EDITOR'S PROFILE of this issue

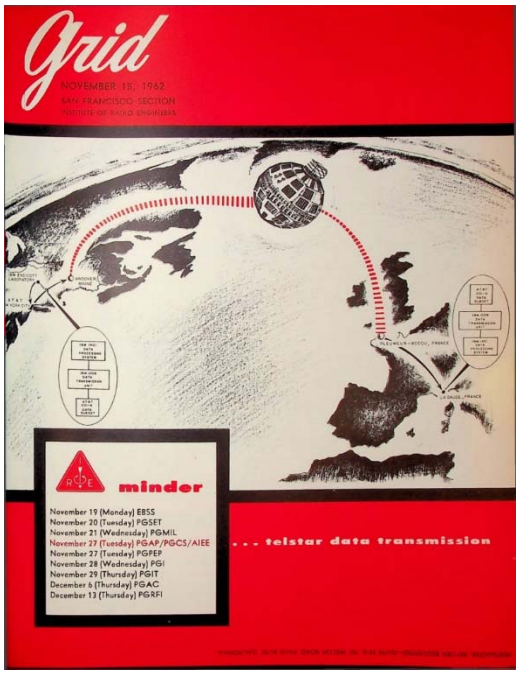
from a historical perspective …

with Paul Wesling, SF Bay Area Council GRID editor (2004-2014)

November, 1962 (mid-month):

Cover: Experiments are being conducted for sending data through satellite links. Here, Telstar and ground-based equipment move data between two IBM computers. More on page 8.

Page 10: We see the first steps of the AIEE and IRE coming together locally under the new umbrella of the IEEE. Education and Student Relations teams will meet to decide how to work with the many student chapters, most of which are already joint AIEE/IRE units.



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https://ethw.org/IEEE_San_Francisco_Bay_Area_Council_History

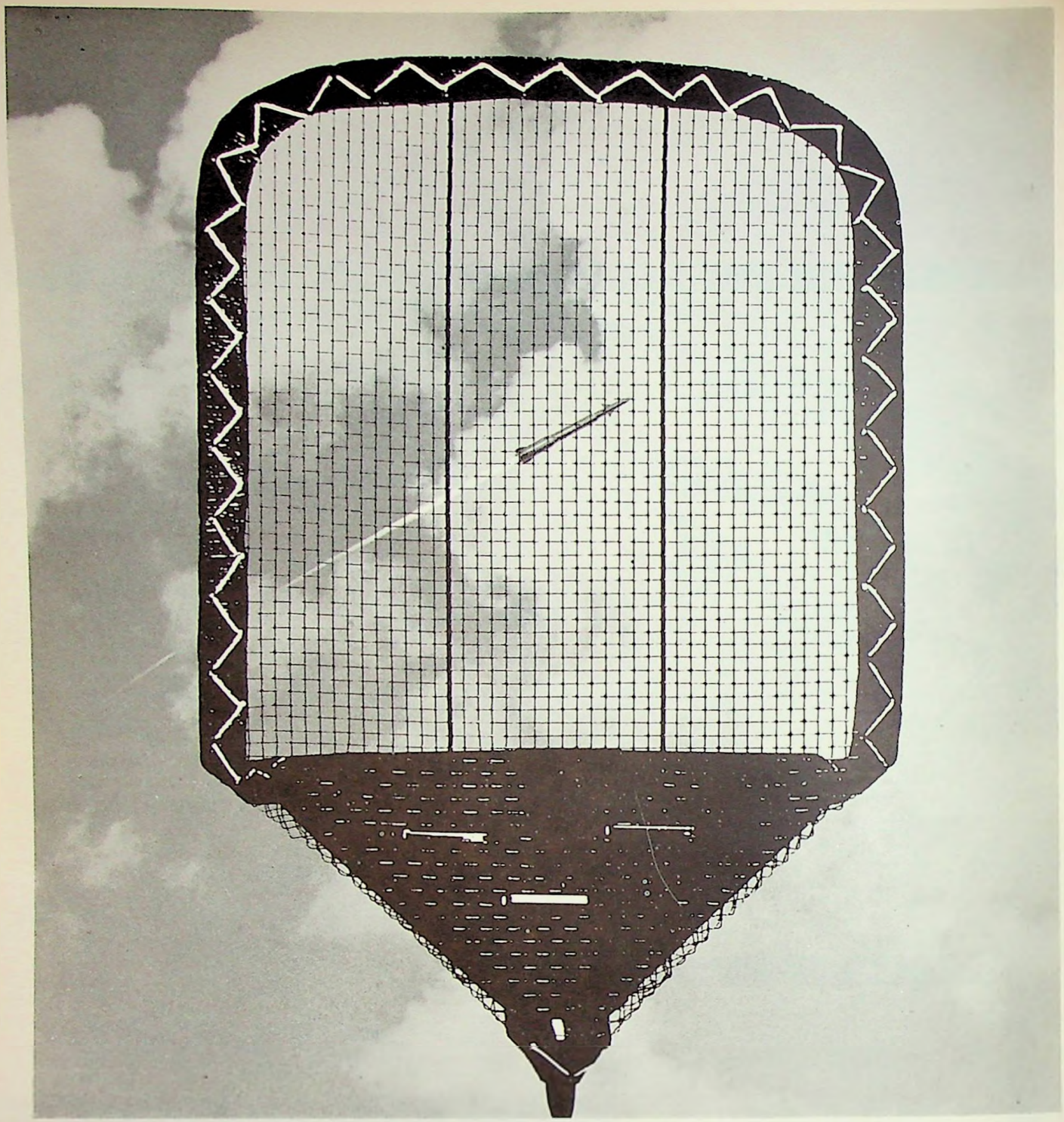
Grid

NOVEMBER 15, 1962
SAN FRANCISCO SECTION
INSTITUTE OF RADIO ENGINEERS

minder

November 19 (Monday) EBSS
November 20 (Tuesday) PGSET
November 21 (Wednesday) PGMIL
November 27 (Tuesday) PGAP/PGCS/AIEE
November 27 (Tuesday) PGPEP
November 28 (Wednesday) PGI
November 29 (Thursday) PGIT
December 6 (Thursday) PGAC
December 13 (Thursday) PGRFI

. . . telstar data transmission



COUNTER MEASURE

Challenging scientific work in the field of Electronic Counter Measures and other defense systems studies now exists at Sylvania. Openings are also available in the following fields: **Operations Research—Systems Analysis, Design—Design and Development of Antennas, Receivers, Transmitters, Transceivers, Servos—Analog Computers—Mechanical Design—Field Engineering.** Sylvania is located but 40 minutes south of San Francisco. Furthering your education? Sylvania encourages and sponsors graduate study at Stanford and other nearby institutions.

