EDITOR'S PROFILE of this issue

from a historical perspective …

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

November, 1961:

Cover: Joe Roizen, working on video tape recording for Ampex in Redwood City, carries his instrumentation with him. One of my companies – DataDisk (later renamed AmComp) – made a digital broadcast disk recorder based on a head-per-track disk drive; the BDR-500 was used by early TV stations to record and recall sports action for instant replay and slow-motion repeats over their networks.

p. 6: Prof. Bernie Widrow of Stanford talks on "Digital Information in Networks of Adaptive 'Neurons'", following up on the September 1961 GRID front cover with the memrister emulation (the ADALINE).

p. 9: Ed Ginzton reports on the life of Sig Varian, killed at the age of 60 when his light airplane crashed off the coast of Mexico. With his brother Rus, he was inventor of the klystron in 1937-39, a key device that opened up microwave communications and high-definition radar, as well as linear accelerators and cancer radiation therapy. He was also a principal in starting Varian Associates.

p. 22: A photo shows the 150-foot dish being lifted onto its mount on a hill behind the Stanford campus. The parabola weighs 70 tons.

p. 22: Spectra-Physics is formed by four founding members to engage in research in laser physics and devices. The laser was invented only three years before, by Charles Townes and Arthur Shawlow of Bell Labs. When I took physics at Stanford in 1963-64, Shawlow had joined the faculty; he brought a clear balloon with a Mickey Mouse balloon inside it into the room – then used a laser to burst the internal balloon without puncturing the outside one. It was impressive! Spectra-Physics released its point-of-sale laser scanner in 1974.

Archive of available SF Bay Area GRID Magazines is at this location:
https://ethw.org/IEEE_San_Francisco_Bay_Area_Council_History

At time of scanning, the bound volumes are held by Paul Wesling. January, 2021 Contact p.wesling@ieee.org


kleine Störung
KØBENHAVN
RAI
DANMARK
Grid
NOVEMBER 1961
GENÈVE
SAN FRANCISCO SECTION
IRE

flexible power for
forward scatter

75 kW CW to 10 kW

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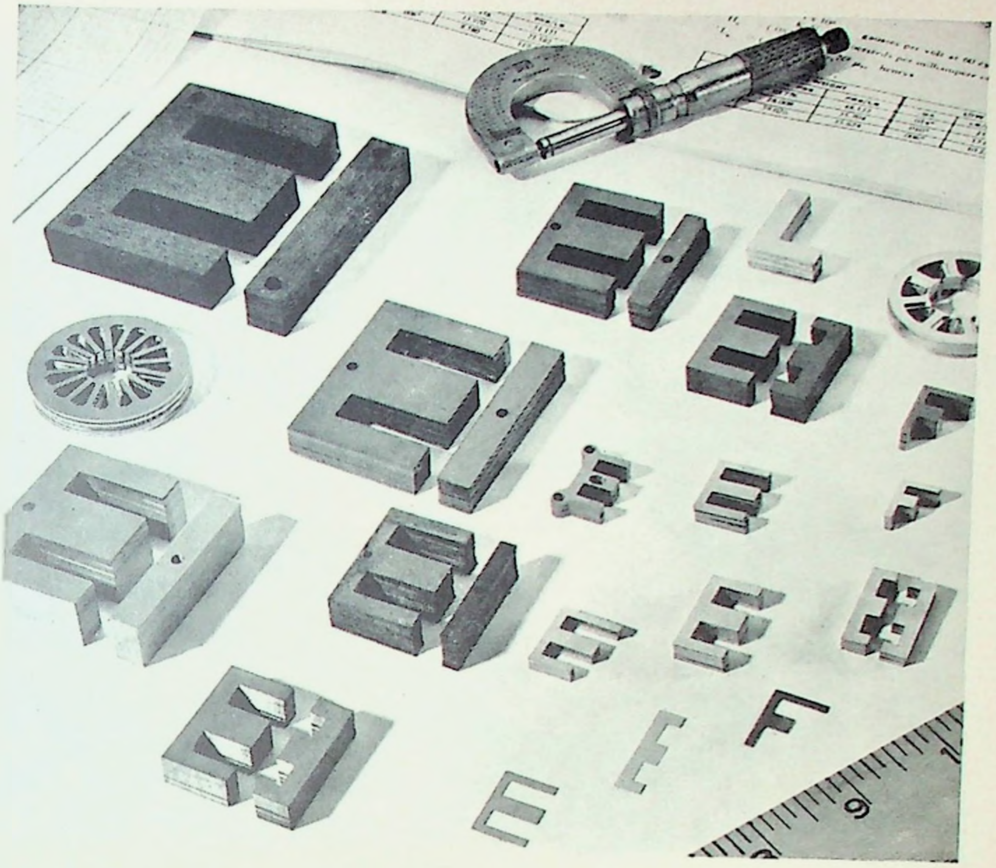

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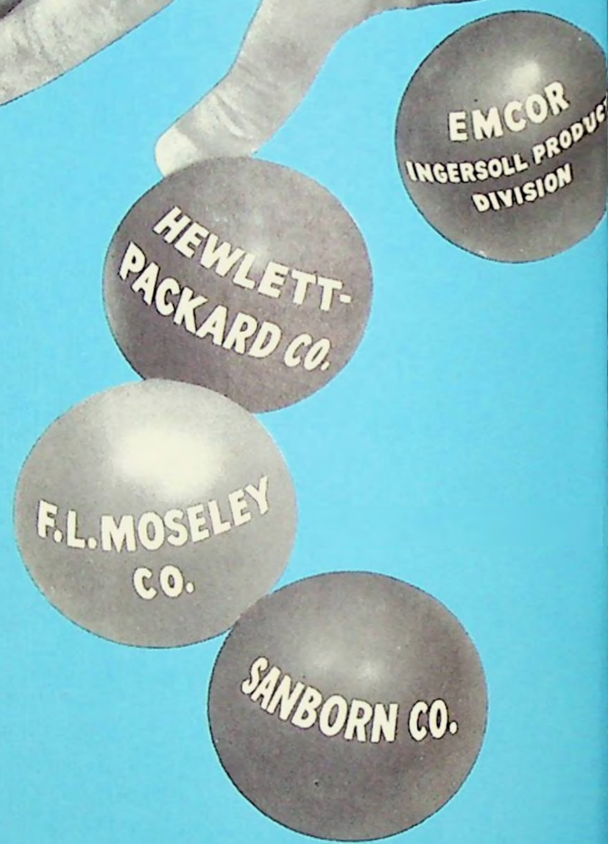

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cover

Joe Roizen, multilingual peripatetic Ampex video consultant, recently returned from a year in Europe devoted to various aspects of vtr technology in that area. On the cover he appears, against a background of European test and identification patterns, bearing full equipment—tailored precisely to airline weight maxima—for plying his specialty: demonstration tapes, slides, technical manuals, cameras, etc.

Plans are presently being made for local meetings at which his experiences may be shared by the Section.

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MEETING CALENDAR

SAN FRANCISCO SECTION — 8:00 P.M. • Wednesday, Nov. 29

(Joint meeting with PGEM)
"The Interplay of Science and Government"
Speaker: Sir Robert Watson-Watt, governing director, Sir Robert Watson-Watt & Partners, Ltd.; chairman, advisory board, Axe Science & Electronics Corp., London, England
Place: Room 310, LeConte Hall, University of California, Berkeley
Dinner: 6:00 P.M., Faculty Club, University of California
Reservations: DAvenport 1-1332 or THornwall 5-6000, Ext. 2660, before noon, November 29

EAST BAY SUBSECTION — 8:15 P.M. • Monday, Nov. 27

"Microminiaturization"
Speaker: G. W. Rollosson, Sandia Corporation, Albuquerque
Place: Lucky Lanes, Railroad Avenue, Livermore
Dinner: 6:30 P.M., Lucky Lanes
Reservations: Winopher Veeder, THornwall 3-2740, Ext. 5451; or Chris Widger, HIghgate 7-5100, Ext. 2470; by Nov. 22

PROFESSIONAL GROUPS

Antennas & Propagation — 8:00 P.M. • Wednesday, Dec. 13

"An Experimental Spherical Reflector Antenna"
Speakers: Robert F. Trainer and William M. Young, Lockheed, Sunnyvale
Place: Main Conference Room, Building 1, Stanford Research Institute
Dinner: 6:30 P.M. (Social Hour 6:00 P.M.), The Red Shack, 4085 El Camino Way, Palo Alto
Reservations: Sandy Torrey, DA 1-3300, Ext. 392

Audio — 8:00 P.M. • Wednesday, Dec. 6

(Joint meeting with the Audio Engineering Society)
"Measurements in Architectural Acoustics"
Speaker: Dr. Vincent Salmon, Stanford Research Institute
Dinner: 6:30 P.M. (Cocktails 6:00 P.M.), Ramor Oaks, 3435 El Camino Real, Atherton
Reservations: Stan Oleson, DA 6-6200

Bio-Medical Electronics — 8:00 P.M. • Tuesday, Nov. 21

"Programmed Learning: Some Experimental Findings"
Speaker: Dr. David McConnell, Brittanica Center, Menlo Park
Place: Room M-112, Medical School Building, Palo Alto-Stanford University Medical Center. Room M-112 is located in the courtyard of the wing in the Center nearest Hoover Tower. Approach from Palm Drive on Stanford Campus, the extension of University Ave., Palo Alto
Dinner: 6:00 P.M., Red Cottage Restaurant, 1706 El Camino, Menlo Park
Reservations: Ken Gardiner, DA 6-6200, Ext. 2659

