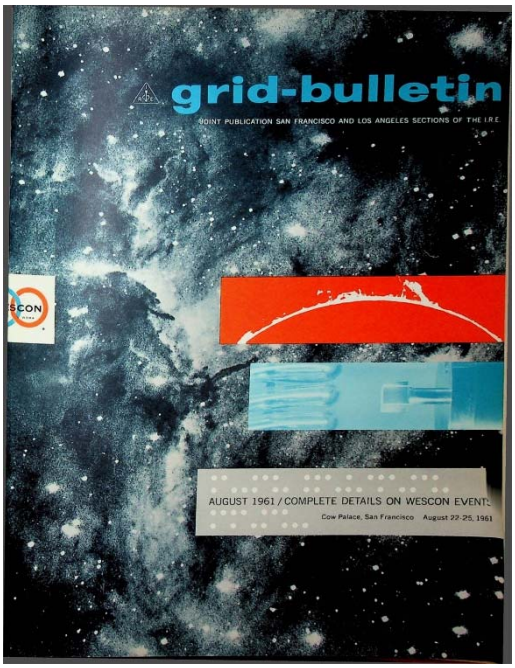
EDITOR'S PROFILE of this issue

from a historical perspective …

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



August, 1961:

In July and August, the LA Section (Bulletin) and the SF Section (Grid) jointly publish the GRID-BULLETIN; it promotes the WESCON show and is distributed to members in both Sections. Although it has its own volume number (6), I'm treating it as a continuation of the GRID volume 7.

Cover: the ruby used in a Hughes laser is shown.

p.12: Prof. Joseph Pettit, dean of engineering at Stanford, received the first Region 7 Achievement Award in 1952. He had received both his EE and PhD from Stanford during WW II, and is an IRE Fellow. He went on to become the president of Georgia Institute of Technology. Photo on p. 50.

p. 14: Simon Ramo, of TRW (Thompson Ramo-Wooldridge, Inc), received the Region 7 Achievement Award in 1953. He is an IRE Fellow. Photo: p. 66.

p. 18: Arnold Beckman is the WESCON luncheon speaker, on "Electronics: Ageless … or Aging?" He founded Beckman Instruments in 1935, and by the 1950's it was quite profitable. A short story: When Nobel prize-winner Bill Shockley left Bell Labs and returned to CalTech to teach, Beckman offered to underwrite a startup for him, suggesting that he locate it in Culver City (part of Los Angeles). Shockley took the funding, to form Shockley Semiconductor Laboratory, but he decided he'd rather return to Palo Alto, where his mother still lived near the Stanford campus and he could become a Stanford faculty member. He started his company in Mountain View (a stone's throw from Palo Alto). There is now a plaque and sculpture at that location (see photo), where the old Sears store used to be, on San Antonio Road.

Source: Wikimedia Commons

p. 18: A photo of William (Bill) Eitel, an IRE Fellow. He went to Los Gatos High School and worked part-time at his father's quarry and uncle's motor-car company, then went to Stanford, taking Fred Terman's first Communications Engineering class in 1925. Bill headed up the tube shop at Heinz & Kaufman during the late 1920's, then in the early '30's founded (with Jack McCullough) Eitel-McCullough (known fondly to Hams as Eimac) to make HF and microwave tubes.

p. 20: Region 7 of the IRE grew considerably as the Bay Area and west coast became the hub of electronics: From 683 members in 1940 to 19,037 in 1960.

p. 20: Prof. Marvin Chodorow of Stanford commented on the presentation of the Region 7 Electronic Achievement Award to Dr. Louis Zitelli of Varian Associates, for breakthroughs in microwave high-power tubes. Chodorow pioneered uses of the klystron tube, invented at Stanford by Russ and Sig Varian in 1937-1939. The new x-band tube should make possible mapping of the moon's surface. Zitelli is profiled on page 46.

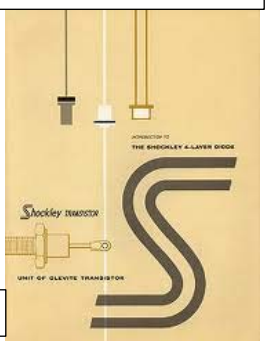
p. 28: The China Lake Section in Ridgecrest CA is described. I visited NOTS (the Naval Ordnance Testing Station) at China Lake as a Scout in 1960, and witnessed the firing of the rocket sled and the use of a Sidewinder missile to shoot down a drone.

p. 32: A photo of Les Hogan of Motorola, inventor of the microwave gyrator under Bill Shockley and an IRE Fellow; he later becomes president of Fairchild Semiconductor with a group known as "Hogan's Heroes". He received the IEEE Frederik Philips Award in 1975. I know his daughter.

p. 50: A tribute to Region 7 IRE Fellow Lee de Forest, who died in 1961. He invented the audion tube, and patented the amplifier and oscillator circuits in Palo Alto in the 1910's.

p. 62: Cyril Ellwell, the "grandfather of Silicon Valley", is an IRE Fellow. As a new Stanford grad, he licensed the Poulsen arc transmitter from Denmark and founded Federal Telegraph in 1909.

p. 64: Prof. David Tuttle of Stanford is an IRE Fellow. He was resident faculty at my freshman dorm in 1962, and I got to know his family.



Source: Computer History Museum

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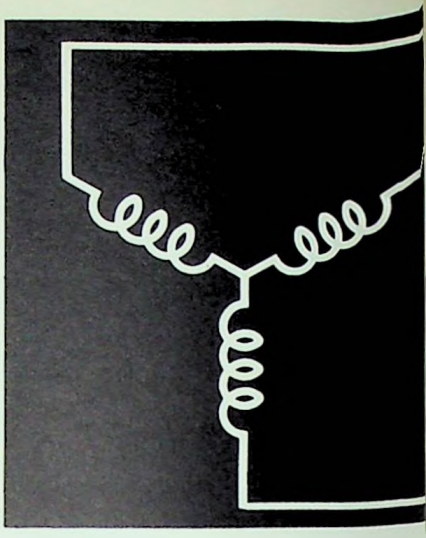
grid-bulletin

JOINT PUBLICATION SAN FRANCISCO AND LOS ANGELES SECTIONS OF THE I.R.E.

AUGUST 1961 / COMPLETE DETAILS ON WESCON EVENTS

Cow Palace, San Francisco August 22-25, 1961

now... high accuracy synchro and resolver testing



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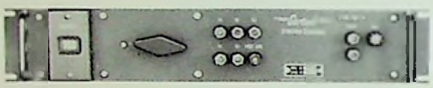

Gertsch Synchro Standards simulate the output of a master Synchro Transmitter (CX), with better than 2 seconds of arc accuracy. Ideal for checking Synchro Control Transformers (CTs), or complete systems. Units feature a low effective unbalance impedance which permits loading the output without introducing stator output errors.

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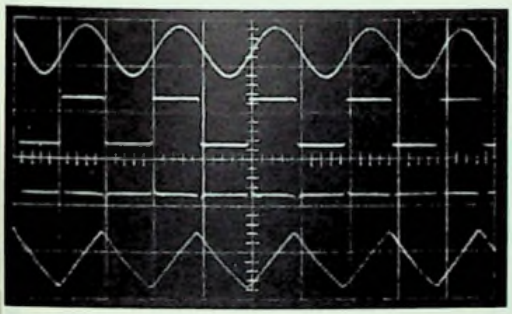

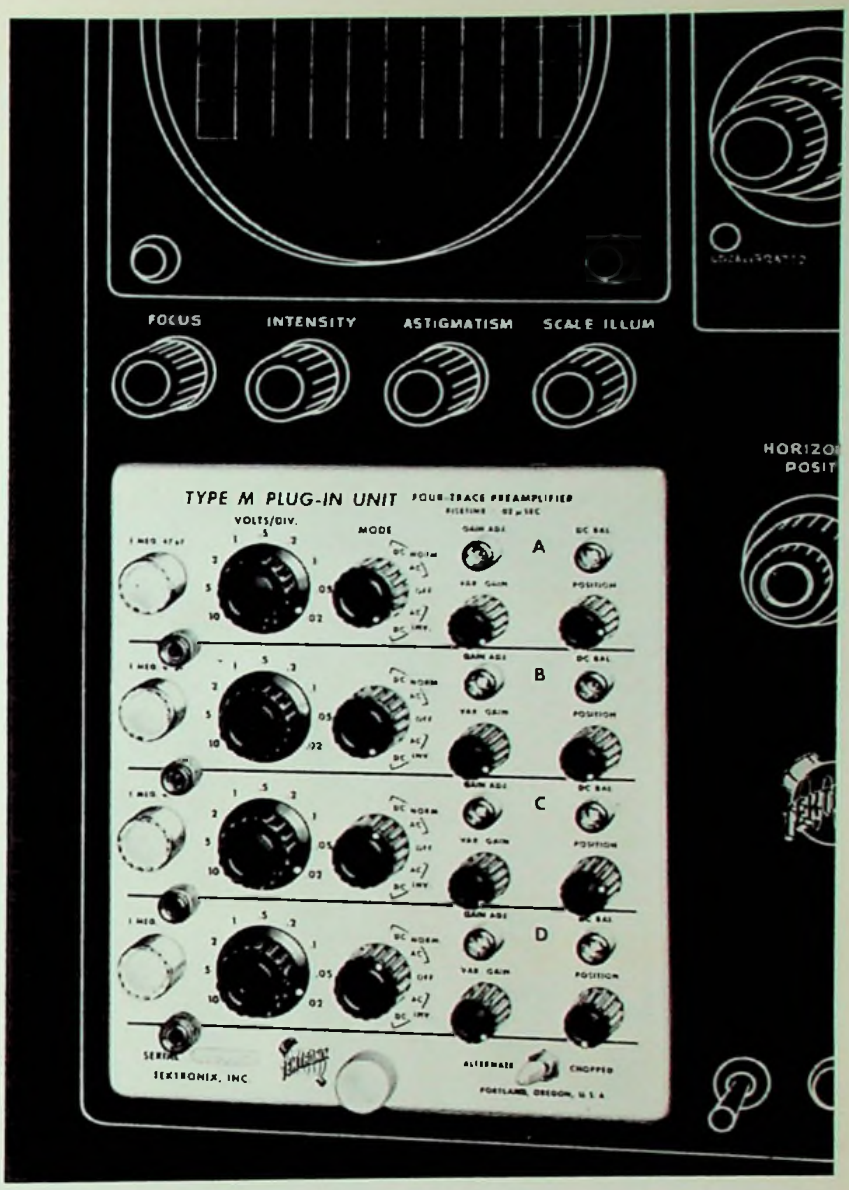

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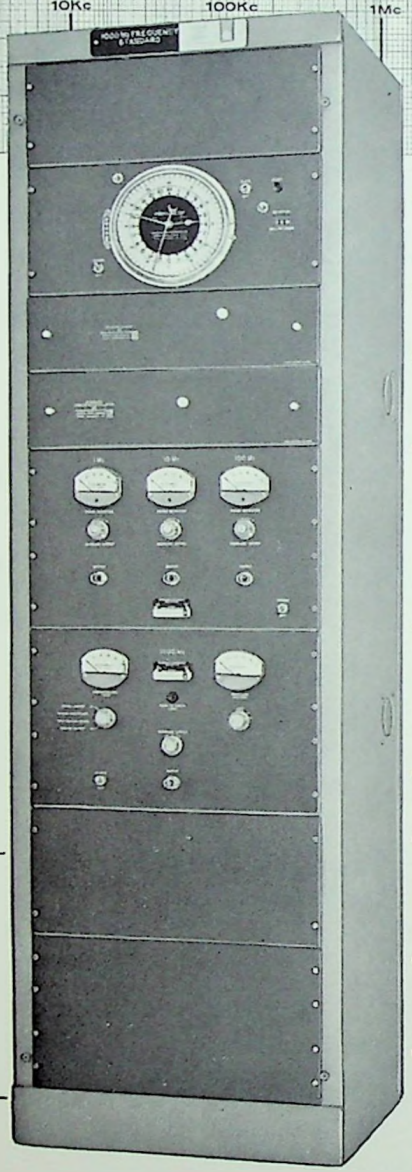

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grid-bulletin

VOLUME 6 AUGUST 1961 NUMBER 2

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contents

cover

Continuing the astronomical theme that leads to Wescon itself, the cover of this issue again uses for background the Nebula in Cygnus as photographed at the Mt. Wilson and Palomar observatories. In the upper inset is a solar atmospheric-disturbance photo from Stanford/SRI and below, a closeup of a ruby from the Hughes laser. Design by West Associates, Los Angeles.

errata

In the July issue, Robert C. Hansen should have been listed instead of Donald R. Proctor as the 1960-61 vice chairman of the Los Angeles Section.

san francisco

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san francisco greetings

WELCOME TO WESCON

The San Francisco Section of the IRE is proud to be a co-sponsor of WESCON with the Los Angeles Section of the IRE and with WEMA. It is fitting that the Seventh Region, acting through the two Sections, be closely identified with WESCON, since the continued growth and popularity of WESCON is a recognition of the growth and importance of the electronic industry throughout the Sections constituting the Seventh Region. In fact, this growth is exemplified by the inclusion in the Seventh Region of the Hawaii and the Alaska Sections.

We are pleased to be able to share with the WESCON visitors the hospitality of "The City," San Francisco, and the many worthwhile activities planned for us by the very able WESCON management. May your visit be a memorable one at what promises to be the best WESCON ever presented.

—STANLEY F. KAISEL, CHAIRMAN, 1961-62
SAN FRANCISCO SECTION, IRE

J. J. Guarrera

los angeles greetings

WELCOME TO WESCON

Part of the standard opening for a welcoming message to any convention is: "Bring plenty of money."

Strange as it may seem, however, we feel there is an element needed for this particular WESCON show which is even more important than money. We would like to say to electronics people from every part of the country: "Bring your ideas—and your problems."

This opportunity that WESCON affords for the exchange of ideas among creative members of the electronics industry is of critical importance during 1961—the year in which the United States was the world's second nation to achieve space flight.

It is a matter of obvious record that the entire future and well-being of our country hinges on the ability of the electronics industry to devise and produce better systems—faster! Ours is an industry which has been spurred to rapid progress.

This progress, in turn, is usually a direct result of the free exchange and germination of creative ideas. In our field, tomorrow's ideas are based on today's knowledge. These basic elements of technical advancement are all built into this WESCON convention.

First, there are the seminars which will fill you in on the latest state of the art in the form of selected, top-quality papers screened for their import and significance. Study the program carefully. Take advantage of the potential of this knowledge.

Then, check carefully the list of field trips scheduled for this year's WESCON show. The ability to visit the front-line facilities covered this year is an important opportunity to improve know-how and technique.

Finally, be sure to seek out and talk shop with other electronics people with problems similar to your own. This type of concentrated exchange of ideas is one of the important breeding grounds of technical progress.

Members of the San Francisco Section of the IRE; representing the Seventh Region, and WEMA, their officers and committees, as well as the WESCON staff and board, who have worked so diligently to conceive and put together this year's meetings and exhibits; are to be congratulated. They are also to be thanked for their important contribution to the well-being of the field in which we earn our livelihood.

—JOHN J. GUARRERA, CHAIRMAN, 1961-62
LOS ANGELES SECTION, IRE

TRIGGER HAPPY

As you read this, WESCON is very much like a spring-wound mechanism full of carefully machined, well oiled parts ready to go into action upon receipt of the proper triggering signal—in this case the dawning of day number 234, August 22, 1961.

This being true, let's look at the individuals who did the machining, oiling, and winding.

Board of Directors

Albert J. Morris, president and general manager of Radiation at Stanford is chairman of the board; O. H. (Hank) Brown, assistant for corporate relations at Eitel-McCullough, Inc., is chairman of the executive committe, John V. N. Granger, president of Granger Associates, is convention director; and Calvin K. Townsend, executive vice president of Jennings Radio Manufacturing Corp., is show director. Members of the board include Bruce S. Angwin, western regional manager, receiving tube department, General Electric Co., Los Angeles; Donald C. Duncan, president, Duncan Electronics, Inc., Santa Ana; S. H. Bellue, vice president, Osborne Electronics Corp., Hawthorne; and Edward C. Bertolet, vice president, Behlman Engineering Co., Burbank. Manager is Don Larson, and office manager and recording secretary is Jeanne W. Howard.

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Jack Silhavy, Varian Associates, is chairman of the exhibits committee and Berkley J. Baker, Litton Industries electron tube division, San Carlos, vice chairman. Members are Ernest Clover, Triad Transformer Corporation, Venice; Jerry Ryan, RCA electron tube division, Harrison, N.J.; J. A. MacPherson, Kinetics Corp., Solano Beach, Calif.; Robert Andrews, Raytheon Company, Waltham Mass.; Calvin Glade, Collins Radio, Richardson, Tex.; William Schlundt, Bendix Corporation, Mishawaka, Indiana; and Richard Ellstrom, Tektronix, Inc., Scottsdale, Arizona.

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Robert Craig, microwave laboratories, Stanford University, is chairman; and Hank N. Meyer, Stanford Research Institute, Menlo Park, is vice chairman. Members are as follows: Victor Buell, Hewlett-Packard Co.; Marsh Gebert, Ampex Corporation, Redwood City (signs and posters); John L. Morton, Hewlett-Packard Co.; Steve W. Miller, Stanford Research Institute, Menlo Park (transportation); William W. Wilson, Neely Enterprises, San Carlos; Richard Stark, Varian Associates (equipment procurement); and E. N. "Pete" Phillips, G.E. receiving tube department, San Mateo, and Harold Nelsen, Ampex

(Continued on page 8)

MORE COMMITTEES

Professional Products Co. (personnel procurement).

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Mrs. Bernard Oliver of Los Altos Hills is chairman and Mrs. Norman Moore of Atherton is vice chairman. Members include: Mrs. Frank Cavier of Palo Alto, Mrs. O. B. Sundberg of Los Altos, Mrs. Hugh Fleming of Menlo Park, Mrs. Louis A. G. terVeen of Portola Valley, Mrs. H. Myrl Stearns of Menlo Park, and Mrs. W. Doolittle of Palo Alto (hospitality).

Mrs. Emery G. Rogers of Atherton, Mrs. Bruce Wholey of Los Altos Hills, Mrs. Charles Black and Mrs. Nathan Most of Atherton, Mrs. Jack L. Nally, Mrs. Richard E. Stark and Mrs. Lee V. Langan, Jr., of Palo Alto (luncheon-fashion show, at the Sheraton-Palace).

Mrs. Wilbur Watson of Palo Alto, Mrs. John Whinnery of Orinda, Mrs. H. Richard Johnson and Mrs. Gordon Eding of Palo Alto, Mrs. Orion Hoch of Redwood City, Mrs. James Palmer of Mt. View (luncheon and theater party).

San Francisco's Fairmont Hotel has the latchstring out for the Wescon Cocktail Party (Tuesday, 6 to 8 p.m.) and the Banquet that replaces the traditional Luncheon (Thursday at 8 p.m.—Lloyd V. Berkner, speaker)

Mrs. James J. Halloran of Orinda, Mrs. Robert Ward of Lafayette, Mrs. R. W. Kane and Mrs. Glenn Walters of Atherton (breakfast and tour of Cow Palace); Mrs. Arnold Wihtol of Palo Alto (event at the San Francisco Museum of Art); and Mrs. W. Noel Eldred of Palo Alto (coordinator for menus at the luncheon events).

Banquet Committee

John S. McCullough, assistant to the general manager of the electron tube division, Litton Industries, is chairman of the All-Industry Banquet Committee, and Cortlandt Van Rensselaer, of Hewlett-Packard Co. is vice chairman. Members include J. C. Ingersoll, Neely Enterprises, San Carlos; Ed Moore, Neely Enterprises, San Diego; E. D. Taylor, Litton Industries, San Carlos; L. E. Bernier, Litton Industries, San Carlos; David G. DeHaas, David G. DeHaas Co., San Diego; Robert H. Brunner, Neely Enterprises, North Hollywood; E. C. Morgan, Dymec Division, Hewlett-Packard Co.; D. K. Mutchler, Litton Industries, San Carlos; and Jerry M. Kelly, Litton Industries, San Carlos.

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Emmet Cameron, Varian Associates, is chairman of the cocktail party committee, and Glenn A. Walters of Dalmo Victor Company is vice chairman. Members include: David Ross, David H. Ross Co., San Carlos; Cortlandt Van Rensselaer, Hewlett-Packard Co.; Richard Huggins, Huggins Laboratories, Sunnyvale; Norman Neely, Neely Enterprises, North Hollywood; Dr. Joseph M. Pettit, Stanford University; V. N. Zachariah, Zack Electronics, San Francisco; Ben Cerruti, Cerruti-Hunter Associates, Redwood City; Robert Ward, Beckman Instruments, Inc., Richmond; John S. McCullough, Litton Industries, San Carlos; S. H. Bellue, Osborne Electronics Corp., Hawthorne; Thomas A. Lynch, Radio Product Sales, Inc., Los Angeles; William Miller, Burton Manufacturing Co., Santa Monica; Donald C. Duncan, Duncan Electronics, Inc., Santa Ana; W. Bert Knight, W. Bert Knight Co., Los Angeles; Jack Ingersoll, Neely Enterprises, San Carlos; Elvin Feige, Elmar Electronics, Oakland; and Robert Honer, Electro Instruments, Inc., San Diego.

Hospitality Committee

John A. Chartz, Dalmo Victor Company, Belmont, is chairman and Donald B. Harris, Stanford Research Institute, is vice chairman. Members include: Earl Goddard, Radiation at Stanford; William A. Edson, Electromagnetic Technology Corp., Palo Alto; Winfield G. Wagener, Varian Associates; Robert N. Ward, Beckman Instruments, Inc., Richmond; Roy C. Henning, Eitel-McCullough, Inc., San Carlos; D. E. Foster, Lenkurt Electric Co.; D. E. Merrill, Dymec Division, Hewlett-Packard Co.; Leonard Larson, Ferro-Magnetics Company, Palo Alto; Harry Mason, Western Gold & Platinum Co., Belmont; Mrs. Jan (Herman) Smith; Mrs. Maryann (Edward) Hall; Mrs. Kathy (Arthur) Kaufman, Ferro-Magnetics Company; Mrs. Sara (Gray) Wilson, Women's Association of the Electronic Industry; A. S. Brown, Stanford Research Institute; Ronald N. Bracewell, Stanford University; Paul F. Byrne, consultant; Marvin Chodorow, Stanford University; Lucien G. Clarke, Stanford Research Institute; Leonard F. Fuller, retired; Edward L. Ginzton, Stanford University; Robert A. Helliwell, Stanford University; Ralph M. Heintz, Sr., Los Gatos; Walter Kohl, Sylvania Electric Products, Inc.; John G. Linvill, Stanford University; Charles V. Litton, Litton Engineering Laboratories, Grass Valley; J. M. Loge, Loge Electronics, Inc., Los Angeles; Laurence A. Manning, Stanford University; Thomas H. Morrin, Stanford Research Institute; William D. McGuigan, Stanford Research Institute; Richard L. Poulus, Electronics Management Corp., Beverly Hills; Joseph M. Pettit, Stanford University; William E. Rambo, Stanford University; Karl R. Spangenberg, consulting engineer; Charles Susskind, University of California; Richard T. Silberman, Electronics Capital Corp., San Diego; Samuel Silver, University of California; H. Myrl Stearns, Varian Associates; Alan T. Waterman, Stanford University; Paul Morton, University of California; and William S. Ivans, Kin Tel, San Diego.

Visitors' Services

Bill Melchior of Eichorn & Melchior, Inc., San Carlos, is chairman and Norman Hiestand, Varian Associates, is vice chairman.

Registration Committee

Robert E. Johnston, Jennings Radio Mfg. Corp., is chairman and Fred J. McKenzie, Stanford Research Institute, is vice chairman. Members include: John D. Dawson, Jennings Radio Mfg. Co.; Thomas A. Christiansen, Hewlett-Packard Co.; Harry Pfeiffer, Varian Associates; William M. Keeley, Sylvania Mountain View; and Clifford H. Holt, Redwood City.

Distributor-Rep Conference

Elvin Feige, Elmar Electronics, Oakland, is chairman of the distributor-rep conference committee; and Charles N. Meyer of Meyer and Ross Co., San Francisco, is vice chairman. Distributor members of the committee are V. N. Zachariah, Zack Electronics, San Francisco; Wendell Fales, California Electronics, West Los Angeles; Frank Zurek, Radio Parts Co., Div. Electronic Components, Inc., San Diego; Herman Middleton, Southwest Wholesale Radio, Inc.,

(Continued on page 9)

salute from wema

WELCOME TO WESCON

Phillip L. Gundy

The 1961 WESCON will be the tenth to be co-sponsored by WEMA and the Seventh Region of IRE.

The close association of these two organizations in staging this annual event has been marked by a high degree of cooperation and excellent teamwork. The result has been a very successful decade for WESCON — an experience that has embellished the stature and achievements of both IRE and WEMA.

Our joint efforts in directing WESCON in the next decade will be even more significant to the electronics industry and the engineers who must provide the technical impetus for its advancement.

The future, not only of our industry, but perhaps of our civilization as well, rests heavily on the ability of this nation's scientists and engineers to keep the United States in the forefront of technological development. Creativity and ingenuity in scientific endeavor will be even more important in the years ahead than in the past decade during which the technical talent in this nation accomplished many remarkable and almost unbelievable scientific achievements.

One of the factors that has contributed to our rapid scientific advancement is the interchange of ideas and information among engineers and industrial firms. An increasingly important medium for this idea interchange in our industry is WESCON.

Each year, at this four-day meeting, there are unparalleled opportunities for technical and management people to demonstrate their own new products and techniques and, at the same time, to learn of the newest technology of others in the industry.

It's hoped that all members of IRE in the Seventh Region will take full advantage of this means of enriching their personal knowledge and capabilities by attending the technical sessions and visiting the manufacturers' exhibits at WESCON, August 22-25.

Just as IRE members play a vital role in the success of WESCON, so do they contribute significantly to the achievements of WEMA in its local council programs. A large percentage of the management people participating in WEMA activities wear the IRE membership insignia.

On this eve of the 1961 WESCON, as our two organizations complete their first decade of co-sponsorship of this great show and convention, I salute the WEMA-IRE partnership which typifies the close relationship of scientific and industrial endeavor in the West.

—PHILLIP L. GUNDY
PRESIDENT, WEMA

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wescon feature

TECHNICAL FIELD TRIPS

The concentration of engineers on the San Francisco Peninsula has produced a constant ferment of professional activity of keen interest to IRE colleagues across the country. WESCON's field trips, tied closely to the main body of the technical program, will concentrate this year on a band of activity running about ten miles north and south of the Stanford University campus.

Bus service from the Cow Palace will be offered for the following tours:

Tuesday afternoon, August 22—Litton Industries electron tube division at San Carlos, to inspect high-power and super-power tube facilities; the University of California's Lawrence Radiation Laboratory at Livermore, where emphasis will be placed on basic work in plasma research (tour limited to 50).

Wednesday afternoon, August 23—Stanford University microwave laboratory will provide an opportunity to learn about research in two fields; that is (1) ionized cesium plasma and (2) electron guns and ion propulsion engines. Another tour visits the joint radio field site of Stanford University and Stanford Research Institute, with its wide variety of experimental installations used for radio-astronomy projects.

Thursday afternoon, August 24 — Melabs, in Stanford Industrial Park at Palo Alto, for a general tour of new facilities devoted to research, development and production of microwave devices (including cavity masers, S-band traveling-wave masers and L-band parametric amplifiers).

Thursday afternoon, August 24 — Hewlett-Packard Co. and its newly expanded center in Stanford Industrial Park, with attention to be concentrated on production areas (prefabrication, wiring and assembly, test and calibration, quality assurance).

MORE COMMITTEE

Phoenix; Wayne Stillman, Standard Supply Co., Salt Lake City; Richard L. Beets, Ward Terry & Co., Denver; William Bigelow, Columbia Electronics, Spokane; J. A. Murphy, Lou Johnson Co., Portland; and Roy Bright, Radio Television Corp., Ltd., Honolulu. Representative members of the committee are David H. Ross, David H. Ross Co., San Carlos; W. Bert Knight, W. Bert Knight Co., Los Angeles; Homer Premil, W. Bert Knight Co., Glendale; Joe Shaw, Ron G. Bowen Co., Salt Lake City; Floyd Harris, Ron G. Bowen Co., Denver; William E. Earl, Sr., Don H. Burcham Co., Portland; Burt C. Porter, Burt Porter, Inc., Seattle; and Jim Hastins, Jim Hastins Sales Co., Honolulu.

Public Relations Committee

Peter N. Sherrill, Hewlett-Packard Co., is chairman and Charles Elkind, IBM Corporation, is vice chairman. Members include: V. N. Zachariah, Zack Electronics; Robert Taylor, Stanford Research Institute; William D. Fenton, Sylvania Electric Products, Inc., Burlingame; Richard K. Gottschall, Convair Corp., San Diego; Berkley J. Baker, Litton Industries electron tube division, San Carlos; Merritt Holman; Thomas D. Boyd, Lenkurt Electric Co.; Mrs. Judith Machanik, Fairchild Semiconductor, Mountain View; Preble Stover, Lockheed; Daniel Wentz, Ames Research Center, Mountain View; Richard W. Larrick, United Technology Corporation, Sunnyvale; Richard L. Paullus, Electronics Investment Management Corp.; Beverly Hills; James L. Todd, Sandia Corp., Albuquerque; and A. G. Newman, General Electric Co., Phoenix; S. E. McCallum, GE, Owensboro, Ky.; Dan Defenbacher, Raychem Corp., Redwood City, Calif.; H. J. Pannell, Jr., Kin Tel, San Diego; Tedrowe Watkins, Tally Register Corp., Seattle, Wash.; Payne Johnson, General Dynamics, San Diego; Odom Fanning, CBS Laboratories, Stamford, Conn.; and H. S. Renne, Bell Telephone Laboratories, New York, N. Y.

THE TECHNICAL SESSIONS

Technical, military, politico-economic, and psychological aspects of arms control—subject of much international debate in Geneva and the major capitals of the world—will be discussed at a special evening session on WESCON Wednesday, listed in the complete program starting below.

The session has been organized and will be led by Dr. L. C. Van Atta, recently special assistant for arms control in the Office of the Director of Defense, research and engineering. Dr. Van Atta returned to California last month to rejoin Hughes Research Laboratories, Malibu, from where he was on leave in his assignment at the Pentagon.

Dr. Van Atta has announced the composition of the panel, each participant having some authoritative connection with the subject.

Speaking on nuclear aspects will be Dr. W. H. K. Panofsky, professor of physics at Stanford University and deputy director of Project M—the two-mile linear accelerator due to be constructed on the Stanford campus. Panofsky is a member of the President's science advisory committee.

Contributing remarks on military aspects will be Rear Admiral P. L. Dudley, special assistant to the Joint Chiefs of Staff for disarmament affairs. Also representing the Defense Department will be Harry Rowen, deputy assistant secretary in the office of the Assistant Secretary of Defense (international security affairs), who will speak on politico-economic aspects.

Other technical areas will be covered by Dr. Donald G. Brennan of MIT's Lincoln Laboratories, Lexington, Mass. Dr. Charles E. Osgood, director of the institute of communications research, University of Illinois, Urbana, will review pertinent psychological problems.

PROGRAM

SESSION 1
BROADBAND ANTENNAS

Tuesday, August 22
Room A—10:00 A.M.-12:30 P.M.

1/1 LOG-PERIODIC RESONANT-V ARRAYS

P. E. Mayes and R. L. Carrel, University of Illinois, Urbana, Illinois.

Simple antennas which cover extremely broad bands at the discretion of the designer can be made by employing the principle of logarithmic periodicity. Log-periodic arrays of linear dipoles of reasonable size yield directive gains up to 10 db over isotropic. By using resonant-V elements in higher-order resonances, rather than half-wave dipoles, increased directivity can be achieved. Furthermore, the some structure can be used in several modes to achieve coverage of different frequency bands. An efficient utilization of the structure is obtained in this way, since many of the elements will be used at more than one frequency.

Typical directive gains from 12 db (over isotropic) in the three-half-wavelengths mode to 17 db in the seven-half-wavelengths mode have been obtained. The input impedance can be controlled to some extent by choice of design parameters. A vswr less than 3:1 can be achieved across the entire band covered by several modes except at "transition" regions where operation changes from one mode to another. Radiation patterns, directivity, side-lobe and impedance data are presented which enable one to design for particular applications.

1/2 DESIGN CRITERIA FOR LOG PERIODIC ANTENNAS

Claes T. Elfving, Sylvania Electric Products Inc., EDL, Mountain View, California.

The logarithmically periodic antenna is a pseudo-frequency independent antenna, the frequency band of operation of which is limited only by the physical size of the antenna structure.

Near-field measurements on a folded log periodic antenna have revealed two waves existing on the structure, and suggest an explanation to the operation of this type of antenna in terms of a transmission line wave and a radiated wave.

The electrical characteristics of log periodic antennas have been evaluated with the help of a "variable parameter" log periodic antenna structure, especially constructed for this investigation. The design of this antenna is such that the basic design parameters, the angles describing the antenna, and the design ratio determining the number of elements on the antenna, can be varied over a wide range. The far-field radiation patterns, impedances, and r-f currents in the radiating elements of the antenna were measured for different values of these physical parameters. These measurements have been closely analyzed and a nomograph relating all important physical parameters of the antenna with the operational characteristics has been developed. With the help of this nomograph the physical design parameters of an optimum antenna for any log periodic antenna application can be determined, within the present state of the art.