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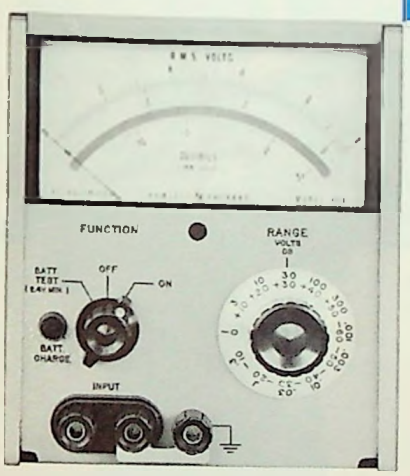

New *hp* portable AC Voltmeter

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SPECIFICATIONS

Range:	0.1 to 3 v rms full scale, 12 ranges
Frequency:	5 cps to 2 mc
Accuracy:	0° C to 50° C, within ±2% of full scale from 10 cps to 1 mc, within ±5% of full scale from 5 to 10 cps and 1 to 2 mc (on 300 v range, accuracy is ±10% from 1 to 2 mc; AC-21A 10:1 Divider Probe allows measurements to 300 v in the 1 to 2 mc range with an accuracy of ±5%); 0° C to −20° C, ±8% of full scale from 5 cps to 2 mc
Nominal Input Impedance:	2 meg-40 pf, 0.001-0.03 v ranges; 20 pf, 0.1-3 v ranges; 15 pf, 10-300 v range
Maximum Input:	600 v peak, 0.3-300 v ranges; 25 v rms, 600 v peak, 0.001-0.1 v range
Power:	4 rechargeable batteries (furnished). 40-hr operation per recharge, up to 500 recharging cycles. Self-contained recharging circuit functions when instrument is operated from ac line
Noise Contribution to Reading Error:	<0.08% at full scale, <0.2% at 50% of full scale, <0.8% at 10% of full scale
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8034 **Price:**	hp 403B, $310.00; hp AC-21A, $30.00

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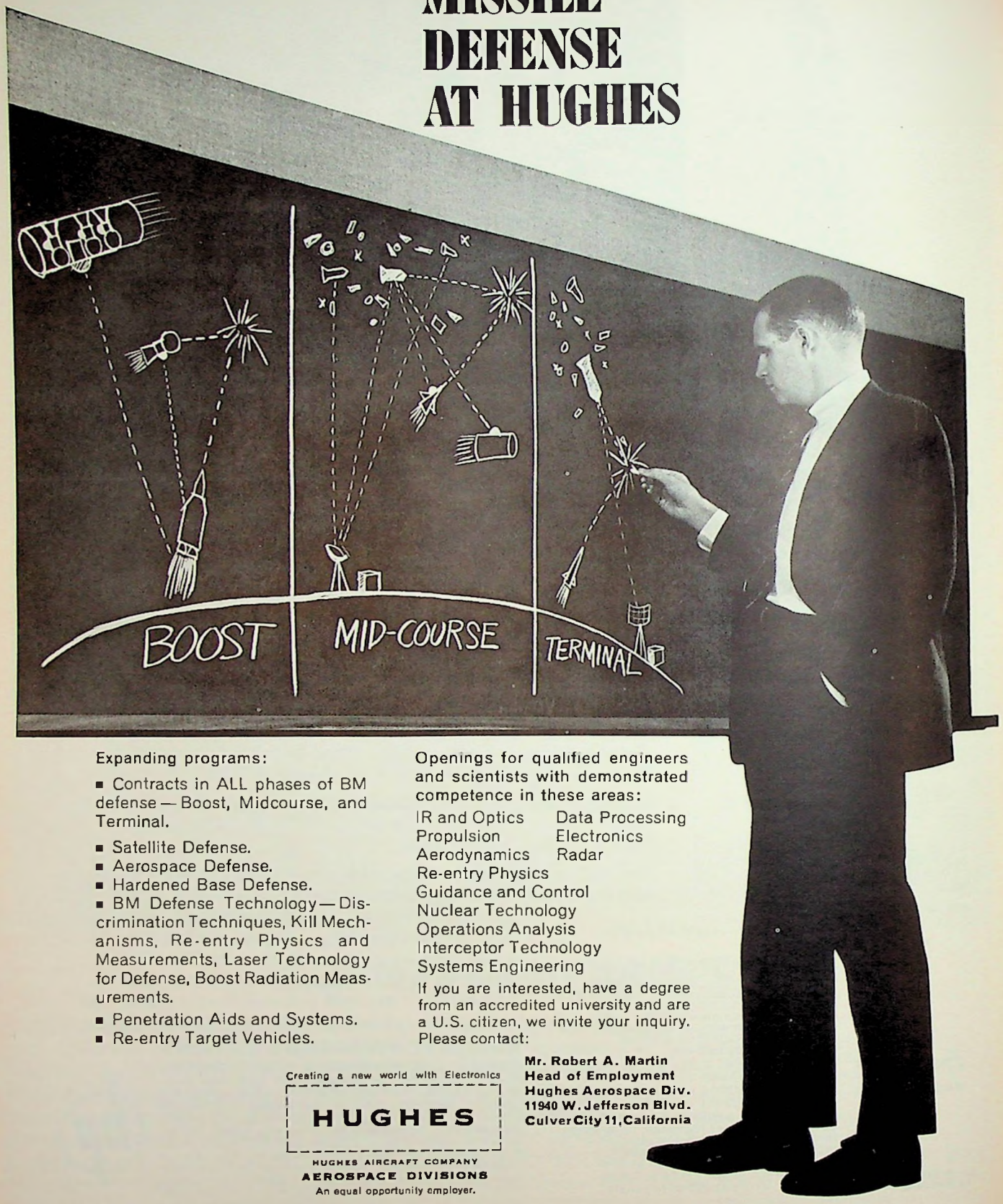
BALLISTIC MISSILE DEFENSE AT HUGHES



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contents

cover

In recent satellite data transmission test of IBM, message from 1401 data processing system in N.Y. to 1401 in France was converted by a 1009 transmission unit from binary coded decimal form into special code. Serial bits converted into audio signals in AT&T digital subset were then transmitted to Maine earth station, thence by microwave via Telstar to station in France and by line to receiving terminal. Digital subset reconverted message into code for another 1009, which checked for error and converted to standard binary coded decimal characters for receiving computer. For more on Telstar see meeting calendar and story on page 8.

