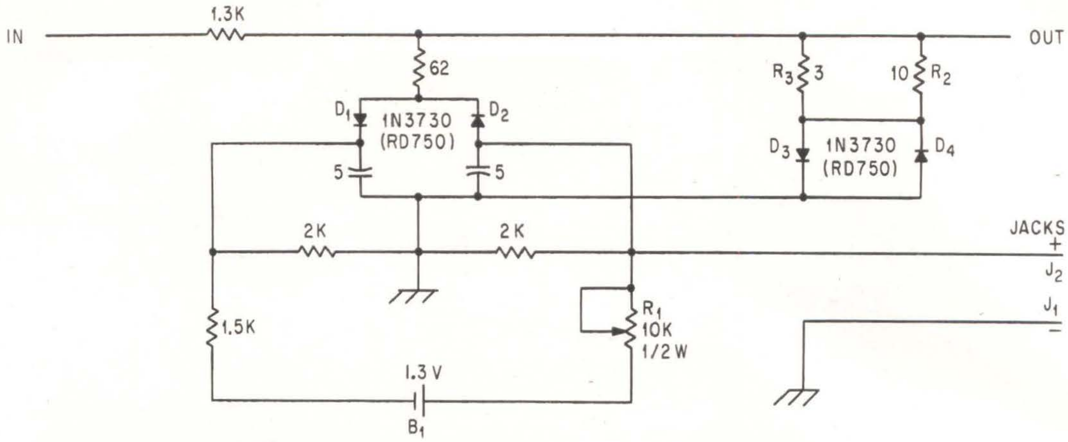
By **C. D. NAIL,** Lawrence Radiation Laboratory U. of California, Livermore, Calif.

IN ANY NONLINEAR attenuator the apparent rise time, measured by the output waveform resulting from an ideal step input, depends on the amplitude of the step. Best (smallest) rise time is obtained for large input and is progressively greater with decreased input.

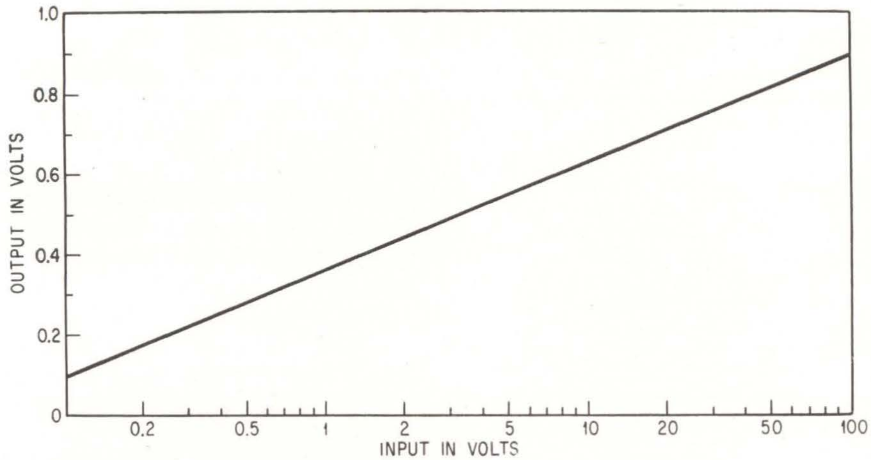
When this attenuator was connected to an oscilloscope having an input impedance of 1 megohm shunted by 47 pf, the observed rise time was less than 20 nsec for an input of 10 volts or more (limited by the inherent rise time of the oscilloscope). At an input of 1.0 volt, the rise time was 70 nsec and at 0.1 volt it was about 400 nsec.

Naturally the input and output impedance of the attenuator are also a function of the signal level. At 0.1 volt the input impedance is equal to 1,300 ohms plus the load impedances of the attenuator are ohm). The corresponding output impedance is 1,300 ohms plus the source impedance (nominally between 50 and 100 ohms). At the 100-volt level the input impedance approaches 1,300 ohms and the output impedance is about 10-12 ohms.

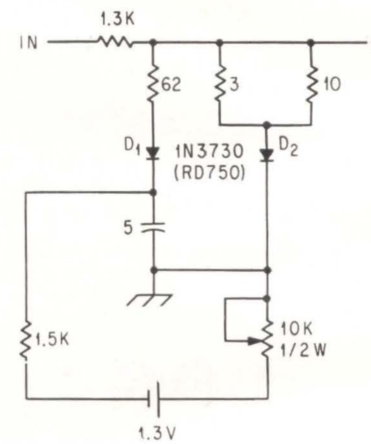
Construction—The circuit of the completed log-attenuator is shown in Fig. 1. The calibration obtained for 0.5-microsecond pulses from a mercury pulser is shown in Fig. 2. No appreciable differences in the calibration were detected when positive or negative pulses were ap-



LOG ATTENUATOR for positive or negative pulses, 100 volts maximum input. The capacitors are 6-volt electrolytics—Fig. 1



CALIBRATION of three-decade logarithmic attenuator—Fig. 2



LOG ATTENUATOR for positive polarity only—Fig. 3

plied, although no care was taken to select matched diode pairs.

Adjustments—To obtain log-linear characteristics in the 0.1-to-1.0-volt region it is necessary to bias diodes D_1 and D_2 in the forward direction to a point near the knee of the conduction curve. This is done with a small mercury battery B_1 and adjusting rheostat R_1. Optimum log-linearity is obtained at a setting of about 0.22 volt (between pin jacks J_1 and J_2) for the diodes specified. The adjustment is not critical in the range of 0.20 to 0.25 volt.

Above 10 volts input, diodes D_3 and D_4 are primarily responsible for the attenuation, so that changes in bias have little effect upon the output at that level.

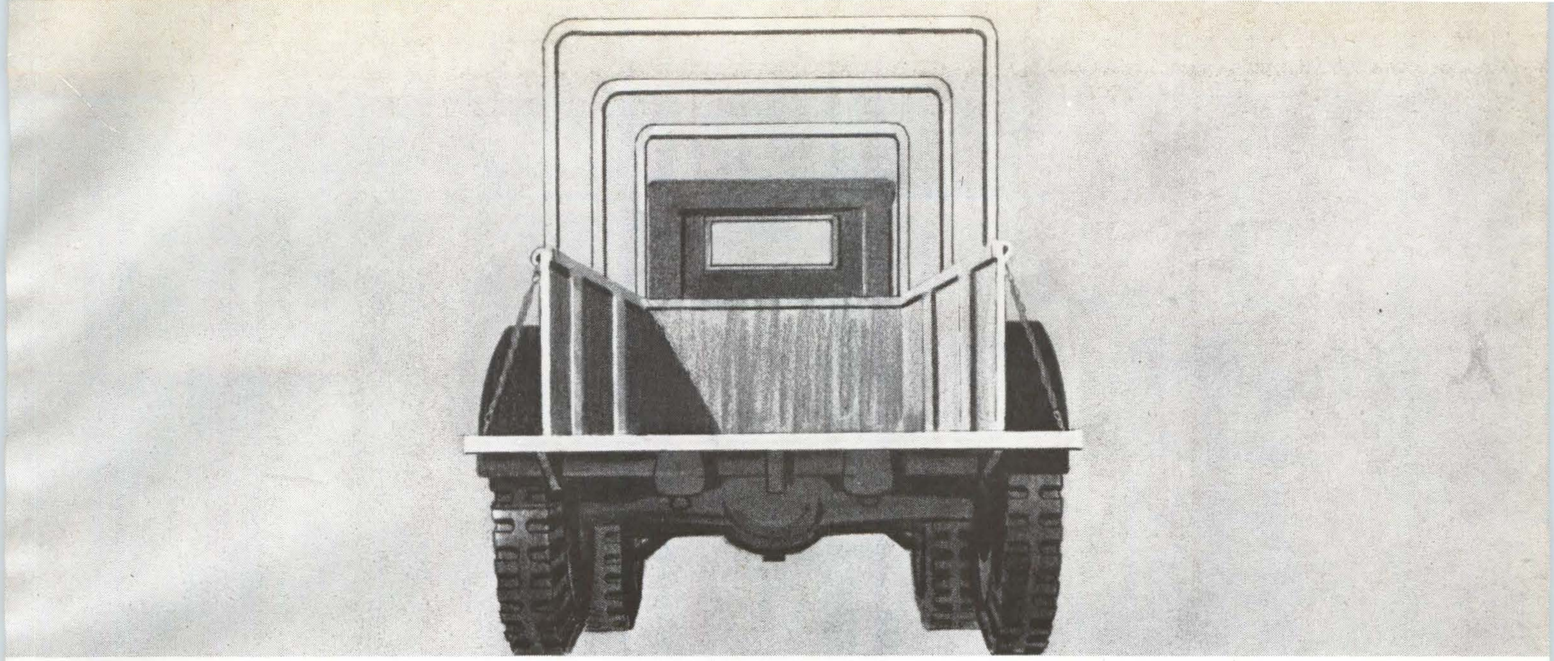
The linearity of the log characteristic can be adjusted in the 20-to-100-volt region by varying the $R_2 - R_3$ combination. Larger values will increase the upward trend of the curve while decreased values will cause the curve to roll off as the input nears 100 volts. The optimum value was found to be about 2.3 ohms and did not vary appreciably with different diodes of the same type and lot.

Calibration was made using a mercury pulser and a number of 50-ohm, fixed attenuators with ratios of 2:1, 5:1 and 10:1.

Simplification—The circuit may be simplified nearly 50 percent if pulses of only one polarity are to be compressed. The simpler circuit shown in Fig. 3 is designed for positive pulses. The transfer characteristics are the same, in the positive direction as for Fig. 1, except that the rise time is slightly better at low levels, due to decreased stray and diode capacitances.

In the negative direction the simplified circuit has little attenuation. Rise time, however, is limited to about 350 nsec by the 1,300-ohm series resistance combined with the shunting capacitances of the diode, output connector and oscilloscope input. For large negative signals (above 80 v) the zener point for the diode is reached and nonlinear characteristics result.

This work was performed under the auspices of the U. S. Atomic Energy Commission.



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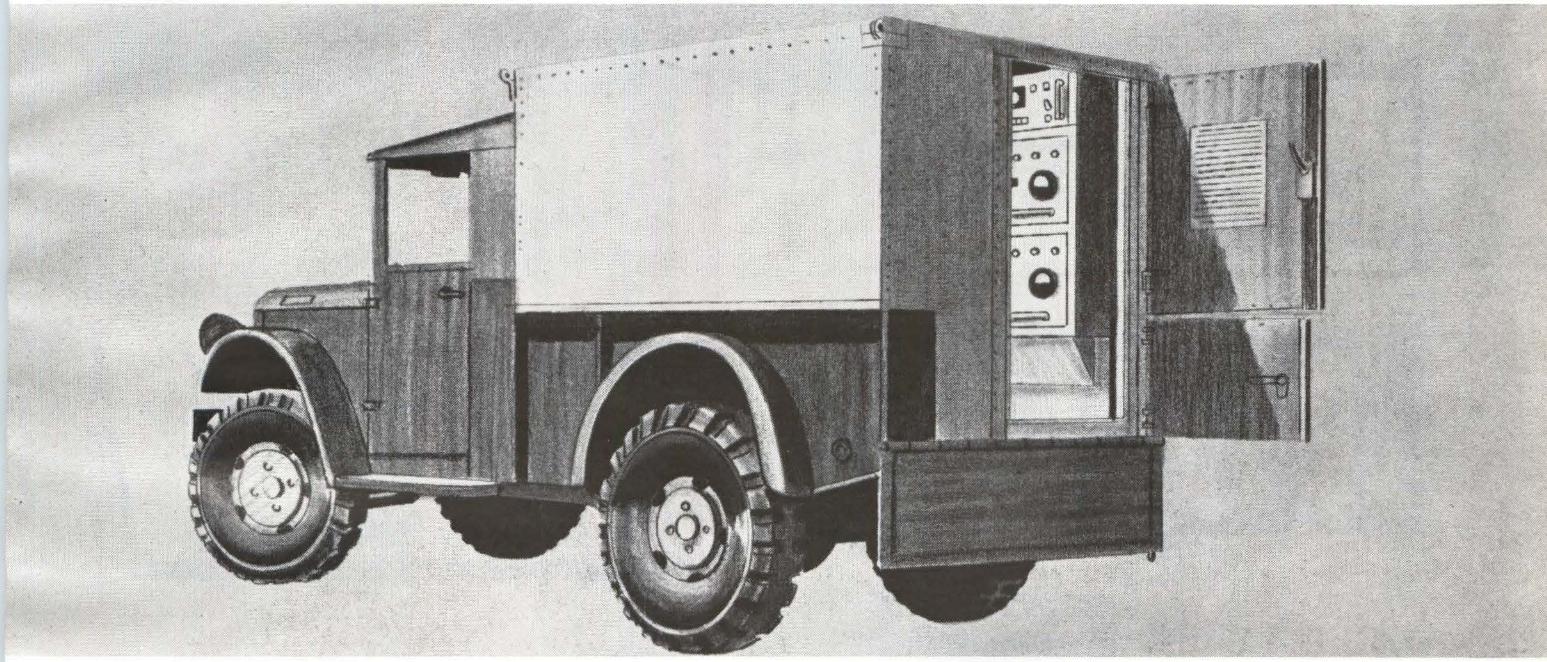

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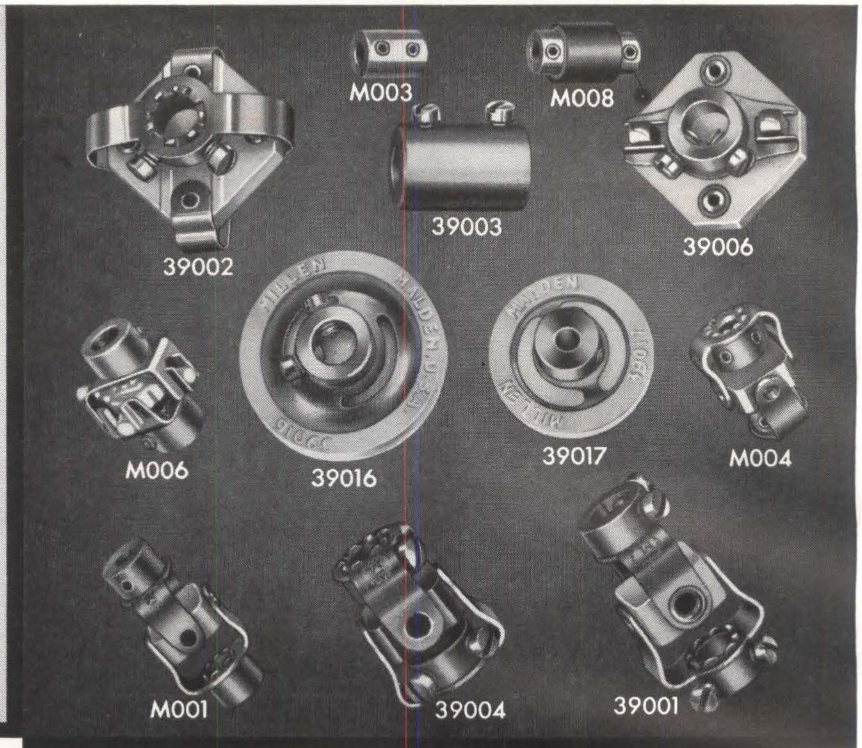

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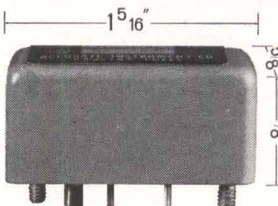

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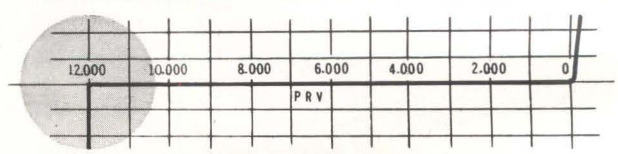

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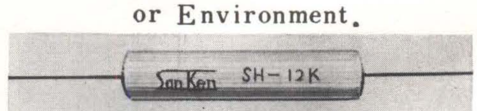

