National Electronics Conference and Exhibition, held at Chicago, September 25-27, 1950

Clemence, C. R.

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NATIONAL RESEARCH COUNCIL OF CANADA

RADIO AND ELECTRICAL ENGINEERING DIVISION

NATIONAL ELECTRONICS CONFERENCE AND EXHIBITION

HELD AT CHICAGO, SEPTEMBER 25 - 27, 1950

BY

C. R. CLEMENCE

OTTAWA

NOVEMBER 1950

NATIONAL ELECTRONICS CONFERENCE

HELD AT CHICAGO, SEPTEMBER 25-27, 1950

INTRODUCTION

The Sixth Annual National Electronics Conference was held on September 25, 26, 27, 1950, in the Edgewater Beach Hotel, Chicago. It was sponsored jointly by the Illinois Institute of Technology, Northwestern University, the University of Illinois, the A.I.E.E., and the I.R.E., with the University of Wisconsin and the Society of Motion Picture and Television Engineers participating.

Although the writer has not attended other conferences, such as the I.R.E., and a first-hand comparison is not possible, it would seem that the papers presented were on a somewhat lower technical plane than is usual. For this reason, then, attendance at future conferences of this type is recommended particularly for young engineers or those with less than average experience in the electronics field.

Regarding presentation of the papers, the same complaint is registered here as has been made in connection with other conferences; that is, the absence of any facility for taking home a reasonable resumé of the papers either as a copy or in note form, since no copies were distributed and the lectures were given in almost total darkness in order that slides could be presented. At first, the writer tried to make notes using a flashlight, but later on gave it up as a hopeless task. A copy of the "Proceedings" has been ordered, of course, but this will not be available until the spring of 1951.

If the purpose of the conference were simply to distribute the lecture information, attendance might not be considered worthwhile, since that information could be obtained by other means, but great value is obtained from personal contacts both with other delegates and with company representatives at the exhibition. For example, the writer had the opportunity of discussing with Bendix, Pioneer, and Helipot salesmen some problems recently encountered in the laboratory. Among the exhibits, the Cossor double-beam oscilloscope was outstanding in its field, and the DuMont oscillograph record camera, supplying finished prints in less than a minute, would be a decided asset in any laboratory. Both the newest and oldest in television sets were on display, the oldest being, in outward appearance at any rate, an exact duplicate of one presently in a corner of the Defence Section offices.

There was a conspicuous absence of Canadians, both as delegates and lecturers, there being only two delegates from this country so far as could be ascertained. Total attendance was about 600, with 59 companies (one Canadian) being represented at the exhibtion.

The after-luncheon addresses were excellent and the committee in charge of this is to be congratulated on securing such eminent men who were, at the same time, very fine speakers.

The abstracts supplied on the following pages give an indication both of subject matter and scope of the lectures, and the writer feels that additional comment, a product of memory only, is quite likely to be inaccurate or misleading. Several speakers stated that they would be glad to answer questions or supply information by mail regarding their particular subjects. In any case, the copy of the "Proceedings" will furnish complete details of all the papers given.

The sessions attended by the writer are marked with an asterisk on the following pages.

OLD TIMERS NIGHT

The Old Timers Night Dinner Tuesday evening in the Ball Room is both a major Conference social event and a climax to the "25 YEARS OF PROGRESS" Silver Anniversary Celebration of the I. R. E. Chicago Section. Guests of honor will be outstanding national figures active in radio and electronics for 25 years or more. Dinner at 6:30 P.M. will be followed by a floor show, ballroom and square dancing. Admission is $5.50 per person or $10.00 per couple. Ladies are invited. Dress will be informal.

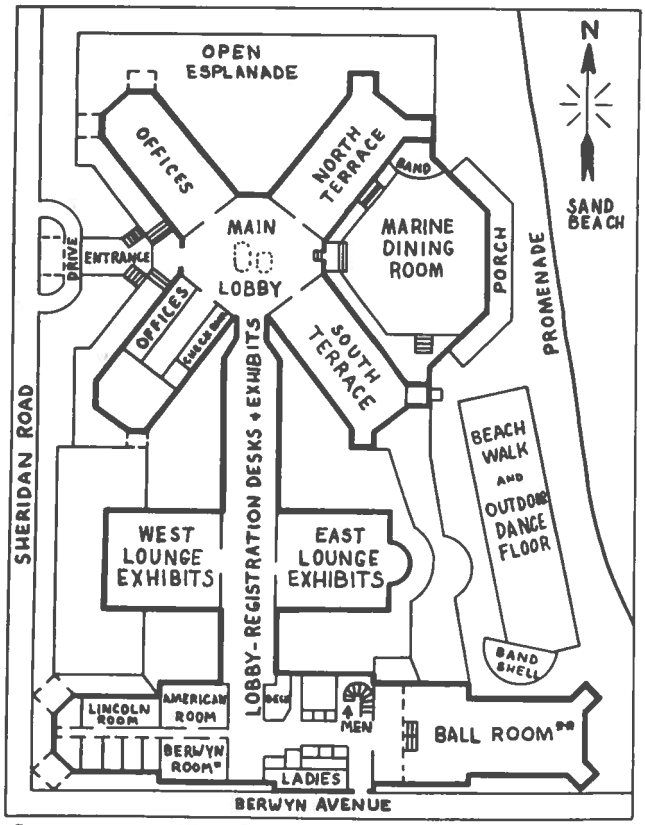
LADIES' ACTIVITIES

Except for the Tuesday night dinner, no formal program has been arranged for the ladies at this conference. However, information concerning things of interest in Chicago can be obtained at the Information Desk.

MAIN FLOOR PLAN

The main floor plan of the Edgewater Beach Hotel is shown here to assist in locating the several activities. Registration and information facilities will be placed at the north end of the long lobby connecting the two main portions of the hotel. Conference and press headquarters for the National Electronics Conference are located in the Berwyn Room.

Technical papers will be presented in the Ballroom, Michigan Room and the North Terrace. Signs will be placed at strategic points to assist in locating these rooms.



* N.E.C. OFFICE + PRESS ROOM ** MICHIGAN ROOM BELOW BALL ROOM

PROGRAM OF THE SIXTH NATIONAL ELECTRONICS CONFERENCE

SEPTEMBER 25, 26, 27, 1950

All Activities Take Place at the Edgewater Beach Hotel

SUNDAY, SEPTEMBER 24

4:00 P. M. to 8:00 P. M.—REGISTRATION
North end of Passaggio (main corridor)

MONDAY, SEPTEMBER 25

8:00 A. M.—REGISTRATION
North end of Passaggio (main corridor)

9:00 A. M. - 9:00 P. M.—EXHIBITS
Displays of new electronic equipment, developments, components and historical exhibits.
East and West Lounges and Passaggio

10:00 A. M.—Meeting of the I.R.E. Sub-committee on Spurious Radiation, Lincoln Room

10:00 A. M.—TECHNICAL SESSIONS

1. **MICROWAVES AND ANTENNAS, Ballroom, Session Chairman, R. M. SORIA, American Phenolic Corp., Chicago.**

   (a) "CORRUGATED END-FIRE ANTENNAS" by Donald K. Reynolds and Winston S. Lucke, Stanford Research Institute, Stanford, Calif.

   This paper is concerned with the radiation properties of corrugated metal surfaces, the propagation characteristics of which have recently attracted considerable interest. It is shown that such a surface, which supports the propagation of a guided mode, may be used to form a high gain flush mounted traveling wave end-fire antenna. The effect of the surface parameters in modifying the propagation over the surface is discussed in its application to the attainment of the optimum end-fire radiation pattern. Several alternative methods of driving the surface are compared in relation to the effects upon field pattern and frequency bandwidth of the structure. The extent of beam shaping possible with these antennas is discussed. Practical forms of corrugated end-fire antennas are described, and theoretical and experimentally measured field patterns are compared.

   (b) "NEW TECHNIQUES IN MICROWAVE SPECTROSCOPY" by William E. Good, Westinghouse Research Laboratories, East Pittsburgh, Pa.