1/3 PROPERTIES OF A PAIR OF WIRE GRIDS FOR USE IN LENS-TYPE HF ANTENNAS

M. Andreasen and R. L. Tanner, Stanford Research Institute, Menlo Park, California.

This paper presents a study of the possibility of using a pair of square-mesh wire grids for a two-dimensional lens-type antenna whose beam can be steered 360 deg. in azimuth. An antenna of this type is particularly useful at lower frequencies such as h-f, where dielectric and waveguide-type lenses are impractical. The property of a pair of grids that makes it suited for lens structures is that the velocity of a wave propagating between two grids can be varied by varying the ratio between the mesh size and the spacing between the grids. Simple design formulas, which have been confirmed by experiments, have been derived for a pair of square-mesh wire grids. Measurements show that the equivalent dielectric constant of the grids is not too frequency dependent for many purposes.

Sponsored by Professional Group on Antennas and Propagation

Chairman and Organizer: Ray Justice. Granger Associates. Palo Alto, Calif.

SESSION 2
NEW MICROWAVE ELECTRON DEVICES

Room B—10:00 A.M.-12:30 P.M.

2/1 THE COAXIAL MAGNETRON, A SUPERIOR MICROWAVE POWER SOURCE

H. M. Olson and L. H. Von Ohlsen, Bell Telephone Laboratories, Laureldale, Penna.

(Continued on page 12)

FUTURE ENGINEERS

The fifth annual future engineers show to be held in connection with the Western Electronic Show and Convention will bring some of the nation's most promising young technical talents to public attention in San Francisco.

Twenty-seven youthful contestants, chosen by Institute of Radio Engineers sections in the west and midwest, will compete for honors in displays and technical paper presentations during the 1961 WESCON at the Cow Palace.

Scholarships totalling $2500 will be awarded winners of the five top places in the future engineers exhibit competition. The top award of $1000 is named in honor of Dr. Lee de Forest.

To be given for the first time will be the new Frederick Emmons Terman Award, named for the present provost of Stanford University in recognition of his contributions to engineering education. The Terman Award, a scholarship valued at $250—will be given the student selected by judges in the technical paper symposium.

Open to the Public

While attendance at the trade exhibition and technical convention is limited to professional men and other WESCON registrants associated with the electronics industry, the future engineers show will be open to the public through a special entrance to the Cow Palace. The hours will be from noon on Tuesday, August 22, and daily Wednesday through Friday from 9 a.m. to 6 p.m.

Several activities will engage the participants when they are not otherwise tending their displays. The chief event will be the annual Awards Luncheon on Thursday, August 24, which will be addressed by Dr. Charles N. Kimball, president of Midwest Research Institute at Kansas City, Mo. Dr. Kimball was keynote speaker for the National Science Fair at Kansas City.

A visit to Ames Aeronautical Laboratory at Moffet Field is planned for one afternoon. Following a dinner in Chinatown the future engineers and their faculty sponsors will have an evening at Morrison Planetarium.

New Settings for Displays

This year WESCON is providing a new set of permanent display booths for the future engineers show, which was established with the 1957 WESCON at the Cow Palace.

Judging of the exhibits will be done by prominent professional engineers, scientists, educators and industry representatives on the second day of WESCON.

(Continued on page 12)

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2N1099	TO 36	10.50
JAN 2N174	TO 36	**16.50**
2N1358	TO 36	**16.50**
2N1358 (Sig. C)	TO 36	**16.50**
2N174A	TO 36	**16.50**
2N174	TO 36	7.15
2N173	TO 36	6.40
2N443	TO 36	6.00
2N278	TO 36	5.25
2N442	TO 36	4.90
2N277	TO 36	3.75
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5-7 AMP. DIAMOND BASE

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2N665	**TO 3**	**12.00**
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MORE FUTURE ENGINEERS

National in Character

This year the competition will have its first participant outside the western states embraced by the Seventh Region of the IRE. The Cedar Rapids, Iowa Section of the IRE is sponsoring William Leighty of Waterloo, Iowa, who is working this summer with the Navy Electronics Laboratory at San Diego.

Following are other participants and their faculty advisors, grouped according to the IRE section areas sponsoring their appearance at WESCON:

Ronald E. Berg of Fort Richardson, Alaska, with an exhibit on "Electricity from Heat"; George Childs of Spenard, Alaska, sponsor.

Melvin S. Falck, Jr., of Albuquerque, with a display on "The Application of Super-Regeneration to Ultra High Frequency"; Mrs. Clarrissa Howard of Highland High School, sponsor.

Darold Pieper of China Lake, with a presentation on "Nuclear Magnetic Resonance"; representing Burroughs High School and to be accompanied by his father, Walter A. H. Pieper.

Dale H. Yamamoto of Hilo, with an exhibit on "Electronic Nerve Cell"; S. Tanaka, Hilo High School, sponsor.

William S. Puett of Santa Maria, with a display on "Elastic and Inelastic Neutron Scattering"; Alvin Hall of Santa Maria Union High School, sponsor.

Dennis Eaton of Ventura, with a project on "Experiments in Ion Migration"; representing Ventura Senior High School and to be accompanied by his father, William H. Eaton.

Daniel F. Cribbs of Ventura, with an exhibit on "Cosmic Radiation—A Quantitative and Directional Analysis"; J. Porter, Ventura High School, sponsor.

James Robert Burk of Whittier, with a display on "Pumping by Ionization"; E. Dorn, California High School, sponsor.

James M. Pfab of Monrovia (title of exhibit and name of faculty sponsor not available at this report).

Niles Puckett of Phoenix, with an exhibit on "Design Construction and Application of a Practical Electrometer"; Dr. R. L. Riese of West High School, sponsor.

Douglas B. Bingham of Castle Rock, Wash., with a display on a "Sequence Controlled Relay Digital Computer"; Ken Aanerud of Castle Rock High School, sponsor.

Richard Lowe of Salt Lake City, with a presentation on "High Altitude Research Equipment"; T. Rex Lowe of Highland High School, sponsor.

Lincoln Bergman of San Francisco, with a display on "An Experimental Validation—The Charge upon the Electron"; John J. Burke of George Washington High School, sponsor.

Richard Hanset of Santa Cruz, with a project on "Slow-Scan Television"; representing Santa Cruz High School and to be accompanied by his father, Eugene H. Hanset.

Michael Pollock of Saratoga, with a display on a "Computer for Chemical Subscripts"; representing Saratoga High School and to be accompanied by his mother, Mrs. Michael D. Pollock.

Dennis M. Taylor of San Jose, with an exhibit on "The Ptolemy Memorial Planetarium"; representing Abraham Lincoln High School and to be accompanied by his mother.

Ronald Sheets of Fremont, with a display on "Machina Vidiens—The Machine That Sees!"; Otto W. Graf, Jr., of Washington High School, sponsor.

George Stransky of Los Altos, with an exhibit on an "Interferometer"; D. Cone, Los Altos High School, sponsor.

Richard Post of Palo Alto, with a presentation on "The Development of a Van de Graaff Generator for Nuclear Investigations"; Henry Martin of Palo Alto High School, sponsor.

Stephen Merrill of Alameda, with an exhibit on "Light Amplification in Zinc Sulfide"; representing Alameda High School and to be accompanied by his father, David H. Merrill.

Richard Glasspool of Berkeley, with a display on a "Pseudomnemonic Instrument"; Ted W. Beck of El Cerrito High School, sponsor.

David Jenson of Berkeley, with an exhibit on "Magnetic Core Circuits"; Ted W. Beck of El Cerrito High School, sponsor.

Stephen Welch of Redwood City, with a project on "Underwater Sound"; representing St. Pius School and to be accompanied by his parents, Mr. and Mrs. Clifford Welch.

Donald Scott Rushmer of Seattle, with an exhibit on "Cochlear Microphonics of the Ear"; Ward Teel of Shoreline High School, sponsor.

David Getty of Tucson, with a project on "Hypersonic Shockwaves Produced by a Magnetohydrodynamic Shock Tube"; David T. Smith of Catalina High School, sponsor.

1952 seventh region achievement

JOSEPH M. PETTIT

Joseph M. Pettit, who is dean of the school of engineering and professor of electrical engineering at Stanford University, was honored with the first of the 7th Region Electronics Achievement Awards at WESCON in 1952. His special field of interest has been electronic measurements and circuit theory, and in 1948 he was given the Presidential Certificate of Merit for wartime work on radar countermeasures.

On the Stanford faculty in various capacities since 1947, Dr. Pettit has also been associated with the Airborne Instruments Laboratory, the OSRD, the USAF, Harvard, and the University of California. His EE (1940) and PhD (1942) were both from Stanford, his BS (1938) from the University of California.

He is a Fellow of the Institute and holds memberships in the American Society for Engineering Education, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu.

MORE PROGRAM (TUES.)

A recently developed new technique of controlling the mode of oscillation in a magnetron has led to an improved type of magnetron called the coaxial magnetron. In the coaxial magnetron the circular electric mode of a coaxial cavity surrounding a conventional array of vane resonators is excited by the pi mode of the vane array. This design yields several advantages over the conventional magnetron; higher power output, greater frequency stability, higher efficiency, and wider tuning range. The importance of these advantages to radar performance and the potentialities of the coaxial magnetron principle are discussed.

2/2 ANALYSIS OF A CROSSED-FIELD WAVEGUIDE AMPLIFIER

W. C. Brown and G. E. Dombrowski, Spencer Laboratory, Raytheon Co., Burlington, Mass.

The r-f structure of this device is a cylindrical waveguide supporting a TE wave having a large angular wave number, i.e., rapid azimuthal field variation. In the presence of an axial d-c magnetic field cross field interaction can take place in which electron motion is confined to transverse sections, precisely as in the magnetron. Energy flow takes place as fast waves in the axial direction. The magnetron oscillator may be considered a special case of this interaction at the lower frequency cutoff. The action of the space-charge at the various transverse sections can be considered, as in the Amplitron, to excite the transmission structure in such phases as to reinforce in an output direction and interfere in the other direction. The device thus serves as an amplifier. With the advent of economical magnetic fields of high strength extending over large volumes, the waveguide amplifier shows considerable promise for generation of large amounts of high frequency power especially at millimeter wavelengths.

The gross behavior of the coupled waveguide

(Continued on page 14)

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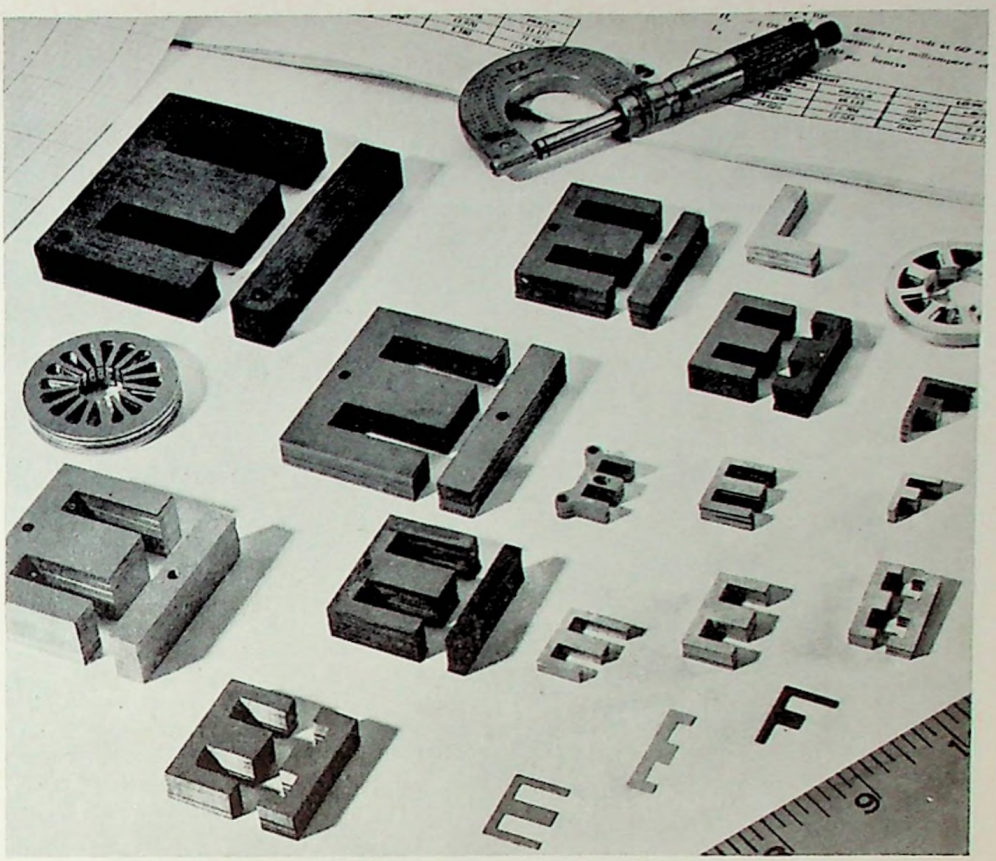

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merit in design

THE TOP TWENTY-THREE

For the third WESCON in a row, visitors will find an industrial-design exhibit. They will see the cream of the new products, adjudged by the panel of design specialists to be the best 23 of this year's 172 entries. On the opening day of WESCON, a further judging will be held to designate up to five Awards of Excellence from this group.

Taking part in the judging were: Henry Joe Police, staff industrial designer for Ramo-Wooldridge Corp., Canoga Park; William C. MacPherson, partner in Dunlap & Associates, Santa Monica industrial designers; Robert Mason of Robert Mason & Associates, San Diego industrial design firm; Jim Powell, industrial designer for Hughes Ground Systems, Fullerton; Joseph D. Portanova, industrial designer for Hoffman Electronics Corp., Los Angeles; and Howard Assel, partner in Dunlap & Associates, industrial designers in Santa Monica.

Don Brundage of Brundage Associates, San Francisco, is chairman of the IDA judging activity and arranged the Los Angeles deliberations.

Placing in the awards competition were the following companies and products:

Helipot Division of Beckman Instruments, Inc., Fullerton, Calif., for a group of panel meters.

Design director, Harold Dsenis; designers, Harold Dsenis and Richard G. Reineman; project engineering supervisors, H. Haiberg and William Loedel.

Collins Radio Co., Cedar Rapids, Iowa, for an f-m transmitter for radio broadcasting.

Design directors, Zierhut/Vedder/Shimano Associates; Van Nuys, California; project engineering supervisor, Fred Damm.

Consolidated Electrodynamics Corp., Pasadena, Calif., for a magnetic-tape degausser.

Design director, R. Heath; designers, Bill Benson and R. Heath; project engineering supervisor, Fred Grant.

Consolidated Electrodynamics Corporation (analytical & control division) for a mass spectrometer.

Design director, Andrew Nowina-Sapinski; project engineering supervisor, Charles G. Blanchard.

Data-Stor Division of Cook Electric Co., Skokie, Ill., for a digital magnetic tape transport.

Designers, Mr. Painter; Teague & Petertil; project engineering supervisor, Elmer Beck.

Ungar Electric Tools, Electronic Division of Eldon Industries, Inc., Hawthorne, Calif., for a soldering iron.

Design director, B. Cagan; designers, Al Knowles and Ervin Harvey; project engineering supervisor, Al Knowles.

Electronic Associates, Inc., Long Branch, N. J., for a transistorized digital voltmeter.

Design director, John Bruce; designer, M. De Camillis; project engineering supervisor, M. De Camillis.

Fisher Berkeley Corp., Emeryville, Calif., for its intercom for office, industrial or home use.

Design director, John Crane; designer, John Crane of Walter Landor & Associates; project engineering supervisor, Robert S. Fisher.

Light Military Electronics Department of General Electric Co., Utica, N. Y., for

(Continued on page 16)

1953 seventh region achievement

SIMON RAMO

Executive vice president and a director of Thompson Ramo-Wooldridge, Inc., Dr. Simon Ramo received the 7th Region Achievement Award in 1953, just prior to his co-founding of Ramo-Wooldridge Corp. in September of that year.

His BS degree in electrical engineering was received from the University of Utah in 1933 with highest honors, and his PhD in electrical engineering and physics from the California Institute of Technology in 1936, magna cum laude.

At General Electric Company he attained prominence on the research staff for work in microwave and electron optics. Beginning in 1946, at Hughes Aircraft Co. he held the positions of director of research of the electronics department, director of guided-missile research and development, and vice president and director of operations.

A Fellow of the Institute, he holds similar rank in AIEE, American Physical Society, American Rocket Society, and the Institute of the Aeronautical Sciences. He is a member of the American Association for the Advancement of Science, Eta Kappa Nu, Phi Kappa Phi, Sigma Pi Sigma, Sigma Xi, Tau Beta Pi, and Theta Tau.

MORE PROGRAM (TUES.)

stream system is shown to be a linear growth of the wave excited at the input. The phase of the space-charge is controlled by the phase rate of the cold structure. Thus, the space-charge takes the form of a helical gear. It is necessary that the input signal must be greater than the space-charge-induced signal in order to control the space-charge phase.

A simple analysis is made using the transmission line description of the waveguide mode and the constant current generator idealization of the electron stream. Using the "induced wavelet" technique of calculating system behavior, a non-linear integral equation is obtained. Exact numerical integrations are presented; they show that gains of 10 to 20 db can be expected before operation becomes unstable. The degree of input mismatch, i.e., the amount of reverse-directed energy flow, can also be determined from these calculations. It is shown that the match can never be made perfect, but that the reverse-directed power can be made at least 20 db below the output level over a band of a few percent. The effect of load mismatch is important in this waveguide amplifier because there is no inherent distinction between input and output except for point of signal application. Results of calculations for various load conditions are presented and the effect on device stability is discussed.

2/3 BEAM-PLASMA AMPLIFIERS

M. A. Allen and G. S. Kino, Stanford University, Stanford, California.

Recent experiments on electron beam-plasma interaction have been performed using a thermally generated cesium plasma. The experimental results obtained are in excellent agreement with the theoretical predictions. These experiments, in which gains of as high as 15 db/cm at S-band have been obtained, show that the possibilities of using this interaction for the amplification of microwaves may, in the future, provide significant advantages over the existing devices now available. There is the possibility of obtaining very high efficiencies at high-power levels; and because no circuit is used, millimeter wavelength amplifiers and oscillators based on beam plasma interaction look extremely promising. The various problems involved in the design of such devices will be discussed.

Sponsored by Professional Group on Electron Devices

Chairman and Organizer: J. T. Mendel, Hughes Aircraft Co., Culver City, Calif.

SESSION 3
HIGH SPEED LOGIC

Room C—10:00 A.M.-12:30 P.M.

3/1 RELATIONSHIPS BETWEEN DEVICE AND SYSTEM DESIGN FACTORS IN UHF COMPUTERS

E. P. Stabler, General Electric Co., Syracuse, N.Y.

The specification of the behavior of a logical building block for an uhf computer will affect the operating speed, simplicity and operating margins of the circuits as well as the overall speed, complexity and reliability of systems made from the individual elements. It often happens that specification changes intended to improve the circuit design have a deleterious effect on the system design. In this paper some approximate measures of the quantitative effect of the specified fan-in and fan-out factors and the functional repertoire on the circuit design and the system design are presented. The use of these quantitative relationships permits a sensible choice of module specifications in terms of the requirements of both the circuit designer and the logical designer. A recently developed 200-mc logic module will be described. The circuit system relationships apply directly to this module and systems which are constructed from it, and similar relationships can be determined for other computing techniques.

(Continued on page 16)

Kinetics motor-driven switch has connector reliability

The selfsame reliability and simplicity of the familiar connector has been built into the Kinetics motor-driven switch for missile and aircraft use. The principle of the switch is sound and straightforward—a small motor is used to engage the switch contacts in a manner similar to that of connector contacts. The positive mechanical action is more reliable than solenoid actuated devices under extreme environments. Because of the high contact pressure, the Kinetics' switch has successfully withstood more than 100 G's rms sinusoidal vibration without contact chatter. The captive contacts require no power to hold them in place once the switch has transferred.

The Kinetics' motor-driven switch features extremely low contact resistance. If arcing should occur, the arc is drawn away from the mating parts of the contacts. As a result, there is little or no change in internal resistance during the life of the switch.

Kinetics has achieved extremely high density construction through unique miniaturization capability. You get the most circuits in the least space. A 100-pole, double-throw switch measures only 5.1" x 2.7" x 3.2", and weighs only 5 lbs., yet each contact can carry up to 15 amps continuously. Some smaller models weigh just a few ounces and are smaller than a pack of cigarettes.

Kinetics switches are used on missiles for main power changeover, range safety systems, destruct circuits, telemetry applications, battery transfer and a host of other applications. They are now in use on virtually all of the major missile programs. For help with your switch requirements, write or phone Kinetics Corporation, Dept. KG-8, 410 South Cedros Avenue, Solana Beach, Calif. SKyline 5-1181.

1961 WESCON IRE WEMA

See the Kinetics' exhibit in the South Annex, A-4230, at the 1961 Wescon Show, San Francisco Cow Palace, August 22 through 25.

KINETICS CORPORATION

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MORE DESIGN

a ballistic missile compute depot test set.

Design director, George A. Beck, FIDI; designer: Ernest V. Hansberry; project engineering supervisor, George H. Siegel.

Hewlett-Packard Co., Palo Alto, Calif., for an electronic enclosure system.

Design director, Carl J. Clement, Jr.; designers, Thomas Lauhon, Allen Inhelder, Don Pahl, Andi Are, Dale Gruye and Herbert Beaven; project engineering supervisor, Carl J. Clement, Jr.

International Business Machines Corp., White Plains, N. Y., for a terminal unit for transmitting pre-punched or variable data over existing telephone.

Design Director, E. Noyes, consultant; designer, F. Wilkey; project engineering supervisor, W. Furlani.

International Business Machines Corporation, White Plains, N. Y., for a paper tape reader input.

Design director, E. Noyes, consultant; designer, J. W. Stringer.

Kaar Engineering Corp., Palo Alto, Calif., three selections — monitor for radio broadcasting of Conelrad alert and weather warnings, hand phone, and radiotelephone for two-way communication in citizen's radio service.

Design director, John Crane; designers, Walter Landor & Associates; project engineering supervisor, Norman C. Helwig.

Lockheed Aircraft Corp., Burbank, Calif., for an infrared gunsight sensitivity checker.

Design directors, D. Amara and E. Kutzscher; designers, L. H. Shillabeer, J. J. Andersen, J. E. Davis and R. J. Robillard; project engineering supervisor, J. B. Beach.

Autonetics Division of North American Aviation, Inc., Downey, Calif., for its high-speed tape reader and precision punch.

Design director, Richard E. Davis; project engineering supervisor, Norman R. Dunbar.

Computer Division of Packard--Bell Electronics Corp., Los Angeles, for its module tester.

Design director, Bernard Caminker; project engineering supervisor, Emil Ruhman.

Precision Instruments Co., San Carlos, Calif., two selections — a recorder-reproducer and a continuous-tape-loop multi-channel simulator.

Design directors, Leonard Albrecht Associates; designer, Leonard Albrecht; project engineering supervisor, Robert L. Peshel.

Sylvania Electric Products, Inc., New York, N. Y., for its large-scale general-purpose digital computer.

Design director, D. Landry; designer, O. Heininger, IDI; project engineering supervisor, C. Pace.

Tektronix, Inc., Beaverton, Ore., for a transport carriage for oscilloscopes.

Design director, Gale Morris; designer, Archie Yergen; project engineering supervisor, Leon Price.

Tektronix, Inc., Beaverton, Oregon for a high-frequency probe.

Design director, Gale Morris; designers, Robert G. White and Gale Morris; project engineering supervisor, Norman Winningstad.

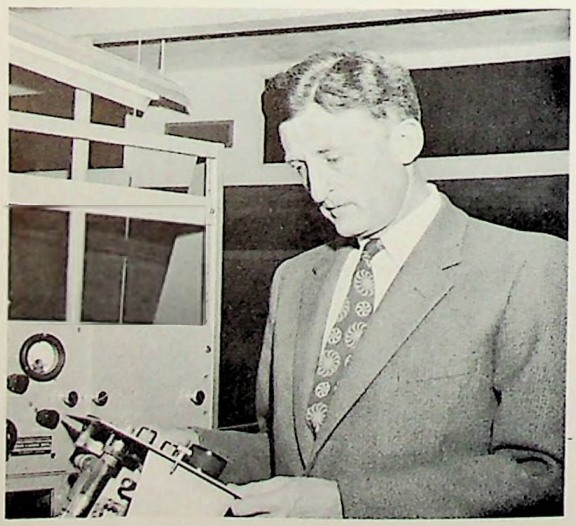
1954 seventh region achievement

JOHN B. SMYTH

At WESCON 1954, John B. Smyth of Smyth Research Associates, San Diego, was presented the 7th Region Achievement Award for that year. A Senior Member of the Institute at that time, Dr. Smyth was elevated to the grade of Fellow in 1956.

A native of Pembroke, Georgia, Smyth received his BS (1934), and his MS (1937) from the University of Georgia; his PhD (1942) from Brown University.

He has served the Institute on the wave propagation committee from 1956 to 1960, in the post of Transactions editor of PGAP from 1953 to 1959, and on the administrative committee of PGAP from 1952 to 1959.



MORE PROGRAM (TUES.)

3/2 ASI — A HIGH SPEED ANTI-SATURATION INVERTER LOGIC CIRCUIT

H. Ditkofsky and A. I. Pressman, RCA Camden, N. J.

This paper describes a novel diode logic-transistor amplifier circuit having negligible storage delay and faster turn-on and turn-off times than any other configuration using the same transistor. Delay through two levels of logic and a stage of amplification is 5 nanoseconds with a fan-out of 5.

The basic amplifier can be built in a single transistor version for cases where loads are local and output capacity is low. A double transistor version is available when loads are remote and must be driven through long signal leads having high capacitance or when loads must be driven through low impedance terminated transmission lines. Both versions can be preceded by either one or two levels of diode logic and for any of these cases, all input and output voltage levels are compatible with one another.

The basic circuit has high repetition rate and does not suffer from the problem of high transient dissipation as no reactive elements are needed. Flip-flops and shift register can be assembled from the basic circuit since it provides signal inversion. A flip-flop so built has been run at a 10-mc rate. A high-speed version of the circuit having delay times of 2 nanoseconds per stage of amplification has been built.

3/3 A TUNNEL DIODE — TUNNEL RECTIFIER, 15 NANOSECOND MEMORY

M. M. Kaufmann, RCA Camden, N. J.

RCA is presently developing ultra high-speed computer techniques under a government sponsored program. One requirement for the project is a memory of approximately 10^5 bits with a cycle time between 10 and 15 nanosec. This paper presents a general discussion of a 15-nanosec memory to be used with the ultra high speed computer.

The tunnel diode has shown the ability to switch between two states faster than any device presently available. Using this high-speed switching property of tunnel diodes the 15-nanosec memory was developed. The memory cell uses a Ge tunnel diode, a GaAs tunnel rectifier, and a bias resistor. The memory is word organized and driven with tunnel diode peripheral circuits. At the present time a 3 x 3 x 3 bit system of tunnel rectifier tunnel diode cells has been built and tested. The system simulates three 32 x 32 bit planes, and uses tunnel diode peripheral circuits except for the clock source which is presently an avalanche pulse generator. The memory cells have been read and regenerated in 12 nanoseconds.

The paper discusses the memory cell operation and its tolerance considerations, the tunnel diode peripheral circuits and their tolerance considerations, the experimental results and the mechanical and transmission line properties of the system.

Sponsored by Professional Group on Electronic Computers

Chairman and Organizer: James B. Angell, Stanford University, Stanford, Calif.

SESSION 4

TECHNOLOGICAL ADVANCES IN MILITARY ELECTRONIC EQUIPMENT

Room D—10:00 A.M.-12:30 P.M.

4/1 CONSIDERATIONS FOR THE DESIGN OF MICROMODULE EQUIPMENT

B. I. Andrews, RCA, Camden, N. J.

Micro-Module equipment is designed for long term usage under combat conditions. Heavy emphasis is placed on reliability, maintainability, and volumetric efficiency. These factors are not

(Continued on page 18)

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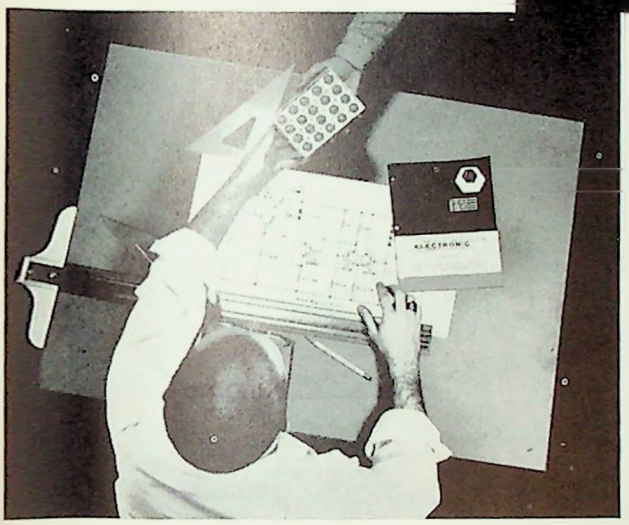

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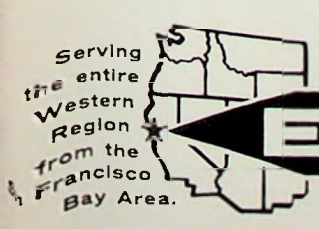

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Arnold O. Beckman, speaker at the WEMA luncheon

during wescon

THE WEMA LUNCHEON

One of the pioneers of electronic manufacturing in the West—Dr. Arnold O. Beckman, founder and president of Beckman Instruments, Inc.—will be the speaker at the annual corporate luncheon of the Western Electronic Manufacturers Association during Wescon. Topic of Dr. Beckman's address will be "Electronics: Ageless . . . or Aging?"

All Wescon registrants and guests are invited to attend the luncheon, according to WEMA President Phillip L. Gundy, vice president of Ampex Corp., Redwood City, Calif. Sitting at the head table with the present WEMA directors will be the 17 industry executives who have served as presidents of the trade association since its founding in 1943, Gundy announced.

Beckman Instruments is typical of a number of western electronic firms which have grown from a man with an idea to a bustling company that is a world leader in its field. Under Dr. Beckman's direction, the company he founded in 1935 has built an international reputation in the development and manufacture of electronic instruments, systems and components.

into arizona

WEMA EXPANSION

Western Electronic Manufacturers Association will soon have a council in Arizona. The new council, which will be the fifth for WEMA, has been authorized by the board of directors. Actual formation of the Arizona Council is scheduled this fall.

The first WEMA members in Arizona were Motorola, Inc., which operates divisions in Phoenix and Scottsdale, and U.S. Semiconductor Products, Inc., Phoenix. Other Arizona firms now in WEMA include Cannon Electric Co., Phoenix; electron division of Controls Co. of America, Tempe; Dickson Electronics Corp., Scottsdale; and Kaiser Aircraft & Electronics, Phoenix.

MORE PROGRAM (TUES.)

independent variables. The designer must find the optimum solution which integrates these variables into useful equipment. In the design of a digital computer, an approach is offered to the solution of maximum volumetric efficiency, consistent with maintainability made necessary by reliability factors. Thermal and connector problems are examined with their regard to their relation to the three variables; the advantages of the Micro-Module approach are discussed.

4/2 ENGINEERING PROBLEMS IN ESTABLISHING A THIN FILM CIRCUIT MANUFACTURING CAPABILITY

J. C. Gioia, Light Military Electronics Dept., General Electric Company, Utica, N. Y.

At the Light Military Electronics Department of General Electric, considerable research has been done on thin film circuits. After surveying some of the questions posed by this research, the author considers the engineering problems in converting microelectronics from an engineering idea to a manufacturing technique.

4/3 DEVELOPMENT OF COMPONENTS FOR TIMM (THERMIONIC INTEGRATED MICRO MODULE) SYSTEMS

W. A. Barrows and E. J. Broderick, General Electric Co., Owensboro, Kentucky.

The ultra-high temperature, radiation tolerant ceramic-metal composites which comprise the TIMM system have been substantially improved since the announcement of the concept by General Electric Company. Earlier presentations have discussed progress in TIMM component capability and suggested possible applications. This paper discusses progress made in the development of components and modules. It covers the development of triodes, diodes, resistors, capacitors, and inductors for the 580C system operating temperature. In an application of TIMM devices, their unique characteristics are utilized in the design of a digital computer. A basic NOR circuit used in this application will be presented in detail. Memory concepts useful with the TIMM components are presented and a component mounting and packaging approach will be discussed.

Sponsored by Professional Group on Military Electronics

Chairman and Organizer: K. T. Larkin, Lockheed Missiles and Space Division, Sunnyvale, Calif.

SESSION 5
ELECTRO OPTICAL COMPONENTS

Room E—10:00 A.M.-12:30 P.M.

5/1 A CONTACTLESS INFINITE RESOLUTION POTENTIOMETER

P. H. Wendland, Electro Radiation, Inc., Santa Monica, Calif. and H. H. Houdyshell, Duncan Electronics, Inc., Costa Mesa, Calif.

This paper describes a new concept of precision potentiometers which eliminates the mechanical wiping action of the contact. The central feature of this device is a continuous, variable optical-electronic contact that uses the outstanding photoconductive properties of either of the compound semiconductors CdS or CdSe.

In operation, a potential distribution is established in a film resistive element which is separated from the collector or slip ring by the insulating action of the photoconductive track. When light strikes the photoconductor, electron-hole pairs are created and the conductivity is immensely increased in the area defined by the light beam. The moveable light beam thus defines a highly conductive path between the resistive element and the collector. The potential "seen" by the load is then the potential that exists on the resistive element at the position at which the light beam is located.

Details of development, design, performance data and applications will be discussed as well as work being conducted with electroluminescent and radioluminescent light sources, the latter having the advantage of no external power supply.

5/2 THE PHOTOREED — A NEW VERSATILE FREQUENCY-SENSITIVE CONTROL

F. H. Inderweisen, Midwest Research Institute, Kansas City, Mo.

The Photoreed, in one unit, performs all the functions of resonant reed relays, tuning fork filters or oscillators, and some l-c and r-c transistor or vacuum tube circuits. Moreover, the Photoreed does not use contacts or employ coils in the output signal circuit which severely load conventional reeds and forks. Maximum Q of the reed or fork material can be utilized, if desired, for very narrow bandpass applications.