Communications Systems — 8:00 P.M. • Wednesday, Dec. 6

(Joint meeting with U.C. Student Chapter, IRE)
"Out of This World"
Speaker: Lester E. Reukema, professor emeritus, University of California
Discussion and demonstration of U.C. television communications system by Ken Winslow, head, television office, U.C.
Place: Room 155, Dwinelle Hall (inside Sather Gate near Bancroft Way and Telegraph Avenue), Berkeley
Dinner: 6:30 P.M., Room B, Dining Commons. Enter through Golden Bear Restaurant Terrace, Student Center Cafeteria (outside Sather Gate, near Bancroft Way and Telegraph Avenue, Berkeley)
Reservations: THornwall 5-6000, Ext. 2535

Electronic Computers — 8:00 P.M. • Tuesday, Nov. 28

"Associative Storage and Retrieval of Digital Information in Networks of Adaptive 'Neurons'"
Speaker: Prof. Bernard Widrow, Stanford Electronic Laboratories
Place: Lockheed Auditorium, 3251 Hanover Street, Palo Alto
Dinner: 6:00 P.M., The Red Shack, 4085 El Camino Way, Palo Alto
Reservations: None required

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MEETING CALENDAR

Engineering Management • Wednesday, Nov. 29
(Joint meeting with San Francisco Section, see above)

Engineering Writing & Speech 8:00 P.M. • Tuesday, Nov. 21
Subject and speaker to be announced
Place: Conference Room, Bldg. 3, Sylvania MVO, Whisman Rd., Mt. View

Information Theory 8:00 P.M. • Thursday, Nov. 30
"A Generalization of Woodward's Theorem on FM Spectra"
Speaker: Dr. Nelson M. Blachman, Sylvania EDL
Place: Lockheed Auditorium, 3251 Hanover Street, Palo Alto
Dinner: To be announced

Instrumentation 8:00 P.M. • Tuesday, Nov. 21
"Frequency Standards Using Atomically Stabilized Oscillators
Speakers: Principles of Operation—Dr. Martin Packard, director of research, instrument division, Varian Associates; Systems Application—Dr. Ross Graves, associate director, communications laboratory, Space Technology Laboratories
Place: Conference Room, Building 1, Varian Associates, 611 Hansen Way, Palo Alto
Dinner: 6:00 P.M., Camino Bowl (Aztec Room), 2025 El Camino Real, Mountain View
Reservations: DA 1-1332 by Nov. 21

Military Electronics December
Social meeting—date and details to be announced

Product Engineering & Production 8:00 P.M. • Tuesday, Nov. 28
"Coatings and Finishes"
Panelists: Don Brown, Parker Rust Proof Co.; Harry Hall, John L. Armitage & Co.; Kenneth King, Hewlett-Packard Co.; and Cal Probst, Minnesota Mining & Manufacturing Co.
Place: Building 4B, Varian Associates, 611 Hansen Way, Palo Alto

Radio Frequency Interference 8:00 P.M. • Tuesday, Nov. 21
"Interference Considerations in Communication Satellites"
Speaker: John J. Downing
Place: Building 202, Lockheed, 3251 Hanover Street, Palo Alto

Space Electronics & Telemetry 8:00 P.M. • Tuesday, Nov. 21
"The State of the Art in High-Power Ground-to-Space Transmitters"
Speaker: Ernst R. Altschul, senior project engineer, Radiation at Stanford
Place: Bldg. 202, Lockheed Auditorium, 3251 Hanover Street, Palo Alto
Dinner: "Meet-the-Speaker" dinner, 6:30 P.M., Camino Bowl, 2025 El Camino Real, Mountain View
Reservations: Cynthia Chaney, DA 1-8010, Ext. 64, by Nov. 21

CHRONOLOGICAL RECAP

November 21—Bio-Medical Electronics, Engineering Writing & Speech, Instrumentation, Radio Frequency Interference, Space Electronics & Telemetry
November 27—East Bay Subsection
November 28—Electronic Computers, Product Engineering & Production
November 29—San Francisco Section/Engineering Management
November 30—Information Theory
December 6—Audio, Communications Systems
December 13—Antennas & Propagation
December Social—Military Electronics

Sir Robert Watson-Watt, speaker at the November SFS/PGEM meeting

meeting ahead

SCIENCE VIS-A-VIS GOVERNMENT

Sir Robert Watson-Watt will address a meeting jointly sponsored by the San Francisco Section and the Professional Group on Engineering Management during November. Details are included in the Calendar, page 6. In his distinguished career in radio physics in Great Britain, he first pioneered radio location of atmospheric disturbances and then laid the foundations for radar.

Sir Robert will discuss the important relationship of science and government in present-day affairs. This involves the evaluation of scientific matters in relation to human affairs and the harder task of conveying these points of view to government officials and frequently the public.

Radar was essentially a military development and for this reason parallel lines of conception and development occurred in several countries prior to World War II. Watson-Watt's role is unique in that he is solely credited in England for the idea, enlisting government support, and carrying out the establishment of this powerful electronic method.

Watson-Watt was born in Scotland in 1892 and remained there through his college days. After graduation from Dundee College of the University of St. Andrews, he accepted a post in the department of meteorology in London. He conceived the method of radio location of storms and carried out the establishment of this method in the department of scientific and industrial research. It was not until World War II, two decades later, that this method was fully implemented and established as a meteorological method.

Watson-Watt was knighted in 1942 for his important scientific accomplishments. He is a Fellow and former vice president of the IRE. He is now living

(Continued on page 8)

Lester Reukema

MORE SCIENCE

in New York State and is occupied in writing and lecturing.

The program will be of wide general interest and Section members may wish to invite friends and associates to this outstanding event.

meeting ahead

TOWARD OTHER WORLDS

Early in December (see Calendar, page 6) an unusually interesting program will be presented jointly by PGCS and the University of California Student Chapter. Lester Reukema, professor emeritus in electrical engineering at the University and a past chairman of the Section, will be the principal speaker.

"Out of This World" is the topic that aptly describes Reukema's lecture on space communications as they will eventually be developed between interplanetary creatures traveling within and outside of our solar system. Reukema is one of the world's best informed and most stimulating speakers on this subject. This will be a non-technical meeting that will be enjoyed by wives and teenage sons or daughters as well.

Reukema, a Fellow of the Institute, has combined a remarkable technical career with a continuing interest in sports and the out-of-doors as represented by the national parks of the United States and Canada. His government service has extended through both World War I and World War II, with important projects relating to, respectively, underwater sound and electromagnetic radiation. His list of publications and current interests and activities exceeds the space possibilities of these pages.

As an added feature of the meeting, the Marconi 4½-inch image-orthicon television camera, video tape-recording facilities, and mobile unit will be described and demonstrated. This equipment is used to record University classes for review and for delayed presentation, to alleviate the classroom shortage and to accommodate student's schedules.

The dining room at the new Student Center, location of the dinner, is just across the creek from Dwinelle Hall. The parking garage under the student union and dining commons is entered from Dana Street opposite the Harmon Gymnasium.

Vincent Salmon

meeting ahead

BUILDING AUDIO

Early in December—as detailed on the Calendar, page 6—Dr. Vincent Salmon of Stanford Research Institute, a widely known authority on the subject, will discuss measurements in architectural acoustics before a joint meeting of PGA and the San Francisco Section of AES. His subject will be divided into a three-part discussion as follows: 1) subjective criteria by which listening qualities of a room are judged, 2) objective measurements that are now used, and 3) the difficulties in making measurements and correlating (1) & (2).

meeting ahead

STABLE ATOMS

Linking a prominent line in the spectrum of an excited atom—with its invariant frequency—to a stable (quartz) oscillator for useful output as a standard of frequency involves techniques of concern to the instrumentation engineer. The program of the November PGI meeting is planned to answer the questions—How does it work? and How do you make it work? The Calendar, page 7, gives full particulars on the meeting.

The two speakers are Dr. Martin Packard and Dr. Ross Graves. Packard, originally from Oregon State, did his postgraduate work at Stanford and earned his PhD in 1949. He joined Varian in 1951 and is presently director of research for the instrument division. Graves' undergraduate work was done at MIT with subsequent work at the University of Minnesota where he took his PhD in pure mathematics. He is associate director of the communication laboratory at STL where he has been for the past six years.

meeting ahead

THE POWER OF RADIATION

Transmitters for exceptionally high-power applications will be discussed by Ernst R. Altschul of Radiation at Stanford during the November PGSET meeting listed in the Calendar on page 7. Altschul, senior project engineer, will describe the design of the most powerful x-band transmitter under construction (100 kw of c-w power) and the radar astronomy transmitter for the Arecibo, Puerto Rico, 1,000-ft reflector (2.5 megawatts peak, 150 kw average). The x-band equipment will be used

audio affairs

VOICE OF THE MEMBERSHIP

A very comprehensive questionnaire designed to influence future meeting programs was sent to the PGA (and to our locally associated AES Section). Nearly 100 replies were received, of which 80 indicated the possibility of the senders attending meetings. Slightly over half want the technical level of the meetings raised. The areas of "specialty interest" are widespread but sound recording is a predominant favorite with instrumentation next, followed by speech and music synthesis and broadcasting almost equally distributed.

Eighty per cent favored tutorial sessions, with preference very definite for the following fields (in order): 1. Architectural Acoustics and Acoustic Measurements, 2. Tape Recorder Electronic Design, 3. Feedback Amplifier Design, 4. Loudspeaker Design, and 5. Tuner Design.

According to Ralph Brown, present chairman of the PGA chapter, an effort will be made to set up occasional tutorial sessions in the indicated fields.

with the Lincoln Laboratories Haystack project.