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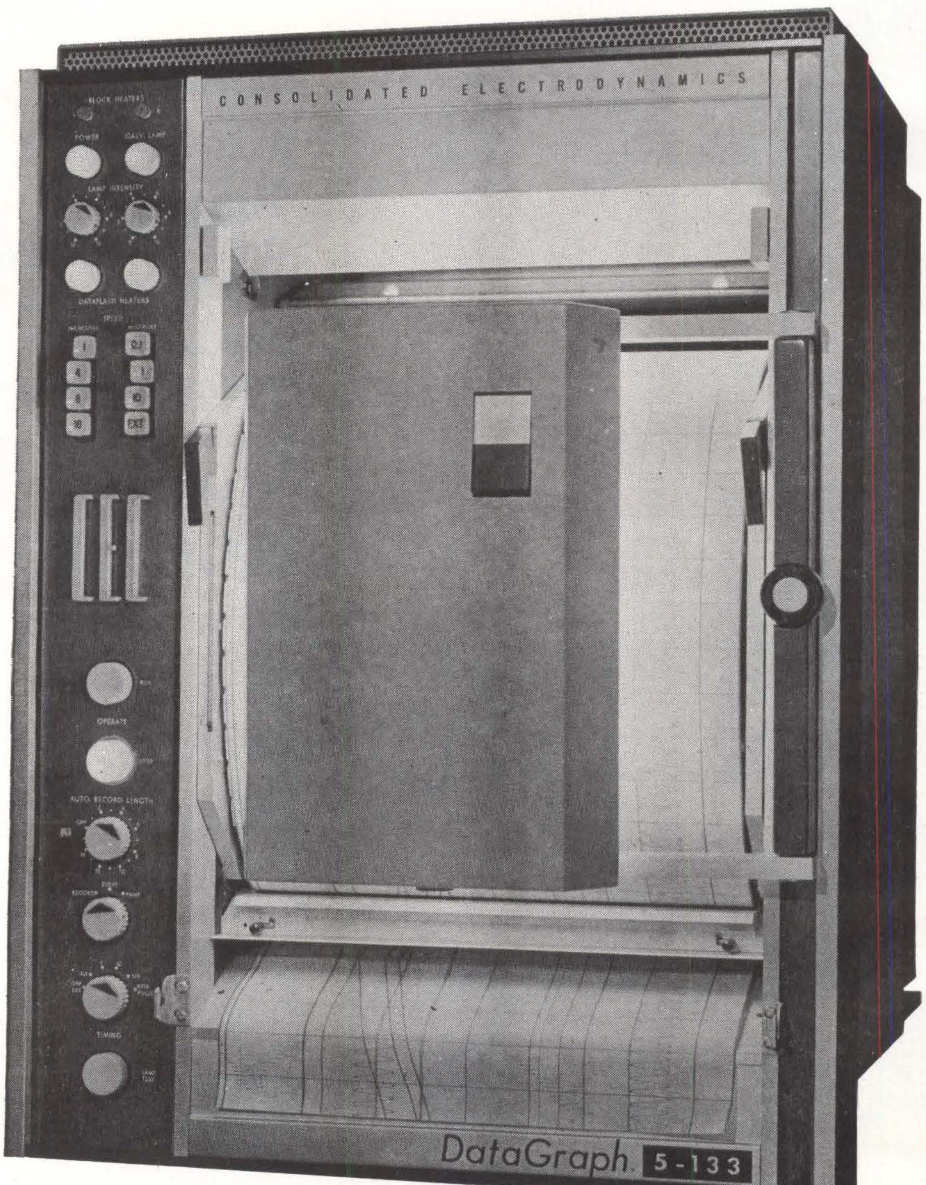

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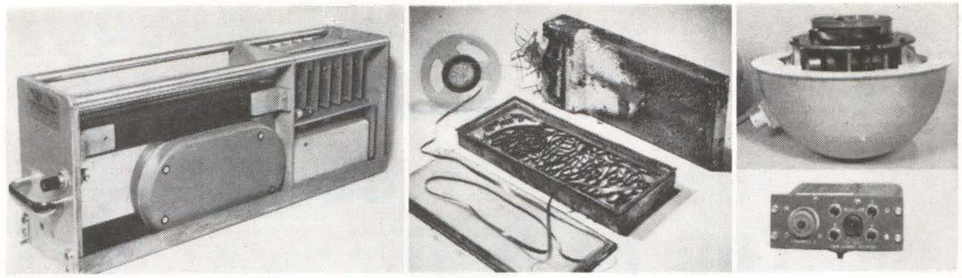


FOUR VERSIONS of cockpit recorder: four-channel amplifier and tape magazine of Lockheed Aircraft Service model (left); United Data Control prototype, showing that liquid ablation preserved tape in bin during fire test (center); Spec Tool will switch from spherical housing (top right) to box; Fairchild's pushbutton control and microphone unit (bottom right) works with fireproof recorder

Hot Mikes Will Record Air Crew's Conversation

Requirements for airliner cockpit recorders will soon be set by FAA

By **ALEXANDER A. McKENZIE**
Associate Editor

FEDERAL Aviation Agency will soon tie down its requirements for a four-channel cockpit voice recorder that must run during the flight of every U. S. carrier aircraft. Costing about $2,000 a unit and upwards of $1,000 for installation, the tab for some 3,000 aircraft will total at least $10 million.

The airlines are unhappy about the expense and weight; pilots have demanded a means of wiping the recorder clean upon safe termination of each flight, but all agree they can't fight FAA and the Congress. There have been too many unexplained air accidents. A crash- and fireproof record of the crew's last words could help save lives on other flights.

Doing the Job—Coordinating efforts of airlines, manufacturers and FAA is the Airlines Electronic Engineering Committee (AEEC) chaired by W. T. Carnes, of Aeronautical Radio, Inc. (ARINC). After FAA suggested minimum performance standards last June, AEEC members representing a standing committee of the Air Lines Communications Administrative Council began planning the kind and size of equipment necessary to meet the specs and satisfy the users.

This paper work parallels results of an FAA equipment development contract to United Data Control, Inc. of South El Monte, Calif., whose recorders are already in service on Australian air lines. Other equipments were later ordered from Lockheed, Fairchild and Spec Tool.

FAA Limits—The magnetic tape recording system desired by FAA must have characteristics beyond those normally required in connecting a mike to a home recorder. Besides such requirements that the record tape come safely through 1,100-deg C fire for 30 minutes, withstand 100 g in 11 milliseconds and survive immersion in salt water, the system must provide multiple records. Simultaneous recordings will be made of everything spoken into pilot's, copilot's and flight crew's microphones and all audio signals introduced into their headphones. Besides these three channels, all vocal expressions of those flight crew members who are within range of a cockpit-mounted continuously active microphone assemby must be recorded on a fourth channel.

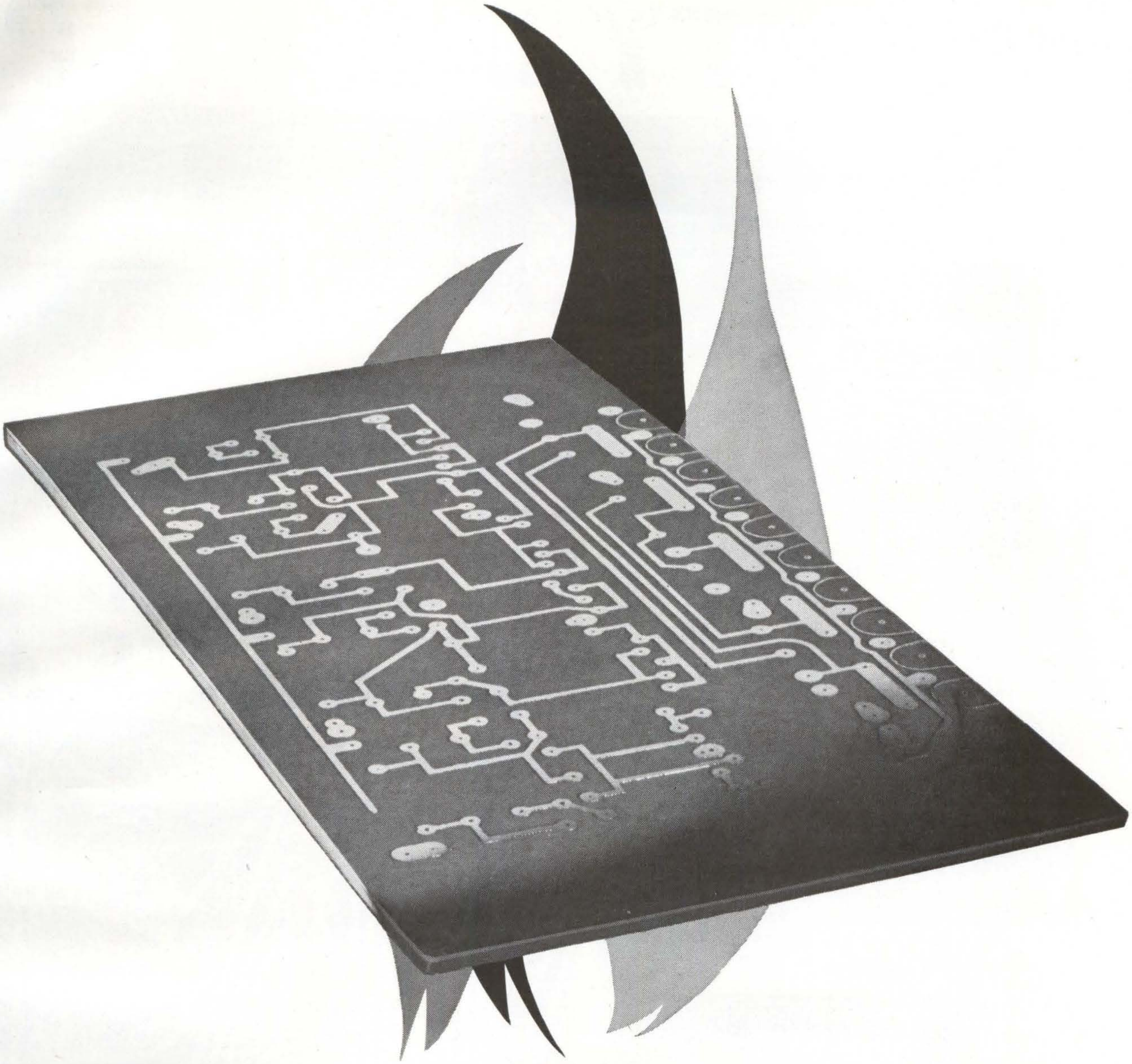
Recording Standards—Trickiest audio problem appeared to be attaining as high as 70-percent intelligibility over aircraft noise on first playback of the tape (subsequent repetitive readings could well exceed 90 percent). Fortunately, FAA's early studies showed that audio spectral energy patterns for all aircraft were similar in frequency with the predominant noise interference below 400 cycles. Low-frequency roll-off starting at 600 cycles and dropping at a rate of 18 db per octave or greater as frequency decreases towards zero suppresses noise peaks and permits hearing voices over the noise level of even piston engine aircraft. This roll-off can be accomplished either with passive filters or design of the microphone preamplifier.

Recorded sound must not vary more than 6 db from 350 to 3,000 cycles; distortion is limited to 10 percent. A visual monitor giving indication that all four channels are recording properly is required. FAA specifies that the output level of the hot microphone shall not vary more than a total of 12 db from 400 to 3,000 cycles at sound pressure input ranges of 60 to 120 db above 0.0002 dyne per square centimeter.

Clean Record—Air Line Pilots' Association (ALPA) initially objected to monitoring normal cockpit conversations, claiming that records from successful flights could contribute nothing to safety. The pilots threatened that if recordings were ever used in any enforcement action flight crews would just stop talking and use hand signals. They also recommended recording throughout the aircraft but agreed that passengers might object to riding in bugged airplanes. The pilots are expected to be satisfied by provision for bulk erase under control of the pilot after the plane has been safely landed and just before all power is turned off.

Monitors Check Air for Lethal Vapor or Dust

CHICAGO—IIT Research Institute has developed for Edwards Air Force Base devices that monitor air for poisons. One detects vapors from boron compounds, or other toxic gas, by using a multiplier phototube to measure characteristic color when an air sample is fed to a flame. In the other, beryllium-oxide dust is detected by the gamma rays a sample gives off when bombarded with alpha particles.



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Device Powers Go Higher

Gains in both tube and transistor power, and at higher frequencies, cited

By **MICHAEL F. WOLFF**
Senior Associate Editor

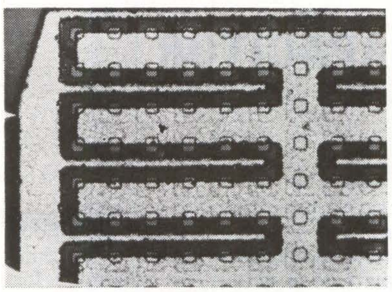
CIRCUIT AND EQUIPMENT designers can expect higher-power devices in several areas of the frequency spectrum. This was evident at the IEEE Electron Devices Meeting Oct. 31 to Nov. 1. Significant advances in both tubes and semiconductor devices were reported.

L. F. Eastman, of Cornell University, cited linear accelerators and ohmic heating equipment as a large upcoming market for superpower microwave tubes, adding that a big need continues for them in military and radar astronomy applications. He predicted the single-beam klystron would reach 1-Mw continuous operation at X band in the next year and 5 to 10 Mw by paralleling tens of lower-power beams. Peak power at S band could reach 1,000 Mw by paralleling tens of klystrons, he said. Crossed-field tubes could be paralleled inside a single vacuum envelope to yield 5 to 10-Mw average power at S band, while 50-Mw peak powers could be generated at X band by internally paralleling tens of anode sections.

High-Power Tubes — Developments reported in this area include:

- Pulsed bwo that produced 107 kw peak and 324 w average power at 100 Gc, reported by J. W. Sedin, K. W. Slocum and M. V. Purnell, of Watkins-Johnson. Tube uses a disc-loaded waveguide circuit and a perveance 0.125×10^{-6} electron gun having an area convergence ratio of 900 to 1. Beam current density is 1,350 amperes per sq cm. First two authors also reported a 1 kw c-w twt amplifier for 35 Gc.
- L-band klystron with a peak power output of 5 Mw and capable of operating at 300 kw average power for extended periods, described by A. J. Prommer, A. J. Smith and W. H. Watson, of Litton Industries. Tube is a 4-cavity klystron that uses a nonintercepting modulating anode. It is tunable over 130 Mc centered at 1,320 Mc.
- Newly developed high-dissipation cooling technique has helped boost Raytheon's Amplitron tube's c-w power to over 400 kw at 3,000 Mc, W. C. Brown, J. F. Skowron, G. H. MacMaster and J. W. Buckley reported. Efficiency is 70 percent, gain is 9 db.

UHF Transistors — Push toward higher transistor power at higher frequencies was emphasized in work reported from three companies.



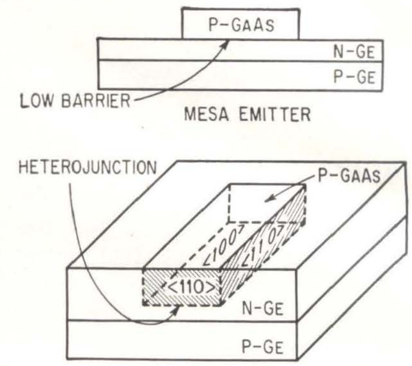
OVERLAY transistor has 156 emitter elements, ½-mil square and fabricated to 1-micron tolerance (RCA)

A 500-Mc transistor with power output almost a factor of 10 higher than that previously reported for single-transistor amplifiers was described by D. R. Carley, of RCA. Called an overlay transistor, it uses an array of 156 separate emitter sites paralleled by metallizing and diffusion (see photo). The new geometry allows a ratio of 8 mils of emitter edge per square mil of emitter area. In a class-C common-emitter amplifier, typical units provide 4.5 w out at 400 Mc and 40 v, some deliver 5 w at 500 Mc with 7-db gain.

A 500 Mc transistor described by R. N. Clarke, of TRW Semiconductors, gave 1 w with 10-db gain and 3 w with 5-db gain as an amplifier. H. Wolf, G. Parker and D. Lance, of Fairchild Semiconductor, reported on planar epitaxial silicon transistors that deliver more than 1 w at 1 Gc with 30-percent efficiency as oscillators.