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MEETING CALENDAR

EAST BAY SUBSECTION

8:00 P.M. • Monday, November 19

"Human Nervous System as a Thinking Mechanism" (Wives' Night)
Speaker: Hyman Olken, Lawrence Radiation Laboratory, Livermore
Place: Villa San Ramon, San Ramon, Highway 21
Dinner: 6:30 P.M., Villa San Ramon, club steak, $3.50, including tax and tip
Reservations: Carl Fernberg, Sandia, 447-5100, Ext. 2286; Berkeley, 843-2740, Ext. 5434; Livermore, 447-1100, Ext. 8011

PROFESSIONAL GROUPS

Antennas & Propagation

7:30 P.M. • Tuesday, November 27

(Joint meeting with PGCS and AIEE, see below)

Automatic Control

8:00 P.M. • Thursday, December 6

"Drag-Free Satellites, Contractor Control in Rotating Reference Frames"
Speaker: Ben O. Lange, graduate study engineer/scientist, Lockheed
Place: Electrical Engineering 126, Stanford University, Stanford
Dinner: 6:30 P.M., Rickey's Hyatt House, 4219 El Camino, Palo Alto
Reservations: Mrs. Pauline Eckman, DA 1-3300, Ext. 268

Communications Systems

7:30 P.M. • Tuesday, November 27

(Joint meeting with PGAP and AIEE, see below)

Information Theory

8:00 P.M. • Thursday, November 29

"A Threshold-Detection Theory and Its Application to Radar Astronomy"
Speaker: Dr. Robert Price, visiting professor, electrical engineering, UC
Place: Philco Auditorium, Bldg. 56, 3825 Fabian Way, Palo Alto
Dinner: 6:00 P.M., Sakura Gardens, 2116 N. El Camino Real, Mountain View
Reservations: Mrs. Radl, YO 8-6211, Ext. 2460, 2522, or 2244

Military Electronics

8:00 P.M. • Wednesday, November 21

"Satellite Control and Communications Systems," 30-Minute Movie, "Horizons Unlimited"
Speaker: Robert Vader, control and communications systems, Lockheed
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover Street, Palo Alto
Dinner: 6:30 P.M., Red Shack, 4085 El Camino Way, Palo Alto
Reservations: General Victor Conrad's office, DA 6-4000, Ext. 2212

Product Engineering & Production

8:30 P.M. • Tuesday, November 27

"Product Engineering for Computers"
Speakers: Charles Single, project engineering, John Brussolo, computer engineering, Boeing
Place: Beckman Instruments, Inc., 2200 Wright Ave., Richmond
Dinner Meeting: 6:30 P.M., Beckman cafeteria
Reservations: Richmond, Mary Nunes, LA 6-7730, Ext. 201; other, Marie Sharp, DA 4-3311, Ext. 45821; a bus may be chartered from Palo Alto if enough interest

Radio Frequency Interference

8:00 P.M. • Thursday, December 13

"Error Detecting Codes for Computer Data Communications Systems"
Speaker: Dr. Fred B. Wood, communications subsystems, IBM, San Jose
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover Street, Palo Alto
Dinner: To be announced, no reservations required

Space Electronics & Telemetry

8:15 P.M. • Tuesday, November 20

"Listening in on the Universe"
Speaker: Charles L. Seeger, acting director, Stanford Radio Astronomy Institute
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover Street, Palo Alto
Dinner: 6:30 P.M., Red Shack, 4085 El Camino Way, Palo Alto
Reservations: Tom Linders, RE 9-4321, Ext. 28394

SAN FRANCISCO SECTION OF AIEE

Communications Division

7:30 P.M. • Tuesday, November 27

(Joint meeting with PGAP and PGCS)
"The Telstar Experiment"
Speaker: Dr. Donald A. Chisholm, technical staff, Bell Laboratories
Place: Pacific Tel. & Tel. Auditorium, 140 New Montgomery Street, S.F.

There is a great deal being written today about technological achievements. But the mass of literature before the public uses the word scientific as the predominant adjective. One can read about our scientific achievements in conquering space (seldom engineering achievements) or our teams of scientists (seldom engineers) who have made our various scientific programs possible. Perhaps this explains why we are again facing an engineering shortage. Maybe we need more public relations agents to explain to the public.

I feel that parents and their children have to be made to realize that engineering is a rewarding and desirable profession. Our country's future is our children's future. It follows then that the future or our country and of the free world depends upon the education and heritage we choose to leave our children. We, as engineers, must have an interest in their education. Do we really know what is going on in our schools? Are we aware of the changes that are occurring in teaching methods? Despite its importance, many able high-school students avoid studying physics. In 1956, a large group of professors, high-school teachers, industrial scientists, and engineers organized the Physical Science Study Committee (PSSC) to do something about it. A completely new approach to the teaching and, more important, to the learning of physics has been worked out. The PSSC course presents physics as an intellectual and cultural pursuit which is part of present-day human activity.

The course begins with the fundamental ideas of time, space, and matter. The student is shown that these concepts cannot be separated and that they are a very real part of the world he sees about him. He is shown the tremendous range of dimensions from the small size of atoms to the large distance in the galaxies. Laboratory experiments are used to show how measurements are made and how their range may be extended by the use of simple instruments. After this exposure to time and space, the student goes on to study matter and its movement through space.

After presenting this broad picture of the universe, certain fields of physics are examined in more detail. Instead of beginning with mechanics, the PSSC course starts with light, because it is a

more familiar subject. The particle theory of light is introduced and, when experiments show it to be inadequate, the student is introduced to wave theory. Waves are presented, not as complex dynamical systems, but as waves on ropes and ripples on water. The colors of oil slicks and formation of images by lenses are shown to be aspects of the wave nature of light. During this portion of the course, the kinematics of the world is emphasized. The second portion of the course treats dynamics, beginning with the laws of motion and proceeding to gravity.

In the final portion of the course, electricity is introduced as a fundamental characteristic of particles previously studied. The student learns how electric forces are measured, how to determine the masses of electrons and protons, and also learns about the motion of charged particles in electric fields. The production of magnetic fields by magnets and electric currents is considered next, together with a discussion of the forces they exert on moving charges. From a study of the laws of induction some feeling is obtained for the existence of electromagnetic waves and the connection between electric phenomena and the electromagnetic spectrum.

In this way the PSSC course presents physics as a logical and integrated subject. Too hard a course? Enough to scare any boy back out to Auto Shop? I don't think so. I tracked down a copy of my high-school physics book and find most of the section on electricity devoted to a detailed description of a radio station and a radio receiver. Heat and sound appear as separate topics from electricity and light. The book is so filled with specific examples that little room is left for basic underlying principles to tie things together. To date, only about 2000 teachers are using the PSSC course and the films and lab material that go with it. Let's find out more about it and encourage this type of teaching locally.

While we are waiting for someone to develop today's ideal curriculum for the electrical engineer of the future we would do well to concentrate on stimulating today's student to continue his thirst for knowledge. To this end the section has contributed greatly. Student awards are an important activity, and the subsection intends to carry this program to the East Bay area this year.

In closing, I would like to plead the case for the open mind. As engineers, we must be particularly careful not to dismiss an idea because someone was dislike on political grounds puts it forward. The mass media do this all the time. Remember Vishinsky's statement five or six years ago that nuclear explosives could be used to move mountains, change the course of rivers, etc.? The American press poked fun at the idea. Of course it was Russian propaganda, but when we exploded an atomic charge underground to prove the potential for excavation, the idea suddenly seemed to have merit. A prejudiced mind doesn't harm one's enemy, it harms oneself. Now, more than ever before, we stand a chance of losing our technical link with other countries. It seems that our propaganda is always right; only the other fellow's jars us.

