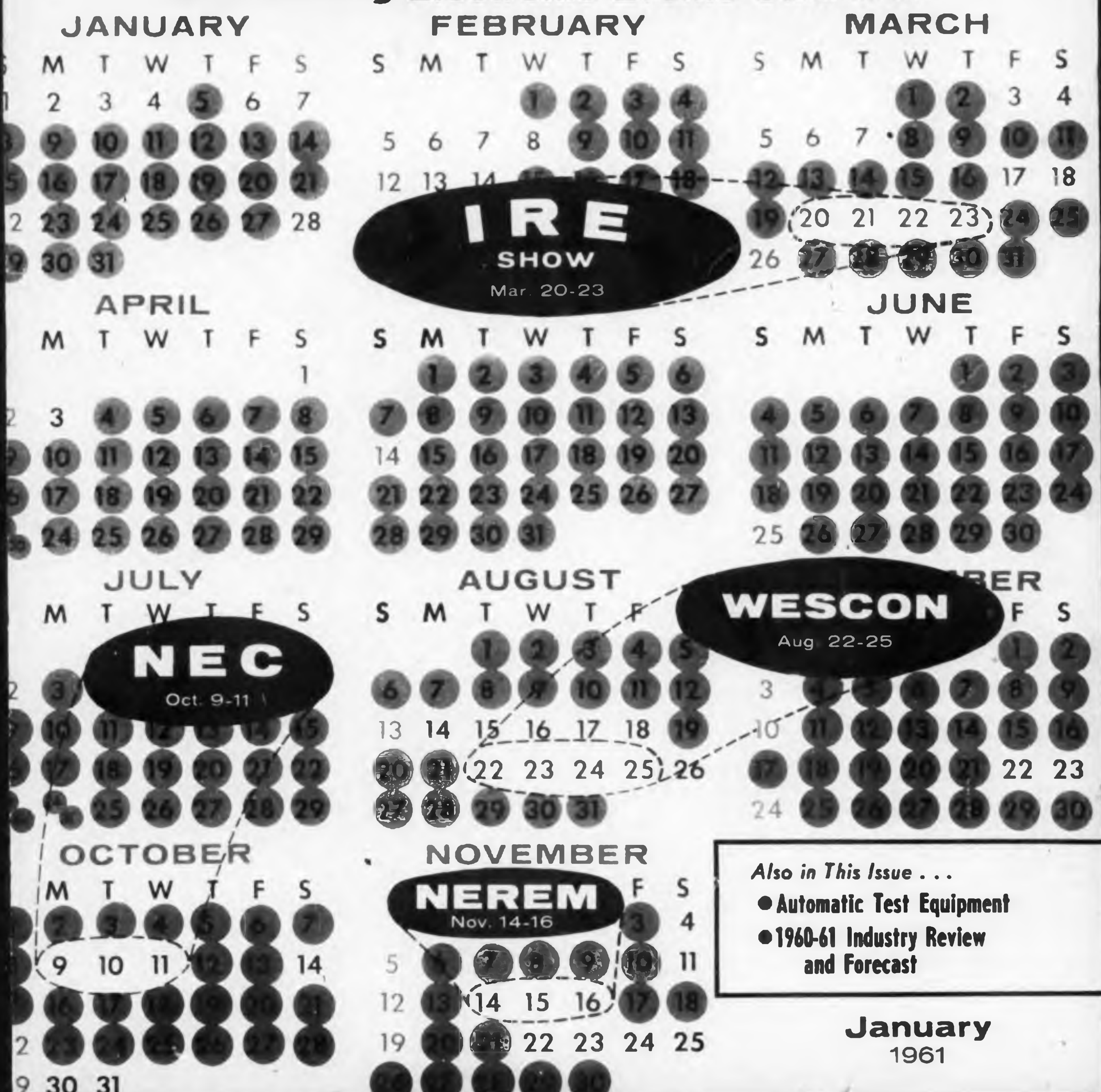
A CHILTON PUBLICATION

1961 Coming Electronic Events Calendar



Also in This Issue . . .

- **Automatic Test Equipment**
- **1960-61 Industry Review and Forecast**

January
1961

ELECTRONIC INDUSTRIES

ROBERT E. McKENNA, Publisher • BERNARD F. OSBAHR, Editor

Electronic Industries —1960-61

THIS has been another record business year for the electronic industries. The total 1960 industry product comes to approximately $10.75 billion composed of: military and government equipment at $5 billion, consumer goods (retail) $3.1 billion, commercial and industrial electronic equipment $1.75 billion, with nearly another billion dollars for replacement parts.

In this issue we have prepared a very comprehensive statistical roundup of the industry that starts on page 124. This information, coupled with that on the "Electronic Industries Totals" pages contained in each month's issue, is aimed at keeping interested readers abreast of all vital marketing information as it becomes available. Along these lines, also in this issue, we should like to call your special attention to the survey article by Jerome Kraus discussing the U. S. Electron Tube and Semiconductor Market for 1961-1965. It starts on page 214.

The current business slow-down, a new president-elect, and our troubled gold position constitute major factors of uncertainty in predicting business conditions for 1961. In checking, we find that most business executives expect 1961 to be about the same in the overall as 1960. Prices, profits and costs are expected to remain at about the same levels. Of course, some industry segments such as semiconductors, microwaves, microminiaturization, and molecular electronics will forge ahead at greater rates than others.

Last month we noted that 1961 would be a record year for conventions, meetings and shows. The total number of days for these activities exceeds the total number of working days in the year. This month we have attempted to illustrate this graphically on our front cover. We have also indicated those which we consider to be prime regional events. It is hoped that through collaboration and cooperation of the interested groups and societies many of the smaller meetings can be tied onto one of the main regional events. The Institute of Aeronautical Sciences and the American Rocket Society have already taken the initiative in this direction and have combined forces for their 1961 West Coast Summer meeting.

In 1960 our editorial staff study program met with considerable success. We list here the subjects that were covered: "Human Factors — Newest Engineering Discipline" (February); "New Roles for the Electron Gun" (March); "The Challenge of Space" (April); "Searching for New Electronic Markets" (July); "Electronics and the Future of Agriculture" (August); "Unconventional Power Converters" (Sept.); "Summary of Microwave Electron Devices" (November); and "MINUTEMAN, Catalyst for Reliability" (December). For those interested, a limited number of reprints for each of these studies are still available. The series of articles on Radio Frequency Interference appearing in March, April, May, June, July, September, October and December issues also received a very high reader acceptance. During 1961 we intend to continue with both these programs. We are in the editorial planning stages now and would welcome any additional reader suggestions for new topic coverage.

During 1960, as well as in past years, we produced four issues with special themes. In March there was the annual IRE Show and Convention issue; in June we had our technical All-Reference and Directory issue; August was the annual WESCON show and convention issue; with November providing the 9th Microwave Issue. In 1961 we shall continue with this grouping. We also have no plans to change the frequency of publication of ELECTRONIC INDUSTRIES. Our aim will be to keep EI as the prime technical *monthly* center for engineers engaged in the design, research, development, manufacture and operation of electronic equipment.

We take this opportunity to thank our readers for their past interest and support. Your continued cooperation promises to make this, our nineteenth consecutive year of publishing, better than ever before. From all EI staff members, a very happy new electronic year to all!

ELECTRONIC INDUSTRIES, January, 1961. Vol. 20, No. 1. A monthly publication of Chilton Company. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. Accepted as controlled circulation publication at Phila., Pa. $1 a copy; Directory Issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr. $18.00; 2 yrs. $30.00.

ELECTRONIC INDUSTRIES

Vol. 20, No. 1 — January, 1961

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

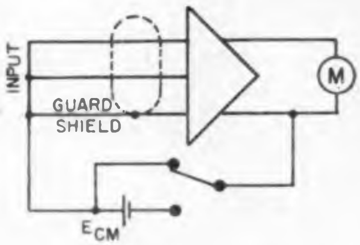
DEPARTMENTS

Highlights

of this issue

Vibration Transducer

Low Level Inputs



Jacobians

Servo Hunting

Crystal Oscillator

Automatic Test Equipment — page 76

There is a great interest in automatic test equipment for complex systems. Some of the problems involved in designing flexible, high-speed, full automatic checkout systems for use by unskilled personnel are described and discussed here.

Designing for Low Level Inputs — page 81

The problems of low level input instrumentation have mushroomed with the missile era. Not only is the new terminology defined in this article but also positive suggestions are offered to eliminate systems engineering problems involved.

Using Jacobians for Frequency-Selective Networks — page 86

This article is an experiment. Instead of presenting a short discussion for those familiar with Jacobians, and a long table of results for those who are not, the entire article contains only one simple network—so simple that results can be verified intuitively.

One Solution to Servomechanism Hunting — page 92

Usually a servomotor drives a potentiometer so that the input voltage exactly matches the feedback voltage. With precision wire-bound pots this is not always possible because of the voltage difference between windings. Precision carbon film pots seem to be the answer.

Level Gauges in the Liquid Helium-Liquid Oxygen Range — page 96

With more emphasis being placed on the operational status of missiles and space vehicles, the problem of simplifying fuel level sensing for field use magnifies. The high sensitivity thermistor is a leading contender for the detector.

Designing a Lightweight Vibration Transducer — page 100

Special transducers must be developed to handle dynamic measurements of electronic hardware under vibrational environments. These devices should be "throw-aways" which can be left in the equipment after the measurements are made. Size and weight are also critical since they affect the data.

Development of an Oscillator for 450-470 MC — page 198

The design and development of a stable, reliable crystal oscillator is a problem made a little harder by new FCC regulations for mobile communications. Here is an engineer's thinking behind the design and development of an oscillator for use under rugged conditions.

Electron Tubes and Semiconductors—What's Ahead — page 214

Electronic tubes and semiconductor devices are parts of much larger equipments or systems. The demand for them depends on many diverse elements including consumer taste and U. S. defense and foreign policy. In this dynamic industry, a forecast cannot be an extension of past performance alone, but must also consider the impact of new developments. This forecast is based on such an analysis.

RADARSCOPE

INFRA-RED WINDOW

The largest germanium infra-red window ever cast, 15 in. in diameter and half-inch thick, is checked by optical technician at Hughes Aircraft Company. The window will be used in detection systems for missile guidance and space surveillance.

RUSSIANS' SOLID-STATE RESEARCH has been accelerated so spectacularly that within 5 to 10 years the Soviets may be publishing more material on the field than the U. S. This is a conclusion of the Government's Office of Technical Services, Business & Defense Services Administration. Most prominent feature of the Soviet's work is reportedly their excellent theoretical research.

THE MILITARY DEPARTMENTS have agreed to forecast their requirements for 13 categories of electronic components on a 5-year basis. The first 5-year forecasts will be released next July. It will cover three types of batteries; 7 capacitors; 7 resistors; all transformers and reactors; 5 electrical indicating instruments; 3 relays; 3 quartz crystals and filters; 4 receiving tubes; 13 power, transmitting special-purpose tubes; 4 semiconductor diode rectifiers and related devices; 2 transistors and all types of connectors and servos.

FAA IS EXPERIMENTING with "forward scatter" to provide communications on the air routes over the North Atlantic. Present h-f communications are frequently interrupted by sunspots, auroral blackouts and selective fading. The FAA hopes that "forward scatter" will provide reliable communications 98% of the time.

HAVE THE SOVIETS developed a synthetic transistor? Rumor out of Moscow is that Nobel Prize Chemist N. N. Semenov has developed a synthetic transistor made of polyacrylonitrile that has parameters similar to germanium transistor.

COMPUTER INDUSTRY is taking a definite form, which may or may not mean more dollars for the electronic end. The trend was first noted a year ago when the Government announced plans to pool their computers so that more Government Depts. could use them. The trend seems to be finding favor with private industry, as well. Plans are for tying both large and small firms to centralized electronic data processing centers which will have on hand a wide variety of computing equipment to handle any particular application. Two segments of the industry are involved, working somewhat independently. The computer people are manufacturing sophisticated, high-powered computers for these centers, and the communications people are concentrating on setting up data transmission links. At this point, while the number of small general-purpose computers is increasing, the increase is at a decreasing rate, while the number of large high-powered computers is increasing at an increasing rate. The small computer field seems to be turning more towards specialized equipment, tailored to meet specific needs in industry.

COCKPIT DISPLAY

Capt. Pete Nagurney, chief pilot of ITT Labs, checks his position over the New York metropolitan area on the new VORTAC Pictorial Display developed by ITT. The pilot sees exactly where he is during every moment of flight by following the intersection of two moving red lines.

Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation

SMALL BUSINESS has been awarded 8,121 prime Government contracts valued at $342,526,468 during the period July through October, 1960. This represents an increase of $81.5 million in contracts over the same period last year.

THE MICROWAVE SPECTRUM is of interest to scientists in many fields outside of electronics. Biophysicists are finding that they can better study living matter in microwave radiation fields. Microwave spectroscopy is being looked to as one of the most important tools for studying matter in solid and gaseous states. At the same time physicists are studying the interaction between microwaves and gas-discharge plasma, because microwaves penetrating through ionized gas permit determination of the electron density, temperature and rift velocity in the plasma. In other applications microwaves are allowing extreme accuracy in measurements, such as measuring the distance to satellites orbiting around the earth.

"TOUCH" SYSTEM for pilot communications proposed by research psychologists at the Human Engineering Laboratory of the Rome Air Development Center, would change frequencies of voice into mechanical vibrations. Pilot would feel the vibrations through a plate in contact with his body. Project is still in research stage.

NOT EVERYONE is disenchanted with "value analysis," contrary to some recent reports. Cost reduction proposals during a recent two-week value engineering seminar at the California Branch of Librascope Div., General Precision, Inc., had an (estimated) saving of $50,000 on the POLARIS program alone. Librascope is a major supplier of POLARIS fire control electronic subsystems.

MAGNETOSPHERIC WAVEGUIDES, magneto-ionic ducts extending from the ionosphere in the northern hemisphere to the ionosphere of the southern hemisphere could guide high frequency transmission between the hemispheres, according to Prof. Thomas Gold, director of Cornell's Space Center. Signals entering these ducts—over 10,000 miles long—leave with practically the same strength. NSF supported the study.

FERRO-ELECTRIC MATERIALS are being studied for use in microwave devices by Caswell Electronics Corp. and the Univ. of Michigan Research Institute. Initial studies aim at developing rapid phase shifters.

MISSILE BLOOM effect is being studied by Radiation Inc., Orlando, Fla. Missile bloom is a whitish glow surrounding missiles at an altitude of about 120 km. It has a rapid growth that persists for many seconds and has a diameter of several miles.

THE IMPORT-EXPORT HASSLE is being further snarled by the Government's attempts to resolve the dollar crisis. Many Government people feel that pressure should be brought to bear on manufacturers who have moved their manufacturing operations overseas—this would include a sizeable number of electronic firms. But another school says that the profits that will ultimately flow back to the U. S. will more than overbalance the temporary outflow of dollars.

SUBTLE "BUY AMERICA" PROGRAM is being met with an equally devious effort to conceal the fact that equipments are of foreign manufacture. Where previously firms were content to leave the question of origin dangling, large numbers are now bold enough to claim that they are personally manufacturing items completely manufactured overseas. Federal Trade Commission is pushing action against a number of these firms vigorously.

WE SEE A TREND developing which will give engineers a bigger share in management decisions—especially in matters concerning depreciation policies and methods. Financial and accounting people do most of the work in this area now, but they are calling on engineers more and more to make decisions which hinge on the effects of technological change. The engineers—to be of real help—will also have to learn more about the accountant's trade.

INDUSTRIAL RESEARCH AND DEVELOPMENT totalled approximately $10 billion in 1960. The aircraft industry accounted for approximately 33% of the money expended, and electrical equipment and communications 25%.

CHECKING TIROS CAMERA

Alignment of the wide-angle television camera on the Tiros II weather satellite is checked by Sidney Sternberg, chief engineer of the RCA Astro-Electronics Division and engineer Ralph Jordan at the RCA Space Center, Princeton, New Jersey.

As We Go To Press . . .

Plotter Draws Weather Map in Three Minutes

The U. S. Weather Bureau has in operation an electronic computer - plotter that mechanically draws a complete weather map of the Northern Hemisphere in less than three minutes. Unit, the Weather Plotter, reads information from magnetic tape and presents this information to a digital-to-analog converter.

Converter instructs the "mechanical hand" of the plotter to automatically draw isobars on a 30 x 30 in. map of the Northern Hemisphere. Unit was developed and produced by Electronic Associates, Inc., Long Branch, N. J.

OLD TUBES STILL WORK

42-year old radio set built by Western Electric Co. for the Signal Corp still works. Inspecting set are (L to R): R. A. Heising, original set designer; Major Gen. R. T. Nelson, and W. H. Doherty, Mngr., Patents Licensing, Western Electric Company.

New Telemetry System

A new data multiplexing system, SS-FM, uses single sideband subcarriers on an FM carrier. It permits transmission of approx. 45,000 cycles of data at an accuracy of 5% in the same r-f bandwidth now used by an FM-FM system with a capacity of 4,000 cycles of data. Up to 30 db improvement in signal-to-noise ratio is realizable.

System was developed at NASA's George C. Marshall Space Flight Center, Huntsville, Ala. for the Saturn program. They were assisted in the hardware development phase by Motorola, Collins Radio, and Lenkurt Electric. System was developed to provide transmission capacity for vibration and other wideband data required by the rocket designer.

Slide Rule Locates Orbiting Satellite

The Air Research and Development Command's Rome Air Development Center has a new type slide rule which quickly locates a satellite moving around the earth. The computing device pinpoints the satellite's path and determines geographical areas visible from the satellite. It also gives the frequency and times it will pass over any particular points on the ground.

Simulator also can be worked backwards to give the launch conditions (time and place) necessary to achieve a satellite's journey. Planning Research Corp., Los Angeles, built the device called the Satellite Trajectory Simulator.

IRE Officers for '61—Berkner is President

Lloyd V. Berkner, Pres., Associated Universities, Inc., has been elected President for 1961 of the Institute of Radio Engineers. Vice Presidents are: (Overseas) Franz Ollendorff, Research Professor at the Technion-Israel Institute of Technology, Haifa, Israel, and (North America) J. F. Byrne, Manager, Riverside Research Lab., Motorola, Inc., Riverside, Calif.

Directors (1961-1963) are: E. F. Carter, Stanford Research Institute, Menlo Park, Calif.; and L. C. Van Atta, Hughes Aircraft Co., Culver City, Calif.

Regional Directors (1961-1962): A. B. Giordano (Region 2), Polytechnic Institute of Brooklyn; A. B. Bereskin (Region 4) University of Cincinnati; M. W. Bullock (region 6) Continental Electronics Manufacturing Co., Texas; and B. R. Tupper (Region 8) British Columbia Telephone Co., Vancouver, Canada.

TV Award

The Institute of Radio Engineers has awarded the Vladimir K. Zworykin Television Prize to Dr. Peter C. Goldmark, President and Director of Research, CBS Laboratories, Stamford, Conn.

He was cited for, "Important contributions to the development and utilization of electronic television in military reconnaissance and in medical education."

ATLAS GUIDANCE

SAC guidance crews for the ATLAS Radio-command guidance system stand-by at an operational Atlas launching site. Maintenance panel is on the left—guidance control officer at guidance console, right.

Update Conelrad

The U. S. Air Force, the FCC, The Associated Press, and United Press International will integrate the entire facilities of the two major wire services for use as an alert system in event of a national emergency. Under the new system, virtually every radio station in the nation can be notified of enemy attack in 3 to 8 minutes. The old system took up to 1 hour. One man can trigger the alert.

ASW Electronics Needs Major Breakthrough

The Military Marketing Data Committee (EIA) says that the electronic market within the Navy's antisubmarine warfare program is relatively small and is likely to remain so unless there is a major scientific development in the field. Right now the market is about $185 million of a total $240 million alloted by the Navy for the ASW program. By 1965 they predict $325 million for electronics out of a total $400 million.

New developments are needed in the areas of long-range detection and classification of submarine and simplified, inexpensive ASW equipment. Marketing opportunities in this area will be concentrated in improved sensors and data processing systems, and command and decision-making equipment.

More News on Page 8

Electronic SHORTS

▶ An Educational Electronics Division has been formed through consolidation of the educational sales groups of Thompson-Ramo-Wooldridge's subsidiary, Magnetic Recording Industries and the companies' Dage Television Div. The new division will be responsible for marketing a wide range of commercial electronic products for use in schools. The products will include CCTV systems, language laboratories, teaching machines, recording systems, electronic classrooms, and other educational services. The division headquarters is at 126 Fifth Avenue, New York City.

▶ Up-to-date information on Government-supported technical R & D work can now be obtained regularly from the Small Business Administration. Abstracts of R & D reports covering principal industrial categories will be provided to interested small manufacturers upon request. These manufacturers will select from an SBA check-list the categories for which they desire technical information. The abstracts in these categories will then be mailed to them automatically as they are issued.

▶ A new high-resolution receiving antenna whose narrow beam sweeps rapidly and continuously by purely electronic control of phasing has been designed and tested by the Antenna Research Section, Radio Systems Div. of the Boulder Laboratories, NBS. There are no mechanically-moved parts in the antenna array. The array consists of seven 5-element Yagis, optimized for a maximum front-to-back ratio of 30 db. Dolph-Chebyshev current distribution is used to limit side lobes to below −20 db. The system, operating at 41 MC, swings a 5.8° beam in azimuth through a 42° sector each 1/20 second.

▶ The FAA has ordered United States airlines to install flight recorders on all jet-powered planes by next May. The regulation went into effect November 1, but if airlines encounter installation or procurement difficulties, extensions will be granted up to May 1st. The units, connected to certain key instruments, record on tape such factors as air speed, and other performance data. Units are enclosed in a small cabinet impervious to fire, impact and water damage.

▶ A Repetitively Pulsed Plasma Accelerator (REPPAC 1) has been fired continuously for 18½ hrs. at GE's Missile and Space Vehicle Dept., Phila. There were nearly 4,000,000 individual firings at the rate of 3,000/min. Each firing produced about 1/10 oz. thrust. The program aims to prove feasibility of using pulsed plasma acceleration for space vehicle attitude control.

▶ A Burroughs Corp. B100, electronic check sorter, has been installed in the National Savings and Trust Co., District of Columbia. The sorter uses MICR—Magnetic Ink Character Recognition. Sorter is the first unit of a complete electronic system the bank plans to install during the next year.

▶ Westinghouse Electric Corp.'s new Astracon light amplifier tube has photographed the faint tracks produced when cosmic rays penetrate a solid crystal. The Astracon takes incoming photons and uses them to release electrons from a light-sensitive input surface. Electrons are accelerated and guided successively onto a series of thin films. At each film, an incident electron ejects five or six more electrons which move to the next film. In a 4-stage tube, they emit about 10,000 photons for each original photon.

▶ "Long-range missiles with computer memory units sealed in their nose cones could be the 'homing pigeons' of future nuclear wars," says Dr. Leonard S. Sheingold, Sylvania Electric Products, Inc. The system could be one way of transferring large volumes of information over ranges of up to thousands of miles—connecting high-data-rate computer facilities at several points on the globe—after conventional communications channels are destroyed.

▶ Gulton Industries, Metuchen, N. J., has designed a new, rechargeable nickel-cadmium battery with a true hermetic seal for highly reliable, long-life outer space performance. The 5-amp. cell can absorb a charge current of 1 amp indefinitely. It can operate for at least 20,000 duty cycles over a period of many years.

Ground Traffic Radar

New Airport Surface Detection Equipment (ASDE) radar, in operation at the Washington National Airport, sweeps the field every second to give a detailed picture of ground traffic, moving or still. Use of instrument landing systems and Airport Surveillance Radars have speeded up airport traffic so much that clearing of runways is becoming increasingly important.

HEART STOPS, IT CALLS DOC

Units that stimulate a patient's faltering heart and broadcast an alarm to the doctor are demonstrated by inventor, Morris Tischler (R) to Edwin H. Seim, Mngr., Westinghouse Electric's X-ray & Industrial Electronics Div.

New Doppler Antennas To Be Tried By FAA

Better radio signals may result from tests of a new type of antenna to be conducted by the FAA at its National Aviation Facilities Experimental Center at Atlantic City.

Feature of the new antennas, being developed by Dorne & Margolin, Inc., Westbury, L. I., under a $124,497 R&D contract, is their size, making it possible to put 100 of them in the usual Doppler installation instead of the present 50. This increase in number of antennas produces a better signal with less "shadowing" effect between antennas, according to FAA engineers. Size of the antenna has been reduced through the use of a cylindrical vertical form instead of the loop antenna now in use with the Doppler.

A new type of signal distributor will also be tested in connection with the antennas.

HUGHES LINE OF K_u-BAND BWO's

Hughes K_u-band backward-wave oscillators are all permanent-magnet tubes with the compact, lightweight Hughes design that has proved so reliable. They are ideally suited for use in microwave signal and sweep generators, panoramic receivers, spectrum analyzers, frequency scan and navigational radars and countermeasures equipment. They feature low spurious output and narrow spectrum width. They are designed to give you thousands of hours of trouble-free life.

The new 326H, shown here, is of particular interest. It is specifically designed for use in test equipment and other strictly commercial instrumentation—and priced for that market. It is a small, streamlined tube with excellent operating characteristics.

All the tubes shown here are production products. Hughes will ship to meet your immediate requirements. For prices and full particulars, write today to Hughes Microwave Tube Division, 11105 Anza Avenue, Los Angeles 45, California.

THE 326H For commercial applications. Minimum output: 10 mw over 12.4 to 18 kmc band with power rising to 65 mw in the center of the band. Like all Hughes BWO's, the Hughes 326H requires no external cooling. All electrodes are isolated from each other and from the case.

CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY

MICROWAVE TUBE DIVISION

THE 315H Minimum average power: 50 mw. Frequency range: 15.8-17.2 kmc. Total weight of tube and magnet: 11.5 lbs.

THE 316H Full band. Minimum average power: 10-60 mw. Frequency range: 12.4-18.0 kmc. Total weight of tube and magnet: 11.5 lbs.

THE 317H Min. avg. power: 60 mw. Frequency range: 13.5-15.5 kmc. Total wt., tube and magnet: 10 lbs.

THE 318H Min. avg. power: 30 mw. Frequency range: 17.5-19.5 kmc. Total wt., tube and magnet: 10 lbs.

Circle 3 on Inquiry Card


MACH 5... MACH 10...
and Beyond
STEVENS Certified THERMOSTATS
Type MX shown;
other Certified disc types available
2° to 6°F Differential Standard
1° to 4°F Differential Special
*Maximum spread of 6°F
including differential and tolerance
STEVENS manufacturing company
STEMCO
THERMOSTATS

Coming Events in the electronic industry

"CALL FOR PAPERS"

17th Annual Society of Plastics Engineers, Inc., Tech. Meeting, Jan. 24-27, Shoreham Hotel, Wash., D. C. Deadline date for papers: Aug. 1, 1961.

American Mathematical Soc., Feb. 22, 1961, Yeshiva Univ., N. Y. Deadline date: Jan. 10, 1961; **Aug., 1961, Stillwater, Okla.** Deadline date: Jan. 10, 1961; **Nov. 17-18, Milwaukee, Wis.** Deadline date: Jan. 10, 1961. Contact: Mrs. Robert Drew-Bear, Head, Special Project Dept., AMS, 190 Hope St., Providence 6, R. I.

Symp. on Materials and Electron Device Processing, Apr. 5-7, 1961, Benjamin Franklin Hotel, Phila., Pa. Submit title and 200-word abstract to Dr. D. E. Koontz, Bell Tel. Labs., Murray Hill, N. J., no later than Jan. 2, 1961. Manuscripts by Feb. 15, 1961.

Radio Tech. Commission for Marine Services Meeting, Apr. 5-7, Sheraton Palace Hotel, San Francisco, Calif. Deadline date for papers: Mar. 15, 1961. Forward to: G. R. McLeod, Exec. Sec'y, RTCM, c/o FCC, Wash., 25, D. C.