Details of these history-making engineering accomplishments taking place in this area promise a meeting of more than ordinary interest.

meeting ahead

SAVE THE SURFACE

For its November meeting (listed in the Calendar, page 7), PGPEP will present a panel of four broadly qualified speakers covering the use, application, and economics of metal coatings of different types. They will concern themselves with finishes all the way from preparation of the metal to the completed product.

meeting ahead

SPECTRUM DETERMINATION

Dr. Nelson Blachman of Sylvania EDL will address the November 30 meeting of PGIT on the subject, A Generalization of Woodward's Theorem on F-M Spectra. Woodward's theorem (the "adiabatic theorem") asserts that the power spectrum of a slowly frequency-modulated signal is given by the first-order probability density of the modulation. Blachman has previously expanded the scope of this approximation by deriving first-order correction terms for certain cases. At this meeting he will discuss a further extension of the theorem to the case of simultaneous amplitude and frequency modulation.

If a narrow-band waveform is multiplied in frequency up to a high harmonic, its spectrum becomes broad by comparison with its modulating frequencies, and this extension of Woodward's theorem provides an easy way of determining the spectrum. A particular case of importance is that of a low-frequency oscillator producing

(Continued on page 10)

Nelson Blachman

Sigurd Varian, 60, a founder of Varian Associates and an electronic pioneer, was killed late in the day of October 18 when his light airplane crashed in a heavy sea off the west coast of Mexico.

The nation and the electronic industry lost an unassuming but rare man recently with the untimely, accidental death of Sigurd Varian. Although he will be remembered most as the inventive and perceptive individual who contributed to the development of the klystron and the firm that bears his name, Varian Associates, he will be missed most by those of us who had the pleasure of living and working with him. Despite his scientific, technical, and business success, Sig Varian remained "one of the boys" to his last day.

The factual story of his part in the invention and development of the klystron and microwaves generally, as well as his contribution to the growth of Varian Associates, has been told many times. However, few people truly appreciate his startling foresight, which was destined to have dramatic impact upon the lives of many.

While a pilot in Mexico in the early 1930's, Sig became acutely aware of the danger of Germany's growing might — and particularly the terrible possible consequences of an attack by the vaunted Luftwaffe. As a flyer, Sig knew there would be but little protection against enemy aircraft attacking either in the night or from the cover of low-lying clouds. He knew we did not possess any means to detect attacking aircraft before too late.

Sig worried about this danger long before the average person was even aware of the inevitable trend of events. He wrote long letters to his brother Russell, outlining the problem and seeking ideas for a solution. When Russell came to the conclusion that short radio waves would do the job, Sig did not hesitate to leave his permanent job and bring his life savings, family, and all his energies to California to help Russell tackle the solution to the problem. It hardly seems credible that two unassuming young brothers with but meager resources would wish to take on a task which was destined to play an important part in history.

The hard work on the project, resulting in the successful demonstration of the klystron, contributed to Sig's exhaustion and serious illness. But, even during the many months in the hospital and at home in bed, Sig continued to participate in creating novel ideas and improvements and remained the moving spirit in carrying on the development of the klystron and microwaves. Upon his recovery, Sig was able to play a major role in developing a large variety of klystrons which proved essential both for defense and other applications.

An inventive genius, Sig was in the forefront of all Varian's engineering developments during his active years with the company. Although he had but limited formal education, he was accepted as a natural scientific and technical leader by a sophisticated group of scientists and engineers. He was a natural raconteur whose easy humor could relax tensions when a project reached the "sticky" stage, and his driving curiosity was so infectious that it frequently kept his co-workers on the job long after sensible people had called it a day.

We who knew Sig as a friend and co-worker feel a tremendous sense of loss. A man like Sig cannot be replaced; he can only be missed.

—ED GINZTON

John Chartz

meeting review

EMOTION AT THE GROCERY STORE

John H. Chartz, vice president of Dalmo Victor Co., spoke at the October meeting of the San Francisco Chapter of the Professional Group on Engineering Management. Chartz discussed his experiences in a 25-year period of stock investment. He had some very good advice to offer any investor and his talk was very well received. He made the point that investors should ignore day-to-day market fluctuations just as they ignore day-to-day price changes in the grocery store. He emphasized something forgotten by most of us: that stock purchase should be made on as rational a basis as possible, and that emotional factors should be suppressed.

MORE SPECTRUM

both a sinewave and narrow-band noise, the output from which is multiplied up to a much higher frequency. When the multiplication is performed by a power-law device, the power spectrum in the neighborhood of the harmonic can be expressed in terms of a tabulated hypergeometric function.

William D. McGuigan, chairman, PGEM

L. Bruce Johnson, vice chairman, PGEM

Glenn A. Walters, sec.-treas., PGEM

He added two more suggestions: that investors should use good, definable yardsticks such as "price-earnings ratio" in comparing stocks; and that investors should understand how accounting practices vary from company to company. And he added that he sincerely believes "the accounting profession is there to help electronic engineers!"

These are the PGEM officers for the 1961-1962 season:

Chairman: William D. McGuigan, SRI.

Vice Chairman: L. Bruce Johnson, Lenkurt Electric Co.

Secretary-Treasurer: Glenn A. Walters, Dalmo Victor Co.

—L. M. JEFFERS

meeting review

OPPORTUNITIES IN NOISY CHANNELS

Professor Peter Elias, chairman of the electrical engineering department at MIT, addressed a meeting of the PGIT in mid-October. The talk was a survey of what is presently known about the information theoretic aspects of networks of noisy channels. The meeting was held in the auditorium of the Sylvania EDL building in Mountain View, with an audience of 45 in attendance.

A simple, but important, example of such a network is obtained by adding a feedback channel to an ordinary unidirectional forward channel. Shannon[1] has shown that the addition even of a noiseless feedback channel (rather hard to find in practice) does not increase the forward channel capacity of a zero-memory channel. But it does permit the use of simpler (and cheaper) coding procedures for a given reliability and rate of transmission. However, the value of this is difficult to measure on a general, absolute scale.

Very little of a general theoretical nature is known about the capabilities of two-way channels with memory, although in special cases certain ad hoc techniques have been developed that appear to be useful. Also, in some instances the addition of feedback does increase the capacity to transfer information in the forward direction.

For an arbitrary network whose branches have known capacities, and where there is a single input node and a single output node, the capacity between input and output is given by the maximum-flow minimum-cut theorem[2] of Elias, Feinstein, and Shannon. This theorem states that the maximum flow through the network is given by the minimum that can be obtained for sums of the branch capacities that are affected when the network is cut in various ways (called "cut-sets") that separate the input from the output. The branches may be either unidirectional or bidirectional, but it should be noted that a unidirectional branch capacity is included in a cut-set sum only if it is directed from the input side of the network to the output side.

As an example, consider Fig. 1, where transmission takes place between nodes T and R by way of the intermediate nodes, A, B, C, and D over branches labelled with their respective capacities (in bits per second, say). It is easily seen that the minimum cut-set consists of branches AC, BC, and BD with a total capacity of $3 + 1 = 4$.

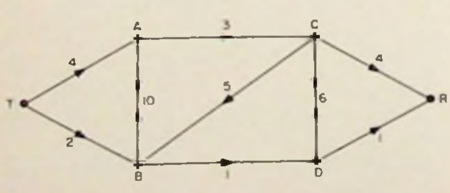

Fig. 1. Max-flow min-cut theorem

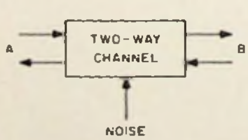

Fig. 2. Interacting channels

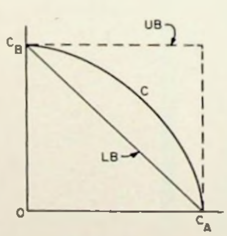

Fig. 3. Trade-off curve

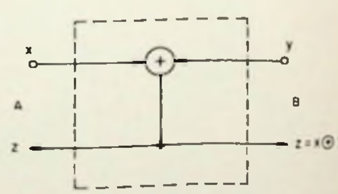

Fig. 4. Noiseless two-way channel

(Note that BC has a capacity of zero in the direction from B to C, and hence does not contribute.)

Thus according to the max-flow min-cut theorem, the capacity of this network is 4 bits per second. Of course, to realize this capacity with a low probability of error, very long coding delays will in general be required on each branch. The problem of finding an optimum apportionment of a given total delay among the various branches is very complex. Solutions have been obtained for specific cases, but there are no generally applicable results known.

The problem of finding the capacities of interacting forward and backward channels between two terminals, A and B, has also been studied by Shannon.[3] Here the symbol received by B (see Fig. 2) is in general a probabilistic function of the symbols sent by both A and B, and of the channel noise. The general result is that the capacities C_A and C_B can be traded off against each other along some curve C (Fig. 3). The trade-off curve is convex upwards and is bounded below by the straight line LB connecting the two intercepts as shown in Fig. 3. Fairly good upper bounds for this curve are also known in terms of the channel parameters.

A simple, but amusing, example of this sort is given by the noiseless two-way channel shown in Fig. 4. Both A and B receive at any instant the modulo-two sum $z = x + y$ of the binary digits x and y sent by A and B. Clearly if B is silent (sends only zeros) then A can transmit without error to B at a rate of one bit per symbol. Likewise for B, if A is silent. However, since each party knows his own transmitted symbol he may recover the correct information sent by the other party by simply "subtracting" his own. Thus A and B may both send simultaneously at a rate of one bit per symbol. In this case the trade-off curve falls along the upper bound UB of Fig. 4. If an AND-gate replaces the modulo-two adder, the trade-off curve becomes the straight line LB.