In other transistor and tube developments:

• Transistors using a *p-n* GaAs-Ge heterojunction as the emitting junction and an *n-p* Ge homojunction as the collecting junction were described by H. N. Yu, of IBM. The



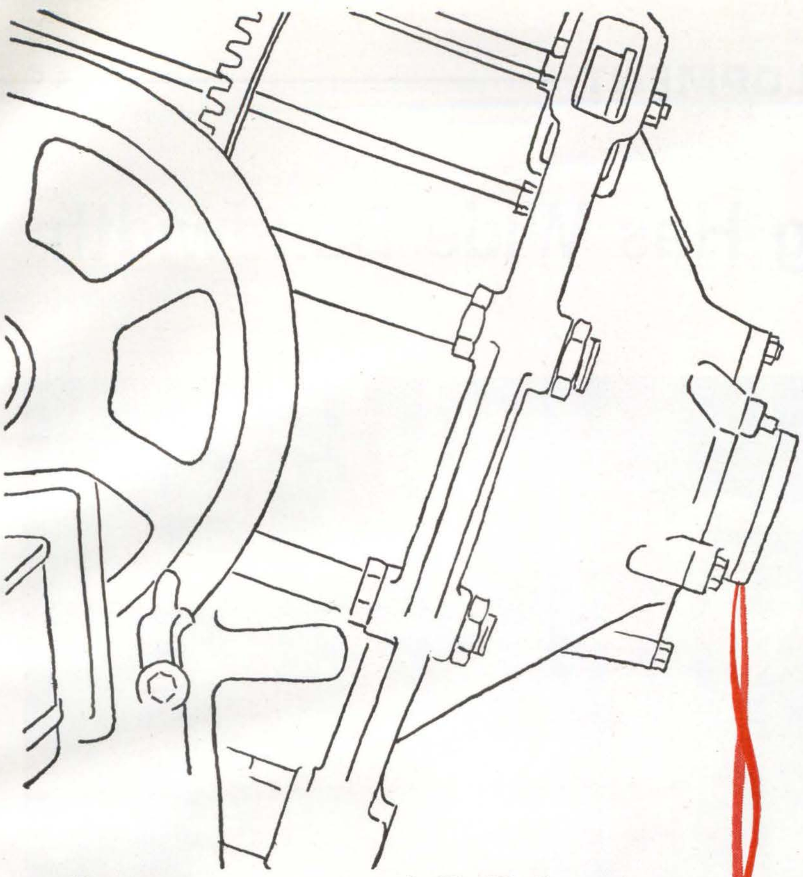
HETEROJUNCTION transistor is made at IBM by new process called post-epitaxial diffusion

experimental transistors (see illustration) are expected to operate at combinations of higher current and frequency than homojunction transistors.

• IBM reported two new experimental silicon *npn* transistors for solid-state memories. The first, described by P. P. Castrucci, J. P. Martin and R. M. Folsom, can operate at nearly twice the speed of presently available units rated for the same voltage, current and gain. It switches 600 ma through a 90-v swing in less than 25 nsec with a circuit beta of 10. Collector-base breakdown voltage is 180.

R. L. Ruggles, W. A. Pieczonka and R. M. Folsom described a low-voltage ultra-fast transistor that will operate at twice the current of presently available units rated for the same speed and voltage. It can switch 1 amp through a 25-v swing in less than 8 nsec with circuit beta of 10.

• Experimental cyclotron-wave microwave amplifier that achieves an excess noise temperature of about 100 K without a pump was reported by G. Hrbek and R. Adler, of Zenith Radio. New tube is called Diftron because the electron beam is launched in a divergent magnetic field. Noise figures of 3 db at S band and less than 2 db at L band are predicted.



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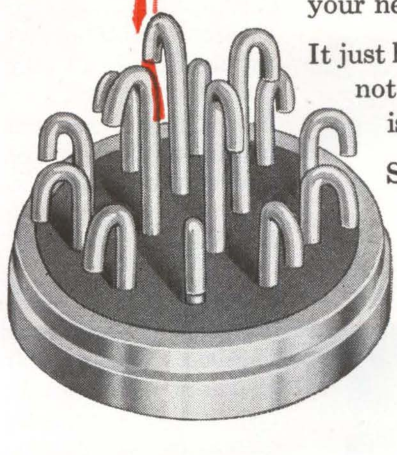

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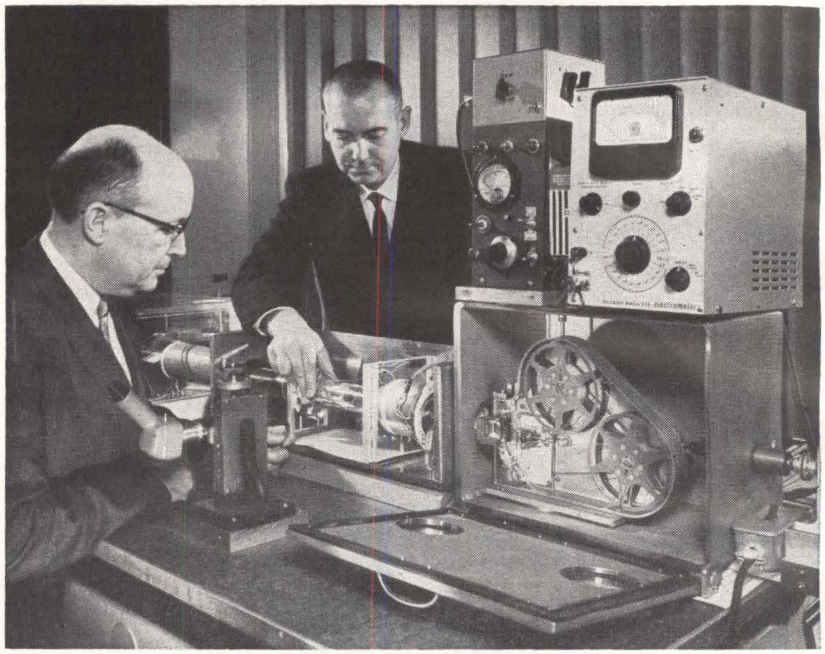
CRT Recording Has Wide Bandwidth

Placing the camera inside the cathode-ray tube cuts losses, raises resolution

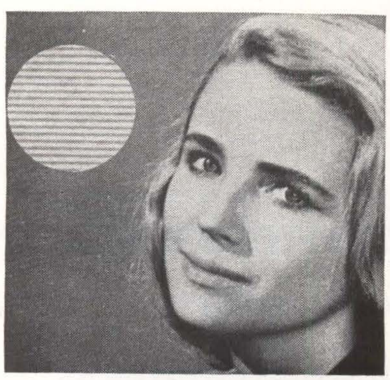
CONVENTIONALLY, electronic information or images are first displayed on the faceplate of a cathode-ray tube, and photographed by means of a camera focussed on the crt face. This process, however, is singularly inefficient in terms of energy; using a P11 phosphor and an electron beam accelerated with 27 kilovolts, typical efficiency from cathode to film is a few tenths of one percent. In addition, the resolution of the system is limited by optical dispersion and by faceplate phosphor thickness.

A new recording process under development in the Kodak Research Laboratories in Rochester eliminates these losses by placing the film directly inside the cathode-ray tube. This does away with both the phosphor faceplate and the optical focussing system; the electron beam strikes the film emulsion directly, producing an image whose sharpness is determined only by the beam focus.

Kodak Research Laboratories has developed a new type of film for electron recording. While responding to a direct electron beam it is relatively insensitive to light, and has extremely fine grain. The experimental combination of the new film and a special cathode-ray apparatus has shown a resolution of better than 5 microns.



EXPERIMENTAL UNIT has camera chamber, lower right, attached to tube containing electron gun, left, with external deflection system; entire system is evacuated to 2×10^{-5} Torr



TELEVISION film recording made on 16-mm film by direct electron exposure. Lines are clearly resolved as shown in inset, top left

Better Than Tape—When recording a television image from a standard 525-line scan onto 16-mm film, the resolution of the new technique corresponds to a frequency bandwidth of nearly 65 megacycles. C. H. Evans of Kodak told ELECTRONICS that a bandwidth of 100 megacycles is practicable, exceeding that of present-day tv magnetic tape by a factor of ten. The very high information packing density of the electron recording film is said to exceed that of magnetic tape by a factor of 100.

The experimental electron recording setup, shown in the photograph, consists of a chamber containing a 16-mm camera with up to 200 feet of film, without lens, and an electron gun in a glass tube. The entire unit is evacuated; pumping down with a fresh film supply takes 1 to 2 hours before a good vacuum of about 2×10^{-5} Torr is achieved. A special film base (Estar) is used to minimize outgassing in the vacuum. By operating the anode of the electron gun at ground potential, the vacuum chamber, camera and film can also be grounded. This requires that the cathode and control grid be operated at a high negative potential. A thoriated-tungsten filament is used rather than an oxide-coated cathode to prevent cathode poisoning during pumpdown and activation. Acceleration potentials are in the 14-to-20-kv range, with electron-beam currents of the order of 0.5 microampere. The size of the trace produced, and

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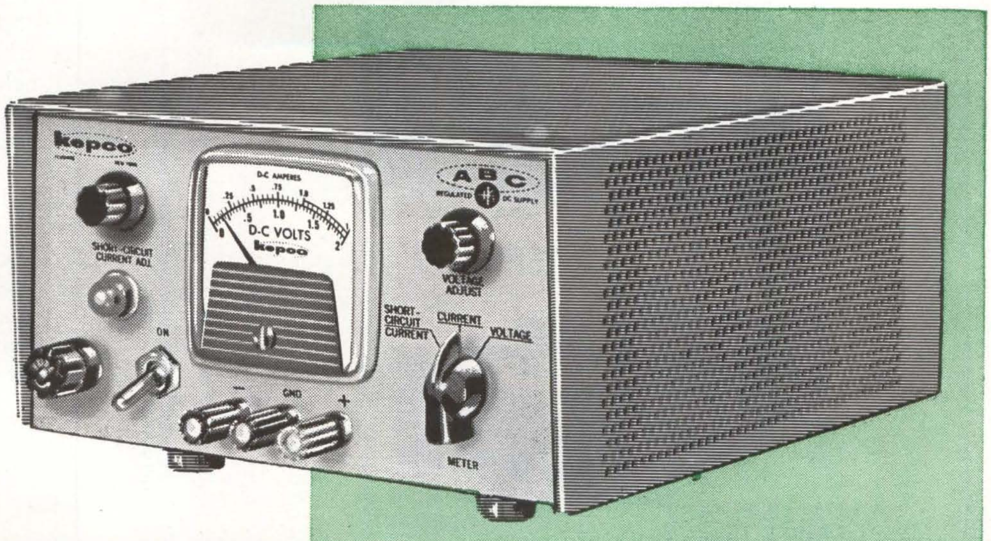

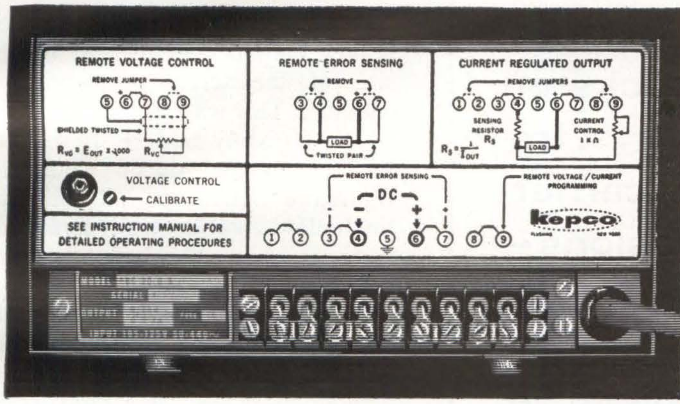

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0—10	0—0.75	0.25	119.00	ABC 10—0.75M
0—15	0—1	0.25	159.00	ABC 15—1M
0—18	0—0.5	0.25	119.00	ABC 18—0.5M
0—30	0—0.3	0.25	119.00	ABC 30—0.3M
0—40	0—0.5	0.25	159.00	ABC 40—0.5M

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DC OUTPUT VOLTS	DC OUTPUT AMPS	RIPPLE RMS MV	PRICE	*METERED MODEL
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0—425	0—0.05	0.5	199.00	ABC 425M
0—1000	0—0.02	1.0	274.00	ABC 1000M
0—1500	0—0.005	1.0	274.00	ABC 1500M
0—2500	0—0.002	1.0	334.00	ABC 2500M

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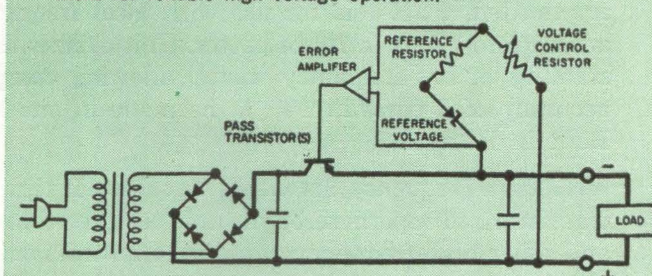

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therefore the resolution, varies with the accelerating potential of the electron beam, because of lateral electron scattering in the emulsion.

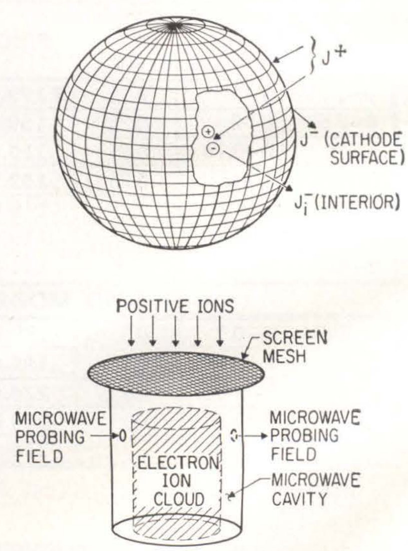
According to Evans, there is no apparent lower limit to the spot size that can be produced on the new electron recording film.

Applications—The new electron recording technique and film is likely to find practical use wherever a high-density, wide-bandwidth optical memory can be used. Suggested applications include predetection recording of telemetry data in the form of i-f signals and high-resolution tv recording.

Screen Mesh Factors Affect Electron Beam

ELECTRON-BEAM mode discharge in hollow cathodes is affected by the size of the screen mesh of the cathode. This was reported at NEC by E. C. Muly and H. L. L. van Paassen of the Martin Company, Baltimore. The experimental Martin hollow cathode with perforated walls is shown in action on the cover.

The perforated-wall hollow-cathode electron beam mode discharge (EBMD) is a high-impedance cold-cathode discharge. A cathode operating in this mode (see cover) pro-



DISCHARGE mechanisms taking place in the spherical screen mesh hollow cathode, top; test cavity used in Martin investigation, of solid copper with one screen mesh face, bottom duces a well-collimated electron beam, when an excess of electrons within the cathode cavity leak out through an aperture in the cathode. This aperture is generally at least three times the diameter of the screen mesh hole size. Electrons produced inside the cathode interact, after effusing from the interior, with gas molecules external to the cathode, and produce positive ions. These positive ions then increase the current by producing more electrons inside the cathode.

The total discharge currents were found at Martin to be a function of the screen mesh characteristics; the mesh hollow cathode was analyzed by microwave techniques, and the results give an indication of the basic mechanisms of EBMD production.

Spherical cathodes have been designed to defocus the positive ions streaming toward the cathode. Use of a concave area surrounding the aperture has been found to increase the range of operation of EBMD.

Infrared Telescope Finds Invisible But Hot Stars

SAN FERNANDO—Using a highly sensitive infrared telescope, scientists at ITT's Industrial Products Laboratory here have detected stars that are too faint in the visual spectrum to be seen. These relatively cool stars emit enough infrared radiation to be sensed by modern techniques.

The discovery makes possible the detection of silent or nonbroadcasting satellites by the heat they emit. Success in this area will be heightened after all other interfereing celestial heat sources have been mapped. In this connection, the laboratory has completed 20 percent of a sky-mapping program for the Air Force.

The infrared telescope is so sensitive that work is sometimes interrupted by heat from bodies of insects flying nearby, and air currents from a cigarette 50 feet away.