8th Annual Society of Tech. Writers and Publishers Convention, Apr 13-14, Mark Hopkins Hotel, San Francisco, Calif. Deadline date for papers: Feb. 1, 1961. Forward to: G. F. Estill, Gen'l Chairman, Maintenance Regulations Mgr., United Air Lines, Intn'l Airport, San Francisco, Calif.

9th National Conf. on Electromagnetic Relays, Apr. 25-27, Oklahoma State Univ., Student Union Bldg., Stillwater, Okla. Deadline for all papers: Mar. 1, 1961. Forward to: Prof. Charles F. Cameron, School of Electrical Engineering.

Spring Conf. for 1961, Chicago Prof. Group on Broadcast and TV receivers of the IRE, June 15-16, O'Hare Inn, DesPlaines, Ill. Deadline for papers: Submit 3 copies of following by Feb. 15, 1961—50 to 100 word summaries including title of paper, author's name, position, title, company affiliation. Forward to: Neil Frihart, Motorola, Inc., 4545 W. Augusta Blvd., Chicago 51, Ill. Limit papers to 2500 words (20 min. presentation).

American Society for Testing Materials Annual Meeting, ASTM, June 25-30, 1961, Chalfonte-Haddon Hall, Atlantic City, N. J. Deadline for papers is January, 1961. Contact Society Hdqs., 1916 Race St., Phila. 3, Pa.

1961 Western Electronic Show and Convention, Aug. 22-25, Cow Palace, San Francisco, Calif. Deadline date for papers: 100-200 word abstracts, 500-1000 word detailed summaries by May 1, 1961. Forward to: E. W. Herold, c/o WESCON's Northern Calif. Office, 701 Welch Road, Palo Alto, Calif.

International Symp. on the Transmission and Processing of Info., Sept. 6-8, 1961, M.I.T., Cambridge, Mass. Receipt of 500-1000 word Abstracts . . . Jan. 1, 1961. Receipt of full length papers . . . Apr. 1, 1961. Submit to: Peter Elias, Research Lab of Electronics, M.I.T., Cambridge 39, Mass.

10th Annual Instrumentation Conf., Nov. 2-3, Louisiana Polytechnic Instit., Dept. of Mech. Eng'g, Louisiana Tech. Student Center, Rushton, Louisiana. Deadline date for papers: June 1, 1961. Forward to: Dr. Virgil Orr.

(See page 107 for "Coming Events")

Radarscope *(Continued)*

"SALES UP, PROFITS DOWN"—This refrain is being repeated monotonously as companies check in with the year-end totals. Expect the profits squeeze to be countered by stepped-up research activities to bring out new products, and increased capital expenditures to improve operating efficiencies.

THE 9 MAJOR TV MANUFACTURERS have consented to a Federal Trade Commission order demanding that the buyers of TV sets be fully informed as to the material going into the cabinet. The art of simulating wood in metal and plastics has become so refined that customers are easily misled by appearance.

FCC IS CONCERNED about the frequent turnover of broadcast stations, wondering openly whether station owners are not simply engaged in trafficking in broadcast properties. The Commission feels that the disruption in operating continuity could be causing programming deteriorations incompatible with broadcasting in the public interest. The Commission records show that for the past three calendar years an average of 555 applications were filed for changes in ownership of stations; approximately 83% for AM stations, 9% for FM stations and 7% for TV stations. More than half of the applications involved stations that had been held by the owners for less than 3 years.

COINCIDENCE added a plus to the recent Discoverer 17 shot. The Air Force's bio-medical and nuclear radiation satellite was launched shortly after a gigantic solar storm occurred. Satellite was exposed to intense radiation for over 50 hrs. Lockheed scientists hope to learn more about the flux, particle type, and energy of the flare itself as a result. Biological specimens did not receive a lethal dose—encouraging news for astronauts.

FIGURES POINT to a smaller increase in private industry expenditures for R & D this year compared to 1959 but a healthy rise is still expected. National Science Foundation reports $9.4 billion for 1959 (up 15% over 1958); but only an 8% rise in '60 over '59 for a total of about $10 billion. Electrical-electronic and aircraft industries get a good share of these funds. Over half (57%) of R & D funds came from the Gov't.

COBOL, a Common Business Oriented (computer) language has been used successfully to interchange programs between data processing systems of different manufacturers. Information was exchanged between Remington Rand's UNIVAC 11 at its Phila. Engineering Center, and RCA's 501 Systems Center at Cherry Hill, N. J. COBOL is a programming system that uses simple English words instead of a complicated machine code, to instruct a computer.

new μmesa* transistors...

450-mw free-air dissipation in one-tenth the volume —of a TO-18 package

*Trademark of Texas Instruments Incorporated

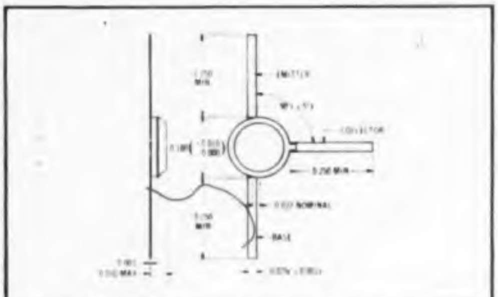
TI 450/451

silicon transistors give you more power per package volume than any other silicon transistor

Use these TI *second generation* transistors to complement your *second generation* high-speed computers.

Check the outstanding advantages of the TI 450 and TI 451 . . .

- ☑ 1/10 the volume of a TO-18 package
- ☑ 450-mw free air dissipation @ 25°C
- ☑ hermetically-sealed-in reliability
- ☑ backed by a full year's warranty
- ☑ electrically the same as 2N706A and 2N753
- ☑ ribbon leads for "two-dimensional" mounting
- ☑ 1/5 the weight of a TO-18 package – only 0.07 gms
- ☑ heat sinking simplified by electrically isolated case



SUGGESTED MOUNTING METHODS

Conventional mounting for dip soldering.

Alternate mounting technique for welded connections or silk-screened wiring connections.

Electrical characteristics @ 25°C ambient

Symbol	Parameter	Test Conditions	Type	Min	Max	Units
t_{on}	Turn-On Time	I_{B1} = 3 ma, I_{B2} = 1 ma V_{CC} = 3 v, R_L = 270 Ω			40	nsec
t_{off}	Turn-Off Time	P. W. ≧ 400 nsec, less than 2% duty cycle			75	nsec
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 ma, I_B = 1 ma (Pulse Test)			0.6	v
h_{FE}	DC Forward Current Transfer Ratio	V_{CE} = 1 v, I_C = 10 ma	TI 450	20	60	
			TI 451	40	120	

Specify TI for all your silicon transistor requirements— small signal • switching • medium power • power

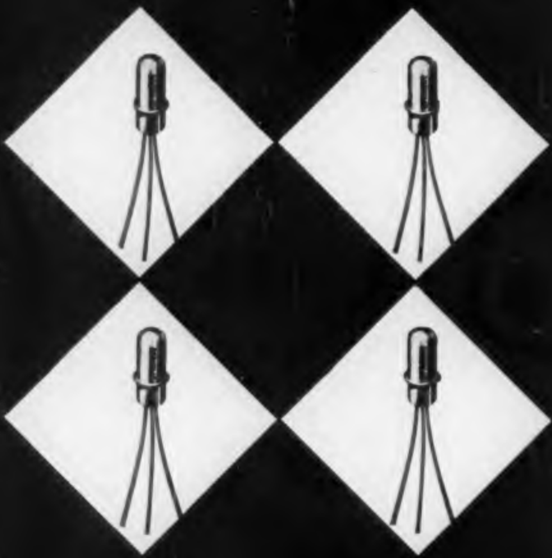
SEMICONDUCTOR-COMPONENTS DIVISION

TEXAS INSTRUMENTS

TEXAS INSTRUMENTS LIMITED, DALLAS ROAD • BEDFORD, ENGLAND

TEXAS INSTRUMENTS INCORPORATED, 13500 NORTH CENTRAL EXPRESSWAY • DALLAS, TEXAS

Circle 5 on Inquiry Card



AVAILABLE NOW IN MASS PRODUCTION

- the highest r-f operating frequency
- the fastest switching time
- cadmium junctions for cooler operation, greater reliability
- storage temperatures up to 100 C

YOU CAN GET SPRAGUE* MADT® TRANSISTORS AT SENSIBLE PRICES

Sprague Germanium Micro-Alloy Diffused-Base Transistors, well-known for their rugged vhf performance, are now *priced below other transistors* with comparable electrical characteristics. In many areas, this permits designers to improve circuit techniques without necessarily increasing costs. Expanded production facilities enable us to *ship quantity orders on short notice.* Add to this their *ultra-fast switching time,* and you have three good reasons why Sprague MADT® Transistors have achieved their high level of acceptance.

With Sprague Transistors, circuits in vhf amplifiers and oscillators can now operate with collector currents as high as 50 ma . . . with power dissipation up to 50 mw . . . with collector to base voltages to 15 v. They have been application tested through the entire military electronics vhf spectrum.

The application table may well suggest the use of one or more Micro-Alloy Diffused-Base Transistor types in your latest circuit designs.

For complete engineering data on the types in which you are interested, write Technical Literature Section, Sprague Electric Co., 233 Marshall St., North Adams, Massachusetts.

MICRO-ALLOY DIFFUSED-BASE TRANSISTOR APPLICATIONS

Type	Application
2N499	Amplifier, to 100 mcs
2N501	Ultra High Speed Switch (Storage Temperature, 85 C)
2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
2N588	Oscillator, Amplifier, to 50 mcs

You can get off-the-shelf delivery at factory prices on pilot quantities up to 999 pieces from your local Sprague Industrial Distributor.

• • •

SPRAGUE®

THE MARK OF RELIABILITY

**Sprague micro-alloy, micro-alloy diffused-base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable.*

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

Demand For High-Pay Execs Drops—But Pay Goes Up

Demand for higher-paid execs is less than it was earlier this year, but the opportunities that do exist will pay more. This from a survey by Executive Manpower Corp., 444 Madison Ave., N. Y. 22, N. Y. They surveyed 133 large companies averaging annual sales of $113 million.

Survey showed an average of 2.2 job openings per company paying from $10,000 to $75,000. A March survey showed an average of 2.5 jobs per company. A survey last year showed 3.5 jobs per company.

Sales execs were most wanted (28.5%). Manufacturing/production execs were in second place (21.9%) and general management-administrative execs third (16.1%). Engineering exec need drooped to fourth (14.7% from 22.5% last year). Marketing/advertising, and financial execs were tied for fifth place.

The jobs will pay more. 30.8% of the positions will pay $20,000 a year, or more, compared to 15.5% in this category six months ago. 9.6% will pay $30,000 or more compared to 4.6% last time. The majority of the jobs would be replacements rather than new positions.

How will these execs be paid? The most popular method is salary plus bonus followed by straight salary, salary plus merit raise, salary plus stock options, salary plus deferred payment and salary plus commission.

About a third of the executives recruited by these companies last year came from outside the company. This was a slight drop from the figure reported in the last survey. More of the firms (59.6% compared to 48.7%) reported that they had management development programs.

New York R&D Guidebook

Copies of "Directory of Industrial Research Laboratories in New York State" are available from the New York State Dept. of Commerce, 112 State St., Albany 7, N. Y. The publication lists more than 1,000 commercial and private research and testing labs, their research fields, names of their executives, and the number of scientists and engineers they employ.

FCC Denies Allocation For "MOBOT" Control

The FCC has denied a petition by Hughes Aircraft Co., requesting an allocation of 100 MC of microwave space in the 13,000—35,000 MC band for the exclusive use of radio - controlled robot devices (MOBOTs) operating in places dangerous to, or unlivable for, humans—such as those characterized by nuclear radiation, poisonous atmosphere, extreme pressure, vacuums, and extremes of heat and cold.

Present Mobots are controlled by cable. Hughes contends that radio would provide more mobility. FCC says it will entertain an application for such operation on an experimental basis to see if there is need for such allocation.

Research On Fuel Cells

The Thomas A. Edison Research Lab., West Orange, N. J., and Standard Oil's R & D Div., Chicago, have launched a joint research program on fuel cells. The fuel cell is a method of electrochemically oxidizing a fuel and converting it directly to electrical energy. (*See "Electronic Industries Looks at Unconventional Power Converters," Sept., 1960, pp. 101-116.*)

The Edison Lab. specializes in electrochemistry, electrolytes, cell reactions, electrodes construction—and activation, and electro-chemical cell construction. Standard Oil researchers will contribute their knowledge of catalysis, combustion oxidation, and hydrocarbon or petroleum fuel characteristics. The project aims at finding a practical and economical way to oxidize hydrocarbon, alcohol, or hydrogen as fuel for the cell. Several cells have been built but none have been practical enough to use a cheap fuel.

Shakedown In Component Business Started—Quill

"A shakedown in the electronic components business is no longer coming, it is here right now," says Joseph S. Quill, Manager of Advanced Marketing, for GE's Advanced Product Planning Operation, Schenectady.

Last year the highly competitive electronic industry in the U. S. had total factory sales of $9.2 billion (consumer equipment, replacement components, industrial-military products). EIA estimates an increase of 9% to $10 billion in 1960.

MEASURE LOW PRESSURES

This device, a photomultiplier ion gauge, can measure pressures to less than one-thousandth of one-billionth atmosphere at the earth's surface. Westinghouse physicists, Lange, Riemersma, and Fox developed it under the AEC's Project Sherwood.

Learning Gap Is Most Critical Area—Dr. Ramo

"Increasing the nation's brain power is more urgent for our national position and for the welfare of civilization than space conquest," says Dr. Simon Ramo, Exec. Vice Pres. of Thompson Ramo Wooldridge, Inc. He spoke before the Illinois Teachers' Institute in Chicago.

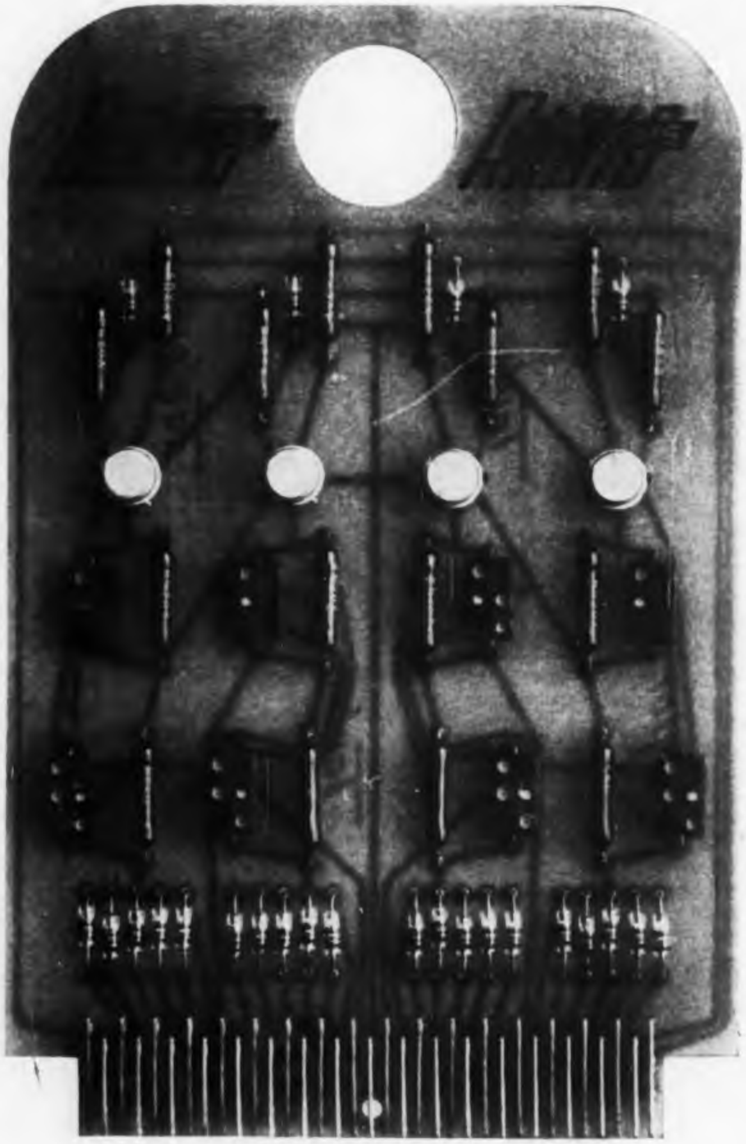
"Improving human brain power by education and extending man's intellect by electronics will buy us more benefits in social as well as scientific advances than concentration on any other field," he said. He predicted that the science of extending man's intellect by electronics (he called it "intellectronics") will become the nation's greatest industry within a decade.

He cited many advances in fundamental electronic techniques as examples: Electronic computers, automatic language translators, learning machines, and machines for the automatic examination and sorting of documents.

Engineers Decertify Union

Engineers at the Sperry Gyroscope Co. have voted to decertify the Engineers Association, IUE-AFL-CIO, as bargaining agent. The NLRB tally of ballots was: 1724 voted "no union"; 1509 voted "yes." More than 90% of those eligible voted.

More News on Page 19



In PRECISION POTENTIOMETERS **if it's news, expect it first from IRC**

Now—a commercial version of the popular square trimmer at 40% cost saving

Now available, a commercial version of the popular square trimmer at a 40% saving in price *and at no sacrifice in quality.*

Circuitrim Type 100—Ideal for circuit board mounting. ½" diameter x ⅛" thick, screwdriver slot in top for setting. 1 watt at 60°C. 10 to 50K ohms ±10%. 320° rotation. Also available, the popular subminiature square trimmer design. Circuitrim Type 200—Superior stability under extreme conditions. ½" square case interchanges directly with established designs. Teflon-coated leads or printed-circuit pins. 1.5 watts at 60°C. 10 to 50K ohms ±5%. Lead-screw actuation, 24:1 adjustment ratio.

Write for Bulletins AE-19 and AE-20. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

STOCKED BY AUTHORIZED IRC MAJOR INDUSTRIAL DISTRIBUTORS

IRC

Leading supplier to manufacturers of electronic equipment

HI-"V" TRANSFORMERS

by C-A-C

C-A-C can now build High Voltage Components rated up to 40,000 volts. New, modern test equipment has been installed. Corona measurements in accord with MIL-T-27A specifications. This addition to C-A-C's broad scope of activities in the magnetic component field will allow you to depend on C-A-C as a new source for High Voltage Transformers and Reactors.

High voltage Filter Reactor—Class "U"—Grade "5"

12,000 Volt Transformer—Class "T"—Grade "5"

Filament Transformer "HV Hi Pot" Rated.

C-A-C welcomes your inquiries on components requiring high levels of voltage output or designs such as the filament transformer shown, wherein the isolation of high voltage potentials is a factor.

C-A-C

COMMUNICATION ACCESSORIES COMPANY

Lee's Summit
Missouri

Phone Kansas City
LAclede 4-3500

318

News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

GENERAL INSTRUMENT CORP. has acquired a 30% ownership in Materials Research Corp., Yonkers, N. Y.

THE NATIONAL ASSOC. OF INDUSTRIAL PLANTS, INC. (NAIP), a new, non-profit, membership-type Trade Organization, has been formed to aid contractors and subcontractors under DOD regulations.

AUTONETICS, Div. of North American Aviation, Inc., has opened a new Integrated Industrial Products Facility at 3400 East 70th St., N. Y., N. Y.

SYLVANIA ELECTRONICS SYSTEMS, Div. of Sylvania Electric Products, Inc., is constructing a new Applied Research Laboratory Facility and new Headquarters Building on a 55-acre site, adjacent to present facilities in Waltham, Mass.

CORNING GLASS WORKS will build a 190,000 sq. ft. plant at Danville, Va., early in 1961, for manufacturing a wide range of specialty glasses under operation of the Company's Technical Products Div.

BRIGGS ASSOCIATES, INC., Norristown, Pa., and **VANGUARD AIR and MARINE CORP.**, Paoli, Pa., have agreed on a plan of merger to be submitted to their respective stockholders. Vanguard recently merged with Northeast Metals Industries, Phila., Pa.

SERVO DEVELOPMENT CORP., Hicksville, L. I., N. Y., has moved into a new 20,000 sq. ft. building at 2 Willis Court, to increase both development and production facilities.

THE SPRAGUE ELECTRIC CO., North Adams, Mass., has acquired Vec Trol Engineering, Inc., Stamford, Conn.

TENSOLITE INSULATED WIRE CO., INC.'s Mechtron Div., Water Street, Peekskill, N. Y., has opened a new facility devoted to the production of cable, cable assemblies and harnesses.

DU PONT CO., Engineering Dept., will build a plant at Buffalo, N. Y., early in 1961 for manufacture of "Telslar" PVF film. The plant will be operated as a unit of the company's Yerkes Research Lab.

AIRTRONICS, INC., subsidiary of Scovill Manufacturing Co., Waterbury, Conn., is doubling its facilities with the construction of a new $1 million plant in the suburban Washington, D. C., area. The 62,000 sq. ft. plant will open in March, 1961.

YORK RESEARCH CORPORATION, Stamford, Conn., has acquired Kip Electronics Corporation, also of Stamford.

TELETRAY ELECTRONIC SYSTEMS, INC., of Silver Spring, Md., and **AUDIO-DYNAMICS**, of Washington, D. C., have agreed to merge through an exchange of stock. Operation of the two corporations will be united under one roof at the Audio-Dynamics plant at 5462 Third St., N.W., Wash., D. C.

LORAL ELECTRONICS CORP., New York, has opened new plant and research quarters adjacent to the company's Headquarters Building. An 80,000 sq. ft., two-story structure, it will accommodate Loral's increased staff and accelerated range of research, engineering and production activities.

SONOBOND CORP., subsidiary of Aeroprojects, Inc., has established a new sales-demonstration headquarters at 202 East Market, West Chester, Pa.

AMP INCORPORATED, Harrisburg, Pa., was presented the "Growth Company of the Year" award for 1960 by the National Association of Investment Clubs. Composed of 5,532 investment clubs and over 76,000 investors, the association cited AMP as an "outstanding example of American free enterprise as shown by its sales and earning growth, excellence of products, outstanding management, public and employee relations.

MIDWEST

FANSTEEL METALLURGICAL CORP., North Chicago, Ill., has consolidated its former Muskogee (Oklahoma) Div., Chemical Div., and Metals-Fabrication Div. into one operating division known as the Chemical and Metallurgical Div.

COLLINS RADIO CO., Cedar Rapids, Iowa, has formed the Communication and Data Process Div. to provide Electronic Data Processing Services to Industry. The Division will integrate, research, products, experience and systems management capabilities of all Collins Divisions and subsidiaries.

FLO-TRONICS, INC., has expanded its Electronic Controls Div. by moving into new facilities at 712 W. Ontario St., Minneapolis, where automatic controls for material handling systems has been developed.

MINIATURE INSTRUMENTS and NATIONAL CONNECTOR CORP are the first two firms to begin construction activity at the 90-acre Science Industry Park, Minneapolis, Minn.

ZENITH RADIO CORP. will acquire from the Milwaukee Road (Milwaukee, St. Paul Railroad Co.) a plot of 28 acres on Chicago's West Side, extending one half mile from Austin Ave. to Narragansett.

GEMEX PRECISION METALS, INC., a new company created by Techno Fund, Inc., of Columbus, Ohio. Techno, in purchasing Gemex from the Vanderbilt Tire & Rubber Co., has committed $1 million in the new company.

THE BENDIX CORPORATION has contracted to purchase the assets of the Micrometrical Manufacturing Company, Ann Arbor, Mich., a producer of electronic-mechanical units for use in metal-working, paper and plastic fields. Micrometrical will continue operation as a subsidiary of Bendix, with its land and building utilized under a long-term lease.

REA MAGNET WIRE CO., INC., subsidiary of Aluminum Company of America, will occupy its 26,000 sq. ft. Laboratory near Ft. Wayne, Ind., in Sept. 1961. It will house labs, pilot plant, and various supporting facilities.

CONTROL DATA CORP., Minneapolis, Minn., has established a new electronic research laboratory at 5710 W. 36th St., St. Louis Park, to investigate the digital electronics equipment field.

HURLETRON, INC., Delaware, Md., has been formed through a merger combining the assets, personnel, and engineering facilities of Electric Eye Equipment Co., Danville, Ill., with those of Whenton Engineering Corp. of Wheaton, Ill.

RCA's ELECTRON TUBE DIV., Indianapolis, Ind., has produced its 500,000,000 receiving-type electron tube. From less than 100 employees producing nine types of tubes the plant has grown to more than 1,500 turning out 80 tube types.

WEST

CHANCE VOUGHT CORP., Dallas, Tex., is the new corporate name of Chance Vought Aircraft, Inc.

LAND-AIR, INC., Stepper Motors Div., Gardena, Calif., has acquired Automation Controls Corp., relay manufacturer.

CIRCUITDYNE CORPORATION, 421 S. Pasadena Ave., Pasadena, Calif., has been newly formed to control several Pasadena-based subsidiaries engaged in special purpose designing, manufacturing and assembling of electronic equipment.

VARIAN ASSOCIATES and EASTERN INDUSTRIES, INC., Palo Alto, Calif., have arrived at a preliminary basis for the merger of Eastern into Varian.

CHALCO ENGINEERING CORP., Gardena, Calif., has established its new subsidiary, Systems Services, Inc., which will specialize in systems installation and management focused on engineered installations of ground support equipment for missile and space programs.

DRESSER ELECTRONICS, **SIE** Division, is the new name for Southwestern Industrial Electronics Co., Houston, Tex., while **DRESSER ELECTRONICS**, **HST** Division replaces the name of the Hermetic Seal Transformer Co., Garland, Tex. The change in names to reflect Divisions rather than companies provides Dresser Industries with a more unified identification.

NARMCO INDUSTRIES, INC., wholly owned subsidiary of Telecomputing Corp., has purchased Electro Instruments Inc.'s 11-acre, 43,000 sq. ft. Research Facility in the San Diego, Calif., Research Park. It is adjacent to Narmco's R&D Division.

CONSOLIDATED ELECTRODYNAMICS CORP., subsidiary of Bell & Howell Co., has acquired the Nuclear Division of American Electronics, Inc., of Culver City, Calif.

GENERAL ELECTRIC CO.'s Electronics plant, 601 California Ave. in Palo Alto, Calif., is constructing a new 8,000 sq. ft. single-story addition to the present plant. Four air-conditioned areas will also be constructed for development and production of complex microwave devices.

BENDIX-PACIFIC DIV. of the Bendix Corp. has broken ground for the first-stage development of its new multi-million-dollar Electronics Center, on an 80-acre site in the northern San Fernando Valley, Calif. While the first building will be used primarily for electronic production, an adjacent building will house the Division's sonar testing facilities.

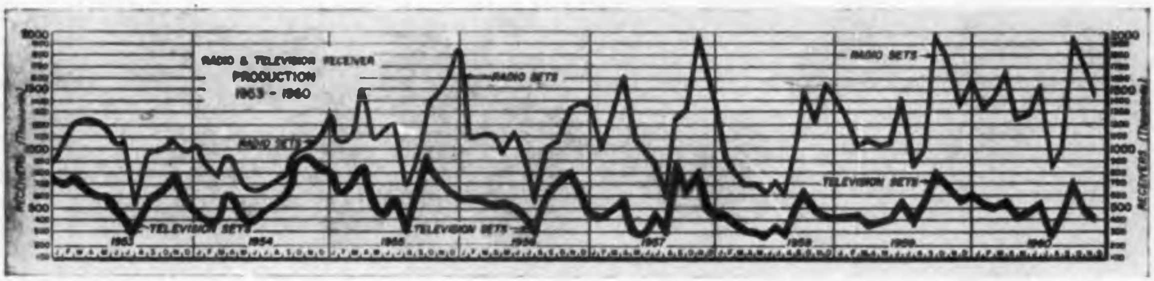
BIRTCHER CORP.'s Industrial Division has moved to a new, modern brick structure of 15,000 sq. ft. located at 745 South Monterey Pass Road, Monterey Park, Calif. Housed in the new plant are both manufacturing and sales facilities.

LINDE COMPANY, Div. of Union Carbide Corp. has opened a new warehouse at 7 South Linden Ave., South San Francisco, Calif., to supply rare gases and special rare gas mixtures to industry in the far West area.