The engineer who aspires to learn has his work cut out for him in such an atmosphere. He must learn that people in general are carried along by the social, political, economic, and psychological interests of the time. He must seek patiently for the truth behind the appearance of things. Truth is hard to come by, and it may only be an approximation when it is reached. But if it is pursued in this spirit, our personal education will never cease, and, with luck and persistence, we will grow in mind as well as in years.

JOHN T. LAVRISCHEFF
CHAIRMAN
EAST BAY SUBSECTION

Olken

Price

meeting ahead

EBSS LEARNS BRAIN FUNCTION

An electronics engineer whose hobby since 1950 has been the study of the human nervous system will address the November 19 meeting of the East Bay Subsection.

"The Human Nervous System as a Thinking Mechanism" will be the subject of Hyman Olken, senior engineer at the electronics engineering department at Lawrence Radiation Laboratory, Livermore, and head of the specification group. He has developed a theory of the physiological mechanism underlying human thought processes, on which he delivered an invited paper at the Houston neurological symposium held recently.

The speaker will first outline the main features of the nervous system anatomy and will then explain a theory he has evolved on how these features accomplish mental functions. Significance of theories of brain function for new developments in communication engineering, such as random networks and neuristors, will be pointed out.

meeting ahead

THRESHOLD DETECTION THEORY

Title of the talk to be given by Robert Price at the PGIT meeting on November 29 will be "A Threshold-Detection Theory and Its Application to Radar Astronomy."

In certain communication situations, such as those encountered in radar astronomy, one needs to decide whether or not a weak random signal (generally nonstationary) is present in a background of receiver noise. Application of the statistical theory of signal detection (or "decision theory") to this problem in threshold signaling leads to receiver structures that are near-optimum; yet which employ familiar operations and are quite practical to construct.

In radar astronomy, large rotating or turbulent targets induce both multipath and doppler spreads in the reflected signal. This redistribution of the transmitted signal energy by the target can be characterized by a two-dimensional "scattering function." Knowledge of this function, together with the specification of the transmitted signal, is sufficient to determine the receiver that can best detect the presence of the target. The receiver structure thus arrived at is a logical merger of correlation and radiometry concepts that are already well understood in radar and passive radio astronomy, respectively.

Using receiver output signal-to-noise ratio as the detectability criterion, the transmitted waveform can be optimized under an energy constraint when the scattering function of the target is known. Simple target models show that low-TW signals are generally superior, and that there is an optimum length for the transmitted pulse. With the transmission and receiver optimized, the target detectability deteriorates as the product of the multipath spread by doppler spread increases, while with a simpler but generally nonoptimum matched-filter receiver the deterioration is considerably more rapid.

Robert Price received the A.B. in physics from Princeton in 1950 and the Sc.D. in electrical engineering from M.I.T. in 1953. Except for a year spent as a Fulbright Fellow in radio astronomy research at the Commonwealth Scientific and Industrial Research Organization in Sydney, Australia, he has been continuously at the Lincoln Laboratory of M.I.T., from which he is presently on leave. His interests lie in the area of statistical communication theory, and particularly in its practical application. He is a fellow of the IRE and a member of the Franklin Institute, Phi Beta Kappa, and Sigma Xi, and serves on Commission 6 of U.R.S.I.

meeting ahead

TELSTAR/AIEE/PGCS/PGAP

The Bell Telephone Laboratories department head responsible for the groups which developed the traveling-wave tube for the Telstar satellite and the ground station will address a joint meeting of AIEE, PGAP, and PGCS on November 27.

Dr. D. A. Chisholm, member of the technical staff at Bell since 1953 concerned with electron tube development, mainly reflex klystrons and traveling-wave tubes, was educated at

Chisholm

Leifer

the University of Toronto, receiving the B.S. in engineering physics, the M.A. and Ph.D. in physics. He was also a research assistant at the university in 1952-53.

wescon news

COMMITTEE CALL

Meyer Leifer, Section-WESCON director and convention chairman of the 1963 WESCON to be held at the Cow Palace August 20-23, has repeated his invitation to members of the San Francisco Section to join the committee of their choice for the event.

"We are gratified by the response to our invitation extended through the **Grid**, but the committee structure is a large one and we need more volunteers for technical programs, facilities, field trips, the banquet, the Future Engineers Show, and hospitality.

"Section members are urged once again to write me immediately at WESCON, Suite 2210, 701 Welch Road, Palo Alto, and volunteer their services. We want the committees to complete their formation as early as possible to insure smooth-working arrangements for this major event. You won't regret the time you devote to this important technical and professional endeavor."

wescon news

NEW DIRECTORS ELECTED

Hugh P. Moore and Dr. Lester C. Van Atta have been elected to four-year terms on the WESCON board of directors.

They succeed retiring members Bruce S. Angwin of General Electric Co., Los Angeles, and Donald C. Duncan of Duncan Electronics, Inc., Costa Mesa, Calif. Angwin and Duncan served as executive committee chairman and board chairman, respectively, for the record-breaking 1962 WESCON held in Los Angeles in August.

For Moore, who is president of

(Continued on page 10)

New DC to 500 mc Coaxial Electronic Switch

Primarily designed for use with a sweeping oscillator, the Kay Mega-Switch KMC 255-A is an extremely fast, accurate electronically controlled coaxial switch that displays two related waveshapes on an oscilloscope. *Superimpose calibrating reference line (3 db, 6 db..) on frequency response display or switch in reference standard to establish tolerance limits.*

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SPECIFICATIONS

Frequency range: DC to 500 mc
VSWR: Less than 1.15:1
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Switching rate: Variable 0.2 to 100 cps
Impedance: 50 ohms
Price: $345.00 F.O.B. Factory
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MORE WESCON

Technical Systems, Inc., a Los Angeles and Palo Alto technical investment firm, it will be a second board term. He served WESCON as a director from 1956 to 1960.

Moore, who has also been prominent as an officer and director of the Western Electronic Manufacturers Association, is also president of Computer Equipment Corp. of Los Angeles and is a director of Radiation at Stanford.

Dr. Van Atta, director of the Hughes Aircraft Research Laboratories at Malibu, returned to California and Hughes in 1961 after extensive service in Washington as a special assistant for arms control in the office of the Secretary of Defense. He has been very active in affairs of IRE in the West and nationally, and is presently a member of the board of directors.

On the WESCON board, Moore and Van Atta will join six continuing members, including Calvin K. Townsend, Jennings Radio Manufacturing Corp., San Jose; John V. N. Granger, Granger Associates, Palo Alto; John A. Chartz, Dalmo Victor Co., Belmont; Meyer Leifer, Ampex Instrumentation Products Co., Redwood City; Edward C. Bertolet, Behlman-Invar Electronics Corp., Santa Monica; and S. H. Bellue, Packard-Bell Electronics, Los Angeles.

Since WESCON will be held in San Francisco in 1963, the four Bay Area directors—Townsend, Granger, Leifer, and Chartz—will form the 1962-63 executive committee. Townsend will become chairman of the board and Granger will serve as executive committee chairman.