   The radio frequency techniques used in a sensitive microwave spectroscope will be described. The discussion will include particular input circuits for obtaining a good signal to noise ratio and these will be compared to those ordinarily used in communication devices. Methods of observing these sharp absorption lines will be mentioned. An all miniature tube crystal controlled frequency multiplier and a silicon-crystal harmonic generator are used in conjunction with a communication receiver to measure the frequency of these lines to a precision of better than one part in a million in the microwave region up to 40,000 mc/sec. The absorption lines are periodically displaced in frequency by the application of an 85 kc. oscillating spark voltage to the absorbing gas. The resultant 85 kc. modulation is detected by the crystal and amplified by a high gain 85 kc. amplifier, detected, and presented on an oscilloscope.

(c) "PROPERTIES OF LONGITUDINAL SLOTS IN CIRCULAR WAVE-GUIDES" by G. E. Feiker and S. C. Clark, Jr., General Electric Co., Schenectady, N. Y.

Measurements have been made at X-band of the complex admittance, radiation patterns, and power handling capacity of longitudinal slots of different widths in circular wave-guide in the vicinity of half-wave resonance. Theoretical calculations of conductance for an idealized thin slot were found to agree with the measured values. The admittance versus frequency characteristic is shown to be equivalent to that of a series resonant circuit across the equivalent transmission line. Radiation patterns were taken of the slot used to feed a pillbox and an E-plane flared horn. The radiation pattern within the pillbox was found to be considerably sharper than predicted by diffraction of the slot aperture. The associated admittance characteristic has an extremely narrow bandwidth, however. The radiation pattern with the flared horn is the normal diffraction pattern, but the admittance differs from that of the open slot. Preliminary measurements of breakdown power under pulsed operation show that the slot with associated E-plane horn will handle power in excess of that predicted by d-c breakdown calculations.

2. MAGNETIC AMPLIFIERS, Michigan Room, Session Chairman, H. J. McCREARY, Automatic Electric Co., Chicago.

(a) MAGNETIC AMPLIFIER VOLTAGE REGULATOR" by John L. Wolff, Westinghouse Electric Corp., East Pittsburgh, Pa.

This paper covers the development and testing of a regulated power supply which uses a magnetic amplifier as the regulating element. Circuit considerations for a simple regulating system are presented and applied to the magnetic amplifier regulating system. The reference for the magnetic amplifier is obtained by means of a parallel linear—non-linear resistive network from which deviations in output voltage are fed back magnetically to the primary circuit. The impedance of the magnetic amplifier in the primary circuit controls the voltage applied to the transformer primary. Fluctuations in load current are detected by means of a control winding in series with the load. The power supply will regulate at 160 volts to 400 volts within 0.5% for load currents from 0 to 500 ma (line voltage constant), and within 0.5% or less for ± 10% change in line voltage and load currents from 0 to 300 ma; or within 1% or less for ± 20% change in line voltage and load currents of 0 to 300 ma.

(b) "NOISE FIGURE OF THE MAGNETIC AMPLIFIER" by N. R. Castellini, Coles Signal Laboratory, Fort Monmouth, N. J.

The performance of the magnetic amplifier is analyzed with particular emphasis upon the noise figures obtainable. The influence of white noise in the input resistance and Barkhausen noise are considered. The relations of the noise figure to the characteristics of the magnetic material and to design factors are indicated.

(c) "MAGNETIC AMPLIFIERS WITH ORTHONOL TAPE CORES" by W. A. Geyger, Naval Ordnance Lab., Silver Spring, Md.

Typical characteristics of magnetic amplifiers having Orthonol tape cores are presented. These characteristics assist in the design of high-performance magnetic amplifiers, especially those of the push-pull differential-feedback type. Superior performance is obtained when rectangular hysteresis loop materials are used. Spirally-wound Orthonol tape cores having multi-layer toroidal windings approach this ideal so that the performance of magnetic amplifiers using this material can be represented to good accuracy by simple linear equations. Another desirable characteristic of Orthonol is that maximum permeability occurs close to saturation flux density. The best form of core construction to take full advantage of the desirable properties of Orthonol is the spirally-wound tape core having multi-layer toroidal windings.

3. DIELECTRIC HEATING, North Terrace, Session Chairman, H. F. FRUTH, Consultant and Physicist, Skokie, Ill.

(a) "DIELECTRIC LOAD TUNING IN RF HEATING" by R. H. Hagopian, Westinghouse Electric Corp., Baltimore, Md.

This paper will describe various methods of tuning different types of dielectric loads. It will limit the discussion to load tuning in the frequency range of 5 to 30 mc, since the bulk of dielectric heating is done in this frequency range. Load tuning with various size generators will be considered, generators of 2 to 10 kw. output rating being in the low-power class, and 20-100 kw. generators in the high-power class. Load tuning divides itself into these two general classes because in the lower power group the generator is usually connected directly to the work, while in the higher power group a transmission line is normally used between the generator and the work circuit. Particular load problems in each class will be discussed, and a recommended method of load tuning described.

(b) "MEASURING DIELECTRIC PROPERTIES DURING HF HEATING" by Eugene Mittelman, Consulting Engineer, Chicago.

A method and apparatus were developed to measure the dielectric constant and the loss factor of dielectric materials as a function of time and temperature in a continuous manner with the operating frequency and power density as parameters. Heating of the sample to various temperatures takes place by high frequency power absorption and the variations of the heating process itself are used to measure the dielectric constant and loss factor. If the amount of power absorbed by the sample is kept constant during the test period the voltage variation will indicate the variation of the loss factor as a function of temperature. Proper techniques to measure the temperature of the sample during the high frequency heating cycle were developed, and are described. The apparatus and its circuits are described in detail and some characteristic measurements are shown. The theoretical and practical significances of the measurements are discussed.

12:15 P. M.—LUNCHEON IN THE MARINE DINING ROOM

Chairman, Nathan Cohn, Leeds and Northrup Co., Chicago, President of the N.E.C.

Address by the Honorable Wayne Coy, Chairman of the Federal Communications Commission. Introduction by Dr. W. L. Everitt, Dean of Engineering, University of Illinois

1:30 P. M.—Meeting of the I.R.E. Region V Committee, Lincoln Room

2:00 P. M.—TECHNICAL SESSIONS

4. TIME-POSITION MEASUREMENT, Ballroom, Session Chairman, L. T. DeVORE, General Electric Co., Syracuse, N. Y.

(a) "THE ELECTRONIC UMPIRE" by Richard F. Shea, Electronics Laboratory, General Electric Co., Syracuse, N. Y.

The electronic umpire is a device which will automatically indicate the passage of a baseball through the "strike" zone and will simultaneously measure its speed. The instrument is in two sections, a ground unit and a control and indicating unit. The ground unit contains three sets of phototubes with their associated pre-amplifiers, together with an optical system whereby the field of the phototubes is restricted to an area corresponding to slots in the top of the box. By this means two sets of phototubes look at the skylight through narrow vertical beams and one set through a similar narrow slant beam. A control tilts the angle of the slant beam. A baseball passing through these beams causes shadows on the phototubes, and these result in pulses. A prescribed sequence of pulses is obtained only if the ball interrupts the slant beam after interrupting the first vertical and before interrupting the second vertical. Thus low or high pitches which produce an incorrect sequence will not indicate a "strike". A timing circuit is actuated by the pulses from the two vertical beams and provides a measure of speed. Various special features are incorporated to provide a quick re-set in the case of low or high pitches, yet a long hold-on for "strikes", also to avoid "strike" indications when a bat interrupts the beams.

(b) "THYRATRONS AS CLOSE DIFFERENTIAL RELAYS" by Jordan J. Baruch, Massachusetts Institute of Technology, Cambridge, Mass.