PRECISION POTENTIOMETER MANUFACTURER'S ASSOC., a new professional organization, has been formed to establish standards for the Precision Potentiometer Industry. **DAVID C. McNEELY**, manager of Beckman's Helipot Div., has been elected President.

Facts and Figures Round-Up
January 1961

ELECTRONIC INDUSTRIES TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in November, 1960.

Amplifiers	679,865
Amplifiers, control	317,606
Amplifiers, synchro signal	101,325
Amplifiers, TW	55,000
Antennas	343,748
Batteries, dry	346,166
Batteries, storage	138,225
Bridges, impedance	129,632
Cable assemblies	389,996
Cable, special purpose	48,750
Cable, telephone	118,803
Calibrators, radiac	25,600
Cavity assemblies	102,999
Coder, transponder	32,188
Communications systems	4,140,289
Computers, flight director	440,000
Controls, electronic	1,836,754
Controls, panel	159,576
Correlators, video	66,801
Coupler, antenna	297,248
Detectors, radiac	144,557
Diode, semiconductor	67,003
Direction finders, radio	33,310
Distribution systems, radar data	705,000
Equalization systems	53,755
Filters, band pass	29,300
Flash units, electronic	35,094
Flight control systems, automatic	1,399,093
Fluxmeters	29,160
Fuel cells	36,974
Generators, thermal noise	35,263
Generators, VOR	50,177
Gyroscopes	166,309
Handsets	47,884
Intercommunications equipment	171,673
Measuring systems	95,457
Meters	29,722
Meters, field strength	46,856
Meters, microwave	45,600
Meters, volt	89,886
Meters, watt	33,913
Microphones	201,167
Motors, servo	258,120
Multicouplers, antenna	472,960
Multiplexers	566,343
Oscillators	58,659
Oscilloscopes	2,391,803
Power supplies	365,535
Programming sets	374,133
Radar equipment	9,694,358
Radar, doppler	710,764
Radio sets	1,502,119
Reactors, saturable	27,445
Receivers, loran	384,200
Receivers, radio	32,264
Receivers, SSB	69,012
Recorders—reproducers	534,543
Relays	25,924
Resistors, variable	27,334
Resolvers	61,206
Signal generators	121,057
Strobotacs	61,620
Switchboards	75,489
Switches, r-f	32,733
Synchros	117,900
Synthesizers, frequency	54,174
Tabulation & plotting systems, digital	98,545
Tape, magnetic	33,250
Telemetry equipment	913,956
Telephone equipment	326,990
Test equipment	4,234,162
Transceivers	481,992
Transformers	47,128
Transistors	142,586
Translators, frequency	33,538
Transmitters, marker beacon	153,734
Transmitters, radio	2,222,847
Transmitters, synchro	101,950
Tubes, electron	3,247,463
Tubes, klystron	482,714
Vacuum tube voltmeters	66,331
Waveguide	51,060
Wire, electronic	60,586

COMPONENTS & COMPANIES

Electronic components manufacturing in the United States is now a $3 billion annual business—almost three times the output of a decade ago—the Business and Defense Services Administration, U.S. Department of Commerce, reported.

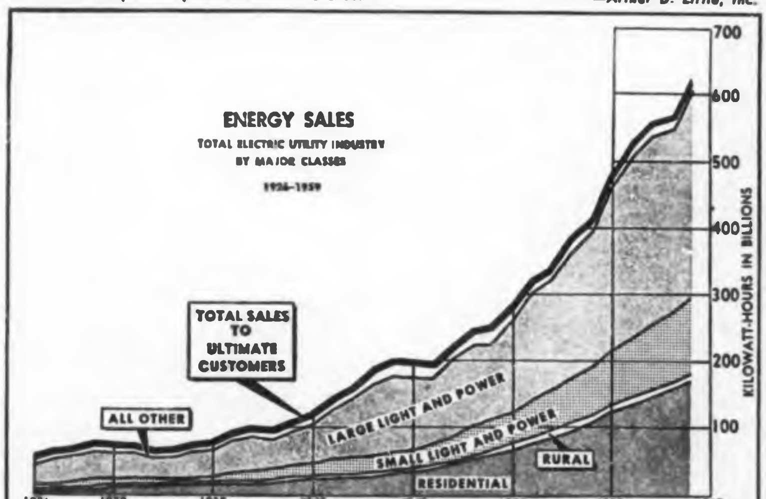
In its first major study of the electronic components industries—"Electronic Components, Production and Related Data, 1952-59," BDSA's Electronics Division says that more than 40% of the total output of these industries is now for military end-use—for the manufacture of military electronic equipment or for maintenance purposes.

Most electronic component producers are small, a relatively few firms accounting for most of the total output. About 75% of the total output is produced in 7 states. In 1959 almost 60% of the total value of shipments originated in 16 metropolitan areas located in 11 states.

Private industry is continually increasing its spending for research. In the next decade it is believed that private industry will quadruple its spending for research—from the current $4.5 billion to a staggering $16.5 billion by 1969. During the same period, over-all national spending for research will rise from $60 to $200 billion.

At the turn of the century in the United States, only 7% of the total manufacturing work force was in the non-production category — scientists, engineers and highly trained technicians—while today the percentage is 24%. The major portion of this gain was made in the past decade.

—*Arthur D. Little, Inc.*



—*Edison Electric Institute*

TRACKING TURNTABLE

Revolving table presents a 3-D display of lights for air traffic control, missile tracking, and ASW. Device, developed by ITT, presents pinpoints of light on a translucent, whirling screen under direction of a computer. Lights visible from all sides.

NEW SLANT ON SPACE

Nearly 9,000 tiny radar antennas on the skyward side of this structure enable ESAR (electronically steerable array radar) to focus its "eye" simultaneously on space vehicles and aircraft at lower altitudes. Bendix built the device for ADC and ARPA.

SILICON WHISKERS

In view magnified 10 times, silicon whisker easily slips through the eye of a standard needle. Scientists at Picatinny Arsenal are growing them for use in their research work as strain gages for detecting weaknesses in such parts as a landing gear.

Snapshots of the Electronic

TRAILBLAZER

Six-stage research rocket fired by NASA from Wallops Island serves as a reentry vehicle for M.I.T.'s Lincoln Lab radar and optical equipment. Research program is sponsored by Advanced Research Projects Agency.

HOT SPOT

Ceramic-quartz reflector is being used to fuse a tungsten carbide coating to a stainless steel rectifier shaft. Units, developed by Plastic Weld Co., Seattle, Wash., can sustain temperatures to over 3500°F controlled to within plus or minus 25 degrees.

Industries

LUNAR CAPSULE

(Left) Final shape of the 300-lb. lunar capsule being built by the Ford Motor Co.'s Aeronutronic Div. for NASA is shown in this artist's rendering. The bulbous capsule and its retrorocket are shown attached to the parent spacecraft which will carry it to moon's vicinity.

FOR DICTATION

International Business Machines Corp.'s new dictation devices use magnetic belts which can be used over and over. Belts hold over 14 minutes of dictation and have an automatic erasure feature. Tape can also be mailed, stored or filed. All products in the line—a dictating unit, a transcriber, and a combination unit are transistorized.

ZEUS COVERALL

Spherical radome, 110 ft. dia. built by Goodyear Aircraft Corp., houses R & D model of Zeus acquisition radar at White Sands Missile Range, N. M. Dome contains world's largest lens for focusing radio frequency energy. Lens is first large scale application of Luneberg lens concept.

CLOSE LOOK

Electron probe microanalyzer, at Jones & Laughlin Steel Corp., Pittsburgh, Pa., can determine the exact composition of a minute segment of steel (an area 1/250th of the thickness of a razor blade). It can detect small chemical changes from one grain of steel to another.

EI's International News

"Let U. N. Operate Space Communications"—Skinner

James M. Skinner, President, Philco Corp. says a system should be adopted by which international space communications would be provided and operated by the United Nations. Speaking before the Peninsula Manufacturers Assoc., he said that, "such international control would represent a major step toward global peace and understanding."

Messages of all kinds—voice, telegraph, teletype, even television—would be brought together in each country through the local communications service to some point—say, the Nation's capital. At that point, all messages are relayed by satellites to a central receiving point in some other country there to be distributed through the local service of that particular nation.

He noted that American space communications leadership is usually linked to military purposes and that it would be a major asset in the court of world opinion if we could demonstrate not only our peaceful motives, but also use our developments to provide a service which would be useful to everyone.

Buy U. S. Computers

Electricite de France, Saint Ouen, France, has bought an RW-300 Digital Computer system from Compagnie Europeenne d'Automatisme Electronique (CAE). CAE, a joint venture of Thompson Ramo Wooldridge, Inc., and two French electronic firms, makes and sells RW-300 computer systems in the European Common Market.

The RW-300 is a digital control computer for use in closed-loop control of full-scale manufacturing processes. Electricite de France will use the system for automatic control of a high-power steam generating plant. Over 600 process variables will be recorded and monitored. The computer will also calculate theoretical and actual performance values and control the plant operation.

British Electronic "Brain" To Read, Write, and Talk

London—Dr. W. K. Taylor of the University of London is building an electronic "brain" which will be able to see, to read, to write, and even to talk. The "talk" will be in the form of squeaks of varying pitch.

The new "brain" will use 4,000 cells (compared to man's 10,000 million) and an eye of 100 photoelectric cells. It will be able to do much more than respond to simple geometrical shapes and alphabetical symbols. The machine will have built into it a selector which can decide which problems are important and which are not.

Primarily a research tool, it will be used to learn more about how the human brain works, including how to train the human brain better and how to detect the onset of (and avoid) a mental breakdown.

Sound Code Used in British Reading Machine For Blind

London—A woman, blind from birth, has just "read" a novel from cover to cover—not through her fingertips but through her ears. She did it with a new British electronic instrument, the Optophone, which converts printed letters into musical sounds. The pitch varies with the shape of the letters. Reading speed can reach 46 words per minute.

The machine uses photoelectric cells. The cells convert the printed words into sounds. The Roman alphabet has only six basic sounds but by learning the Optophone's chords and permutations the sounds can be interpeted as words. The cells are triggered by a point of light which traverses each line at a controlled speed.

A similar type of machine is being developed by Battelle Memorial Institute, Columbus, Ohio. Battelle's machine uses 11 separate sound channels with frequencies from 400 to 4000 CPS. (See Human Factors—Newest Engineering Discipline, ELECTRONIC INDUSTRIES, pp. 93-94, Feb. 1960.)

AIR COMMITTEE

Working Party 53, an Air Standardization Committee of personnel from the USAF, the Royal Canadian AF, and the United Kingdom's Royal AF, visit Sperry Microwave Electronics Co. in Clearwater, Fla. Group is evaluating facilities for Air Navigation and Air-to-Surface Directing Equipment.

Jap Electronic Exports Up 75% in First Half of 1960

Government statistics show that Japan's shipments of electronic products to the U. S. are going up. Shipments in the second quarter of 1960 alone were higher by $1,000,000 than in all of 1958. This represents a 75% rise for the first half of 1961. Japanese TV receivers are now being sold in the New York area and should spread to the rest of the country before Christmas.

Martin Sheridan, Dir. of Public Relations, Admiral Corp., in commenting on these figures (before the Electronics-Electrical Commodities Group of the Purchasing Agents Assoc. of Chicago) urged American manufacturers to publicize the fact that the Japanese products do not carry Underwriter Laboratories' approval.

Italian Semiconductor Firm To Service Common Market

Turin—International Rectifier Corp., El Segundo, Calif., and Piemontese Sviluppo Industriale S.P.A. (Piedmont Industrial Development Co.) have combined forces to launch a multi-million-dollar semiconductor manufacturing facility. It will be located near Turin, Italy and will build semiconductor devices for the European Common Market. A complete range of semiconductor rectifiers and automotive diodes is planned.

International Rectifier will provide scientists and technicians to supervise the installation and operation of the manufacturing plant. Production is scheduled to begin in April 1961 with full production scheduled for the summer of 1961.

New French Subsidiary

Paris—The Garrett Corp., Los Angeles, has formed a new French subsidiary, Breguet-Garrett, S. A. Co-owners are: Maison Breguet (a French industrial firm), Westland Aircraft, Ltd., and Garrett International, S. A., Geneva. The new firm will manufacture air conditioning systems designed by Garrett with applications for the new jet aircraft being developed in France.

Nine Countries Represented At Oak Ridge Lab's School

Thirty-seven scientists and engineers from nine countries (including the U. S.) are training at Oak Ridge National Laboratory in specialized courses on reactor technology. Sessions, sponsored by AEC, are on Nuclear Reactor Operations Supervision and Nuclear Reactor Hazards

Evaluation. Each course covers a year of work.

Purpose of the first course is to prepare an engineer or scientist to superintend the safe operation of a research or power reactor. Emphasis is on experience in reactor operation. Instruction is given in the scientific and engineering principles of a nuclear reactor and its associated machinery. The second course develops ability in evaluating possible hazards associated with all aspects of reactor operation.

Students come from Finland, India, Indonesia, Japan, New Zealand, Pakistan, Philippines, Viet Nam and the U. S., including Puerto Rico.

TUNIS INTERNATIONAL FAIR

Tunisian President, Habib Bourguiba (foreground left), visits Dow Corning Corporation's section at the Eighth Tunis International Fair. Demonstration is on silicone parting agents. U. S. Ambassador Walter N. Walmsley, Jr., is back of the Tunisian President.

Lay Caribbean Cable

Puerto Rico — American Telephone and Telegraph Co. is planning another link in their oceanic telephone system—a deep-sea cable in the Caribbean. The cable would be between Puerto Rico and Antigua via the islands of Virgin Gorda, Dog, and St. Kitts.

The Puerto Rico-Antigua system would be a single coaxial cable equipped for two-way transmission. It would have a capacity of 84 voice circuits and connect with the cable placed in service (this year) between the U. S. and Puerto Rico.

Underwater TV Checks Fish

Scotland—A Marconi-Siebe, Gorman underwater TV camera will be used for research into fish and hydraulic problems on Scottish locks. The camera will inspect fish screens which guard turbine intakes and prevent smolt (young salmon) from being swept into the turbines. The job was previously done by divers. The camera will also be used to study fish behavior in the fish passes and to inspect the tunnels linking dams and power stations.

Circle 11 on Inquiry Card

As We Go To Press (cont.)

New Yarn Inspector Uses Photoelectrics

Developed by Lindly & Company, Inc., Mineola, N. Y., a new series 1000 Ultra Yarn Inspector automatically detects, counts, and indicates imperfections in yarns and fibers in process in textile mills. Fully transistorized, it uses a sensitive photoelectric system that "watches" the strands of yarn as they speed across an inspection bar. Defects measuring a fraction of a thousandth of an inch can be detected. An auxiliary unit available with the inspector automatically corrects the operation of the device to ensure its functioning properly at all times.

Memory Switch Stores Multiple Digit Numbers

An electric "memory" switch, stores multiple-digit numbers using principles of the ordinary combination lock. It consists of sets of switch indexes and wafers coaxially arranged with tumbler-type couplings between them. The number of indexes depends upon the number of digits to be stored. The number of positions on each index wafer depends on the switches' function. Developed at MIT's Instrumentation Lab. by Paul D. Shannon, the device—the n-Digit Decade Switch—is a possible method of simplifying automatic control of electrical currents used in testing gyroscopes used in inertial guidance systems for missiles and space vehicles. Because of its flexibility, the switch could be used to simplify a variety of automatic control systems by reducing the number of switches and dials needed.

Piezoelectric Unit For Ignition Systems

Clevite Corp.'s Cleveland Graphite Bronze Div. has developed a new source of electricity for ignition systems, "Spark Pump," so-called because it produces a spark each time pressure is applied to it.

The new device contains two ceramic parts that convert a single short motion into a 20,000-volt charge. It performs a job now requiring a magneto, points, coil, and condenser.

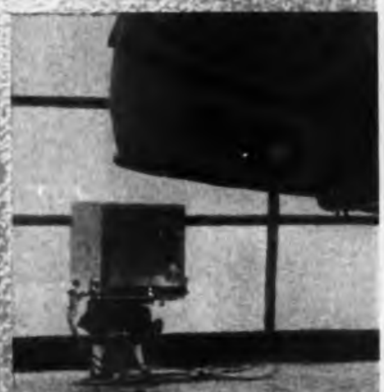
A Spark Pump switch, and a spark plug now constitute a complete ignition system for a small motor.

(Continued on page 28)

INSIDE 1,000 ERUPTING VOLCANOS!...

These are the conditions faced in placing closed-circuit TV cameras within 10 feet of the cluster of eight rocket engines used to power the SATURN space vehicle. The severe heat and vibration generated during a static firing called for a Vidicon having the highest sensitivity characteristics while being of the most rugged construction.

GEC'S 7226A — Ruggedized Vidicon was found capable of meeting these extreme requirements . . . successfully. The engineers and technicians were able to monitor and film the exhaust characteristics in recent static firings of the National Aeronautics and Space Administration's SATURN vehicle because of the dependable performance of four 7226A VIDICONS manufactured by General Electrodynamics. The 7226A GEC Vidicon meets military environmental conditions for shock and vibrations MIL-E-5272A; illumination, 1,000 ft-c; temperature, 71°C.



If you have a project requiring difficult applications for Vidicons, Scan Conversion, Image Conversion, or Display Tubes, contact General Electrodynamics Corporation . . .

where tube research begins. . . .

GEC

GENERAL ELECTRODYNAMICS CORPORATION

Circle 13 on Inquiry Card

As We Go To Press (cont.)

Spark Pump is the first device using a piezoelectric element to create a spark twice as powerful as that produced by an ordinary magneto and condenser. It produces a constant high voltage at all engine speeds, eliminating complex starting mechanisms.

IBM Introduces "1418" Character Reader

IBM's solid-state 1418 Optical Character Reader reads data printed in widely-used type styles on paper or card documents, at the rate of 480 characters per second or as many as 400 documents a minute. The printed data is automatically translated into machine language for direct input to an IBM 1401 computer. The 1418 reads numbers printed ten characters to the inch in a standard IBM type by 407, 408 or 409 accounting machines, the 1403 printer, or an electric typewriter. It can also read numbers in the elongated 407 type style, seven characters to the inch. In addition, the 1418 can be equipped for mark-reading—in which vertical markings made with ordinary pencil or dark inks represent specific information determined by the format of the document.

New Flight Trainer

UDOFTT (Universal Digital Operational Flight Trainer, Tool) has been developed by the Data Systems Operations of Sylvania Electric Products, Inc., Needham, Mass., a subsidiary of Gen. Tel. & Elec. Corp.

It uses initial logical design studies made at the Moore School of Elec. Eng'g, Univ. of Pa., under a $2 million contract with the U.S. Navy.

It operates at a rate of more than 200,000 operations sec., the computer system can respond instantly to commands of a student pilot within a simulated cockpit or an instructor at an external control panel. During a simulated flight, more than 50 emergency conditions can be introduced.

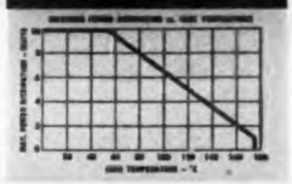
UDOFTT can extract information or calculations already made and make new ones in 5 one-millionths of a sec. It can also simulate the operation of a tank, helicopter, nuclear sub., hydrofoil craft or space vehicle.

SHARPEST ZENERS AVAILABLE!

NOW... GI [illegible] OF QUALITY ZENER DIODES

NEW 10-WATT ZENERS...

- *Extremely low Dynamic Impedance*
- *Superior Case Design*
- *Up to 175° C Operation*
- *Diffused Junction Type*
- *100% Scope Tested*



Outstanding Quality—New line of superior quality 10-watt zener diodes provides dependable uniformity of electrical characteristics ... *completes* the family of General Instrument zeners. Unique case design, which employs thermal matching of silicon and package, enables units to withstand rapid temperature cycling and thermal shock. Low junction operating temperature means high reliability and long life. Conservatively rated diodes show extreme stability under life tests at maximum parameters.

New Diodes Available for Immediate Delivery in Types 1N1808; 1N2044 through 1N2049; and 1N1351 through 1N1362. Voltage ranges from 7.5 to 30 volts (higher upon request).

REPRESENTATIVE GROUP OF SUPERIOR GI ZENERS FOR YOUR MOST EXACTING CIRCUIT REQUIREMENTS 10 WATTS TO ¼ WATT

New 10-Watt Zeners				3.5-Watt Stud Mount				1-Watt Axial Lead				¼-Watt Axial Lead			
Type	Zener Voltage (v)	Test Cur 55°C (ma)	Max Dyn Imp (ohms)	Type	Zener Voltage (v)	Test Cur 25°C (ma)	Max Dyn Imp (ohms)	Type	Zener Voltage (v)	Test Cur 25°C (ma)	Max Dyn Imp (ohms)	Type	Zener *Voltage (v)	Test Cur 25°C (ma)	Max Dyn Imp (ohms)
1N1808	[illegible]	[illegible]	[illegible]	1N1588	3.6-4.3	150	2.6	1N1518	3.6-4.3	[illegible]	[illegible]	1N708	5.6	25	[illegible]
1N1351	10	500	[illegible]	1N1589	4.3-5.1	125	2.3	1N1519	4.3-5.1	[illegible]	8.5	1N714	[illegible]	12	[illegible]
1N1352	11	500	2	1N1590	5.1-6.2	110	1.4	1N1520	5.1-6.2	35	5.5	1N718	[illegible]	[illegible]	[illegible]
1N1353	12	400	[illegible]	1N1591	6.2-7.5	100	.58	1N1521	6.2-7.5	[illegible]	[illegible]	1N721	[illegible]	4	[illegible]
1N1355	15	300	2	1N1592	7.5-9.1	45	[illegible]	1N1522	7.5-9.1	[illegible]	[illegible]	1N723	24	[illegible]	[illegible]
1N1357	18	350	3	1N1593	9.1-11	70	7	1N1523	9.1-11	[illegible]	1.5	1N733	[illegible]	4	[illegible]
1N1358	20	180	3	1N1594	11-13	50	2.4	1N1524	11-13	25	2.4	1N735*	[illegible]	[illegible]	[illegible]
1N1359	22	150	3	1N1595	13-16	40	3.4	1N1525	13-16	15	[illegible]	1N736*	[illegible]	1	[illegible]
1N1360	24	150	3	1N1596	16-20	35	6	1N1526	16-20	11	11	1N742*	150	1	[illegible]
1N1361	27	150	3	1N1597	20-24	30	4	1N1527	20-24	9	16	1N748*	180	1	[illegible]
1N1362	[illegible]	150	4	1N1598	24-30	25	11	1N1528	24-30	7	28	1N752*	[illegible]	1	[illegible]

*Supplied with ±10% tolerance only.
Intermediate values supplied with ±5% tolerances on order.

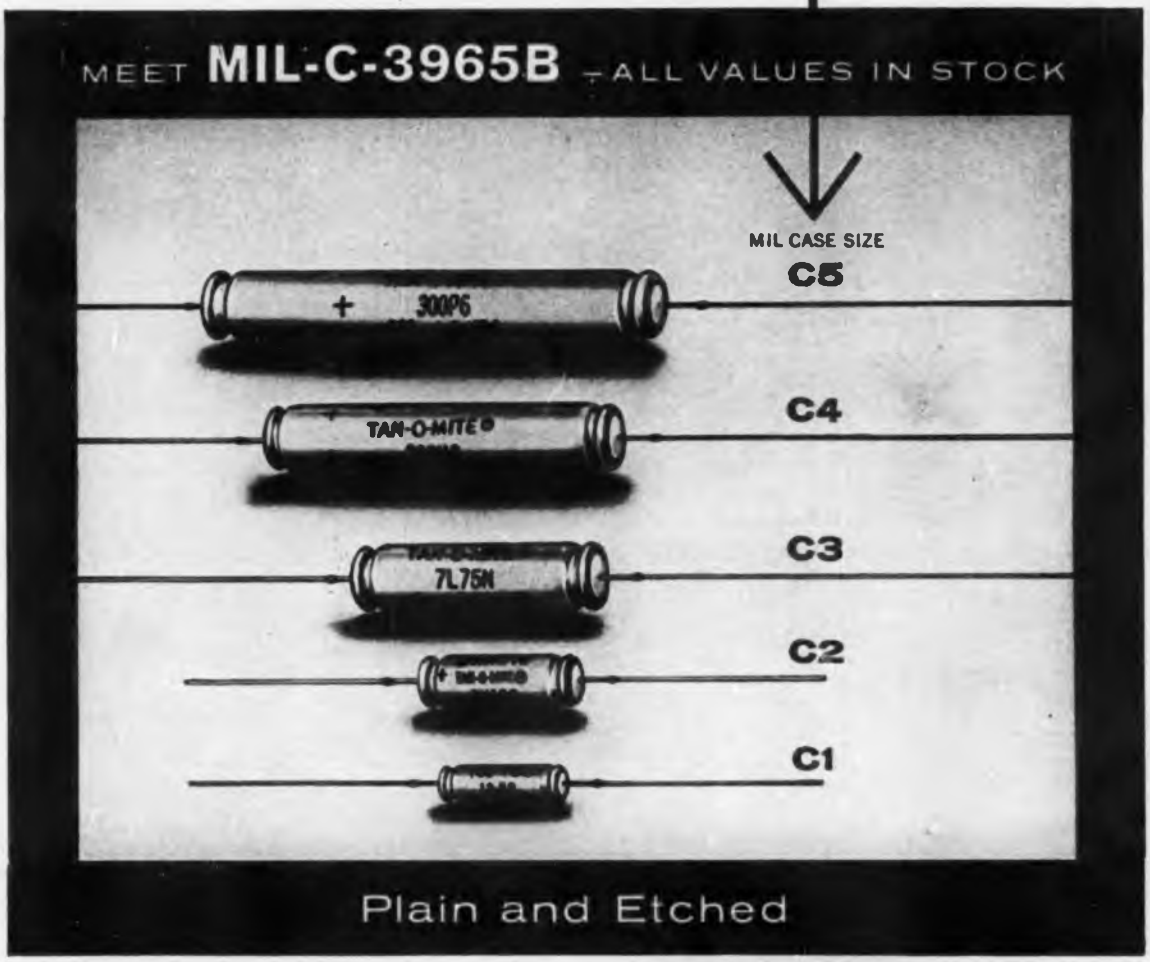
CONTACT GENERAL INSTRUMENT for full technical information on the complete line of zener diodes, and for applications assistance on all your semiconductor needs.

GENERAL INSTRUMENT
GENERAL TRANSISTOR
TRANSISTORS, DIODES, RECTIFIERS

GI SEMICONDUCTOR
DIVISION OF GENERAL INSTRUMENT CORPORATION
65 Gouverneur Street, Newark 4, New Jersey

IN CANADA: General Instrument—F. W. Sickles of Canada Ltd., P.O. Box 408, 151 S. Weber Street, Waterloo, Ontario, Canada. Sherwood 4-8101.

All 5 MIL Tantalum Foil Capacitor Sizes From OHMITE



Whether you need *immediate delivery* from stock on prototypes, or production quantities of tantalum foil capacitors, Ohmite can handle your requirements.

Tan-O-Mite® Series TF foil capacitors now include all five MIL sizes in both plain and etched types, polar and nonpolar units, insulated and uninsulated cases—all in ratings to 150 VDC. Capacitance values for plain foil units range to 400 mfds; etched foil units, 580 mfds.

Write for Specification Bulletin 152G which lists 200 stock values, including all MIL values, and shows a *handy scale for conversion* between "equivalent series resistance," "power factor," and "dissipation factor."

OHMITE

Rheostats
Power Resistors
Precision Resistors
Variable Transformers
Tantalum Capacitors
Tap Switches
Relays
R.F. Chokes
Germanium Diodes
Micromodules

OHMITE MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois

As We Go To Press (cont.)

Nike Centers Now Tied to SAGE Net

The Army has completed a network of electronic centers designed to coordinate air defenses of key industrial and population centers in this country. The Missile Master Centers are in Washington, Baltimore, Seattle, Boston, New York, Buffalo, Detroit, Pittsburgh, Philadelphia, Chicago, and Los Angeles.