Another interesting class of problems is concerned with arbitrary networks of directed branches (like Fig. 1) but where zero delay is specified at each node (except possibly at T and R). It is assumed also that all branches fanning out from a given node carry the same signal. When the individual channel noises are independent the situation is fairly tractable. However, when the channel noises may be dependent on each other, very little can be said in general. For example, a series cascade of two channels with capacities C_a and C_b may exhibit any capacity C_s from zero to infinity under suitable constraints on the noises. A parallel combination of these channels will have a capacity C_p bounded below by the larger of C_a and C_b. Under certain additional conditions of reversibility on the channels, it may be shown that $C_s + C_p = C_a + C_b$.

A subclass of zero-delay networks, namely those with continuous channels subject to gaussian noise was also described by Elias. A simple cascade of power-limited repeater links is one example studied by DeSoer. Here, if only linear transfer functions are used to couple one link to the next, the capacity of a long cascade can drop to zero because the channel noises accumulate indefinitely. Clearly quantization at the links is required to combat the noise effectively.

Another example is furnished by the parallel combination of two continuous band-limited channels with independent additive gaussian noise. As discussed by Elias' the channel capacities add, so that a received signal-noise power ratio $r_i = r_1 + r_2 + r_1 r_2$ should be obtainable at the receiver. However, optimum diversity combining yields only $r_0 = r_1 + r_2$. When the individual signal-noise power ratios, r_1 and r_2 are small, r_0 and r_i are nearly equal. But for large signal-noise ratios, the ideal value is roughly the product, $r_1 r_2$, while the diversity value is only the sum, $r_1 + r_2$. Elias' has shown that the ideal value r_i can be obtained, with zero-delay coding and linear diversity combining, by making use of a noiseless feedback channel. Similar results have also been obtained for slightly more complex networks, e.g., a bridge of five branches, but they elude us for networks more complicated than that.

In summary, Elias stressed the incompleteness of our present knowledge of information network theory. This field is really a rather loosely defined problem area instead of a "theory." Only the simplest questions that one can pose in this field have been answered in any generality. The generalizations to complex, multi-input, multi-output networks of interacting, time-dependent channels with various constraints (delay, reliability, etc.) constitute a field that is wide open for future work.

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—FORREST F. FULTON, JR. & BERNARD ELSPAS

meeting review

COMPUTERS—ARMY STYLE

The first meeting of the 1961-62 season of PGMIL took place early in October at the Lockheed, Palo Alto, Auditorium. It was preceded by a speaker's dinner.

Speaker of the evening was Major General F. F. Uhrhane, commanding

(Continued on page 12)

November PGMIL gathering included: L. ter Veen, Bill Doxey, Walter Prise, Stanley Kaisel, Capt. P. H. Enslow (rear, aide), Maj. Gen. USA F. F. Uhrhane (speaker), Peter Lacy, Archie Brown, Charles Antony, and Frank Mansur

general, headquarters U.S. Army electronic proving grounds, Fort Huachuca, Arizona. The subject of his talk was, The Signal Corps Program in Tactical Automatic Data Processing.

In his talk, General Uhrhane presented a progress report on the development of the Army's command control information system. Since 1956 the U.S. Army has been investigating the possible applications of adp techniques and methods to tactical operations. Systems developed cover mobile units for field applications and extend into an area of handling of personnel records.

The general took his listeners on the historical path of the computer-development program of the Army, starting with the first Eniac of 1946. This model was followed by Mobidic; the general-purpose mobile computer Basic Poc; and a smaller mobile unit, Informer version. Compac II (jeep type) and Micropac are still under development.

Although not as commonly known as missile and satellite types of data-processing equipment, in many ways the Army's control-information systems are required to perform more diversified functions and mobility and ruggedness are extremely important characteristics. Equipment is based on the use of solid-state devices.

The general's talk was illustrated by a number of color slides showing conditions under which the equipment must operate, and the equipment itself. The excellent manner in which Uhrhane presented his topic provided the audience a vivid picture of the part adp plays in operation of the modern army and participation of electronic industry in these efforts. At the conclusion of this presentation, Walter Prise, who as chairman of PGMIL presided at the meeting, expressed deep appreciation to Uhrhane for his highly informative talk.

Uhrhane is a graduate of the United States Military Academy of 1930. He also received an MS degree in electrical engineering from Ohio State University. A unique feature of his career is that in every commissioned grade he was connected with electronics research and development work. General Uhrhane was responsible for the introduction of new types of electronic equipment to field troops and for collection of technical intelligence in the general work of communications, radar, and other electronics.

Following the main presentation, Charles Antony, program chairman, indicated that he is planning a social affair to bring members and guests of PGMIL together in December. Officers of PGMIL feel that their group covers many areas of interest to other professional groups and invited them to visit this meeting.

Program members and the numerous prominent guests present were served coffee and doughnuts at the conclusion of the meeting. An outstanding feature of the evening was punctual scheduling of both the dinner and the program events.

—JOE WETTSTEIN

meeting review

CIRCUIT CHEMISTRY

The first Fall meeting of PGPEP was held at the Hewlett-Packard electronics instruction laboratory of Stanford University in late September. W. Dale Fuller, microsystems electronics manager of the Lockheed Missiles and Space Co. spoke on thin-film titanium circuits.

Fuller pointed out that thin-film integrated circuits of titanium and titanium oxides have the capability of meeting today's electronic requirements of improved reliability, reproducibility, wider environmental ranges, product versatility, and size reduction. The fabrication processes being developed at Lockheed are essentially all chemical and this inherently contributes to economical production.

The fabrication of a thin-film titanium circuit starts with a molten-salt process that results in the complete coating of an inorganic substrate with a thick film of very pure titanium metal. After cleaning, a pattern of copper or another conductive material is electroplated onto the metallized substrate to produce termination areas or interconnection tabs. The circuit pattern is then fabricated from the metallized substrate by photoetching processes.

The next step in the fabrication of the thin-film circuit is the conversion of selected areas of the continuous circuit pattern into a resistive or dielectric material. An anodic process is used for both of these materials in which the electrolyte and the electrical process parameters determine the resulting material. A jig is used, which restricts the electrolytes to the selected area. An important part of this conversion process is a technique for the measurement of the electrical parameters — resistance, capacitance, or dissipation factor—during the anodic process. This type of process control is termed "dynamic testing."

At the completion of this fabrication process, the active devices are assembled to the thin-film circuit by spot welding or thermal compression bonding and the integrated circuit is ready for use.

Individual electronic functions may be fabricated in this manner for experimental system development. However, to utilize the full potential of integrated circuits—complete sub-systems—a more complex assembly of circuits may be fabricated to further reduce the number of external interconnections that are required in the system.

Fuller received his BSEE at Michigan College of Mines and his MSEE at Iowa State University. He started his career in electronics at General Electric followed by teaching at Iowa State College. The next ten years were spent in Texas and Oklahoma doing research in electronics and microminiaturization. Previous to joining Lockheed, he was director of research at Varo Manufacturing in Dallas.

—HARMON R. TRAVER

A. F. Dixon, Rheem; W. Dale Fuller, Lockheed, speaker; and Thomas E. Scatchard, Beckman; at the September PGPEP meeting

Harmon R. Traver photo

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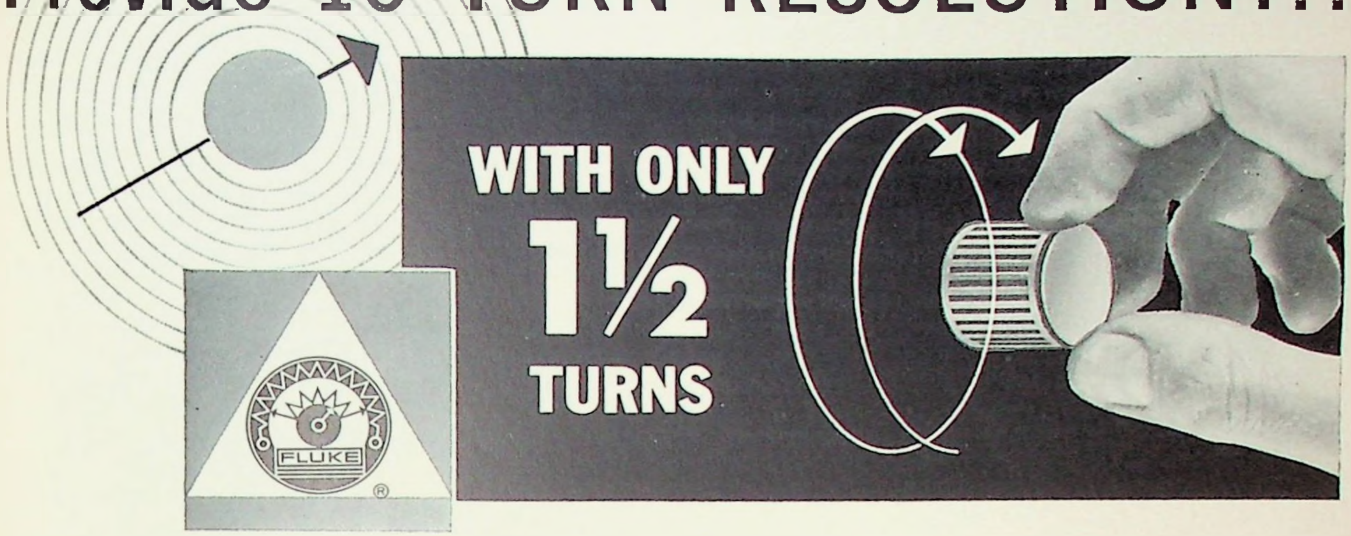

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This high resolution, small size, and ease of operation, is achieved by a unique **FLUKE** patented design. A schematic of the Model 20A is shown below. Basically, the Model 20A consists of a main resistance element and a concentric smaller vernier. The vernier element is connected to the main element through two contacts spaced 30° apart. This spreads any 30° segment of the main winding over the 270° of vernier rotation. The vernier slider is rotated by the potentiometer shaft. As the shaft is turned and the vernier slider completes its rotation, a mechanical stop causes the vernier frame to turn, moving the spaced vernier contacts along the main element. This method provides a coarse adjustment at either end of the vernier adjustment.