The Photoreed evolved from combining the resonant reed or tuning fork with the photoelectric principle, i.e., the action of light on a suitable photosensor to regulate the current through the photosensor and its load circuit. The photosensor is exposed to the light by the action of a shutter fixed to the free end of the vibrating reed or fork. No electrical contacts are required.

The design criteria of Photoreed are discussed for each circuit function. Performance data on actual units under each type of circuit application are presented. Advantages of performance, flexibility and low cost over resonant reeds and tuning forks are revealed.

5/3 A NEW APPROACH TO DIGITAL DISPLAYS USING ELECTROLUMINESCENCE

E. O. Stone, Sylvania Electric Products, Seneca Falls, N. Y.

Electroluminescence is a solid state phenomena that has many advantages over conventional illumination devices. For example, it is not subject to catastrophic failure, as are incandescent lamps, neon lamps or other gaseous devices. Electroluminescent digital readout devices are extremely attractive from the standpoint of size considerations; since their size is that of the substrate upon which the device is constructed. Electroluminescent digital display devices may take practically any shape or configuration. Power requirements are low, and they may be driven from any a-c potential source. Electroluminescent digital readout devices most generally take the form of a "segmented" figure called a numeric.

To operate an electroluminescent numeric it is only necessary to apply a-c of the proper voltage and frequency between the segmented and the common electrodes. This may be accomplished by mechanical, electro-mechanical, electronic, or by an electro-optical matrix called a "translator." Electroluminescent-photoconductor (el-pc) translators may also take various shapes and configurations and el-pc translators may be used to convert from the decimal to the various binary codes, or from binary codes to the decimal, or directly to a segmented el readout device. Digital information may also be held for an indefinite period

(Continued on page 22)

7th Region IRE Fellows: W. W. Eitel, president, Eitel-McCullough, San Carlos; and John B. Smyth, Smyth Research Associates, San Diego

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regional roundup

THE REGION

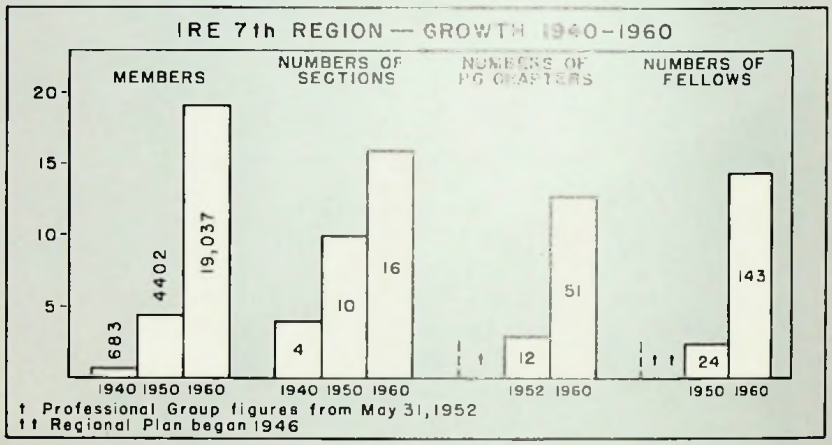
Region 7 was born in 1946 along with the other Regions of the Institute when the regional plan was first put into effect. Ten years prior to this, the stretch of real estate which was to become the Seventh Region contained only three Sections: Los Angeles with 188 members, San Francisco with 169, and Seattle with 40.

By 1950 (as shown in the chart below), the Region had grown from the 683 members of 1940 (estimated) to 4402, with corresponding growths in other areas such as numbers of professional group chapters (a measure of technical activity) and numbers of Fellows (a measure of technical accomplishment).

By the end of 1960—latest available complete figures—Region 7 was pushing hard on a total of 20,000 members with the impressive sub-totals shown in Table 1 below.

Reports on almost all the sections and subsections follow, giving detail on activities of the past year. Thumbnail sketches of most of the Fellow members are distributed throughout the pages of the issue.

Carnahan



regional roundup

ACHIEVEMENT—1961

Once again it is the pleasure of the Seventh Region to announce the presentation of its Electronic Achievement Award to one of its outstanding members: Dr. Louis T. Zitelli, Varian Associates, for a major breakthrough in the achievement of high power in the microwave range.

Zitelli has been responsible for the highest known c-w power at x-band, since his tube, known commercially as the VA-849, is rated for 25 kw average power at 7-8.5 kmc. In the laboratory, a tube has produced 43 kw average power at the same frequencies.

In a recent publication (RCA Review, December 1960) a noted authority, Dr. L. S. Nergaard, has indicated that the state of the art in microwave power, given by a product of power (kw) times frequency squared (f in kmc) stands at 100. The corresponding figure for this Zitelli tube is 2750!

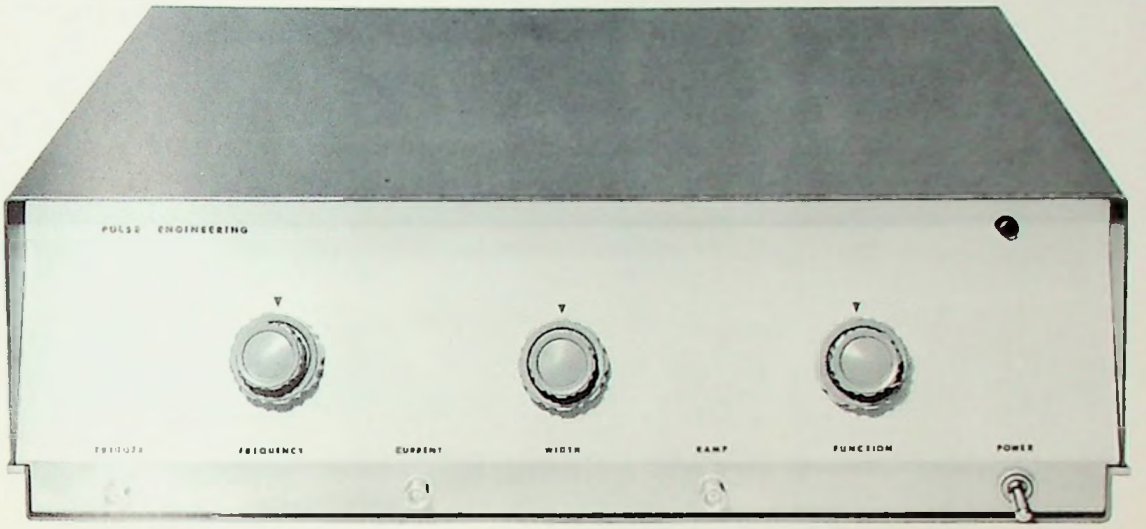
Dr. Marvin Chodorow, director of the microwave laboratory at Stanford University, has stated that the VA-849 in combination with a 100-ft parabolic antenna should make possible radar

(Continued on page 22)

TABLE I
Region 7 Section Membership Breakdown
(December 30, 1960)

Sections	F	SM	M	A	S	Total
Alamogordo-Holloman	—	13	68	28	1	110
Albuquerque-Los Alamos	2	90	379	85	129	685
Anchorage	—	6	73	38	6	123
China Lake	—	8	88	18	3	117
Fort Huachuca	1	23	62	11	1	98
Hawaii	—	9	73	52	5	139
Las Vegas	—	4	37	20	7	68
Los Angeles	26	527	2,359	498	400	3,810
Buenaventura S.	—	24	139	21	9	193
Orange Belt S.	6	90	389	71	127	683
Pasadena S.	10	99	383	95	112	699
San Fernando S.	9	257	1,216	229	61	1,772
Santa Ana S.	6	207	1,025	202	132	1,572
Santa Barbara S.	6	47	190	39	115	397
Phoenix	6	60	397	81	100	644
Portland	3	28	153	52	180	416
Sacramento	1	17	150	46	55	269
Salt Lake City	1	11	167	24	193	396
San Diego	3	91	612	138	54	898
San Francisco	46	488	2,250	426	504	3,714
East Bay S.	11	69	290	71	204	645
Seattle	5	57	691	123	330	1,206
Richland S.	—	4	52	15	38	109
Tucson	1	33	132	27	81	274
	143	**2,262**	**11,375**	**2,410**	**2,847**	**19,037**

This instrument kills pulse transformer "shot-gun" specs with definitive pulse inductance measurement



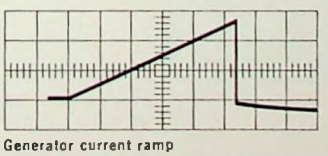
AT WESCON:
BOOTH 2808

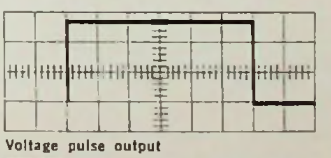
The new ramp/pulse generator

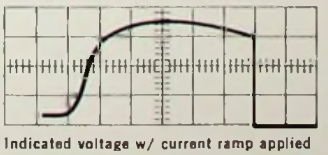
Almost every circuit engineer has encountered the problem of the pulse transformer that "meets the specs"...but doesn't do the job. One primary reason: the lack of a really accurate method of measuring pulse inductance. Attempts to perform this measurement on sine wave impedance bridges have yielded varying results, depending on the type of transformer (gapped or ungapped), the type of core material, the core's previous magnetic history. The inductance indicated by present measurement methods is a function of the slope and location of the minor hysteresis loop traversed by the core flux; and the slope, shape and location of the hysteresis loop can be radically different from its sine wave counterpart.

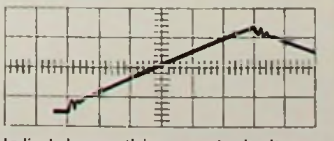
Pulse Engineering's RAMP / PULSE GENERATOR makes possible an entirely new method of measuring pulse inductance: a known current ramp is applied to the unknown coil and the peak induced voltage is observed on a scope. The fact that this method is far easier is only the first part of the story. The second part is accuracy: the peak pulse inductance value is related to a simple peak voltage amplitude measurement. Third, the transformer's pulse core loss may be determined by a simple calculation. Fourth, you eliminate the annoying parasitic oscillations that often occur on the current ramp during magnetizing current measurements.

The RAMP / PULSE GENERATOR also has a pulse voltage output for magnetizing current or pulse droop measurement. Its internal impedance in this type of operation is about 1 ohm, thus producing virtually droopless voltage pulses. The price of this fully transistorized instrument is around one thousand dollars. We think it will save you ten times that much. Write today for technical information.


Generator current ramp


Voltage pulse output


Indicated voltage w/ current ramp applied


Indicated magnetizing current w/ voltage pulse applied

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MORE 7TH

mapping of fine details on the moon.

"Other proposed experiments will be made possible by this combination of high power and high frequency which either would not have been possible at all or would have been highly marginal, Dr. Chodorow said. "It is probable that in the months to come, many important results will be achieved, which are based on the performance of this device."

The certificate and emblem of the Electronic Achievement Award will be presented to Zitelli at the WESCON Banquet on August 24. The Award is intended to give early recognition to outstanding contributions in the fields of education, research and invention, product or systems engineering, and contributions to the literature or to IRE activities.

The rules of the award eliminate specifically possible nominees who have already received an IRE award or other national recognition of their contributions. Previous winners of the Award are listed in the pages of this issue.

Selection of the winner is accomplished in the following way: The sections of the Seventh Region are asked by the award committee to propose nominees. From this list the award committee, chaired this year by Dean Tom Martin, Jr., selects two nominees who are then voted on by the Seventh Regional Committee, comprising the officers of Region Seven and the chairmen of the sections.

—WES CARNAHAN, DIRECTOR
REGION 7, IRE

regional roundup

THE ALAMOGORDO-HOLLOMAN YEAR

The 1960 IRE year in the Alamogordo-Holloman Section can be summed up, perhaps, as a year of change, growth, and progress.

Practically all the members of this Section are connected, directly or indirectly, with the military activities of the Tularosa Basin. This means that many of us must travel and in time, transfer. This fact of our professional lives gave the Section three chairmen in one twelve-month period.

Change and growth in themselves do not mean progress, but they may provide the materials required. During the last IRE Year the Alamogordo-Holloman Section committees worked to encourage high-school students in their pursuit of scientific careers. Also, work was done by many members in an effort to provide worthwhile and enjoyable meetings. In addition, the Section magazine, "The Missile," continued to flourish and to grow in stature.

—W. S. STOTTS, CHAIRMAN
ALAMOGORDO-HOLLOMAN SECTION

regional roundup

THE ALBUQUERQUE-LOS ALAMOS YEAR

The Albuquerque-Los Alamos Section of the IRE now weighs in at slightly over 60 tons. As a group of 700 members we are an average-sized section since there are somewhat over 100 sections and subsections in the International IRE complex of 86,000 members. Our members belong to 1¼ profes-

(Continued on page 28)

1955 seventh region achievement

JOHN VAN NUYS GRANGER

This year's WESCON Convention Director John V. N. Granger gained the 7th Region Achievement Award for his contributions to the development of aircraft antennas and his organizational leadership in IRE affairs at WESCON five years ago. He is also president of Granger Associates, Palo Alto.

Possessor of an unusually horizontal span of accomplishments in art and journalism, he received an AB from Cornell College in Mt. Vernon, Iowa, in physics and mathematics, and an (MS in communications engineering (1941) from Harvard. His PhD was earned in 1948 at Harvard, after wartime services in England and France, with a thesis on low-frequency aircraft antennas.

In 1949 he joined SRI, becoming assistant chairman of the engineering division in 1951, and later assistant director of the division. Granger Associates was formed in 1956.

A Fellow of the Institute, Granger is a director of the San Francisco Section.

MORE PROGRAM (TUES.)

of time by a regenerative el-pc, or "neon-pc" holding circuit.

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Chairman and Organizer: W. Dale Fuller, Lockheed Missiles and Space Division, Sunnyvale, Calif.

SESSION 6
CURRENT AND FUTURE RADIO ASTRONOMY AND TECHNIQUES

(Joint session with IAU)

Room A—2:00 P.M.-4:30 P.M.

6/1 **LOW NOISE RECEIVERS**

P. D. Strumm, Applied Technology, Inc., Palo Alto, Calif.

Radio astronomy receiving systems have been among the first to warrant the addition of exotic and complex low-noise amplifiers in the maser and parametric families. Such low-noise amplifiers provide the ultimate in sensitivity over relatively small bands. The figure of merit of a radiometer system,

$$M_{ft} = T_{sys}/\sqrt{B}$$

shows how system noise (T_{sys}) and bandwidth (B) can be traded. In some applications, large bandwidths can be used to offset moderately large system noise. The principal exception to this rule is found in hydrogen-line profile measuring systems where small bandwidths are usually desirable to permit good frequency resolution. For those systems, the maser is especially useful. At several radio telescopes, special attention to the stability problem has resulted in maser systems that are sufficiently reliable for routine day-in and day-out operation.

For many general sky mapping and point-source explorations an optimum radio frequency lies in the range 1 to 10 gc because of antenna noise. Several successful systems operate at about 8 gc where broad interference-free bands and narrow antenna beams are available. Low-noise broadband traveling wave tubes are still useful in these applications because of the large bandwidth that can be used (typically several hundred megacycles).

Despite the high sensitivities now available, there still remain several technical problems to be solved before the radio astronomers will be satisfied that the system engineers have finished their jobs.

6/2 **DEVELOPMENTS IN ANTENNA TECHNIQUES FOR RADIO ASTRONOMY**

Emile-Jacques Blum, Observatory of Paris, Meudon, France.

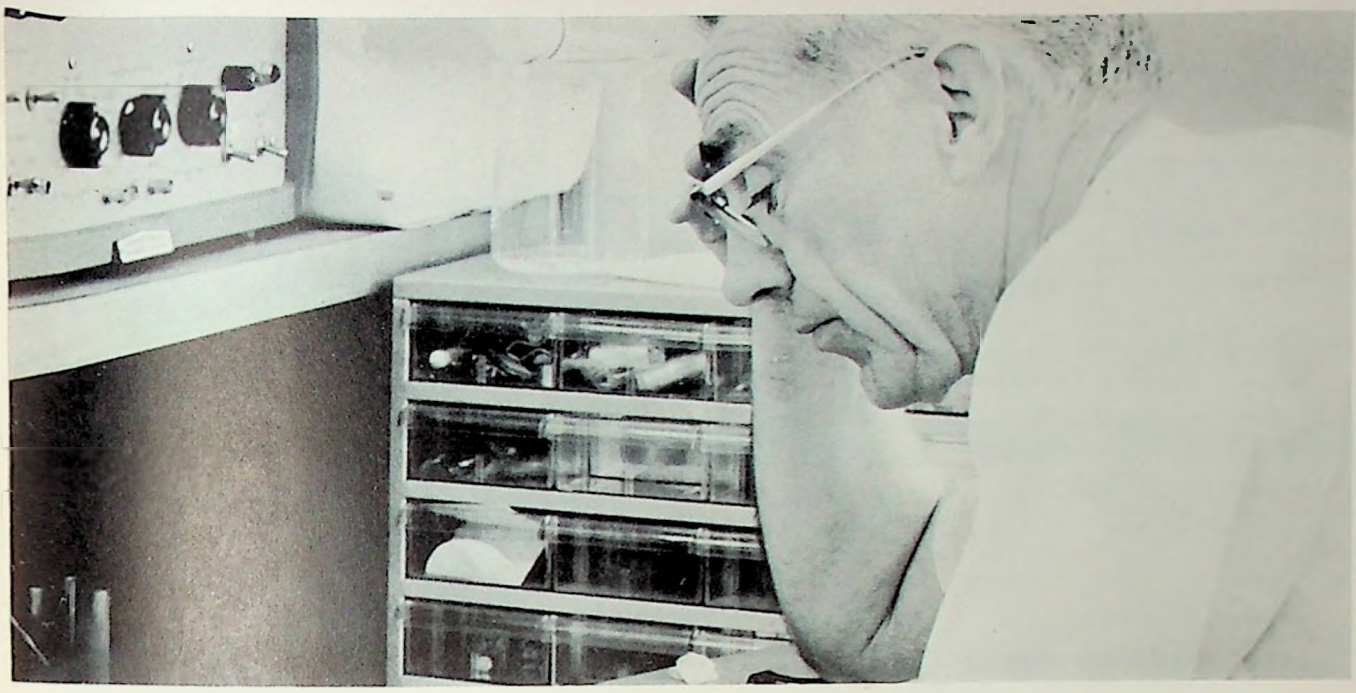
The first radio astronomy antennas were borrowed from radar; but very quickly new antenna types, better adapted to the special problems of radio astronomy, were developed. The first objective of the radio astronomers was a high resolving power. To obtain this, they made extensive use of techniques in one and then two dimensions. At the same time, using the Fourier transformation, they developed basic theories which allowed them to choose the best instrument for a given type of measurement, and to use the data in a logical fashion. Further, the theories guided the development of new methods of reception. In the measurement of very weak noise signals the sensitivity and stability of the radio telescope are of primary importance, and these are not independent of the type of antenna employed. Here again the radio astronomers have made a substantial contribution. A number of instruments representative of these trends will be described, and their performances will be compared with other, more classic, instruments. Finally, the probable evolution of these techniques in the near future will be discussed.

6/3 **RADIO ASTRONOMY IN THE SOLAR SYSTEM**

E. A. Lilley, Harvard University, Cambridge, Mass.

(No abstract furnished)

(Continued on page 26)



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Thought provoking developments at WESCON

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INFORMATION SCIENCES

Mathematical and statistical research; computer programming; advanced programming systems; computation services; digital system studies; logical design.

DATA PROCESSING

Data processing subsystems research and development; optical recognition systems.

ELECTROMAGNETIC SYSTEMS

Electromagnetic physics; electronic and mechanical scanning antenna systems; development of complete sensor systems and special microwave components.

RESEARCH LABORATORIES

Solid state physics; magnetic thin-film research; advanced components for information processing.

COMPONENT DEVELOPMENT

Advanced component technology; materials and processes; computer development; chemical deposition of magnetic surfaces on drums, disks, rods.

AUDIO-VISUAL

INSTRUCTRON systems for assembly and instructional applications; design of work stations.

INSTRUMENTS

Research and development in analytical instruments; detection and monitoring of toxic high-energy missile fuel vapors; gas leak and water vapor detection.

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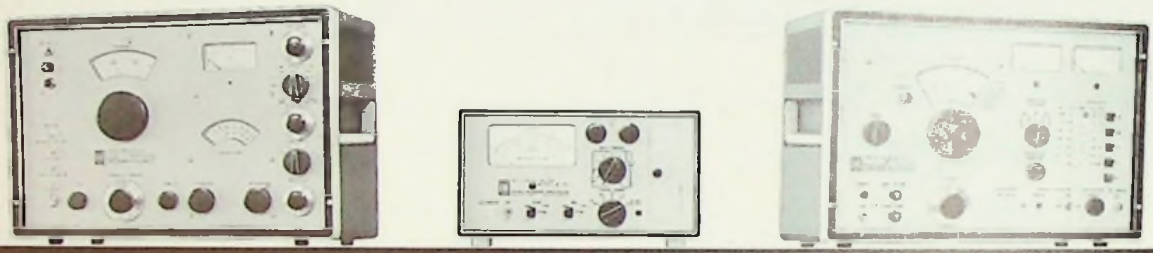

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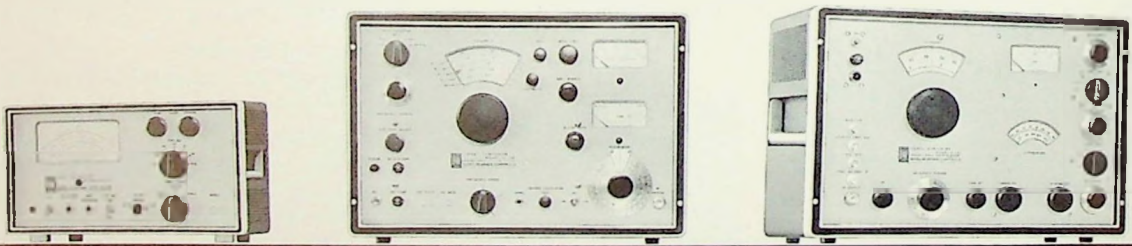

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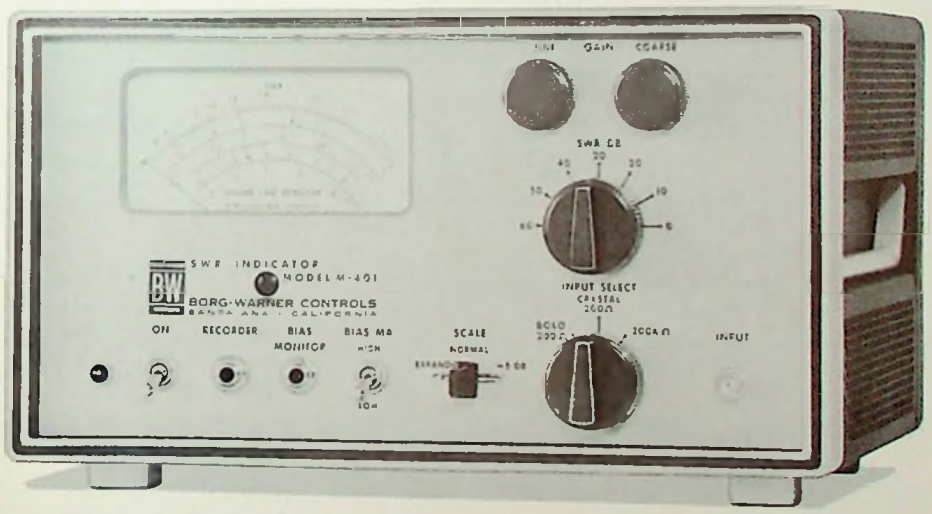

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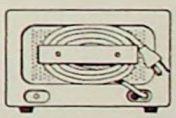

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MORE PROGRAM (TUES.)

6/4 RADIO ASTRONOMY BEYOND THE PLANETARY SYSTEM

Gart Westerhout, Leiden, Netherlands.

Radio emission from beyond our planetary system originates in the galaxy and in extragalactic sources, some or perhaps most at distances beyond the reach of optical telescopes. Three mechanisms cause the radiation: 1) Synchrotron emission from relativistic electrons in a magnetic field. 2) Field-free emission of normal electrons in ionized clouds. 3) 21-cm line emission from neutral hydrogen. Study of the latter has revealed the spiral structure of our galaxy. Studies of other galaxies are under way.

Study of the ionized hydrogen clouds by radio and optical means gives much new information about temperature and density of the interstellar gas. Most of the radiation at meter waves is caused by the synchrotron process. It is believed that in our own galaxy magnetic fields are concentrated in the spiral arms, and thus the radio emission. The study of the point sources is extremely interesting. Recent diameter measurements and very accurate position measurements have enabled the identification of a small percentage of these sources with peculiar extragalactic nebulae. A large-scale survey of sources indicates that it is not unlikely that most of the sources are at very large distances; conclusions about the shape of our universe may be drown.

Sponsored by International Astronomical Union and Professional Groups on Antennas and Propagation and on Space Electronics & Telemetry

Organizer: Professor S. Silver, University of California, Berkeley
Chairman: Professor H. Weaver, University of California, Berkeley

SESSION 7
SOLID STATE DEVICES I

Room B—2:00 P.M.-4:30 P.M.

7/1 SUPERCONDUCTOR SOLENOIDS

R. W. Boom and R. S. Livingston, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Superconductor solenoids capable of producing magnetic fields in the 100-kilogauss range will be discussed. Several designs using 0.010 to 0.060-in. dia Nb_3Sn wire in the 1.5 - 4.2K temperature range will be described. While small coils will be considered, special attention will be given to large aircored solenoids (> 15 in. i-d) which require 100 to 1000 miles of conductor. Methods for maximizing the field and minimizing the wire length will be given. Problems concerning cooling, best space factor, fabrication, power supplied, and safety will be discussed. The designs will be based on recent ORNL experiments in both pulsed and constant magnetic fields.

7/2 PARAMETRIC QUARTZ AMPLIFIER

C. H. Becker, Westinghouse Electric Corp., Baltimore, Md.

A parametric quartz amplifier is described that utilizes the general principle of parametric operation in periodic molecular structures of the solid state. A new type of amplification, oscillation, and detection was established, which operates on a strictly mechanical basis. The signal is propagated in the quartz by means of transverse, ultrasonic waves. Amplification occurs due to the parametric interaction of longitudinal pump waves with the signal waves. Both waves are simultaneously piezoelectrically excited in the same elastic structure of the quartz.

The new amplifier represents a single elastic structure of the solid state with a 3-dimensionally distributed parameter. Extreme miniaturization of the geometry is possible. In addition, the boundary modes of the amplifier exhibit very high quality factors ($Q > 10^4$) unknown with conventional amplifier techniques.

Electronic currents are entirely eliminated from the amplification process, hence the new amplifier is completely free of electronic noise. The still remaining noise, is of a quantum mechanical nature, which represents the ultimate noise limit of strictly molecular amplifiers.

In principle, the parametric quartz amplifier can be constructed as a single- or multiple-mode amplifier with extremely narrow frequency bandwidth, or as a broadband traveling-wave amplifier of similar gain.

7/3 TERRESTRIAL DETERMINATION OF SOLAR CELL SHORT CIRCUIT CURRENT UNDER OUTER SPACE SOLAR ILLUMINATION

H. K. Gummel and F. M. Smits, Bell Telephone Laboratories, Murray Hill, N. J., and A. R. Froiland, Smithsonian Observatory, Table Mountain, Calif.

For a determination of the short-circuit current of solar cells under illumination outside the atmosphere, the short-circuit current of solar cells is being measured concurrent with spectral recordings of the solar spectrum at the Table Mountain installation. From prior measurements of the solar spectrum through various airmasses, the zero airmass solar spectrum can be obtained in a well established manner. These measurements, combined with laboratory measurements of the spectral response of solar cells, permit an accurate extrapolation of the short-circuit current for zero airmass illumination.

This method requires only relative spectral measurements and thus is not susceptible to the uncertainties of absolute spectral intensity calibrations. The method has been successfully used on solar cells having a wide variety of spectral response curves due to various levels of electron irradiation.

Sponsored by Professional Group on Electron Devices

Chairman and Organizer: Professor James F. Gibbons, Stanford University, Stanford

SESSION 8
COMPUTER APPLICATIONS

Room C—2:00 P.M.-4:30 P.M.

8/1 PLATO: AN AUTOMATED TEACHING DEVICE

D. Bitzer, P. G. Braunfeld and W. Lichtenberger, University of Illinois, Urbana, Ill.

PLATO—a teaching machine developed during the past nine months at the coordinated science laboratory of the University of Illinois—is a device for teaching a number of students individually by means of a single, central, high-speed, general purpose, digital computer. Each student is provided with his own keyset and television display. The keyset enables the student to control the sequence of materials to him by the machine, as well as to transmit to the computer answers to its questions. The computer communicates to each student by closed circuit television. It selects slides and writes or erases sentences and diagrams on a storage tube. The two outputs are superimposed and displayed on the student's television screen.

Not only textual materials are presented to each student at a rate determined by that student, but the computer frequently poses questions. The student's answers—which may take the form of numerals, algebraic expressions, or words and phrases—are judged by the computer without revealing the correct answer to the question. Supplementary material is presented by the machine upon request for any question which the student finds difficult. The computer keeps detailed records of each student's progress through the material.

The system has been used to present a variety of subject-matters, ranging from mathematics to topics in French grammar.

8/2 AN ADVANCED DIGITAL DATA SYSTEM FOR USE IN NUCLEAR REACTOR DEVELOPMENT

W. V. Botts, Jr., Atomics International, Canoga Park, Calif.

The design and application of a high-speed digital data system for use in the development of compact nuclear reactors are described. The three modes of operation are defined, and the hardware for implementing these operations is described. Considerable emphasis is placed on the details of some of the advanced techniques used in obtaining fast and accurate data reduction.

The system described is a 100 channel low level, i.e., 0 to 10 mv, time-shared system. Each input is sampled at a rate of 10 samples per second giving an overall system speed of 1 kc. The entire data system, including the 100 channel low-level switch, is composed of solid-state electronics and operates to an overall system accuracy of 0.076 per cent. The ultimate end product obtained with this system is a magnetic tape which is compatible with the IBM 709 and 7090 computers from which complex data reduction is obtained.

8/3 THE USER LOOKS AT THE INFORMATION STORAGE AND RETRIEVAL FIELD

R. R. Segel; Daniel, Mann, Johnson & Mendenhall, Los Angeles, Calif.

This paper discusses the broad field of science called Information Storage and Retrieval from the aspect of the user. It discusses how the art extends from disciplines such as semantics right through to the latest high-speed electronic devices, and that the fact is often overlooked that all of this must be directed from the standpoint of the user. His hopes and aspirations for a system, and his present and future requirements are discussed, and there is a presentation of the information channels open to him and his utilization of them. In addition, the engineer's benefits from the utilization of the methods and from

(Continued on page 28)

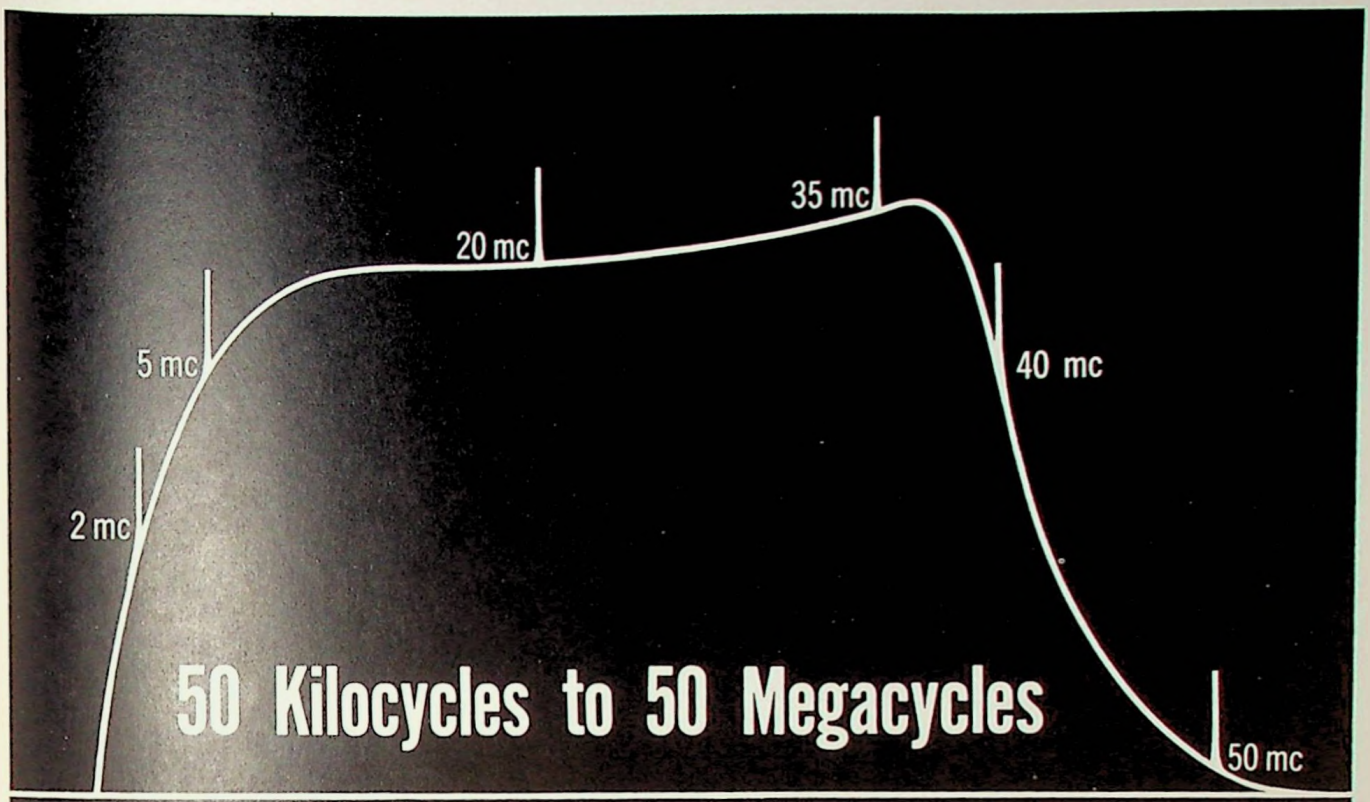
1956 seventh region achievement

THOMAS L. MARTIN, JR.