Gen. George H. Decker (C), U. S. Army Chief of Staff, inspects Missile Master Control center near Pittsburgh, Pa. Rodney Gauss, section chief at Martin Co., Orlando, Fla. (designer of the system), explains its operation. This is the 7th installation to be activated this year. Looking on (L to R): Maj. M. D. Salter, Maj. H. T. Taylor, Col. J. C. Parker, and Maj. C. H. Hoddinotte.

Missile Master is basically a communications and fire coordination system linking all Nike missile batteries defending a given geographic area. By tying into SAGE centers the Nike defenses are linked to the all North American Air Defense Command (NORAD) network. The Martin Co., Orlando, Florida is prime contractor for the centers.

New BDSA Aid Named

Robert E. Dailey, assistant to the vice president and general manager of the Telecommunications Division of the Stromberg-Carlson Company, Rochester, New York, today was named assistant to the director of the Communications Industries Division, Business and Defense Services Administration, U. S. Department of Commerce.

Mr. Dailey comes to BDSA on loan from Stromberg-Carlson under an arrangement by which executive personnel from industry take temporary assignments — usually 6 months — without compensation from the Government. The service also qualifies him for membership in the National Defense Executive Reserve which would staff the operation of a production agency in case of national emergency.

SILICON
MICRO-ELECTRONIC COMPONENTS

New! Micro Mesa Silicon Diodes

ULTRA FAST LOW CAPACITANCE

PSI TYPE	Equiv.	Forward Current @ 1 VDC (mA)	Breakdown Voltage @ 100 μa (volts)	Capacity @ 0 VDC (pf)	Inverse Current 25°C (μa)	Inverse Current 100°C (μa)	Rev. Recov.** (nanosec.)
PD301		10	50	4	.025 (−20V)	50 (−20V)	4
PD302	1N906	10	50	4	.1 (−20V)	10 (−20V)*	4
PD303	1N907	10	50	4	.1 (−30V)	10 (−30V)*	4
PD304	1N908	10	50	4	.1 (−40V)	10 (−40V)*	4
PD305	1N914	10	100	4	.025 (−20V) 5.0 (−75V)	50 (−20V)	4
PD306		10	50	2	.025 (−20V)	50 (−20V)	4
PD307	1N905	10	50	2	.1 (−20V)	10 (−20V)*	4
PD308	1N904	10	50	2	.1 (−30V)	10 (−30V)*	4
PD309	1N903	10	50	2	.1 (−40V)	10 (−40V)*	4
PD310	1N916	10	100	2	.025 (−20V) 5.0 (−75V)	50 (−20V)	4
PD311	FD100	10	75 @ 5μa	2	.1 (−50V)	100 (−50V)	2

*At 100°C.
**Switching 10 mA to −6 volts recovery to 1 mA.

General Purpose Computer Micro-Diodes

EIA EQUIV	TYPES		BV (volt) 100 μa	I_F (mA) @ 1V	I_R (μa) −10V & 25°C	I_R (μa) @ 25°C	I_R (μa) −10V & 100°C	I_R (μa) @ 100°C	Recovery Time	(2) [illegible]
		PD-101	50	5	1		25		1 μsec	100K
	1N[illegible]		50	5	.025	.1 @ −40	5	30 @ −40	1 μsec	100K
		PD-102	50	30	.5		25		.3 μsec	100K
		PD-103	50	100	.5		25		.3 μsec	100K
	1N[illegible]		50	100	.025	.5 @ −40	5	30 @ −40	.3 μsec	[illegible]
1N457			70	20		.025 @ −60		5 @ −60 (1)		
		PD-104	100	5	.5		25		.3 μsec	100K
	1N[illegible]		100	5	.025	.1 @ −[illegible]	5	30 @ −[illegible]	.3 μsec	[illegible]
1N662			100	10	1	20 @ −[illegible]	25	100 @ −[illegible]	.5 μsec	[illegible]
		PD-105	100	20	.5		25		.3 μsec	[illegible]
		PD-106	100	80	.5		25		.3 μsec	[illegible]
	1N[illegible]		100	30	.025	.1 @ −[illegible]	5	30 @ −[illegible]	.3 μsec	[illegible]
1N663			100	100		5 @ −75		50 @ −75	.5 μsec	[illegible]
		PD-107	100	100	.5		25		.3 μsec	100K
	1N[illegible]		100	100	.025	.5 @ −[illegible]	5	30 @ −[illegible]	.3 μsec	[illegible]
1N[illegible]			120	100		.05 @ −[illegible]		25 @ −[illegible] (1)	.3 μsec	80K
1N458			150	7		.025 @ −125		5 @ −125 (1)		
1N459			200	3		.025 @ −175		5 @ −175 (1)		
		PD-108	200	10	.5	5 @ −100	25		.3 μsec	[illegible]
		PD-109	200	10	.025	1 @ −100	5		.3 μsec	[illegible]
1N643	1N[illegible]		200	10	.025	1 @ −100	5	15 @ −100	.3 μsec	[illegible]

1. @ 150°C.
2. JAN 256 6mA to −40V.
typical capacity at −10V = 2 pf

RATINGS
Maximum power dissipation 250 mw @ 25°C.
Maximum temperature range −65°C to +150°C.
Peak pulse current 2 amperes; 1 μsec 1% duty cycle.
Typical junction capacity = 2pf @ −10V.
Meets all environmental specifications of Mil-S-19500B

PHYSICAL CHARACTERISTICS:
HERMETICALLY SEALED—Bonded Surface films.
TERMINALS—.004x.013 gold plated leads. Lead length ½ inch minimum.
MARKING—Type number designated by color of body and color of stripes on pointed (cathode) lead.
ALL DIMENSIONS SHOWN IN INCHES.

Silicon Pico-Transistors

picotransistor

microtransistor

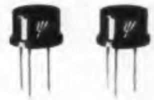
*TYPE	BV_{CBO}	I_{CBO}	V_{EBO}	h_{FE} (min)	h_{fe} (20mc)
PMT 011	30V	10μa (20V)	4V	15 (150mA, 10V)	3.1
PMT 012	30V	10μa (20V)	4V	30 (150mA, 10V)	3.5
PMT 013	60V	1μa (30V)	5V	20 (150mA, 10V)	2
PMT 014	60V	1μa (30V)	5V	40 (150mA, 10V)	2.5
PMT 019	40V	1μa (10V)	5V	30 (5mA, 5V)	2.5

Total Dissipation 25°C. 100 mw
*Available in both Micro and Pico configurations. Type numbers above indicate Pico configuration. For Micro configuration add 100 to type number. Thus, Pico transistor PMT 011 is designated PMT 111 in Micro version.

LOOK INSIDE ***FOR LATEST INFORMATION AND SPECIFICATIONS ON PSI SILICON DIODES, ZENERS AND RECTIFIERS***

ADVANCED SILICON MESA TRANSISTORS FOR ADVANCED CIRCUIT DESIGN

BRAND NEW! 2N1837



...outperforms 2N697!

COMPARE THESE OUTSTANDING DIFFERENCES!

MAXIMUM RATINGS

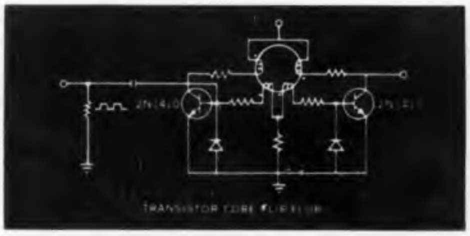
Parameter	2N697	2N1837	Unit	Test Condition	% Improvement
V_{CEX}	40.	50.	Volts	R_{BE} = 10Ω	25% Higher
V_{CBO}	60.	80.	Volts	I_{CBO} = 100 μA	33% Higher
V_{EBO}	5.	8.	Volts	I_{EBO} = 100 μA	60% Higher
Power Dissipation	2.0	2.0	Watts	25°C Case Temp	—
Power Dissipation	0.6	0.8	Watts	25°C Ambient Temp	—
I_{CBO}	1.0 100	0.5 50.	μA μA	V_{CB} = 30V, T = 25°C V_{CB} = 30V, T = 150°C	50% Decrease
V_{BE}(SAT)	1.3	1.3	Volts	I_C = 150mA, I_B = 15mA	
V_{CE}(SAT)	1.5	0.8	Volts	I_C = 150mA, I_B = 15mA	47% Decrease
h_{FE}	40-120	40-120		V_{CE} = 10V, I_C = 150mA	
h_{fe}	2.5 min	7.0 min		V_{CE} = 10V, I_C = 50mA f = 20 mc	280% Increase
C_{ob}	35.	18.	μμf	V_{CB} = 10V, I_E = 0 f = 140 kc	48% Decrease

Only half the collector to emitter voltage drop... nearly three times the small signal beta ... half the collector capacitance ...half the leakage current!

PSI is also in large volume production of many standard switching transistors including 2N696, 2N697, 2N699, 2N1420 and 2N706.

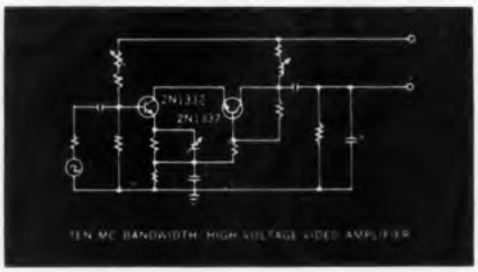
High Speed Switch Types—2N1409-2N1410

Typical switching speed of 52 nanosec turn on time and 130 nanosec turn-off . . . saturation resistance of only 5 ohms and power ratings of 2.8 watts (25 C case temp.) For use in low current logic or high current core-driver circuitry.



TRANSISTOR CORE FLIP-FLOP

High Versatility Types—2N1335 thru 2N1341



TEN MC BANDWIDTH HIGH VOLTAGE VIDEO AMPLIFIER

The higher power dissipation, faster rise time and lower collector capacitance of the 2N1337, for example, makes this transistor an unusually fine performer in advanced video amplifier circuits.

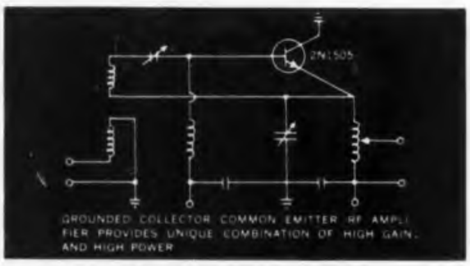
These 2.8 watt, 120 volt VHF transistors are well suited to IF and DC amplifiers, RF power amplifiers and oscillators and to high voltage switching applications.

Communication Types—2N1505-2N1506

This series of silicon mesa transistors provides high power output at Very High Frequencies. Typical power outputs are one-half watt at 200 mc with 3 db gain or one watt at 70 mc with 12 db power gain operating from 28V source.

A power output of 2.5 watts at 250 mc. may be obtained by using these transistors with a High-Q Varicap® frequency multiplier.

"VARICAP" is the registered trade-mark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.



GROUNDED COLLECTOR COMMON EMITTER RF AMPLIFIER PROVIDES UNIQUE COMBINATION OF HIGH GAIN AND HIGH POWER

AVAILABLE NOW! PT530—5 watt 30 mc Power Amplifier
PT901—High Frequency High Power Transistor

Silicon General Purpose Diodes

EIA Type Number	Minimum Saturation Voltage @ [illegible] @ 25°C (volts)	Maximum Forward Voltage DC @ 25°C (volts)	Maximum Inverse Current at Maximum DC Operating Voltage (µa @ volts)		Minimum Average Rectified Current (mA)	
		@ 100 mA	@ 25°C	@ [illegible]	@ [illegible]	@ 100°C
[illegible]	[illegible]	1.0	[illegible]	25	[illegible]	70
[illegible]	[illegible]	1.1	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	125	50
[illegible]	[illegible]	1.0	[illegible]	10	200	70
[illegible]	200	1.0	[illegible]	25	[illegible]	70
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50
[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	70
[illegible]	200	1.0	.025 @ − [illegible]	[illegible]	[illegible]	70
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50
[illegible]	100	1.0	[illegible]	1	200	70
[illegible]	[illegible]	[illegible]	.025 @ − 125v	15	[illegible]	70
[illegible]	[illegible]	[illegible]	[illegible]	30	125	50
[illegible]	[illegible]	1.0	[illegible]	1	[illegible]	70
[illegible]	[illegible]	[illegible]	[illegible] − 60v	[illegible]	[illegible]	[illegible]
[illegible]	90	1.1	.250 @ − 60v	30	125	50
[illegible]	80	1.0	.025 @ − 30v	5	200	70
[illegible]	40	1.0	.025 @ − 30v	15	200	70
[illegible]	40	1.1	.250 @ − 30v	30	125	50

EIA Type Number	Minimum Saturation Voltage @ 100 µa @ 25°C (volts)	Minimum Forward Current @ +1.0 VDC @ 25°C (mA)	Maximum Inverse Current at Maximum DC Operating Voltage (µa @ volts)	
			@ 25°C	@ 100°C
1N464A	150	100	.5 @ 125	30 @ 125
1N464	150	3	.5 @ 125	30 @ 125
1N463A	200	100	.5 @ 175	30 @ 175
1N463	200	1	.5 @ 175	30 @ 175
1N462A	70	100	.5 @ 60	30 @ 60
1N462	70	5	.5 @ 60	30 @ 60
1N461A	30	100	.5 @ 25	30 @ 25
1N461	30	15	.5 @ 25	30 @ 25
1N460A	200	100	.025 @ 175	5 @ 175
* 1N[illegible]	200	3	.025 @ 175	5 @ 175
1N459A	150	100	.025 @ 125	5 @ 125
* 1N458	150	7	.025 @ 125	5 @ 125
1N457A	70	100	.025 @ 60	5 @ 60
* 1N457	70	20	.025 @ 60	5 @ 60
1N456A	30	100	.025 @ 25	5 @ 25
1N456	30	40	.025 @ 25	5 @ 25

* JAN Types

Zener Diodes 500 mW Power Dissipation

Also available at 750 mW in Configuration "B".

EIA TYPE NUMBER	Zener (Breakdown) Voltage @ 5 mA		Maximum Inverse Current		At Inverse Voltage (v)	Maximum Dynamic Resistance (ohms) 1
	E_z Min. (v)	E_z Max. (v)	I_R @ 25°C (µA)	I_R @ 100°C (µA)		
1N702	2.0	3.2	75	100	−1	60
1N703	3.0	3.9	50	100	−1	55
1N704	3.7	4.5	5	100	−1	45
1N705	4.3	5.4	5	100	−1.5	35
1N706	5.2	6.4	5	100	−1.5	20
1N707	6.2	8.0	5	50	−3.5	10

1. Measured at 10 mA DC Zener current with 1 mA RMS signal superposed.

Also Available 1N708-1N723 covering 5.6v to 24v Zener Voltages.

PSI TYPE NUMBER	Elect. Equiv.	Zener Voltage @ 200 µA @ 25°C		Maximum Inverse Current		At Inverse Voltage (v)
		E_z Min. (v)	E_z Max. (v)	I_R @ 25°C (µA)	I_R @ 100°C (µA)	
PS6313	1N1313	7.5	10	.5	5	6.8
PS6314	1N1314	9	12	.5	5	8.2
PS6315	1N1315	11	14.5	.5	5	10.0
PS6316	1N1316	13.5	18	.5	5	12.0
PS6317	1N1317	17	21	.5	5	15.0
PS6318	1N1318	20	27	.1	10	18.0

LOW VOLTAGE PRECISION REGULATOR DIODES

PSI NUMBER	E_z ±5% @ 25°C @ 20 mA (Volts)	Max. Dynamic Impedance @ 20 mA (ohms) (1)	Max. Rev. Current @ 25°C µa	Typical Temperature Coefficient mv/°C
PS1171	1.50	9	20 @ 0.5V	−3.5
PS1172	1.60	12	20 @ 0.5V	−3.5
PS1173	1.80	18	20 @ 0.5V	−3.5
PS1174	2.20	12	20 @ 1.0V	−4.8
PS1175	2.40	18	20 @ 1.0V	−4.8
PS1176	2.70	27	20 @ 1.0V	−4.8
PS1177	3.00	18	20 @ 1.0V	−6.4

For 2% Types specify PS1171A - PS1177A

(1) Measured with 1 mA (RMS) superposed on 20 mA D.C.

DIMENSION NOTE: Regulator diodes maximum diameter .405", maximum length .53".

Also available 1421 thru 1426 extending regulating voltage to 5.2 volts.

Voltage Reference Diodes

EIA TYPE NUMBER	REFERENCE VOLTAGE @ 7.5 mA @ 25°C. (volts)			Max. Voltage change from 25°C Reference Voltage (volts) −55°C to +100°C	Max. Dynamic Resistance (ohms)
	Min.	Avg.	Max.		
1N2765	6.46	6.80	7.14	±0.050	20
1N2766	12.92	13.60	14.28	±0.100	40
1N2767	19.38	20.40	21.42	±0.150	60
1N2768	25.84	27.20	28.56	±0.200	80
1N2769	32.30	34.00	35.70	±0.250	100
1N2770	38.76	40.80	42.84	±0.300	120

1. Measured with 1 mA AC superposed on 7.5 mA DC
Max. Operating Temp. @ Iz=7.5 mA: −65°C to +175°C.

NEW! Military Types Zener Diodes (MIL-E-1/12

EIA TYPE NUMBER	Zener Voltage E_z(Volts)[1]	Max. Inverse Current E_R = −1V µA		Max. Dynamic Resistance I_z = 20mA I_{ac} = 1 mA (Ohms) (Max.)
		25°C	150°C	
1N746A	3.3	10	30	28
1N747A	3.6	10	30	24
1N748A	3.9	10	30	23
1N749A	4.3	2	30	22
1N750A	4.7	2	30	19
1N751A	5.1	1	20	17
1N752A	5.6	1	20	11
1N753A	6.2	0.1	20	7
1N754A	6.8	0.1	20	5
1N755A	7.5	0.1	20	6
1N756A	8.2	0.1	20	8
1N757A	9.1	0.1	20	10
1N758A	10.0	0.1	20	17
1N759A	12.0	0.1	20	30

1. "A" versions ±5% Zener Voltage Tolerance.
2. E_z measured at Test Current I_z = 20mA
All of the above types can be supplied in ±10% Tolerance of center Zener Voltage Value. (Omit suffix "A" for these units.)

F

Maximum Average Rectified Current (mA)	
@ 25°C	@ 150°C
200 40	70
200 30	70
200 50	70
200 60	70
200 40	70
200 55	70
200 75	70
200 90	30

Silicon Diffusion Computer Diodes

The Broadest Line in the Industry...

Choose from military approved, low capacitance, high conductance, low leakage, high voltage types with assurance of unsurpassed reliability.

Fast Recovery Types

MILITARY TYPES						
EIA TYPE NUMBER	Minimum Saturation Voltage* @ 100 µa (volts)	Minimum Forward Current @ +1.0 volt (mA)	Maximum Reverse Current (µa)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Resistance (ohms)	Maximum Recovery Time (µs)
1N663*	100	100	5 (75v)	30 (75v)	200K	0.3
1N662‡	100	10	1 (10v) 20 (50v)	20 (10v) 100 (50v)	100K	0.5
1N658*	120	100	.05 (50v)	**25 (50v)	80K	0.3
1N643†	200	10	.025 (10v) 1 (100v)	5 (10v) 15 (100v)	200K	0.3
1N663A	100	100	1 (75v)	15 (75v)	200K	0.3
1N662A	100	100	1 (10v) 20 (50v)	20 (10v) 100 (50v)	100K	0.5
1N643A	200	100	.025 (10v) 1 (100v)	5 (10v) 15 (100v)	200K	0.3
1N789	30	10	1 (20v)	30 (20v)	200K	0.5
1N790	30	10	5 (20v)	30 (20v)	200K	0.25
1N791	30	50	5 (20v)	30 (20v)	200K	0.5
1N792	30	100	5 (20v)	30 (20v)	100K	0.5
1N793	60	10	1 (50v)	30 (50v)	200K	0.5
1N794	60	10	5 (50v)	30 (50v)	200K	0.25
1N795	60	50	5 (50v)	30 (50v)	200K	0.5
1N796	60	100	5 (50v)	30 (50v)	100K	0.5
1N797	120	10	1 (100v)	30 (100v)	200K	0.5
1N798	120	10	5 (100v)	30 (100v)	200K	0.25
1N799	120	50	5 (100v)	30 (100v)	200K	0.5
1N800	120	100	5 (100v)	30 (100v)	100K	0.5
1N801	180	10	1 (125v)	30 (125v)	200K	0.5
1N802	180	50	5 (125v)	30 (125v)	200K	0.5
1N803	200	10	5 (175v)	30 (175v)	200K	0.5
1N804	200	50	10 (175v)	50 (175v)	200K	0.5
[illegible]	60	6	5 (50v)	25 (50v)	400K	0.3
[illegible]	120	6	5 (100v)	50 (100v)	400K	0.3
[illegible]	240	6	10 (200v)	100 (200v)	400K	0.3
1N625	30	4 @ 1.5v	1 (20v)	30 (20v)	400K	1 µsec
1N626	50	4 @ 1.5v	1 (35v)	30 (35v)	400K	1 µsec
1N627	100	4 @ 1.5v	1 (75v)	30 (75v)	400K	1 µsec
1N628	150	4 @ 1.5v	1 (125v)	30 (125v)	400K	1 µsec
1N629	200	4 @ 1.5v	1 (175v)	30 (175v)	400K	1 µsec

*Maximum DC working inverse voltage is 80% of minimum saturation voltage.

†MIL-E-1/1173 (SigC) ‡MIL-E-1/1139 (SigC) *MIL-E-1/1140 (SigC) *MIL-E-1/1160 (SigC)

**Max. Reverse Current at 150°C.

OTHER SPECIFICATIONS: Peak Pulse Current, 1 µsec, 1% duty cycle: 3.0 Amps. Storage and Operating Temperature Range: −65°C to 200°C.

...es

...258)

Fast Switching Low Capacitance Types

EIA TYPE NO.	MIN. SAT. VOLTAGE @ 100 µa (volts)	MIN. FWD. CUR. @ 1.0 volt (mA)	MAXIMUM REVERSE CURRENT (µa)		REVERSE RECOVERY CHARACTERISTICS			MAX. CAP. @ ZERO VOLTS (pf)
			25°C	150°C	REVERSE RESIST. (Ohms)	MAX. RECOV. TIME* (µs)	TYPICAL RECOV. TIME** (nsec)	
[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*Switching time [illegible]

**Switching time [illegible]

PSI

Very High Voltage Silicon R

- Many values...1,000 to 30,000 Volts
- No voltage derating over entire temperature range of —55 C to 150 C
- Extremely rugged
- Non metallic "cold" case
- Wire-in leads...easy to mount
- Use in printed circuit board applications

EIA TYPE NUMBER	Peak Inverse Voltage (volts)	Maximum Average Rectified Current (mA) @ 25°C	@ 100°C	MAX RMS Input Voltage* (volts)	MAX DC Fwd Voltage Drop @ 100 mA DC 25°C	Dimensions (Inches) L.	Dia.
1N1730	1000	200	100	700	5	.5	.375
1N1731	1500	200	100	[illegible]	5	.5	[illegible]
1N1732	2000	200	100	1400	8	1.0	.375
1N1733	3000	150	75	2100	[illegible]	1.0	.375
1N1734	5000	100	50	3500	[illegible]	1.0	.5
1N2382	4000	150	75	2800	18	1.0	.5
1N2383	6000	100	50	4200	27	1.5	.5
1N2384	8000	70	25	5600	27	1.5	.5
1N2385	10000	70	25	7000	30	2.0	.5

*Resistive or Inductive Load
Maximum DC Reverse Current @ Rated PIV 10 µA @ 25°C, 100 µA @ 100°C.
Maximum Surge Current (8msec.): 2.5 Amps.
Continuous DC Voltage same as PIV.
Operating Temperature Range −55°C to 150°C.

EIA TYPE NUMBER Fuse Clip Types	Length Inches	Absolute ... H.W. 75 ... Peak Inverse Voltage Volts
1N1139	[illegible]	[illegible]
1N1140	[illegible]	3600
1N1141	[illegible]	4800
1N1142	[illegible]	4800
1N1143	[illegible]	6000
1N1143A	[illegible]	6000
1N1144	[illegible]	7200
1N1145	[illegible]	7200
1N1146	[illegible]	8000
1N1147	[illegible]	12000
1N1148	[illegible]	14000
1N1149	[illegible]	16000

Storage and Operating Temperature

MAXI

EIA TYPE NUMBER	Peak and Continuous Inverse DC Voltage −65°C to 175°C (Vdc)
1N3052	12,000
1N3053	14,000
1N3054	16,000
1N3055	18,000
1N3056	20,000
1N3057	22,000
1N3058	24,000
1N3059	26,000
1N3060	28,000
1N3061	30,000

Operating Temperature Range: −5

PSI TYPE NO.	MAXIMUM RATINGS: Recurrent Peak Inv. Voltage at 150°C (Volts)	RMS Voltage at 150°C (Volts)	Avg. Forward[2] Current I_o (mA) at 25°C	at 150°C	ELECTRICAL CHARACTERISTICS: Min. E_b at 100 µA at 25°C (Volts)	Max. E_f at 500 mA at 25°C (Volts)	Max. I_b (µa) Recurrent Peak Inv. Voltage at 25°C	at 100°C	Max. Avg. Inverse Current[2] at 100°C (µa)
PS405	50	35	400	150	75	1.5	5	50	300
PS410	100	70	400	150	130	1.5	5	50	500
PS415	150	105	400	150	180	1.5	5	50	500
PS420	200	140	400	150	240	1.5	5	50	500
PS425	250	175	400	150	285	1.5	5	50	500
PS430	300	210	400	150	340	1.5	5	50	500
PS435	350	245	400	150	400	1.5	15	75	900
PS440	400	280	400	150	450	1.5	15	75	900
PS450	500	350	400	150	500	1.5	15	75	900
PS460	600	420	400	150	675	1.5	15	75	900

PSI TYPE NO.	MAXIMUM RATINGS: Recurrent Peak Inverse Voltage (Volts) @ 100°C	RMS Voltage @ 100°C (Volts)	Avg. Forward Current I_o (mA)[1] @ 25°C	@ 100°C	ELECTRICAL CHARACTERISTICS: Min. E_b @ 100 µA @ 25°C (Volts)	Min. I_f @ 1.5V E_f @ 25°C (mA)	Max. I_b (µa) @ Recurrent Peak Inv. Voltage @ 25°C	@ 100°C	Max. Avg.[2] Inverse Current @ 100°C (µa)
PS005	50	35	250	140	75	100	10	75	100
PS010	100	70	250	140	130	100	10	75	100
PS015	150	105	250	140	180	100	10	75	100
PS020	200	140	250	140	240	100	10	75	100
PS025	250	175	250	140	285	100	10	75	100
PS030	300	210	250	140	340	100	30	100	100
PS035	350	245	250	140	400	100	30	100	100
PS040	400	280	250	140	450	100	30	100	100
PS050	500	350	250	140	500	100	30	100	100
PS060	600	420	250	140	675	100	30	100	100

1. Resistive or Inductive Load.
2. Average over one cycle for half wave resistive or choke input circuit with rectifier operating at full rated current and maximum RMS input.