The factors governing the use of thyratrons as relays are discussed, and the limitations on the differential between

the "pull-in point" and the "drop-out point" are considered. It is shown that the limiting condition is, in general, the distribution of initial electron velocities. A method for decreasing the effect of initial electron velocity will be described. Using this method, which is based on velocity statistics in the tube, a thyratron relay with only a .005% differential (0.5 millivolts at a 10 volt operating level) has been developed. Circuitry involved will be discussed.

(c) "ELECTROMECHANICAL PULSE DELAY UNIT" by James F. Gordon, Bendix Radio Co., Baltimore, Md.

A newly developed miniature type electro-mechanical delay unit is described wherein an accurate continuously variable or fixed delay may be either locally or remotely accomplished. Delays from 125 to 5000 micro-seconds are readily accomplished. An accuracy of 0.3 micro-second throughout the range is readily obtained and is independent of repetition rate. The practical delay limit is discussed along with the probable ultimate accuracy. Some of the more important design considerations involving Meachem delay circuits are considered and their practical solutions are displayed. Methods for obtaining both long term and short term stability are discussed. The effects of changing the character of the exciting pulse and also the load into which the unit operates are considered and the means of minimizing these effects is presented. Several advanced applications of the unit are discussed along with a novel variable repetition rate high stability pulse generating system. Considerable attention is given to the form of the equipment to create a reliable unit which is completely accessible for maintenance and adjustment.

5. CIRCUITS, Michigan Room, Session Chairman, W. O. SWINYARD, Hazeltine Research, Inc., Chicago.

(a) "MINIATURIZING PENTODE AMPLIFIERS BY POSITIVE FEEDBACK" by W. B. Anspacher, Naval Ordnance Laboratory, Silver Spring, Md.

This paper analyzes the feasibility of removing all the bypass condensers from a two stage pentode amplifier and nullifying the resulting degeneration by means of a positive feedback path between the two screen grids. The method of attack used was an analysis of the mid-frequency equivalent circuit of the positive feedback amplifier in order to obtain an expression for the feedback resistor required to achieve normal gain.

An expression for the feedback resistor is developed in terms of the various amplification factors obtained by successively removing the screen grid and cathode bypass condensers. An expression for the value of feedback resistor required for infinite gain is also obtained, and can be used to determine the feedback resistor tolerance. The high frequency response of the positive feedback amplifier is found to be limited by inherent screen grid to ground capacities though the circuit is shown to be capable of reliable performance under conditions of normal gain up to frequencies somewhat beyond the audio range.

(b) "ELECTRONIC CIRCUIT DESIGN USING CONDUCTANCE CURVES" by Keats A. Pullen, Ballistic Research Laboratory, Aberdeen Proving Ground, Md.

The use of conductance contours in tube circuit calculations has proven advantageous in the rapid approximation of preferred design constants. This paper presents hitherto unreported developments in the handling of multi-electrode tube circuits under conditions calling for more than one signal injection electrode. These developments permit simplified direct circuit design for use with screen degenerative, cathode degenerative, or combination degenerative circuits as well as with circuits calling for external screen drive. They apply also to more complex tubes, hexodes, etc. Application of the general conductance technique to some hitherto unpublished semi-linear circuits is discussed. The technique used in computation of complex non-linear circuits using conductance data on a point by point basis is briefly indicated. These principles can be applied to many non-linear circuit problems.

(c) "ANALYSIS OF TWIN-T FILTERS" by Louis G. Gitzendanner, General Electric Co., Schenectady, N. Y.

The twin-T filter is a simple filter which in many instances proved superior to L-C filters. It has been found that in contrast to previous analyses, a better understanding of the circuit, applicable to many variations of it, may

be obtained by studying certain vector diagrams. The paper starts by making assumptions leading to a very special but easily explained filter and then proceeds to give a qualitative explanation of how the results differ in practical designs. The basis of rejection filter design with design formulas for the case of matched resistance load and source impedances is covered for both symmetrical and unsymmetrical frequency response. Design formulas are given for the case of load impedance appreciably higher than source impedance, a case often met in electronic work. By using designs tailored to the application appreciable improvements in characteristics result.

(d) "CASCADING CATHODE-FOLLOWERS TO PROVIDE HIGH IMPEDANCE TRANSFORMATION RATIOS" by Sidney E. Smith, and William J. Kessler, University of Florida, Gainesville, Fla.

A unique method of cascading two cathode-followers to couple a low impedance load to a very high impedance source employs the simple expedient of returning the load resistor of the first stage to the cathode of the second stage with these advantages:

The amplification of each stage is increased; the effective input resistance of the first stage is increased markedly over the value obtaining in a similar isolated stage; and the output resistance of the second stage is reduced slightly from that of a similar isolated stage.

The method by which the amplification equations were derived is outlined and examples of the application of the circuit as a high ratio impedance transformer and as an amplifier input circuit of very high input resistance are given.

6. TUBE TECHNOLOGY, North Terrace, Session Chairman, A. H. WING, JR., Northwestern University, Evanston, Ill.

(a) "ELECTROLYTIC TANK STUDIES IN DESIGNING HIGH VACUUM TUBES" by John E. Jacobs, General Electric X-Ray Corp., Milwaukee, Wis., and J. A. M. Lyon, Northwestern University, Evanston, Ill.

The electrolytic tank has been successfully applied to the prediction of performance of various electrode shapes in the design of multi-section X-ray tubes for operation in the 250 KVP region where an electron beam of uniform density is desired. The electron trajectories are determined graphically from the field maps of the tubes and experimentally from actual measurements on the tube. By use of the electrolytic tank a modification of the Pierce electrode configuration has been introduced into tubes where voltages across the Pierce electrodes are as high as 70 KVP. By avoiding lens defects it is possible to achieve electron efficiencies as high as 97% through lenses of the Pierce type operating at 70 KVP.

(b) "A BEAM-TYPE TUBE THAT MULTIPLIES" by Alexander Somerville, Northwestern University, Evanston, Ill.

A beam-type electron tube which is capable of performing analogue multiplication is described. The electron optical features of the tube and the results obtained are presented. Some consideration is also given to required circuits and to ways in which feedback can be used to improve the linearity of the product output. A method of analyzing the linearity of a multiplying mechanism is proposed. No effort was made in this work to achieve high frequency response, but the tube gives promise of operating in the video range. The basic principle used to obtain the product signal in this tube is set forth, and extended to describe other electrical and mechanical mechanisms which can be built to yield a product output signal.

(c) "LOW-NOISE MINIATURE PENTODE FOR AUDIO AMPLIFIER SERVICE" by R. A. Wissolick and D. P. Heacock, RCA Victor Div., Harrison, N. J.

The RCA 5879, which was designed for audio applications requiring a miniature tube having reduced noise, is described. The design features which account for the improved microphonics level, the low hum, and the reduced leakage noise in this single-ended, 9-pin miniature pentode are discussed. Data are presented to compare the performance of the 5879 with other tubes used in similar applications.

(d) "GLASS SELECTION AND PRODUCTION TECHNIQUES FOR X-RAY AND OTHER TUBES" by J. B. Gosling, General Electric X-Ray Corp., Milwaukee, Wis.

The transition from soft, lime glasses to the hard, borosilicate glasses to the specific glasses used in x-ray and valve tube manufacture and the parallel development of sealing metals for use with these glasses is discussed. The importance of certain electrical properties for specific tube applications and final processing to improve quality of hand blown bulbs and some simple tests for physical properties are described. Glass working equipment used in the x-ray industry is shown and various processes for working the heavy glass bulbs are described.

6:00 P. M.—Dinner Meeting, A.I.E.E. Committee on Electronics, Lincoln Room

TUESDAY, SEPTEMBER 26

8:30 A. M.—REGISTRATION

North end of Passaggio

9:00 A. M. - 6:30 P. M.—EXHIBITS

Displays of new electronic equipment, developments, components and historical exhibits.