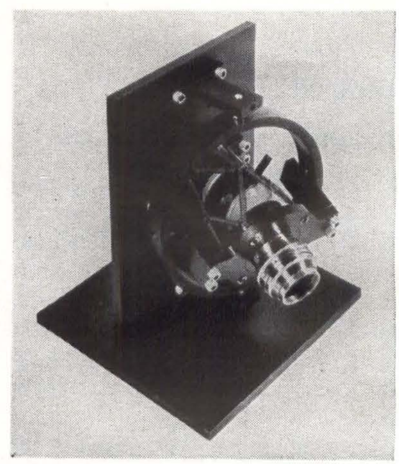
Fiber Optics IR Tracker

UNUSUAL optical head for tracking with an infrared vidicon tube has been developed at GE's Advanced

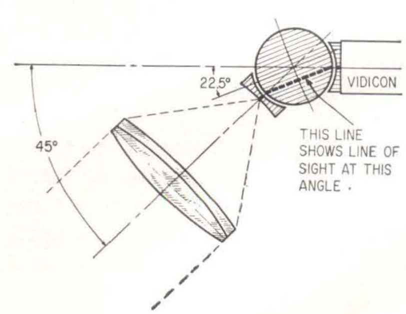
Electronics Center in Ithaca, N. Y.

Designed to cut the required space and the optical transmission losses inherent in conventional tracking systems, the unit has three special fiber optics elements: a rotating fiber ball and two fitting lens-like parts, one to deliver the image to the ball and one to transfer it to the vidicon. These three parts replace a complex system of rotating prisms, derotating prisms, bearings and correcting lenses. The glass fibers used are 10 microns in diameter, have nominal aperture of 0.66. The fiber optic parts were made by Mosaic Fabrications, Inc., Southbridge, Mass.

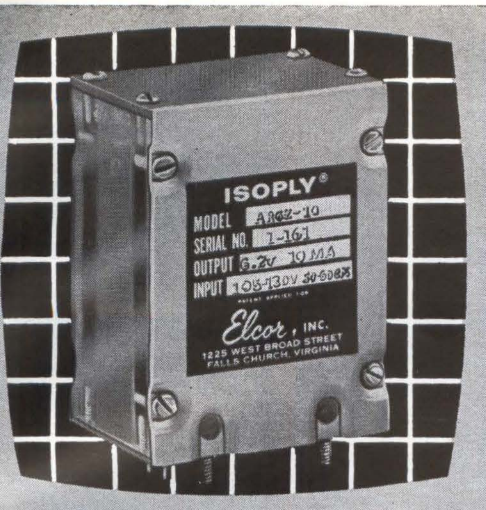
K. W. Harper of GE told ELECTRONICS that the present model of the system can scan through up to 45 degrees in any direction; the fiber ball itself, moved by a spring differential drive, rotates half the amount of the total deflection. Resolution in the range of 275 lines per inch is said to be adequate for most tracking systems.



ROTATING fiber optics assembly is mounted in gimbals, with springs moving the ball (center) through half the deflection angle



GEOMETRY of system shows how image is transmitted through fiber optics ball. Narrow spaces between ball and fitting parts are filled with silicone lubricant whose index of refraction is the same as that of the glass fibers



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Output ripple	1 mv p-p
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b Load stability	.01% per ohm of load change
c Temperature coefficient	.01% /C° from 0°C to 60°C
d Long term stability after 15 minutes warm-up	.01% per day (with line load and ambient temperature held constant)
Isolation	
a Intercircuit capacitance from dc output to primary winding	.1 pf
b Shunt capacitance from dc output to ground	20 pf
c Insulation voltage	1000 vdc
d Leakage resistance to ground	greater than 100,000 megohms
*Hum and noise induced in external circuit with power supply ungrounded (neither output terminal grounded)	less than 10 uv p-p per kilohm impedance to ground
Dimensions	1⅝" x 2¼" x 3-1/16"
Weight	.75 lb.

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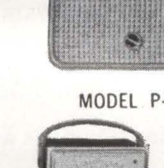

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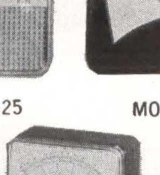

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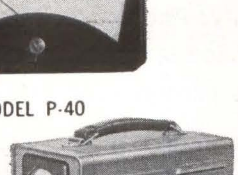

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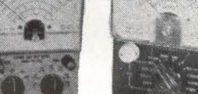

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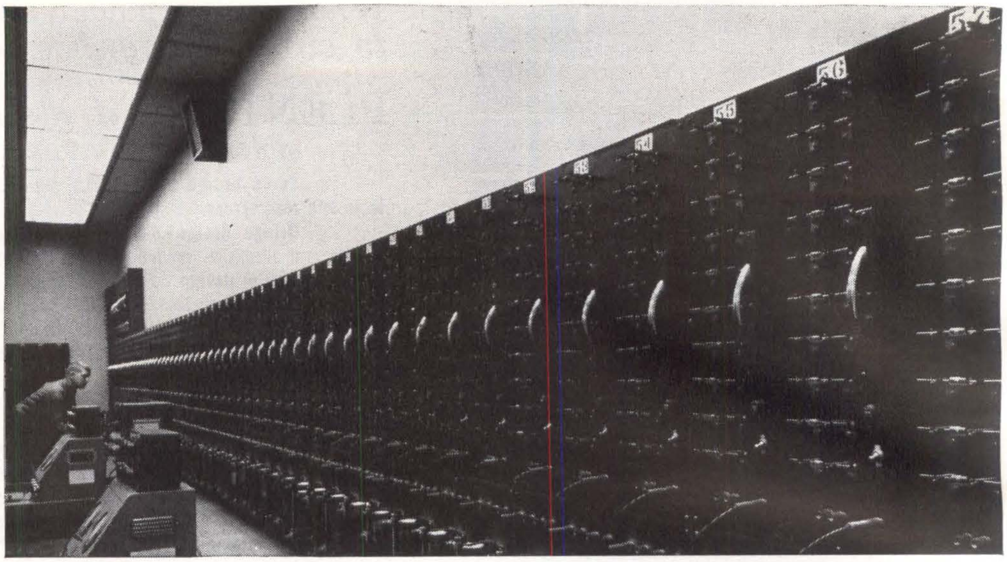

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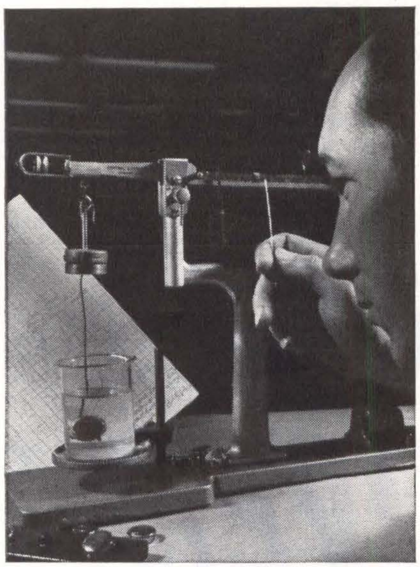

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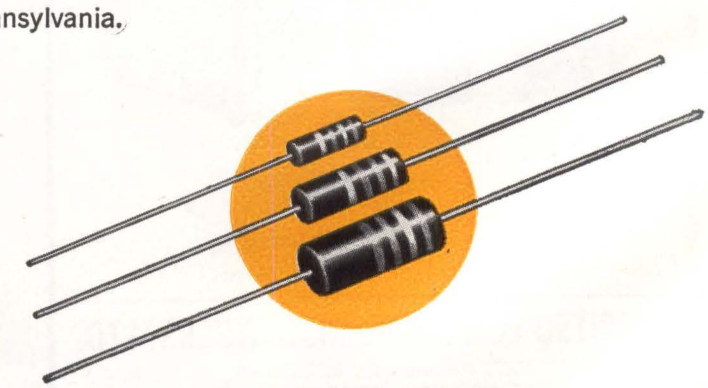

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How Rare Earth Chelate Lasers Work

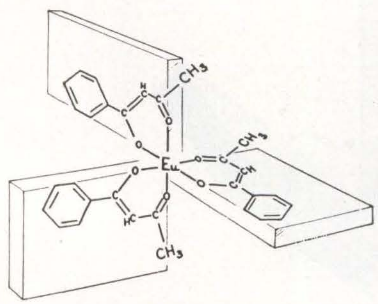
Although presently limited, rare earth chelates promise better overall performance

By MAX METLAY
Advanced Technology Laboratories,
General Electric Company,
Schenectaday, New York

ADVANTAGES of the rare earth chelates for laser applications include their solubility in a variety of organic solvents and in various plastics. Plastic based lasers allow special shapes for special purposes; liquids are useful for high power lasers because excess heat can be rapidly disposed of. In addition, chemical tuning—that is, producing lasers with slightly different wavelengths by making small variations in the structure of the chelates—should be possible.

Characteristics—Chelates are molecules in which a central inorganic ion is covalently bonded to one or more organic molecules, and there are at least two bonds to each molecule. The compound shown in Figure 1, europium trisbenzoylacetonate or EuB_3, is that upon which one of the first successful rare earth chelate lasers was based.

The rare earth chelates combine, in an intricate way, some of the advantages, and the liabilities, of the inorganic ions used in lasers, and of organic molecular systems. The fluorescence spectra produced by many rare earth chelates is characteristic of the central rare earth ion, showing the discrete, sharp emission lines necessary for laser action. The absorption spectra, however, are characteristic of the organic part of the molecule, that is a broad absorption through most of the ultraviolet region, and sometimes extending well into the visible

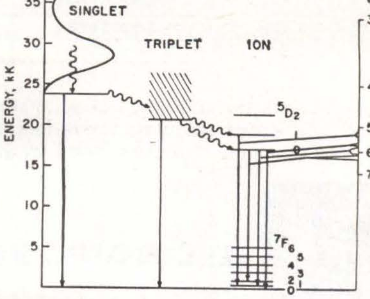


STRUCTURE of europium trisbenzoylacetonate, a typical rare earth chelate—Figure 1

region. This broad absorption is much more efficient in utilizing the broad band pumping light produced by the usual flash lamp than is the narrow line absorption of the inorganic rare earths.

Energy Levels—The current thinking on the reasons for the spectral properties of the rare earth chelates is schematically described in Figure 2, an energy level diagram for an europium chelate. The molecule in its ground state absorbs pumping energy, and is raised to an excited singlet state. A singlet state is one in which the spins of all electrons are paired. The curve in this section of the diagram represents the absorption curve of the chelate. It indicates that there is a band of excited singlet states, extending over the energy range corresponding to the wavelengths indicated. The height of the curve at a particular wavelength (that is, energy) is proportional to the density of states at that energy. From the excited singlet state, the molecule goes over to a triplet state in a very rapid process of 10^{-8} seconds duration or less. A triplet is a state in which the spins of two electrons are unpaired. The triplet state also consists of a band of excited states, but no detailed knowledge of the distribution of states in the band exists. After the absorption of a given photon, the molecule arrives at the lowest triplet state with an excess of energy, that is, the difference between the original energy of the photon and that of the triplet state. This excess energy is dissipated by the production of heat, or photon radiation. If the lowest triplet state is higher in energy than the resonance level of the central ion (that is, the level from which fluorescence originates in the free ion), then the energy will be fed into the resonance level, and the central ion will emit its characteristic fluorescence radiation. The fluorescence spectrum is indicated at the right of the figure, as is the relationship of the spectral peaks to the energy level transitions responsible for them. The most prominent fluorescence line—613 mμ—corresponds to a transition ending at the $^7F_2$ level, which lies about 0.12 ev above the ground state. This energy is sufficiently large so that the equilibrium population of the terminal state is about 1% of the ground state at room temperature, and much less at lower temperatures. The chelates, therefore, act as four-level laser materials.

Measurements — Observations reported on two europium chelate



ENERGY LEVEL diagram for a typical europium chelate—Figure 2 lasers, one plastic and the other liquid,[1,2] include spikes of laser light, a "ringing" phenomenon, lifetime shortening and wavelength narrowing. The 6129 Å line decreased from a half-width of 8 Å to less than 0.3 Å during lasing.[1] No measurements on beam divergence have been reported. The plastic laser was in the form of thin filaments, and parallel polished ends were not attempted. The liquid laser was incorporated in a quartz tube, with polished quartz pistons at the ends forming a Fabry-Perot cavity. Concentration of active material was about 3×10^{18} molecules/cm^3.

The present materials are limited in efficiency and power output because the absorption coefficient in the ultraviolet is very high. This means that the pumping light does not penetrate very far into the cavity. A small tail on the visible end of the absorption curve allows an inefficient pumping in the visible. The pumping threshold reported for one solution of EuB_3 was about twice that for ruby.[2]

Possibilities—Several groups are investigating the rare earth chelates with a view toward improving laser performance, decreasing pumping power, increasing stability, achieving new wavelength capabilities, and so forth. These, of course, are problems which must be solved before rare earth chelates can compete successfully with the materials currently in use in lasers. Examples of these investigations include a study of the effect of the interaction of chelates with other molecules such as some complex forming species on the intensity and lifetime of fluorescence in our laboratory,[3] and by M. Kleinerman and co-workers at American Optical Company.[4] F. Ohlmann and co-workers at Westinghouse are investigating a variety of liquid systems.[5] Fundamental aspects of energy transfer in rare earth chelates are being studied by G. A. Crosby and co-workers at the University of New Mexico.[6] Other groups in the field include those at Space Technology Laboratories,[7] Electro-Optical Systems,[8] and Melpar.[9]

It is not yet possible to predict how soon the problems limiting the usefulness of rare earth chelate lasers will be overcome. It does seem likely, however, that the present first generation materials will be succeeded by others of increasing utility. These materials, having improved pumping characteristics and greater stability, will provide a family of laser materials having high power capabilities, and a new and useful range of wavelengths.

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Solid-State Thyratron Simplifies Control

A NEW class of silicon power semiconductors has been developed by General Electric. This family of bilateral triode switches is expected to simplify the fullwave a-c phase control circuits that now use two-terminal silicon symmetrical switches and three-terminal silicon-controlled rectifiers.

The units are modified *pnpn* structures, essentially solid-state thyratrons, which work in both directions. Company spokesmen say they have found a practical way to gate the devices, eliminating associated gate circuits. Gate trigger requires less than 100 milliamperes and less than 5 volts to control current bilaterally.

Developmental units have just come out of F. E. Gentry's Advanced Engineering Rectifier Components Group, and have been turned over to GE's Applications Group for followthrough. F. W. Gutzwiller says the high control power gain of the new component is expected to eliminate the sophisticated pulse transformer presently required for triggering two-terminal silicon symmetrical switches.

Two multilayer semiconductor

structures were described by Gentry at the IEEE Electron Devices meeting, Oct. 31, in Washington, D. C. Both structures can be triggered into a highly conductive state in either direction by applying a low voltage, low current pulse between the signal control terminal and one of the main load terminals. Hence, both halves of an alternating current waveform can be controlled from a simple low-power trigger source.

Passivation of Germanium Now Commercially Possible

LONDON—Commercial quantities of tetragonal germanium dioxide—a rare and highly stable modification of germanium dioxide that can be used in passivating germanium—will soon be available, according to researchers at the British Post Office Research Station, Dollis Hill, London. A practical new method of producing the tetragonal germanium dioxide has been evolved that uses a water/hydrogen atmosphere to control the minute quantities of oxygen required for the reaction.

Germanium devices, claim GPO scientists, have previously been difficult to protect. Silicon devices can easily be protected by a film of highly-stable and easily produced silica, but normal germanium dioxide is unsuitable because it is highly soluble. The tetragonal form of germanium dioxide is extremely stable, even to hydrofluoric acid solutions, but previously it was difficult to produce.

Silicon Crystals Grown On Insulating Bases

H. M. MANASEVIT and W. I. Simpson of Autonetics have grown single crystals of silicon on sapphire substrates. The crystals were grown using a chemical vapor deposition process in which the deposits are obtained through the hydrogen reduction of silicon tetrachloride at high temperatures. After etching for configuration, the sapphire substrates provide "built-in" insulation replacing the various doping processes now used to eliminate electrical interference from non-insulating silicon substrates.