Silicon Subminiat Rectifiers

MEDIUM POWER - Military

EIA TYPE NUMBER	MAXIMUM RATINGS: Peak Inv. Voltage (v)	Maximum Avg. Rectified Current (mA)[1] @ 25°C	@ 150°C	ELECTRICAL CHAR: Minimum Saturation Voltage @ 100°C	Maxim Rever Curr @ PIV @ 25°C
AF 1N645	225	400	150	275	0.2
AF 1N646	300	400	150	360	0.2
AF 1N647	400	400	150	480	0.2
AF 1N648	500	400	150	600	0.2
AF 1N649	600	400	150	720	0.2

MIl-E-1/1143 (USAF)
1. Resistive or Inductive Load
Maximum Storage and Operating Temperature Range − 65°

NEW! High Voltage-High Current Cartridge Rec

1,500 to 20,000 Volts @ 200 to 500 mA

Rectifiers

bsolute Max. Rtgs. H. W Res. Load at 25 C Ambient		Electrical Characteristics at 25 C Ambient	
eak erse tage olts	Max. Rectified DC Output Current mA	Forward DC Volt Drop at Rated DC Current Volts	Reverse DC Current at Rated PIV mA
600	65	27.0	.025
600	65	18.0	.025
800	60	36.0	.025
800	50	24.0	.025
000	50	45.0	.025
000	65	30.0	.025
200	50	54.0	.025
200	60	36.0	.025
000	45	60.0	.025
000	45	60.0	.025
000	50	52.0	.025
000	45	60.0	.025

ature Range −55 C to 150 C

XIMUM RATINGS

Equivalent RMS Voltage (Vdc)	Forward Drop at 100 mA dc at 25°C (Vdc)	Average Rectified Current* (mAdc)	
		25°C	100°C
8,450	70	100	50
9,900	75	100	50
11,300	80	100	50
12,700	85	100	50
14,150	90	100	50
15,500	95	100	50
17,000	100	100	50
18,350	105	100	50
19,750	120	100	50
21,150	125	100	50

−55°C to 175°C.

ture

y Types

HARACTERISTICS

ximum everse rrent PIV (μA)	Max. Avg. Voltage Drop @ I_o =400 mA @ 25°C (v)
@ 100°C	
15	1.0
15	1.0
20	1.0
20	1.0
25	1.0

-65°C to 150°C

ctifiers

PSI® High-Q Varicap®

VARICAP TYPE NUMBER	Capacitance* @ 4 VDC 50MC (μμf)	Quality Factor Min. (Q) @ 4VDC 50MC	Max. Working Voltage (VDC)	Minimum Saturation Voltage @ 100 μADC (VDC)	Maximum Inverse Current (μADC)	Capacitance Change (Ratio)
PC-112-10	10	50	80	90	0.5**	from 2VDC to 80VDC, 4.0 to 1 Min.
PC-113-22	22	50	80	90	0.5**	
PC-114-47	47	50	80	90	0.5**	
PC-115-10	10	100	100	110	0.5†	from 2VDC to 100VDC, 5.2 to 1 Min.
PC-116-22	22	100	100	110	0.5†	
PC-117-47	47	100	100	110	0.5†	
PC-122-47	47	75	100	110	0.5†	
PC-132-10	10	50	25	30	0.5‡	from 1VDC to 25VDC, 3.0 to 1 Min.
PC-133-22	22	50	25	30	0.5‡	
PC-134-47	47	50	25	30	0.5‡	
PC-135-10	10	150	50	60	0.5♯	from 1VDC to 50 VDC, 4.0 to 1 Min.
PC-136-22	22	125	50	60	0.5♯	
PC-137-47	47	100	50	60	0.5♯	

*All capacitance values are ± 20% All values at 25°C

**Measured @ 50VDC †Measured @ 75VDC ‡Measured @ 10VDC ♯Measured @ 30VDC

"VARICAP" is the registered trade-mark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.

NEW!

MICRO-MINIATURE BRIDGE RECTIFIERS PS2411 thru PS2419

MICRO-MINIATURE HIGH VOLTAGE RECTIFIERS PS2422 thru PS2430

Please Note: All specifications and information contained herein are current as of *November 15, 1960*

This catalog contains only highlights of the complete PSI line of semiconductor devices. For current information on PSI, save this and other inserts which appear periodically in leading electronic publications.

PSI®

Pacific Semiconductors, Inc.

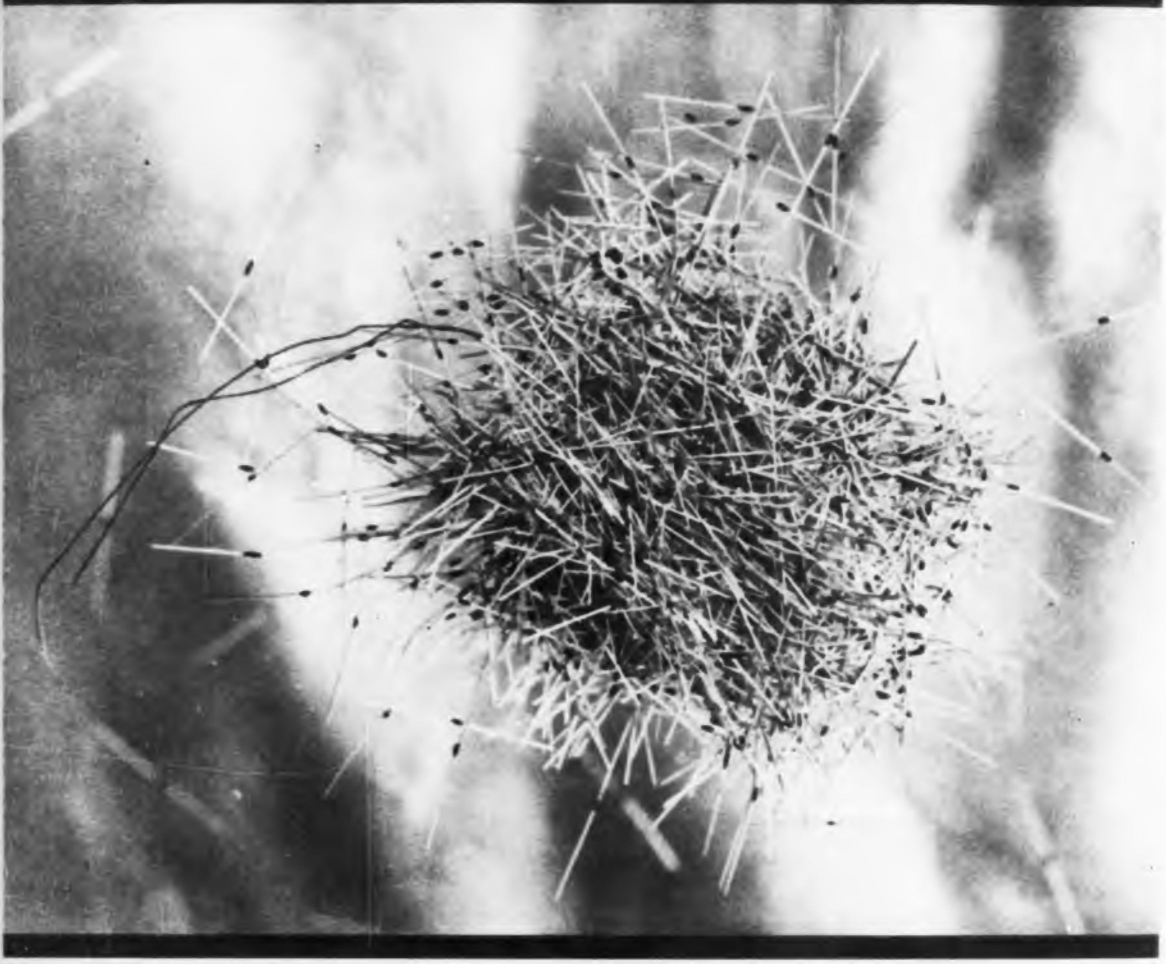
A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE, INC.
GENERAL SALES OFFICE: 12955 Chadron Avenue, Hawthorne, California

REGIONAL AND DISTRICT SALES OFFICES

NEW YORK—870 Broadway, Newark 4, New Jersey • Humboldt 4-5616 • TWX: NK 1010
Boston—471 Washington Street, Wellesley 81, Mass. • CEdar 5-0171
Syracuse—4453 E. Genesee Street, DeWitt, New York • GIbson 6-4600
PENNSYLVANIA—320 Huntingdon Pike, Rockledge, Philadelphia 11, Pa. • Pilgrim 2-8089 TWX: Rockledge PA 1064
Baltimore—1811 North Rolling Road, Baltimore 7, Maryland • WIndsor 4-3622
ILLINOIS—6957 West North Avenue, Oak Park, Illinois Village 8-9750 • TWX: OKP 1547
Dallas—P.O. 6067, Dallas, Texas • RIverside 7-1258
Detroit—1204 North Woodward Avenue, Royal Oak, Michigan • LIncoln 8-4722
St. Paul—2664 Caltier, St. Paul 17, Minnesota • MIdway 6-2471
CALIFORNIA—8271 Melrose Avenue, Los Angeles 46, Calif. • OLive 3-7850
San Diego—5022 Field, San Diego, California • BRowning 6-2261
Palo Alto—701 Welch Road—Suite 305, Palo Alto, Calif. DAvenport 1-2240

DISTRIBUTORS IN MAJOR ELECTRONIC CENTERS COAST-TO-COAST

RELIABILITY
Comes in All Sizes



Here's reliability so big you can barely see it. A needle and red thread almost concealed among thousands of silicon diodes demonstrate the super-miniaturization of PSI Micro-Diodes. These are the smallest known semiconductor devices, with reliability equal to or greater than conventional diodes.

At Pacific Semiconductors, Inc. reliability comes in all sizes—in a broad product line ranging from tiny Micro-Diodes and Pico-Transistors to large 30,000-volt cartridge rectifiers.

But size is only part of the story. At PSI, reliability begins at the conceptual stage of a device. It is as essential as the ability to manufacture in large production quantities. Reliability is as basic as original thinking.

PSI

Pacific Semiconductors, Inc.

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE, INC.

CORPORATE HEADQUARTERS: 14520 South Aviation Boulevard, Lawndale, California

General Sales Offices: 12955 Chadron Avenue, Hawthorne, California

LITHO IN U.S.A.

Tele-Tips

END OF THE YEAR AGAIN, and time to go through the old file of bits and pieces that somehow never get into print. And these are the things we learned:

Space travelers are likely to suffer from kidney stones. Weightlessness will mean little opportunity for exercise, producing a wasting of muscles and loss of calcium in the bones. The calcium will wind up in the kidney system as stones.

Space travelers will need only 90 minutes sleep nightly.

Physicists predicted that the pressure of sunlight on the orbiting Echo balloon would force it towards the Earth—and they were right. The balloon is being pushed towards Earth at the rate of 3½ miles a day.

Lockheed designed tape recorder for missiles that records 1,200,000 bits per minute and reads back 18 times as fast as recorded. The recorder will log data during those periods when radio contact with the missile is lost.

Can you raise vegetables under the low atmospheric pressure found on the Moon? Teenage scientists in 47 states and 3 foreign countries are attacking the problem by growing experimental "Moon Gardens." Republic Aviation Corp. has a handbook on the subject that has already been requested by about 1500 persons.

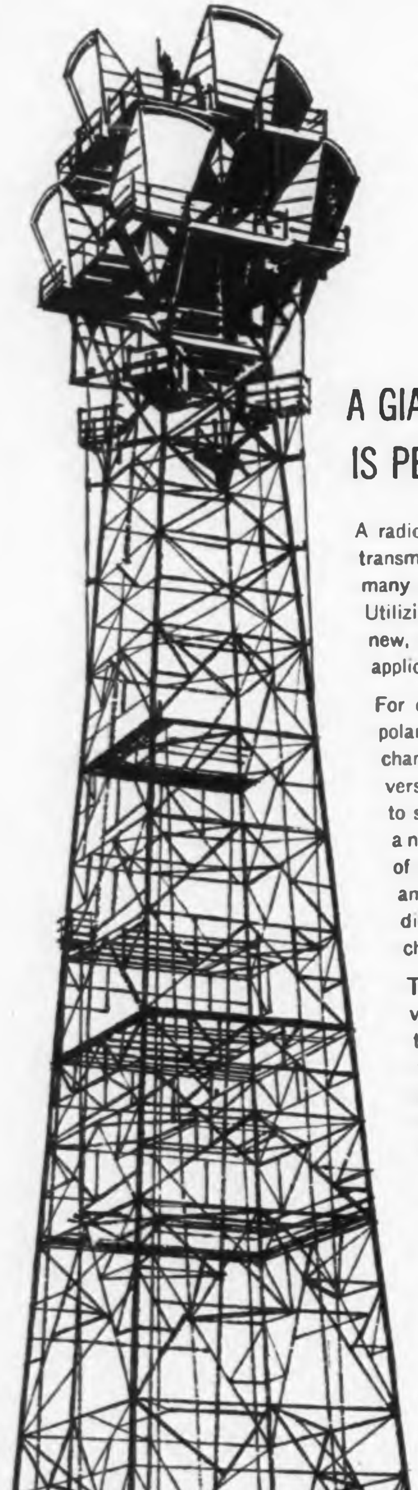
Technicians will be needed to make space ship or satellite repairs. They will require extensive training, probably with an earthbound model of the unit they will work on later in space.

ON THE SUBJECT OF COMPUTERS: In all the whole of history up to 1945, the calculating devices available increased man's abilities by a factor of about 100. In the few short years since 1945, the speed of calculation has been increased by a factor of about 250,000, through the development of electronic computers.

(*Continued on page* 47)

◄Circle 20 on Inquiry Card.

Circle 21 on Inquiry Card



A GIANT RADIO HIGHWAY IS PERFECTED FOR TELEPHONY

A radio relay system operating at 6 billion cycles per second and able to transmit 11,000 voices on a single beam of microwaves—several times as many as any previous system—has been developed at Bell Laboratories. Utilizing the assigned frequency band with unprecedented efficiency, this new, heavy-traffic system was made possible by the development and application of new technology by Bell Laboratories engineers and scientists.

For example, they arranged for the waves in adjacent channels to be polarized 90 degrees apart, thus cutting down interference between channels and permitting the transmission of many more telephone conversations in the same frequency space. They developed ferrite isolators to suppress interfering wave reflections in the waveguide circuits; and a new traveling wave tube that has ten times the power handling capacity of previous amplifiers and provides uniform and almost distortionless amplification of FM signals. They devised and applied a new high-speed diode switching system which instantly switches service to a protection channel when trouble threatens.

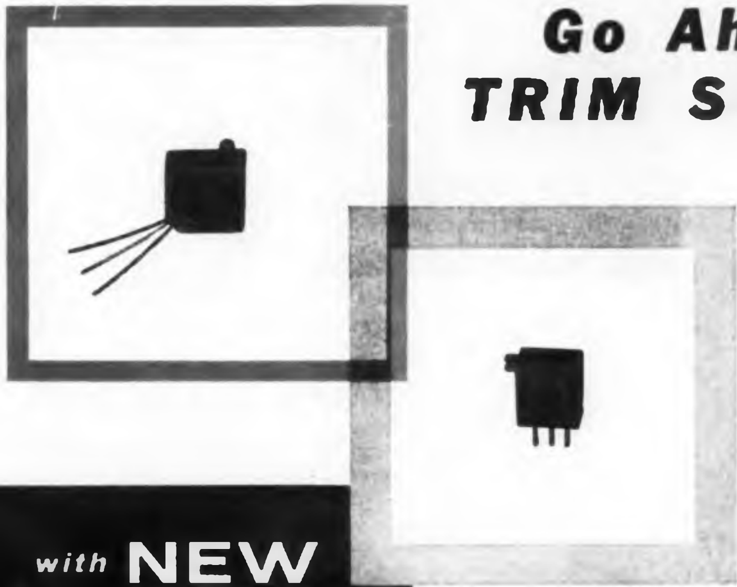
To transmit and receive the waves, the engineers applied their invention, the horn-reflector antenna. Elsewhere, this versatile antenna type is brilliantly aiding space communication research in the reception of radio signals from satellites. For radio relay, a single horn-reflector antenna can efficiently handle both polarizations of the 6000 megacycle waves of the new system; at the same time it can handle 4000 and 11,000 megacycle waves used for existing radio relay systems. Thus it enables all three systems to share economically the same radio towers and routes.

Produced by the Bell System's manufacturing unit, Western Electric, the new system is now in operation between Denver and Salt Lake City, and will gradually be extended from coast to coast. This new advance in radio technology is another example of how Bell Telephone Laboratories works to improve your Bell communication services.

BELL TELEPHONE LABORATORIES

World center of communications research and development

Go Ahead, TRIM SQUARE



Trimmers shown actual size

with **NEW**

SPECTROL

Trimming Potentiometers

- *SIZE*
- *PERFORMANCE*
- *RELIABILITY*
- *ECONOMY*

SIZE

THE MODEL 50
3/8" square, 3/16" high, and weighing 1 gram, the Model 50 is available in standard resistances of 50 ohms to 20K ohms.

THE MODEL 60
1/2" square, 3/16" high, and weighing 2 grams, the Model 60 is available in standard resistances of 50 ohms to 50K ohms.

PERFORMANCE

Stack 'em . . . up to 35 Model 50 trimmers in one cubic inch. Adjust 'em, 25 turns for full electrical travel . . . take your choice of side or top adjustment, slotted fillister head screw, Allen hex socket, or slotted headless screw flush mounted. Dissipates 1 watt — Model 50 and 2 watts — Model 60. Dual wiper provides double assurance of positive contact under all conditions. High resolution, typically 0.061% for the 50K ohms model. Resistance tolerance, ±5%, temperature range, −55 to +150°C.

RELIABILITY

At no extra cost, Spectrol trimmer potentiometers meet or exceed all applicable military specifications for altitude, fungus resistance, salt spray, sand and dust, humidity, temperature cycling, shock and vibration. Guaranteed load life, 1000 hours minimum.

ECONOMY

Prices in 1-9 quantities: Model 50 — $7.50 each, Model 60 — $6.50 each. Spectrol trimmers are ready now for immediate delivery from your local distributor. For complete technical information, call your Spectrol representative or write Dept. 44.

SPECTROL ELECTRONICS CORPORATION

1704 South Del Mar Ave. • San Gabriel, California 28
ATlantic 7-9761 • CUmberland 3-5141
1250 Shames Drive • Westbury, Long Island, N. Y.
EDgewood 3-5850

THE RECORDING THAT WASN'T

. . . It's happened to lots of magnetic tape users

Maybe you've been one of these unfortunates . . . who've spent thousands of dollars . . . plus many man hours . . . to record valuable information on magnetic tapes . . . only to find the data useless from accidental distortion or erasure.

Unexpected exposure to an unpredicted magnetic field, and presto!—your valuable data is filled with irritating odd noises. Distortions may result in virtual data erasure.

Unprepared tape users never realize the danger of loss until it's too late.

Such losses have become increasingly common from damaging magnetic fields during transportation or storage. These fields may be produced by airplane radar or generating equipment or other power accessories. Also by generators, power lines, power supplies, motors, transformers, welding machines, magnetic tables on surface grinders, magnetic chucks, degaussers, solenoids, etc.

Since 1956, many military and commercial tape users successfully avoid such unpleasant surprises. Their solution is shipping and storing valuable tapes in sturdy NETIC Tape Data Preservers.

Data remains clear, distinct and distortion-free in NETIC Preservers. Original recorded fidelity is permanently maintained.

Don't take chances with *your* valuable magnetic tapes. Keep them *permanently clear* and *distinct* for *every* year of their useful life in dependable NETIC Preservers. Can be supplied in virtually any size and shape to your requirement. Write for further details today.

For complete, distortion-free protection of valuable tapes during transportation or storage. Single or multiple containers available in many convenient sizes or shapes.

MAGNETIC SHIELD DIVISION PERFECTION MICA CO.

1322 No. Elston Avenue, Chicago 22, Illinois

Burton Browne advertising

NOW

In the Model CM-100, Mincom's latest instrumentation recorder/reproducer, the series elements

THE MINCOM CM-100

before data storage have been reduced to recorder and mixer only, one step from the antenna.

IS PERFORMING

With the CM-100's 1-megacycle response and constant phase equalization at all speeds, an original

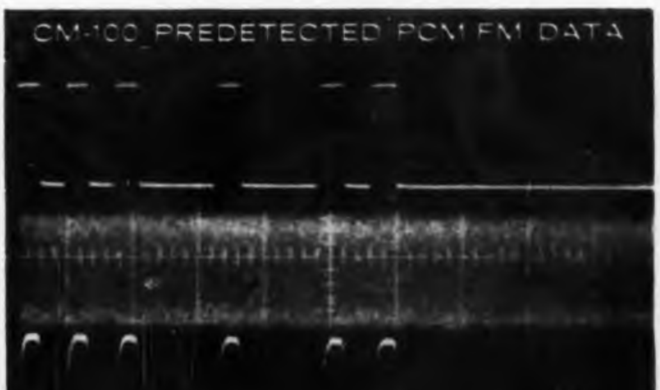
OPERATIONAL

IF signal of 5.0 megacycles thus can be heterodyned so that the carrier swing and its sidebands

PREDETECTION RECORDING

fall within the Mincom CM-100's frequency range – in FM, FM/FM modulation, PCM and PCM/FM.

...and actually doing it at defense facilities as you read this page.



5.0-mc IF carrier heterodyned down to 750 kc. Random-spaced pulses. 20 µs on-20 µs off-type information. Sweep rate: 50 µs/cm.

Write for brochure.

...WHERE RESEARCH IS THE KEY TO TOMORROW 3M COMPANY

MINCOM DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

2049 SOUTH BARRINGTON AVENUE, LOS ANGELES 25, CALIFORNIA • 425 13th STREET N.W., WASHINGTON 4, D.C.

Circle 24 on Inquiry Card

A Toast to Environmental Testing

The Deutsch hermetic receptacle has withstood every kind of trial and tribulation we could think of, and will soon be toasted from Cape Canaveral to Edwards as the only connector giving true hermetic sealing against extreme environmental conditions. The secret of this leak-proof performance is the unique compression glass insert molded into the connector shell as one solid piece with contacts fused right in. And we can guarantee sealed reliability because Deutsch handles every step of production under quality control procedures that have set new standards in the industry. For more information on the connector with the full glass insert, contact your Deutschman today or write for Data File A-1.

DEUTSCH

Electronic Components Division · Municipal Airport · Banning, California

ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

Tele-Tips

(*Continued from page 41*)

An IBM 650 data processing system has been put to work in a law library, locating information for barristers. The EDP system provides in minutes facts that would have taken many hours to find by conventional methods.

The Coast And Geodetic Survey Dept. is using a computer to spot the origin of earthquakes. Approximately 1500 earthquakes are now located annually. The survey hopes to double that number within a few years.

Russian-English Translator has been developed by IBM for the Air Force that turns out 35 words per second. The machine has some shortcomings—it translates only on a word-for-word basis—but a sophisticated word analyzer is on the drawing boards that will break down sentence structure. It should be ready early this year.

AND THESE SHORT SHOTS: National Bureau of Standards has a new camera that takes pictures so small it can produce the entire bible page-by-page on an area smaller than Lincoln's head on a penny.

Some medical people believe that microminiaturized circuits could be introduced into the human body by swallowing and telemeter physiological data directly to the physician. The original of this idea came out a few years ago, developed by Rockefeller Foundation.

Signal Corps Patent Advisor Harry E. Thomason, of Washington, D. C., built himself a **solar heating system** for his 3 bedroom home. The system cost $2500 and last winter he paid only $4.65 in fuel bills.

Engineer Lloyd F. Knight, of Servo Corp., has built an automatic baseball umpire that calls balls and strikes. His system uses three TV cameras, one at each side of the batter and a third directly overhead.

NEW FROM *hp* Highest reliability Highest quality

NEW 170A MILITARIZED SCOPE—TO 30 MC!

hp 160B MILITARIZED 15 MC SCOPE!

Vertical, time axis plug-ins provide unique

hp 166A Plug-in (Time-Axis) furnished with the -hp- 160B and 170A Oscilloscopes (as pictured), provides standard input connections, including trigger input, Z-axis, single-sweep arming input.

hp 162A Dual Trace Amplifier plug-in (vertical) gives maximum sensitivity to 20 mv/cm, permits viewing of two phenomena simultaneously, offers differential input for common mode rejection, meets environmental requirements of MIL-E-16400C. Electronic chopping permits better utilization of sweep speeds, extends simultaneous viewing of 2 signals to lower frequencies without flicker. -hp- 162A, $350.00

hp 166C Display Scanner (Time-Axis plug-in) provides output to duplicate, on an X-Y recorder, any repetitive waveform appearing on CRT trace. Resolution with permanent, large-scale records is higher than either scope CRT or photograph, and you can observe the scope trace while records are made. Unit converts high speed signals to slower signals having the same waveshape; scanning speed is arranged to keep Y output within the bandwidth of conventional recorders. -hp- 166C, $300.00.

hp 166D Sweep Delay Generator (Time-Axis plug-in) delays the main sweep of the 160B and 170A Scopes for detailed examination of a complex signal or pulse train. In addition, it offers a unique mixed sweep feature to show an expanded segment of a delayed waveform while still retaining a presentation of earlier portions of the waveform. Delay time 1 μsec to 10 sec. Delaying sweep 18 ranges. Delayed length 0 to 10 cm. Delay functions: trigger main sweep, arm main sweep, mixed sweep. -hp- 166D, $325.00.

OSCILLOSCOPES

Meets military specifications
Conventional controls for simple operation
Uniquely versatile dual plug-ins providing:

1. **X-Y records of repetitive waveforms**
(-hp- 166C Display Scanner Plug-in)
2. **New sweep delay convenience**
(-hp- 166D Sweep Delay Generator Plug-in)
3. **Widely versatile input capabilities**
(-hp- 162A Dual Trace Amplifier Plug-in)

These are the scopes you have been waiting for! Built to exacting military specifications, they offer instantly expandable measurement capability—*when you need it*. It's easy! Just add a moderately priced plug-in unit!

Both -hp- 160B and 170A employ the same vertical and time-axis plug-ins providing the widest range of application with minimum plug-ins and minimum investment. Details of these plug-ins are given on the opposite page.

New -hp- 160B and 170A follow MIL-E-16400C for shock, vibration, humidity and temperature. Important features include high stability tube-transistor circuits, regulated dc filament voltages and premium components throughout. Power transistors in efficient heat sinks insure cool operation; etched circuits on translucent epoxy glass simplify circuit tracing and servicing.

Simple, conventional controls speed set-up time and actual measuring. Improved preset triggering insures optimum operation for almost all conditions with just one adjustment—even on signals down to 2 mm deflection. Both -hp- 160B and 170A give you big, bright presentation on a 5" CRT, with a clear, steady trace free from bloom or halo.

A push-button beam finder automatically locates off-screen beam or trace (especially useful for operation by inexperienced personnel). And to increase general-purpose usefulness: 24 calibrated sweep times, 0.1 µsec/cm to 5 sec/cm, ± 3% accuracy. Vernier extending slowest sweep to 15 sec/cm. Seven-range magnifier increasing fastest sweep to 0.02 µsec/cm. Horizontal sensitivity 0.1 v/cm to 10 v/cm. Vernier extending minimum sensitivity to 25 v/cm. -hp- 160B, $1,850.00; -hp- 170A, $2,150.00.

versatility for the -hp- 160B and 170A scopes!

SPECIFICATIONS—-hp- 160B and 170A with -hp- 166A Plug-in

VERTICAL

Bandwidth:	-hp- 160B, 15 MC -hp- 170A, 30 MC
Voltage Calibrator:	9 calibrated ranges ± 3%, 0.2 mv to 100 v peak to peak
Current Calibrator:	5 ma peak to peak ± 3%

HORIZONTAL

Bandwidth:	dc to 1 MC
Sensitivity:	7 ranges 0.1 v/cm to 10 v/cm. Vernier extends minimum sensitivity to 25 v/cm
Input Impedance:	1 megohm shunted by 30 pf

SWEEP GENERATOR

Internal Sweep:	24 ranges, 0.1 µsec/cm to 5 sec/cm, ± 3%. Vernier extends slowest sweep to 15 sec/cm
Magnification:	7 calibrated ranges, X1, X2, X5, X10, X20, X50 and X100. Increases fastest sweep to 0.02 µsec/cm
Triggering:	Internal, power line or vertical input signal (2 mm or more vertical deflection); external (½ v peak to peak or more)
Trigger Point:	Positive or negative going voltage. Trigger level of external sync signal adjustable —30 to +30 volts
PRICE:	-hp- 160B, $1,850.00 (cabinet or rack mount) -hp- 170A, $2,150.00 (cabinet or rack mount)

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

HEWLETT-PACKARD COMPANY
1057B Page Mill Road, Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000

HEWLETT-PACKARD S.A.
Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36

Sales representatives in all principal areas

Circle 27 on Inquiry Card

Widest Choice of Glass Sealing Alloys for Semi-Conductors

You use different glasses for different semi-conductor applications. So to get the most perfect match of glass-sealing alloy, choose from the broad line offered by Superior. Quantities as small as 50 ft. in any size and analysis may be ordered and in precision-cut short lengths. All alloys are cold drawn to close tolerances in seamless or WELDRAWN[1] form. Sizes from .012 to ⅝-in. OD. In addition to the standard alloys listed in the following, many special alloys are available to order. For complete details, write for Data Memo No. 15, Superior Tube Co., 2502 Germantown Ave., Norristown, Pennsylvania.