This unique design results in a versatile, high performance potentiometer. For example, thin card-type windings reduce residual reactance and allow operation at much higher frequencies than other potentiometers with similar DC specifications. The one and one-half turn control of the entire adjustment range allows substantial time savings in frequently adjusted or multiple potentiometer installations such as analog computers and data logging systems. Equipped with a screwdriver slotted shaft, the Model 20A also makes an ideal high resolution trimmer.

The Model 20A is available from stock in resistance values ranging from 100 ohms to 25 K ohms, and can be provided with a calibrated readout dial and lock-type knob.

If greater resistance values are required, write for information on the **FLUKE** Models 21A, 22A, and 30A. The Model 21A and 22A have increased power ratings and are available in resistance values to 100 K. The Model 30A features resolution of 20 times that of the 20A series, resistance values from 1 K to 100 K, and a power rating of 5 watts.

MODEL 20A PARTIAL SPECIFICATIONS

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Power Rating: 2 watts at 20° C, derated to 0 at 100° C.

Price: As shown, $8.50.

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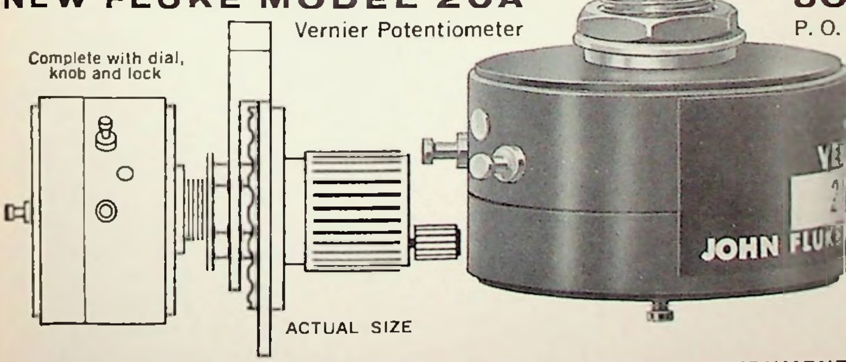
Vernier Potentiometer



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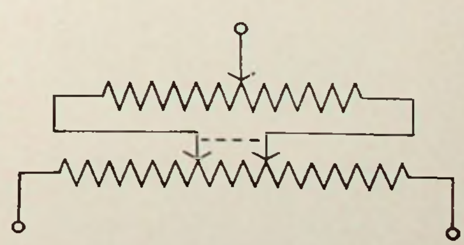
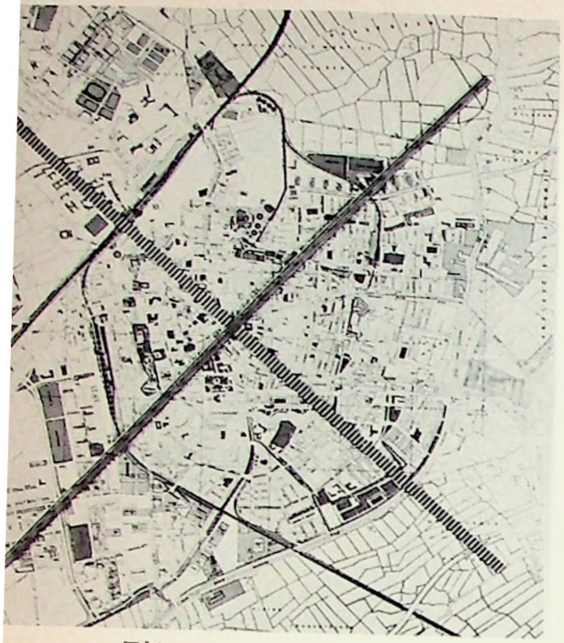


SCHEMATIC

MANUFACTURERS OF ELECTRONIC TEST AND MEASURING INSTRUMENTS FOR LABORATORY—PRODUCTION LINE

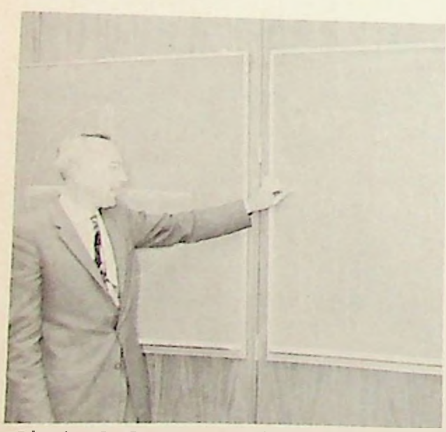


This is how the Benelux cross would appear if superimposed on the city of Leiden, Netherlands

meeting review

DEEP, DEEP SPACE

At the first meeting of the season, members of PGAP heard Charles L. Seeger, acting head of the Stanford Radio Astoronomy Institute, give an interesting description of a very large and impressive radio-astronomy antenna currently under construction in the Netherlands. The subject of Seeger's lecture was "The Benelux Cross Antenna Project" of which he was formerly chief scientist. The meeting, held at Stanford Research Institute, followed a well attended speaker's dinner. The speaker was introduced by the chairman of the PGAP chapter, Ray L. Leadabrand. Leadabrand also announced that this year's tutorial series during February and March 1962 would be on millimeter waves; including power generation, antennas, and transmission lines.



Charles L. Seeger, speaker at the PGAP meeting reviewed on this page

Seeger began his talk with a discussion of why large radio astronomy antennas are necessary. He pointed out that radio astronomers would be able to gather additional information concerning our galaxy by studying a nearby galaxy that is similar to our own. In order to have sufficient resolution for this study, it is necessary to have a pencil beam of approximately one minute of arc. The resolving power of a radio telescope is proportional to its aperture and its sensitivity is proportional to the total area.

However, in addition to resolution capabilities and sensitivity, a radio telescope must be capable of discriminating between nearby sources. Discrimination is acquired by increasing the width of the antenna array. For a 5-kilometer-long antenna the width must be at least 85 meters to achieve sufficient discrimination to make use of the available resolution. The Benelux antenna (originally conceived by Seeger in 1954) is a 5-kilometer by 5-kilometer 600,000-square-meter simultaneous-multiple-beam 408-mc, radio telescope. It is in the shape of a cross similar to the original Mills cross constructed in Australia in 1953.

The Benelux cross will be a rather spectacular feature on the surface of the earth—perhaps best seen from the moon. It is located on the border of Belgium and Holland and stretches into both countries. If it were centered on Leiden (population 75,000 to 80,000) it would extend beyond the city in all directions. Two hundred and fifty amplifiers will be used corresponding to the 250 elements which make up the antenna. The input amplifier from each element will be a parametric device with less than 80 deg excess noise temperature. The amplifiers will have an amplitude stability of one per cent or better and the electrical phase angle will be maintained within one degree over a one per cent bandwidth throughout the entire system and array. Each of the reflector elements will be fed with a four-element binomial feed, reducing the edge illumination by 30 db. Sidelobe suppression for the entire array is expected to be greater than 50 db.

The one minute arc beamwidth would require several lifetimes to make a survey of the entire sky. In order to alleviate this problem, a total of 300 simultaneous beams will be generated through the use of 250 phase shifters for each beam. Reliability comparable to a first-class commercial computer is expected to result in an operation time of more than 90 per cent. Because of the highly repetitious nature of the system, completely automatic fault location will be incorporated.

The project, supported by the governments of Belgium, the Netherlands, and Luxemburg, is expected to be completed in four to five years at a cost of only 6 to 7 million dollars.