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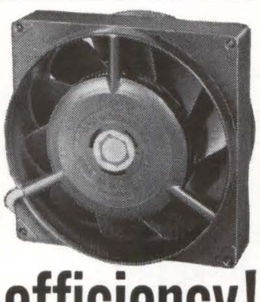

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Output @ 50 cps (0 back pressure) (.25" back pressure)	100 cfm 62.5 cfm	75 cfm 5 cfm
Operating Temp. Range	−55°C to +85°C	−18°C to +44°C

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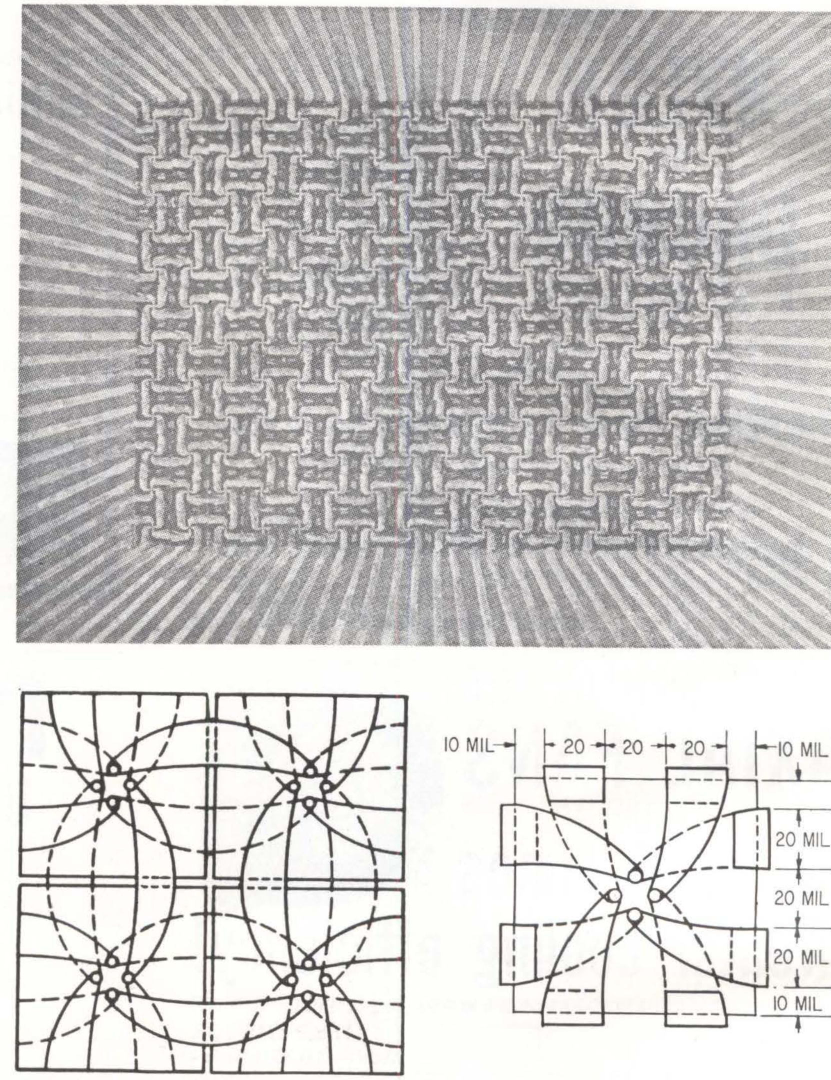
Electrons Work Tiny Ferrites

Drill smaller apertures, but need better control for interconnections

ELECTRON-BEAM machining of ferrite wafers reduces size limits of memory elements for digital computers, thus increasing operational speed, R. A. Shahbender, of RCA Laboratories, reported at the National Electronic Conference last month.

At the present 0.02 mil is the smallest obtainable aperture radius for conductors used with memory toroids. This is considerably smaller than the radius obtainable by conventional techniques, but within capabilities of electron-beam drilling.



MICROAPERATURE MEMORY is a mosaic of 12 × 16 interconnected wafers drilled by electron-beam technique. Each wafer (right) 80 × 80 × 10 mils has 4 apertures of 1-mil diameter each and center spacing of 2 mils. Four separate windings each linking an aperture in the pattern shown (left) are fabricated by photoetching techniques. Interconnections are formed by conventional mass production techniques

Aperture Drilling—Blank wafers of dry-pressed, sintered ferrite are electron-beam drilled with a pulsed beam to provide microapertures.

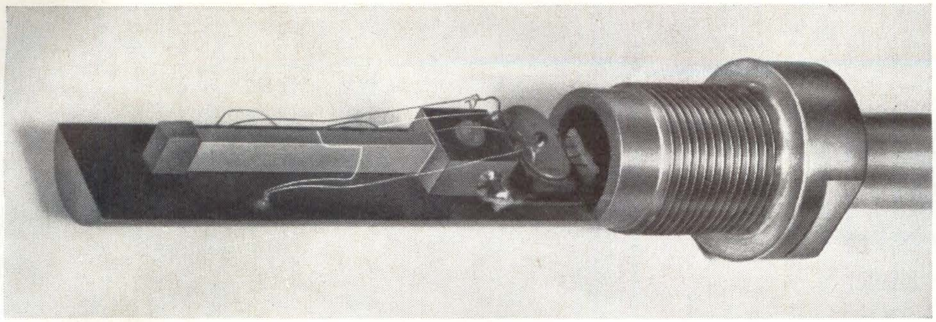
To drill an aperture pattern, the beam is sequentially deflected by energizing deflection coils. A high degree of beam focus drills these small diameter apertures. A drilling rate of only 6 wafers per minute is mainly attributed to mechanical factors rather than the time required for actual drilling.

Optimum drilling conditions are typically; 80 to 100 kilovolts, 150 to 200 microamperes, 10-microsecond pulse width and repetition rate of 100 pps, Shahbender said. For the selected ferrite the melting point is close to the sublimation point. Thus recrystallization at point of impact of the focused beam is not excessive.

Depositing Connections—Selective electron-beam evaporation of copper on the ferrite surface to form interconnections between filled apertures is another operation. Only very thin layers of about 1 micron thick are feasible. Beam power level must be minimized to prevent damage to the ferrite. Thicker layers require higher power and this undesirably grooves the ferrite surface.

The use of this technique for interconnections is severely hampered in available machines, but improved control of position and beam power level of individual electron pulses will accomplish this operation and may be highly successful for miniaturized electronic equipment, Shahbender said.

Machine Shapes—Flexibility provided by the electron beam process



An elegant, but tiny refrigerator, utilizing the Nernst-Ettingshausen effect, has been demonstrated in the Solid State Physics Laboratories at Lockheed Missiles & Space Company. This type of cooling is applicable below 200° Kelvin, where thermoelectric cooling is no longer efficient. It shows particular promise for space application because of the reliability inherent in its all-solid state construction.

In the Nernst-Ettingshausen effect, heat is pumped as a result of an electrical current flowing in a magnetic field. The heart of the present device is a bismuth antimony single crystal. Other crystal systems are also being investigated.

This thermomagnetic cooling device is one of the results of the Lockheed research program in transport phenomena in solids.

Another investigation concerns the quantum theory of the electronic structure of crystals. An ingenious computer program has been devised for determining the essential features of the energy band structure of a wide variety of crystals. Results for a given case can be obtained in an hour or less. Conclusions drawn from the theoretical solution elucidate many of the electronic properties of crystals, and have widespread significance.

Lockheed scientists and engineers are also studying: Electron spin echo phenomena; the interaction of electrons with microwave phonons; coupled traveling waves in crystals; semiconductor lasers; antiserromagnetic resonance; various theoretical and experimental aspects of superconductivity.

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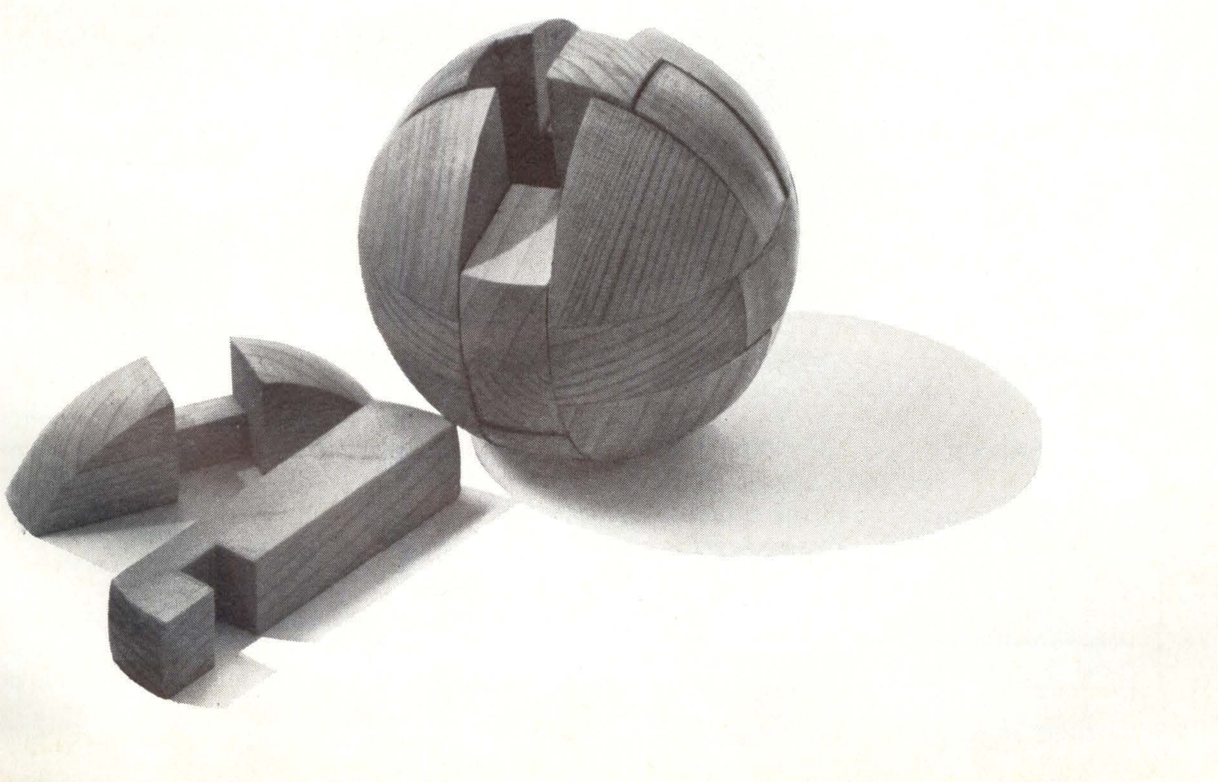
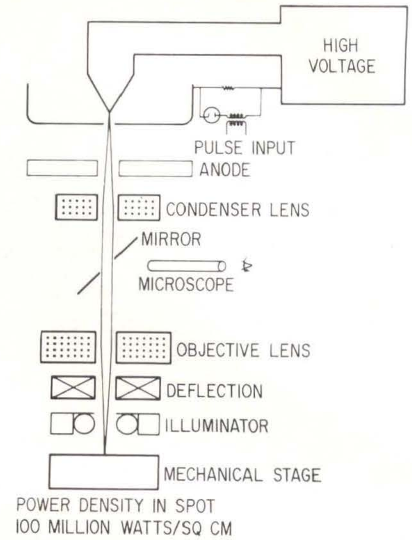




DRILLING MACHINE uses sharply focused pulsed beam to drill microminiature holes in ferrites without excessive recrystallization

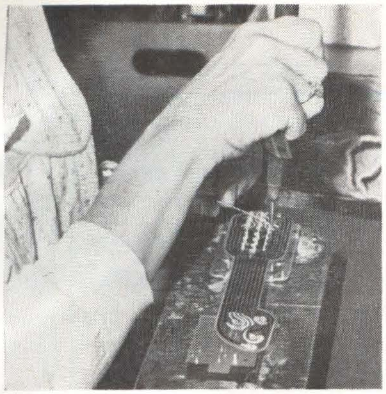
is used to great advantage to fabricate a variety of miniaturized multiapertured transfluxors, he reported. These devices are operated at moderate and high speed with low power. Geometrical shapes, difficult or impossible to attain by conventional dry-pressing techniques are easily achieved in miniaturized form by electron-beam machining, he added.

Miniature toroids with 3-mil internal diameter and 9 mil external diameter are fabricated by this technique. To rotate the beam and make a circular cut, 60-cps current is applied to the deflection coils. The internal aperture is first formed, then the external diameter is cut. Optimum beam operating conditions are 80 to 100 kv at 150 microamperes.

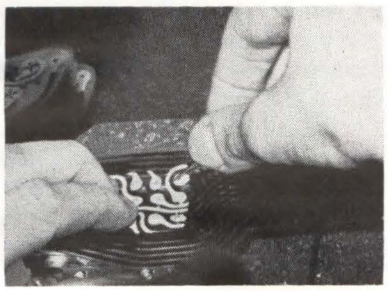
Iron or Machine Can Solder Printed Cables

EXTENSIVE use of flexible printed wiring since its introduction several years ago has demonstrated that this type of wiring is compatible with both hand and mechanized soldering methods, according to Sanders Associates, of Nashua, N. H.

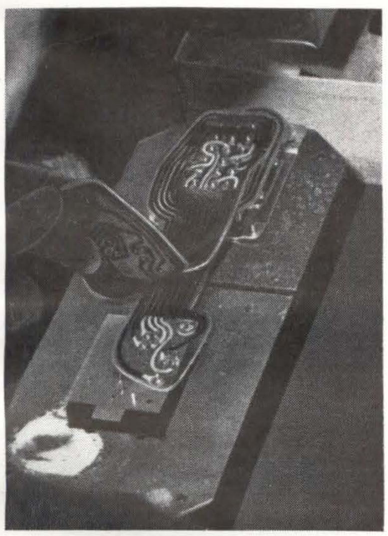
The company points out that its Flexprint wiring depends on thermoplastic insulation to position the con-



TYPICAL production setup for soldering Flexprint cable to assembly's fixed terminals



OPERATOR uses tweezers to press solder pads down over terminal pads

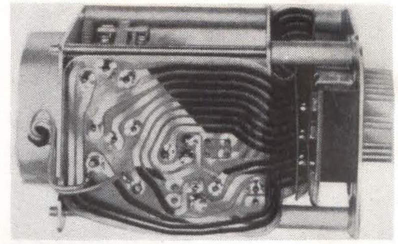


LAYERS of printed cable are stacked to save space and weight

ductors. Soldering techniques must be selected for minimum detrimental effects on the thermoplastic.

For hand soldering, the recommended iron is a 23-watt pencil iron with a ⅛-inch-diameter bit. For mechanized soldering, dip or fountain-type soldering can be used.

In dip soldering, eutectic solder temperature should be kept within 5 deg C of 200 C and the solder should be covered with Shell Peblum



SOLDER fillets are bright and smooth

oil A. An epoxy-fiberglass fixture that exposes only the joints is used.

Fountain soldering is similar to dip soldering, except that molten solder is pumped through tubes to selected areas of the assembly. Tubes protrude through the oil-covered solder and the pump is immersed in the solder pot. Solder flow through a tube is controlled by a gate valve so it overflows smoothly without dross.

Fused Terminals Provide Secure P-C Connections

PROMISING new technique is being widely applied by Bendix in new product assembly. Called the bifurcated fused terminal, it is used instead of plated-through holes for terminals on printed circuit boards.

A tinned terminal is inserted in the terminal hole of a printed circuit board. The terminal is turned down on two sides to create a slot and fused to the board by a special mechanism. This fusing means that soldering later either to insert a component or to remove one will not release the post from the board.

Components are inserted in the slots and the printed board goes through a flow-soldering unit. Capillary action draws molten solder up through the terminal to insure an electrically sound, rugged bond.

If it is necessary to remove a component, the soldering iron need contact only the fused terminal. Thus the component and p-c board conductor are exposed to a minimum of destructive heat.

Bifurcated fused terminals have the advantages of both point-to-point wiring and printed wiring with improved reliability in the finished product, says Bendix.