Kovar.[2] Excellent for hard glasses. Oxide fuses into glass. Provides vacuum-tight joint. Coef. thermal expansion 50.3/53.7 (30-450°C). See note.

Sylvania #4.[3] Well matched for certain soft glasses. Used for internal seals. Coef. thermal expansion 85 (25-300°C). See note.

#52 Alloy. Popular for sensitive magnetic use and for thermostatic work. Coef. thermal expansion 95 (20-400°C). See note.

#42 Alloy. A nickel-iron alloy practical for sealing to soft glass. Coef. thermal expansion 53 (20-400°C). See note.

AISI Type MT-1010. A low carbon steel with good bending and flaring qualities.

OFHC Copper. May be used with either hard or soft glasses. Coef. thermal expansion 165 (25-300°C). See note.

AISI Type 446. Stainless steel suitable for soft glasses. Highest heat resistance of chromium irons.

AISI Type 430. Less chromium than 446. Easier to work. Appropriate for soft glass seals.

AISI Type 430 Ti. Same properties as Type 430. Stabilized with titanium to improve weldability. Suitable for soft glasses.

[1]A Superior trademark registered United States and Canada.

[2]Kovar Alloy Tubing is stocked and sold through the Stupakoff Division of The Carborundum Company, Latrobe, Pa. The name "Kovar" is a registered trademark of the Westinghouse Electric Corporation (No. 337,962).

[3]T.M. Reg. U.S. Pat. Off., Sylvania Electric Products, Inc.

Note. Expressed in in./in./°F $(x\ 10^{-7})$.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N. Y.—an affiliated company making precision metal stampings and deep-drawn parts.

Now...12-Nanosecond Total Switching Time with CBS MADT* Transistors

Total switching time for typical CBS 2N501 and 2N501A transistors in this circuit is less than 12 nanoseconds. The basic circuit can readily be cascaded to form fast-switching ON and OFF stages for computers. Since the transistors have a high gain-bandwidth product at only -3 collector volts, the size and cost of your power supply can be substantially reduced.

The economical CBS 2N501 and 2N501A also offer a wide choice of design possibilities in other fast-switching circuits. Consult the table for high switching rates permitted in the variety of circuits shown.

Order engineering samples for your prototype design. Call or write for technical data and delivery information, today, from your local sales office or Manufacturer's Warehousing Distributor.

Wide Choice of Fast Switching Circuits
With CBS 2N501 and 2N501A

Logic Circuits	*Switching Rate*
Special non-saturating	140 mc
Emitter follower coupled	140 mc
Base gating	140 mc
Transformer coupled pulse	140 mc
Diode transistor logic (DTL)	20 mc
Resistor capacitor transistor logic (RCTL)	20 mc
Direct coupled transistor logic (DCTL)	7 mc
Resistor transistor logic (RTL)	1 mc
Pulse Generators & Shaping Circuits	
Blocking oscillators	10 mc
Regenerative amplifiers	10 mc
Schmidt trigger circuits	10 mc
Monostable multivibrators	5 mc
High Current Pulse Amplifiers†	
Line drivers	10 mc
Core drivers	10 mc
Read-write amplifiers	10 mc

†Switching current, 35 ma.

*Micro Alloy Diffused-base Transistor, trade-mark, Philco Corp

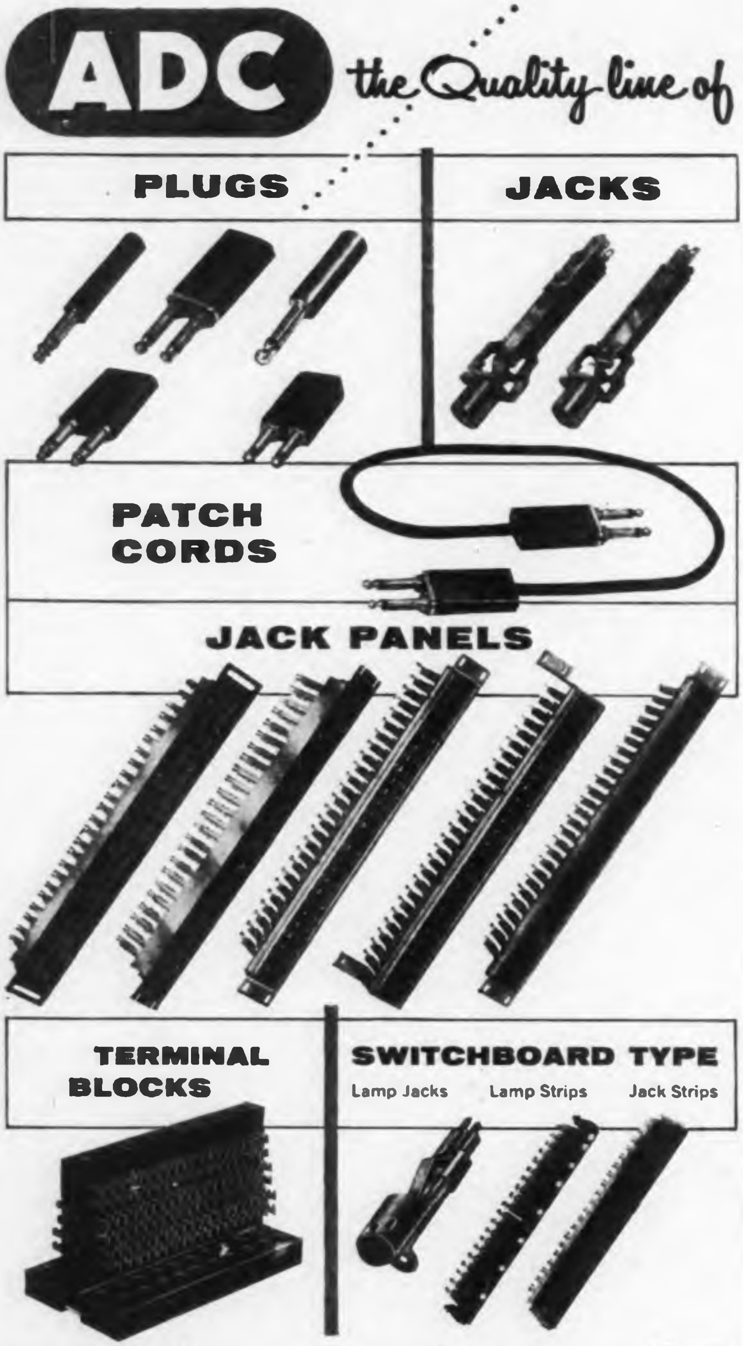
Circle 29 on Inquiry Card

CBS semiconductors®

More Reliable Products through Advanced Engineering

CBS ELECTRONICS, Semiconductor Operations, Lowell, Mass. • A Division of Columbia Broadcasting System, Inc. Semiconductors • tubes • audio components • microelectronics

Sales Offices: Lowell, Mass., 900 Chelmsford St., GLenview 2-8961 • Newark, N. J., 231 Johnson Ave., TAlbert 4-2450 • Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAymond 3-9081 • Minneapolis, Minn., The Heimann Co., 1711 Hawthorne Ave., FEderal 2-5457 • Washington, D. C., 1735 Desales St., N.W., EMerson 2-9300 • Dayton, Ohio, 39 North Torrence St., CLearwater 2-1972 • Toronto, Ont., Canadian General Electric Co., Ltd., LEnnox 4-6311.



Letters to the Editor

"You Missed Us—"

Editor, ELECTRONIC INDUSTRIES:

We feel that there has been an omission in your November, 1960 issue on Page 157. Under the Products and Manufacturers section, Fairchild Aircraft and Missiles Division is not included.

At present, this Division of the Fairchild Engine and Airplane Corporation holds three (3) antenna contracts; (1) 60 Ft. Diameter Parabolic Dish for the "Pincushion" Radar System, (2) 12 Ft. x 15 Ft. Elliptical Parabolic Dish for the AN/SPS-30 Radar System and, (3) 15 Ft. Diameter Folding Parabolic Dish for a Solar Power System.

This information is called to your attention in the interest of editorial accuracy.

Claude S. Huber
Chief Project Engineer
Special Projects
Fairchild Aircraft and Missiles Division
Hagerstown 10, Md.

"Thanks"—From ESMA

Editor, ELECTRONIC INDUSTRIES:

The Board of Directors and I, plus present members of ESMA, would like to thank you for your very wonderful editorial in the November issue of ELECTRONIC INDUSTRIES.

Cooperation such as yours has certainly helped to get our organization off the ground. At the present rate applications are coming in, we should number several hundred by the IRE.

Your knowledge of the industry and its problem impressed all of us. This present period has been a busy one trying to organize committees, etc. We have not made too many public moves due to our lack of membership strength. By IRE time we have high hopes that we will then be in a position to start accomplishing things for the benefit of our industry.

Again thank you for your consideration and help.

C. G. Barker
President
Electronics Sales Managers Association
Port Washington, L. I.
New York

Designing Rotary Joints

Editor, ELECTRONIC INDUSTRIES:

Would you please send me a reprint of the article "Designing Rotary Waveguide Joints," by Conway A. Balt, Jr. which appeared in the

(*Continued on page* 54)

NEW!
DIRECT READING FREQUENCY METER

a full octave and beyond
3.95 to 11.0 KMc

DELIVERY FROM STOCK

Model No. N414A — Price: $495.00

- Direct reading from 3.95 to 11.0 KMc
- Covers a full octave and beyond
- Reaction type with 0.1% absolute accuracy
- Non-contacting choke for long life and high Q
- Standard Type N Connectors for universal utilization

Meet the newest member of the FXR "family" of direct reading frequency meters. This coaxial type, Model No. N414A, has a range from 3.95 KMc to 11.0 KMc and by use of FXR Series 601 coax to waveguide adapters converts to waveguide setups. The unit covers "a full octave and beyond" with an absolute accuracy of 0.1% throughout its range. It is a perfect companion for the FXR Models No. C772 and X772 signal sources.

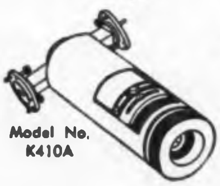
This newest direct reading frequency meter augments FXR's existing line, recognized as the largest in the industry. Direct reading, reaction type units are available for use up to 39.5 KMc while micrometer types extend FXR's coverage up to 220 KMc.

Write or call now for data sheets on Model No. N414A and other units in the integrated FXR family of precision frequency meters.

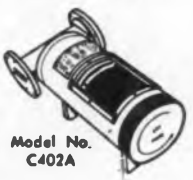
FXR "FAMILY" OF DIRECT READING REACTION TYPE FREQUENCY METERS

Model No. N410A

Model No. X410B



Model No. K410A



Model No. C402A

Model No.	Frequency Range (KMc)	Absolute Accuracy (%)	Approx. Q	Waveguide Type RG-( )/U	Flange Type UG-( )/U	Price (F.O.B. Woodside)
COAXIAL TYPES						
N410A	1.00- 4.00	0.10	3000	(3/8" Coax Type N)		$495.00
N414A	3.95-11.0	0.10	500 to 1500	(3/8" Coax Type N)		495.00
WAVEGUIDE TYPES						
•H410B	3.95- 5.85	0.08	8000	49	149A	250.00
•C410B	5.85- 8.20	0.08	8000	50	344	180.00
•W410B	7.05-10.00	0.08	8000	51	51	165.00
•X410B	8.20-12.40	0.08	8000	52	39	150.00
Y410A	12.40-18.00	0.10	4500	91	419	210.00
K410A	18.00-26.50	0.10	4000	53	425	230.00
U410A	26.50-39.50	0.10	3000	96	381	250.00
C402A	5.85- 8.20	0.03	8000	50	344	1275.00
X402A	8.20-12.40	0.03	8000	52	39	1275.00

• With transmission coupling probe.

DELIVERY FROM STOCK

FXR M.M. TYPES (Micrometer Reading)

Model No.	Frequency Range KMc	Price (F.O.B. Woodside)
Q410X	33-50	$325.00
M410X	50-75	300.00
E410X	60-90	500.00
F412A	90-140	750.00
G412A	140-220	750.00

DELIVERY FROM STOCK

FXR, Inc.
Design • Development • Manufacture
25-26 50th STREET
WOODSIDE 77, N. Y.
RA. 1-9000
TWX. NY 43745

PRECISION MICROWAVE EQUIPMENT • HIGH-POWER PULSE MODULATORS • HIGH-VOLTAGE POWER SUPPLIES • ELECTRONIC TEST EQUIPMENT

Letters to the Editor

(*Continued from page 52*)

November, 1960 issue of ELECTRONIC INDUSTRIES.

I am not on your mailing list, but a few of my colleagues are, so occasionally, I have the opportunity of reading your magazine. Even though many of the articles do not pertain to my field, I have found them quite interesting and hope that you will continue to publish such fine articles in the future.

Earl DeJonge
Microwave Design Engineer
The Bendix Corporation
Bendix Mishawaka Division
Mishawaka, Ind.

"The Company Library—"

Editor, ELECTRONIC INDUSTRIES:

"The Company Library — White Elephant or Work Horse?" is an excellent article that should be in the hands of all companies planning a library as well as in the hands of all managers and supervisors who do have libraries. I shall call attention to it to local Special Library Association members.

(Mrs.) Marjorie M. Ford
Technical Librarian
Minneapolis-Honeywell Regulator Company, Military Products Group
Ordnance Division
1724 South Mountain Avenue
Duarte, Calif.

The "Savannah" Simulator

Editor, ELECTRONIC INDUSTRIES:

I have just noted the picture of the N. S. Savannah Simulator (built by Westinghouse), in the November issue.

This picture was taken back in July 1959 when the Simulator was first installed. Considerable work has been done since then, in modifying to make the unit more exact.

The caption with the picture is incorrect—insofar as Borg-Warner is concerned. The instructor's desk was constructed on the job and is made up of Emcor assemblies.

At present writing, training of Savannah crews is about complete.

All work of installation was done by field personnel from Westinghouse, E. Pittsburgh and Baltimore Engineer & Service under my supervision. Design engineers were C. H. Culbertson, N. E. Bush and D. D. Blewitt of Power Control & Communications, Dept. E., Pittsburgh.

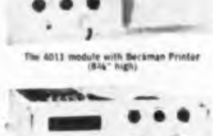
Paul A. Broemer
Lynchburg, Va.

(*Continued on page 60*)

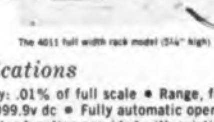
this .01% dvm is different!

Because... it has a unique self-adjusting stepping-switch drive which eliminates thyratrons, provides smooth, quiet, trouble-free operation for longer life... it introduces Range Hold operation that restricts "stepping" when repeated readings on only one decade range are to be made... it comes as a space-saving half-rack module 8" square for portable use and side-by-side rack installation with a Beckman/Berkeley Printer, converters, etc., or as a full rack width model 5¼" high... it combines a fistful of other important features with recognized Beckman/Berkeley experience. *Write for Technical Bulletin 4011.*

- **automatic polarity**
- **automatic ranging**
- **print out**
- **$995**



The 4011 module with Beckman Printer (8¾" high)



The 4011 full width rack model (5¼" high)

Specifications

• Linearity: .01% of full scale • Range, from 0.001v to 999.9v dc • Fully automatic operation • Ratiometer function provided with existing internal circuitry • 4 digit in-line, in-plane display, and binary-coded output • Variable sensitivity control • Oven-regulated Zener power supply • Self-contained standard cell for accurate calibration

Beckman® | *Berkeley Division*
Richmond, California

T28

Circle 33 on Inquiry Card

First commercially priced silicon rectifier

More in use than any similarly rated unit

One of the first silicon rectifiers in volume production

TARZIAN M-500 Silicon Rectifier

The Sarkes Tarzian M-500 silicon rectifier is rated at 500 milliamperes dc, with a peak inverse voltage rating of 400 volts. This was the first commercially priced silicon rectifier, and more M-500's are now in use than any similarly rated unit.

The Tarzian M-500 is a cartridge type rectifier with end ferrules that snap quickly and easily into standard clips. The M-500 is made by a special Tarzian process that provides optimum forward to reverse ratios and long, useful life.

For additional information, practical application assistance, and prices on the M-500, write Sarkes Tarzian, Inc., Semiconductor Division, Bloomington, Indiana

DC amps (100° C)	Peak Inv. Voltage	Tarzian Type	Max. RMS Volts	Max. Recurrent Peak Amperes (100° C)	Max. Surge Amps 4MS	JEDEC No.
0.5	400	M-500	280	5	30	1N1084

Other voltage and current ratings also available in this style.

SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

In Canada: 700 Weston Rd., Toronto 9 • Export: Ad Auriema, Inc., New York

SILICON NEWS from Dow Corning

(PART 2)

The Untouchables

Single Crystal Silicon... the "Pinnacle of Purity"

Dow Corning single crystal silicon is produced by vacuum zone refining hyper-pure polycrystalline rod. Result: The purest silicon produced! Typically, impurity content is only 0.15 part per billion of boron for crystals that are consistently above 1000-ohms centimeter resistivity. Boron content is even lower for crystals of 2000-ohms centimeter and above . . . available on a selective basis.

This highest purity P-type silicon is the result of a completely integrated processing facility that starts with the production of trichlorosilane and ends with the crystals heat-sealed in airtight polyethylene envelopes. Purity and quality control dominate every step — in producing the basic chemicals . . . in growing polycrystalline rod . . . in vacuum zone refining . . . in product evaluation and in packaging.

Purity pays off . . . in rectifiers and diodes having higher peak inverse voltage ratings — in maximum utilization because of uniform lateral and radial profiles over the entire length of the rod. With Dow Corning single crystal rod, you're assured of maximum yield and minimum waste per rod. Rod diameter variation is controlled to less than 1.4 mm (0.055 inches)—simplifying mechanical preparation for either the diffusion or alloying process.

Hyper-pure silicon for every need is now available from Dow Corning. If you grow your own crystals from polycrystalline chunk using the Czochralski method . . . if you zone refine polycrystalline rod . . . if you need 1000-ohm centimeter or better resistivity in single crystal P-type — Dow Corning should be on your preferred source list.

Each Dow Corning single crystal rod is checked for resistivity over its entire length. Resistivity and lifetime profiles, like those shown below, are supplied with each crystal.

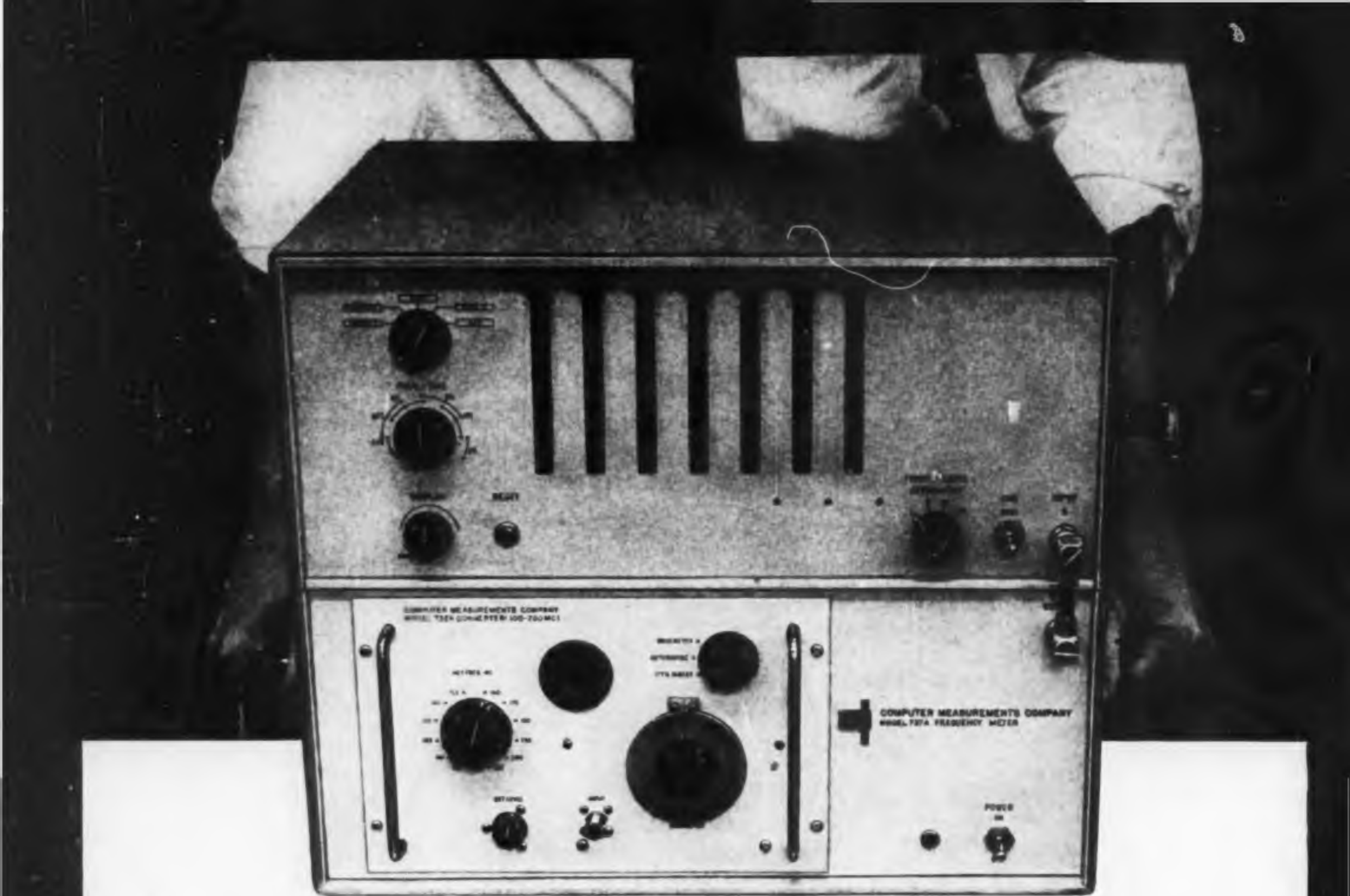
Write for "Hyper-Pure Silicon for Semiconductor Devices." Address Dept. 3413.

HYPER-PURE SILICON DIVISION
Address: HEMLOCK, MICHIGAN

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.



Model 737A shown with Model 732A Converter Plug-In

⟶ **Measure frequency dc to 220 mc**
⟶ **Measure period to 0.1 microsecond**
⟶ **Measure time interval 0.1 microsecond to 10^7 seconds**
⟶ **Count dc to 10 mc**

CMC, first with solid state reliability, announces the transistorized Model 737A frequency-period meter.

Here, combined in one compact package weighing a scant 53 pounds, are the functions of a high speed counter, frequency meter, and period meter. Sensibly priced at $2400, the Model 737A mates an all solid state counter with a plug-in vacuum tube heterodyne converter.

Only 14" high, 17" wide, and 13" deep, CMC's new Model 737A requires a mere 125 watts of power which in itself reduces operating temperatures and contributes to long trouble-free life. And except for the vacuum tubes, the new unit is unconditionally guaranteed for two years.

NEW TECHNICAL BULLETIN TELLS ALL

Your nearby CMC engineering representative will be happy to provide you with full technical, sales, and delivery information and arrange a demonstration at your convenience. For a free copy of our new technical bulletin, please address Dept. 44.

THREE PLUG-INS AVAILABLE

1. 10 mc to 100 mc frequency converter; 2. 100 mc to 220 mc frequency converter; 3. Solid state 0.1 microsecond to 10^7 second time interval section.

Converter plug-ins $250 each. Time interval plug-in $300.

FEATURES AND ADVANTAGES ✱ *Decade count down time base, frequency divider circuits never need adjustment.* ✱ *Automatic decimal point.* ✱ *Nixie readout available as standard option.* ✱ *Stability, 2 parts in 10^7 standard, 5 parts in 10^8 special.* ✱ *Accuracy, ±1 count ± oscillator stability.* ✱ *Sensitivity, 0.25 v rms.* ✱ *Standardize against WWV.* ✱ *Remote programming without special regard to cable length, type of cable, or impedance matching.* ✱ *Printer output to drive digital recording equipment, punches, inline readout and other data handling gear, $80 extra.*

CMC 36

Computer Measurements Co.
A Division of Pacific Industries
12970 Bradley Avenue, Sylmar, California
Phone: EMpire 7-2161

SPECIFY ARNOLD IRON POWDER CORES... COMPLETE RANGE OF SIZES AND SHAPES FOR YOUR DESIGNS

Arnold offers you the widest range of shapes and sizes of iron powder cores on the market.

In addition to toroids, bobbin cores and cup cores—typical groups of which are illustrated below—Arnold also produces plain, sleeve and hollow cores, threaded cores and insert cores, etc., to suit your designs. Many standard sizes are carried in warehouse stock for prompt shipment, from prototype lots to production quantities. Facilities for special cores are available to order.

The net result is extra advantage and assurance for you. No matter what shapes or sizes of iron powder cores your designs require, you can get them from a single source of supply—with undivided responsibility and a single standard of known quality. And Arnold's superior facilities for manufacture and test assure you of dependably uniform cores, not only in magnetic properties but also in high mechanical strength and dimensional accuracy.

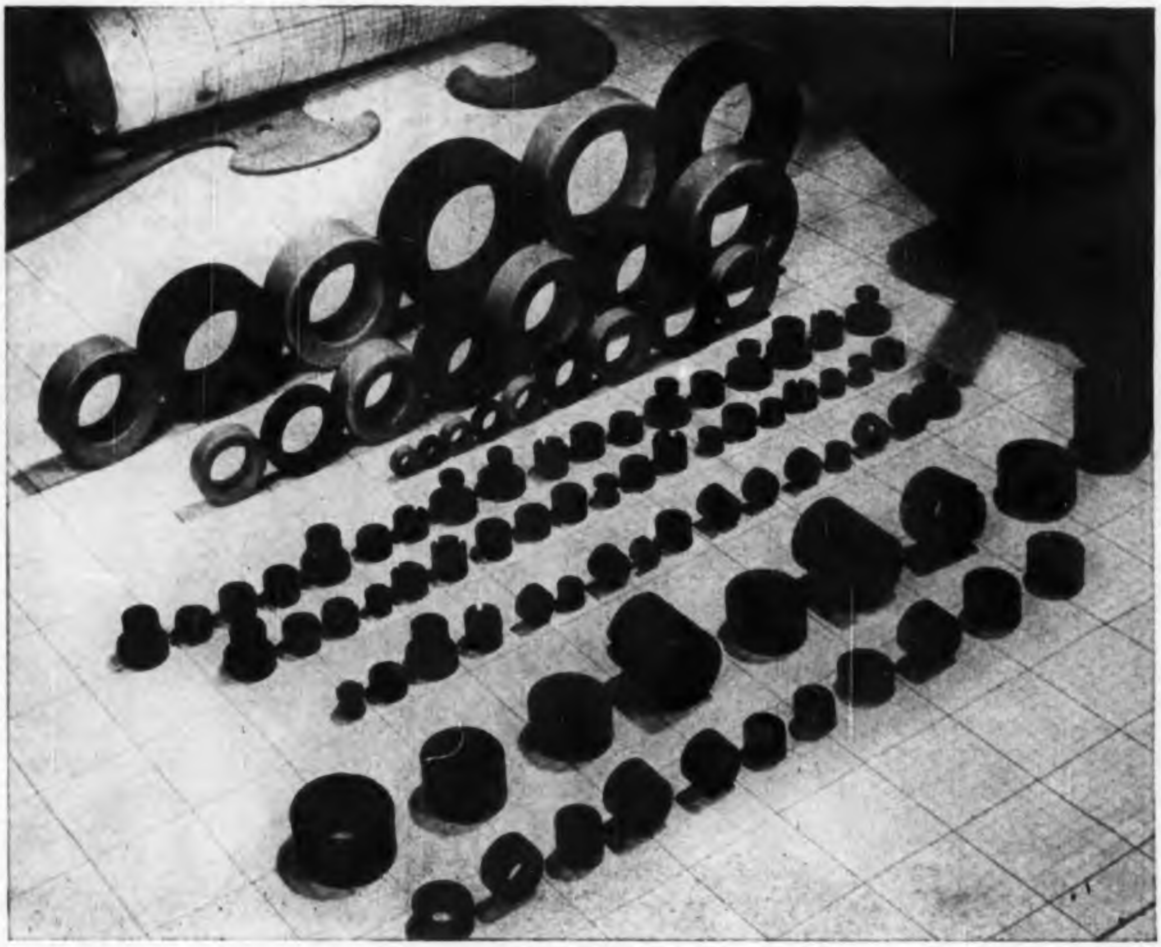
● For more information on Arnold iron powder cores, write for a copy of our new 36-page Bulletin PC-109A. *The Arnold Engineering Company, Main Office and Plant, Marengo, Illinois.*

ADDRESS DEPT. EI-1

ARNOLD

SPECIALISTS in MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES • *Find them FAST in the YELLOW PAGES* 2841



Circle 37 on Inquiry Card

Letters to the Editor

(*Continued from page 54*)

For Technical Secretaries

Editor, ELECTRONIC INDUSTRIES:

Why not print an article or series of articles for technical secretaries? Many hours of unnecessary labor might be eliminated if we secretaries had a "manual" of terms, *correctly* spelled and abbreviated. Since I must do a great deal of work from rough copy, I must spend time deciphering crude script and erasing that which was not correctly interpreted. Of course I have become familiar with some terms, but there are always a few which are new (and sometimes not always clear to the author of the report)! Definitions, in laymen's language, would also be helpful. Though not scientifically inclined, I am interested in what is going on about me.