WESCON's board is traditionally made up of four directors each from the Bay Area and from Southern California, with two directors from each area representing IRE and two representing WEMA. WEMA and the Seventh Region of IRE are WESCON's co-sponsors.

consolidation notes

FIRST JOINT COMMITTEE

First consolidated effort on the IRE/AIEE section level under the IEEE merger will be in the field of education and student relations, with co-chairmen appointed by the San Francisco sections working together in this important field.

Hulse

Honey

The cochairmen are: AIEE, E. H. Hulse, head, electronics engineering department, Lawrence Radiation Laboratory, Livermore; and IRE, Richard C. Honey, technical program coordinator, electromagnetic techniques laboratory, Stanford Research Institute.

The committee works with the student branches at Bay Area colleges and universities, most chapters being jointly sponsored, and conducts an annual paper contest for engineering students which also has joint sponsorship.

meeting review

MODULATION/DEMODULATION

The joint meeting of PGMTT and PGED at Stanford on September 26 heard Professor A. E. Siegman talk about modulation of beams of light. Professor Siegman has been engaged in work of this type at Stanford during the past year.

The basic demodulator consists of a photo cathode followed by an ordinary microwave tube circuit. The most commonly used structure is a traveling wave tube, but the first device, built in 1955 was a klystron. At present, Sylvania is manufacturing a photo traveling wave tube with an optical cathode, but otherwise similar to their usual L-, S-, and X-band traveling wave tubes.

The photo cathode is a square-law device; that is, the beam current is proportional to the square of the electric field of the light beam. The detection scheme can operate in either the video mode (detecting a microwave frequency signal on a single light beam) or the heterodyne mode (detecting the beat frequency between two optical frequencies). Because the ruby laser operates at several optical frequencies, the photo cathode can detect microwave beat frequencies from a single laser.

Heterodyne Scheme

Optical receivers will probably em-

ploy the heterodyne scheme, for it has advantages in frequency selectivity and angular discrimination. The best optical filters pass a band 100 gc wide, but a heterodyne system, detecting only at the intermediate frequency, could look at much narrower bandwidths. And the local oscillator and received signals must be exactly parallel when they strike the detector surface. Otherwise, the beat frequency will vary in phase across the face of the detector and will be canceled out in the resulting current. This property enables the detector to serve also as a high-gain antenna.

A modulator has been built using a microwave cavity and a bar of KDP (KH_2PO_4). Crystals of KDP exhibit a nonuniform directional dielectric constant when subjected to an electric field. This property is employed to produce elliptical polarization on a polarized light wave passing through the cavity. The simplest device consists of a cavity, containing the crystal of KDP, resonating in the TM_{010} mode. The unmodulated light beam is fed through a polarizer and into one end of the cavity. It then passes through the KDP crystal which is at the center of the microwave electric field. Here the two perpendicular components of the light wave are delayed unequal amounts to produce elliptical polarization. The now modulated light beam then leaves the cavity and passes through a second polarizer to produce an amplitude modulated, linearly polarized beam. Several other crystals can be used as modulators, including ADP ($NH_4H_2PO_4$), ZnS, and CuCl. The last two look very good electrically, but have proven difficult to grow. A modulator employing KDP has produced 15 percent modulation on a laser beam when driven by one watt at 3 gc.

PIN Diode

A second demodulation scheme uses a PIN diode (a three-layer diode having positive- and negative-doped regions separated by a layer of intrinsic material). When the diode is properly biased, all carriers are swept out of the intrinsic region and no current flows. But, if the intrinsic region is then bombarded by light, electrons are freed and flow out in the form of a detected current. The diode can operate over a much broader part of the spectrum than can the photo cathode, the latter be-

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ing sensitive only within a portion of the visible spectrum while the diode works through the infrared region. The phototube, however, is superior in terms of bandwidth and equivalent resistance. A typical tube can operate over a 3:1 bandwidth with a resistance greater than 100K ohms, but the diode, limited by shunt capacitance, has no more than 1000 ohms impedance, in a 5- to 10-percent frequency band.

The most common use envisioned for modulated light beams is as a communication carrier. Such a system could have a bandwidth of several thousand megacycles and a beam width of only a few miles at distances as great as that to the moon. Other possible uses exist in the fields of surveying and astronomy, where distances could be measured to small fractions of a microwave wavelength, and emitted light studied for possible natural modulation frequencies.

ROBERT JOE PRICKETT

meeting review

BINARY SUPERPOSITION

The first fall meeting of PGIT was held late in September, at the Philco auditorium in Palo Alto. The speaker, Dr. William H. Kautz, addressed an audience of about 30 on the subject, "Data Communication through Binary Superposition Channels." Dr. Kautz is a senior research engineer, specializing in switching theory, coding theory, and logical design at SRI's computer techniques laboratory.

The speaker described a new family of binary codes developed originally for an information retrieval application. The first portion of his talk was concerned with this retrieval application, then a possible communications application of these novel codes was sketched. Finally, the third and major portion of the discussion centered on detailed properties of the codes, and techniques for constructing them.

Retrieval Application

The retrieval application was described in terms of a model for information retrieval from a large file of documents—10,000 to 1,000,000 documents. Each document is provided with an accession number and a set of relevant descriptors. These descriptors are chosen from a dictionary of terms, and each such descriptor is assigned a binary code word of fixed length, n, containing a small number

of binary 1's. The coded descriptors pertaining to any given document are superposed on the same n-bit field. Superposition here means a bit-wise inclusive-OR operation (as in the punching of holes in a card). An individual in search of information concerning, say, superconductive thin films consults the dictionary of terms and finds "superconductivity" and "thin films" among them. The n-bit code vector obtained by superposition of the coded descriptors for "superconductivity" and "thin films" is used as a "quiz word" against the entire document file. The test is on logical inclusion (rather than identity match); thus, any document whose superposed descriptors have 1's in each position where the quiz word has 1's will be caused to "drop out," i.e., be selected for the searcher's attention. Among the documents (accession numbers) thus called to attention will certainly appear all documents bearing both desired descriptors. However, other documents also may appear in the output, since the fortuitous combination of 1's from entirely unrelated descriptors may place 1's in all the specified positions. Such documents are called "false drops"; they are rejected only by user inspection. Clearly, a useful system must have a fairly low false-drop rate.

Existing Systems

Systems are in existence that employ this kind of superposed coding for document retrieval. In the past, coding assignment of descriptor codes for these systems has been accomplished by random selection of code words, with some weeding out of obviously interfering codes. (For example, the same or nearly the same code words should not be assigned to different descriptors.) Such randomly selected codes will still suffer, of course, from false drops. However, the false-drop rate is statistically predictable, at least on the basis of suitable randomness assumptions. In practice, these assumptions are not always met. For example, not all descriptors are used with the same frequency, nor are they used independently of each other. Thus, the predicted false-drop rate for ramdomly selected superposed codes is only a rough guide.