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* * *

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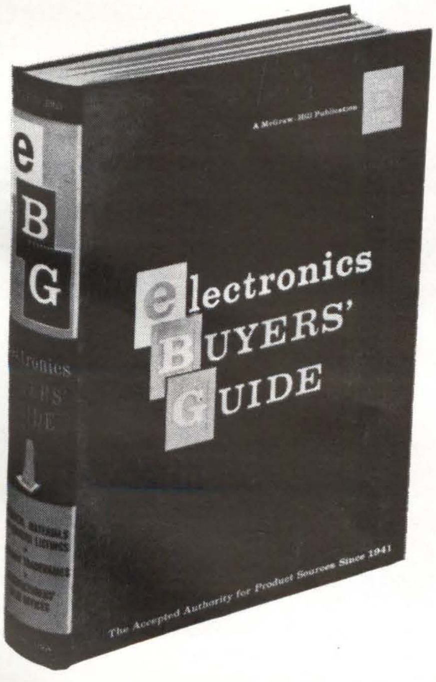
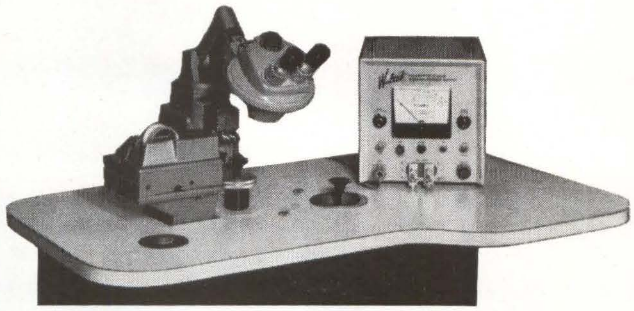
*



NEW! Weld on top of p.c. boards...thin films... and inside transistors with the MINI-WELDER!



New Model 500 "Mini-Welder" welds wire from .0003″ up to .030″ or ribbon from .000125″ up to .020″ on top of thin films (down to 1000 Å), copper p.c. boards, many kinds of depositions, laminates, and etched circuits. Console is equipped with: Power supply, parallel gap or "one-sided" weld head, XY micropositioner, fine wire feeder, product holder, B&L StereoZoom optics, Formica topped table and actuating system. Welds many different materials. For lab or production use. Write for details.

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Appliance Wire	Business Machine Wires	
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1/64″ & 1/32″ TFE Insulation	.006″ FEP Insulation with nylon jacket	.010″ TFE or FEP Insulation

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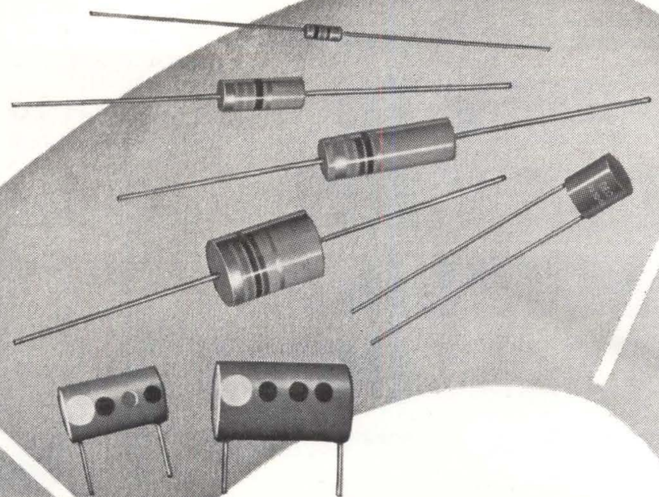
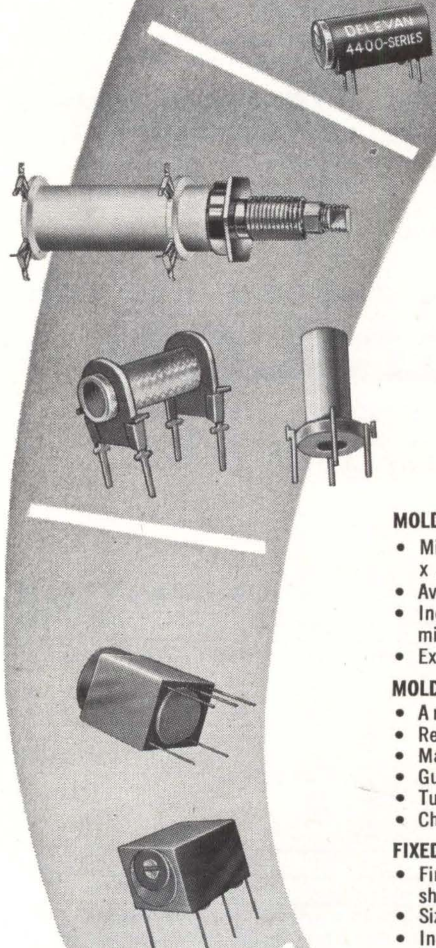


15 Standard Coil and Transformer Lines with Proven Reliability for all Circuit Applications



Delevan's successful performance in the manufacture of precision coil and transformer products results from a unique blending of engineering and manufacturing experience in the field of micro-miniature precision-made components.

From Delevan's inception, its product philosophy called for an extremely high degree of precision manufacturing to meet exacting performance levels required by all quality-minded manufacturers of electronic systems.

This led to the creation of Delevan's in-plant certified test laboratory . . . with great consideration given to the design and processing techniques which resulted in the products' repeated reliability under extensive environmental testing.

In addition to Delevan's standard line of coil and transformer products, a specialized group of engineers are available for the sole purpose of designing custom coils of any variation to your specifications.

All Delevan products meet the requirements of U. S. Government Specification MIL-C-15305 Grade & Class 4 for RF and IF Coils and Transformers, and are manufactured to the rigid Quality Control Procedures as established by MIL-Q-9858.

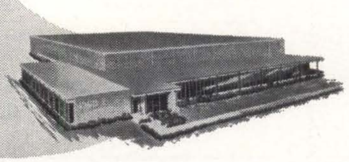
MOLDED FIXED
- Miniature sizes down to .095 inches dia. x .250 inches length
- Available in 10 standard series
- Inductances from .15 microhenries to 220 millihenries
- Excellent Q values for all circuit applications

MOLDED TUNABLE
- A remarkable break-thru for design engineers
- Reliable high-quality molded tunable coil
- Maximum Q values
- Guaranteed L values .18 uh to 70,000 uh
- Tuning ranges as high as three to one
- Chassis or printed circuit applications

FIXED SHIELDED
- Finest industry advancement in molded shielded coils
- Size .157 inches dia. x .375 inches length
- Inductance range from .10 microhenries thru 120 millihenries
- Epoxy molded for reliability

MOLDED TUNABLE SHIELDED
- Model DSV (vertical mount) and DSH (horizontal mount) units for printed circuit boards
- Electrostatically and electromagnetically shielded
- Maintainable tuning core torque with repeated core cycling
- Foolproof encapsulation eliminates possibility of improper fills or cures which allow entry of moisture
- Minimum coil form thickness assures highest Q and L values
- Compatibility between coil form and potting materials provide maximum moisture resistance
- A unique, patented vibration and shockproof tuning feature requires no extra space for core in extended position
- Only .50 inches maximum over tuning length

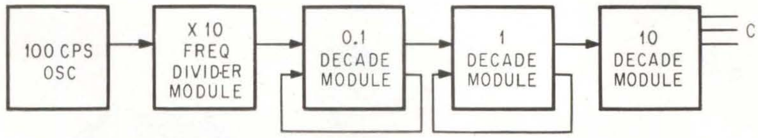
DELEFORMS
- Ceramic forms centerless ground for reproducible windings
- All purpose terminals for connection of external wiring
- Nickel plated metallic parts to prevent corrosion
- Internal teflon washer creates vibration proof unit
- Various powdered iron and ferrite cores available



Delevan Electronics Corporation
A SUBSIDIARY OF AMERICAN PRECISION INDUSTRIES INC.
270 QUAKER ROAD EAST AURORA, NEW YORK 14052

Magnetic-Core Module Resists Shock

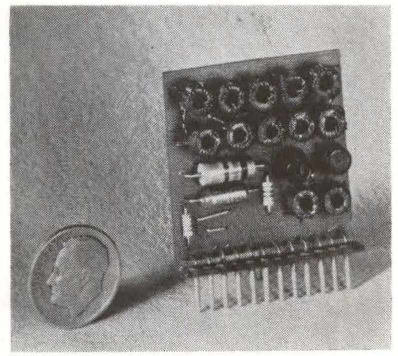
Miniature device has no moving parts and infinite storage life



TYPE 25900 magnetic-core module is designed for use in a variety of timing and programming applications where reliability is a major consideration. Unit contains no moving parts and all switches are solid state rather than mechanical. Advantages include greater shock and acceleration resistance, greater temperature operating range, smaller size, infinite storage life and lack of lubrication requirement.

The module requires no standby power. It can be programmed, left idle for any time period and at the time of use, will start timing from the pre-programmed position. In the decade ring-counter configuration, outputs will occur at the preset time and the module will continue counting with a period of ten times the input period. In the non-ring counter configuration, outputs will occur at the pre-set time and the module will become inoperative until it is programmed or set again. Outputs from the cores are used directly to gate scr's that in turn can actuate relays, steppers and other electromechanical devices.

Device is a one core-per-bit counter composed of magnetic tape wound on stainless-steel bobbin cores with integral drivers. Each decade module contains 12 cores and two solid-state switches plus associated passive components. Applications include binary to decimal



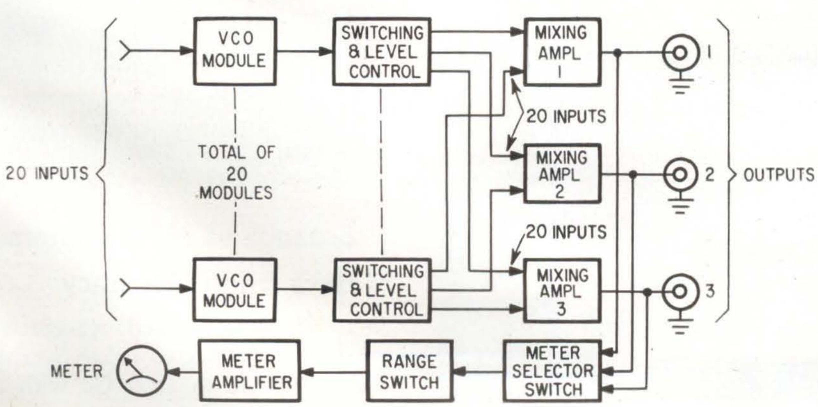
decoder, electronic counter, electronic programmer, intervalometer and frequency divider. Hamilton Watch Co., Lancaster, Pa.

CIRCLE **301,** READER SERVICE CARD

Data-Insertion Converter Handles 20 Inputs

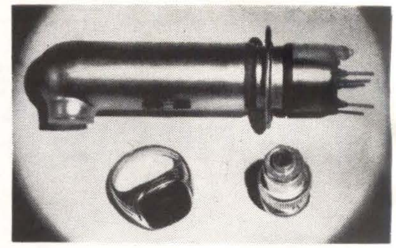
TWENTY external signals in the range 0 to 5,000 cps with between 0.5 and 20 volts peak to peak can be accommodated by model DIC-1 data insertion converter. Unit consists of twenty IRIG subcarrier voltage-controlled oscillators, three mixer amplifiers, four precision power supplies and a metering circuit as shown in the diagram.

Incoming signals modulate the subcarrier oscillators whose outputs can be independently and linearly summed into 1, 2 or 3 composite outputs. The signal from each vco may be included in, or excluded from any or all of the composite outputs. Individual control of the signal level from each vco to each mixing amplifier is provided. Metering of the three outputs from the mixing amplifiers permits establishing pre-emphasis schedules and desired over-all output level. Power is furnished by precision positive and negative 10-volt supplies and by zener-regulated, positive and negative 20-volt supplies. Defense Electronics, Inc., 5455 Randolph Rd., Rockville, Md. **(302)**



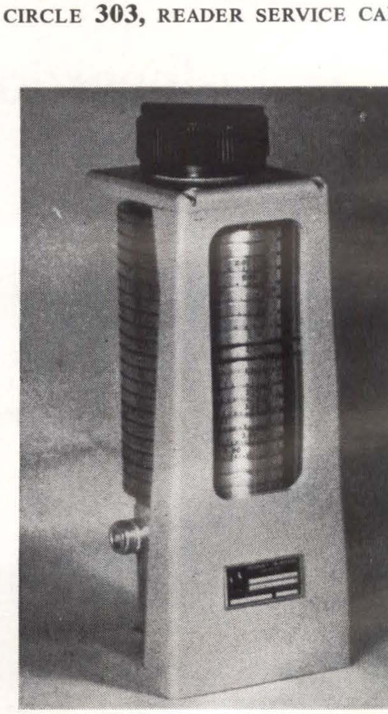
Diodes Demodulate Laser Outputs

OPTICAL-detecting, photomixing diodes are capable of demodulating laser outputs in optical communication systems operating between 0.4 and 5.7 microns. Called the L4500 series, the four units have typical cutoff frequencies of 40, 10, 0.5 and 0.8 Gc for an output power decrease of 6 db per octave. Ratio of the number of hole-electron pairs generated by incident photons to the number of incident photons (typical



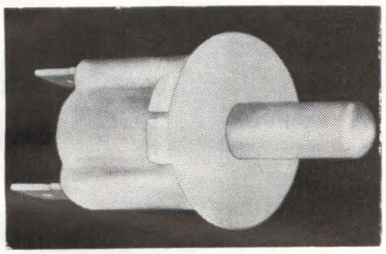
photon efficiency) ranges from 50 percent for silicon units to 25 percent for intermetallic diodes. Current efficiency is 85 percent for the four models, while light-sensitive areas for the series are 5, 20, 200 and 300 square mils. Units are packaged in a UG-88 U coaxial connector to provide transmission of output frequencies that cover the entire operational bandwidth of the particular diode. Coherent detection techniques improves the directivity of infrared photodiodes by many orders of magnitude. Moreover, calculations demonstrate that photomixing of coherent infrared radiation can increase detector sensitivities by 4 orders of magnitude. A maximum improvement of six to seven orders of magnitude appears possible. Prices range between $100 and $390. Philco Corp., Lansdale Div., Lansdale, Pa.

CIRCLE **303,** READER SERVICE CARD



Broadband Wavemeters Have High Accuracy

SERIES of broadband wavemeters provide frequency coverage over the range 1.0 Gc to 18.0 Gc with an absolute accuracy of ± 0.05 percent. Units are suited for use as frequency markers in conjunction with broadband sweep generators and spectrum analyzers or in tuning a transmitter, receiver local oscillator or signal generator. Spurious signals are a minimum of 20 db down, absorption dip is 1.5 ± 1 db and power capacity is 20 watts. Wavemeter retains its accuracy over a temperature range of 22 C ± 10 C. Available frequency ranges are 1.0 Gc to 2.0 Gc, 2.0 to 4.0 Gc, 4.0 Gc to 8.0 Gc, 8.2 Gc to 12.4 Gc and 12.0 Gc to 18.0 Gc. Frequency Engineering Laboratories, Farmingdale, N. J. **(304)**



Door Switch Is Rugged Device

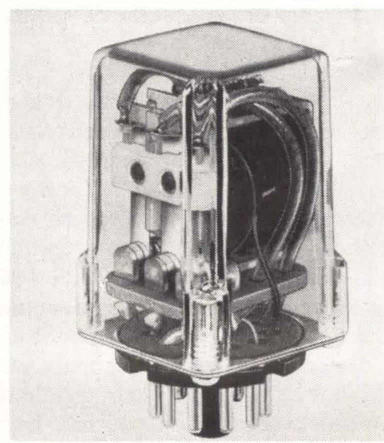
LOW-COST door switch rated at 3 amperes, 125 v a-c has been developed. It can be used wherever door movement must make or break a circuit. It can also serve as an economical industrial limit switch. Made of unitized Nylon, Zytel 101, the switch snaps into position and needs no screws due to its pressure fit design. Fits a $\frac{3}{4}$ in. diameter hole and has $\frac{1}{4}$ or $\frac{3}{16}$ in. tab terminals for quick connection. It has been tested to over 500,000 operations. Normally open, makes within $\frac{3}{64}$ in. stroke; normally closed, breaks within $\frac{1}{64}$ in. stroke. Oak Mfg. Co., Crystal Lake, Ill. **(305)**

TWT Supply Features Low Noise

MODEL MWA-5A is a low-noise traveling wave tube preamplifier power-supply unit designed to improve the sensitivity of reconnaissance or communication receivers. The basic device may be used with a variety of existing ppm and pm TWT's by simply changing a plug-in circuit board with each tube type. Unit is sufficiently versatile to accommodate other proposed TWT's, and is capable of covering 1 Gc to 11 Gc in a series of bands dictated by the tube bandwidths with typical noise figures between 9 and 12 db.