In 1956, Thomas L. Martin, Jr., now dean of the department of engineering at the University of Arizona, received the 7th Region Achievement Award. His work has largely centered around radar receivers, atmospheric ionization, and transistor circuitry.

His PhD in electrical engineering (1951) was from Stanford, while his BEE and MEE were both from Rensselaer Polytechnic Institute. Prior to joining the faculty of the University of Arizona in 1953, he served on the faculties of the University of New Mexico and Rensselaer.

Martin is a Member of the Institute, of AIEE, the American Society for Engineering Education, Eta Kappa Nu, Sigma Xi, Sigma Tau, Sigma Pi Sigma, Tau Beta Pi, and Phi Kappa Phi.



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MORE ALBUQUERQUE

sional groups as compared with 1 for IRE members as a whole.

At the turn of the year our treasury had $3.77 per member versus $2.66 per member on a national basis. Our budget is spent rather freely for scholarships and awards, and we are doing our best to encourage the up-and-coming generation of engineering talent. We spend part of our money on the "Blast," our bi-monthly publication. Much of our money goes toward subsidizing dinner meetings. The professional groups were each given $25 "pin money" this year for use in promoting their meeting attendance. But, like the other sections, we still do not have the formula for getting more than 15 per cent of the members out for the meetings.

At the present time we are getting set to act as hosts for the National Symposium for Space Electronics and Telemetry to be held in Albuquerque on September 6, 7, and 8, 1961.

This Section enjoys living at a high altitude, a mile high for those in Albuquerque, and over 7000 ft for those at Los Alamos. Our members are employed to a great extent in the nuclear-science field with Sandia Corporation at Albuquerque and the Los Alamos Scientific Laboratory, forty miles northwest of Santa Fe, New Mexico. This area, which is a natural place for electronic manufacturing, is just now being discovered and beginning an electronics expansion. A number of companies have sprouted locally, and outside companies such as Curtiss-Wright, Gulton Industries, Sparton Radio, and Fairbanks-Morse are moving into the territory.

Who can guess how large this Section will be when the untapped potential here is realized!

—ROBERT CREVELING,
JUNIOR PAST CHAIRMAN
ALBUQUERQUE-LOS ALAMOS SECTION

regional roundup

THE CHINA LAKE YEAR

The China Lake Section of the IRE consists of 100 members residing in the China Lake-Ridgecrest area. Most of these are employed by the Naval Ordnance Test Station, but there are 21 members in the Edwards Air Force Base area, one in Rosamond and one in Bishop.

Since the annual banquet in June of last year (at which the members heard a very interesting talk by Dr. Henry L. Richter on JPL efforts toward exploration of the moon), the Section has had five meetings. Frank E. Goodwin gave a description of progress at Hughes Aircraft in applying masers to aircraft radar systems, which outlined

(Continued on page 30)

MORE PROGRAM (TUES.)

the standpoint of producing desired methods and equipment are detailed.

Sponsored by Professional Group on Electronic Computers

Chairman and Organizer: John Reid Anderson, Stanford Research Institute, Menlo Park

SESSION 9
SIGNAL SELECTION

Room D—2:00 P.M.-4:30 P.M.

9/1 THE APPLICATION OF TIME/FREQUENCY CORRELATION FUNCTIONS TO THE CONTINUOUS WAVEFORM ENCODING OF MESSAGE SYMBOLS

C. A. Stutt, General Electric Co., Schenectady.

The Ville-Woodward concept of correlation of waveforms for simultaneous shifts in time and frequency is discussed in relation to the problem of specifying and realizing a set of continuous envelope waveforms for representing M equally probable symbols. The correlation of two finite energy time functions u(t) and v(t) is given by

$$\chi_{uv}(\tau,\Delta) = \int_{-\infty}^{\infty} u[(2t-\tau)/_2]\, v[(2t+\tau)/_2]$$

where τ and Δ are time-shift and frequency-shift variables. With $u(t) = v(t)$, this function is called the radar ambiguity function, and may be called a t/f auto-correlation function. In problems of communications and waveform classification, more than one waveform is involved, and the t/f cross-correlation function, $u(t) \neq v(t)$, becomes important. A matrix of all possible correlation functions is proposed as a measure of the quality of a set of M envelope waveforms and as a means of specifying such waveforms. Since correct waveform indentification is the important consideration, it is suggested that suppression of peaks in the cross-correlation functions is more important than controlling the shape of the auto-correlation functions.

Theorems on uniqueness of the correlation functions and their squared magnitudes and on the rotation of correlation functions are used in connection with specifying correlation matrices suitable for deterministic waveform design. With the uniqueness theorems, certain matrices, which would give non-preferential treatment of the equally probable symbols, are shown to give rise to trivial classes of waveforms. A particular matrix in which the terms are equal in magnitude along the minor diagonals is shown to yield a set of frequency multiplexed waveforms. The natural role of Hermite functions in connection with the rotation theorem is employed to advantage in obtaining a set of waveforms of more general interest which might be employed in a communication channel wherein frequency, as well as time, is a statistical parameter. Simple examples of waveforms and correlation functions produced by this rotation procedure are given.

9/2 A CRITERION FOR SIGNAL SELECTION BASED UPON COMPARISON OF EXPERIMENTS

T. L. Grettenberg, Stanford University, Stanford.

The methods of comparing statistical experiments are investigated as possible criteria for comparing codes in a communication system. It is found that one method of comparing codes (the divergence criterion) is implied by each of the comparison criteria considered when the receiver is of the maximum likelihood ratio type. Although the divergence criteria is thus less stringent than the other criteria for comparing codes, it has the property that its application does not require a choice of loss function or a knowledge of the a-priori probability distribution of the message source.

The divergence of a code is shown to have two interpretations in terms of the performance of the communication system. The expected value of the divergence may be interpreted as the difference between the average information the re-

(Continued on page 30)

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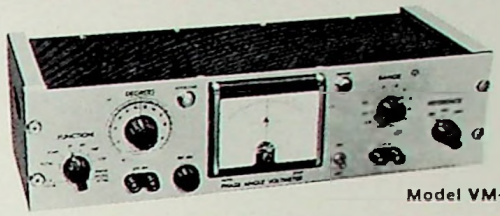
PHASE ANGLE VOLTMETERS

Provide direct reading of total, fundamental, in-phase and quadrature voltages; phase sensitive nulling of in-phase or quadrature components; direct reading of phase angle without ambiguity. Single-, three-frequency and broadband types, in bench, rack-mount and miniaturized models.

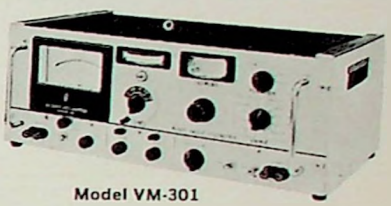


Model VM-202

Model VM-202 Single Frequency Voltmeter. 1 mv to 300 v in 12 ranges; accuracy ±2% of f.s. Phase accuracy: dial 1°, meter ±3% of f.s. degrees. Signal: 1 freq., 30 cps to 10 kc. Input impedance: 10 meg. Reference: 100k ohms, 0.25 v min. Nulling sensitivity: 2 uv, phase sensitive. Harmonic rejection (with filters) : 55 db. Scale: 3-0-3, 10-0-10, linear. Phase dial: 4 scales, 90° (elec.) apart. Dimensions: 5¼" h. x 19" w. x 7⅛" d.

Model VM-204 Three Frequency Voltmeter. Similar to VM-202 but accommodates signals at any three specified frequencies. Choice of frequencies from 60 to 4500 cps in standard models, to 10 kc on special order. Dimensions as VM-202, but 2" deeper case.

Model VM-230

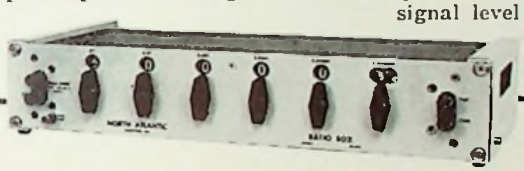


Model VM-301

Model VM-230 Transistorized Voltmeter. Miniaturized, ruggedized version of VM-202 for modular inclusion in ground support and other systems requiring small size, dependable performance in severe environments. Range down to 300 microvolts f.s. on order. Input impedance 1 meg. Voltmeter response 20 cps. to 20 kc.

Model VM-301 Broadband Voltmeter. For applications where signals from 10 cps to 100 kc must be instrumented with highest accuracy. Phase shift accuracy 0.2° absolute, uniform over full 360°. Phase shift can be read while sweeping frequency in half-decade steps. Nulls unaffected by changes in signal level; harmonic effects eliminated by plug-in filters.

Complete data on any of these models will be forwarded on request



Model RB-503 (10 ppm) and RB-504 (1 ppm)

RATIO BOXES

Precision inductive AC voltage dividers to meet all range, accuracy and cost requirements. Rack, panel and portable bench models, deviation, binary ratio standards and automatic stepping types. Maintain accuracy over specified frequency range; feature in-line readout, high input and low series impedance. Range of characteristics available in this series include:

Ratio Range	—.111110 to +1.111110
Frequency	30 cps to 10 kc
Accuracy	10 ppm to 1.0 ppm
Input Voltage	0.35f to 2.5f
Input Impedance	60 k to 1 megohm
Effective Series Impedance	7.5 ohms to 0.5 ohms

Model RB-520 and RB-521 (10 ppm)

PHASE SENSITIVE AC-to-DC CONVERTERS

Compact, modular units meet requirements of ground checkout, production and other test systems for phase sensitive conversion of AC signals to proportional DC voltages. High linearity, sensitivity and fast response. Manual selection or remote relay programming of total, fundamental, in-phase and quadrature voltage functions. Half-panel rack mount models also available.

Model PSC-410

	PSC-410	PSC-420
Signal	single freq.	multiple freq.
Range	10 mv to 300 v	10 mv to 300 v
Frequency: Total	60 cps to 5 kc	30 cps to 10 kc
Phase Sens.	400 and 800 cps (60 cps to 2 kc special)	60 cps to 10 kc (3 per unit, max.)
Accuracy: Total	0.1% to 1/10 f.s.	0.1% to 1/10 f.s.
Phase Sens.	0.1% f.s.	0.1% f.s. to 5 kc 0.25% f.s. to 10 kc
Response	0.1 sec at 400 cps	0.1 sec at 400 cps
Output (10 k load)	0-10 v dc	0-10 v dc
Programming	range, function	range, function, freq.

COMPLEX VOLTAGE RATIOMETER

Single unit, integrated system includes all instrumentation, circuitry and accessories for measurement of phase angle, transformation ratio and related quantities. Direct reading of phase angles up to 0.5 radians, and transformation ratios to 0.001% unaffected by quadrature. Standard model accommodates any three specified frequencies from 60 cps to 3 kc, and includes both signal and reference channel filters. Phase angle voltmeter may be used separately.

Model CVR-550

Ratio Range	±1.111110
Ratio Accuracy (max)	$\pm (0.001 + \frac{0.0001}{\text{ratio}})$ %
Outputs	Ratio on six-digit ratio box. Angle in both degrees and milliradians

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Dr. E. G. Witting, Helmut Ternow, and J. G. Reid, Jr., at the Ft. Huachuca Section PGMIL Chapter installation
—Vernon Horne photo

MORE CHINA LAKE

the problems and possibilities very lucidly. The Section also heard from Dr. H. Lyndon Taylor of Texas Instruments about Radiation Effects on Semiconductors. On-Station speakers were P. Firsht, head of the local patent division, discussing Patent Law for Engineers; D. E. Martz on Detection and Measurement of Infared Radiation; and C. Jenkins describing an underwater project.

At this year's annual banquet to be held on July 20, the Section will have the honor of hearing John F. Byrne, vice president of the IRE and general manager of the Motorola systems research laboratory at Riverside, California. Byrne's subject will be "The Microwave Remote Data Relay System between Edwards Air Force Base and Ely, Nevada."

—MELVILLE C. CREUSERE, CHAIRMAN
CHINA LAKE SECTION

regional roundup

THE FORT HUACHUCA YEAR

The Fort Huachuca Section is still the smallest of the three Arizona sections—approximately 100 members—but not the least active section in the Seventh Region. During the 1960-61 activity year, nine Section meetings were held on a variety of highly interesting professional papers with an average attendance of 66 persons. Officers were: Helmut G. Ternow, chairman; Samuel M. Dyer, vice chairman; Jack Llewellyn, secretary; Edwin R. Knowles, treasurer.

The highlight of the year was a joint Arizona Sections Fellow-Awards dinner sponsored by the Fort Huachuca Section at the Fort Huachuca Officer's Lakeside Club in February with a formal presentation of the IRE Fellow certificate to Major General (Ret.) Emil Lenzner. Fifteen Fellow grade members were present from all over the U.S.A. including all Fellows residing in Arizona.. Keynote speaker was Dr. Daniel E. Noble, Fellow IRE, and national director, who spoke on "Electronics Is a Generic Art."

Another major event was the organization of a PGMIL chapter and the formal installation of its newly elected officers, Joseph G. Reid, Jr., chief scientist at the AEPG, as chairman; and George M. Strawn as vice chairman; performed by Dr. Edward G. Witting, deputy assistant secretary of the Army for research and develoment and national chairman of PGMIL. (See picture) At the dinner meeting in May, Witting spoke on "Integrated Electronics."

Among the 65 members present were A. W. Rogers, Fellow IRE, assistant chief and technical director for research and

(Continued on page 32)

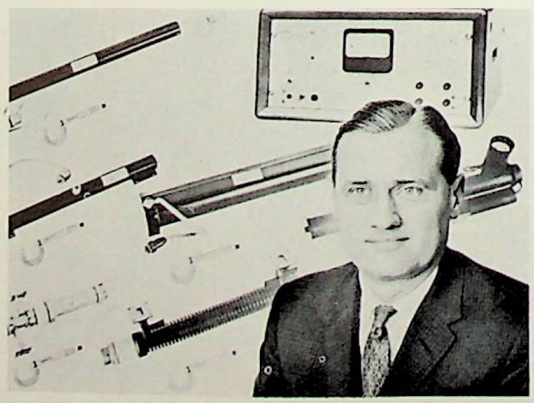
1957 7th region achievement

DEAN ALLEN WATKINS

Dean A. Watkins, president of Watkins-Johnson Co. and director of the electron-devices laboratory at Stanford University, received the 1957 Seventh Region Achievement Award for basic contributions toward reducing noise in microwave electron tubes.

Before joining the Stanford faculty in 1953, Watkins was head of the microwave-tube department in the research laboratories of Hughes Aircraft Co. Prior to this he had been a design engineer for Collins Radio Co., and a member of the staff of the Los Alamos Scientific Laboratory.

Born in Omaha, Nebraska, he attained his BS at Iowa State College in 1944, MS at California Institute of Technology, 1947, and PhD Stanford 1951. He became a Fellow of the IRE in 1958.



MORE PROGRAM (TUES.)

ceived signal provides about the transmitted message and the average information the received signal provides about a message which was not transmitted. The second interpretation is in terms of error probabilities. If the divergence of code A is greater than the divergence of code B, then there exists an a-priori probability distribution for the message source such that the probability of error in receiver A is less than the probability of error in receiver B.

9/3 SIGNAL HAVING GOOD CORRELATION FUNCTIONS

R. Lerner, Lincoln Laboratory, MIT, Lexington, Mass.

A set of finite energy signals, called L-sequences, is described which have good auto- and cross-correlation properties. A set of p^2-p such signals exists, each having p degrees of freedom, for every prime number p.

Sponsored by Professional Group on Information Theory

Chairman and Organizer: Professor Norman Abramson, Stanford University, Stanford

SESSION 10
R & D PERSONNEL MANAGEMENT AIDS

Room F—2:00 P.M.-4:30 P.M.

10/1 EFFECTIVENESS OF ENGINEERING EMPLOYEE TESTS

K. V. Newton, The Bendix Corporation, Kansas City, Mo.

This study examines several types of tests which have been used in the selection of engineers for employment. These tests include measures of intelligence, personality, aptitude, and technical knowledge. Experience with testing in World War II and improvements in testing technology have stimulated use of selections tests. As applied to engineers, the program has lagged those of other fields, although use of tests in selecting engineers is widespread. Emphasis in this paper is on mechanical and electrical engineers in industrial organizations.

Information from literature, from discussions and correspondence with personnel directors, and an analysis of experience with tests within the Bendix organization are combined in an effort to present as complete a picture as possible of the effectiveness of tests and testing programs in initial hiring of engineers. Actual job performance is used as the primary means of comparison with test results. Some conclusions are drawn regarding the usefulness of a testing program.

10/2 A CASE STUDY OF PERFORMANCE EVALUATION FOR A R/D LABORATORY

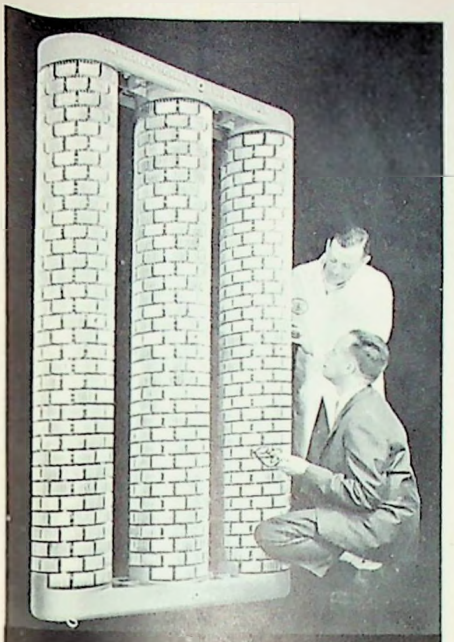
Arnold Addison and Henry L. Yeagley, Jr., Pennsylvania State University, University Park, Penna.

Industry Commentary: J. A. Morton, Bell Telephone Laboratories, Murray Hill, N. J.; H. D. Ross, IBM, New York, N. Y.; A. N. Curtiss, RCA West Coast Missile and Surface Radar Division, Van Nuys, Calif.; D. W. Pugsley, Space Technology Laboratory, Los Angeles, Calif.

Research administrators are becoming more interested in controlling and rewarding engineers and scientists for their performance in contributing to the success of the enterprise. This paper deals with the development, installation and testing of a dual evaluation method of performance rating as applied to the engineers and scientists engaged in research activities in a laboratory operated by an academic institution.

A committee of research personnel reviewed four types of plans: factor type, narrative by the supervisor, personal review form, and coaching. Suggestions of the committee provided the basis for developing a new plan. A method was established whereby the engineer rates himself on a factor type form before the actual interview

(Continued on page 32)



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MORE FT. HUACHUCA

development, Department of the Army, representing the chief signal officer; Major General Francis F. Uhrhane, Senior Member IRE, and commanding general of the proving ground, and Major General (Ret.) Roger B. Colton, Fellow IRE who is known as the "daddy" of the SCR-584, America's first effective fire-control radar set.

The new Fort Huachuca PGMIL Chapter now has 39 members and the first luncheon meeting was held in June, with an attendance of 40 persons to hear Dr. Drumley of Zenith research speak on "Narrow Beam Parametric Amplifiers."

At the annual meeting on June 27, the following Section officers for the 1961-62 term were elected: James W. Virden, chairman; Dr. Robert E. Frese, vice chairman; Lynnon T. Knight, secretary; and Clarence S. Wilcox, treasurer.

—HELMUT G. TERNOW

regional roundup

THE HAWAII YEAR

The Hawaii Section started its year with a very successful joint meeting with the local chapter of the American Rocket Society. William E. Mileski of Lockheed's missiles and space division gave a talk on "Tracking of Satellites in the Discoverer Program." Another joint meeting recently brought together the local Chapter of AIEE and the Hawaii Section. Edward C. Schoen's presentation of "Time Assignment Speech Interpolation Equipment in Telephone Circuits" was well received by both factions.

Highlighting the program of the year were talks given by Dr. Ralph E. Partridge and Dr. William Pong of the University of Hawaii. Their topics were "Investigations of the Ionosphere Using Satellite Transmissions" and "Maser Theory, Technology, and Applications" respectively.

Partridge, chairman of the electrical engineering department of the University, announced to Section members that the School will offer a graduate program in electrical engineering for the first time this fall.

The Section's "Future Engineer's Show" award this year goes to Dale Yamamoto of Hilo, Hawaii, for his electronic exhibit simulating a biological nerve cell.

—D. L. DANG

regional roundup

THE LAS VEGAS YEAR

In October, Harry Shultheis, Dymec, Inc., presented a paper entitled "Designing Digital Systems around Electronic Counters."

A dinner meeting was held in December at Fong's Garden. Dr. Lewis

(Continued on page 34)

MORE PROGRAM (TUES.-WED.)

with his supervisor. This preview prepares him for the interview knowing by what factors he has been evaluated. Because of this, he is better prepared to discuss the rating which his supervisor. A form was designed which measures job performance and academic contributions. These two separate but related aspects comprise the total evaluation of the professional personnel. The plan was installed on a trial basis and evaluated by a questionnaire, a series of discussions with the raters, and an analysis of variance. This evaluation indicates that the plan is effective and is a useful tool for a management development program. The importance of the research administrators wholeheartedly endorsing the program and supporting its requirements, is emphasized.

Sponsored by Professional Group on Engineering Management

Chairman and Organizer: Oscar T. Simpson, Philco Corp., Palo Alto, Calif.

SESSION 11
RADIO ASTRONOMY ANTENNAS

Wednesday, August 23

Room A—10:00 A.M.-12:30 P.M.

11/1 THE DIFFRACTION THEORY OF LARGE APERTURE SPHERICAL REFLECTOR ANTENNAS

A. C. Schell, Air Force Cambridge Research Laboratories, Bedford, Mass.

In this paper the fields along the axis of a spherical reflector are determined by using the geometry of the system rather than by considering each term of the aberration separately. The result is an exact expression for the physical optics field along the axis, and shows the manner in which the field distribution changes from the small aberration case, where there is a well defined focus, to the geogmetric optics limit.

In order to use a spherical reflector as an efficient antenna, a set of feed elements is located along the axis to reduce the effects of spherical aberration. The number and position of these elements are dictated by the reflector size and curvature, and by the allowable distortion of the wavefront. Expressions for the performance of a spherical reflector antenna with a set of axial feed elements are developed.

These results are applied to the case of the 1000-foot diameter spherical reflector of the Department of Defense ionospheric facility in Puerto Rico to illustrate the method of feed design for this type of antenna.

11/2 CORRELATION ANTENNAS WITH NON-UNIFORMLY SPACED ELEMENTS FOR INCOHERENT SOURCES

L. C. Davenport and C. J. Drane, Air Force Cambridge Research Laboratories, Bedford, Mass.

The space frequency response of passive discrete antenna arrays with uniformly and closely spaced elements can be improved by the introduction of a compound interferometric system of non-uniformly, widely spaced elements, as well as data-processing circuitry. The latter provides a frequency translation of signals received at certain antenna elements, coupled with their multiplication by non-translated signals followed by the time average of these products in accordance with a prescribed pattern such that one might achieve radiation patterns that are equivalent to those obtained by more conventional techniques that require in general many more antenna elements. In this paper there is described a particular experimental system consisting of an X-band slot array resonant at 9375 mc, three interferometer pairs which are arranged linearly end to end, all coupled to appropriate data-processing equipment. The final result is an antenna radiation pattern of the form $(\sin Nx)/Nx$. With this system of 54.8λ aperture, it is possible to achieve approximately a one degree beamwidth with a reduction to 20 per cent of the antenna elements normally required, at the expense of data-processing circuitry complexity. Experimental data is presented showing the applicability of systems of this type to the mapping of radiation emitted by extended incoherent sources such as those commonly encountered in radio astronomy.

11/3 A HIGH RESOLUTION RADIO TELESCOPE

J. L. Yen and D. A. MacRae, University of Toronto, Toronto, Canada.

A radio telescope with a resolution of 4 minutes of arc by 20 minutes of arc, designed at the University of Toronto, is described. The operating frequency is 710 mc. The antenna is a wide-spaced array of 6λ Yagis. The novel technique of multiple-lattice configuration is used so that element spacing can be increased to 4λ without undue high-order beam interference. The steering of the N-S arm is accomplished by "zoned steering," where the elements are displaced and rotated to line up with the incoming wave front without the need of phase shifters. The purpose of the instrument, performance and limitations of the design are discussed.

Sponsored by Professional Group on Antennas and Propagation

Chairman and Organizer: Charles E. Seegar, Stanford University, Stanford

Shockley *Brown*

7th Region IRE Fellows: William Shockley, director of Shockley Transistor unit of Clevite Transistor, Palo Alto; A. S. Brown, special assistant to the director, Stanford Research Institute, Menlo Park; C. Lester Hogan, vice president, Motorola Semiconductor Products, Inc., Phoenix; Harner Selvidge, vice president, Meteorology Research, Inc., Burbank

Hogan *Selvidge*

SESSION 12
STEREOPHONIC F-M BROADCASTING

Room B—10:00 A.M.-12:30 P.M.

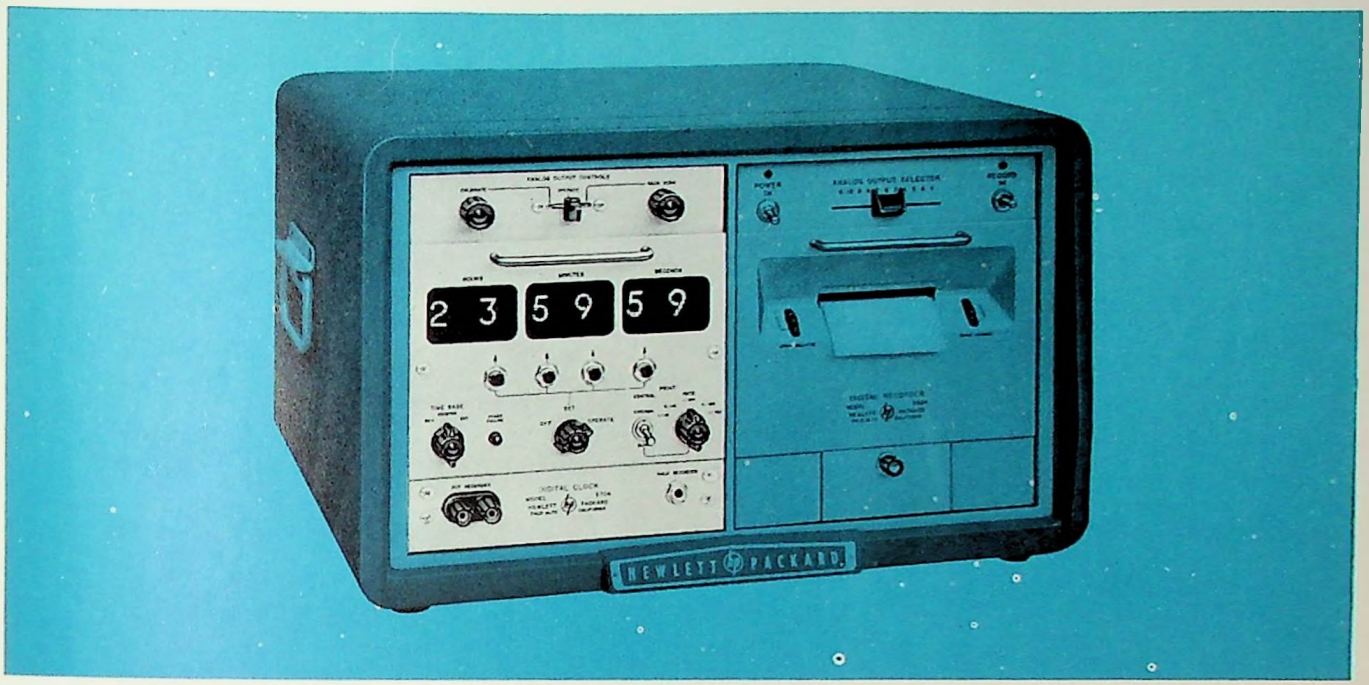
12/1 STANDARDS FOR STEREOPHONIC BROADCASTING

Harold Kassens, Federal Communications Commission, Washington, D. C.

In March, 1955 the Commission amended its rules to provide for the issuance of subsidiary

(Continued on page 35)

ADD TIME-OF-DAY TO RECORDED DATA



clocks for hp digital recorders
control taking of readings
fit in Digital Recorder cabinet
available for field installation

hp 570A and 571B Digital Clocks mount in the left-hand side of hp 560A and 561B Digital Recorders, respectively. The clocks may be installed in the field, and fit either in cabinet arrangement, as shown, or into a combined Recorder-Clock rack mount arrangement only 10½" high.

Time appears as a 23 hour, 59 minute, 59 second presentation (12-hour clocks are available on special order). Display is by long-life, in-line indicator tubes. All time digits are available for printing.

Two operating modes provide utmost usefulness. In the first mode, hp or Dymec Digital Counters, Digital Voltmeters or other external equipment control print rate; time being printed simultaneously with other data. In the second mode, for tests where less frequent readings are desired, the Digital Clocks control the timing of readings. A front panel control selects reading rates of 1 per second, 6 per minute, 1 per minute, 6 per hour or 1 per hour.

SPECIFICATIONS

Indication: Six in-line long-life digital display tubes. Indication to 23 hrs., 59 min., 59 sec.

Time Base: Ac line, 1 pps from counter, or external 1 pps.

Accuracy: Time base accuracy + 0, — 1 second.

Print Control: Front panel control selects CLOCK or EXTERNAL control mode. PRINT RATE of 1 sec., 6/min., 1/min., 6/hr., 1/hr. also chosen on front panel control.

Output: Six time digits for time recording. Holdoff signals for hp, Dymec counters.

Power Interruption Alarm: Front panel warning light.

Analog Output: 570A retains analog output of 560A.

Prices: hp 570A (fits hp 560A/AR) $1,050.00; hp 571B (fits hp 561B/BR) $950.00.

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

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MORE LAS VEGAS

Fussell, Jr., of EG&G, spoke on "The Peaceful Uses of Atomic Energy."

In January, Conrad L. Ryan of the Southern Nevada Power Company discussed "Power System Design and Operation."

The members traveled to the Tonopah Missile Range in March and a paper entitled "Instrumentation Systems of the Tonopah Missile Range" was presented by John C. Eckhart of the Sandia Corporation. The members were then taken on a tour of the Tonopah Missile Range.

New officers were installed at the May meeting. They are as follows: chairman, Jacob H. Jurmain, EG&G, Las Vegas; vice chairman, Gerald R. Luetkehans, EG&G, Las Vegas; secretary, Lawrence S. Kreyer, EG&G, Las Vegas; and treasurer, Christian L. Delzer, Southern Nevada Technical Institute, Las Vegas.

The speaker at this meeting was Arthur J. Steele of Lockheed, who presented a film entitled "T Plus Infinity." This film described the early stages of the Discoverer satellite program.

—LAWRENCE S. KREYER, SECRETARY
LAS VEGAS SECTION

regional roundup

THE LOS ANGELES YEAR

With Section membership hovering close to 9,300, new ventures were tried in order to provide services to its members. For, besides holding 185 Section, Subsection and Professional Group meetings which attracted close to 12,000 members, a spring lecture series on "Recent Advances in Electron Devices" was chairmanned by Matthew Brady. Held in two locations, California Polytechnic College, Pomona; and in Los Angeles; the series sold out in the smaller auditorium in Pomona, and attracted 270 attendees in Los Angeles.

Another successful special event, held the previous December, was the Seminar on Reliability in Space Vehicles which attracted 200 to an all-day program of 12 papers and featured Dr. Nicholas Golovin, NASA Consultant, as the luncheon speaker. The seminar was sponsored by PG's RQC, ED and CP.

In February, the Winter Convention on Military Electronics was both a financial and technical success. It was the acme of the trio of special events, attracting 1500 attendees, featuring 120 papers, many classified, 34 exhibits, and two top-notch military speakers, Vice-Admiral John T. Hayward and Brig. Gen. Chester W. Clark.

Twenty-two professional groups operated in the Section during the past year. As the year ended, the petition for the establishment of a new chapter on Antennas & Propagation-MTT (Or-

(Continued on page 36)

MORE PROGRAM (WED.)

communications authorizations to f-m broadcasters. The adoption of these rules permit f-m stations to transmit a second program by multiplex techniques on a frequency-modulated subcarrier. After a few years of operation under these rules it became evident that multiplex techniques could be employed for additional uses beyond the limited scope originally provided. A notice of inquiry was released in July of 1958 for the purpose of exploring these additional uses of f-m multiplexing.

A preliminary examination of comments submitted in response to this notice of inquiry indicated a wide-spread interest in the subject of f-m stereophonic broadcasting. A further notice of inquiry was issued on March 12, 1959 to afford interested persons an opportunity to comment specifically on the matter of f-m sterophonic broadcasting.

About this some time, the Electronic Industries Association organized the national stereophonic radio committee for the purpose of developing and recommending national standards for f-m sterophonic radio. After extensive study, the NSRC submitted for Commission consideration seven f-m sterophonic broadcasting systems. An additional system was submitted directly to the Commission by its proponent. Based upon the information submitted by the NSRC and additional information available to it, the Commission issued on May 9, 1960 a notice of proposed rule making requesting comments on these eight systems.