For the season 1961-62, the Professional Group chapter on Antennas & Propagation has these officers:

Chairman: Ray L. Leadabrand, SRI
Vice Chairman: John B. Damonte, Dalmo Victor Co.
Secretary: Raymond D. Egan, Stanford University

—R. D. EGAN

Ray L. Leadabrand, chairman, PGAP

John B. Damonte, vice chairman, PGAP

Raymond D. Egan, secretary, PGAP

meeting review

REPORT FROM ABROAD

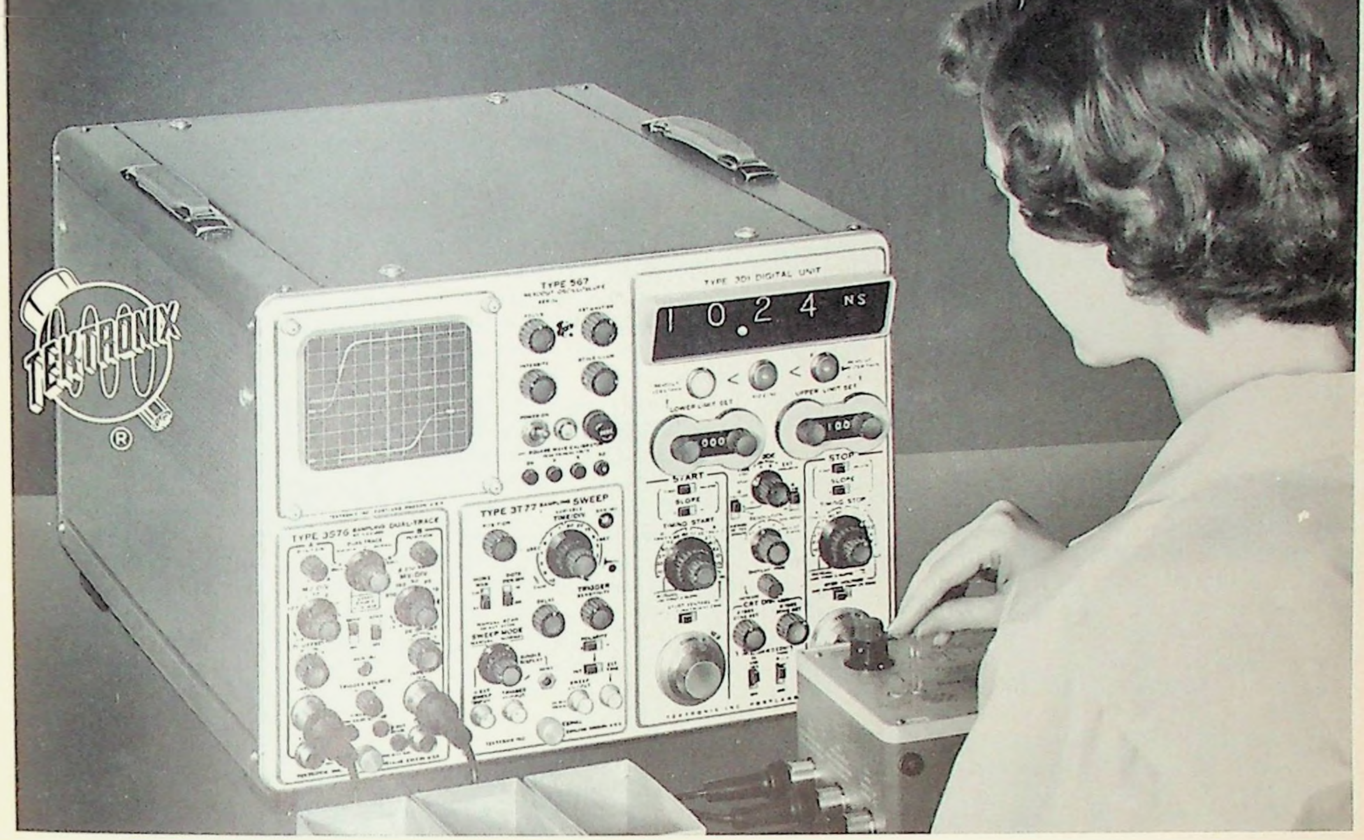
The first 1961-1962 joint meeting of PGED and PGMTT was held in September at Stanford. Speaker for the evening was Hubert Heffner, professor of electrical engineering, Stanford University. After a very brief introduction by Dr. P. Vartanian, Heffner gave a very interesting talk titled, Microwave Research in Europe.

The talk was essentially a record of his experiences in Europe during the past year when he worked as a scientific liaison officer for the U.S. Office of Naval Research at London.

This office was set up just after the war and employs approximately ten scientists, most of them on temporary assignments, who represent various specialties in the physical sciences. The function of these scientists is to select and visit various countries in Europe with the purpose of gathering and giving information on the scientific re-

(Continued on page 16)

FASTER AND SIMPLER PRODUCTION-RUN TESTS WITH NEW DIGITAL READOUT OSCILLOSCOPE



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Hubert Heffner

MORE EUROPE

search activities conducted in these countries. Much of this information is published in individual reports as well as in the monthly European Scientific Newsletter. Heffner mentioned that due to the time involved in correspondence and preparation for each visit to a foreign country he could spend only a minor part of his time outside England. The countries he visited included Yugoslavia, Norway, and Germany.

Heffner's talk was organized into three parts. In the first part he made general observations on European science. Here he emphasized that the greatest percentage of scientific work done in Europe is concentrated in England. For example, in 17 European countries there are 731 laboratories doing some kind of solid-state research supported by universities, by government, or by industry. Of these laboratories, 291 are in England, 146 in Germany, and 89 in France. In other branches of physical sciences, such as microwaves, England is also the country where most of the work is done.

Continuing with his general observations he remarked that the total level of original scientific activity was far smaller in Europe than in the U.S. This was mainly attributed to comparative lack of funds in Europe. The philosophy of government support for scientific research is not prevalent in Europe except, to a small extent, in France, Germany, and England. Besides Philips in Holland and CSF in France there are very few industries which indulge in research; this is still considered mainly to be a responsibility of universities. The caliber of people doing R & D work is not very different from that of people in the U.S. In England, however, the people who administer R & D contracts are of a higher caliber in scientific training and background than here.

An important consequence of the lack of sufficient support for scientific research in Europe is that the research organizations are, "not up to the critical size wherein enough people work to cross-fertilize each other's ideas. This results in a lack of virility in scientific activities as compared to similar activities n the U.S."

The second part of Heffner's talk dealt wth specific research activities going on in Europe. He had considerable interest in parametric amplifiers of both diode and beam types. Most of the work on diode types was a repetition of similar work done in the U.S. There were two exceptions that Heffner considered to be worth mentioning. One referred to an interesting circuit developed by K. H. Locherer and R. Mauer at Telefunken. This circuit used a regenerative down converter with two phase-shift networks, one with +90° phase shift and the other with −90° phase shift, in such a way as to result in a non-reciprocal parametric amplifier. The experimental results were as follows: signal frequency, 550 mc; pump frequency, 1800 mc; bandwidth, 4 mc; gain, 20 db forward and −30 db backward; power, 20 mw per diode. The other work, by B. Robison and J. T. deJager in Holland, was on a 21-cm parametric amplifier circuit for hydrogen line. This consisted of a 1400- to 2400-mc up converter for frequency switching by means of a 1000-mc pump, having a 1-db gain, 150-mc bandwidth, and 80 K noise temperature, and a degenerative 2400-mc amplifier with 20-db gain, few-mc bandwidth, gain stability of $1:10^3$ over 1 hour, and 45 K noise temperature with a GaAs diode or 16 K with a Texas Instrument SD-502. This amplifier and up converter were connected to a circulator followed by a mixer. This circuit was considered by Heffner to be the first practical parametric amplifier for radiometry.

As regards beam-type amplifiers Heffner discussed the sealed-off Adler tube built by T. J. Bridges at SERL, England. With this tube, a gain of 24 db was obtained at 2700 mc and at a noise temperature of 96 K, of which the contribution by the beam alone is 62 K. There was also a description of the work done by J. C. Vokes and T. J. Bridges on the noise reduction in d-c pumped quadrupole amplifiers by means of beam expansion. This scheme did not give the desired results—the measured noise temperature was 1200 to 1600 K instead of the expected 16 K. The explanation for this discrepancy, according to Heffner, is not yet totally clear.

Brief mention was made of the work done by Dr. Wessel Berg at the Norwegian Defense Research Establishment on transverse-wave noise matrix and of the 4-cavity klystron at SERL, England. This klystron operates at 400 mc, with 130-amp beam at 250 kv (beam power 32.5 Mw), and having an efficiency of 61 per cent. Interesting work done by Dr. B. Agdur at the Royal College of Technology, Stockholm, on beam-to-plasma interaction was also described.

The third part of the talk was presented after the meeting was officially adjourned. This part compared the educational system in Europe with that of the U.S. Heffner felt that, as in research activities, the educational system in the U.S. was more efficacious through the lecture system than the independent study system emphasized in Europe. He added that perhaps the best method would be to have a mixture of the U.S. and European systems weighted in favor of the U.S. system.

The overall impression communicated by Heffner was that, although there were very capable individuals carrying out praiseworthy research in Europe, the total of the activities, the level of these activities, and the education imparted therefrom were below those of the U.S.

Officers, elected to serve the Professional Group on Microwave Theory & Techniques, are as follows:

Chairman: Perry H. Vartanian, Melabs

Vice Chairman: Peter D. Strum, Applied Technology

Secretary-Treasurer: Howard C. Poulter, Hewlett-Packard Co.

—A. M. SERANG

Perry H. Vartanian, chairman, PGMTT

Peter D. Strum, vice chairman, PGMTT

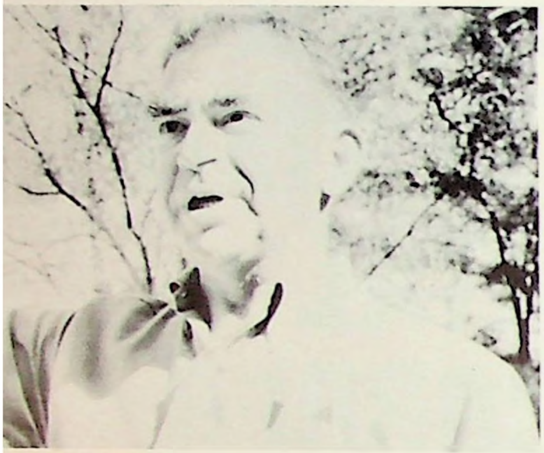
Howard C. Poulter, sec.-treas., PGMTT

meeting review

TEETH FOR RESEARCH

Dr. Herbert Bandes of Arthur D. Little Co., spoke before the East Bay Subsection picnic outing late in September. His announced topic was The Ratchet Effect in Research and he opened his talk by demonstrating a mechanical ratchet—a device that does mechanical work when rotated in one direction and permits backing off without undoing work already performed when rotated in the other direction. Work may again be done when rotation in the original direction is resumed.