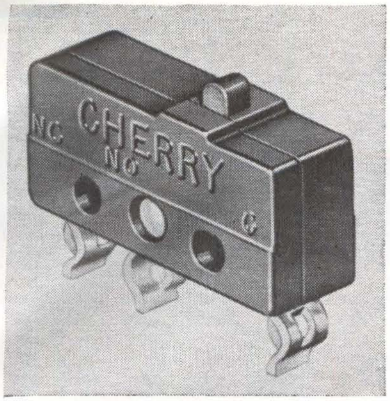
Replacement of the tube to cover L, S, C or X band operations can be accomplished in minutes through disconnect power plugs. Front panel metering is provided for the tube voltages and currents to permit analysis of operating conditions. The TWT may be remotely located up to 200 feet from the power supply without degradation of performance. Applied Technology Corp., 930 Industrial Ave., Palo Alto, Calif.

CIRCLE **306**, READER SERVICE CARD



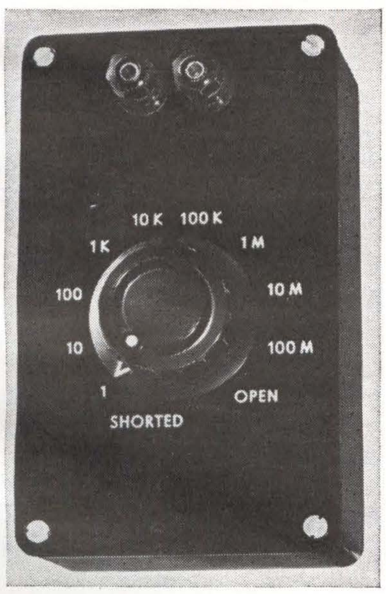
Relay Provides High Versatility

DESIGNED for maximum versatility, series U general purpose relay is available with single, double or triple pole double throw contact arrangements in either a 5-amp or 10-amp rating. Standard coil voltages 6, 12, 24, 48, 115 and 230 v a-c; and 6, 12, 24, 48 and 110 v d-c. The relay can be obtained in an open type with solder terminals or with a plastic dust cover. The single and double pole enclosed versions have 8 pin; the triple pole has 11 pin terminals for quick plug-in to octal sockets. Hart Mfg. Co., Hartford 1, Conn. (**307**)



Subminiature Switch Has Target Terminals

DEEP-WELL target-type solder terminals are featured on the E62 and E61 series subminiature snap-action switches. Having greater soldering area because of the cylindrical shape, the new terminal type permits easier wire insertion, faster installation and greater anchorage with better solder adherence. The switch pictured, E62-13A, has a rating of 10.1 amperes 125/250 v a-c, ¼ h-p 125 v a-c. Cherry Electrical Products Corp., P. O. Box 439, Highland Park, Ill. **(308)**

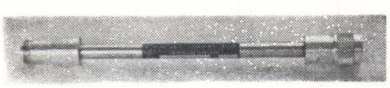


Resistance Calibrators Save Time and Space

NOW AVAILABLE is a resistance calibrator that covers 1 ohm through 100 megohms and has a shorted and an open position for zeroing meters. Unit is useful for speedy checkout and calibration of ohmmeters or ohmmeter sections of multimeters

CIRCLE 85 ON READER SERVICE CARD

in industrial calibration laboratories. Accuracies available are: 1 percent, 0.1 percent and 0.05 percent. The 1 percent calibrators use carbon resistors, the 0.1 percent and 0.05 percent units have wirewound resistors. Dimensions are 3¾ by 6¼ by 3. Panco Electronic Enterprises, 2112 Pontius Ave., West L. A. 25, Calif. CIRCLE **309,** READER SERVICE CARD

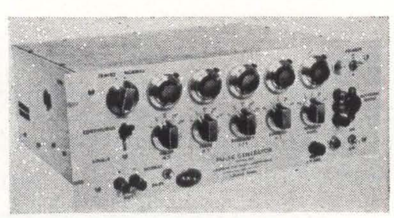


Coax Attenuators Cover from 2 to 10 Gc

SERIES 3650 coaxial attenuators are general purpose devices covering the frequency range from 2 to 10 Gc (20 db covers 2.5 to 10 Gc). They are designed to satisfy the need for an economical attenuator for systems and laboratory applications where a high degree of precision is not required. The devices are ruggedly constructed and are negligibly affected by temperature or humidity changes. They are supplied with type N connectors in any arrangement desired. Maury Microwave Corp., 10373 Mills Ave., Montclair, Calif. 91763. **(310)**

Pulse Generator Operates in 6 Modes

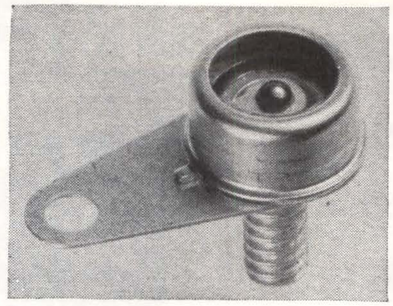
ON THE MARKET is model 155 pulse generator, which provides, without the use of external synchronization or control systems, high versatility. It provides operation in six modes: single pulse, single pairs of pulses,



single trains of pulses, repetitive pulses, repetitive pairs of pulses, repetitive trains of pulses. Maximum power is 25 w at 250 v, providing energy for use of a pulse isolator, strobe light, relays and solenoids. An accessory output plug is provided on the front panel. All frequencies, durations, delays, and the like, are calibrated to within 5 percent; are stable to 1 percent or better over long periods. Resetability accuracies are in the order of 0.1 percent. American Electronic Laboratories, Inc., Richardson Road, Colmar, Pa. **(311)**

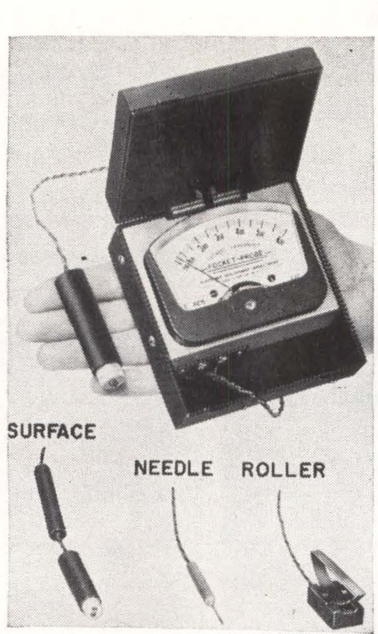
Ga-As IR Light Source Has High Power

GALLIUM-ARSENIDE infrared light source, the SNX-110, is typically capable of a continuous optical output of 20 mw at 25 C package temperature with a forward bias of 2 amperes. Peak optical outputs ex-



ceeding 1/4 w have been achieved at package temperatures of —195 C. Specially designed package features a concentrically mounted threaded copper stud which, when attached to a properly designed heat sink, provides efficient dissipation of the heat generated during diode operation. Texas Instruments Inc., 13500 North Central Expressway, Dallas, Texas.

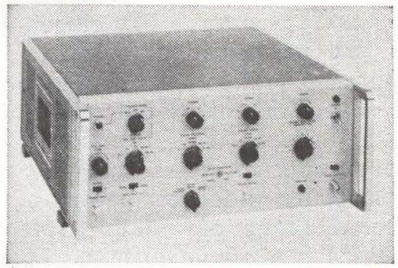
CIRCLE **312,** READER SERVICE CARD



Portable Pyrometer Has Versatility

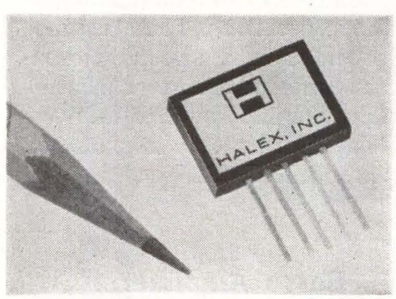
POCKET-SIZED pyrometer measures 4 in. by 4½ in. by 2 in. The Pocket-Probe features a large scale, automatic temperature compensation, red pointer, fast acting thermocouple, 2-ft long wire cable from pyrometer to probe, and replaceable thermocouples. Connections are brazed or welded to guarantee constant accuracy. Readings are very fast. Pocket-Probe is available in any temperature range with either surface probe, needle probe or roller contact type. Standard accuracy is

2 percent. Accuracy of 1 percent can be easily supplied. Price is \$44.90. Electronic Development Laboratories, 29 John St., New York 38, N. Y. **(313)**



Pulse Generator Offers High Peak Power

VERSATILE pulse generator offers high peak power pulses of known shape. Model 214A can provide positive or negative 100-v, 2-amp pulses into 50 ohms. Source impedance is 50 ohms on all but the highest output range to minimize errors caused by re-reflections when operating into unmatched loads — a feature which permits the output pulse characteristics to be accurately specified. At maximum output, pulse rise and fall times are typically 15 nsec; on all other ranges, less than 13 nsec. Internal triggering extends to 1 Mc, and oscilloscope-type controls make it possible to trigger from the positive or negative slope of almost any d-c to 1 Mc external signal from −40 to +40 v. Other features include single pulse, double pulse, and pulse burst capabilities. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. **(314)**



D-C Amplifier Features Low Drift

MODEL 1030 is a general-purpose thin-film d-c amplifier with preset gain up to 100, bandwidth of 100 kc, and drift of less than 100 μv/deg C. It utilizes vacuum deposited resistors, terminals and interconnections on a 0.75 in. by 0.55 in. encapsulated substrate. Thickness of the module is 0.10 in. Active components consist of micro size silicon diodes and transistors. Flat ribbon leads can be welded or soldered. Output amplitude into a 1,000-ohm load is 1 v rms at an output impedance of less than 100 ohms. Power requirement is +12 and −12 v. Amplifier will operate over a temperature range of −40 to +100 C. Price is \$250 in quantities of 1 to 9. Halex, Inc., 139 Maryland St., El Segundo, Calif.

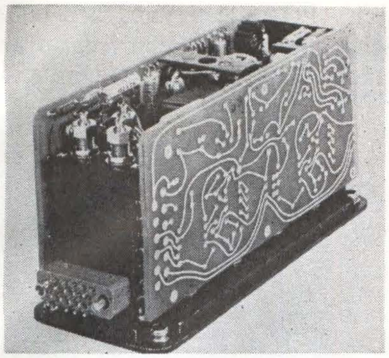
CIRCLE **315,** READER SERVICE CARD

Sweeping Oscillator Is Solid-State Unit

MODEL 100 Marka-Sweep is an all solid-state sweeping oscillator providing extremely flat sweeps up to 100 Mc wide. It provides at least 1 v rms metered output for all modes of operation—line-locked, variable, manual or c-w. Fixed, pip-type frequency markers and variable birdie-type markers are available simultaneously. Additional features of the unit include a built-in detector, precision step-attenuator, and provision for external modulation of the sweep oscillator. These features are provided in a sweeping oscillator and marker generator measuring only 8 by 19.5 by 13.5 in. overall. Kay Electric Co., Maple Ave., Pine Brook, N. J. **(316)**

D-C Servo Amplifier Has 3 Summing Inputs

MODEL A457 is designed to drive d-c servo motors and torquers up to 28 v d-c and 4½ amp. The basic model A480 has 3 summing inputs with independent gain adjustment.



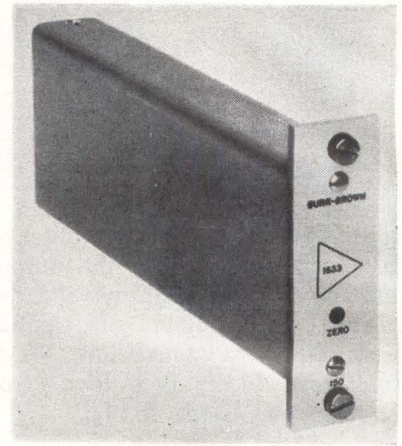
Special features are d-c isolation of the signal inputs from the output and the 28 v d-c supply, and a-c carrier type amplifier with built-in carrier frequency generator. Westamp, Inc., 11529 Pico Blvd., Los Angeles 64, Calif. **(317)**

Pulse Transformers for High-Frequency Use

SMALL, molded pulse transformers, encased in standard, low-silhouette packages, are available for high-frequency coupling applications and use on small, solid-state pulse circuits in the nanosecond range. Designed for operation in both commercial and military environments, these transformers have an o-d of 5/16 in., and a height of only $\frac{1}{8}$ in.

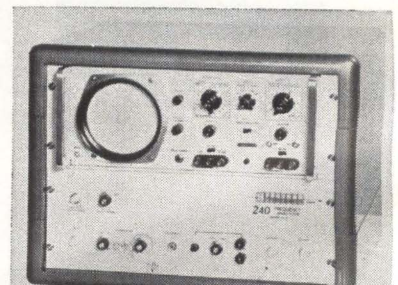
Leads are composed of wire 10 to 12 mils in diameter, suitable for either soldering or welding. Available in inductances as high as 500 microhenries per winding, units contain 4 leads mounted on 0.2-in. centers, or 6 leads mounted on 0.28-in. diameter circle. Price: under $20

each. PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.
CIRCLE **318,** READER SERVICE CARD



D-C Power Amplifiers With Choice of Output

FEATURED in the models 1633 and 1635 are 5 to 15 w peak output, 500 ma output current capability, voltage gain of 10, ±0.5 db response from d-c to 10 kc, and a choice of single-ended or differential output. Useful in driving low impedance loads, the units are also general laboratory tools. An output circuit is designed to draw minimum idle current from external power supply. Model 1633 is designed to deliver ±10 v at 500 ma, and model 1635 is designed to deliver 60 v peak-to-peak at 500 ma. Burr-Brown Research Corp., Box 6444, Tucson, Ariz. **(319)**

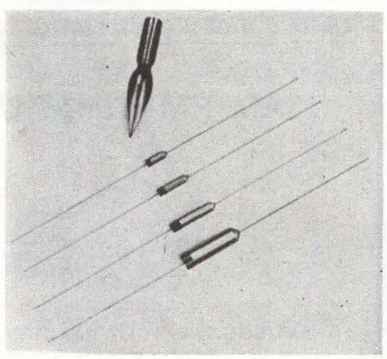


Spectrum Analyzer Offers Fast Sampling

REAL-TIME multiple-filter spectrum analyzer, model 240, employs a bank of 240 magnetostrictive rod filters sampled 240 times per sec with a rotating capacity-coupled commutator. A new rotor configuration provides two sweeps per revolution; the rotor speed is 7200 rpm. The filter element bandwidth of 100 cps is standard, giving a 20-kc analysis band. Other element bandwidths, including 3, 10 and 25 cps, are also available. Model 240 with scope is $9,740. It is available without scope for $8,950. Spectran Electronics Corp., 146 Main St., Maynard, Mass. **(320)**

Cleaner & Deoxidizer For Circuit Boards

THIS PRODUCT (Fremont 238A) is designed for cleaning and deoxidizing copper on epoxy or polyethylene boards prior to applying solder plate. Its chief advantages are: removal of all oxidation and stain with minimum effort; inhibition of copper tarnishing, and an economical overall cleaning job. Fremont Industries, Inc., 219 West 90th St., Minneapolis 20, Minn. **(321)**



Tantalum Capacitors Come in 4 Case Sizes

LINE of subminiature straight-wall tantalum capacitors with liquid electrolyte and highly reliable seals is announced. They feature 85 C capability with high capacitance in a subminiature package. The electrolyte is thixotropic. Package is insulated and leads can be welded or soldered. Line includes four case sizes ranging between 0.312 in. long by 0.115 in. in diameter to 0.875 in. long by 0.225 in. in diameter. There are 28 standard units with capacitances between 2 and 330 μf at 85 C and at working voltages between 6 and 60 v. International Telephone and Telegraph Corp., Palo Alto, Calif. **(322)**

—LITERATURE OF

WIRE STRIPPER Artos Engineering Co., 2757 S. 28th St., Milwaukee 46, Wisc. Bulletin 563A describes an all-electric, hand-fed wire measuring cutting and stripping machine.
CIRCLE **360,** READER SERVICE CARD

PERFORATED TAPE READER Cook Electric Co., Data-stor Division, 8100 Monticello Ave., Skokie, Ill., Specifications and operation information on the model 56 perforated tape reader are contained in a 4-page brochure. **(361)**

INPUT SCANNER Cohu Electronics, Inc., Kin Tel Division, Box 623, San Diego 12, Calif. Data sheet 19-72 covers the 453M input scanner which simplifies design of complete data acquisition systems. **(362)**

MINIATURE RECORDERS Rustrak Instrument Co., Inc., 130 Silver St., Manchester, N.H. Condensed catalog covers a line of miniature galvanometer chart recorders. **(363)**