Subsequently the NSRC field-tested six of the proposed systems and submitted the results of these tests. Based upon these comments and the comments of many individuals and companies interested in this proceeding, the Commission on April 19, 1961 adopted a report and order amending its rules to provide for the transmission of stereophonic programs using a composite of systems 4 and 4A; the systems proposed by Zenith and General Electric.

In selecting the chosen system over others proposed, the Commission considered audio frequency response, signal-to-noise ratio and distortion of both the main and sub-channels. Relative costs were also a factor.

12/2 STEREOPHONIC F-M RECEIVERS AND ADAPTERS

D. R. von Recklinghausen, H. H. Scott Inc., Maynard, Mass.

The sterophonic f-m broadcast signal specifications recently adopted by the Federal Communications Commission can be interpreted in two different ways. One approach in design of receiving equipment is to treat the composite stereo signal as a matrixed sum and difference signal the difference information being carried by the two a-m sidebands of a 38-kc suppressed carrier. The other approach is to treat the composite signal as a time multiplex signal with the transmitter in effect "switching" at a 38-kc rate between the two modulation inputs.

Since this composite signal is available at the output of an f-m detector, stereophonic adaptors can be designed to recover the two channels from the composite signal using either the "sum-and-difference" or the "time multiplex" approach. Different 38-kc wave shapes can be used for demodulation of the subcarrier information. Generation of the 38-kc re-insert carrier can be accomplished by amplification and doubling of the 19-kc pilot signal broadcast or by synchronization of an oscillator by the pilot signal.

Usage of stereophonic adaptors in conjunction with tape recorders requires suppression of supersonic signals to prevent beat tones with the bias oscillator frequency. Special demodulator and filter circuitry is required for this purpose. The combination of an f-m tuner with a stereophonic adaptor determines the overall stereo performance of the equipment. Performance characteristics of a particular design are shown.

(Continued on page 36)

MORE LOS ANGELES

ange County) was approved by the Section executive committee.

As the year ended, the new Crescent Bay Subsection was being formed to provide service to Section members in the geographical area running along the coast line from approximately Malibu, south to International Airport, and east to La Cienega. Since they were just organizing, their only meeting of the year was in June and featured Dean Boelter of UCLA. Crescent Bay is now awaiting national headquarters' approval of its petition for formal recognition.

In June, the Section had the pleasure of entertaining Dr. Lloyd V. Berkner, international IRE president, during a one-day visit to Los Angeles.

Two major plans were undertaken this year and will be continued into the ensuing year. The first plan, initiated by Walter Hausz, retiring chairman, was to have additional subsections to serve the member better in his own community. Movements in this direction were taken with the establishment of the Crescent Bay Subsection. Now the majority of the Section membership is encompassed by subsections. The other area to be studied is that of the continued expansion of professional groups into subsections, and how, due to increased meeting costs, such chapters are to be financed.

—RONALD TANSKY

regional roundup

THE PHOENIX YEAR

The outstanding activity of the Phoenix Section during the 1960-1961 season was sponsorship of the IRE Seventh Region Conference, held April 24 to 26 at the Westward Ho Hotel, in Phoenix. There were over 1500 registrants, and the affair was judged a great success.

Prior to the Conference, the IRE Board of Directors held its annual meeting in Phoenix.

Other activities during the season included the annual treasure hunt, held in November, and Fellow's night, a social affair held in February at the Camelback Inn, at which Dr. Sloan Robertson of Goodyear Aircraft, newly-elected Fellow of the IRE, was honored.

A chapter of the Professional Group on Electronic Computers has been successfully formed, and the chapter of the Professional Group on Military Electronics has been reactivated.

—HARRY R. HYDER, VICE CHAIRMAN
PHOENIX SECTION

regional roundup

THE PORTLAND YEAR

The Portland Section has increased its membership to nearly 250. The section publication, The "Portland Pi," has completed its second year, is financially self-sustaining, and hopes to expand its coverage during the coming year.

The continuing problem of the Section is the matching of programs and speakers to the interests of the members. Though the percentage of members attending meetings appears to be typical in comparison with other sections, it is difficult to secure attendance sufficient to justify inviting special speakers from a distance. Despite this problem, a number of outstanding programs have been presented and very well received. Particularly noteworthy was the lecture on "Ferromagnetism and Ferromagnetic Domains" by Dr. John K. Galt of Bell Telephone Laboratories.

A partial solution to the problem of attendance has been found in joining forces with other technical societies for a number of meetings. We hope more of this can be done in the coming year. Joint programs have included meetings with high-school and college students

(Continued on page 38)

1958 seventh region achievement

WALTER P. DYKE

Technical director of Linfield Institute, McMinnville, Oregon, and president of Field Emission Corp., Dr. Dyke was honored by the 7th Region Achievement Award in 1958 for the invention and development of field-emission cathodes. His degrees of BA in physics (1938) and PhD in physics (1946) were from Linfield College and University of Washington, respectively. He has been a staff member in the radiation laboratory at MIT, and a professor of physics and head of the department at Linfield College.

His society memberships include, in addition to the Institute, the American Physical Society, the Oregon Academy of Science, the American Association of Physics Teachers, Sigma Xi, and Phi Sigma Phi. He has received the Presidential Certificate of Merit and the Oregon Academy of Science Citation.

MORE PROGRAM (WED.)

12/3 CONVERTING F-M BROADCASTING STATIONS FOR STEREOPHONIC TRANSMISSION
James Gabbert, KPEN, San Francisco, Calif.

In April of this year, the Federal Communications Commission approved a set of standards for f-m stereophonic multiplex broadcasting. This event by the FCC has been hailed by many leading broadcast authorities as the greatest event since the advent of television. The system chosen was based primarily on the system developed by the Zenith Radio Corporation of Chicago, Illinois, and the General Electric Company of Utica, New York.

At the present time there are over one thousand f-m broadcast stations authorized by the FCC. Within the next twelve months most of these stations will be making the decision whether or not to commence stereo broadcasting and if so, how best to do it. We at KPEN have already made the decision to begin stereo broadcasting at the earliest possible time, probably during the early part of this summer. As a pioneer stereo station, we are faced with several problems. The major problem is the fact that the only information available to us is that supplied by Zenith and General Electric from their field tests and from the field tests conducted by the national stereo radio committee and the FCC at Pittsburgh, Penna. This information is basically theoretical and of a laboratory nature and does not encompass the practical problems that a typical f-m station will encounter in the conversion to f-m multiplex stereo broadcasting.

The paper will cover alternatives available to the one thousand f-m broadcasters of this country, the steps we at KPEN chose to convert our facilities to f-m, the problems we had in conversion, and our estimation of the final results with suggestions and necessary information on future conversion of other stations based on our experience.

We feel that KPEN will be among the very first stations to have completed a typical conversion, not a laboratory installation, and therefore the information to be submitted will be of major significance to both the electronic and broadcasting industries.

Sponsored by Professional Group on Broadcasting, Professional Group on Audio, and Professional Group on Broadcast and Television Receivers

Chairman and Organizer: R. A. Isberg, University of California, Berkeley

SESSION 13
HIGH DENSITY TAPE RECORDING

Room C—10:00 A.M.-12:30 P.M.

13/1 REPRODUCTION AND EQUALIZATION OF PULSES FROM A MAGNETIC TAPE SYSTEM
G. J. Fan, IBM, Yorktown Heights, N. Y.

The output pulse from a tape system using a square-wave input can be shaped by filtering either the input spectrum or the output spectrum. Such filtering can substantially reduce the width of the output pulse. A reduction of the output pulse width by a factor of five to ten has been demonstrated experimentally. Such shaping has its limitations. For a system with a good signal-to-noise ratio, the paper gives a method for obtaining an optimum shaping.

A quantitative evaluation of the present digital tape system is carried out numerically. The behavior of the present system is demonstrated by replacing the tape system with a filtering network of the same frequency response. The effect of non-linearity and the phase relationship of the system are also discussed. It is shown that they pose a rather serious problem for input equalization, but do not introduce a serious handicap for equalization at the output.

Much of the theory in this study has been verified by experiments, some of the more pertinent of which are discussed in detail.

(Continued on page 38)

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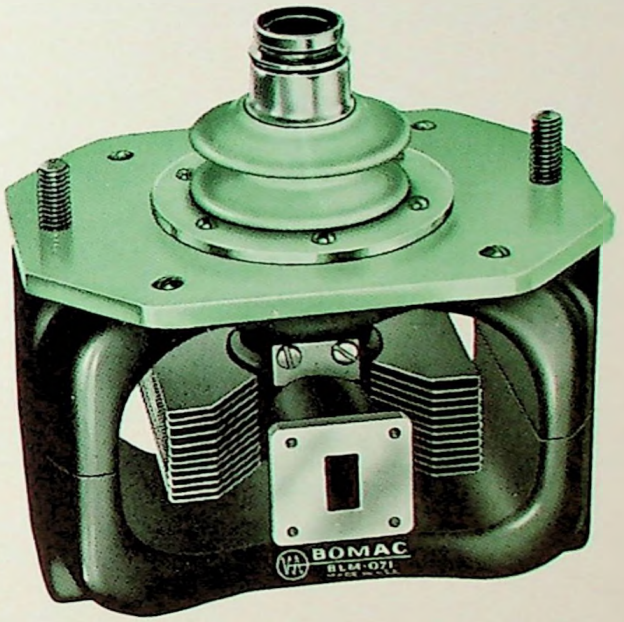
BOMAC K_U BAND MAGNETRONS

Designers of radar equipment will find Bomac Laboratories' new BLM-071 K_U-band pulse magnetron meets exacting requirements for airborne systems: lightweight, rugged, powerful. This newest contribution from Bomac is a fixed-frequency tube (15.9-16.1 kMc) rated at 100 kW peak, at 0.001 duty cycle.

Cathode structure is greatly improved over similar magnetrons. Operable at high ambient temperatures, with input/output terminals permitting pressurization to 30 psia. Special construction minimizes leakage current. High power output and low operating voltage are combined in a compact, ruggedized unit. Long life. Weight: less than 8½ lbs.

The many advantages to Bomac's BLM-071 magnetron make it readily adaptable to navigation, high-altitude mapping, airport surveillance, and similar applications. Write for full technical details.



FEATURES: Frequency 15.9-16.1 kMc.
Peak Power 100 kW.
Normal efficiency 30%.
Duty cycle 0.001 Max.
Pulse width 0.06 to 1.2 usec.

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MORE PORTLAND

in the area, presenting engineering as "A Career of Opportunity." "Engineers' Night at the Medical School" was arranged principally by the IRE Professional Group on Bio-Medical Electronics. Six papers were presented and nearly 500 attended the meeting. The PGBME group, though small, continues to be active and receives excellent cooperation from the staff of the University of Oregon Medical School.

—MERLE L. MORGAN, CHAIRMAN
PORTLAND SECTION

regional roundup

THE SACRAMENTO YEAR

At our annual meeting in May the ballot results were announced for a new slate of officers for the year 1961-1962 as follows: Chairman, Alan O. Rohde, chief engineer—detection and guidance branch, Western GEEIA Region, USAF, McClellan AFB, Calif; vice chairman, Joseph R. Kowalczyk, project engineer—Western GEEIA Region, USAF, McClellan AFB, Calif.; and secretary-treasurer, Jean C. Bissett, assistant chief of interference section, Western GEEIA Region USAF, McClellan AFB, Calif.

Our 7th Region Director, C. Wesley Carnahan, has honored our Section with several visits. We wish to thank Wesley Carnahan for his kind and considerate effort he has given our Section. He also spoke at our annual October Reno meeting on the subject, "Space and Such."

The Reno meeting with all its frills was arranged by Professor Irving J. Sandorf, chairman of the electrical engineering department, University of Nevada.

Professor Sandorf has been appointed chairman of the 7th Region education committee. The Sacramento Section is greatly honored.

The Section was also honored by having at our December meeting, Dr. Ronald L. McFarlan, IRE international president, who spoke on "Microwave Fuel to Power on Airborne Platform."

(Continued on page 40)

A. O. Rohde, J. R. Kowalczyk, and J. C. Bissett, 1961-62 Sacramento Section officers

MORE PROGRAM (WED.)

13/2 HIGH DENSITY DIGITAL MAGNETIC TAPE RECORDING

C. N. Bastel and W. L. Ross, RCA, Los Angeles.

Deriving data clocking from recorded digital data on a per channel basis makes possible high packing densities not directly limited by tape skew. As packing densities are increased with currently available ferrous oxide coated magnetic tape, a point is reached where adjacent "bits," or flux reversals, interact, with resultant demagnetization. However, data can be recovered at densities considerably beyond this point. To extend the data recovery range to the maximum possible extent requires an optimum selection of system components, including magnetic tape and head, and read/write circuits.

The principal limitations on packing density are imposed by magnetic-tape-to-head transfer characteristics and costs. Advancements in magnetic recording medium may extend the useful range of the basic approach described.

13/3 PULSE RESOLUTIONS FROM MAGNETIC AND HALL REPRODUCE HEADS

Irving Stein, Ampex Corporation, Redwood City, Calif.

The resolutions of pulses stored on a magnetic medium, either tape or drum, by both magnetic and Hall reproduce heads is determined. Comparison is made for different size magnetic gaps and varying thicnesses of Hall heads. The relative resolutions as a function of medium-to-head spacing for both types of heads is also determined. It is found that the Hall head is theoretically capable of better resolution than magnetic heads, but that practical considerations at present prevent the full utilization of the better Hall head resolution.

Sponsored by Professional Group on Electronic Computers

Chairman and Organizer: Erwin Tomash, Ampex Computer Products, Culver City

SESSION 14
DETECTION AND SIGNAL PROCESSING

Room D—10:00 A.M.-12:30 P.M.

14/1 CROSSCORRELATION WITH BINARY SIGNALS

G. R. Cooper, Purdue University, Lafayette, Ind.

Crosscorrelators employing binary signals have significant advantages from the standpoint of mechanization. A fundamental question that arises, however, concerns the smoothing time required to achieve a given signal-to-noise ratio at the correlator output. This question is examined for correlators employing either random telegraphic signals of infinite duration or periodically repeated pseudo-random binary sequences. The analysis includes the effects of external disturbances appearing at the output of the system being measured and it is shown that these often play a predominant role. A modification of the correlator that employs infinite clipping of the system output before multiplication is shown to yield the same correlation function and the smoothing time for this system is discussed. All theoretical results and some typical experimental results are presented graphically.

14/2 THRESHOLD COMPARISON OF PHASE-LOCK, FREQUENCY-LOCK AND MAXIMUM LIKELIHOOD TYPES OF F-M DISCRIMINATORS

J. J. Spilker, Jr., Lockheed Missiles and Space Division, Palo Alto, Calif.

In making a comparison of demodulation techniques for f-m signals, one of the most important criteria for evaluation is the threshold input signal-to-noise ratio (snr). It is at this value of input snr that the output snr begins to decrease more rapidly than a simple proportionality to the input snr.

The objective of this paper is to present a consistent derivation of the threshold snr for several major types of f-m discriminators, namely, the phase-lock discriminator, the frequency-lock discriminator (f-m discriminator with negative feedback), and the maximum likelihood (a posteriori most probable) computer. This last discriminator is of interest mainly because its operation provides a bound on the performance of other types.

The operation of the discriminators in the presence of gaussian interfering noise is described, and the causes of threshold are investigated. The probability of losing the "locked on" state of operation is computed. Curves of the threshold input snr are plotted vs the ratio of signal-to-modulation bandwidths, and these curves are compared for the various types of discriminators. Experimental confirmations of some of the theoretical results are given.

14/3 CLASSIFICATION AND EVALUATION OF COHERENT SYNCHRONOUS SAMPLED DATA TELEMETRY SYSTEMS

A. J. Viterbi, JPL, California Institute of Technology, Pasadena, Calif.

This paper analyzes the various types of continuous wave and pulse modulation for the transmission of sampled-data over channels perturbed by additive white gaussian noise. Optimal coherent synchronous detection schemes for all the different modulation methods are shown to belong to one of two general classes: linear synchronous detection and correlation detection. The figures of merit, mean square signal-to-error ratio and bandwidth occupancy, are determined for each system and compared.

Sponsored by Professional Group on Space Electronics and Telemetry

Chairman and Organizer: R. G. Davis, Lockheed Missiles and Space Division, Sunnyvale, Calif.

SESSION 15
MICROWAVE COMPONENTS AND TECHNIQUES

Room E—10:00 A.M.-12:30 P.M.

15/1 MICROWAVE VARIABLE ATTENUATORS AND MODULATORS USING P-I-N DIODES

J. K. Hunton and A. G. Ryals, Hewlett-Packard Company, Palo Alto, Calif.

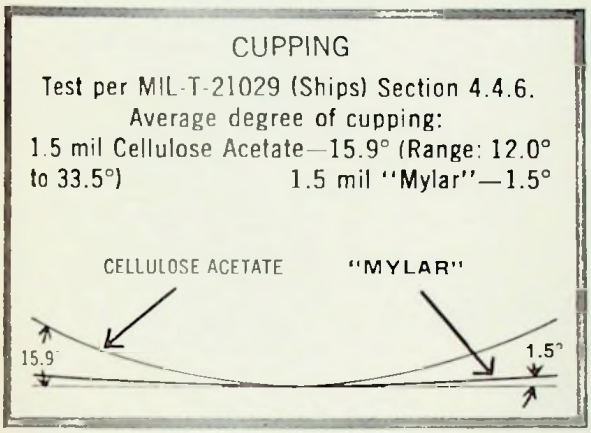
The p-i-n diode is a double diffused junction with an intrinsic layer separating the p and n regions. At frequencies above 100 mc, the diode ceases to be a rectifier because of carrier storage effects. However, its capacitance is quite small because of the separation of the p and n regions by the I layer. Conductivity of the I region can be varied by a d-c bias current and the device becomes an electrically variable resistor which can be used for microwave attenuators and modulators.

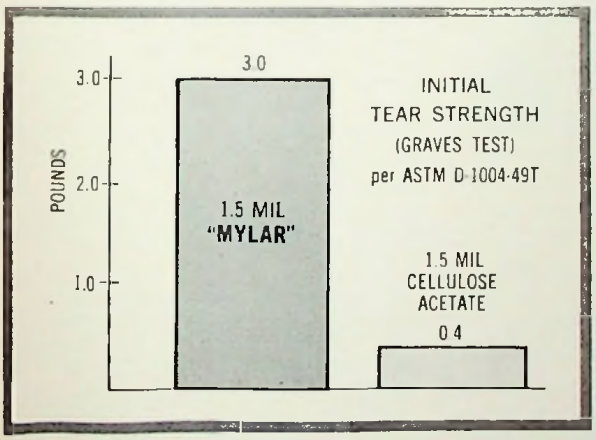
The p-i-n junction is mounted on a post which is inserted in a 50-ohm strip transmission line. From a circuit standpoint the element is equivalent to a short length of transmission line terminated in a variable resistance. Post geometry is chosen to make this effective line impedance 50-ohms so the element is a pure 50-ohm resistance shunting the main line at the appropriate bias current. At zero bias the element is a shunt capacitance whose value is determined by the effective elemental line length. Attenuators are designed with a number of these elements spaced ¼ wavelength apart at midband. Analysis is carried out for the two limiting cases of an array of 50-ohm shunt resistors giving an image attenuation of 4 db per element and an array of shunt capacitances giving a line of lowered characteristic impedance. Bandwidths of 4 to 1 with low swr can be achieved with this method.

Experimental attenuators in various frequency ranges from 1 to 12 kmc have been built and the results are discussed. Special problems associated with pulse modulation are also discussed and experimental results are shown.

(Continued on page 40)

GUARD AGAINST READ/WRITE ERRORS WITH RELIABLE TAPES OF MYLAR®



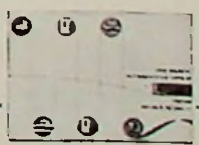


Unstable tape can cup or ruffle—cause read/write errors because the tape loses contact with the recording and playback heads. Dimensionally stable "Mylar"* polyester film base prevents tape cupping or ruffling. It does not shrink from dryness or swell from excess humidity, but maintains the original width and flatness of the tape.

"Mylar" is strong . . . has an ultimate break strength over 20,000 psi! Tapes of "Mylar" can resist edge nicks, stretching or breaking from sudden stops and starts. And since it contains no plasticizer to dry out, tapes of "Mylar" can be stored indefinitely without becoming brittle.

A stable tape assures accurate data acquisition—helps prevent costly read/write errors and loss of valuable test data. Tapes of "Mylar" have this stability. To be sure you'll get the best performance, insist on a base of "Mylar" on your next order for magnetic tape. Write for the free booklet on comparative test data. Du Pont Company, Film Dept., Wilmington 98, Delaware.

*"Mylar" is Du Pont's registered trademark for its brand of polyester film. Only Du Pont makes "Mylar".



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MORE SACRAMENTO

Other meetings included a visit to the engineering department of Chico State and a talk by Associate Professor William Lane, on computers. We are developing a meeting program to reach as many of our outlying area members as possible. The Section's geographical area reaches as far as Nevada, Redding, and Modesto, Calif.

We had several joint IRE-AIEE meetings; "Radio Astronomy," Mrs. Natalie Leonard, Sacramento State College; and Telephone Night with "Project Echo" and "Pulse Code Modulation," Charles P. Morrill, Jr., and Donald S. Cannon, Pacific Telephone & Telegraph Co., Sacramento; "Cryogenic Flow Measurements," G. R. Deppe, Aerojet General Corp., Sacramento; "Time—Slow or Fast," Prof. Irving J. Sandorf, University of Nevada (this was our ladies night out and dinner meeting); "Analog Computers" and "Space Vehicle Re-Entry Problems," John Cook of RCA and George Story, Western GEEIA Region, USAF; "Noise and Human Reaction," Louis Bourget, material and research laboratory, division of highways, State of California.

—JOSEPH R. KOWALCZYK
SEC.-TREAS. SACRAMENTO SECTION, IRE

regional roundup

THE SALT LAKE YEAR

The program chairman, Art Vodak, arranged meetings at various industrial plants and other centers of electrical engineering activity during the year. These centers included Hercules Powder Company, Marquardt Aircraft Company, Utah Air National Guard, Utah State University, Brigham Young University, and the University of Utah. Lectures and guided tours were usually included in these meetings. Also, the Salt Lake Section was fortunate to obtain the services of several outstanding nationally recognized individuals. These speakers included Glen Wade of Raytheon Spencer Labs, who spoke on "Noise in Microwave Amplifiers;" H. E. D. Scovil and E. D. Reed of Bell Labs, who discussed "Masers;" and Wes Carnahan of Varian Associates, who talked on "High Power Microwave Amplifiers." Eleven meetings were held during the year. Attendance ranged from about 40 to over 100.

Under the direction of Professor Darrel Monson of Brigham Young University, a student paper contest was held in Salt Lake City. One contestant was selected from each of the universities in the area encompassed by the Salt Lake Section. First prize ($25.00), second prize ($15.00), and third prize ($10.00) awards were made to the winners.

(Continued on page 42)

MORE PROGRAM (WED.)

15/2 THE ISOMODULATOR

Howard Scharfman, Raytheon Company, Waltham, Mass.

A microwave ferrite device, called an isomodulator, is described which modulates a microwave oscillator while simultaneously isolating the oscillator from load variations. The basic device is similar to a ferrite circulator of the Faraday rotational type. Two orthogonal mode transducers oriented at 45 deg to each other are connected to the ends of a ferrite rotater to which two longitudinal magnetic fields are applied by means of separate coils to obtain a quiescent 45 deg non-reciprocal rotation and a small modulation of the rotation angle. With a matched load on the side arm (port 3) of the input orthogonal mode transducer and a short circuit on the side arm (port 4) of the output transducer the device is a two port with good isolation from output (port 2) to input (port 1) and with an input reflection coefficient modulation whose magnitude depends on the depth of modulation of the rotation angle. This variable modulated reflection coefficient may be used to pull a microwave oscillator, and it is shown how, by properly adjusting the phasing between the oscillator and the isomodulator, and the modulation of the angle of rotation, one may obtain various degrees of amplitude and/or frequency modulation. For small frequency deviation the variation of rotation angle is small and the device gives good isolation from load variations simultaneously.

A specific isomodulator is described which was designed for X band operation in a c-w system at the 200-watt level. Details of the theory, design, and operation of the device are covered, and certain unusual constructional features, which enable the device to work at high power levels and in severe environmental conditions, are discussed.

Brunetti *Wright*

7th Region IRE Fellows: Cledo Brunetti, president, Grand Central Rocket Co., Redlands; Jay W. Wright, director of engineering facilities, King Broadcasting Co., Seattle; R. M. Ashby, vice president of research and development, Autonetics Div., North American Aviation, Inc., Downey; Burgess Dempster, president, Electronic Engineering Co., Santa Ana, Calif.

Ashby *Dempster*

15/3 A PRACTICAL APPROACH TO THE DESIGN OF PARAMETRIC FREQUENCY MULTIPLIERS

G. Luettgenau, J. Williams and H. Miyahira, Pacific Semiconductors, Inc., Lawndale, Calif.

An extension of the exact analysis of parametric frequency multipliers is presented, which indicates a practical approach to the design problem. The discussion includes detailed comments on general design considerations; power handling and frequency characterization; modulation, phase distortion, and noise; high order multipliers; and a description of an experimental 2.5-watt 2-kmc generator, a 5-watt 400-mc generator, and a 20-watt 250-mc generator. The circuits described are typical examples of voltage and charge-controlled configurations in the vhf—microwave range and illustrate the capabilities and advantages of each under given system requirements.

Sponsored by Professional Group on Microwave Theory and Techniques

Chairman and Organizer: Edward M. T. Jones, Stanford Research Institute, Menlo Park, Calif.

SESSION 16

METHODS OF RELIABILITY IMPROVEMENT

Room A—2:00 P.M.-4:30 P.M.

16/1 REDUNDANCY AND THE DETECTION OF FIRST FAILURES

D. C. James and A. H. Kent, The Martin Company, Denver Colo.

This paper reviews the field of reliability improvement methods and attempts to correlate them with respect to practicability and effectiveness. The disclosures pertaining to majority vote and dissenting vote are considered advances in the state of the art. The need for increased reliability in electronic equipment with respect to present and future designs is cited.

A general discussion on reliability improvement methods follows along with a discussion of expected levels of improvement. The limitations to be expected with the various methods are also discussed. The subject of redundancy is then carefully explored. Both component and circuitry redundancies are considered along with dual, triple, and quadruple degrees of redundancy. The subject of majority voted redundancy is explored—its limitations and advantages are discussed. A particular problem, that of component failure detection, is discussed and a logical solution developed. The resulting function, "dissenting vote," along with possible applications are presented.

In conclusion, a reliability analysis of a typical majority voted, triply redundant, dissenting vote indicated system is given.

16/2 USE OF THE WEIBULL DISTRIBUTION FUNCTION IN THE ANALYSIS OF MULTIVARIATE LIFE TEST RESULTS

A. A. Procassini and A. Romano, Motorola, Inc., Phoenix, Ariz.

Literature of recent years contains many references to typical mortality curves, descriptions of various sampling plans designed for life testing and relationships that exist between stress levels and failure rates. Relatively few references are contained, however, to multivariate life testing for semiconductor devices.

A reliability improvement program has been undertaken at Motorola involving a germanium, pnp, transistor with maximum rated power of 150 mw at 25 C. During the early part of the testing program it was found that the failure rate of these devices is not constant. Because of the fact that the failure rate was changing, the actual distribution of failure ages was sought. The Weibull distribution has been applied to the data obtained from the "matrix" tests.

The method used for obtaining the Weibull parameters, α, β, and γ, for each operating life

(Continued on page 42)

LITTON ALL-INERTIAL AUTOMATIC NAVIGATOR INSTALLED IN AN OPERATIONAL FIGHTER

NEW PROOF OF LITTON'S CONTINUING CONTRIBUTIONS TO THE DEVELOPMENT OF INERTIAL NAVIGATION IS FURNISHED BY THE LN-3-2B AUTOMATIC NAVIGATOR THAT IS NOW BEING INSTALLED IN CANADA'S CF-104 FIGHTER.

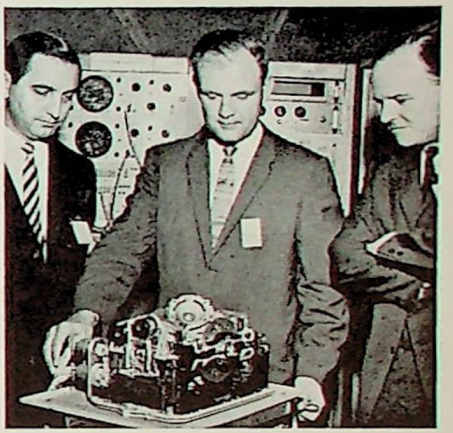
Three-hundred-and-sixty-degree freedom of aircraft maneuver on every axis is made possible by four-gimbal isolation of the Litton stable platform that keeps the system's accelerometers aligned in inertial space. Voltage signals from the accelerometers are transmitted to a computer where they are integrated to compute vehicle position components.

In addition, an adapter unit provides 27 outputs of pitch, roll and heading angles and ground speed to other equipment in the aircraft such as bombing computer and autopilot.

In flight, tight servo loops hold all sensitive elements of the stable platform at null regardless of acceleration. Any relative motion between the gyro case, which is fixed to the platform, and the floated gyro rotor, which is fixed in space, is sensed and corrected to keep the platform including accelerometers oriented to vertical and north. Any acceleration along an axis produces an accelerometer torquer current which is proportional to the applied acceleration. This torquer current holds the accelerometer at null, and the same signal is transmitted to the navigation computer.

Another indication of the scope and caliber of Litton inertial engineering is the new combined doppler and inertial navigation system being produced by Litton Systems for the Lockheed P3V-1 anti-submarine patrol aircraft. The inertial system continuously measures accelerations along the two horizontal axes and computes velocity components and aircraft position in latitude and longitude. Velocity information from the AN/APN-122 doppler radar is used in the inertial navigation system to optimize system performance.

A half dozen other Litton inertial navigation systems have been successfully developed to the operational phase. Still others are now in earlier phases of development.

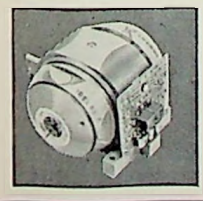


EXAMINING LN-3 STABLE PLATFORM UNDER TEST AT LITTON'S WOODLAND HILLS, CALIF. FACILITY ARE L-R: VIC SYMONDS, LITTON-CANADA; P. LUTH, LITTON-CALIF.; D. BELYEA, DCP.

These programs are being carried forward by engineers specializing in inertial navigation and related techniques. By engineers with their own long-range plans, and the ability to make important contributions to inertial engineering. By engineers who prefer engineering to paper work. By engineers willing and able to see a job through from concept to product.

Are you specially qualified in inertial equipment, computers, data processing systems, tactical data systems, displays, advanced communication techniques? Write today to Donald Krause, Research & Engineering Staff, Litton Systems, Inc., 336 No. Foothill Road, Beverly Hills, California.

Qualified applicants will be considered regardless of race, creed, color or national origin.



LITTON SYSTEMS, INC.
Beverly Hills, California

DIVISION OF LITTON INDUSTRIES

MORE SALT LAKE

The first issue of "The Salt Lake Crystal" was printed in December. This bulletin of the Salt Lake Section was edited by Hugh Hilliary of EMF Associates.

—CHARLES L. ALLEY,
UNIVERSITY OF UTAH
SALT LAKE CITY, UTAH

regional roundup

THE SAN DIEGO YEAR

Our new slate of officers, elected in January 1961, is as follows: David G. DeHaas, chairman; Edmond W. Carlson, vice chairman; David Proctor, secretary-treasurer.

Regular monthly meetings were maintained throughout the year with the exception of the month of September and covered the following topics from July 1960 through June 1961: Space Communications; Research at General Atomic in the Nuclear Age; Semiconducto Technology—A Survey; The Interaction of a Plasma with an Electro-Magnetic Wave; Deep Sea Operation of Bathyscaph "Trieste"; Exploring the Moon — Project Ranger; Automatic Drafting—A New Engineering Technique; Three-Level KU-Band Maser; Doppler Navigation; Phase-Lock Receiving Systems.

Our May Section meeting was devoted to a tour of Kin Tel and Cubic Corporation and was well received by the Section membership.

Don Pritchard, a senior at San Diego State College was sent to the Seventh Region Conference in Phoenix this year for the annual student papers contest. He was awarded $50.00 as our local winner.

During the year, the Professional Group on Space Electronics & Telemetry was added to our already existing Professional Group Chapters on Audio, Microwave Theory & Techniques and Antennas & Propagation, Military Electronics, and Bio-Medical Electronics.

The WESCON Board held its first meeting of the year in San Diego and this Section is delighted to be able to participate by having its current chairman and two past chairmen taking active committee roles in the 1961 WESCON.

—DAVID G. DEHAAS, CHAIRMAN
SAN DIEGO SECTION

regional roundup

THE SAN FRANCISCO YEAR

The San Francisco Section has been functioning now for a year under new bylaws in which the Section executive committee, including PG chairmen and

(Continued on page 44)

1959 seventh region achievement

ALLEN M. PETERSON

Dr. Allen Peterson, manager of the communications and propagation laboratory at Stanford Research Institute, Menlo Park, and associate professor of electrical engineering at Stanford University, was the recipient of the 7th Region Achievement Award in 1959. It was presented for leadership in basic electronic-physics research in support of the national defense program.

An internationally recognized authority in radio-wave propagation, he headed a program in upper-atmospheric study by radio-sounding techniques in conjunction with the recent IGY, made numerous scientific contributions to the discovery and interpretation of propagation phenomena; including the discovery of the ground backscatter of radio signals and meteor-burst communications, conducted research in radio propagation in auroral zones, and studied the propagation effects of nuclear explosions.