East and West Lounges and Passaggio

9:00 A. M.—Meeting of the S.M.P.T.E. Central Section, Board of Managers, Lincoln Room

10:30 A. M.—Meeting of the I.R.E. Sub-committee on Measurements, Lincoln Room

10:00 A. M.—TECHNICAL SESSIONS

7. TELEVISION, Ballroom, Session Chairman, GEORGE W. COLBURN, George W. Colburn Laboratories, Inc., Chicago. (This session is also the September Meeting of the Central Section of the Society of Motion Picture and Television Engineers.)

(a) "TELEVISION IN INDUSTRIAL APPLICATIONS" by J. A. Good, Diamond Power Specialty Co., Lancaster, Ohio

An extensive and thorough survey of industry indicates that industrial television equipment of the closed-circuit, wire-line type has many potential applications in situations where its cost can be justified from the viewpoints of accident prevention, direct reduction of operating costs, and reduction of invested capital required to make information available at points remote from operating centers. Such situations are common in manufacturing, mining, mills, public utilities, banks, and power plants. Some closed circuit television applications in surgical and other kinds of teaching, nuclear physics research, and theatrical projects have already been made and show great promise. Equipment design considerations, such as the grade of performance needed and the requirements for simplicity of operation and minimum maintenance, will be covered. Some of the possible applications of such equipment will be illustrated using an operating unit.

(b) "STEREO TELEVISION IN REMOTE CONTROL" by H. R. Johnston, C. A. Hermanson and H. L. Hull, Argonne National Laboratories, Chicago.

The study of the possibilities of using three dimensional television in conjunction with remotely controlled electric manipulators is part of a long range development program being undertaken by the Remote Control Engineering Division of the Argonne National Laboratory. Manipulation of objects in three dimensional space requires that depth perception be incorporated into any scheme used to view and control the means of manipulation. It is not sufficient to use ordinary two dimensional television for this purpose since the ability to judge depth is almost entirely lacking. The study which was undertaken has as its object the development of a workable system of stereo television which could point the way to a practical method of viewing and operating remotely controlled manipulators. A motion picture showing the equipment in operation will be presented.

(c) "THE GENLOCK—A NEW TOOL FOR BETTER PROGRAMMING IN TELEVISION" by John H. Roe, Supervisor, Television Terminal Equipment Product Design, RCA Victor Division, Camden, N. J.

Increasing demands for the use of superpositions, lapdissolves, and other more elaborate special effects in broadcast television programs has focussed attention on the development of some basic tools required for the production of such effects. The Genlock is a device which locks a local sychronizing generator in step with a remote generator, thus combining two otherwise independent scanning systems to work as one, and permitting the use of lap transitions and other effects between the two systems with the same stability as though only one system were involved. The operation of the unit is automatic, requiring no manual adjustment. The equipment and circuits used will be described, and the method of operation will be outlined.

8. INSPECTION AND CONTROL, Michigan Room, Session Chairman, W. C. WHITE, General Electric Co., Schenectady, N. Y.

(a) "RELIABLE ELECTRONIC EQUIPMENT—A PROGRESS REPORT" by G. B. Devey, Office of Naval Research, Washington, D. C.

The Office of Naval Research investigations directed toward improving the reliability of electronic equipment are reviewed. Implications of poor reliability as a limiting factor in applications of electronics to industrial uses are pointed out. Three fundamental needs to achieve reliability are set forth and explained, quality components, quality design, and quality production. A report on the state of the art and where immediate application may be made of these findings to industrial and military electronics equipment is given.

(b) "DETECTION OF TRAMP METAL" by C. W. Clapp, General Electric Co., Schenectady, N. Y.

The detection of unwanted pieces of tramp metal in a process material is a problem that has engaged the attention of many engineering groups. This paper discusses some of the principles found useful in the design of suitable metal detecting equipment. The first equipment described was designed to detect machine gun bullets, shell fragments, large spikes, etc. in logs cut from a western forest that had, at one time, served as a military gunnery range. To facilitate handling of the logs, they were floated in water. The inspection equipment was likewise partly submerged in sea water to allow the logs to pass freely through. The second equipment described was designed to detect broken rock drill bits, shovel teeth, etc. in partly crushed taconite iron ore. The problem to be solved here was one of discriminating between the undesired metal and highly magnetic ore.

(c) "SELECTING CRITICAL COMPONENTS FOR MATCHED CHANNEL RADIO RECEIVING SYSTEMS" by Harold D. Webb, University of Illinois, Urbana, Ill.

Several types of superheterodyne receiving systems which require matching stage by stage are: (1) wide band amplifiers with selective filters; (2) double superheterodyne channels with the final IF at an audio frequency; (3) RF amplifiers with many tracking points; and (4) double superheterodyne channels with wide band RF amplifiers in which the RF band spread and first IF are chosen to eliminate image frequencies and cross modulation products, the second IF amplifier being used to obtain selectivity. The application of the probability of matching pairs or other groups of components from a large group is discussed, with emphasis on the practical production of matched receivers by automatically matching critical components.

9. EXPLORATION AND NAVIGATION, North Terrace, Session Chairman, WALTHER RICHTER, Allis-Chalmers Co., Milwaukee, Wis.

(a) "RECENT LORAC DEVELOPMENTS" by J. E. Hawkins, Seismograph Service Corp., Tulsa, Okla.

A new method of geographical radio surveying, the LORAC system (LOng Range ACcuracy), has been tested experimentally on the Gulf Coast. A brief resume of the principles of the LORAC system will be given. Results of the experimental system will be described, and some of the developments in process will be mentioned.

(b) "FLIGHT PATH CONTROL" by David L. Markusen, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

This paper presents an analysis of the dynamic stability problems concerned with automatically flying an aircraft along a path in space as defined by such radio beams as ILS and omni-range. A control system in which the bank angle is proportional to the off-course error is shown to be inherently unstable. This system may be stabilized over a limited range of gain by the use of electrical lead networks or by the use of a heading reference. The design of the resulting control system is a compromise between gain, damping, and response to noise. The analytical work has been confirmed by analog computer results and by flight test.

(c) "RADIO INTERFERENCE BLANKING AHEAD OF RECEIVER" by M. M. Newman and J. R. Stahmann, Lighting and Transients Research Institute, Minneapolis, Minn., and Edward Svendson, U. S. Naval Academy, Annapolis, Md.

The Radio Interference Blanking Scheme is designed to detect and reject radio interference before it can reach and shock-excite the receiver. Impulsive interference excitation in a receiver greatly increases the duration of the original disturbance, so that removing or limiting the disturbance within the receiver after the first circuits have been "impulse-excited" results in considerable loss of signal carrier as well. However, by removing the interference before it reaches the receiver, a very much smaller portion of the signal carrier is lost, and a very much greater number of disturbances can be rejected than with any scheme limiting within the receiver. Laboratory tests have indicated improvement ratios of the order of 50 DB. for some very severe corona interferences of pulse repeat rates of as high as 100,000 pulses per second. In the case of aircraft under severe thunderstorm conditions, the "blanking-scheme" may provide satisfactory continuity of communications.

12:15 P. M.—LUNCHEON IN THE MARINE DINING ROOM

Chairman, O. D. Westerberg, Commonwealth Edison Co., Chicago, Chairman of the N.E.C. Board of Directors

Address by E. A. McFaul, formerly of Northwestern University. Subect: "Is the Engineer Slipping?" Introduction by Titus LeClair, Commonwealth Edison Co. and National President of A. I. E. E.

1:30 P. M.—Meeting of the I.R.E. Sections Committee, Lincoln Room

2:00 P. M.—TECHNICAL SESSIONS

10. RESEARCH INSTRUMENTATION, Ballroom, Session Chairman, R. R. BUSS, Northwestern University, Evanston, Ill.

(a) "THE ELECTRON OPTICAL SYSTEM OF A PERMANENT MAGNET ELECTRON MICROSCOPE" by John H. Reisner, RCA Victor Div., Camden, N. J.