Random superposed codes suffer from another limitation relative to the desired retrieval application. It was

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required that document codes be uniquely decomposable into the original set of descriptors from which they were composed, assuming that no more than a given number, m, of descriptors apply to each document. A code with this property is called "uniquely decipherable to order m," or "UD_m" for short. Random superposed codes fail to possess this property.

Kautz/Singleton

The codes developed by Dr. Kautz and his associates, principally Dr. R. C. Singleton, are specifically tailored to provide this UD_m capability by systematic assignment of descriptor codes. Moreover, they possess zero false-drop rate when no more than m descriptors are superposed per quiz word used for searching. Thus, these codes are also "ZFD_m codes" (zero false drops to order m). The speaker indicated later that these two properties are related in an interesting way.

A possible application of these ideas to communications was pointed out. Consider the problem of sharing n channels of the frequency spectrum among N transmitters, where $N > n$. This is usually done on a specific time and frequency basis, with exclusive assignment of a given frequency to a given transmitter (at least for certain hours of the day). However, using the concept of superposed coding, one might assign to each transmitter several channels of the whole "field" of n, selected either randomly or on the basis of Kautz's codes. If no more than m transmitters are "on" at a given time, it should still be possible for a receiver to extract the desired information from one transmitter, even though other transmitters may be simultaneously using some of these frequencies. Similar schemes have been suggested by Costas (see Proc. IRE, Dec. 1959, pp. 2058-68). They may be more efficient in the utilization of bandwidth in congested situations than conventional frequency assignment techniques.

Code Construction

The formal problem of superposed code construction is as follows: "Find a large number N of n-bit code words, such that for a given integer, m, every (inclusive-OR) sum of up to m words is (a) distinct from all other such sums (UD_m property), or (b) does not logically include any other code word (ZFD_m property)."

In order that the resulting code be efficient, it is, of course, desirable that N be as large as possible. The speaker pointed out that very little is known about this optimality question.

The relationship referred to earlier is the implication:

$ZFD_m \Rightarrow UD_m \Rightarrow ZFD_{m-1}$, etc.

In the connection, there is also an interesting analogy to the properties of standard error-correcting codes.

Construction of these superposed codes was first described in terms of a constant, w, the number of 1's per descriptor code. Codes with $w = 1$ yield the trivial code with $N = n$ that is ZFD_n. For $w = 2$ one can find UD_2 codes for which N behaves roughly as $n^{3/2}/2$. Actual values of N for small n are:

n =	4	5	6	7	8	10	. . .	50
N =	3	5	6	8	10	15	. . .	175

These UD_2 codes were constructed by an ingenious graph-theoretical approach. In fact, let the n nodes of a linear graph be interpreted as positions of 1's in a word, and let a branch joining two nodes represent a weight-two descriptor code. Then the problem of constructing UD_2 codes is seen to be equivalent to finding linear graphs of n nodes and N branches which contain no closed loops of fewer than five branches (i.e., no triangles and no quadrilaterals). The maximum values of N are shown above.

Techniques using balanced incomplete block designs (and partially balanced incomplete block designs) may be employed to construct ZFD_2 codes with $w = 3$, 4, etc. For these codes $N \sim n^2/6$.

Dr. Kautz described in some detail how the properties of error-correcting codes can be exploited to construct UD_2 for which $N = 2^{n/4} - 1$. They are obtained by first selecting a parity check matrix for a double-error-correcting Bose-Chaudhuri code of length N. This matrix will have N columns and n/2 rows. Consider the column vectors of this matrix. Each column vector is doubled in length (to n) by replacing zeros by the digits, 01, and by replacing ones by the digit pair, 10. The resulting set of N vectors form a UD_2 code.

Latin Squares

Other techniques for construction of superposed codes involve the use of Latin squares to permit the com-

position of given codes to yield larger codes. For example, a given UD_2 code with parameters n and N can be iterated to yield a UD_2 code with parameters, $n' = 3n$ and $N' = N^2$. Extension of this technique by using sets of orthogonal Latin squares yields a ZFD_m code with parameters $n'' = (m+1)n$ and $N'' = N^2$, provided that it is possible to find $m - 1$ orthogonal Latin squares of size N by N. (This is known to be possible for $m \leq N$ if N is a power of a prime number.)

As an example of this technique, Dr. Kautz mentioned that the (trivial) code with $n = N = 8$ and $w = 1$ could be iterated to yield first a ZFD6 code with $n' = 56$ and $N' = 64$, which can in turn be iterated to result in a ZFD6 code with $n = 392$ and $N = 4096$. A randomly selected code for $N = 4096$ would need $n = 100$ in order to reduce the false-drop probability below 10^{-4}. However, the deterministic code is better in terms of its guaranteed performance level, the lack of dependence of this performance on descriptor frequency and interdescriptor correlation, and also its unique decipherability up to six constituent descriptors.

Several other construction techniques were mentioned, among them the use of nonbinary error-correcting codes as a starting point, and also other composition methods.

Unknown Optimals

During the question-and-discussion period following the lecture, Dr. Kautz was asked if these codes were in any sense optimal. His answer was essentially that almost nothing is known regarding this point; the information theoretic point of view has not yet shed any light on it. Another questioner asked if multidimensional extensions of Latin squares, e.g., Latin cubes, had any application here. Dr. Kautz's answer indicated that there are a number of different generalizations of this sort—most of them not applicable to the coding problem. The possible use of some sort of Latin hypercube, as well as some other composition methods, is the subject of present study. He plans to publish this material early next year.

The small, but alert, audience present at the lecture seemed to be quite intrigued by the novel ideas presented by Dr. Kautz, judging by the

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number of impromptu groups seen discussing these ideas during the coffee break which followed the lecture. It was felt that the 1962-63 season had got off to a flying start by this stimulating talk.

BERNARD ELSPAS

meeting review

PGCS MEETING WITH AIEE

On September 25 Cecil M. Kortman, manager, systems design, electronic systems, research and engineering, Lockheed Missiles and Space Company, presented an informative and interesting paper, titled "Sample Data Telemetry for Satellite Applications," to a joint meeting of the Communications Divisions of AIEE and PGCS. The paper was supplemented by a large number of excellent slides depicting both systems' concepts and actual hardware.

Mr. Kortman laid the groundwork for his paper with the past history of satellite telemetry, going back to the utilization of the early FM/FM systems. The various classes of data normally handled between the space vehicle and the tracking station were analyzed with respect to the basic requirements of speed and accuracy. These requirements were then compared with the capabilities of the various present-day modulation techniques.

Examples of past and present packaging of the space-vehicle hardware emphasized the progressive strides that have been made in this field.

Photos of tracking-station facilities illustrated the high degree of integration required by these systems. Ground-station predetection recording techniques, demodulation techniques, and analogs to digital converters were described. Also considered from the system data analysis flow chart was the reduction of redundancy that could be achieved in data processing.