Peterson received his BS, his MS, and his PhD degrees in electrical engineering from Stanford University. Within the Institute he is active in PGAP, PGEC, and PGIT. He holds memberships in the Scientific Research Society of America, Sigma Xi, the Society for Industrial and Applied Mathematics, Union Radio Scientifique Internationale, Commission III of the U.S. Committee of URSI, and the National Science Foundation panel reviewing aurora and ionospheric research.

MORE PROGRAM (WED.)

test condition is described. Results of the program will be described.

Use of the Weibull distribution to describe the relationships of failure percentage, junction temperature, and voltage is shown to be valuable in understanding the results of the "matrix" study. Its use has provided a basis for study of such effects as screening and aging on the varying acceleration factors experienced during the test program.

16/3 KEWB — A RADIATION BURST TEST FACILITY

W. M. Haussler, Atomics International, Canoga Park, Calif.

It is now a well established fact that brief pulses of intense radiation, such as those produced during a nuclear detonation, can disable or cause serious malfunction of most electronic systems even though they are located outside the thermal and shock destruction zones. This fact has given rise to the need for a device which can simulate the radiation environment accompanying a nuclear detonation. Coincidental with the evolution of this need, a family of nuclear reactors has been demonstrated as being capable of producing radiation bursts which, in all important respects, adequately simulate a nuclear weapon. These devices offer additional advantages over field tests involving actual detonation in that they may be operated on a routine repetitive basis at a much reduced cost and under carefully controlled laboratory conditions.

The kinetic experiments on water boiler (KEWB) reactor has a demonstrated ability to perform in the capacity of a weapon simulator. The reactor is of the aqeous homogenous type and produces the shortest duration pulse of any of the thermal neutron reactors operating today. Radiation pulses of varying widths down to 3.0 milliseconds can be obtained with the assembly together with peak neutron and gamma intensities of 3×10^{16} neutrons/cm^2-sec and 3×10^{3} R/sec respectively. Equipment occupying several cubic feet can be located in the immediate vicinity of the reactor core and exposed to these intense radiations.

Sponsored by Professional Group on Reliability and Quality Control

Chairman and Organizer: R. A. Davis, Palo Alto, Calif.

SESSION 17

INDUSTRIAL ELECTRONICS

Room B—2:00 P.M.-4:30 P.M.

17/1 A DIGITAL CONTROL SYSTEM FOR REFINED OIL BLENDING

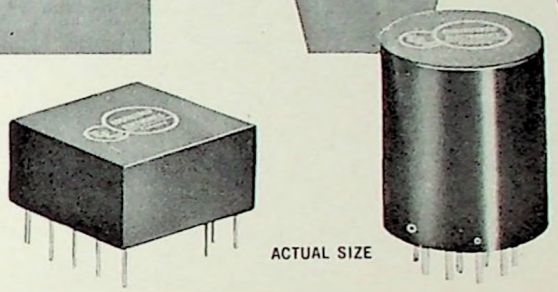
C. A. Hill, Packard Bell Computer Corp., Los Angeles, Calif.

A digital electronic system is described which controls the flow of many fluids in an n-line manner, thus producing an accurately controlled final blend. The control system consists of a series of small, identical special purpose logic units, each of which accepts a pulse rate proportional to the rate of flow of one blend component and generates the appropriate control valve setting by comparing the component pulse rate with a pulse rate proportional to the desired final blend rate.

Turbine type flow meters are convenient for use with a digital system since their output consists of pulses, each one representing the flow of a known volume of fluid through the meter. The meter output is standardized, ratioed according to blend component percentage and compared quantitatively in a differential summer with the output of a variable frequency blend-rate control oscillator. Contents of the differential summer are decoded and converted to an analog signal which positions a control valve in the blend component feed line. The complete electronic-hydraulic system is a closed servo loop which continuously corrects the control

(Continued on page 44)

NEW



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That's how simple it can be when EECO's new U-Series Digital NOR-Circuit modules are used. Engineering time can be spent designing systems, because EECO has taken care of circuit details. The first units of this new family of compatible germanium transistor circuit modules operate over the frequency range of 0 to 25 kcs. These units are designed to meet the requirements of MIL-STD-202B, as modified by temperature specifications of individual units.

PACKAGING

Two packaging styles are available. Both use all-welded electrical connections and both are encapsulated. Rectangular units with wire leads (to simplify dip-soldering) are available for installation on circuit cards. Cylindrical units with pins are available for installation in tube-type sockets. This latter package is admirably suited for system breadboarding. System wiring can be accomplished at the sockets; modifications in system design can be performed easily and rapidly. The cylindrical packages measure ⅞" diameter by 1.0" seated height. The rectangular packages measure 0.95" long by 0.95" wide by 0.5" seated height.

Write, wire, or phone today for detailed information on the EECO U-Series of NOR units or for information on any of our other families of digital circuit modules.

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MORE SAN FRANCISCO

all standing committee chairmen, meets only three times a year to consider policy matters and the budget. Normal problems of operating the Section are handled by the smaller operating committee. Former IRE President Ronald L. McFarlan met with the operating committee on December 8, and IRE President Lloyd V. Berkner met with the executive committee on February 6.

Operating committee members for the past year included the following: Donald A. Dunn, chairman; Stanley F. Kaisel, vice chairman; Peter D. Lacy, secretary; Charles Susskind, treasurer; Victor B. Corey, junior past chairman; C. W. Carnahan, 7th Region director; Bernard M. Oliver, director-at-large; E. Finley Carter, director-at-large; Albert J. Morris, Section-WESCON director; and John V. N. Granger, Section-WESCON director.

There are a number of standing committees in the present Section organization. These were chaired by the following members of the executive committee: Henry W. Schroeder, arrangements; Stanley E. Webber, awards; Earl J. Shelton, education; Earl G. Goddard, historical; Frank K. Inami, membership; Peter N. Sherrill, publications.

In addition, the Section administration includes a PG coordinator, Frank Mansur, and a delegate to the San Francisco Engineering Council, Harry H. Smith. The executive committee includes chairmen of the East Bay Subsection and 18 PG chapters. There were two new PGs added to the Section this year, Radio Frequency Interference and Information Theory.

Total PG meetings this year were 109 plus 5 subsection meetings with a total attendance in excess of 5,000. There are four PGs in the Section with over 450 members: Circuit Theory, Electron Devices, Electronic Computers, and Microwave Theory and Techniques. The student chapters now number six with the addition of Heald College this year.

Six outstanding papers won awards at the annual joint AIEE-IRE student papers contest. In addition, four outstanding high school students were selected from exhibitors at the Bay Area Science Fair and sent, along with their teachers, as representatives of the San Francisco Section to participate in the Future Engineers Show at WESCON in Los Angeles.

A special report to the Section was prepared by an ad-hoc committee on professional engineering legislation consisting of A. E. Siegman and J. S. McCullough. Their report appeared in the March 1961 **Grid** and may be of interest to other sections. A detailed review of IRE relations with other engineering societies and possible state legislation affecting IRE members as engineers was prepared for the information of Section members. This is a topic that comes up regularly, and about which the facts are often unclear.

—DONALD A. DUNN

1960 seventh region achievement

EBERHARDT RECHTIN

Dr. Rechtin, one of the relatively early participants in the U.S. missile and space programs, joined the Jet Propulsion Laboratory with a PhD from Cal Tech some ten years ago, and received the 7th Region Achievement Award last year for research in communications systems and leadership in setting up deep-space communications stations.

Responsible for direction of the JPL effort in space communications since its inception five years ago, he has been a specialist in range instrumentation, missile radio guidance, information and filter theory, secure communications, and extreme-range communications.

He is a Senior Member of the Institute, of Sigma Xi, and of Tau Beta Pi. He is a chairman of the avionics panel of the NATO advisory group on aeronautical research and development.

MORE PROGRAM (WED.)

valve setting to maintain the differential summer at center position.

17/2 RADIOGRAPHY OF LARGE MISSILES WITH A LINEAR ELECTRON ACCELERATOR

J. Haimson, Varian Associates, Palo Alto, Calif.

A major contribution toward insuring successful performance and safety of solid propellant missiles such as the Polaris, Skybolt, and Minuteman is the early detection of defects which may exist either at a depth within the propellant or at the bond between the casing liner and the fuel. Absence of flaws is of the utmost importance if a consistent burning rate and accurate flight trajectory are to be assured. Furthermore, it is necessary to detect even the smallest discontinuity in order to evaluate its influence upon the performance of a missile and to permit useful statistical data to be compiled from which minimal inspection specifications can be prepared.

The missile industry's increasing demand for extreme sensitivity of flaw detection on a production basis required a new type of x-ray equipment with a capability heretofore unavailable. The main requirements for high energy radiographic inspection of large solid-propellant missiles include:

(1) Suitable choice of radiation energy to provide a compromise between minimum absorption, useful field cone size, and film unsharpness,

(2) A source size of small dimensions to insure good resolution,

(3) An intense x-ray output so that exposure times may be relatively short,

(4) A flexible system that can be easily maneuvered within the confines of a radiation cell.

A brief description of the characteristics of high energy x-rays is given in this paper to establish their relationship with the above requirements. The radiographic linear electron accelerator is shown to meet these requirements, and some comparisons are made with previously available high energy equipment. Some theory and details of a specific radiographic linac are described, together with several special features that extend the versatility of this equipment.

17/3 THE UNIVERSAL DIGITAL TRANSDUCER

A. Blaustein, Dejur Amsco Corp., Long Island City, N. Y.

The development and production of sensors and transducers for direct utilization with digital computers has not kept pace with the phenomenal progress of the digital computer industry. The bridging of this gap has been accomplished by the development of a unique solid-state converter which digitizes the analog output of resistive, inductive and capacitive sensing elements. The end result is a miniature self contained universal digital transducer package consisting of sensor and converter. The converter output signal is digital and can be fed directly to electronic counters and digital computers.

The principles of operation, the compatible sensors, the various outputs attainable, the general performance characteristics, as well as many important application areas are described and discussed in detail in the subject paper.

Sponsored by Professional Group on Industrial Electronics

Chairman and Organizer: Robert De Liban, Barrett Electronics Corp., Menlo Park, Calif.

SESSION 18

NAVIGATION AND AIR TRAFFIC CONTROL

Room C—2:00 P.M.-4:30 P.M.

18/1 SELF-ADAPTIVE FLIGHT CONTROL THROUGH FREQUENCY REGULATION

R. G. Buscher, K. B. Haefner and M. F. Marx, General Electric Co., Schnectady, N. Y.

(Continued on page 46)

New multi-purpose

BROADBAND FERRITE AM MODULATOR

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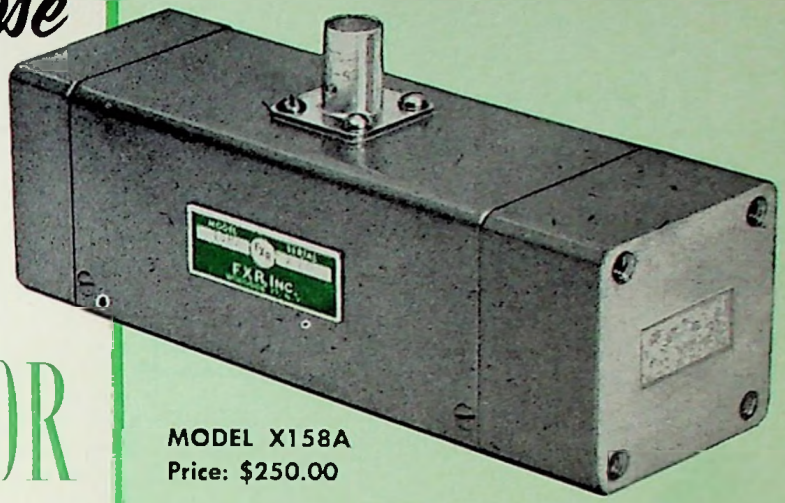

MODEL X158A
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FXR's new X158A broadband ferrite modulator is the first absorption amplitude modulator to provide full coverage of X-band, 8.2 to 12.4 Gc. A primary use of this unit is to provide a clean AM microwave signal for high accuracy measurements. Previously any attempt to modulate a microwave oscillator left much to be desired because of error-producing FM, jitter and double moding.

The modulator coil of the X158A has been designed so that any standard, 1 watt, commercial audio oscillator will provide substantially 100% modulation at 1,000 cps.

- Covers entire X-band, 8.2 to 12.4 Gc
- Metallized plastic construction for high frequency audio response
- Low driving power required
- 30 db minimum dynamic attenuation
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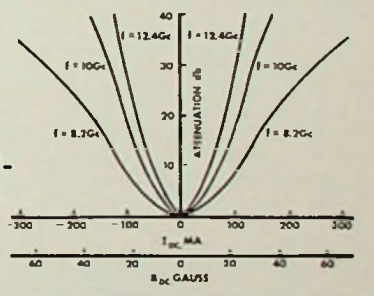

APPLICATIONS

Microwave Measurements
As an amplitude modulator for high accuracy microwave measurements

Microwave Transmitter Modulation
With proper biasing of the control solenoid low distortion modulation is obtained over the audio range

Fast Microwave Switching
For front panel or remote switching of signal generators and other low power units

Electrically Controlled Microwave Attenuation
For electrically controlled microwave attenuation of system energy from either remote or local positions

SPECIFICATIONS FOR MODEL X158A FERRITE MODULATOR

Freq. range: 8.2 to 12.4 Gc
Max. insert loss: 1.0 db
Min. dynamic attenuation: 30 db
Max. input and output VSWR: 1.20
Max. average RF input power: 2 watts
Coil characteristics: 35 millihenries 55 ohms @ 1 kc
Max. solenoid current: 300 ma DC
Insertion length: 5"
Cover flanges to mate with: UG-39/U
Waveguide type: WR90

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regional roundup

THE SEATTLE YEAR

The 1960-61 year was concluded June 17 with the annual field trip; this year to the Naval underwater tracking range near Keyport, Washington. The past year under the chairmanship of Dr. D. K. Reynolds of the University of Washington was a very successful one, especially from the standpoint of membership participation. A good selection of speakers brought near capacity attendance to practically all the meetings.

With two newly formed professional groups, the PGEM Chapter and the Joint Chapter of PGMTT and PGAP, Seattle now has three professional groups including PGCT.

The annual banquet, held in May, featured Dr. Shimada of the University of Washington department of electrical engineering as the speaker. The topic of Shimada's talk was "Coexistence of the Old and the New in Japan."

Charles E. Williams, an IRE member since 1915, has undertaken the formidable task of collection and preserving early IRE information and wireless artifacts from the Section area. The Seattle Section, fourth oldest in the country, dates back to the year 1915.

Chairman Reynolds will be succeeded for the 1961-62 year by Wilfred J. Siddons of Boeing Aero-Space, and Reynolds will be on the next ballot as a candidate for the position of director, IRE Region 7.

Because of the presence of the Century 21 Exposition in Seattle, the 1962 World's fair, the annual 7th Regional Conference will be held here for the second time in three years on May 23-25, 1962. Melvyn R. Paisley of Boeing Aero-Space has been appointed general chairman.

—ROBERT G. HOVE
EDITOR, SEATTLE IRE

regional roundup

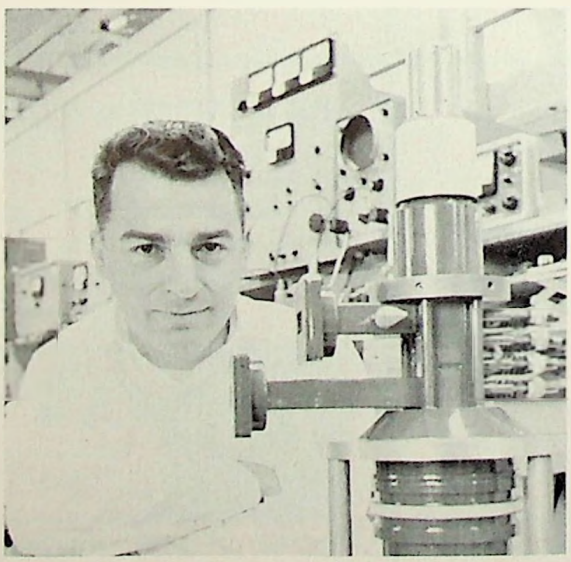
THE TUCSON YEAR

Meeting subjects during the 1960-61 period were as follows: 1) Dr. Douglas Hamilton, project engineer for the applied research laboratory at the University of Arizona, opened the season with a lecture on "Tunnel Diode Logic and Switching Circuits." 2) Dr. Lester R. Ford, Jr., of CEIR gave a lecture on "Implications of Computer Simulation to Large Scale System Design." 3) Dr. Robert E. Freese of the combat development department of USAEPG gave a lecture on "Sensitivity of Ranking to Waiting." 4) Dr. Livingston of the Kitt Peak National Observatory gave a lecture on "Television in Astronomy." 5) Harry C. Knowles of Motorola, Phoenix, gave a lecture on "Epitaxial Mesa Transistors." 6) A. Schnapf of RCA, Camden, gave a lecture on "The Performance of Tiros I." 7) C. W. Carnahan, director of central research at Varian Associates, and director, 7th Region IRE, gave a lecture

(Continued on page 48)

1961 seventh region achievement

DR. LOUIS T. ZITELLI



Current accomplishment within the Seventh Region is being recognized this year by presentation at WESCON 1961 of the Seventh Region Electronic Achievement Award to Dr. Louis T. Zitelli, manager of klystron development at Varian Associates, Palo Alto. Zitelli's citation is "for achieving a major breakthrough in the accomplishment of high power in the microwave range."

A native of San Jose, Zitelli was educated at San Jose State College and Stanford University where he received his PhD in 1950. He joined Varian Associates in that year and has since been engaged in theoretical and development work on high-power pulsed and c-w klystron amplifiers. He is a member of the Institute and of Sigma Xi.

MORE PROGRAM (WED.)

A two-axis self-adaptive control system has been designed and been flight tested in a jet airplane under sponsorship of the United States Navy bureau of naval weapons. This paper deals with the description of the system concept, design of the frequency sensor, and the flight test results of this program.

The system design objectives are presented. The feedback configuration enabling adaptive control and the manner of gain changing is discussed using root locus techniques. System behavior in the presence of actuator and aerodynamic non-linearities is described. The effects of sensor characteristics and aircraft elasticity on the dynamic response are included. System tie-in characteristics are presented to indicate integration of this type system with the pilots controls, and the guidance sections of the complete avionics package.

The problems associated with monitoring one oscillatory mode of a multi-mode system are discussed. The statistical nature of the signals and the feasibility of utilizing them are covered. The use of filters to alter the statistical character and allow the sensing of the desired mode is discussed. Discussion of some sensing methods uch as lead-lag networks, quadratic filters and phase measurements is included. The particular sensing method chosen for the program employed a period measurement of the monitored mode. The device mechanized to perform this period measurement in the system during the flight test program is described.

Following the system conception and the computer analysis, the next logical step in evaluating the General Electric self-adaptive control was to conduct a flight test on a high performance vehicle. The mechanization and installation of the system prototype is discussed along with a short description of the instrumentation and test procedures employed in the flight test program. Typical flight test data are presented, and a resume of pilot evaluation is given.

18/2 A PICTORIAL NAVIGATION SITUATION DISPLAY

E. S. Guttmann, Gilfillan Bros., Los Angeles, Calif.

A new small lightweight airborne map-projection display device is described, which provides a pilot with pictorial readout of latitude-longitude position coordinates obtained from standard navigation computers such as AN/ASN-7. The new device, AN/APA-115, provides internal micromap storage of a jet navigation chart of the entire continental United States, plus 90 radio facility charts and approach plates, emergency data, and indexes. Any of the stored fields may be selected readily by the pilot; in the automatic mode the map is shown in normal jet navigation chart scale (or at 3 times this scale), moving according to navigational position behind a centered aircraft image which rotates to depict aircraft heading. All stored information is carried in the form of a cylindrical micromap electromechanically servoed axially for latitude and rotationally for longitude. The optical projection system is enclosed by the drum. Several possibilities for future expansion of the device are suggested, including radio facility inputs and superposition of radar video on the map image.

18/3 AIR TRAFFIC CONTROL COLOR FILM

M. G. Ettinghaff and P. D. Strosnider, Librascope Division, General Precision, Inc., Glendale, Calif.

The need for a modern, electronic, high-speed data processing system for handling air traffic control functions has intensified in recent years. Librascope Division, General Precision, Inc., in cooperation with the Federal Aviation Agency (FAA), has built an electronic data processor called the central data processor, which is stated to become the cornerstone of semi-automatic air

(Continued on page 48)

7th Region IRE Fellow Lee de Forest, father of the electronic industry, died June 30, 1961 at his home in Hollywood. A small part of our great debt for the pioneer work on the triode half a century ago in Palo Alto is acknowledged by the titles of both the **Grid-Bulletin** and the **Grid**.

wescon features

LADIES' DAYS

Cultural and entertainment attractions of San Francisco will figure in the program arranged for the several thousand women expected in the Golden Gate City during the Western Electronic Show and Convention.

Activities will be concentrated in downtown San Francisco, providing a sampling of the fashionable social life for which the city is noted. The schedule will include:

Registration starting at 9 a.m. on Tuesday, August 22, in the California Room of the Fairmont Hotel, hostess lounge for the week.

A reception and exhibition at the San Francisco Museum of Art in Civic Center, starting at 2:30 p.m. on Tuesday, the 22nd. George D. Culler, director, will discuss a special display.

On Wednesday, the 23rd, there will be a luncheon in the Colonial Room of the St. Francis Hotel at Union Square, to be followed by a special performance by the San Francisco Actor's Workshop repertory company at the Marines' Memorial Theater.

Thursday, August 24, will offer a luncheon and fashion show in the Garden Court of the Sheraton-Palace.

On Friday, the concluding day of WESCON, the women will have an opportunity to see the trade exhibition at the Cow Palace. For the first time since WESCON's formation, wives will be welcomed to examine the hundreds of booths—1180 of them this year—and industrial products that engross their husbands during the annual WESCONs. Transportation to the Cow Palace will be provided and a Continental Breakfast will be served there before the guided tours begin.

Whinnery *Noble*

7th Region IRE Fellows: J. R. Whinnery, dean of the college of engineering, University of California, Berkeley; D. E. Noble, executive vice president, Motorola, Inc., Phoenix; Joseph M. Pettit, dean of engineering, Stanford; Frank R. Norton, project manager of Minuteman launch-control system, Space Technology Laboratories, Inc., Northridge, Calif.

Pettit *Norton*

Wolcott *North*

7th Region IRE Fellows: C. Frederick Wolcott, technical director, Gilfillan Brothers, Los Angeles; Harper Q. North, president, Pacific Semiconductors, Inc., Culver City; Bertram A. Trevor, technical administrator, RCA, Tucson; S. E. Webber, section manager of General Electric microwave laboratory, Palo Alto

Trevor *Webber*

MORE PROGRAM (WED.)

environment limits for long thermal exposures and very short high-temperature shocks.

c) The influence of forced air convection upon the temperature rise of the connector. Power transmitted by the connector can be increased whenever a forced air thermal environment is contemplated.

d) Comparative analysis of connector capabilities, under normal operation and in a thermal environment. Compared are connectors complying to MIL-C-26500A(USAF) versus connectors complying to MIL-C-26482(ASG) and MIL-C-5015D. The outstanding operating features and reliability upgrading of the MIL-C-26500A (USAF) are discussed.

e) An empirical method is reported whereby connector thermal characteristics may be predicted. This method is especially useful for calculating the temperature rise or the operating ambient temperature of a connector when various current combinations are applied to a given unit.

20/2 SEMICONDUCTORS IN A HYPER-NUCLEAR ENVIRONMENT

L. B. Gardner and A. B. Kaufman, Litton Systems, Inc., Woodland Hills, Calif.

The operating characteristics of several different types of transistors and diodes have been examined during their exposure to a hyper-nuclear environment. These devices were selected on the basis of high alpha cut-off frequency, small base width, and low resistivity. They included both silicon and germanium npn and pnp types. The hyper-nuclear environment consisted of a fast neutron exposure in excess of 10^{14} n/cm^2 above an energy of 2.9 mev accompanied by a gamma exposure in excess of 10^{11} ergs/gm(C). This total integrated exposure was accumulated during 100 hours in the gtr (ground test reactor facility). The purpose of this test was to find semiconductor devices that would be suitable for application within a servo-amplifier used as part of Litton's ngl inertial guidance platform. As such, the characteristics that were of interest were the d-c and a-c beta at 400 cps and low collector currents as a function of exposure to the nuclear environment. These parameters were measured during irradiation. Additionally measured were the V_{be} versus I_b characteristic curves both before and after irradiation. The diode characteristics of interest were the forward and revese voltage drops at currents less than 1 ma. As a result of these irradiations, a germanium transistor and a silicon diode were found that would exhibit satisfactory operating characteristics after their exposure to the nuclear environment. This paper will discuss all of the seminconductors tested and their observed characteristics before, during, and after irradiation. Specific part numbers and manufacturers will be delineated. This work was sponsored by the U.S. Air Force as part of contract AF33(600)-41452, radiation-resistant-no-gimbal-lock inertial-guidance platform.

20/3 TRANSIENT RADIATION EFFECTS IN CAPACITORS AND DIELECTRIC MATERIALS

H. W. Wicklein and R. H. Dickhaut, Boeing Airplane Co., Seattle, Wash.

Measurements of dielectric leakage, capacitance, electric strength, and charge scattering phenomena have been performed at the Kukla and Godiva III critical assemblies for tantalum and aluminum electrolytic, wax- and oil-impregnated paper, Mylar, mica, and ceramic capacitors, and for Mylar and Vitamin Q-impregnated paper. Leakage data indicate that gamma-induced conductivity in capacitor dielectric varies directly with $\gamma\Delta$, where γ is the gamma radiation rate and Δ is 0.9 for Mylar, 0.7 for Vitamin Q-impregnated paper, and approximately 1.0 for the other dielectrics. A small portion of the tantalum oxide conductivity induced by gamma radiation

(Continued on page 52)

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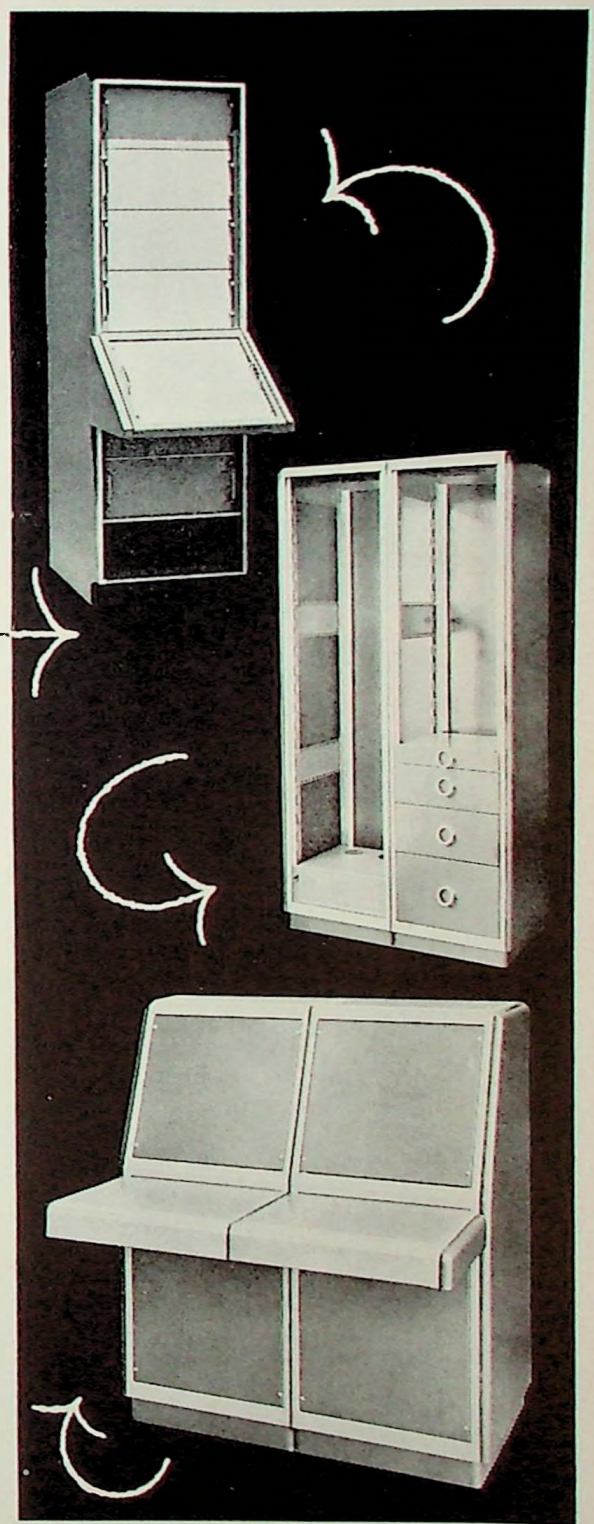

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MORE PROGRAM (WED.-THURS.)

exhibits a recovery time of approximately 150 μsec. Transient capacitance changes due to radiation are non-existent within ±0.1 percent for mica and Vitamin Q capacitors. Transient charging of tantalum capacitors was noted during irradiation with no applied voltage. No drastic changes in electric strength were noted during irradiation of Mylar and Vitamin Q-impregnated paper.

Results will be compared with a summary of data collected by other investigators. The use of test data in parametric form as a tool for predicting transient radiation effects will be discussed.

Sponsored by Professional Group on Component Parts

Chairman and Organizer: L. S. Shuey, Sprague Electric Co., Los Angeles, Calif

— — — — —

SPECIAL SESSION
ARMS CONTROL

California Masonic Memorial Temple
1111 California Ave., San Francisco
8:00 P.M.-10:00 P.M.

Recognizing the wide-spread interest and concern with the problem, WESCON plans an evening session at which a group of specially-qualified individuals from government and the scientific community will discuss the background, current status and future implications of the arms control effort, with particular emphasis on the implications for research and development.

Chairman: L. C. Van Atta, Special Assistant for Arms Control, Office of the Director of Defense, Research and Engineering, Washington 25, D. C.

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(Continued on page 54)

Lindsay

Royden

7th Region IRE Fellows: William W. Lindsay, Jr., consulting engineer, Los Angeles; George T. Royden, retired, Phoenix; Theodore Moreno, manager of research and development, tube division, Varian Associates, Palo Alto; Donald B. Harris, senior executive engineer, engineering research division, Stanford Research Institute, Menlo Park

Moreno

Harris

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MORE PROGRAM (THURS.)

SESSION 21

POINT-TO-POINT COMMUNICATIONS VIA SATELLITE RELAYS

Thursday, August 24

Room A—10:00 A.M.-12:30 P.M.

21/1 TWELVE ADVANTAGES OF STATIONARY SATELLITE SYSTEMS FOR POINT-TO-POINT COMMUNICATIONS

S. G. Lutz, Hughes Research Laboratories, Malibu, Calif.

With the exception of those systems that are intended to satisfy special military requirements, passive satellite communication systems will not be economically competitive with high-capacity, active satellite systems because of greater terminal costs. There are twelve reasons why stationary-orbit systems should become the backbone of future global communications, and these are discussed in detail. Seven of these are based on economic and system advantages, while the remaining five arise from interference coordination advantages in frequency sharing among satellite systems and with surface services. Stationary satellites present space technology and propagation delay problems, but these are rapidly being overcome. It is therefore recommended that more planning and regulatory emphasis be focused on stationary satellite communication systems, since nonstationary, nonmilitary systems will only be interim or supplementary systems.

21/2 TECHNIQUES FOR INCOHERENT SCATTER COMMUNICATION

D. P. Harris, Lockheed Missiles and Space Division, Palo Alto, Calif.

Communication circuits involving orbital reflecting chaff or scattering from electrons in the upper ionosphere (exospheric scatter) result in large differential doppler frequency spreading of the received signals. In many cases the distortion and rapid fading of these signals call for communication techniques unlike those of conventional practice. Performance calculations and curves are presented for a communication technique appropriate for such circuits. A straightforward procedure for near-optimum system design is described and a simplified method of making approximate performance calculations is developed. The relative performance of some other techniques applicable to such circuits is considered. The results are also compared with those normally achievable by means of more conventional techniques on propagation circuits that are free from selective fading and doppler spreading.

21/3 THE OPERATIONAL ANALYSIS OF A NEW YORK-LONDON COMMUNICATIONS SATTELITE LINK BY MACHINE CALCULATION

W. Williams, Jr., and L. K. Arquette, Bendix Systems Division, Ann Arbor, Mich.

This paper will present the results of an IBM-704 study of the permissible transmission times of a wideband active earth satellite designed to link New York City and London. In addition to visibility times, eclipse times have been calculated and those times during which the two cities are unfavorably located in the satellite antenna gain pattern have been determined for the two cases of a solar oriented and a spin stabilized vehicle. The satellite is presumed to traverse an elliptical ($e \sim 0.25$), inclined ($i \sim 45°$) orbit with a period of nearly three hours (158.6 minutes) which, because of its proximity to the nonspherical earth, requires the inclusion of the secular advance of the apsidal line and the secular regression of the nodal line in the orbital calculation. Several launch dates and times have been employed to initiate these operational analyses such that the longer permissible (satellite not in eclipse, mutually visible to New York City and London, which are not in an antenna "null") transmission times occur a month and a half after injection.

Sponsored by Professional Group on Communications Systems

Chairman and Organizer: General J. D. O'Connell, General Telephone & Electronics Laboratories, Inc., Menlo Park, Calif.

SESSION 22

CIRCUIT DESIGN FOR EXTENDING PERFORMANCE

Room B—10:00 A.M.-12:30 P.M.