A simplified electron optical system has been designed for electron microscopy capable of direct magnifications to 6000 times with fifty kilovolt electrons, and providing a resolution of 100 Angstroms. The simplification imposes limitations on flexibility of operation, such as variability of magnification, and on resolution, such as the omission of the condenser lens, and the omission of means for alignment of optical components. Thus, the electron gun becomes the resolution limiting component. Limitations in machining practice necessitate the use of a semi-permanent adjustment of internal transverse alignment adjustment for the objective lens and an external adjustment for the electron gun. Permanent magnets energize the magnetic lenses arranged in a magnetic circuit in such a way that the small amount of stray flux existing does not limit resolution. The optical system is brought to focus by changing focal lengths through adjustment of the electron accelerating voltage. Photographic results show as great as 20,000 diameters magnifications.

(b) "ELECTRONIC SCANNING TECHNIQUES FOR LOW LEVEL CIRCUITS" by B. R. Shepard, General Electric Co., Schenectady, N. Y.

Often it is desirable to read or observe a number of measuring elements at the same time and still use only one channel to transmit the information to a remote point. To do this, a scanning device is needed which will successively read the information on the measuring elements at a high rate so that essentially continuous information is obtained from each element. Preferably the scanning device should operate directly at the output of the measuring elements without requiring preamplification. The amount of preamplification required is determined by the noise generated by the scanner as it scans the measuring elements. The noise performance of a scanning device can be presented on a universal curve which will enable its operation under most practical conditions to be predicted from one set of readings. Scanning devices are described which are capable of scanning at rates on the order of 100,000 elements per second.

(c) "THE POINT-CONTACT PHOTOCONDUCTANCE CELL" by George D. O'Neill, Sylvania Electric Products Co., Bayside, N. Y.

The action of radiant energy on the conductivity of a metal-germanium point contact will be briefly described and demonstrated. With suitable germanium crystals properly prepared, the impinging photons create hole-electron pairs. Holes produced close to the whisker are collected by the whisker so that the conductivity of the device is a function of the radiation intensity in the vicinity of the contact. The area over which useful interaction takes place is quite small, as recombination occurs rapidly. The magnitude of the response is large in the optimum wavelength region. With proper concentration of the light, the response is much greater than with conventional photocells. The frequency response is very high and will follow intensity variations up to at least 10^5 per second. A demonstration will be given of some applications including switching, punched-tape and sound-track pickup.

(d) "A MULTIPURPOSE D-C AMPLIFIER WITH REDUCED ZERO OFFSET" by Will McAdam, R. E. Tarpley, and A. J. Williams, Jr., Leeds and Northrup Co., Philadelphia, Pa.

"Zero offset" is the amount of amplifier input required to bring the output to zero, and hence can be a component of error. In contact-modulated d-c amplifiers zero offset is usually negligible, but under sufficient amplification some zero offset can be observed. This paper describes an amplifier, primarily for current measurement (using a calibrated resistor), in which the zero offset is consistently less than 1.4 times the peak-to-peak fluctuations from thermal agitation. The impedance level set by the calibrated woven-wire resistor is one megohm and the zero offset is consistently less than 10^{-12} ampere. The means used in attaining this performance are discussed. Overall d-c feedback provides stabilization of gain and a "null-current input" (low input impedance). A hypothetical circuit approximating the dynamic null-current input is explained. An improved method to provide additional null-current ranges is described. A second one megohm woven-wire resistor provides a voltage range for each current range. The zero offset for the voltage ranges is consistently less than one microvolt.

11. COMPUTERS, Michigan Room, Session Chairman, E. R. WHITEHEAD, Illinois Institute of Technology, Chicago.

(a) "THE STUDY OF OSCILLATOR CIRCUITS BY ANALOG COMPUTER METHODS" by Han Chang, R. C. Lathrop and V. C. Rideout, University of Wisconsin, Madison, Wis.

A high speed electronic analog computer can be applied to the study of self-oscillating circuits. The use of the computer is considered to be superior to experimenting with actual oscillators in many cases, for the following reasons: (1) It is possible to conveniently produce nearly any desired gm characteristic by using an arbitrary function generator. This means that optimum gm curves for a particular oscillator circuit can be determined without resorting to the construction of special tubes. (2) Theoretical analysis of oscillators frequently requires that an idealized gm characteristic be used. Since either idealized or actual gm curves may be synthesized on the computer, it is possible to check the idealized theoretical analysis with either the idealized or actual experimental results. (3) The circuit parameters can be varied quickly and conveniently.

(b) "ROSETTE PRINCIPAL STRAIN COMPUTER" by C. M. Hathaway and R. C. Eddy, Hathaway Instrument Co., Denver, Colo.

This report concerns an instrument developed to compute the magnitude, direction, and sense (tension or compression) of the major and minor principal strains existing in a stressed member. This is done by solving the applicable equations for the output of resistance type strain gages cemented to the stressed member in any of several simple geometric configurations or rosettes. The problems of switching to accomodate the various equations are discussed. The designs of the power supplies, amplifiers and oscillator, the computing dynamometer with its servo system, and the angle indicating oscilloscope are covered.

(c) "A VERSATILE SMALL SCALE ANALOG COMPUTER" by James T. Carleton, Westinghouse Electric Corp., East Pittsburgh, Pa.

The development and use of the Anacom, general purpose analog computer, have demonstrated that a large number of problems may be solved without the use of many bulky and expensive elements. A versatile small scale analog computer has been developed which is capable of solving a large number of problems independently and which, when used in conjunction, broadens the scope of the Ancom itself. This paper describes the small scale analog computer and its application to the solving of closed loop regulating problems. Typical problems are illustrated by examples.

(d) "AN ELECTRICAL ANALOG COMPUTER FOR INDETERMINANT MECHANICAL STRUCTURES" by J. P. Corbett and J. F. Calvert, Northwestern University, Evanston, Ill.

The application of a simple analog computer to problems arising in the design of large size indeterminant structures with rectangular framing is described. Elements of an electrical network are connected in almost the same diagramatic form as are the beams and columns of the physical structure. In addition impedances are connected to ground from each circuit junction. When electric currents are forced into the junctions of the network, such that the magnitude of each is proportional to the sum of the fixed end moments at the corresponding points of the structural framework, the absolute value of the resulting electrical potential to ground appearing at each junction in the electrical system is proportional to the angular rotation at the corresponding junction point of the structural framework. The signs of the potentials are alternately the same as and opposite to those of the angular rotations. Provisions for reading potentials with signs which match those of the angular rotation is made through the meter wiring. A study showed that potentials, calibrated in terms of angular rotations, could be read at the rate of about 300 to 400 per hour after the wiring connections were plugged into the computing board.

12. ELECTROACOUSTICS, North Terrace, Session Chairman, B. B. BAUER, Shure Bros., Inc., Chicago.

(a) "FUNCTION OF A-C BIAS IN MAGNETIC RECORDING" by R. E. Zenner, Armour Research Foundation of Illinois Institute of Technology, Chicago.

The function of AC bias in magnetic recording is analyzed in a manner similar to that used to explain amplitude modulation. Certain simplifying assumptions are made to facilitate manipulation of mathematical expressions. The analytical results are compared with experimental observations of harmonic distortion, amplitude of fundamental, spurious recorded frequencies, frequency response, difficulty of erasure and the like.

(b) "RECENT DESIGN DEVELOPMENTS IN ELECTRONIC ORGAN TONE GENERATORS" by S. L. Krauss and C. Tennes, C. G. Conn, Ltd., Elkhart, Ind.

The tone generators to be described produce two tone characters simultaneously. The resultant non-sinosoidal tone is of particular interest because of its unique character and ready acceptance in the electronic organ field. Listener preference trends will be discussed in reference to the tone character evolved. The generator units are of compact construction and use inexpensive tubes and a minimum of electrical components for economical manufacture and ease of service. An instrument utilizing the generators discussed will be demonstrated to illustrate the solo, ensemble and the novelty effects achieved.

(c) "DESIGN OF LOUDSPEAKER ENCLOSURES" by Leo L. Beranek, Massachusetts Institute of Technology, Cambridge, Mass.