MAURICE H. KEBBY

meeting review

NOISE IN OPTICAL MASERS

The October 17 meeting of PGED/PGMTT at Stanford heard Dr. William Louisell, visiting associate professor, now on leave from Bell Telephone Labs, speak on quantum noise in optical masers, showing that the limit of sensitivity of the optical maser is determined by what is called quantum noise. The problem was treated by statistical methods, and the results give a noise figure that is in agreement with experimental data.

First, giving a brief review of the changes necessary to convert from a classical formulation of a problem to a quantum formulation, Dr. Louisell discussed the harmonic oscillator and the electromagnetic field in a cavity. These problems were set up in almost identical manner, and in fact the electromagnetic field in the cavity could be considered to be a collection of harmonic oscillators with a total energy equal to the sum of the energy of the individual harmonic oscillators. Then to change to a quantum formulation of the problem, the two variables, momentum, and position or electric and magnetic field, which commute in the classical problem, are now restricted so that the commutator of these two variables (now considered as operators) is $i\hbar$. The electric field in the cavity now may only have certain discrete values, that is, only a value corresponding to some integral number of photons.

The formulation of the problem in statistical terms involves setting up a function of the field amplitude which will give the probability of the field having any given amplitude. It is possible to set up a generating function which will give all properties of interest for the system merely by differentiation, instead of integrating separately to find the various moments required.

The example used to depict the amplifier or attenuator was a cube of material in which atoms are being excited by radiation from outside. It was assumed that the atoms had previously reached an equilibrium temperature with a Boltzman distribution of energy. Then for the cast of no input signal and no input noise, the statistical generating function was obtained. This generating function showed that there was an output noise signal even with the zero input conditions, which must then be of quantum origin. The energy distribution in this noise signal is gaussian and at optical frequencies corresponds to a temperature of about 10,000°K/photon and, at microwave frequencies, corresponds to only a fraction of a degree. It was pointed out, however, that the very high equivalent noise temperature at optical frequencies is not a meaningful param-

(Continued on page 19)

LaForge

Egan

Barger

Beadling

Fields

Dugan

grid swings

IT IS REPORTED:

Louis LaForge has been appointed manager of engineering for Stewart Engineering Co., Santa Cruz, responsible for research and development of new products and techniques.

Dr. Raymond D. Egan has been appointed to the new position of manager, advanced communications, at Granger Associates, with responsibility for development of advanced communications systems.

Elma C. Dewar has joined Applied Technology, Inc., as supervisor of the company's technical publications department.

Dale Barger has been named assistant production manager of Alfred Electronics.

David Beadling, former manager of Fairchild Semiconductor's diode plant in San Rafael, has been appointed to the new post of director of planning.

Dr. James N. Shoolery has been appointed sales manager, instrument division, Varian Associates, with responsibility for sales promotion and service engineering of NMR and EPR spectrometers and laboratory magnet systems.

Franz C. McVay has joined Applied Technology, Inc., as senior engineer.

Richard L. Fields has been named field application engineer with T. Louis Snitzer Co. in the Sunnyvale office after four years as senior design engineer for spaceborne equipment at Philco Corp.

Robert W. Dugan has been named marketing director of Amelco, Inc., Mountain View, marking expansion of the firm's marketing program in the areas of planar transistors, microcircuitry, special assemblies, solar cells, and special products dealing with solid-state technology.

Richard B. Mulock has joined Lenkurt Electric Co., Inc., as a reliability consultant in commercial products engineering.

Groff

Orth

Denver R. Groff has been appointed to the newly created position of personnel manager for Stewart Engineering Co., Santa Cruz, with initial responsibility of establishing a recruiting program for professional and technical personnel.

Richard T. Orth, former vice president of operations of Eitel-McCullough, Inc., has been appointed to the newly created post of vice president, general manager, coincidental with the resignation of Gould Hunter, vice president of administration, corporate secretary, and board member.

Charles J. Chapin has been named consultant and special advisor to Coastal Publications Corp. of New York and California, with headquarters at the new Palo Alto office at 4103 El Camino Way. His principal functions will be the analysis of the documentation required to support complex systems and systems' interfaces and associated management problems.

Chapin

Jardine

Carl T. Jardine has been appointed products sales manager at Philco Corp.'s WDL and will direct marketing activities in areas of tracking telemetry and control systems.

Douglas R. Hayward, former director of public relations at Lenkurt Electric Co., Inc., has been named assistant director of public relations at United Technology Corp., Sunnyvale.

Koller

Granger

Gordon W. Koller has been named manager of the Sunnyvale office of Market Street Van & Storage after two years as sales manager and ten years with the firm.

Dr. John V. N. Granger, president of Granger Associates, was the keynote speaker at the 6th National Conference on Product Engineering and Production at the Jack Tar Hotel, San Francisco, on November 1.

events of interest

Dec. 4-6—**FJCC (Fall Joint Computer Conference).** Sheraton Hotel, Philadelphia, Pa. Exhibits: R.A.C. Lane, RCO Bldg., 204-1, Camden 8, N.J. Program: E. Gary Clark, Burroughs Research Center, Box 843, Paoli, Pa. Proceedings.

Dec. 6-7—**PGVC (PG on Vehicular Communications) Conference.** Disneyland Motel, Los Angeles, Calif. Exhibits: Leslie M. Walker, LA County Dept. of Comm., 500 West Temple St., Los Angeles 12, Calif. Program: W. J. Weisz, Motorola, Inc., Comm. Div. 4545 W. Augusta Blvd., Chicago 51, Ill. IRE TRANSACTIONS on Vehicular Communications.

Jan. 8-10—**Millimeter and Submillimeter Conference.** Cherry Plaza Hotel, Orlando, Fla. Program: J. W. Dees, Martin Co., P.O. Box 5837, MP-172, Orlando, Fla.

MORE REVIEW

eter because of the extremely high frequency.

Thus the limiting sensitivity of an amplifier is finally determined by noise of a quantum nature as obtained by statistical methods. The discussion also showed that the methods of classical statistical analysis may be applied to the quantum problem by adding the above-mentioned quantum noise. The same results are obtained if the amplifier is replaced by an attenuator.