22/1 STABLE LOW-NOISE TUNNEL DIODE FREQUENCY CONVERTERS

F. Sterzer and A. Presser, RCA, Princeton, N.J.

A tunnel diode down converter (f_{in} = 780 mc, f_{osc} = 810 mc, f_{if} = 30 mc) that is stable with input vswr's exceeding 10:1 varied through all phases will be described. A complete receiver consisting of the converter followed by a 30 mc i-f amplifier with 1.4 db noise figure, has a double side-band system noise figure of 3.8 db. Passive circuit losses in front of the converter account for 0.5 db. These losses are due to the local oscillator input circuit, a d-c block and the i-f output circuit, and can, in principle at least, be eliminated by careful design. The converter itself has a noise figure of 2.5 db and a conversion gain of unity.

22/2 THEORY AND DESIGN OF WIDE BAND PARAMETRIC CONVERTERS

E. S. Kuh, University of California, Berkeley, Calif.

The paper treats the parametric converter from the circuit-theory point of view. A linear time varying capacitance is imbedded in an arbitrary linear passive and time-invariant network. First,

(Continued on page 56)

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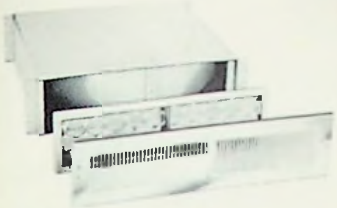

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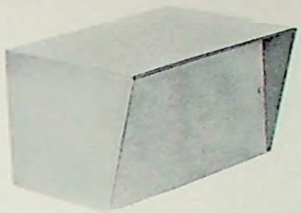

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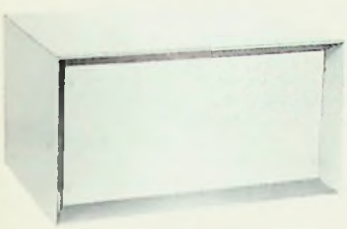
Bud Cowl-Type Miniboxes have a projecting cover which reduces glare from overhead lighting. It also provides protection for controls and dials. Cover has two box braces to which the bottom is attached by means of sheet metal screws. When assembled, this type of construction results in a sturdy, rigid housing. The unit may be table mounted or hung from a wall. Fabricated of .040 aluminum and furnished natural or with light gray hammertone finish. Four sizes available.



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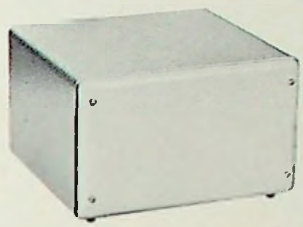

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This Bud Utility Cabinet is a very practical housing with symmetry and strength. The rounded contour corners as well as the flanged panels combine to preserve the eye-catching design. All parts are fabricated from 20 gauge steel to provide strength and rigidity. Both front and rear panels are removable, the front panel being solid while the rear panel is louvred to provide ventilation. The body is finished in smooth dark gray enamel and the panels in light gray enamel. Four rubber feet supplied. Six sizes available.

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MORE PROGRAM (THURS.)

we review the steady state analysis of such a circuit. The formula for transducer power gain is next derived. Based on the formula, the maximum gain-bandwidth product is studied using Bode's relationship.

We prove that for the non-inverting type parametric converters, the optimum transducer power gain is that of Manley Rowe, i.e., ω'/ω. The maximum percentage bandwidth is given by $(C_1/C_o)(\omega'_o/\omega_o)(1/2)$. Simple coupling circuits which approach the optimum situations are presented along with typical design examples.

22/3 AN ANALYSIS OF THE MODES OF OPERATION OF A SIMPLE TRANSISTOR OSCILLATOR

J. F. Gibbons, Stanford University, Stanford, Calif.

A simple transistor oscillator circuit is analyzed in an illuminating way. The analysis predicts oscillation in either of two modes and provides a means of determining the maximum frequency of oscillation in each. The two modes are identified as "three-terminal" or "two-terminal" according to whether r-f current is required in the base lead to produce the oscillations. In the three-terminal mode, the circuit will oscillate up to a frequency

$$f = \sqrt{(f_a/n)/(8\pi r'_b C_c)}$$

where $1 \leqslant n \leqslant 3$ depending on the type of transistor employed. Oscillations in the two-terminal mode at higher frequencies than this are predicted by the analysis and have been observed.

Sponsored by Professional Group on Circuit Theory

Chairman and Organizer: Victor H. Grinich, Fairchild Semiconductor Co., Palo Alto

SESSION 23
NANOSECOND TECHNIQUES

Room C—10:00 A.M.-12:30 P.M.

23/1 NANOSECOND PULSE MEASUREMENTS

C. N. Winningstad, Tektronix Co., Beaverton, Ore.

Transmission line methods are used to analyze nanosecond circuits, with emphasis on the first-order quantitization of circuit parameters. Other considerations discussed: Current and voltage sources for signal injection, probes for voltage and current measurements, and the nongaussian response of transmission lines. The foregoing are used in a discussion of millipicojoule triggering, special jigs used to measure switching times of semiconductor devices, and distributed-deflection and sampling-type oscilloscopes.

23/2 A TRIGGERED NANOSECOND PULSED LIGHT SOURCE

T. G. Innes and Q. A. Kerns, University of California Radiation Laboratory, Berkeley, Calif.

A small light-source capable of generating pulses of light less than 2 nanoseconds in length has been developed to simulate nuclear events.

The techniques to measure the light pulse shape and photon emission are given along with the results. Descriptions of the electrical pulse generator and distribution networks necessary to use the light source are given.

23/3 ANALYSIS AND MEASUREMENT OF PHASE CHARACTERISTICS IN MICROWAVE SYSTEMS

P. Lacy, Wiltron Co., Palo Alto, Calif.

Phase characteristics play an important role in many new microwave systems involving steerable antenna arrays, interferometry, monopulse reception, pulse compression and nanosecond pulses. This paper reviews and extends the analysis and measurement of the composite phase characteristics of groups of interconnected microwave networks that are used and must be controlled to attain full system performance. The relations between the complex transfer characteristic, location of discontinuities, and pulse response will be covered.

Sponsored by Professional Group on Instrumentation

Chairman and Organizer: Nicholas Pappas, Iconix, Inc., Palo Alto, Calif.

SESSION 24
SYSTEM DESIGN CONSIDERATIONS IN MILITARY ELECTRONICS

Room D—10:00 A.M.-12:30 P.M.

24/1 THE ROLE OF ELECTRONICS IN THE SPECTRUM CONCEPT OF MILITARY OPERATIONS

E. Deimel, Light Military Electronics Dept., General Electric Co., Utica, N. Y.

War is not confined to military action, but encompasses the spectrum of international activities from peaceful competition to mutual annihilation. Within the spectrum are economic penetration, pre-emptive buying, incitement to riot, border incidents, and brush fire wars.

Recognition of the nature of this aggression shows that countermeasures must be undertaken not only on the military front but also on a broad, closely integrated front in which all activities reflect consistent national purpose. In the current international climate, by definition, that nation which is invulnerable to retaliation has the upper hand. The role of electronic devices in military actions has been defined reasonably well; it has not, however, been clarified in assuring invulnerability in non-military, cold war encounters.

The potential applications of electronic equipment to the cold war is the primary subject of this paper.

24/2 SYSTEM DESIGN CONSIDERATIONS FOR EFFICIENT USE OF AUTOMATIC TEST EQUIPMENT

J. Roscoe, Hughes Aircraft Co., Culver City, Calif.

Extensive efforts have been undertaken, particularly by the military, to use automatic test equipment in the maintenance of complex systems. The principal reasons for utilizing automatic checkout equipment are to enhance the prime equipment reliability and to decrease the time, cost, and skill level required for maintenance. Proper inspection, coupled with good automatic test equipment can, indeed, achieve significant results in these areas. however, for maximal benefits, the prime systems must be designed for test-ability. Principles of design for test-ability and the benefits which can thereby be achieved are presented.

24/3 ON THE MEANING OF QUANTIFIED MAINTABILITY

N. J. Maroulis, Light Military Electronics Dept., General Electric Co., Utica, N. Y.

The meaning of quantified maintainability is analyzed in terms of maintenance operations on aew aircraft, missiles, and space vehicles. A brief description of maintainability mathematical models, based on probability theory, is supplied, and the assumptions underlying these models are also analyzed in terms of the maintenance operation.

The author asserts that because maintainability is an attribute of both the prime system and its associated support systems, the meaning of any maintainability "number" must be associated with a specific support system. The use of the pert/pep technique and its possible application to quantifying maintainability is also described.

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Chairman and Organizer: John Day, Granger Associates, Palo Alto, Calif.

(Continued on page 58)

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MORE PROGRAM (THURS.)

SESSION 25
COHERENT OPTICAL EMISSION

Room E—10:00 A.M.-12:30 P.M.

25/1 FUNDAMENTAL ASPECTS OF OPTICAL MASERS
J. R. Singer, University of California, Berkeley, Calif.

25/2 SOME POTENTIALITIES OF OPTICAL MASERS
B. M. Oliver, Hewlett Packard Co., Palo Alto, Calif.

25/3 THE RUBY MASER AS A LIGHT AMPLIFIER
P. P. Kisliuk and W. S. Boyle, Bell Telephone Laboratories, Murray Hill, N. J.

25/4 ALKALI VAPOR OPTICAL MASERS
H. Cummins, Columbia University, New York.

25/5 OPTICAL MASER STUDIES AT LINCOLN LABORATORY
H. A. Bostick, Lincoln Laboratories, Lexington, Mass.

25/6 REPETITIVE HAIR-TRIGGER MODE OF OPTICAL MASER OPERATION
M. L. Stitch, E. J. Woodbury, J. H. Morse, Hughes Aircraft Co., Culver City, Calif.
(no abstracts furnished)

Sponsored by Professional Groups on Electron Devices and Microwave Theory and Techniques

Chairman and Organizer: Professor J. R. Singer, University of California, Berkeley

SPECIAL SESSION
FUTURE ENGINEERS SYMPOSIUM

Room F—10:00 A.M.-12:30 P.M.

This special session will consist of a competition among the five top technical papers submitted by student exhibitors at the Future Engineers Show. The author of the paper judged best by a panel of judges will receive the Frederick Emmons Terman Award of $250.00.

Chairman: Alan B. Simpkins, Delcon Corporation, Palo Alto, Calif.

SESSION 26
SPECTRUM CONGESTION IN VEHICULAR COMMUNICATIONS

Room A—2:00 P.M.-4:30 P.M.

26/1 MULTI TRANSMITTER/RECEIVER INSTALLATION PROBLEMS AND CURES
S. Meyer, Hammarlund Mfg. Co., New York.

This paper discusses the most often encountered problems in multi receiver/transmitter land-mobile station installations.

A step-by-step checkout procedure is presented along with a list of cures proven to be most reliable yet modest in cost. The techniques recommended are useful in the 25-54 mc, 144-174 mc and 450-470 mc bands. The paper covers the use of such techniques as cavity resonators, notching receiver crystals, transmission line stubs and colinear antenna techniques.

Reference is also made to specific land-mobile systems now in service citing channel frequencies and channel spacings.

26/2 ALLOCATION OF FREQUENCIES FOR THE MOBILE RADIO SERVICE — SHOULD CHANGES BE MADE?
G. Olive, RCA, Camden, N. J.

The subject of intermodulation is discussed with emphasis on its impact on the mobile radio service. Frequency sequences capable of producing this type of interference are illustrated.

The use that has been made of digital computers to combat intermodulation interference is discussed along with the measures available for its elimination or minimization.

(Continued on page 60)

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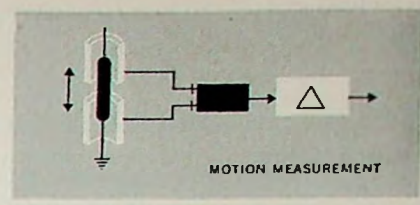

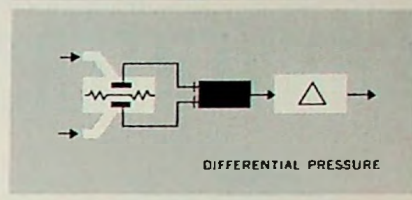

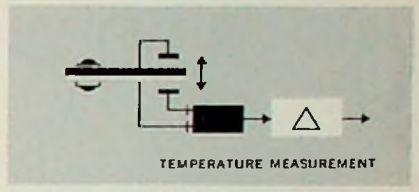

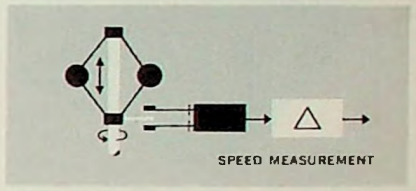

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Hutter

Fink

MORE PROGRAM (THURS.)

SESSION 28
NONLINEAR CONTROL SYSTEM THEORY

Room C—2:00 P.M.-4:30 P.M.

28/1 ON THE APPLICATION OF LYAPUNOV'S SECOND METHOD TO THE SYNTHESIS OF NONLINEAR CONTROL SYSTEMS

A. Stubberud, C. T. Leondes and M. Margolis, University of California, Los Angeles, Calif.

An approach to the design of nonlinear compensation networks is presented in this paper. The design procedure is based in Lyapunov's second method, a method of examining the stability of a set of differential equations. A Lyapunov function is formed for the control system under question, and this function is then manipulated to minimize the system settling time. A method for generating Lyapunov functions for a particular class of feedback control systems is then discussed. Finally some examples of the design procedure are presented.

The chief merits of the design procedure are: (1) the nonlinear system which is determined will not introduce instability into the system; and (2) the nonlinear differential equations of the system need not be solved, thus eliminating many of the computational difficulties associated with nonlinear design.

28/2 MATHEMATICAL ANALYSIS OF AUTOMATIC GAIN CONTROL CIRCUITS

R. C. Davis, 3817 Finecraft Drive, Claremont, Calif

A mathematical analysis of conventional single-loop and multiple-loop automatic gain control systems is presented. In contradistinction to previous linearizations a completely non-linear analysis is presented which is not restricted to small deviations in input level. We obtain in closed form the solution of the non-linear differential equation for the output envelope when the transfer function of the fixed portion of the forward path gain is unity. (This termed the bagc circuit.) Solutions to more complicated circuits are obtained either by perturbation techniques or by the maximum operation. The solution to the multiple-loop bagc circuit is obtained and is shown to be equivalent to a single-loop circuit with appropriate characteristics. For practical calculations with complicated input envelopes a generalization of Watson's lenma is used. The bagc circuit with an amplitude-modulated gaussian narrow-band carrier is analyzed using the theory of vector-valued Markoff processes. An approximate method for obtaining the probability amplitude distribution of the output envelope for "fast" and "slow" bagc circuits is developed. An approximate procedure is developed to determine the stability of a complicated agc circuit with a periodic input envelope.

28/3 DUAL MODE FILTERING OF POLYNOMIAL SIGNALS IN NOISE

L. G. Shaw, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

A procedure is presented for finding the best (minimum mean square error) filter out of a class of dual-mode (adaptive) filters when the input consists of a sample out of an ensemble of fixed order polynomials plus "almost white" noise. The discussion is based on sampled data filtering with the error being observed only at uniformly spaced sampling instants. The additive noise values at successive sampling instants are assumed to be uncorrelated. The nonlinear filters consist of two linear discrete subfilters and an input-sensitive decision element which switches between them.

The linear subfilter design procedures used here are modifications of the Zadeh-Ragazzini approach to polynomial filtering. The modification makes the resulting filters unbiased estimators over an ensemble of polynomials of a given order rather than unbiased for each polynomial of a given order.

(Continued on page 64)

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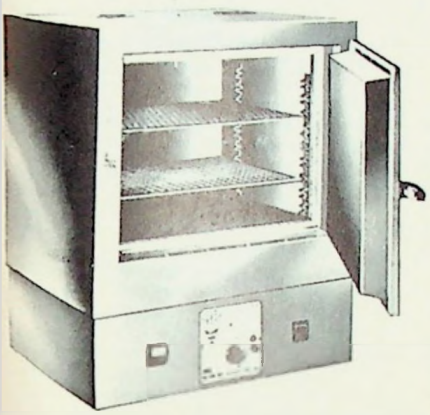

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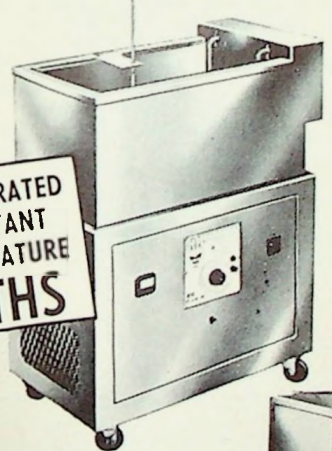

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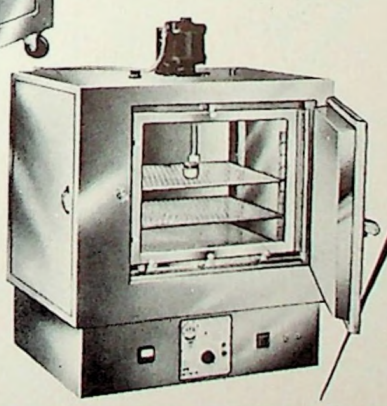

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MORE PROGRAM (THURS.)

The optimum switching problem bears significant resemblence to more standard problems in statistical detection theory. This novel arrangement of simultaneous optimization from both points of view results in transcendental equations which must be solved by trial and error. An efficient iterative procedure for searching out the solutions is presented. The best-dual mode filter is shown to be better than the best linear filter for the class of inputs under consideration.

Sponsored by Professional Group on Automatic Controls

Chairman and Organizer: Professor E. I. Jury, University of California, Berkeley

SESSION 29
SPECTRUM UTILIZATION FOR SPACE COMMUNICATIONS

Room D—2:00 P.M.-4:30 P.M.

29/1 IMPACT OF SPACE COMMUNICATION ON THE SPECTRUM

J. Hacker, Jr., General Electric Co., Santa Barbara, Calif.

Developments in technology of terrestrial communication, and of the technologically backward two-thirds of the world, along with developments in space technology, will result in increasing demands on the radio spectrum. How best to meet all of these needs is the problem of spectrum management.

Space operations generate communication requirements of their own; but space technology can help alleviate congestion in some frequency bands, by providing alternatives more efficient in spectrum utilization than present terrestrial techniques.

Early experience in sharing among space and terrestrial communication systems can help planning and regulation to obtain the greatest practicable useful communication in the radio spectrum.

29/2 INTERFERENCE CONSIDERATIONS FOR COMMUNICATIONS SATELLITES

N. Berger, J. Downing, F. Fulton and D. Harris, Lockheed Missiles and Space Division, Palo Alto, Calif.

This paper analyzes quantitatively the interference problems which can be expected to arise when communications satellites share the same frequency-allocation spectrum as is occupied by existing terrestrial point-to-point microwave relay systems. The primary objective of the study is to evaluate the feasibility of such a frequency-sharing doctrine, through establishing the conditions which must be met in order to maintain tolerably low interference levels. It is concluded that frequency-sharing between terrestrial and satellite-borne communication facilities is feasible, provided that considerable caution is observed with respect to siting the respective ground installations.

29/3 EFFICIENT MULTIPLEXING OF INTERMITTENT TRANSMITTERS

F. Fulton Jr., Lockheed Missiles and Space Division, Palo Alto, Calif.

The usual method of allocating spectrum space to various users does not take into account the extent to which the allocations are actually utilized. A model of a situation in which not all of a group of transmitters are simultaneously active is used to study the extent to which allocation procedures could theoretically take advantage of partial utilization. For this model a random coding argument shows that procedures exist that allow the group to operate satisfactorily in a bandwidth determined only by the maximum number which are simultaneously active, even though the active transmitters do not know which others of the group are also active. This performance is obtained by allowing arb-

trarily long block codes; practical restrictions on the block length make it necessary to use an excess of power, which can be supplemented by an excess of bandwidth. Significant reductions are potentially available in the bandwidth requirements of groups of intermittent transmitters, even if the transmitters use only binary signaling.

Sponsored by Professional Group on Space Electronics and Telemetry and Professional Group on Military Electronics

Chairman and Organizer: Jobe Jenkins, Lockheed Aircraft Corp., Sunnyvale, Calif.

SESSION 30
QUANTUM DEVICES

Room E—2:00 P.M.-4:30 P.M.

30/1 **DESIGN AND OPERATION OF AN EXPERIMENTAL COLIDAR**

E. J. Woodbury, J. M. Morse, R. S. Congleton, and M. L. Stitch, Hughes Aircraft Company, Culver City, Calif.

An experimental Colidar (COherent LIght Detecting And Ranging) pulsed ranging system has been successfully operated in full sunlight against noncooperative targets at ranges up to seven miles. A breadboard model embodiment of the Colidar principle which makes use of the properties of the optical maser is described. The design of suitable supplies for pused operation of flash tubes used for excitation, the effect of varying geometry associated with the single-crystal rubies, the design of transmitting and receiving optics to maximize the power on target and best make use of optical filtering and photodetectors in the receiver, and the selection of suitable electronic circuitry will be discussed by showing how each contributed to the design of the experimental Colidar. Results of some ranging experiments will be given including the effects of target reflectivity, atmospheric ab-

(Continued on page 66)

Hyland

Edson

7th Region IRE Fellows: Lawrence A. Hyland, vice president and general manager, Hughes Aircraft, Culver City; William A. Edson, director of research, Electromagnetic Technology Corp., Palo Alto; D. F. Tuttle, Jr., professor of electrical engineering, Stanford; I. J. Kaar, senior scientist, Hoffman Electronics Corp., Los Angeles

Tuttle

Kaar

Hausz

Ramo

7th Region IRE Fellows: Walter Hausz, technical military planning operation, General Electric Co., Santa Barbara; Simon Ramo, executive vice president, Thompson Ramo Wooldridge, Inc.; Nathan I. Hall, vice president of engineering, Hughes Aircraft Co.; Edward L. Ginzton, chairman of the board, Varian Associates, Palo Alto

Hall

Ginzton

MORE PROGRAM (THURS.)

sorption, and sun noise.

An experimental Colidar will be demonstrated as part of the presentation.

30/2 A SOLID STATE SPIN ECHO MEMORY SYSTEM FOR A MICROWAVE COMPUTER

L. K. Wanlass and J. R. Singer, University of California, Berkeley, Calif.

Electron spin echo was studied both experimentally and theoretically as a carrier digital computer memory system at microwave frequencies. A new method of storing the phase microwave pulses as used in phase-script information systems of the Von Neumann type is proposed and investigated in detail. A complete carrier computer regenerative memory system using two spin-echo devices and a single connecting channel will be described and considered from a theoretical standpoint.

We have carried out a general study of solid state paramagnetic crystals as spin-echo storage materials. It was found that neutron irradiated calcite crystals possess a number of desirable features, and these are considered in detail. The work includes a theoretical treatment of memory storage capacity, indicating that the storage of a single cubic-centimeter crystal should exceed 10,000 bits. Since storage capacity and regeneration times are limited by paramagnetic relaxation processes, rather detailed experimental studies of spin-spin and spin-lattice, as well as cross-relaxation times were conducted by spin-echo techniques.

The authors conducted signal-to-noise ratio measurements of spin echos at 10 kmc carrier frequency, and spurious echos as well as multiple recall are considered as noise sources for the memory system. The spin-echo method is found to present a feasible serial storage system for high-speed (microwave) computers.

30/3 THE AMMONIA BEAM MASER AS A STANDARD OF FREQUENCY

J. A. Barnes, D. W. Allan, and A. E. Wainwright, National Bureau of Standards, Boulder, Colo.

It has been suggested that an error in tuning of the resonant cavity in an ammonia beam maser could be detected by observing a frequency shift of the maser with the application of a magnetic field. Following this suggestion, an oscillatory magnetic field was applied to the NBS double-beam maser and a low-noise phase demodulator was constructed to detect any phase modulation present in the maser signal. With this equipment, a servo-loop was completed to constantly control the tuning of the maser's resonant cavity. Not only did this result in the elimination of the most critical parameter of the maser's frequency dependence, but improvement of the frequency dependence upon other parameters was also observed.

Comparison of the maser system with the national standard of frequency (cesium beam) over a period of one month showed that the maser frequency was resettable to within ± 3 parts in 10^{11} with ordinary $N^{14}H_3$ used in the maser. It also demonstrated a drift rate of less than 2 or 3 parts in 10^{12} per hour.

Since the maser's frequency is rather dependent upon geometrical alignment it is still not considered by the authors as a reliable primary standard of frequency. However, as a very low drift secondary standard of frequency the maser has much to its credit.

Sponsored by Professional Group on Microwave Theory and Techniques

Chairman and Organizer: Professor A. E. Siegman, Stanford University, Stanford

MORE PROGRAM (FRI.)

SESSION 31

PROPAGATION STUDIES FOR NEW COMMUNICATIONS TECHNIQUES

Friday, August 25

Room A—10:00 A.M.-12:30 P.M.

31/1 LABORATORY SIMULATION OF VLF PROPAGATION AND UNDERGROUND ANTENNA PERFORMANCE

T. C. Larter, M. E. Louapre and A. Stogryn, Space Electronics Corp., Glendale, Calif.

Low frequency electromagnetic wave propagation in the range from 1 to 50 kc has come under close study recently in connection with highly reliable and long range communication systems. The mode theory of propagation has proved useful for predicting signal levels at frequencies up to 20 kc. Above 20-30 kc the numerical computation of the field intensity from the mode theory becomes very difficult because of the large number of terms involved. Quantitative estimates of the field, however, can be obtained from appropriate model studies.

Thus a scaled earth-ionosphere model provides a convenient method of simulating wave propagation provided all physical factors involving lengths are reduced by the same factor. It should be emphasized that simultaneous scaling or simulations of the earth, ionosphere, and the air in between will be necessary for the study.

Theoretical studies on the model simulation principle are presented in this paper. Comparisons of the theoretical results with those obtained from the actual models fabricated in a laboratory are also presented. Materials with permittivities and conductivities suitable for scaling the earth, the air, and the ionosphere were selected and tested in a microwave bridge. A salt water tank was set up to determine the radiator pattern and to make impedance measurements. Both flat and spherical earth-ionosphere models were constructed and tested below a scaled frequency of 36 kc and at ranges up to 10,000 km.

31/2 SYNCHRONIZED-OBLIQUE IONOSPHERE SOUNDING FOR H-F OWF DETERMINATION

R. D. Baker, R. D. Egan and L. D. Seader, Granger Associates, Palo Alto, Calif.

The reliability of long-haul communications at high frequencies is critically dependent on the choice of frequency. The optimum working frequency (owf) is known to be just below the maximum usable frequency for the path, but involves also questions of received noise level, multipath, and the elevation-plane radiation patterns of the communications antennas. Reliance on long-term predictions of ionosphere conditions, such as those issued by the National Bureau of Standards, has proven to be inadequate for the performance demanded of modern high-traffic communications. This paper describes the design and application of a step-frequency ionosphere-sounder system which is capable of sampling up to 120 frequency channels in the 4 to 32 mc band in as short a time as 1.2 seconds, providing real-time display of the ionosphere modes present, and the received signal strength, noise, and intereference levels as a function of frequency. The use of such systems in communications control is discussed.

31/3 FREE ELECTRON SCATTER AS A COMMUNICATION MODE

A. M. Peterson, Stanford University, and Stanford Research Institute, Menlo Park, Calif.

Scattering of radio waves by density fluctuation of free electrons in the upper region of the ionosphere offers attractive possibilities for long-distance communications in the vhf and uhf bands. The communication capacity of this propagation mode will decrease only slowly up to distances in excess of 4,000 km. A wide range of frequencies can be used with the 100 to

(Continued on page 68)

MORE PROGRAM (FRI.)

1000 mc range being the most likely for practical application. In free electron scattering a doppler spreading occurs as a result of the thermal motion of the ions in the scattering region. The doppler spreading characteristics require the application of "incoherent" communication techniques using measurements made at different frequencies and/or arrival times corresponding to possible multipath signals. Continuous waves or low-duty-cycle pulse transmitters can both be used but will require different antennas and coding methods for most effective opeartion because of the interplay between doppler spreading and multipath time delay. It appears that an average of 100 teletype channels with a 1 in 10^4 error rate could be supported over a 4,000-km path using frequencies in the range 200 to 600 mc, if powers of 10^6 watts and antennas of 10^4 m^2 effective aperture were employed. The capacity of the circuit would vary from approximately 10 to 1000 teletype channels because of the normal variation of ionospheric electron density. Though this range of variation is large it is important to note that a useful capacity will always be present, and the communication capacity will be relatively unaffected by absorption during sid's or auroral region blackouts.

Sponsored by Professional Group on Antennas and Propagation

Chairman and Organizer: Professor Von R. Eshleman, Stanford University, Stanford

SESSION 32
SOLID STATE DEVICES II

Room B—10:00 A.M.-12:30 P.M.

32/1 P-N JUNCTION CHARGE STORAGE DIODES

J. L. Moll, Stanford University, Stanford, Calif., S. Krakauer, Hewlett-Packard Co., Palo Alto, and R. Shen, Harvard University.

The design theory for p-n junctions for a new class of applications will be described. The storage diode acts approximately as an ideal nonlinear capacitor and is useful in generation of nanosecond pulses, harmonic generation, wave shaping, etc. The diffusion capacitance of a p-n junction is used to obtain the nonlinear capacitor. Optimum design requires very large "built-in" retarding fields so that injected carriers are constrained to the region near the junction. The retarding fields are obtained by diffusing phosphorous into one face of a silicon slice and boron into the opposite face in a symmetric diffusion. The resulting impurity profile varies approximately as a hyperbolic sine function. A compromise must be made between junction capacitance, series inductance, breakdown voltage, and speed.

32/2 A NEW SEMICONDUCTOR TETRODE, THE SURFACE-POTENTIAL CONTROLLED TRANSISTOR

C. T. Sah, Fairchild Semiconductor Corp., Palo Alto, Calif.

A new transistor tetrode which has essentially infinite input resistance and very small input capacitance is disclosed in this paper. This device is designed based on the recent advances in the understanding of the controlling factors on the transistor beta (h_{FE}) at low and intermediate current levels. It has the planar transistor geometry. A thin oxide is grown on the surface covering the emitter-base junction. In addition, a field-effect electrode is formed with a metal ring which covers the oxide on the emitter-base junction surface. By varying the potential applied between the field electrode and either the emitter or the base, the beta (h_{FE}) of the transistor may be varied over as much as five orders of magnitude at low currents. Thus, the field electrode (or the gate or grid) may be used as the control electrode similar to the grid of a vacuum tube pentode or tetrode.

Theory and operating characteristics are pre-

sented and discussed. These include the transconductance (several thousand micromhos), voltage gain, magnitude of input impedance (10^{15} ohms and 1 to 100 pf) and some noise characteristics among other equivalent circuit parameters.

32/3 P-N-P DOUBLE DIFFUSED GERMANIUM SWITCH

J. Brixey and W. Jaeger, Texas Instruments, Inc., Dallas, Tex.

Double diffused pnp germanium mesa units have been built by adapting (with some novel modifications) some of the methods used routinely for silicon double-diffused units. Gallium is diffused into 0.15 Ω cm p-germanium to form the emitter. Subsequently, antimony is diffused through and beyond the emitter to form the base region. These diffusions and the subsequent assembly will be detailed.

Controlled variations in base width and overall depth to which the base is diffused and its effect on t_t in saturated switching leads to the conclusion that base transit time and/or base effectiveness (doping level and profile) exert considerable influence on t_s. Data also indicates that low switching times and high gain-band width products may be interrelated. Finally, several runs made on epitaxial-germanium and some comparisons will be made.

Sponsored by Professional Group on Electron Devices

Chairman and Organizer: Gordon Moore, Fairchild Semiconductor Corp., Palo Alto

SESSION 33
MODERN PARTICLE ACCELERATORS

Room C—10:00 A.M.-12:30 P.M.

33/1 THE R-F SYSTEMS FOR THE PRINCETON PENNSYLVANIA ACCELERATOR

D. A. Barge, J. Kirschgessner, G. K. O'Neill, G. Rees, and J. Riedel, Princeton University, Princeton, N. J.

A high-intensity 3 bev proton synchrotron is being constructed at Princeton, New Jersey, and is due to become operative in the fall of 1961. The r-f system for this accelerator is described. The repetition rate is 20 cps, resulting in a required accelerating voltage of 150 kv per turn. Acceleration is on the eighth harmonic, and occurs at four stations disposed symmetrically around the ring. The frequency range is 2.5 to 30 mc. Each accelerating station consists of a drift tube inside a double cavity. From 2.5 to 6 mc, the drift tube capacity is resonated with a ferrite inductor and accelerates the beam in much the same way as the bevatron r-f system does. When the frequency reaches 5.5 mc the double cavity is excited.

The ferrite-tuned double cavity is similar to the Brookhaven ags double cavity. Total peak r-f power generated is 500 kw. A ferrite biasing current of 12,000 amp, required to tune the cavity to 30 mc, is supplied from 25 kw audio amplifiers, employing special turns ratio switching transformers.

Drive power of 50 kw r-f is supplied to the finals from 100 mc bandwidth distributed amplifiers. Special transmission line transformers are used to match these amplifiers to their loads. The master oscillator frequency is programmed from the magnet current with an analog function generator.

33/2 BEAM CAPTURE AND ACCELERATION IN THE BROOKHAVEN ALTERNATING GRADIENT SYNCHROTRON

Martin Platkin, E. C. Raka, H. Hahn, and H. Halama, Brookhaven National Laboratory, Upton, N. Y.

The Brookhaven ags is a proton accelerator with maximum energy of 33.0 bev. Except for a short starting cycle the accelerating system is a full feedback type termed a "bootstrap" system. In this accelerator, the particle rotation

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MORE PROGRAM (FRI.)

frequency, which varies from 1.4 mc/sec to 4.5 mc/sec, is determined from the bunched beam, and is used to drive the accelerating cavities. Additional feedback is provided from a radial pickup system which corrects the r-f phase to keep the beam at the desired radius. As the relative phase relation between the frequency pickup electrode and the accelerating stations must remain essentially constant, a system was developed to compensate for the several thousand degrees of differential (with frequency) phase shift through the r-f system. This system involves multiple heterodyning and automatically cancels any quantity of linear differential phase shift.