Loudspeaker enclosures need not be as large in volume as has been supposed by many experimenters. The box should include sufficient absorbing material to eliminate resonances, and it should be chosen so as to suitably dampen the lowest loudspeaker resonance. If a very low amplifier impedance is used, overdamping of the resonance will occur if large damping is introduced into the loudspeaker enclosure. Location of the loudspeaker and location of acoustical materials in the enclosure and its shape are treated.

4:00 P. M.—Meeting of the A.I.E.E. Sub-committee on Electronic Instruments, Lincoln Room

4:00 P. M.—Round Table Discussion on Television Station Operation, Balmoral Room, Second Floor

Facilities will be provided for an informal discussion on such matters as microwave techniques, tube life, video recordings, network connections, lighting techniques, remote pickups, etc. Representatives from television stations and equipment manufacturers are expected to participate in what is hoped will be an informal exchange of practical, useful operating information.

6:30 P. M.—OLD TIMERS NIGHT DINNER IN THE BALL ROOM (Ladies Invited. Dress Informal.)

WEDNESDAY, SEPTEMBER 27

8:30 A. M.—REGISTRATION

North end of Passaggio

9:00 A. M.-3:30 P. M.—EXHIBITS

Displays of new electronic equipment, developments, components and historical exhibits.

East and West Lounges and Passaggio

9:00 A. M.—I.R.E. Chicago Section Executive Committee Meeting, Lincoln Room

10:00 A. M.—TECHNICAL SESSIONS

13. OSCILLOGRAPHY, Ballroom, Session Chairman, E. H. SCHULZ, Armour Research Foundation of Illinois Institute of Technology, Chicago.

(a) "PROGRESS REPORT ON MILLIMICROSECOND OSCILLOGRAPHY" by Y. P. Yu, and P. S. Christaldi, Allen B. DuMont Laboratories, Inc., Clifton, N. J., and H. E. Kallman, Consulting Engineer, New York, N. Y.

Considerable progress has been made in CR tubes, cameras and circuits for high-speed oscillography in measuring short time intervals. High-gain deflection amplifiers of the distributed type have been developed. One to be described, has a voltage gain of 3000 and is down only

30% at 150 mc. A balanced undistorted output signal of over 130 volts is developed and the overall rise time is less than 0.004 microsecond. 2 inch deflections are obtained on CR tubes operating at 29 kilovolts. One form of the amplifier provides uniform amplification from zero frequency. High-speed sweep circuits employing gas-filled tubes exhibit some starting-time jitter. A high-vacuum linear sweep generator has therefore been developed with speeds up to 400 inches per microsecond, resulting in balanced, jitter-free output capable of producing two to three times full-screen deflection. Departure from linearity does not exceed about 5%. Repetition rates up to 40 kc are obtained, with the probable upper limit many times that frequency. Calibration is accomplished with gated oscillator circuits producing timing marks at intervals of 2 millimicroseconds, which also does not appear to be the upper limit attainable.

(b) "A SIX CHANNEL CATHODE-RAY RECORDING OSCILLOGRAPH" by Warren D. Tilton, Jr., Hathaway Instrument Co., Denver, Colo.

The characteristics and design problems of a six-channel cathode ray recording oscillograph with particular emphasis upon the design work necessary to make the instrument versatile so that it may be used for a multitude of recording applications is presented. The oscillograph is designed to record transient and recurrent phenomena of frequencies from d-c to 100 KC upon moving and still charts. The moving charts are either 35 mm or six inches wide and operate up to speeds of 6000 inches per second. Mechanical and electrical design problems are discussed, such as the construction of a three-foot diameter drum which is driven at 3000 RPM to attain chart speeds of 6000 inches per second. The electrical circuits discussed are those used to intensify the cathode ray tubes at different points of the drum travel, control circuits for operating chart drive motors, and a high voltage regulated power supply.

(c) "A PORTABLE PROJECTION OSCILLOSCOPE" by Victor Wouk, Beta Electric Corp., New York, N. Y.

The instrument described presents an oscillogram 14" x 16" capable of being viewed by large audiences in rooms with normal ambient light levels. The frequency response is flat vertically to about 50 KC, and usable to about 120 KC. Horizontally, the response is flat to over 100 KC, and is usable to 300 KC. Linear sweeps from 20 cps to 7 KC, are available. A "Norelco" projection television optical system is employed to render the unit unusually compact. It weighs 55 pounds, and occupies a cabinet 13" x 19" x 16". The viewing screen fits inside the cabinet, rendering the unit completely portable. Means for making direct film recordings are provided. Design details will be outlined and possible applications pointed out.

(d) "A CATHODE-RAY OSCILLOGRAPH FOR IMPULSE TESTING" by W. G. Fockler, Allen B. Dumont Laboratories, Inc., Clifton, N. J.

The instrument described uses the 5RP11A CR tube with a thin aluminum backing on the screen material to improve brightness and stability, and a shield between deflection plates to reduce the effect of cross coupling. It contains a precision voltage calibrator accurate to ±1%, regulated accelerating voltage power supplies, a wide range of crystal-controlled frequencies for timing waves, adjustable trigger or sweep delay, and an adjustable line phase delay circuit for use where 60 cycle excitation is applied to the piece under test. Since the signal input impedance of the equipment is 75 ohms, RG59/U coaxial cable is employed to get the desired signal delay. Using a small matching section, the cable reproduces the pulse very accurately without the reflections encountered with lumped constant lines. The camera has an f/1.5 lens, uses 35 mm film, and has provision for exposing and removing single frames. The instrument and some test results will be shown, and operating techniques and precautions in the testing laboratory will be outlined.

14. INSTRUMENTATION AND COMPONENTS, Michigan Room, Session Chairman, G. H. FETT, University of Illinois, Urbana, Ill.

(a) "NON-LINEAR TECHNIQUES FOR IMPROVING SERVO PERFORMANCE" by Donald McDonald, Cook Research Laboratories, Chicago.

Speed of response and accuracy of servomechanisms have greatly improved in the last ten years resulting from the development of highly refined techniques of linear analyses for closed loop systems and from the improvement of servo motors and controllers. Fundamental limitations in these factors will be discussed. If nonlinear elements are used in servomechanisms, system performance can be improved without improvements in the characteristics of existing controllers and servo motors. This practice has been neglected because of the extreme difficulty encountered in handling and solving nonlinear differential equations. Phase plane and space analysis applied to nonlinear servo problems give an analytical interpretation of the effect of nonlinear elements and assist in the design of nonlinear servos. Energy relations are derived of general use in servo problems, and criteria for improved servo performance are outlined.

(b) "ELECTRONIC CONTROL FOR HEATING SYSTEMS" by J. M. Wilson, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

The basic "moduflo" system described consists of one or more room thermostats, an outside anticipator or compensator, and an electronic amplifier. The temperature sensing elements are resistance elements with positive temperature coefficients. They operate into an A.C. bridge circuit feeding the amplifier, which via relays controls any type of automatic furnace using gas, oil, or coal in radiant, warm air, hot water, or steam heating systems. Control is effected by varying the burner off-on cycles in direct proportion to the heating load as anticipated by the electronic control equipment. Operation is explained and advantages over mechanical control systems in the form of steady room temperatures, lower heat losses and greater sensitivity to changing conditions are outlined.

(c) "AUTOMATIC CONTROL OF INACCESSIBLE TERMINAL VOLTAGES" by R. L. Cosgriff and E. H. Gamble, Curtiss Wright Corp., Columbus, Ohio.

The problem of controlling some quantity such as a voltage or current not accessible for conventional feedback control appears frequently. A good example is controlling the air gap flux in a two-phase induction servomotor. In many cases it is possible, provided all network elements are not constant or unknown, to control the desired quantity if only fixed elements couple the two input terminals to the two terminals where the controlled quantity appears. The method adopted uses a conventional constant feedback amplifier to drive the device in which the physical quantity is to be controlled so that the coupling network output voltage is very nearly proportional to the amplifier voltage. An analysis of this method is presented and is applied to the two-phase motor case. Tests are described and data are presented to verify the method and its application. Limitations of the method are outlined and examples of suitable problems are mentioned.