MAHLON FISHER

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Wallson Assoc., Inc.	Perlmuth Electronics
Ward-Leonard Company	Long & Assoc., Inc.
Waters Corporation, The	G. H. Vaughan
Watkins-Johnson Co.	Perlmuth Electronics
Western Sky Industries	Premmco, Inc.
Western Ultrasonics, Inc.	J. T. Hill Co.
Westrex Div. Litton Industries	American Wireless
Wilk Instruments	V. T. Rupp Co.
Wiltron Co.	O'Halloran Associates
Wincharger Corp. (Zenith Radio Corp.)	Premmco, Inc.
Winchester Electronics, Inc.	Long & Assoc., Inc.
Winslow Electronics, Inc.	Peninsula Associates

REPRESENTATIVE DIRECTORY

McDonald Associates
716 Wilshire Blvd.,
Santa Monica; 394-6610

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15 - 41st Avenue,
San Mateo; FI 5-7961

Neely Enterprises
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LY 1-7661; 1317 - 15th St.,
Sacramento; GI 2-8901

O'Halloran Associates
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Peninsula Associates
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WH 8-3334

Striker Company, John E.
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DA 3-4606

Whychell Company, T.
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MEMBERSHIP

Kennedy

Jensen

Following are the names of members who have recently been transferred to a higher grade of membership as noted:

Senior Member

Floyd J. Jensen
Hugh D. Kennedy

Member

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R. B. Barnett
W. D. Boltz
C. R. Ditzen
D. E. Fisk
Brian L. Jones
E. W. Malone
I. B. Oldham
J. R. Peoples
R. S. Pepper
R. M. Richardson
W. H. Slattery
G. H. Wilson

Associate

K. H. Kimura
D. E. Otvos

Following are the names of IRE members who have recently entered our area, thereby becoming members of the San Francisco Section:

E. Abrahamson
D. L. Albertson
W. D. Beers
R. H. Brazeal, Jr.
J. D. Bruce
R. A. Christensen
G. J. Coe
R. De Sobrino
J. A. Doub
G. S. Downs
M. V. Duffin
J. S. Eggenberger
P. S. Farrelle
T. H. Fine
D. I. Gildenberg
S. Gordon
J. E. Green
F. G. Griffin
D. W. Grimes
D. J. Herick
T. F. Hou
Jen Hsu
A. J. Keicher
R. S. Kong
E. D. Lawrence
H. D. Limbaugh
L. S. Litman
J. R. Long
R. A. Magnuson
J. C. Moffatt
R. A. Mueller
A. E. Negrin
G. A. Panec
M. B. Parmett
E. D. Parr
J. H. Peterson
O. Puris
J. L. Reinartz
W. D. Silva
W. L. Skinner
L. D. Smithey
S. Stein
R. D. Stine, Jr.
G. P. Strong
R. G. Suchannek
P. D. Thomas

Following are the names of individuals who have been elected to current membership:

E. A. Sutherland
A. E. Sutorus
V. M. Turesin
M. J. Twite, Jr.
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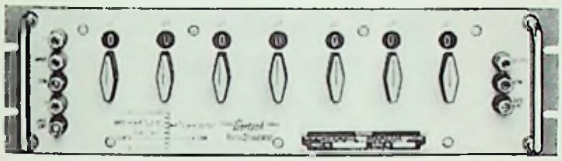

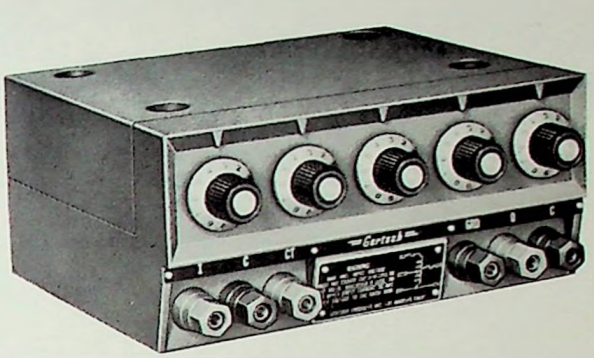

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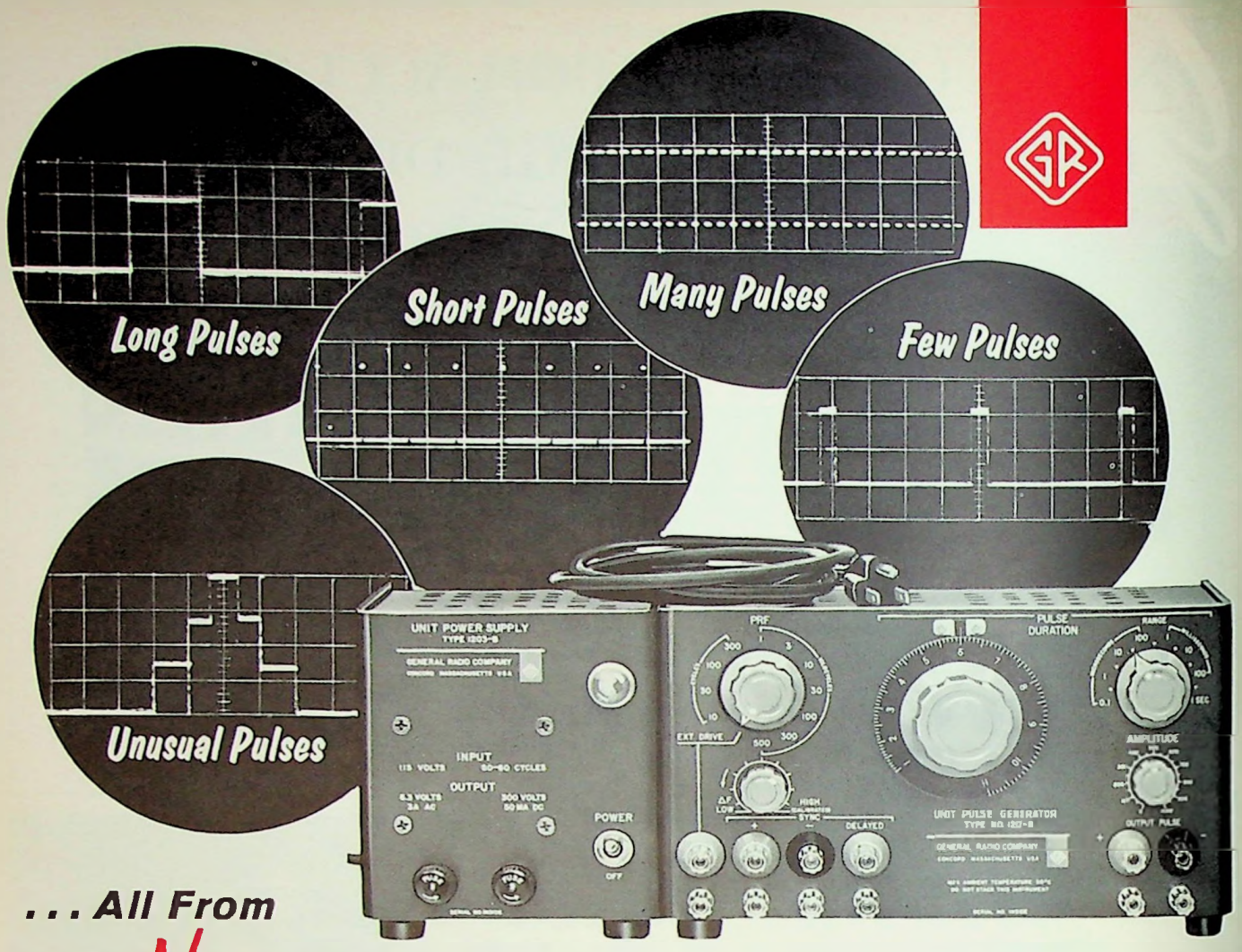

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