This effect is seen in technical fields: advance is made up to a point and then stops while other fields are investigated. Bandes illustrated this effect by discussing the events leading up to the discovery of transistors and semiconductors.



Herbert Bandes

The transistor was invented just 13 years ago but has captured a share of the electronics field that was worth $300 million in 1960 and is still expanding. A brief history of events leading up to the invention of the transistor was used to illustrate the delays between observation of an effect and its application:

- 1823—Michael Faraday observed that silver sulfide was a semiconductor (i.e.: Resistance decreased with an increase of temperature)
- 1873-74—The photoelectric effect was discovered in copper oxide, silicon carbide, and selenium

These discoveries received scant attention because there was little need for the materials and because physics and chemistry were not sufficiently advanced to explain the effects observed or point out applications.

- 1910—The first commercial application of semiconductors was as detectors in crystal radios, but the crystal detector was soon replaced with the vacuum tube.
- 1928—Use of selenium and copper oxide as rectifiers in industrial, chemical, and electrolytic processes.

Then came World War II and radar. Silicon detectors and mixers for radar represented the first large-scale application of semiconductors.

In 1945, germanium was first used in the electronics field followed by the discovery of the transistor in 1948.

The lag and delays between discovery of the semiconductor effect in 1823 and its use in the transistor can be explained by considering the three circumstances needed for development of any new device or material.

1. A consumer demand sufficiently large to support the cost of the development in time and money.
2. Sufficient theoretical guidance to permit understanding of the phenomena to be developed.
3. Development of processes and prosaic tools to a level which will permit investigation and economical fabrication of the device.

These points may be illustrated by considering some of the developments in other technical fields which led to or assisted in the development of the transistor.

Development of quantum mechanics through consolidation of then existant material in the field of physics by Heisenberg and Schrodinger in 1925-26 was necessary for transistor/semiconductor development. This then permitted Wilson to explain the semiconductor effect in 1931.

In 1939 a paper was published in Germany describing the transistor effect in potassium bromide. This paper received little attention for two major reasons: World War II broke out, and potassium bromide has a very high resistance.

Even so, it is not likely that the transistor could have been invented then rather than 9 years later because details of electrical conduction and surface effects were not known in 1939; the device requires levels of chemical purity which were not available; and the necessary analytical tools were also not available.

Some of the tools and processes which had to be developed and engineered prior to transistor development were as follows: Mass Spectograph (1915), x-ray determination of crystal structures of solids (1912), methods of obtaining high purity graphite used in producing germanium (1940's), epoxy cements, glass to metal seals, and methods for crystal growth.

In closing, Bandes pointed out that he had tried to show the interrelation between engineering research, product development, and material development required to produce a new device. Research cannot stand by itself and the path to a new development is seldom direct.

—JAMES B. WRIGHT

meeting review

JUST THE FAX, MAN

The marvels of electrostatic printing and high-speed alphanumeric electronic computer-readout display were described and demonstrated at the September meeting of PGCS by Bill Evans, at the A. B. Dick Research and Development Laboratory in Palo Alto.

The Videograph system was developed by Bill Evans and his associates at the Stanford Research Institute under a contract with the A. B. Dick Company. Commercial models of the equipment have been supplied to Time and Life magazines to print 10,000,000 labels per week from addresses stored in an IBM 7070 tape-readout system. This is the highest speed computer output printer and it produces labels at the rate of 36½ per second.

The Videograph printer utilizes a special cathode-ray tube having an array of one-mil-diameter wires spaced 4 mils apart on centers sealed into the face plate. The ends of the wires inside the tube are scanned and charged by the varying intensity of an electron beam. The ends of the wires that protrude through the face plate of the tube charge a sheet of specially sensitized paper that is highly conductive on the back side and a dielectric on the front side. The charged pattern attracts finely divided plastic toners that are fixed to the paper by heat.

The printing speed of the system is limited by the bandwidth of the video channel. A system used by the Denver and Rio Grande Railway transmits 4000 documents per day over a 240-kc bandwidth microwave channel. This results in savings of over $1,000.00 per month compared to the cost of operating a conventional facsimile system.

Other advantages of electrostatic printing are that characters can be written in microseconds, no exposure to light is required, and there are no chemical solutions. At the present time the speed of the system is greater than the industries can utilize.

—R. A. ISBERG

meeting review

CRACKS IN THE LANGUAGE BARRIER

Although it still retranslates the Russian word for "bootlegger" as "homebrewer," the IBM automatic language translating machine AN/GSQ-16, Mark

(Continued on page 20)

MORE LANGUAGE

II, is busy working for the Air Force producing English language versions of Russian written material. The machine, its purposes, and its principles were described recently by Dr. Harwood G. Kolsky at the October meeting of the San Francisco Section PGEWS, held in the Hewlett-Packard Company auditorium. Kolsky is the manager of the systems science department of IBM's San Jose research laboratory.

The necessity for such a machine, Kolsky pointed out, became apparent when the Air Force realized that the U.S. was as much as two years behind in translating Russian technical articles, some of them presaging the first Sputnik. When it was decided to utilize automatic machine techniques to enhance our translating capabilities, a study was made of the requirements in this field. It was found that, although there are over 1,000 different languages spoken on our globe, 90 per cent of all written material was produced in only 12 languages and 96 per cent in only 20 languages.

To provide the required multi-language facility, the IBM machine operates on binary character codes utilizing a high-density photographic glass disk as a dictionary. This disk is 10 inches in diameter and stores translations of 150,000 words, phrases, and idioms in the one-inch-wide outer annulus. Thus, to switch languages, it is only necessary to "change the record."

There are three stages in language translation, each succeeding stage being of increased complexity but providing a more lucid translation. The experimental Mark I machine was a straight "lexical" translator, producing one-for-one word translation as if reading an ordinary translating dictionary. When more than one translation corresponded to a given foreign work, the Mark I printed out each possible translation in a string. For instance the French word "son" might be printed out as "his / her / its / their / sound / bran," the machine not knowing whether the translation should be a pronoun or noun. Foreign words not in the dictionary were transliterated letter by letter and printed out in red ink.

The Mark II, now in production and operation, adds the facility of a syntactical analysis of phrase and sentence structure. This machine has the capability of looking at the preceding word and the succeeding word in order to attempt to select one of several possible translations. If the preceding or succeeding words falls into a particular group or type designation, the translating choice is narrowed. For instance in translating the French phrase for "loud sound," the machine would see that "loud" was an adjective and therefore "son" should be translated at least as a noun rather than a pronoun. Then if "loud' were classified in some "auditory" category, the selection of the correct noun translation for "son" would be made.

The Mark III, now in the design stage, enlarges the syntactical analysis capability to a semantic analysis. Whereas the Mark II looked at the preceding word and succeeding word in a "dual pass" on the track, the Mark III will be a "multi-pass" machine being able to look at whole clauses and sentences. With this broadened search area, the selection of the correct translation is made more accurately.

Material to be translated is inserted into the machine by a typist who copies the foreign material on a keyboard with the foreign characters. In inserting Chinese material, the ideograms are broken down into their component brush strokes. For instance one ideogram might be typed as "vertical line/ concave curve/horizontal line/vertical line." After translation, the material is printed out in English. The speed of the machine is such that it is now running below capacity, being limited by other system functions such as programming and insertion.

After his presentation, with slides, Kolsky read several translations directly as produced by the machine. Although some comic mistranslations resulted in a few places, a careful reader, with no knowledge of the original foreign language, could read and understand the material.

The speaker was introduced by Vice Chairman and Program Director Frank Mansur of Lockheed. The meeting was presided over by Chairman Jim Weldon of Sylvania.

Other current officers of the PGEWS chapter are:

Secretary: Paul E. T. Jensen, Sylvania EDL

Treasurer: Milton R. Dunning, Lenkurt Electric Co.

—DOUGLAS WM. DUPEN

meeting review

PLASMAS FOR FUN AND PROFIT

Thirty-eight persons attended the PGED meeting in October. The speaker for the evening was Dr. Matthew A. Allen, research associate at the Stanford University microwave laboratory. The topic of Allen's talk was, Electron-Beam Plasma Interaction for Microwave Amplification.

Allen made a very interesting presentation starting with a concise physical and mathematical description of a plasma, its properties and its interaction with an electron beam. Using a simplified model of a plasma made up of equal numbers of ions and electrons with the ions idealized to be motionless, Allen showed that a plasma has resonance and waveguiding properties. For an r-f modulated electron beam interacting with a plasma, these resonance properties lead to the description of the plasma as a dielectric whose r-f permittivity is a function of the plasma frequency and the r-f signal frequency.