(d) "BOROCARBON FILM RESISTORS" by R. O. Grisdale, A. C. Pfister, and G. K. Teal, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Recent years have seen an increasing growth in the use of pyrolytic carbon resistors. Known variously as "cracked carbon resistors" or as "high stability carbon film resistors", they comprise very thin films of microcrystalline carbon formed over the surfaces of suitable ceramic cores. While primarily developed for high frequency applications in this country, the pyrolytic carbon resistor possesses other characteristics which have led and are leading to greatly expanded fields of application. Principal among these are the tolerances of one per cent or better attainable in production, the stability in use, the relatively small and predictable temperature coefficient of resistance, and the low noise level. Unlike thin metal films, the specific resistance of pyrolytic carbon films is independent of film thickness within the limits of experimental error, and the films, which are on the average only a few hundred millionths of an inch thick, have been employed in resistors. The temperature coefficient of resistance for the films, which is always negative, increases from a lower limiting value of about —180 parts per million per degree Centigrade (PPM/°C) with thick films to about —750 PPM/°C for very thin films with a resistance per square cm. of about 20,000 ohms. It is expected that borocarbon resistors will find widespread use in the telephone plant and in the communications and electronic field in general.

15. **NUCLEONICS I, North Terrace, Session Chairman, EARNEST WAKEFIELD, Radiation Laboratories, Chicago.**

(a) "ELECTRONICS ASPECTS OF RADIATION INSTRUMENTS" by E. E. Goodale and R. M. Lichtenstein, General Electric Co., Schenectady, N. Y.

D. C. Amplifiers with high input impedance for current and charge measurements are considered along with grid currents, leakage currents, insulation, stray capacities, input and output impedances, and the effects of negative feedback. The type of circuit action required in Geiger Tube quenching circuits and various methods of accomplishing it are taken up. Noise, bandwidth, overshoots, gain and inverse feedback in linear amplifiers and the principles of operation, design, and analysis of non-linear ("trigger") circuits are discussed. High voltage power supplies are covered.

(b) "CORONA VOLTAGE REGULATOR TUBES FOR NUCLEONICS" by D. L. Collins, Victoreen Instrument Co., Cleveland, Ohio.

The use of corona voltage regulators offers several advantages over other methods of regulation commonly used. These are illustrated in a discussion of tube characteristics, theory of operation, parameters, and applications. Typical circuits are presented for scintillation and proportional counter applications, and for both fixed and variable laboratory power supplies.

(c) "ELECTRONICS IN PARTICLE ACCELERATORS" by T. M. Dickinson and T. W. Dietze, General Electric Co., Schenectady, N. Y.

Whenever a new type of equipment is conceived, there immediately arise many new problems to tax the ingenuity of the designer. Since particle accelerators or "atom smashers" are essentially electronic devices, consisting of evacuated enclosures in which charged particles are accelerated and deflected by the influence of electric and magnetic fields, the work of the electronic engineer starts with the basic design of the machine itself. Then follows the design of all of the components involved in injecting and removing the particles, timing of these operations, the application, generation and regulation of accelerating voltages, metering of the high energy beam, and protection of components. This paper briefly describes the operating fundamentals of various accelerators and then goes into some detail on the more interesting and unusual electronic circuits devised to meet the special problems.

12:15 P. M.—LUNCHEON IN THE MARINE DINING ROOM

Chairman, Karl Kramer, Jensen Mfg. Co., Chicago, Executive Vice President of the N.E.C.

Address by John V. L. Hogan, President of Interstate Broadcasting Company, Inc. and Radio Inventions, Inc. Past-president of I.R.E. Subject: "What's Behind I.R.E.?" Introduction by Raymond F. Guy, National Broadcasting Company and National President of I.R.E.

2:00 P. M.—TECHNICAL SESSIONS

16. **INDUSTRIAL CONTROL, Ballroom, Session Chairman, W. G. DOW, University of Michigan, Ann Arbor, Mich.**

(a) "INDUSTRIAL ELECTRONIC CONTROL DESIGN PRACTICES" by E. H. Vedder, Westinghouse Electric Corp., Buffalo, N. Y.

Electronic control is now widely used but not universally accepted in industry. In only limited fields is electronic control the only practical method. Acceptance increases only as electronic control becomes competitive in cost, performance and reliability to other methods. Some control equipment uses 100 or more tubes and failure of any one may shut down a large mill. Even 10,000 hour tube life operating 24 hours a day is comparatively short, and though other components have improved markedly, much further improvement is needed. Receiver-type components are unsuitable for industrial use, especially sockets, potentiometers and plugs. Circuit designers cannot rest on present laurels if any. Constant efforts must be made to reduce complexity, eliminate critical adjustments, develop "fail safe" circuits and remove the necessity for calibrated tubes and components. Typical control apparatus will be used to illustrate current design practices.

(b) "ELECTRONICS IN ELECTRIC POWER CENTRAL STATIONS" by A. J. Ward, Sargent and Lundy, Chicago.

For maximum utilization of new developments in industry, all divisions should be aware of needs and progress in other divisions where similar functions are performed. This paper constitutes a survey of Central Power Station electronic applications considered by component function. Single function devices such as rectifiers for control and power conversion, low-burden isolating amplifiers for instrumentation, power amplifiers for servo circuits and drives, bridge and balancing circuits for measurement and error detection, and specialty devices for conductivity measurement, flame failure detection, etc. are separately considered. Combinations of such devices with each other and with mechanical devices to perform more complex functions are outlined. Finally, complete electronic systems for communication, television and other similar functions are discussed to round out the survey and indicate where further work is needed.

(c) "AN INDIRECT METHOD OF PROCESS CONTROL" by R. G. Durnal, Westinghouse Electric Corp., Pittsburgh, Pa.

A method of servomechanism process control applicable to processes in which it is difficult or impossible to measure the primary variable is described. It is best suited to processes in which the energy input is electrical in nature, but is also applicable where input quantities can be converted to electrical signals. The method involves the formulation of a secondary or indirect variable consisting of a product of electrical quantities. This secondary variable is then regulated by a servomechanism operating on the process input. Several means of generating the secondary variable are described and analyzed. A practical example of the method to a physical process requiring the generation of the application of the method to a physical process requiring the generation of the product of velocity times the cube root of current is described.

17. **SIGNAL GENERATORS AND ANALYZERS, Michigan Room, Session Chairman, B. D. WICKLINE, Illinois Bell Telephone Co., Chicago.**

(a) "A 20 MC TO 1,000 MC SWEEP OSCILLATOR" by John E. Ebert, and Herbert A. Finke, Polytechnic Research and Development Co., Inc., Brooklyn, N. Y.

The sweep oscillator described covers the frequency range from 20 to 1,000 MC in one continuous tuning adjustment and at the fundamental oscillator frequency. A novel tank circuit forms the core of the instrument. At the high frequencies it is a conventional quarter wave coaxial line resonator with a plunger. As the plunger moves back for low frequency operation the exposed section of the inner conductor gradually tapers from a solid tube to a helix. Because of the inductive loading the wavelength is greatly foreshortened on this section and the resonator covers a large frequency range in short travel. Frequency sweeping is accomplished by rotating, with a synchronous motor, a specially shaped condenser plate close to the high impedance end of the tank cavity.

(b) "A MINIATURE CRYSTAL CONTROLLED S-BAND SIGNAL GENERATOR" by W. F. Marshall, Bendix Radio, Div., Baltimore, Md.