HIGH-SPEED SWITCHING James Electronics Inc., 4050 North Rockwell St., Chicago, Ill. Catalog F-5174 details typical circuit applications and specifications of new relays to aid equipment, application and system engineers with their switching circuit problems. **(364)**

DIGITAL VOLTMETER Epsco Inc., 275 Massachusetts Ave., Cambridge, Mass., has available literature on the new, all-silicon model SI-500 DVM. **(365)**

STANDARDS AND COMPONENTS General Radio Co., West Concord, Mass. An illustrated booklet describes an extensive line of standard resistors, inductors, and capacitors. **(366)**

FACILITIES BOOKLET Maser Optics, Inc., 89 Brighton Ave., Boston 34, Mass., has printed a new short-form brochure describing its products, capabilities and facilities in the field of laser devices and systems. **(367)**

R-F JACK Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y. A new subminiature recessed bulkhead r-f jack is described in data sheet CK-4. **(368)**

SLIDE CHARTS Perrygraf Corp., 150 So. Barrington Ave., Los Angeles 49, Calif., has published a folder telling how the electronic industry uses slide charts to increase sales. **(369)**

OSCILLOSCOPES AND CAMERAS Scientific Instruments, 750 Bloomfield Ave., Clifton, N. J. Short form catalog No. 129 illustrates and describes high, medium and low-frequency oscilloscopes and scope cameras. **(370)**

TRIMMER POTENTIOMETER Minelco Miniature Electronic Components Corp., 600 South St., Holbrook, Mass. Supplement No. 1 to bulletin P-62 describes model MP2 low-cost sealed miniature trimmer potentiometer. **(371)**

T-Y RECORDER Houston Instrument Corp., 4950 Terminal Ave., Bellaire 101, Texas. A new concept in recording a variable as a function of time is described in a 4-page T-Y recorder brochure. **(372)**

THE WEEK

XENON POWER SUPPLIES Sola Electric Co., Elk Grove Village, Ill. Catalog XE-108 covers a complete line of power supplies for xenon and mercury arc lamps. **(373)**

POWER MODULES Technipower Inc., 18 Marshall St., South Norwalk, Conn. Catalog No. 634A contains technical data on a wide line of solid state power modules. **(374)**

POWER TRANSISTORS Bendix Semiconductor Division, Holmdel, N. J., offers data sheet on 16 germanium *pnp* alloy power transistors designated 2N2552-2N2567. **(375)**

SIGNAL CONDITIONING AMPLIFIER Spaceonics Div., Portable Electric Tools, Inc., 1200 E. State St., Geneva, Ill. Sheet S-2001 covers a signal conditioning amplifier for telemetry. **(376)**

PRINTED-CIRCUIT PRODUCTION Industrial Circuits Co., East Paterson, N. J., offers a revised edition of a technical booklet describing printed-circuit design and manufacturing techniques. **(377)**

C-W KLYSTRONS Raytheon Co., Waltham, Mass. 02154. A 4-page information bulletin covers a line of low-noise X-band c-w klystrons. **(378)**

PRECISION POTENTIOMETER Litton Precision Products, Mt. Vernon, N. Y. Details of the model MDU20-10 ultrashort potentiometer are contained in a specification sheet. **(379)**

SWITCHING COMPONENTS Electronic specialty Co., 5121 San Fernando Road, Los Angeles 39, Calif., has available a catalog giving complete technical data on switching components. **(380)**

ALUMINUM WIRE Hudson Wire Co., Ossining, N. Y., has prepared a paper titled, "Technical Analysis, Silver Plated Aluminum Wire." **(381)**

ELECTRONIC COMPARATOR Carter-Princeton, 178 Alexander St., Princeton, N. J. 08540, offers a data sheet on its electronic comparator that can detect 1 nanoampere of current. **(382)**

HYBRID JUNCTIONS Anzac Electronics, Inc., Moody's Lane, Norwalk, Conn. 06851. A preliminary data sheet on models H and HD uhf broadband hybrid junctions is available. **(383)**

CENTER SCREWLOCK CONNECTORS Continental Connector Corp., 34-63 56th St., Woodside 77, N. Y., has released a 6-page brochure covering center screwlock miniature rectangular plug and socket connectors. **(384)**

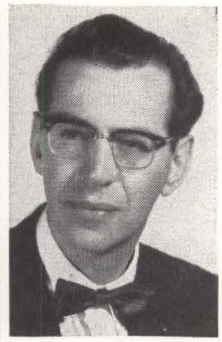
SOLID-STATE CHOPPER Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif. A catalog sheet describes model 5 electrostatically shielded Microchopper. **(385)**

GLASS-CERAMIC SPHERES Emerson & Cuming, Inc., Canton, Mass. Brochure covers Eccospheres—hollow micron sized spheres of glass-ceramic composition which are used in foams, casting resins, light weight ceramics, and deep water floats. **(386)**


L. J. McLaughlin


G. J. Shomphe


L. E. St. Jean


N. R. Wild

Sanders Adds Four Directors

SANDERS ASSOCIATES, Inc., Nashua, N.H., voted at its annual meeting of shareholders to increase its board of directors from 8 to 12, and elected four new directors in addition to members of the previous year.

"The increase in the number of directors," president Royden C. Sanders, Jr., told the meeting, "has been prompted by the tripling in the last three years of our sales, the multi-plant operations and the increased diversity and complexity of our products."

The four newly elected directors, all of them executives of the company, are:

Leo J. McLaughlin, manager of contracts, in charge of corporate contract negotiations. He joined the company in 1954.

George J. Shomphe, manager of manufacturing, was one the founders of the company in 1951.

Lloyd E. St. Jean, manager, Geospace Electronics division, has been the manager of the Plainview facility since its inception and was previously chief engineer of equipment design in the Nashua plant. He joined the company in 1954.

Norman R. Wild is corporate scientist, and one of the founders of the company. He was elected and served as a director in 1958.

Hewlett-Packard Revamps Corporate Setup

HEWLETT-PACKARD Company, Palo Alto, Calif., has announced a corporate reorganization whereby its largest subsidiary, the Sanborn Company of Waltham, Mass., will become a division of the parent firm.

David Packard, H-P president, said Sanborn's transition to divisional status, "should be achieved within a few months, pending completion of necessary legal arrangements."

Packard also announced that W. Bruce Wholey has been named general manager of Sanborn. Wholey, for the past three years, has served as general manager of H-P's Microwave division.

John A. Young, formerly sales manager of the Microwave division, has been appointed general manager, succeeding Wholey.

TRW Announces Name Changes

SUBSIDIARY companies and divisions comprising the TRW Electronics units of Thompson Ramo Wooldridge Inc. now have new names.

Pacific Semiconductors, Inc., Lawndale, Calif. is now TRW Semiconductors Inc.; Good-All Capacitor Division becomes TRW Capacitor Division; and the former Radio Condenser Company and Radio Industries, Inc. become TRW Electronic Components Division.

Milam Electric Mfg. Co., a TRW subsidiary, and TRW Microwave Division names remain unchanged.

General Precision Appoints Lee

APPOINTMENT of R. W. Lee as president of the Information Systems Group, General Precision, Inc., Glendale, Calif., is announced. He had been executive vice president and general manager of the group.

The Information Systems Group comprises the Librascope division, Commercial Computer division and a Research and Systems Center with plants in Glendale, San Marcos, Burbank, and Sunnyvale, Calif. It produces digital computers, shipboard weapons fire-control systems, and command and control systems.

Aden Accepts Key EOS Post

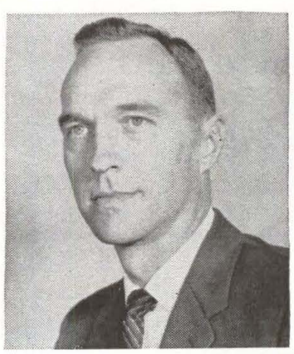
ARTHUR L. ADEN has joined the staff of Electro-Optical Systems, Inc., as a corporate vice president and associate technical director. In this capacity, he will assist John M. Teem, vice president and technical director, in overall direction of the technical activities of the corporation.

Aden was formerly a vice president of Motorola Instrumentation and Control, Inc., in Phoenix, Ariz., where he served as manager of operations for the Solid State Systems division and associate director of research and development in the Military Electronics division.

General Radio Elects Sinclair

DONALD B. SINCLAIR, executive vice president of General Radio Company, West Concord, Mass., has been elected president of the firm, succeeding Charles C. Carey, deceased.

Sinclair joined GR in 1936 and subsequently became chief engineer. In 1955 he was appointed vice president for engineering and in 1956 was elected a director. For the past two years he has held the post of executive vice president and technical director.



Newly Formed Company Names Fisher

GEORGE F. FISHER, former vice president and general manager of Midland and Wright divisions, Pacific

Industries, has been named president of the newly formed Valpey-Fisher Corp., Holliston, Mass. The new company is a result of a reorganization of Valpey Crystal Corp. This permits significant expansion of technologies, production facilities, and product lines.

Valpey-Fisher Corporation will develop and manufacture packaged piezoelectric crystal-controlled oscillators and quartz filter and oscillator crystals used in commercial and military applications.

PEOPLE IN BRIEF

Thurman L. Sipp promoted to director of technical services at C. P. Clare & Co. **Eric D. Daniel** moves up to director of research at Memorex Corp. **J. E. McEvoy** advances to chief engineer of Bailey Meter Co. **Robert W. Carr** raised to mgr. of the Professional Products div. of Shure Brothers, Inc. **Walter P. Davison,** ex-Collins Radio Corp., appointed a senior scientist at ITT Federal Laboratories California Operations. **Parker L. Folsom,** Capt. USN Ret., named mgr., system analysis and planning, at the Univac div. of Sperry Rand Corp. **Walter Morton,** formerly a consulting engineer, now technical director of Dynamics Instrumentation Co. **David W. Lang,** previously with United Electrodynamics, Inc., joins Nortronics div. of Northrop Corp. as exec advisor for special projects in the Systems Support dept. **James F. Borst** leaves Crydom Laboratories to become product mgr. for d-c laboratory and test stand instrumentation at Endevco Corp. **Bernard Kessler** elevated to marketing v-p of The Mica Corp. Andersen Laboratories, Inc., promotes **Walther M. A. Andersen** to chairman of the board; and hires **Charles S. Fama,** ex-Melpar, Inc., as chief engineer for electronics. **Warren R. Yuenger,** recently with Ling-Temco Vought, named senior project engineer at Electrac, Inc. **Louis M. Palamara,** formerly with Erie Technical Ceramics, now mgr. of the ceramic plant of Hi-Q div. of Aerovox Corp. **George Weinman** leaves Electronics Fitting Corp. to head the new Gorn Connector div., Waltham Precision Instrument Co., Inc.

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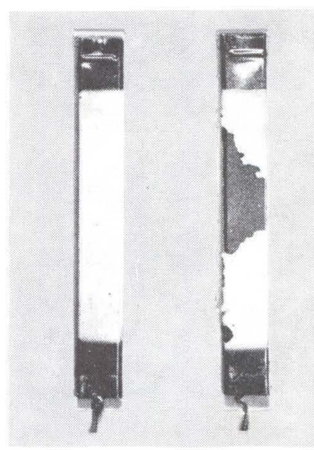
Ends cathode peeling, even after long periods of high-temperature, high-voltage tube operation.



Picture on right is an example of peeling which may occur in nonbonded cathode of a horizontal-deflection-amplifier tube after several hundred hours of operation in a TV receiver.

From RCA research, another major contribution to electron-tube performance and reliability: the bonded cathode. Its emissive-oxide coating will not peel even after extended service under high-voltage, high-temperature conditions encountered in TV horizontal-deflection-amplifier tubes and damper diodes. Permanent adhesion of the emissive-oxide coating of the RCA bonded cathode improves over-all tube performance and reliability...with resultant extension of tube life. Here's why!

THE NEW RCA BONDED CATHODE:

- virtually eliminates peeling of emissive oxide coating
- reduces cathode interface-type impedance effects during life
- reduces grid-to-cathode shorts during life
- improves stability of cathode-to-grid spacing
- improves anode-voltage-per-mil-spacing safety factor in damper diodes
- transmits heat more efficiently and uniformly—thereby, providing more uniform cathode-current density

The RCA bonded cathode was first applied with outstanding success in beam power tube types 6DQ6-B and 6JB6, and half-wave vacuum rectifier types 6AU4-GTA and 6AY3. This new development is now being incorporated in a growing number of types where service conditions indicate the need. Call your RCA Field Representative for details.

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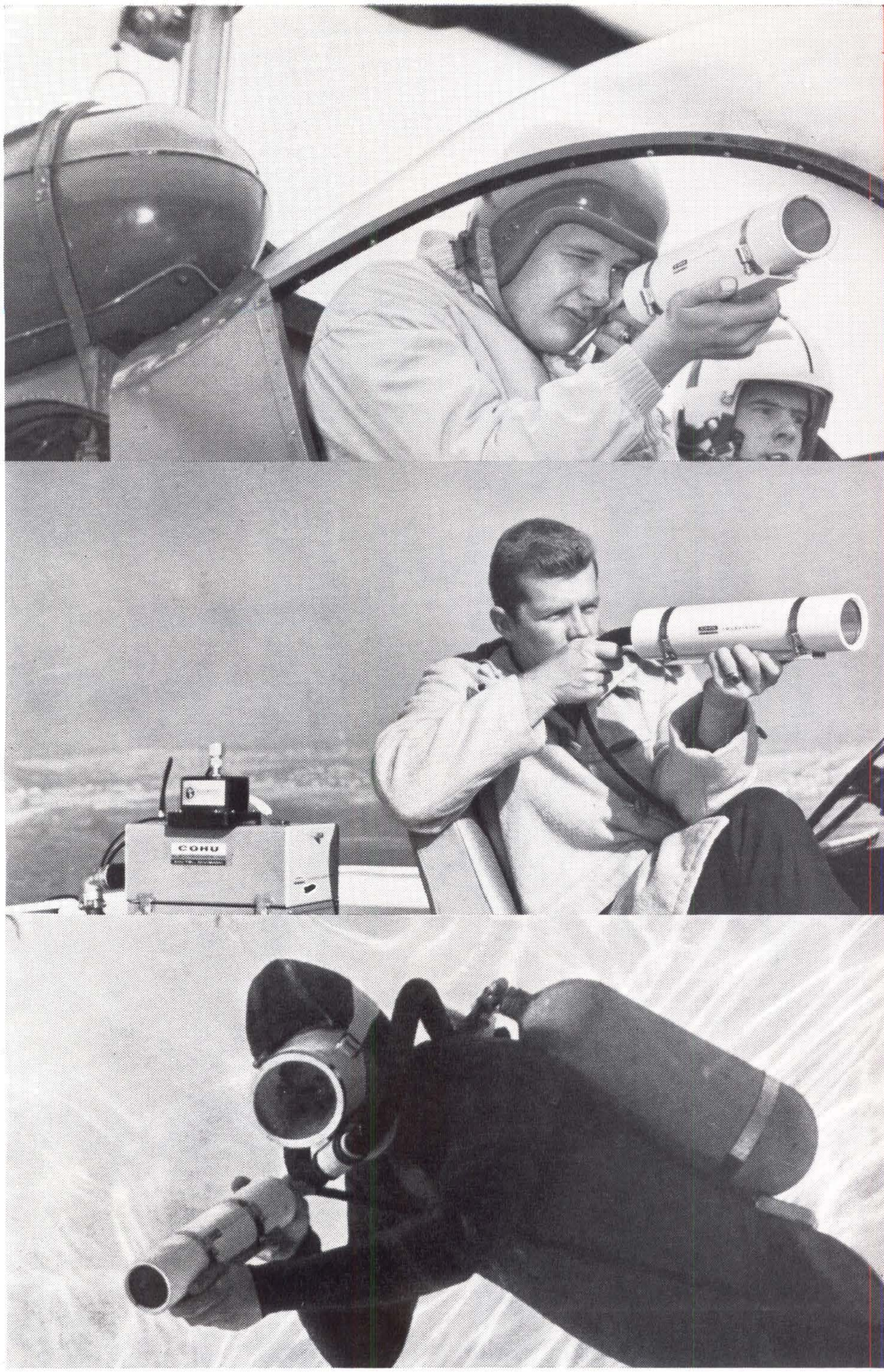

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