The ability of the r-f system to bunch, capture and accelerate protons in the ags is determined to a great extent by the properties of the feedback loops of frequency and radius. Any excessive noise or fast transients lose beam; any excursion in phase beyond the correction limits, or at a faster rate than the system can follow will lose beam. The system over all and in parts, has been tested for its response to phase modulation. Polar plots of the gain and phase response to phase modulation were taken and the results were used as a basis to modify portions of the system with subsequent improvement in beam capture. Capture and acceleration efficiencies are now quite high and as each source of perturbation in the system is located and eliminated these efficiencies are approaching the theoretical maxima.

33/3 THE ZERO GRADIENT HIGH INTENSITY PROTON SYNCHROTRON

A. V. Crewe, Argonne National Laboratory, Argonne, Ill.

Construction of the 10-15 bev zero gradient proton synchrotron (zgs) at Argonne National Laboratories is proceeding approximately on schedule, with completion of the basic machine expected in the summer of 1962.

The injector of the zgs consists of a 750 kv Cockroft-Walton accelerator and a 50 mev linear accelerator. The latter is expected to produce pulse-currents of 20 milliamps for 200 microseconds. The ring magnet will be pulsed at 15 pulses per minute to a peak field of 22 kilogauss in 1 second. The field will be sustained at its peak value for 0.2 seconds and will fall to residual levels in 1 second. The expected beam intensity is 10^{12} to 10^{13} protons per pulse. The average power required to pulse the magnet is 7 megawatts; the peak power 117 megawatts. 20 megawatts of auxiliary power is planned for operation on experiments in two areas, one of which will produce an external proton beam.

Sponsored by Professional Group on Nuclear Science

Chairman and Organizer: Harry G. Heard, Radiation at Stanford, Palo Alto, Calif.

SESSION 34
CODING FOR RELIABILITY

Room D—10:00 A.M.-12:30 P.M.

34/1 ON TIME-VARYING CODING NETWORKS

A. Marcovitz, Columbia University, New York, N. Y.

The sequential generation and decoding of some error correcting codes require the use of time-varying linear modular sequential circuits. The design procedure is more complex than that for codes using fixed systems since the decoder associated with a time-varying decoder need not be the inverse of the coder. Further the coder may not possess either an inverse or a quasi-inverse.

The design procedure involves first obtaining a coder, preferably one with an inverse or quasi-inverse. (The necessary and sufficient conditions for the existence of an inverse and a quasi-inverse are given.) The inverse is then found. The coder

(Continued on page 72)

Helliwell

Herold

7th Region IRE Fellows: R. A. Helliwell, professor, Stanford; E. W. Herold, vice president of research, Varian, Palo Alto; C. F. Horne, president, General Dynamics, Pomona; Austin Eastman professor, University of Washington, Seattle

Horne

Eastman

Spangenberg

Hewlett

7th Region IRE Fellows: Karl R. Spangenberg, engineering consultant, Palo Alto; William R. Hewlett, executive vice president, Hewlett-Packard Co., Palo Alto; Harry R. Lubcke, consulting engineer, Hollywood; Walter Selsted vice president, Ampex Corp, Redwood City

Lubcke

Selsted

MORE PROGRAM (FRI.)

may be altered by making use of the options that exist in the coder design so as to obtain a simpler coder. This coder need not have the same inverse or even any inverse as long as it performs the proper coding. Then, the decoder may be modified. By iterating these procedures, simplifications of the design of the coder and decoder often result.

34/2 SEQUENTIAL DECODING FOR DISCRETE INPUT MEMORYLESS CHANNELS

B. Reiffen, Lincoln Laboratory, MIT, Lexington, Mass.

A scheme is described which sequentially encodes the output of a discrete letter source into the input symbols of a discrete input memoryless channel, with adjacent channel symbols mutually constrained over a length, n. The encoder permits desired channel input symbol probabilities to be approximated closely. Decoding at the receiver is accomplished with delay n by means of sequential tests on potential transmitted sequences with reject criteria set so that incorrect sequences are likely to be rejected at short lengths and the correct sequence is likely to be accepted. Averaged over a suitable defined ensemble of encoders, the decoding scheme has an average probability of error, with an upper limit whose logarithm approaches $-nE(R)$ for large n. $E(R)$ is dependent only on the data rate, R. For a channel symmetric at its output with equally likely inputs, the exponent $E(R)$ is optimum for rates greater than a rate called R_{crit}. For such symmetric channels, a computation cutoff rate R_{comp} is defined. For $R < R_{comp}$, the average number of decoding computations does not grow exponentially with n, but algebraically. R_{comp} is also defined for a non-degenerate channel which may be asymmetric. In this case too, the average number of decoding computations grows algebraically with n for $R < R_{comp}$.

Hershberger

Stoddart

7th Region IRE Fellows: W. D. Hershberger, professor of engineering, University of California, Berkeley; R. I. Stoddart, president, Stoddart Aircraft Radio Co., Hollywood; E. Finley Carter, president, Stanford Research Institute, Menlo Park; Richard C. Raymond, manager, technical military planning operation, General Electric, Santa Barbara

Carter

Raymond

34/3 THE RELIABILITY OF CODED AND UNCODED BINARY MESSAGES AS A FUNCTION OF THE RATE OF SYMBOL TRANSMISSION

R. D. Klein, Northeastern University, Boston, Mass.

A normalizing procedure is developed to allow the study of the relative efficiencies of binary error-correcting codes without bias due to redundancy. In this, the per-digit reliability of a given system (Slepian's q) is considered as a continuous, monotonically non-decreasing function of the positive real variable R, the rate at which symbols are transmitted over a noisy channel with fixed time-bandwidth product and average power constraints. Thus the n digits of an (n,k)-coded message are "squeezed" into the same time-bandwidth product and total energy as was occupied by the uncoded k-digit message. In this manner, a "non-redundant" coding procedure is achieved and the reliability of a coded message can be used as an unbiased measure of the efficiency of the code for the particular system studied and at the particular rate R.

Using this, it is shown that for any analytic reliability function $q^{(R)}$ and message length k, there exist (n,k) codes such that "non-redundant" coding yields an improvement in message reliability over that of the uncoded message for relatively low per-digit error rates and also for extremely high error rates. In addition, for low per-digit error rates the highest efficiencies are achieved by those codes for which

$$q_e \leq \min[(n/i),\ 2^{\,n\,-\Sigma(n/i)}]$$

Sponsored by Professional Group on Information Theory

Chairman and Organizer: Bernard Elspas, Stanford Research Institute, Menlo Park

SESSION 35

NEW TECHNIQUES TO EVALUATE PRODUCT DESIGN

Room E—10:00 A.M.-12:30 P.M.

35/1 RANK CORRELATION TESTING APPLIED TO PRODUCT DESIGN

I. R. Whiteman, C-E-I-R Inc., Los Angeles, Calif.

One of the problems associated with mass production is that of producing parts to fall within tolerance; another problem is the determination of the proper tolerance limits. It is important that the tolerance limits of the components are such that permissible variations in the components are not reflected in the output of the assemblage; it is equally important that the tolerances are not so restrictive that there are associated cost penalties.

A simple method for the determination of proper tolerance limits is through the use of a rank correlation test. Rank correlation tests require no assumptions about the distribution of tolerances. They are simple and straightforward in their application and provide a rapid assessment of permissible tolerance limits.

35/2 A SURVEY OF APPLICATIONS OF RADIOACTIVITY TO ELECTRONICS

A. J. Moses, Hazleton Nuclear Science Corp. Palo Alto, Calif.

The nature of radioactivity and its ease of detection has encouraged the use of trace quantities of radioactivity in the solution of many problems in physical and biological sciences.

The application of radioactivity to electronics has been developing more slowly, perhaps due to a lack of information to the electronics engineer.

This talk will outline very briefly the types of radiation and their detection with emphasis on particular applications to research, development and quality control in electronics.

The removal of solder flux from printed circuit boards and the removal of oil from commutators

(Continued on page 74)

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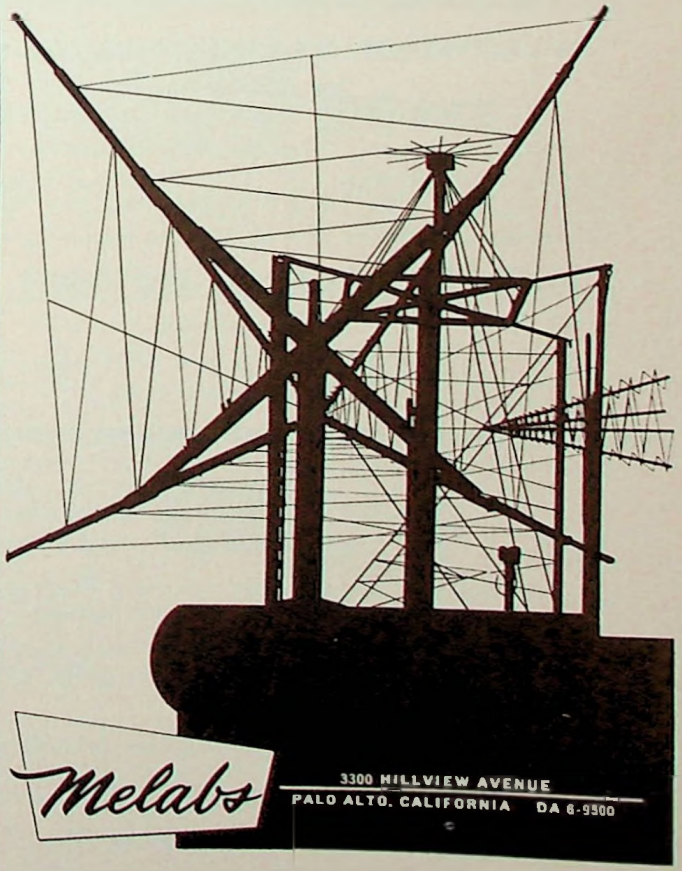

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afford typical applications of radioactive trace to the determination of the efficiency of a clean ing process.

35/3 OPTIMIZED USE OF INDUSTRIAL DESIGN TECHNIQUE

Donald J. McFarland, Latham-Tyler-Jensen, Inc Long Beach, Calif.

Industries as well as products have definit growth curves or patterns. Within the broad fiel of electronics, there are a variety of industrie all moving rapidly along their respective curves The newer the industry, the more unique th products and the fewer the competitors. Th older the industry, the more similar the product and the more the competitors. Profits and price are high in the early stages, and low in th more mature stages even though sales volum is much greater.

The same concept applies to other fields suc as consumer products. Since it is easier to loo at what has already happened than to anticipat what might happen, this paper describes indus trial design techniques in more established field and relates them to what is likely to happe in electronics. In effect, the suggestion that th "honeymoon is over" is the theme of the paper Techniques commonplace to consumer product will be more and more important as competitio grows and differences between products becom less distinct. Such factors as lightness of weight portability, appearance, simplicity of use, specia features, etc., will enhance salability. The alter native to creative product design in electronics is price competition which means reduced profits and consequently lower research budgets—and thus stagnation.

The paper further suggests that the greatest weakness in electronics is the step from the laboratory circuitry to the final products. Either unmechanical circuit engineers refuse to let go of their creation, or the product is hastily as sembled from purchased parts without a fraction of the attention paid to the electronic miracle it performs. This critical step is the very place in which the industrial designer can contribute the most. Unfortunately, most designers are called upon to do little more than superficial styling at this stage.

Examples and illustrations in both fields, con sumer and electronics, will highlight and amplify the premise of this paper. A generalized list of questions applicable to most electronic products constitute a check list to assist in optimizing product design.

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Cohn *Cady*

SESSION 36
NEW DEVELOPMENTS IN COMMUNICATIONS SYSTEMS

Room A—2:00 P.M.-4:30 P.M.

36/1 THE HC-270 — A FOUR PHASE DIGITAL DATA TRANSCEIVER

J. E. Toffler and J. N. Buterbaugh, Hughes Communications Division, Los Angeles, Calif.

The Hughes HC-270 digital data transceiver is o be announced at the Fifth National Symposium on Global Communications.* This GlobeCom introductory paper deals with wireline transmission facilities, a comparison of representative transmission techniques, a brief description of the HC-270 system operation, and the basic reasons for selecting a differentially coherent, four-level, phase-shift keying system to obtain data rates up to 4800 bits per second. Also included are results of performance tests indicating superiority over other types of systems.

In the present paper, it is proposed to describe some of the unique design features of the transceiver, particularly the following:

(1) Logical design of the four-phase transmitter, showing how the incoming data stream is coded into quaternary bits (quaternits), and how the four phases are generated—entirely by means of logic.

(2) Detailed explanation of the orthogonal transformation matrix and the auto-correlation detection method by which the receiver identifies a change in phase.

(3) Design of the phase-locked loop and advance-retard counter to recover timing information from the received signal.

(4) Illustrations and brief description of actual equipment, showing size, modular construction, operator controls, and a summary of important electrical, mechanical, and environmental specifications.

*A High Speed, Serial, Four-Phase Data Modem for Regular Telephone Circuits, by G. L. Evans, E. Enriquez, and O. C. Wilson, all with Hughes Communications Division.

36/2 HIGH SPEED SERIAL DATA OVER PARALLEL, LOW SPEED H-F RADIO LINKS VIA SEPATH

C. S. Krakauer, Rixon Electronics, Inc., Silver Spring, Md.

This paper describes the present requirements for the transmission of high-speed serial data over existing h-f radio links. The incompatibility between modern high speed data processors and existing mux equipment is shown to be caused primarily by the multipath and other phenomena. Sepath is presented as the means to establish the desired compatibility. Sepath is a synchronous serial to parallel/parallel to serial conversion system whose logic and operation is fully described both in relation to clear and crypto text.

36/3 DEPENDANCY OF CROSSTALK ON UPPER AND LOWER CUTOFF FREQUENCIES IN PAM TIME-MULTIPLEXED TRANSMISSION PATHS

H. M. Straube, RCA, New York, N. Y.

The nature of crosstalk in pam time-multiplexed transmission paths is first briefly discussed. The dependencies of crosstalk on upper and lower cutoff frequencies are then derived, considering all previous significantly-interfering samples. It is shown that, in typical cases, the most formidable general expressions may be reduced to very simple design equations with good approximation. The paper concludes with a summary of pertinent results.

Major emphasis is placed on the lower cutoff dependency which has apparently received only empirical, not analytical, treatment in past literature.

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Chairman and Organizer: Alan F. Culbertson, Lenkurt Electric Co., Inc., San Carlos

(Continued on page 76)

MORE PROGRAM (FRI.)

SESSION 37
ULTRASONIC AIDS TO THE MILITARY & INDUSTRY

Room B—2:00 P.M.-4:30 P.M.

37/1 A METHOD FOR NON-DESTRUCTIVE EVALUATION OF PHYSICAL PROPERTIES IN RUBBER-SOLID COMPOUNDS

J. G. Martner, Stanford Research Institute, Menlo Park, Calif.

A method and instrument for measurement of physical properties of plastic materials is under development. The method is based on an ultrasonic transmission-attenuation technique in which the total amount of energy absorbed by a plastic or rubber specimen medium is a function only of the geometry of the specimen-transducer system and the physical properties of the specimen. If the geometry is such that the ratio of specimen thickness to wave length is 0.5 or multiples thereof, compressional wave transmission through the specimen depends mostly on physical property changes that might occur in this specimen during cure or upon aging. Experimental work was done with filled and unfilled rubber specimens.

37/2 EVALUATING SONIC ENERGY CLEANING

Dr. Thomas Bulat, Bendix Corporation, Davenport, Iowa.

The need for a method of evaluating sonic energy cleaning is obvious to anyone who has been associated with the subject. This paper discusses briefly the philosophy of evaluation methods and the possibility of obtaining a generally accepted evaluation method. Specifically it discusses known and proposed methods of evaluation. These are divided into two main categories: (1) methods which are based on acoustical parameters or direct physical activity in the cleaning solution; (2) methods based on actual cleaning action in the insonated bath. Several evaluating techniques are covered in each category along with comments as to their efficacy.

37/3 THE EFFECTS OF BONDING AND BACKING MATERIALS ON THE CHARACTERISTICS OF ULTRASONIC DELAY LINES

W. Konig, L. Lambert and D. Schilling, Columbia University, New York, N.Y.

The results obtained from a theoretical and experimental investigation of the variation of insertion loss and reflecton coefficient with frequency of bonded piezoelectric transducers are presented. The effects of the backing material employed and the thin conductive bond between the transducer and the delay medium are included in the development and analysis of the equivalent circuits.

The effects of indium and lead bonds on transducer characteristics are investigated in detail for a typical delay-line configuration. For indium, which is the material in prevalent use in the delay line industry, it is shown that the bond will seriously degrade delay-line performance for high-frequency applications. It is then shown that the use of lead will result in a significant improvement in performance by decreasing the effect of the bond on delay-line characteristics. Typical calculated and experimental characteristics are presented.

The effect of the impedance of the backing material employed on the triple-travel spurious response of a delay line is investigated. For an optimum backing material, a triple-travel response level which is 60±¼ db below the main response across the passband is predicted.

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Chairman and Organizer: Gilbert G. Brown, Amsco Electronics Co., Palo Alto, Calif.

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Smith

Mohr

th Region IRE Fellows: Otto J. M. Smith, professor of electrical engineering, University of California, Berkeley; Milton E. Mohr, vice president and general manager, Ramo-Wooldridge, Los Angeles; Sidney Frankel, director of engineering, Sierra Electronics Corp., Menlo Park; Francis L. Moseley, president, F. L. Moseley Co., Pasadena

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Post

Bramhall

th Region IRE Fellows: Edgar A. Post, manager of the radio and weather sciences laboratory, Stanford Research Institute, Menlo Park; F. B. Bramhall, engineering consultant, Lenkurt Electric Co., San Carlos; Sloan D. Robertson, head of research and development, Goodyear Aircraft Corp., Litchfield Park, Arizona; John F. Byrne, military electronics division, Motorola Inc., Phoenix

Robertson

Byrne

MORE PROGRAM (FRI.)

SESSION 38
COMPUTER THEORY

Room C—2:00 P.M.-4:30 P.M.

38/1 DIODE AND TRANSISTOR LOGIC IN SYNTHESIS OF SYMMETRIC BOOLEAN MATRICES

H. K. Cooper, Pacific Semiconductors, Inc., Lawndale, Calif.

This paper will discuss the logic principle of two minimization techniques. It will compare the two and indicate relative advantages and disadvantages of each. One of the techniques, symmetrical function synthesis, will be treated in more detail since it is a relatively new subject, and one that has been covered only generally, if at all, in previously published literature. In conjunction with this subject it will be shown that the basic principles of symmetric function synthesis may be used in the design of transistor and diode computer circuitry. It will be shown that direct analogy in relay synthesis may be applied to the development of solid state circuitry to realize complex symmetric functions.

38/2 LOGICAL SYNTHESIS OF UNIT-TIME ARITHMETIC CIRCUITRY

Burton Singer, Case Institute of Technology, Cleveland, Ohio.

A unit-time arithmetic circuit is defined as one which accepts a set of m binary numbers in parallel form at clock time tn and performs arithmetic operations on them in such a way that the result appears at the circuit output at clock time t(n + 1) with no carry or borrow propagation. Thus a unit-time circuit represents an upper bound on computation speed. This paper describes logical techniques for synthesizing unit-time arithmetic networks and indicates the practical problems of implementing such circuits.

In most of the literature on logical synthesis of digital systems, the connectives and and or are employed; however, complex expressions for the output variables in terms of input variables usually result. This, in turn, leads to a complicated system structure. If the exclusive-or connective is used with the and connective to write logical expressions describing the arithmetic operations, considerable circuit simplification is achieved.

Logical expressions for unit-time addition, subtraction, multiplication, and division networks are derived using and and exclusive-or connectives. The application of these synthesis techniques to machines which do not require unit-time computation is also discussed.

38/3 A DECISION THEORETIC APPROACH TO MACHINE LEARNING AND PATTERN RECOGNITION

David Braverman, Stanford University, Stanford, Calif.

A decision theoretic model of machine learning and pattern recognition is formulated and investigated when patterns in each class possess a common property which is unknown to the recognition system. Bayes decision rules for recognition of the class of a pattern are obtained as functions of the measurement of a set of characteristics of the pattern and the measurement of the characteristics of a finite number of learning patterns from each class. The role of the learning measurements is defined and examples of recognition systems for minimization of the probability of misrecognition of unknown signals in additive gaussian noise and unknown binary signals in multiplicative geometric noise are presented.

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Chairman and Organizer: Richard I. Tanaka, Lockheed missiles and space division. Sunnyvale, Calif.

(Continued on page 80)

SESSION 39

THE USE OF OPERATOR CHARACTERISTICS IN ELECTRONIC SYSTEMS

Room D—2:00 P.M.-4:30 P.M.

39/1 THE CONCEPT OF "EQUALIZING ABILITY" IN OPERATOR SELECTION AND TRAINING

H. P. Birmingham and R. Chernikoff, U. S. Naval Research Laboratory, Washington, D. C.

Systems such as the helicopter, aircraft, submarines, and space vehicles have dynamic characteristics describable by higher order equations. In handling any of these systems, the operator must compensate for these system dynamics, as would an automatic system. A computing network designed to compensate for system dynamics is generally called an equalization network, and the ability of a human operator to perform this compensating function is called "equalizing ability."

The concept of "system equalization" as a human skill in controlling higher order systems has been recognized previously. The "quickened" display was developed in order to make such equalization by the human unnecessary in some specific situations. This paper discusses equalization as a basic human ability which can be acquired and measured outside of the particular system or vehicle of interest, and suggests that cognizance of its importance can lead to an improved approach in the selection and training of operators of these vehicles and systems.

39/2 ISOLATION OF HUMAN PERFORMANCE VARIABLES IN AN OPERATIONAL MAN-COMPUTER SYSTEM

M. M. Okanes, System Development Corp., Santa Monica, Calif.

A methodology was developed for precisely identifying the human actions taken in an exercise utilizing synthetic inputs to the air surveillance subsystem of the sage air defense network. A model was developed which resulted in the capability to perform a diagnostic evaluaton of crew performance. The model rationally ties together: criteria, data specification, inputs, and performance profiles. The general goal of the air surveillance subsystem is to provide an accurate and timely crt display of the existing air picture for purposes of weapons action. Criteria were developed to show the quantitative discrepancy between the "raw" air picture and the display provided by the air-surveillance subsystem. A computer program was developed to store appropriate response data gathered during an evaluation exercise. A system of inputs was logically and empirically derived from a "Stress Variables Analysis" of the system. A number of stress categories were identified with a variety of stress-events contained with each category. After exercise completion, an additional computer program evaluates crew responses to each stress-event and prints out the results. A diagnostic profile is constructed from this information which is then used for remedial training.

39/3 DECISION-MAKING IN PROBLEMS UTILIZING INDUCTIVE AND DEDUCTIVE INFERENCE

H. C. Ratz and G. H. M. Thomas, University of Saskatchewan, Saskatoon, Canada.

An experimental investigation is reported into the performance of human operators in a problem-solving situation calling for both inductive and deductive reasoning. The problems required search because the total data available at any stage was incomplete. The task consisted of manipulating binary variables in an attempt simultaneously to satisfy all of a number of

(Continued on page 82)

MORE PROGRAM (FRI.)

rules consisting of logical statements about the variables. The structure of the problem was completely unknown to the operator, and he was permitted a written record of his past trials and partial successes. Using this record he could avoid repetitions, but could not deduce anything further with certainty. If his decisions were otherwise random, then his expected behavior could be predicted easily. The experimental evidence shows conclusively that human operators did substantially better than expected on the basis of objective deduction only, and that this gain in performance was related to a general measure of redundancy in the problem. Thus, inductive inference appears in these problems as the process of assuming patterns or hypothesizing consistency of structure in the data, and the experiments give a quantitative measure of the separate effects of deduction, induction, and guess.

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Chairman and Organizer: Richard S. Hirsch, I.B.M. Advanced Systems Dev. Division, San Jose, Calif.

SESSION 40

MICROWAVE SOLID STATE DEVICES

Room E—2:00 P.M.-4:30 P.M.

40/1 MAGNETICALLY TUNABLE NON-RECIPROCAL BAND PASS FILTER USING FERRIMAGNETIC RESONATORS

Cumar Patel, Stanford University, Stanford, Calif.

The characteristics of a magnetically-tunable bandpass filter having non-reciprocal characteristics have been studied. A theoretical analysis

(Continued on page 84)

Iams

Elliot

7th Region IRE Fellows: Harley Iams, acting director, Hughes Research Laboratories, Culver City; Robert S. Elliot, professor of engineering, University of California, Los Angeles; Gilbert McCann, professor of electrical engineering, California Institute of Technology, Pasadena; Emory Lakatos, member of the senior staff, Ramo-Wooldridge Corp., Canoga Park

McCann

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CONFERENCES & SYMPOSIA

August 21-September 6—**10th Pacific Science Congress,** National Academy of Sciences. Bernice Pauahi Bishop Museum, University of Hawaii. Honolulu, Hawaii.

August 23-25—**Pacific General Meeting, AIEE.** Hotel Utah, Salt Lake City, Utah. Raymond C. Mayer, 51 E. 42nd St., New York.

September 6-8—**Space Electronics & Telemetry 1961 National Symposium.** University of New Mexico, Albuquerque, New Mexico. General chairman for the Symposium is Allen B. Church, Sandia Corporation. For information regarding program, contact: Dr. B. L. Basore, 2405 Parsifal, N.E., Albuquerque, New Mexico.

September 11-15 — **Instrument-Automation Conference & Exhibit, Instrument Society of America.** Memorial Sports Arena, Los Angeles, Calif. Wm. H. Kushnick, ISA, 313 Sixth Avenue, Pittsburgh, Penna.

September 12 — **Eighth Annual San Francisco Bay Area Quality Control Conference.** Cubberley Hall, Stanford University, Palo Alto, Calif. Conference chairman, Grant Ireson, executive head, Stanford University industrial engineering department. Tentative program follows:

"Polaris Testing—The Sure Way to Quality and Reliability," Commander R. W. Smiley, USN, Lockheed Missile and Space Company, Sunnyvale, Calif.

"Quality Control—Its Growth and Future," J. Y. McClure, Convair, Fort Worth, Texas.

"Reliability Organization at Philco," W. Wahrhaftig, Philco Corp., Palo Alto, Calif.

"A Statistical Rating System for Chemical Quality Control," Jesse Y. Black, Shell Oil Co., Chemical Division.

"Problems Associated with the Application of Classification of Characteristics," E. C. Bennet, Norair Division, Northrop Aircraft Co., Hawthorne, Calif.

"The Interrelation of Quality Control and Value Engineering," R. J. Dombrow, USAF, Air Force systems command, Los Angeles, Calif.

"Methods of Multivariate Analysis in Studies of Quality Control Variables," G. A. Rowe, University of California, Berkeley, Calif.

"Efficiency of 100% Inspection," G. Livingston, Fairchild Semiconductor Corp., Mt. View, Calif.

Other speakers include Vice Admiral W. F. Raborn, USN, Washington, D.C., and Colonel Ole O. Griffith, USAF, Wright-Patterson AFB, Ohio.

MORE PROGRAM (FRI.)

of the equivalent circuit of a ferrimagnetic resonator between two waveguides was carried out for the case where the r-f magnetic fields in the waveguides are eliptically polarized, and the expressions for the external Q (Q_e) and the overall filter response were obtained.

The filter consists of two waveguides with a common broad wall. The ferrimagnetic resonator (in this case an yttrium-iron-garnet sphere) is mounted in a circular iris cut in the common broad wall in an off-center position. The filter is ideally non-reciprocal only when the r-f magnetic fields are circularly polarized, and in this case becomes a four-port circulator with filter characteristics. Thus for a filter structure that uses waveguides as the circuit elements, the off-axis position of the yig sphere determines the frequency behavior of Q_e and of the degree of non-reciprocity. Experimental filters tunable from 8.2 to 12.4 kmc using waveguides have been tested and the theoretical predictions have been verified. Typical values of insertion loss were 2-3 db and of loaded Q, Q_L, 850-1250.

40/2 AN ELECTRONICALLY TUNABLE BAND-REJECT FILTER

K. L. Katzebue, Watkins-Johnson Company, Palo Alto, Calif.

The principle of using low-loss garnet resonators for the construction of narrow-band, electrically-tuned microwave filters has been applied to the construction of a practical band-reject filter in S-band. Three single-crystal yttrium-iron-garnet (yig) resonators are employed to give a three-stage rejection filter which combines high rejection and a narrow rejection band with very low insertion loss.

A simple circuit model was developed which satisfactorily predicts the performance that can be obtained with such filters. Curves based on this model are presented that quickly enable the designer to estimate filter behavior.

Various practical problems in the construction of such filters are presented and illustrated by the design of the S-band filter. Pertinent performance characteristics are 30 to 40 db rejection with a bandwidth of less than 20 mc in low S-band and less than 0.1 db insertion loss. The packaged three-resonator filter occupies about nine cubic inches, weighs about one pound and requires about 1.6 watts of power to tune 600 mc.

40/3 A NON-DEGENERATE TRAVELING WAVE PARAMETRIC AMPLIFIER

K. P. Grabowski, Hughes Aircraft Co., Fullerton, Calif.

All traveling-wave parametric amplifiers reported to date have been degenerate, i.e.: the idler is supported by the same mode of the same circuit as the signal. It is well known that a non-degenerate parametric amplifier has a considerable radar-noise-figure advantage over a degenerate amplifier and hence for single diode amplifiers research and development is directed almost exclusively to the non-degenerate version. This paper will report the characteristics of an operating S-band, non-degenerate, traveling-wave parametric amplifier. Gain has been obtained over a considerably larger frequency band than has been reported for non-degenerate single-diode amplifiers or even degenerate single-diode amplifiers at these frequencies and a circuit investigation indicates that 50 percent bandwidths are possible. The noise figure is below any reported for a degenerate traveling-wave parametric amplifier and is approaching the noise figure of single-diode amplifiers with the same signal-idler separation.

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Chairman and Organizer: Philip S. Carter. Stanford Research Institute, Menlo Park

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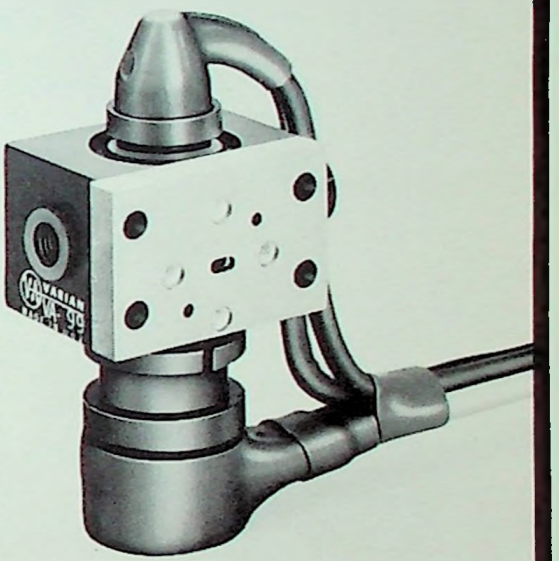

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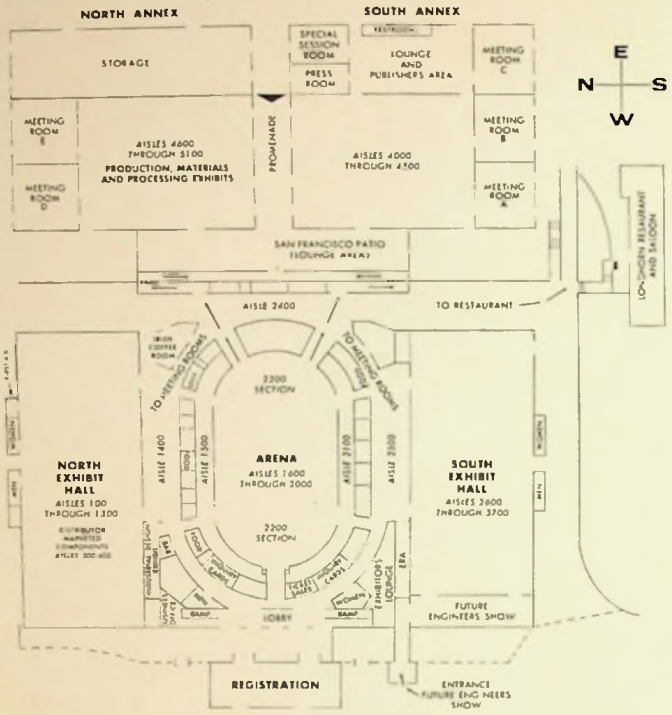

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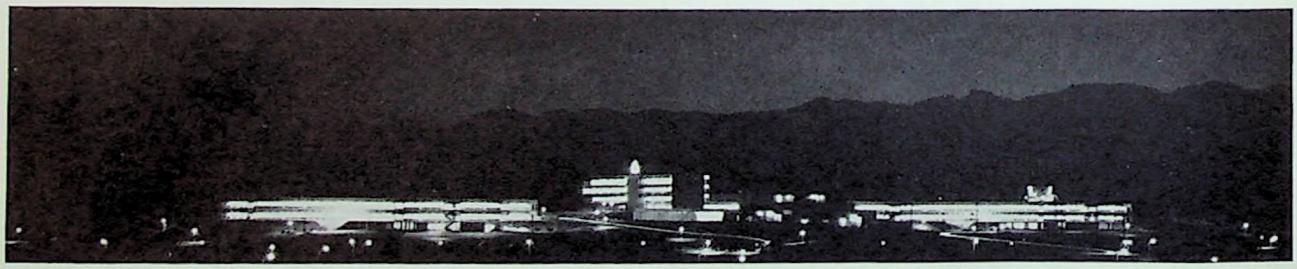

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