For dimensionally infinite plasmas this functional dependence is such that for signal frequencies less than or equal to the plasma frequency the signal will be amplified. For a finite plasma and an electron beam constrained by a unidirectional d-c magnetic field, the plasmas are anisotropic in their dielectric properties. Here the

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James J. Weldon, chairman, PGEWS

Frank Mansur, vice chairman, PGEWS

Paul E. T. Jensen, secretary, PGEWS

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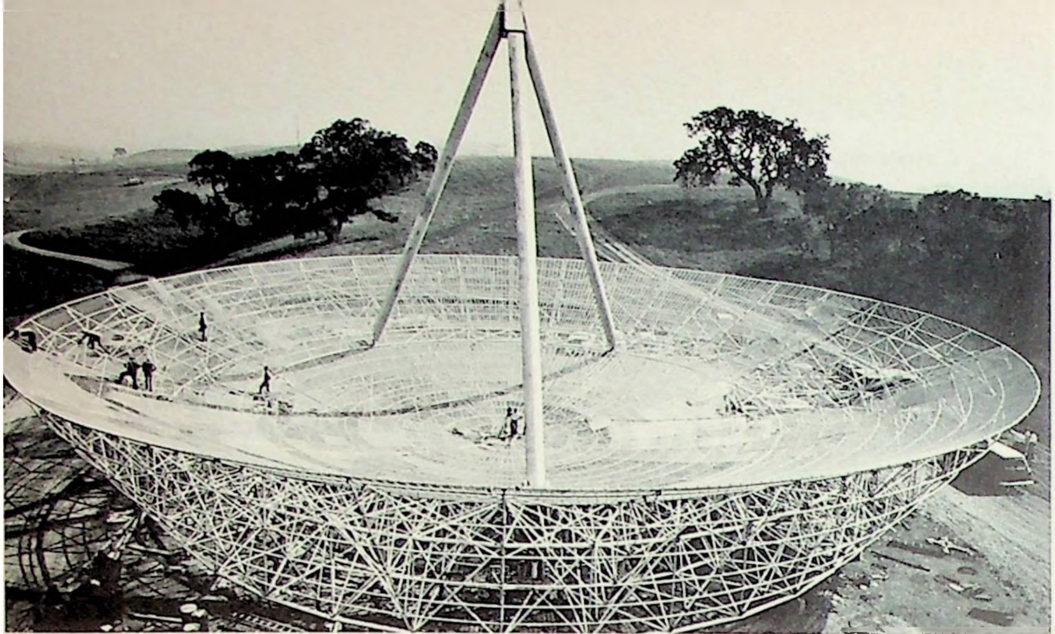

As can be seen from many points along the Peninsula, the new Stanford 150-ft dish has now been lifted to its mount. The 70-ton parabola is expected to be in use before the end of the year

grid swings

IT IS REPORTED:

Recent sales representative appointments include: **Ault Associates,** Menlo park, for **Abacus Incorporated; John F. O'Halloran & Associates** for the **Dielectric Products Engineering Co.** of Raymond, Maine; **Chafin & Associates** for **Knapic Electro-Physics, Inc.,** Palo Alto; and **George W. Ledbetter & Associates** for **Struthers-Dunn Inc.,** Pitman, N.J.

Spectra-Physics, Inc., a newly organized firm, will engage in research, engineering, and manufacture of scientific instruments. The founding members of the company are: **William Earl Bell, Arnold L. Bloom, Herbert M. Dwight,** and **Kenneth A. Ruddock.**

Elliott C. Levinthal, founder and former president of Levinthal Electronic Products, is currently engaged in research at **Stanford University** school of medicine as part of a project to develop equipment for use in a space probe to gather information about the possible existence of life on other planets.

Robert Olander, formerly marketing manager of the ITT Components Division of International Telephone & Telegraph Corp., Palo Alto, now occupies a corresponding position with **Texas Research & Electronic Corp.,** Dallas, Texas.

The **Women's Association of the Electronic Industry** has elected a new slate of officers for the coming year: **Mary Fraser,** IBM, president; **Marie Cieslak,** Eichorn-Melchior, vice president; **Betty Spencer,** Jennings Radio, treasurer; **Vera Noble,** Varian Associates, auditor; **Norma Duffield,** Dalmo Victor, recording secretary; and **Margery Felton,** Fairchild Semiconductor, corresponding secretary.

Recent personnel appointments at **Philco Corporation** find **Preston D. Wagar** manager of the West Coast facility

(Continued on page 25)

MORE PLASMAS

permittivity is a tensor whose elements are dependent on the plasma, cyclotron, and signal frequencies. Again the r-f signal modulating the electron beam is amplified, but with certain added features different from those existing in an infinite plasma.

In essence, the beam-to-plasma interaction is similar to that between the beam and the resonant circuit in an easitron with the difference that for a plasma device the beam permeates the resonant plasma medium. The theoretical calculations for a cylindrically symmetric confined plasma device predict r-f gains of the order of 10 to 15 db per centimeter of interaction at S-band frequencies.

The second part of Allen's talk described the experimental work done on beam-to-plasma interaction. He described three methods for producing plasmas.

One method is by means of electric discharge using either a simple diode discharge or the Philips ionization gage type of discharge. About three years ago the first experimental study of beam-plasma interaction was conducted at the California Institute of Technology. A discharge-generated plasma was used in this study.

The second method of producing plasmas is by ionizing a gas by collision with the electron beam, which is also used for interaction. This method was used at Sperry Rand Corp., where ionized hydrogen was used as the plasma medium. Work done in Russia has also utilized this method. The Russian scientists have been able to construct tubes operating at 8-mm wavelength. The residual gas in these tubes has been used for the plasma.

The third method is to synthesize a plasma. This method, used at Stanford University Microwave Lab, consists of introducing cesium vapor between two parallel, heated tungsten surfaces. The cesium molecules ionize on contact with tungsten and subsequent thermionic electron emission from the tungsten results in a highly ionized cesium plasma. The measured gain-frequency response of devices built at Stanford was in good agreement with theory, and gain of 15 db per centimeter at S-band has been obtained without occurrence of any oscillations.

Allen concluded his talk with a brief outline of the advantages that can be anticipated in the use of plasma devices for microwave generation and amplification. The usual limitations on beam perveance, circuit dissipation, beam interception, circuit dimensions, and tolerances are avoided due to the absence of a physically impermeable circuit structure. Thus it may be possible to use high-current large-diameter beams at low voltages to obtain large powers at high frequencies. Also, since no synchronism is necessary for plasma-beam interaction, efficiency should be high. For r-f coupling to the electron beam it should be possible to use large couplers immersed in the plasma yet far away from the beam. Strong coupling is possible through the strong r-f fields that exist within the plasma far away from the beam. Finally, since the interaction is non-reciprocal, no attenuator is required for stable r-f amplification.

Substantial interest was generated in the audience by Allen's talk, as was evidenced during the question period. For those who were unable to attend the meeting and are interested in exploring this topic further, the reporter recommends Stanford Microwave Lab. Report No. 833, July 1961, titled, "Beam Plasma Amplifiers" by Dr. M. A. Allen and Dr. G. S. Kino.

—A. M. SERANG

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for development of
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events of interest

IRE MEETINGS SUMMARY

Nov. 30-Dec. 1—**Professional Group on Vehicular Communications.** Hotel Radison, Minneapolis, Minnesota. Exhibits: Jean Poole, G. E. Co., 3280 Gorham Ave., Minneapolis, Minnesota. Program: Joe Kahnke, Minneapolis-Honeywell, Aero. Div., 1541 Edgewater Ave., St. Paul 13, Minn.

Dec. 12-14—**Eastern Joint Computer Conference.** Sheraton Park Hotel, Washington, D.C. Exhibits: Charles Phillips, 5603 Jordan Rd., Washington, D.C. Program: Bruce Oldfield, IBM, 326 E. Montgomery, Rockville, Md.

NON-IRE LOCAL EVENT

Dec. 13—Santa Clara Valley Subsection, **American Institute of Electrical Engineers.** The Polaris Missile by Gene D. Schott, division manager, guidance and control design, Lockheed Missiles and Space Co. 8:00 p.m., Old Plantation Restaurant, Los Altos. For dinner reservation call: Mrs. J. George, RE 9-5840, or Miss Delores Tryforos, DA 6-7000.

IRE PAPERS CALLS

Dec. 15—100-word abstract, 500-word summary, and biographical sketch of author for the National Aerospace Conference (Dayton, Ohio; May 14-16, 1962). Send all material in triplicate to: George A. Langston, Papers Committee Chairman, 4725 Rean Meadow Drive, Dayton 40, Ohio.

Dec. 18—50- to 100-word abstracts and 500- to 1000-word summaries for the PGMTT National Symposium (Boulder, Colo.; May 22-24, 1962). Send to R. W. Beatty, Technical Program Committee Chairman, National Bureau of Standards, Boulder, Colorado.

Dec. 20—500-word abstracts in triplicate for the Bay Area Symposium on Reliability and Quality Control (Monterey; May 4-5, 1962). Send to: Mr. Frank B. Durand, 553 Connemara Way, Sunnyvale, California.

Jan. 1—300-word abstracts in duplicate, for the 1962 PGHFE International Congress (Long Beach; May 3-4). Send to: John W. Senders, Technical Program Committee Chairman, Minneapolis-Honeywell Regulator Co., 2600 Ridgeway Road, Minneapolis 40, Minn.

Jan. 15—500- to 1000-word abstracts for the International Symposium on Information Theory (Brussels, Belgium; Sept. 3-7, 1962). Send to: Dr. F. L. Stumpers, Philips Research Laboratories, Eindhoven, Netherlands.

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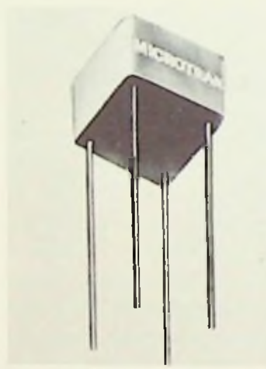

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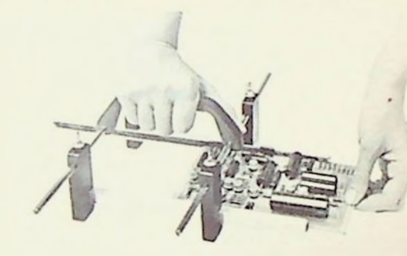

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the section

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Complete data in Bulletin FM-4A.

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