My boss gave me the report on duplicating papers ("How To Duplicate Technical Papers") to read. It is a timesaver to him, then, as well as myself, that I become better acquainted with various office machines. Would not a simple article such as I have mentioned also be welcome for the same reason?

Thank you for listening!

Sylvia N. Berman
Group Secretary

Massachusetts Institute of Technology
Department of Aeronautical Engineering
Instrumentation Laboratory
Cambridge 39, Mass.

Editorial Note:—Anybody have such a manual?

Electronics and Agriculture

Editor, ELECTRONIC INDUSTRIES:

Dr. T. E. Hienton, of ARS, USDA, recently gave us a reprint from the August issue of ELECTRONIC INDUSTRIES, titled "Electronics And The Future Of Agriculture."

As the trade association for approximately 1,000 rural electric cooperatives which serve most of the farm areas of the United States, we think this article would be of value to the systems.

Are reprints of the article available?

We'd appreciate hearing from you . . . .

James Sherwood
Assistant Manager
Power Use Section

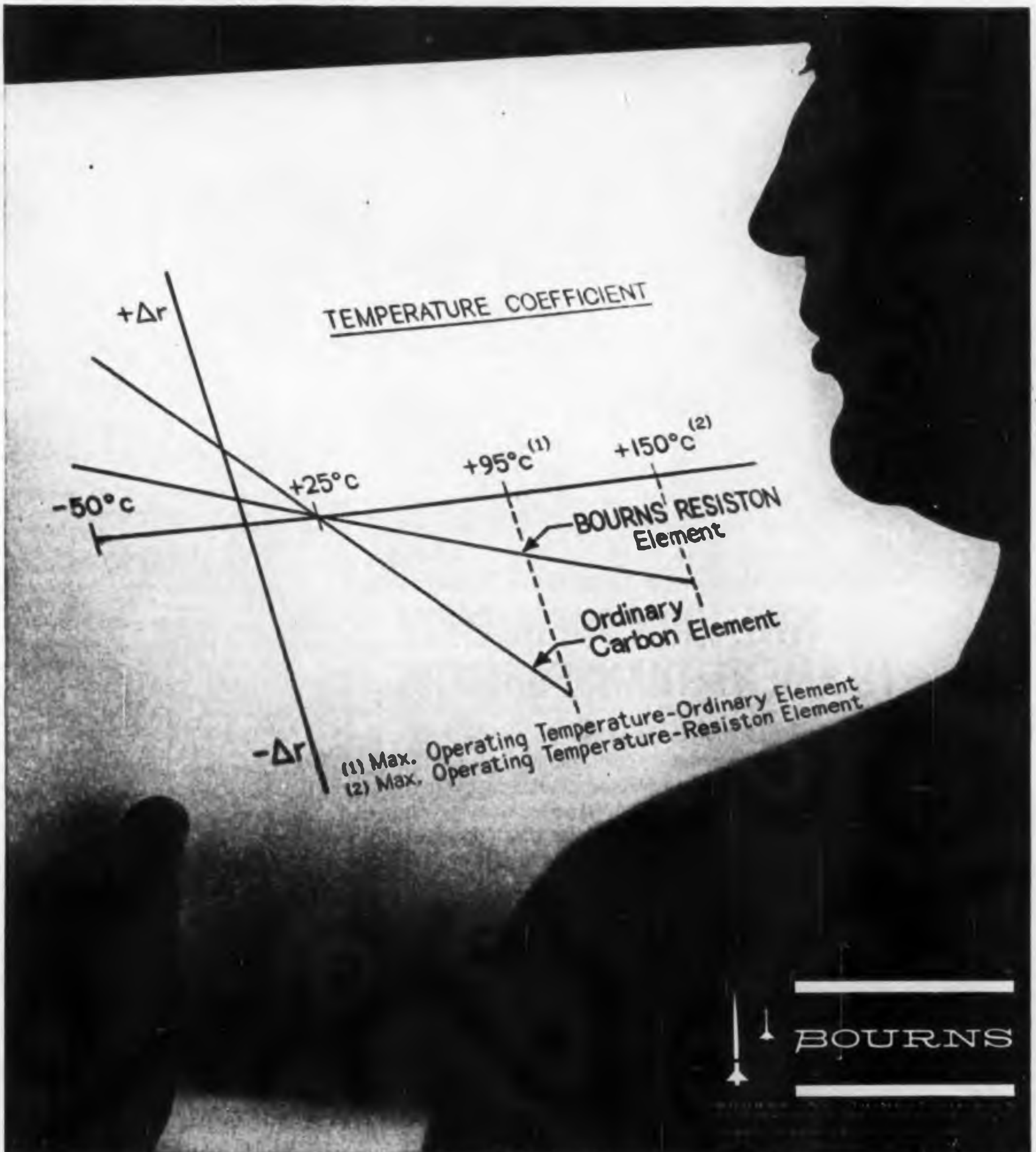
National Rural Electric
Cooperative Association
2000 Florida Avenue
N. W. Washington 9, D. C.

At Last—High Reliability in Carbon-Film Potentiometers!

Bourns Trimpot® carbon-film potentiometers now offer you twice the stability of any carbon unit heretofore available ... at temperatures as high as 150°C. Now, for the first time, you can incorporate high-resistance, infinite-resolution potentiometers in your circuit without sacrificing reliability. The reason: Resiston°, a remarkable new carbon element that virtually eliminates the problems normally caused by extremes of temperature and humidity.

Thanks to this exclusive Bourns development, Trimpot carbon units can operate at temperatures up to 150°C—with resistance shift only half that of ordinary carbon elements. In addition, they far exceed the requirements of Mil-Specs for humidity and MIL-R-94B.

Trimpot Resiston units are available from factory and distributor stocks with three terminal types ... three mounting styles ... and standard resistances ranging from 20K to 1 Meg. Resiston elements are available in most Bourns configurations. Write for the new Trimpot summary brochure and list of stocking distributors and representatives.



Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

Books

The Theory and Design of Inductance Coils 2nd Ed.

By V. G. Welsby. Published 1960 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 232 pages. Price $6.00.

This 2nd edition is in line with modern practice. The main purpose of the book is to explain the underlying design principles of all types of inductors in a way readily understood by those mainly interested in practical results rather than to give an exhaustive mathematical treatment. Resulting from the development of microwave radio and of h-f techniques during recent years, much interest has been created in the principles of electromagnetic wave propagation. This aspect is referred to, and it is shown how a picture derived from electromagnetic field theory simplifies the understanding of inductors.

Electronic Maintainability, Vol. III

Edited by F. L. Ankenbrandt. Published 1960 by Engineering Publishers, Div. of A. C. Book Co., Inc., P. O. Box 2, Elizabeth, N. J. 312 pages. Price $10.00.

Maintainability has a direct bearing on the usefulness of any product, whether it be complex electronic gear in a satellite or guided missile, a huge electrical generator, or milady's hair dryer. This book, based on the third EIA conference on maintainability of electronic equipment, contains an authoritative discussion of the developments which have been changing maintainability from the vaguely practiced art of yesterday to the rigorous science of today and tomorrow.

Many aspects of modern maintainability are discussed in depth. The subject matter ranges from the maintenance problems of space flight to the determination of adequate working space for electronic technicians. The contributors are among the foremost workers in the field.

Inertial Guidance

By Charles S. Draper, Walter Wrigley and John Hovorka. Published 1960 by Pergamon Press, 122 E. 55th St., New York 22. 130 pages. Price $6.50.

This book is a descriptive treatise on the physical principles and engineering methods underlying the navigation and control of vehicles solely by means of signals from sensors that depend only on the inertial properties of matter for their operation. The starting points are conventional navigation and Newtonian physics, and the development proceeds from an examination of traditional navigation in terms of physics, through a discussion of past uses of inertia in navigation, to the interpretation of the operations of navigation in terms of control theory, the ultimate inertial guidance system being regarded as a feedback system which operates

New Frequency Meter and Discriminator

3c to 1.5 Mc, Direct Reading. ±0.2% Accuracy

... Simple, Direct Frequency Measurements
... Simplifies Recording of Drift and Stability
... A Highly Linear Pulse-Count Discriminator for Measurements of FM Deviation and Incidental FM.

FREQUENCY METER

- Logarithmic meter maintains constant accuracy, even at one-tenth of full scale.
- Calibrated interpolator . . . effectively expands meter scale by a factor of 10 . . . permits readings to 3 significant figures from any of the 15 preset references on each range.
- Higher frequency measurements can be made by heterodyne techniques. This method also permits drift measurements up to one part in 10^8, or better, when using stable frequency standards.
- Readings independent of input waveform. Sensitivity: 20 mv rms from 20c to 150 kc, rising to 200 mv at 3c and 1.5 Mc.
- Built-in calibration.

DISCRIMINATOR

- Output: 15v, full scale, on all ranges
- Low Noise: Residual fm more than 100 db below full output
- Linearity: Same as output current accuracy statement

RECORDER OUTPUTS

- Adjustable output provides current proportional to input frequency up to 5 ma to drive recorders.
- Interpolator output for high-impedance recorders provides voltage proportional to frequency deviation from preset references.

Type 1142-A Frequency Meter and Discriminator . . . $495

A C C U R A C Y

Output Current: ±0.05% of range setting +0.05% of measured frequency, below 15 kc; ±0.1% of range setting +0.1% of measured frequency above 15 kc

Additional Meter Error: Direct reading, ±1% above 10% of full scale. Interpolating, ±0.1% of range switch setting.

Write For Complete Information

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

The Best Instruments In Electronics

NEW YORK, WOrth 4-2722
NEW JERSEY, Ridgefield, WHitney 3-3140
CHICAGO Oak Park Village 8-9400
PHILADELPHIA Abington HAncock 4-7419
WASHINGTON, D.C. Silver Spring JUniper 5-1088
SAN FRANCISCO Los Altos WHitecliff 8-8233
LOS ANGELES Los Angeles HOllywood 9-6201
IN CANADA Toronto CHerry 6-2171

Circle 41 on Inquiry Card

Books

(Continued from page 62)

in 3-dimensional space in the gravitational field as its sole environment. The writing is directed at graduate-level engineering scientists who are not necessarily specialists in any of the relevant fields mentioned above.

The problems discussed include the most recent ballistic missile guidance, where classification permits, or the use of gyros in geometrical stabilization is given a unique treatment.

The book is tutorial, with the emphasis on the growth of engineering ideas in the field and the relationships of these concepts. It does not attempt to set up categories of systems except in a broad and general manner and it does not break inertial guidance efforts up into categories of activity. Rather, the underlying similarities and differences of various engineering approaches are discussed.

Management Control Systems

Edited by Donald G. Malcolm and Allen J. Rowe. Published 1960 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 375 pages. Price $7.25.

Consolidating expert testimony on management controls by some thirty experienced individuals in all areas of management, the editors and contributors have constructed a case where "designed" controls to produce better results in management controls systems and management patterns now and for the long range future. Within this thesis the problem of designing adequate control is given careful consideration, especially in relation to the fact that the design of systems is currently at best the systematic process rather than one where analytical evaluation is possible.

Great attention of course is given to computers and their role in this problem. Contributors to this symposium describe and weigh the advantages of using computer applications to simulate company activities so as to create a management-laboratory where the effects of policy and procedures can be tested and evaluated prior to their adoption.

This book is actually the proceedings of a symposium held at the System Development Corp., Santa Monica, Calif., July 29-31, 1959.

Frequency-Power Formulas

By Paul Penfield, Jr. Published 1960 by The Technology Press, Massachusetts Institute of Technology and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 168 pages. Price $4.00.

This book is the first systematical and general treatment of frequency-power formulas.

The book centers on the formulas announced in 1956 by J. M. Manley and H. E. Rowe of the Bell Telephone Laboratories, and asks, "What systems obey the Manley-Rowe formulas

Mercury-wetted contact relays, steel-enclosed and ready for mounting on your own assembly line, give you Clare reliability in operation, combined with new ease of application and handling. Clare HG and HGS relays have test records of over 10 billion operations, without maintenance or change in characteristics. In these new modular cases, they're sturdy, magnetically shielded, easily replaceable.

Choose either the standard Clare HG relay, or the HGS—super-fast and super-sensitive. You'll gain extra convenience and increased component-density with these Clare Relay modules.

Now you can mount CLARE BILLION-OPERATION RELAYS on your own printed circuit board

Typical Clare mercury-wetted relay steel-enclosed modules for circuit-board mounting. From top: HGSM Relay Module, HGM Relay Module, HGPM Relay Module. Epoxy molded Relay Modules are also available.

C. P. CLARE & CO.

Books

(Continued from page 64)

and how can these formulas be extended?" The answer is that the formulas are obeyed by any system with an energy-state function, and in particular by distributed systems that obey Hamilton's principle. The book also describes three other types of frequency-power formulas that have equal theoretical standing with the Manley-Rowe type of formulas, although they have fewer practical uses.

Vacuum Technology Transactions, 6th Vol.

Edited by C. Robert Meissner. Published 1960 by Pergamon Press, Inc., 122 E. 55th St., New York 22. 872 pages. Price $17.50.

This volume contains the authoritative proceedings of the 6th National Symposium sponsored by the American Vacuum Society, and as such is the only completely up-to-date review of progress in this field.

Treatises in particle accelerators, chemistry, electronics, human food refinements, metallergy, physics of structures, studies of surfaces and materials and in thermodynamics are included as well as engineering accomplishments. Instrumentation of systems, the active fields of thin film research, and new methods of vacuum pumping are presented.

Books Received

General Electric Transistor Manual, 5th Ed., including Tunnel Diodes

Published 1960 by General Electric Co., Semiconductor Products Dept., Syracuse, N. Y. 329 pages, spiral bound. Price $1.00.

Repairing Transistor Radios

By S. Libes. Published by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 168 pages, paper bound. Price $3.50.

Tubes and Circuits

By George J. Christ. Published 1960 by Gernsback Library, Inc., 154 W. 14th St., New York 11. 192 pages, paper bound. Price $3.45.

Using and Understanding Probes

By Rudolph F. Graf. Published 1960 by Howard W. Sams & Co., Inc., 1720 E. 38th St., Indianapolis 6, Ind. 190 pages, paper bound. Price $3.95.

Proceedings of the National Electronics Conference, Vol. XVI.

Published 1960 by National Electronics Conference Inc., 228 N. LaSalle St., Chicago, Ill. About 900 pages. Price $6.00.

Selection and Application of Semiconductor Devices, ARINC Spec. No. 409

Published 1960 by Aeronautical Radio, Inc., 1700 K St., N.W., Washington 6, D. C. 49 pages, paper bound. Price $1.00.

(Continued on page 70)

SOME VERY IMPORTANT ODDS . . . AND ENDS

What odds will you accept that your circuitry connections perform with absolute reliability, every time you need them? Chances are you **demand** odds approaching 100 percent in your favor—you cannot afford a compromise with precision in the thousands of terminals in your equipment.

AMP INCORPORATED has a single task: to make wire terminations so reliable that the odds on failure at the end of your wires are **zero**.

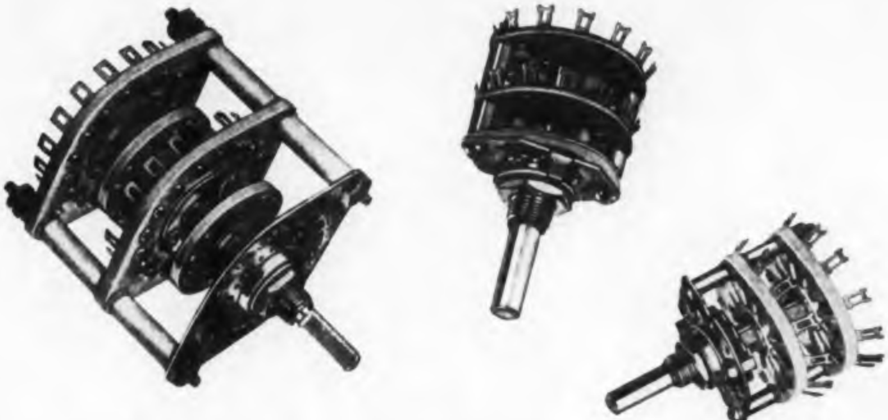
AMP makes wire terminations—15,000 solderless, snowflake-different kinds of them—for any circuit connection anywhere in the world, backed by 1800 patents issued or pending in the U.S.A. and 18 other countries. It makes the tools to apply its terminals to any size, shape or kind of wire. It makes these products in the U.S., and in Great Britain, France, Holland, West Germany, Italy, Australia, and Japan, for distribution anywhere, to any industry.

For the unabridged AMP story, write for our Selectalog and Autolog catalogs.

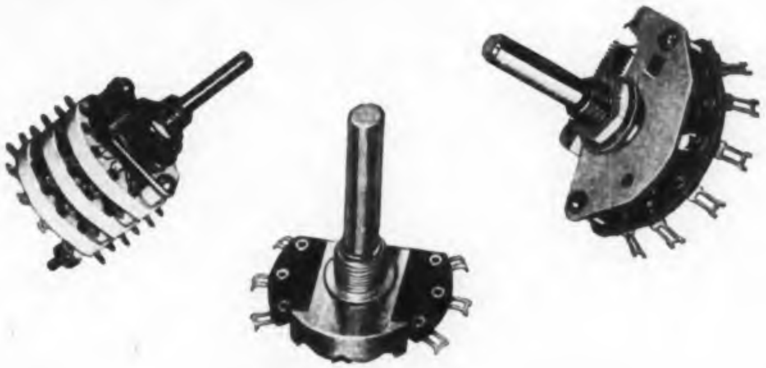
AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany



for switches quick



make a quick switch to Centralab

The switch you need is available *fast* from CENTRALAB. From the simplest general purpose units to the most highly specialized, you get speedy service on samples, quotations, and production.

In fact, on a wide variety of standard switches you can get immediate local delivery, in industrial quantities, at factory prices — from your near-by CENTRALAB distributor.

Write today for CENTRALAB's unique Switch Visualizer (which simulates actual switch operation). Used in conjunction with our detailed layout sheet, it simplifies and speeds up switch design—for you, and for us. We'll also send along a copy of Catalog 42-405, listing detailed electrical and mechanical specifications on all CENTRALAB switches and including a complete listing of all standard types available for immediate delivery.

Centralab CRL ®

P—6021

The Electronics Division of Globe-Union Inc.
938 E. Keefe Avenue • Milwaukee 1, Wisconsin
Centralab Canada Ltd. • Ajax, Ontario

←Circle 46 on Inquiry Card

Circle 47 on Inquiry Card

Books

(Continued from page 66)

GOVERNMENTAL PUBLICATIONS

Orders for these reports should be addressed to Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Make check or money order payable to "OTS, Dept. of Commerce." Prepayment is required. Use complete title and PB number for each report ordered.

A Versatile Printed Circuit Switch for Application in Laboratory and in Production.

By W. H. Hoffman, Jr. 27 pages. PB161458. Price $1.00.

Junction Transistor Measurements and Practical Standards

By B. Reich. 20 pages. PB161469. Price 75¢.

Theoretical and Experimental Research in Thermoelectricity.

163 pages. PB161468. Price $3.00.

Human Engineering Bibliography 1957-1958.

235 pages. PB161125. Price $5.00.

Human Engineering in the Navy 1959

By P. G. Cheatham. 14 pages. PB161428. Price 50¢.

A Method for Performing Human Engineering Analysis of Weapon Systems.

By A. Shapero. 71 pages. PB161660. Price $2.00.

Status of Electronic Microminiaturization

By M. J. Doctor. 28 pages. PB161674. Price 75¢.

A Simplified Electronic Tracking Apparatus (SETA)

By P. Gain and P. M. Fitts. 17 pages. PB161550. Price 50¢.

Thermoelectricity Abstracts.

This is the third in the series. 120 pages. PB161301. Price $2.50.

Symposium on Superconductive Techniques for Computing Systems

418 pages. PB161763. Price $4.50.

Fundamentals of Ultrasonic Welding (Phase I)

By J. B. Jones, et al. 99 pages. PB161677. Price $2.50.

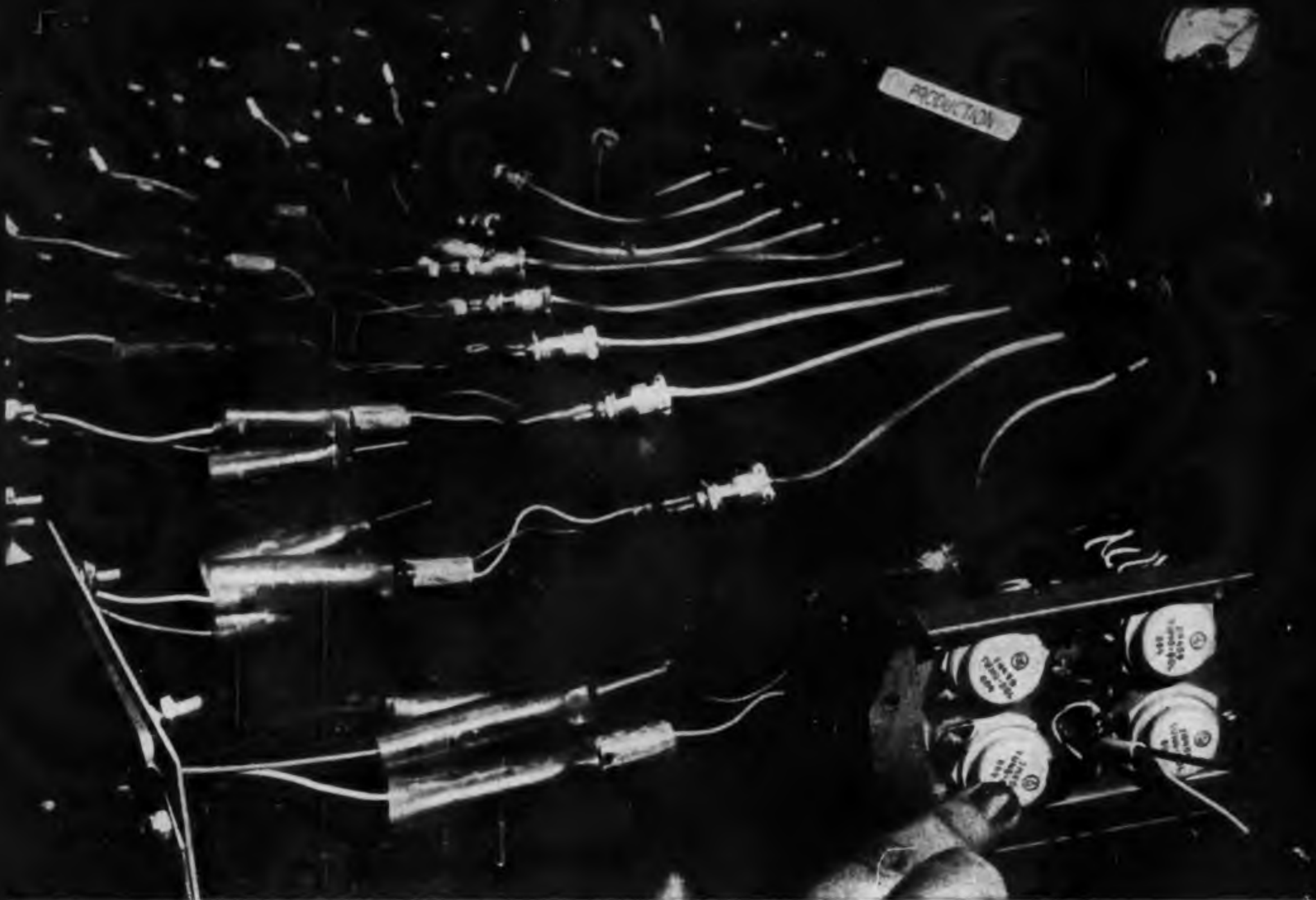
Research and Development Leading to the Establishment of Ultrasonic Test Standards for Aircraft Materials.

By G. L. Cross, et al. 147 pages. PB161753. Price $2.75.

Transistorized Four-Segment Commutator for a Direct-Current Machine.

By F. L. Schwartz. 47 pages. PB161721. Price $1.25.

* * *



Tung-Sol transistors meet tight specs of *FLITE-TRONICS* miniature airborne power supply

Flite-Tronics' miniaturized PC-8 airborne power supply is fast becoming standard equipment aboard many commercial, private and military aircraft. More and more aircraft designers, seeking means of eliminating the costly maintenance problems associated with dynamotors, are replacing them with these all-transistorized Flite-Tronics units. Moreover, the PC-8 provides large-scale reductions in weight and volume over rotary gear while sharply curtailing power drain losses.

Heart of these bantamweight power supplies is Tung-Sol 2N459 germanium power transistor. Tung-Sol made an all-out effort to meet the exceedingly difficult specifications laid down by Flite-Tronics for their high reliability equipment. This is how Flite-Tronics reported the results: "The ability of Tung-Sol transistors to meet the required performance levels is largely responsible for the success of the PC-8. We have had no equipment failures whatsoever from these transistors."

If you need the space-saving, power-saving features of semiconductors, or if your design calls for tubes, you can be assured of premium performance when you specify Tung-Sol. And Tung-Sol makes both to a single standard of unexcelled quality. While your equipment is in the planning stage contact Tung-Sol application engineers. They will gladly assess your circuitry and give you an impartial recommendation for the component complement that most efficiently answers your design needs. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193

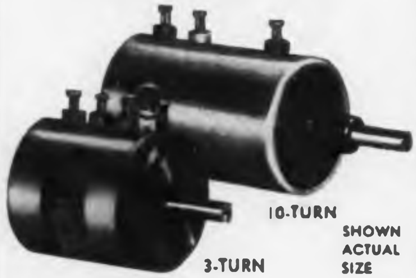
Technical information available through Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. In Canada: Abbey Electronics, Toronto, Ontario.