A compact, portable S-band signal generator especially designed for field testing of microwave receivers is described. It uses the well known principle of harmonic generation by pulsing a silicon crystal with a suitable U.H.F. signal. Accurate frequency measurement at microwave level is obviated by generating the U.H.F. signal from a stable crystal oscillator followed by frequency multiplication stages. The series mode oscillator produces a 50 mc. output which is tripled in a pentode stage and doubled in a suppressor modulated 6AS6 output stage, with the suppressor biased to cut-off for pulsed operation or grounded for C.W. operation. The modulator unit contains a trigger generator with variable PRF, a variable delay generator, and a modulator pulse generator with adjustable pulse width. A 1N21C crystal multiplier provides an output of 10 millivolts into a 50 ohm load at the 10th harmonic of the 300 MC input. Use of broad band tuned circuits in the oscillator-multiplier makes crystal plug-in operation possible over a 100 mc. range at S-band frequencies. Exclusive of power supply, only six miniature tubes are required with a total power drain of less than 50 watts.

(c) "A HIGH RESOLUTION SPECTRUM ANALYZER" by Theodore Miller and David S. Sims, Westinghouse Research Laboratories, East Pittsburgh, Pa.

A high resolution spectrum analyser for operation in the 50 KC region of the radio spectrum is described. A frequency range of three kilocycles may be examined with a resolving power equivalent to 20 cycles. A continuous self-recording system capable of recording over a 60 decibel level is included as an integral component of the instrument. The minimum time required for "sweeping" across a narrow band-pass filter is also considered.

18. NUCLEONICS II, North Terrace, Session Chairman, LOUIS MEAD, Tracerlab, Inc., Chicago.

(a) "RADIOACTIVE SNOW GAGE WITH TELEMETERING SYSTEM" by J. A. Doremus, Motorola, Inc., Chicago.

In the past, the water content of snow cover in mountainous areas has been measured by a laborious process. A completely revolutionary system has been devised in which a small sample of radio-active material is buried close to the surface of the ground at the place where measurement is desired. A Geiger-Mueller tube is suspended over the spot and detects the radiation from the sample. As snow falls, it fills the space between the sample and the G-M tube and thereby attenuates the radiation. The attenuation is a function of the water-content of the snow cover and therefore gives the desired data at one reading. Impulses from the G-M tube are conducted to a telecoder which turns these pulses into signals which can readily be transmitted via radio. A frequency-modulated transmitter operates for a certain period each day sending the coded signals toward the recording station. This system will provide an accurate check on the available water from snow in the California mountains where in the summer, diligent use of this water makes every gallon worth its weight in oranges.

(b) "DESIGN CHARACTERISTICS OF AIR PROPORTIONAL COUNTERS" by A. C. Scheckler, General Electric Co., Syracuse, N. Y.

A description is given of an investigation of the effect of dimensional changes upon the characteristics of air proportional counters. The investigation is based upon observations of results and upon basic studies, such as the study of flux distribution due to the high voltages imposed upon a proportional counter. An effort is made to define the electrical characteristics of the associated circuitry by means of the limitations imposed by the physical and electrical characteristics of the proportional counters. A novel method of coupling proportional counters to their associated circuitry is described. An attempt is made to define the extent of the field of usefulness of proportional counter for counting beta-gamma and/or alpha particles are described, and the effect of these limitations upon counter design and associated circuitry is pointed out.

(c) "AN INVESTIGATION OF A SCINTILLATION COUNTER USING ANTHRACENE CRYSTALS" by Bernd Ross, Radiation Counter Laboratories, Inc., Chicago.

A quantity of anthracene was purified by a process based upon P. R. Bell's method. Crystals as large as 4.2 cm x 4.6 cm x 1.9 cm were grown from Riley's Scintillation Grade Anthracene, and the material purified by the author. A quantity of anthracene crystals was obtained from Harshaw Chemical Co. A comparison of the gamma efficiencies of these crystals was made in a scintillation counter using a type RCA5819 photo multiplier. The wavelength of the maximum intensity from the fluorescence emission spectrum of anthracene was determined with a Littrow spectrograph, and the relative efficiency of the photomultiplier for that wavelength was calculated. The magnetic defocussing effect upon the multiplier was investigated by rotating the counter and all associated equipment in the earth's magnetic field. A gamma absorption curve in lead, and integral bias curves for Ra gammas were plotted. Test results and these curves are presented. An increased counting rate by a factor of 25 was noted for the scintillation counter as compared to a thin window G-M tube (Tracerlab TBC1) for Ra gammas at equivalent geometries.

7:30 P. M.—Armed Forces Communications Association, Sheridan Room

EXHIBITORS

COMPANY	BOOTH NO.
Aerovox Corporation, New Bedford, Mass.	39
American Phenolic Corp., Chicago, Ill.	42
Arnold Engineering Co., Chicago, Ill.	59
Ballantine Laboratories, Inc., Boonton, N. J.	17
The Barry Corporation, Cambridge, Mass.	47
Berkeley Scientific Co., Richmond, Calif.	16
Bird Electronic Corporation, Cleveland, Ohio	3
The Book Shop Bindery, Chicago	37
Boonton Radio Corp., Boonton, N. J.	8-9
Brush Development Co., Cleveland, Ohio	44-45
Central Lab Div. Globe-Union Inc., Milwaukee, Wis.	66
C. P. Clare & Co., Chicago, Ill.	12
The Clough-Brengle Co., Chicago, Ill.	6
Central Scientific Co., Chicago, Ill.	24
Concord Radio Co., Chicago, Ill.	36
Condenser Products Co., Chicago, Ill.	60
C G. Conn, Ltd., Elkhart, Ind.	41
Cossor (Canada) Limited, Halifax, N. S., Canada	18
Allen B. DuMont Laboratories, Inc., Clifton, N. J.	25-26
Electro Products Laboratories, Inc., Chicago, Ill.	49
Electro Voice, Inc., Buchanan, Mich.	57
Engineering Research Assoc., Inc., St. Paul, Minn.	90
Freed Transformer Co., Inc., Brooklyn, N. Y.	61
General Electric Company, Schenectady, N. Y.	20-21
General Radio Co., Cambridge, Mass.	31-32
Goodyear Aircraft Corp., Akron, Ohio	29-30
Hathaway Instrument Co., Denver, Colo.	67-68
Hermetic Seal Products Co., Newark, N. J.	43
Hewlett-Packard Co., Palo Alto, Calif.	10-11
Industrial Electronics, Inc., Detroit, Mich.	72
Institute of Radio Engineers, Chicago Section, Chicago, Ill.	95
Institute of Radio Engineers, New York Headquarters, New York, N. Y.	96-97
Kay Electric Co., Pine Brook, N. J.	64
Leeds & Northrup Co., Philadelphia, Penna.	35
Roy J. Magnuson, Chicago, Ill.	62
Measurements Corp., Boonton, N. J.	69-70
Millivac Instrument Corp., New Haven, Conn.	48
Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Philadelphia, Penna.	55-56
Ohmite Manufacturing Co., Chicago, Ill.	71
Polytechnic Research & Development Co., Brooklyn, N. Y.	13
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RCA Victor Div., Tube Dept., Camden, N. J.	91-94
Raytheon Mfg. Co., Radio Receiving Tube Div., Chicago, Ill.	27
Robert A. Waters, Inc., Waltham, Mass.	46
Scintilla Magneto Division, Bendix Aviation Corp., Sidney, N. Y.	58
Shallcross Mfg. Co., Collingdale, Penna.	65
Signal Corps Engineering Laboratories, Fort Monmouth, N. J.	79-87
S. M. A. Company, Chicago, Ill.	33-34
Sola Electric Co., Chicago, Ill.	7
Sorenson & Company, Inc., Stamford, Conn.	40
Spencer-Kennedy Laboratories, Inc., Cambridge, Mass.	28
Sprague Electric Co., North Adams, Mass.	5
Superior Electric Co., Bristol, Conn.	50-51-52
Surprenant Mfg. Co., Boston, Mass.	1-2
Tech Laboratories, Inc., Palisades Park, N. J.	22
Technology Instrument Corp., Waltham, Mass.	19
Tektronix, Inc., Portland, Oregon	14-15
Tel-Instrument Co., Inc., East Rutherford, N. J.	53-54