TUNG-SOL®

Circle 49 on Inquiry Card

NOW FROM BORG, MAKER OF FAMOUS MICROPOTS, COMES AN IMPORTANT BREAKTHROUGH IN THE FIELD OF MINIATURIZED PRECISION POTENTIOMETERS

NEW BORG 2100 SERIES MINIATURE MICROPOTS



10-TURN

3-TURN

SHOWN ACTUAL SIZE

A new concept in the field of miniature precision potentiometers . . . Borg 2100 Series Micropots! Only 7/8" diameter, these new Micropots are wirewound, multiturn and linear. Housings are aluminum for maximum heat dissipation and are completely sealed against sand, dust and moisture. Permanent concentricity is assured. Terminals are gold plated for perfect solderability and are color coded to identify function! Available in ten and three-turn models, the 2100 Series can be ganged up to three units. Standard resistance ranges of from 25 to 120,000 ohms for ten-turn models, and from 10 to 40,000 ohms for three-turn models are available. Other resistances on special order. Let us send you complete information on new Borg 2100 Series Micropots today!

BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation
JANESVILLE, WISCONSIN
Phone PLeasant 4-6616

BORG

Write for complete engineering data . . .
ask for Catalog Sheets BED-A160 and BED-A161

Mechanical Rotation ....ten-turn: 3600° +5° −0°*; three-turn: 1080° +5° −0°*
Electrical Rotation ....ten-turn: 3600° +5° −0°*; three-turn: 1080° +5° −0°*
Total Resistance Range ....ten-turn: 25 to 120,000 ohms**; three-turn: 10 to 40,000 ohms**
Standard Linearity ....±0.5%
Temperature Range ....−55°C to 125°C

*These tolerances are identical.
**Tolerances: ten-turn — 25 to 50 ohms ±10%; 100 to 120,000 ohms ±3%; 120,000 ohms ±5%.
three-turn — 10 to 30 ohms ±10%; 100 to 40,000 ohms ±3%.

Circle 50 on Inquiry Card

Circle 51 on Inquiry Card →

• THE S-PLANE AS AN AID TO FILTER DESIGN

The complex frequency plane, or as it is known, the S-plane, plays an important role in modern circuit theory and related fields. It is the aim of this paper to illustrate the usefulness of the S-plane in the design of single and double-tuned filters.

• NOMOGRAPH FOR POTENTIOMETER LOADING

Most nomographs for potentiometer loading assume that a known voltage is applied to a potentiometer. This paper describes the increasingly important case when a known current is used. The nomograph gives the numerical value of the loading error so that the output can be corrected.

• CONSIDERATIONS IN DESIGNING TWO MILLIMETER WAVE COMPONENTS

Lack of a self-excited coherent source of millimeter power has led to the design of crystal harmonic generators. Sufficient signal has been obtained for the construction and calibration of impedance meters, mode converters, detectors, attenuators, tuners, phase shifters, etc. Novel design and construction techniques are described.

• SILICON PHOTO CELLS FOR LOW LIGHT APPLICATIONS

Analyzing the characteristics of silicon photocells in low-light sensing applications such as perforated tape and punched card data reading systems. The practicability of these devices in installations where mechanical sensing is now used is demonstrated.

Plus all our other regular departments

Our regular editorial departments are designed to provide readers with an up-to-the-minute summary of world wide important electronic events. Don't miss Radarscope, As We Go To Press, Electronic Shorts, Coming Events, El Totals, Snapshots of the Electronic Industries, El International, News, Briefs, Tele-Tips, Books, Representatives News, International Electronic Sources, Personals, etc.

COMING SOON—

• THE 1961 ANNUAL ALL-REFERENCE ISSUE

The fourth consecutive annual edition containing year-round technical reference information for electronic engineers. The editorial staff is already at work compiling and selecting data for this issue. Suggestions from user-readers for new topics and compilations to be included will be given careful consideration.

Some Typical Problems in the

Design of

By JEROME E. TOFFLER

Member of Tech. Staff
Hughes Aircraft Co.
P. O. Box 90902, Airport Sta.
Los Angeles 45, Calif.

THERE is great interest in automatic test equipment for guided missiles, aircraft, and other complex electronic and electromechanical systems—particularly in military applications.

Here we will discuss some of the problems involved in designing a versatile, high-speed, fully automatic missile checkout system to be used in the field by unskilled personnel. The problems treated are by no means confined to missiles only; they are inherent in the concept of automatic testing, and they are encountered in any project of similar scope.

This work is based on studies performed by a group of test equipment designers at Hughes Aircraft Co. It does not represent an existing system, although many of the circuits and sub-systems were built and tested. In some cases, an indication is given of the degree of complexity or amount of hardware required for a given application.

The decision as to whether a given system of test equipment should be manually operated, semi-automatic, or fully automatic involves many technical, economic, or military factors. This article considers only the most challenging (and most interesting) alternative; namely, complete automation together with other required capabilities listed below.

Brief Description of Concept

Here are the design objectives to be met:

1. The testing is to be performed at a moderately high rate of speed, approximately five tests per second.

2. The testing is to be fully automatic requiring no decisions or actions on the part of the operator. (A possible exception occurs if the missile, or other device being tested, requires some mechanical or electrical adjustments. In this case, the equipment must stop and wait while the adjustments are performed by the operator.)

3. Test results are to be displayed in Go-No-Go and Low-Go-High form and also as a decimal number giving the actual value of the measurement. A permanent record is to be printed or punched showing the results of each test.

4. All quantities to be measured are transduced into time, frequency, or voltage. Scaling circuits and analog-to digital converters (ADC's) convert the information into three binary coded decimal (BCD) digits appearing on twelve wires.

5. The system must be able to measure double-ended or "floating" voltages.

6. The system must be able to perform the arithmetic operations of comparison, addition, and subtraction.

7. The testing is to be "random access." This means that the order of testing or the tests to be performed may be changed by merely changing the program. The following information, in particular, is to be furnished by the program (rather than being permanently "built into" the equipment):

a. The two test points at which a measurement is to be performed.

b. The high and low acceptance limits of three BCD digits each.

c. The type of measurement to be performed, and the proper scale factors.

d. The stimuli which are to be supplied for the test being performed.

e. The number of the test.

Proposed Hardware

Below is a listing of methods of meeting the above requirements.

These are also indicated in the block diagram of Fig. 1.

1. The program is in the form of standard, eight hole, punched mylar tape. A high speed, photoelectric tape reader reads the information for a test into shift registers. A test begins when the required information has arrived in the registers.

2. Selection of test points is performed by a 10 x 10 x 6 crossbar switch. This device is similar to those used in modern telephone exchanges, and is described in Ref. 1. The 600 possible contacts on the crossbar switch are allotted as follows: 400 for selection of the test point on the high or "hot" side and 200 for selection of the test point on the common or reference side.

3. Selection of stimuli (mechanical, electrical, microwave, hydraulic, etc.) is performed by 128 electromechanical relays. The equipment must be able to apply or remove any number of these stimuli at any time and in any order called out by the program.

4. Two ADC's are used: one for time and frequency, and one for voltage. All voltages are scaled to the range of 0 to 1 volt before entering the voltage ADC.

5. For reasons of accuracy, flexibility, and speed, digital components and techniques are used throughout. In particular, a digital arithmetic unit is used for addition, subtraction, and comparison.

Presently there is a great interest in automatic test equipment for complex systems. Some of the problems involved in the design of flexible, high-speed, fully automatic checkout systems for use by unskilled personnel are described and discussed here.

Automatic Test Equipment

Perhaps the best way to understand and appreciate the design considerations is to analyze some of the commands which must be included in the program for each test. The following assignments are made for holes (binary bits) on a frame of the tape:

1. High acceptance limit—12 bit BCD, representing three decimal digits, plus one bit for sign (plus or minus).

2. Low acceptance limit—same number of bits as for high acceptance limit.

3. Measurement scale—3 bits. This information determines the scale factors which must be applied to voltage, resistance, time, and frequency to bring them within ranges where they can be accurately measured. It also indicates location of the decimal point in test results. There are eight scale factors which can be selected: 1, 10, 100, . . . 10,000,000.

4. Test point selection—12 bits. Four bits are used to select the horizontal coordinate on the crossbar switch, four more to select the vertical coordinate,

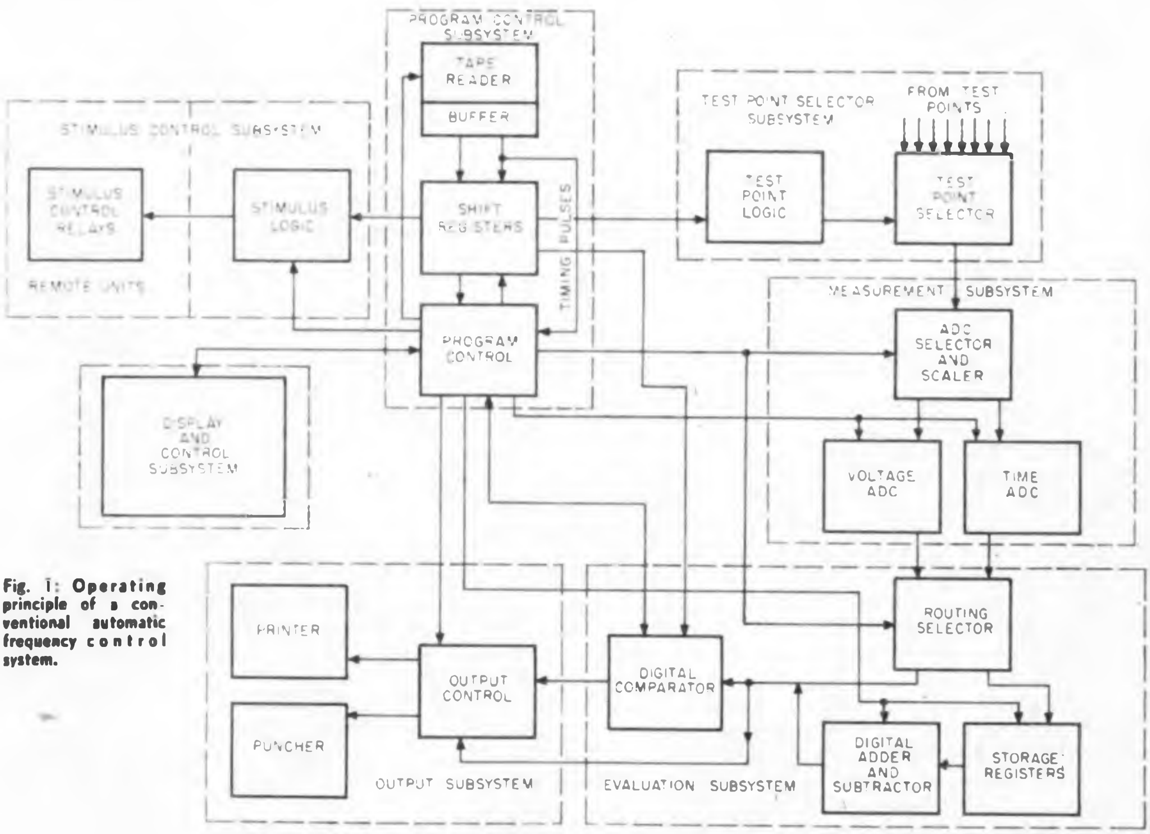


Fig. 1: Operating principle of a conventional automatic frequency control system.

Automatic Testers *(Continued)*

and four to select the proper levels on the switch for the high and low test points.

5. Measurement type — 4 bits. This determines which type of measurement is to be made. The types are as follows:

a. dc voltage
b. ohms (dc resistance)
c. dc voltage (floating)
d. time
e. ac peak voltage
f. frequency
g. ac RMS voltage

Provision is also made for two types of "special" measurements using external equipment, and two spares.

7. Stimuli control—8 bits. Seven bits are used to select one out of the 128 Stimulus Control relays; and one bit is used to determine whether the stimulus is to be applied or removed.

8. ADC select—one bit. This bit determines whether the desired test result is to be on the 12 wires from the Voltage ADC or the 12 from the Time ADC (counter.)

9. Time delay—8 bits. This allows for a preset delay of 0 to 25.5 sec. in increments of 0.1 sec. for required timing functions.

10. Arithmetic and comparison operations — approximately 12 bits, depending on various alternative methods which are available. This subject is discussed below in more detail.

11. Number of the test being performed—12 bit BCD representing three decimal digits.

Major Problem Areas

The so-called major problems to be considered fall into three general categories:

1. Problems in which the solutions are apparent but which add enormously to overall system complexity;

2. Problems which require special equipment not available on today's market, leading to costly and time-consuming development programs;

3. Problems whose solutions are blocked by the state of the art or by more fundamental limitations, such as the laws of physics. Examples are given below:

Problem 1—Encoding & Decoding

This type of problem, which is an example of the first category listed above, occurs in selection of the Stimuli Control relays. Seven bits of information are used to select any of 128 (2^7) relays. One other bit determines whether the relay is to be energized or de-energized. A solution (although not necessarily the optimum one) can be readily determined. However, it will be found that the number of components required (transistor or diode gates, inverting amplifiers, power amplifiers, flip-flops, etc.) comes as an unpleasant surprise to most engineers, particularly those who are working on a limited budget. One solution involved 314 packaged circuits at an average cost of $30 each.

Similar problems occur in selecting the desired test points selecting the proper scale factors, and in general, any case in which n bits are used to control 2^n distinct conditions.

Other encoding-decoding problems occur because all data which is displayed or printed must be in decimal form, while the tape commands and arithmetic operations are based on a BCD code. Furthermore, many types of measuring equipment provide decimal readout, or use a different code or different voltage levels than those required. These cases all require some form of "conversion" equipment to insure that the signals are of the proper form and magnitude in various portions of the equipment.

Problem 2—Modification of Parts

A good example of this problem is the counter required for time and frequency measurements, and precise timing operations. A number of excellent counters are available which have the necessary capabilities. However, they are controlled by manually operated rotary switches on the front panel. For the present application, the counter must be controlled remotely with binary information.

A remotely controlled counter is not being built commercially simply because there is insufficient demand for it. This means that a standard counter must be purchased, "torn apart," and provided with the necessary relays which will perform the functions normally performed by the front panel switches. These modifications can be a tedious, time-consuming task for both electrical and mechanical designers.

Problem 3—Original Development

Some of the instruments involved are so unique in function that it is easier to design from "scratch" than to attempt to modify existing commercial equipment. An example is the ohmmeter circuitry.

The ohmmeter is required to measure 4 ranges of resistance with full scale values of 10 ohms, 1000 ohms, 100,000 ohms, and 10 megohms. To operate compatibly with the Voltage ADC, the ohmmeter must deliver a voltage proportional to resistance with a maximum value of 1.0 v. and an accuracy of 1% in any of the above ranges. This problem can be solved by using a dc "analog computing type" feedback amplifier. By including the unknown resistance as part of the feedback loop, the overall amplifier gain is made exactly proportional to the value of this resistance. Hence, if an accurately known voltage is applied to the amplifier input, the output is proportional to the resistance value. Other examples of special circuitry are discussed below in connection with transients.

Problem 4—Transients

Transient problems are closely related to the desired operating speed of the equipment. Two typical examples will be given.

Example 1. A dc voltage has a 60 CPS ac voltage superimposed on it. It is desired to measure the average dc value. However, only 50 msec. can be allowed for the voltage to reach "steady state." It is seen that a basic conflict exists here. If adequate filtering is provided for the 60 CPS, there is difficulty in reaching the dc steady state, since filtering implies delay. Insufficient filtering means that the dc value will fluctuate and cause erroneous readings. The problem can be relieved somewhat by using special filters, perhaps requiring isolating amplifiers between sections. Properly designed filters can provide the optimum rise time of the dc voltage for a given attenuation of the ac voltage.

Example 2. Same conditions as above, except that this time it is desired to measure the ac voltage, rather than the dc. The obvious solution is to use an ordinary RC coupling network. This creates a serious problem however, due to the transient introduced by the dc step function. It is generally known that a transient of this nature will decay to 1% of its initial value in 5 RC time constants. In the present case, this might not be long enough. If the dc voltage is 100 v. and the superimposed ac is 1 v. at least *10* time constants are required to reduce the dc transient to a suitably low value. Attempting to solve the problem by reducing the size of the RC time constant causes undesirable attenuation of the ac signal. Again, special filters may be required.

An additional problem introduced by filters is the energy storage due to charges on capacitors and flux-linkages in inductors. This energy must be removed between successive measurements which use the same filter. Special "reset" circuitry may be required to insure zero initial conditions at the start of each measurement.

For cases in which high operating speed is the most important requirement, the use of "strain gage" techniques should be considered. In this system, the filters or the coupling networks are permanently connected to the pins at which it is desired to make measurements. Hence, the desired voltages are always present, waiting to be read. Although it neatly solves the transients problem, this method causes other difficulties. For example, if it is necessary to measure ac voltage and later measure dc resistance at the same pin, two connections to the pin are required, since dc resistance cannot be measured through the coupling capacitor.

Problem 5—Double-ended Measurements

To be completely flexible, the test equipment should be capable of making double ended measurements, particularly of dc voltage. As an example, suppose that two wires are 99 and 101 volts above ground, respectively; and it is desired to measure the difference between them. This requires a differential amplifier with an allowable common mode voltage of at least 100 v., and an overall gain of ½ or less (assuming all voltages are to be converted to the range of 0-1 v.). Suppose that another measurement involves a differential voltage of 50 v. In this case, the overall amplifier gain must be 1/50 or less. Unfortunately, the gain of a stabilized differential amplifier cannot be easily and precisely changed, as in the single-ended case; and scale changing becomes a

serious problem. Furthermore, the requirement for high common mode voltage immediately disqualifies many existing differential amplifiers, particularly those using transistors.

Other possible solutions include:

1. a chopper to "chop" between the two lines, thus converting the dc to ac which can be passed through a capacitor to block the common mode voltage;
2. a single-ended amplifier attached to each line and their output subtracted;
3. a differential amplifier with a fixed gain to convert the differential voltage to single-ended, with scale changing performed elsewhere. Unfortunately, these solutions all present difficulties, such as transients, scale changing, matching of amplifiers, or insufficient output range. The problems are most severe when the desired differential signal is either very small or very large compared to the common mode voltage.

It is hardly necessary to point out that measurement of double-ended signals increases the required number of test points, and makes test point selection more complicated.

Problem 6—Timing & Sequencing

Proper timing is probably the most obvious and fundamental requirement in automatic checkout equipment. A few examples of timing functions are listed below.

1. If instructions are read off a tape into storage registers, nothing must happen until the instructions have filled the registers, at which time a "start" signal must initiate the test.
2. The desired test points must be selected, and the proper stimuli must be applied or removed at the start of a test. If these operations are performed with relays or other electromechanical devices, it is necessary to wait for the pull-in or drop-out time. Also, it may be necessary to allow time for the stimuli to take effect (example: build-up of hydraulic pressure, rolling or tilting motions, etc.)
3. Time must be allowed for transients to decay. This problem was discussed above.
4. Time must be allowed for the comparison circuits to decide whether the measurement is a "pass" or a "fail."
5. Time must be allowed for the output devices to print or punch the test results.
6. Time must be allowed for "reset" in preparation for the next test.

All of these functions, and many more, must be carried out by means of "preset" or "internal" timing signals. Preset timing signals are derived from the punched tape directly, or from fixed timers. Fixed timers include devices such as delay lines, monostable multivibrators, counters, or time delay relays, all of which provide an accurate, known delay interval.

For example, a 50 msec timer could be used to delay the operation of the Voltage ADC until transients had decayed, provided all circuits are designed so that transients will decay within this period.

Internal timing signals are derived from devices

Automatic Testers *(Concluded)*

which have the capability of indicating the end of their cycle. Examples: A crossbar switch has auxiliary contacts which can be used to indicate the selection of a cross-point. The Voltage ADC puts out a pulse when its analog-to digital conversion has been completed. The "pass" or "fail" signals activate the display devices. In all these cases, the delay is not fixed, but is determined by the time required to complete a certain event.

Problem 7—Arithmetic Operations

The arithmetic, or evaluation, subsystem performs the tasks of tolerance comparison, addition, and subtraction. The problems involved are essentially the same as in digital computer design, a few of which are listed below:

1. Selecting a suitable code (decimal, pure binary, BCD, etc.) and arithmetic system compatible with the code.
2. Providing storage registers for high and low tolerances, test values, numbers to be added or subtracted, sums and differences. Three storage registers of 12 bits each are used for this purpose.
3. Accounting for the sign (plus or minus) of all quantities involved.
4. Providing proper timing and reset signals.
5. Checking of decimal points to distinguish, for example, between 43.7 volts and 0.437 volts.

Since a decimal readout is required, and since the items of hardware selected use the 8-4-2-1 BCD code, it appears almost mandatory to perform arithmetic operations with this code. Any other alternative involves costly, complex conversion equipment.

Performing addition and subtraction using the 8-4-2-1 code creates problems regarding the propagation and utilization of "carries," also the problem of obtaining a "nines complement" for subtraction, since this code is not self-complementing. These topics, as well as many other aspects of decimal addition and subtraction, are covered in Ref. 2, which considers both serial and parallel operation and mixed serial-parallel systems.

Problem 8—Reliability

Generally speaking, electronic test equipment is built out of exactly the same types of hardware and circuitry as the systems being tested. Consequently, it is subject to the same maladies, even though in many cases its operating environment may be less severe.

Stated in simplified terms, the failure rate of any system is equal to the sum of the failure rates of its component parts. This means that a complex automatic system can have a high failure rate (poor reliability) just because it contains a very large number of parts.

However, this disadvantage is offset by the fact that many techniques which have been developed to improve reliability of digital computers are directly applicable to digital test equipment. The following are examples:

1. Self-test routines can be included in the program to detect and isolate a malfunction very quickly.
2. Special codes can be used to detect and correct simple errors in data transmission.
3. Equipment can be duplicated or operations can be repeated, with a comparison of results.
4. Redundancies, or "forbidden combinations," can be used to indicate an error. For example, in the 8-4-2-1 code, the combinations 1010, 1011, 1100, 1101, 1110, and 1111 should not occur in normal operation.

Methods of obtaining error-free computer operation are discussed in greater detail in Ref. 3, which includes the above techniques, as well as others.

Conclusions

The above material is intended to illustrate some of the practical problems which are encountered at the "working level" of system design and circuit design. It is *not* intended to discourage future effort. Fortunately, in any particular system of test equipment, many of the problems discussed will not occur for the very simple reason that certain capabilities are not required. On the other hand, other features might be needed (particularly in future programs), which have not been considered here, such as:

1. All switching to be performed by solid state devices;
2. Program to be stored on a high speed magnetic drum instead of tape;
3. Diagnostic sub-routines to be included in the program to help isolate a malfunction in case a test "fails."

It is clear that a thorough investigation into capabilities which are actually needed is the most important step in the practical design of automatic test equipment (and one that is often neglected!). After the requirements have been determined, consideration can be given to additional desirable features which may be classed as "luxuries." However, as with all luxuries, they must be sacrificed if the price proves to be too high in dollars, time, or manpower.

Recent studies (Ref. 4) indicate that *high speed, automatic, digital* test equipment can make important contributions to the reliability of complex weapons systems. It is certain that future requirements will place ever-increasing emphasis on the words above which are *underlined*, and new and better solutions will be found for some of the "typical" problems.

References

1. "Crossbar Switch Applications," by Kurt Enslein. *Electrical Manufacturing*, April, 1958. Pages 86 thru 95.
2. *Arithmetic Operations in Digital Computers*, by R. K. Richards. D. Van Nostrand Co., Inc., Princeton, N. J., 1955, Chapter 8.
3. *Logical Design of Digital Computers*, by Montgomery Phister, Jr. John Wiley and Sons, Inc. New York, N. Y., 1958. Chapter 10.
4. "Field Testing Reliability into A Complex Weapon System," by Robert A. Kirkman. *Missile Design and Development*, December, 1959. Pages 20 thru 23.

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

The problems of low level input instrumentation have mushroomed with the missile era. Not only is the new terminology defined in this article but also positive suggestions are offered to eliminate the systems engineering problems involved.

For Systems Engineering . . .

Designing for Low Level Inputs

By D. B. SCHNEIDER

Neff Instrument Corp.
1088 East Hamilton Rd.
Duarte, California

IN any input instrumentation system, common mode voltages are always present. To prevent ground loops and to obtain the most accurate data without degradation of system accuracy due to the presence of common mode voltages, at least one of the following three criteria must be met.

a. Provide an ungrounded source.
b. Provide an ungrounded load.
c. Provide an isolated amplifier.

In practice, a floating source may sometimes be provided by insulating the transducer from ground and using a floating power supply. In many cases, such as thermocouples, floating the source is impossible. Again in practice, a floating load may be provided, such as a galvanometer, but in any multi-channel telemetry or digital data system, the load ultimately reaches a common instrument ground. In the case of a grounded source and a grounded load, an isolated amplifier provides the only known method toward accurate data acquisition.

Common Mode Signals

Fig. 1 depicts a series of grounded transducers using differential amplifiers into a data system.

Assuming a copper-constantan thermocouple and a steel frame, secondary copper-iron and iron-constantan thermocouples are actually formed which generate unwanted voltages. These spurious voltages appear as common mode signals to the amplifiers. If amplifiers are used whose input and output signal lines are common, Fig. 1, ground loops are formed through the data system (see arrows). Thus, input data provided to the data system is a signal equal to t_1 plus an error proportional to the difference temperature between t_1 and t_2 and not at true representation of the signal developed by the copper constantan thermocouple. This error can easily be larger than the actual signal. If an isolated amplifier is used, ground loops are broken and true temperature data is acquired.

Another example of a mandatory requirement for isolated amplifiers is in the case of strain gages using a common power supply, Fig. 2.

It is readily apparent that two arms of each bridge are parallel with the same arms of every other bridge through the amplifiers. If these are active arms, each

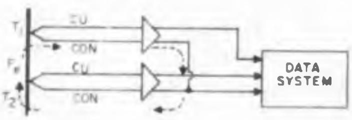


Fig. 1: Some grounded transducers using differential amplifiers into a data system.

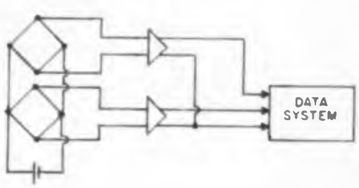


Fig. 2: Strain gages using a common power supply also require isolated amplifiers.

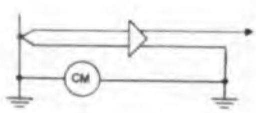


Fig. 3: When a current path is connected between any two different ground potentials, ground loop currents will flow.

Low Level Inputs *(Continued)*

bridge will have an effect on every other bridge in the system. If these arms are used for temperature compensation and calibration, a similar result occurs. The only way in which these bridges can be electrically separated is to use either individual, isolated. power supplies or isolated amplifiers, or both.

Usually, ac common mode voltages are caused by large amounts of current being pumped into the ground from power sources, thereby resulting in different ground potentials. As soon as a current path is connected between any two different ground potentials, Fig. 3. ground loop currents flow.

As mentioned above, it is easy to cope with dc ground loop currents by conductive isolation. But for ac common mode, large amounts of common mode voltage and circulating current can be found and the cure becomes increasingly difficult. For example, a common mode voltage of 1 volt can be induced into 100 ft. of input signal lines by less than 10 kw of 115 volt, 60 CPS power parallel to and 1 ft. from the signal lines.

In many installations hundreds of feet of signal lines are placed in the same tunnel with many times 10 kw of 60 CPS power. Thus, several volts of common mode signal can easily result.

The usual attempt to minimize the common mode voltage is to install a large bus bar to connect grounds. In many cases, a decrease in common mode voltage has not been obtained after bus bar installation. Common mode voltages of 1 volt due to ground currents are frequently found in both ground and airborne installations; usually at the power frequencies of 60 CPS and 400 CPS, respectively. In several known cases, common mode voltages up to 5 volts have been measured. Thus it becomes imperative that we find a way to break the conductive flow of ground loop currents and reject these common mode voltages.

So far, we have discussed some of the most common causes and effects of common mode signals and have mentioned that the solution to our problem lies in the application of an isolated amplifier. Just what is an isolated amplifier? Fig. 4 shows the input section of an isolated amplifier.

Isolated Amplifier

In truth, the isolation of an amplifier is entirely dependent upon the input circuit. Therefore, the utmost care must be used in design and layout of this important section. The heart of the input circuit is the transformer. The transformer prevents conductive flow of the input signal to any other succeeding circuit. Extreme measures are taken to properly shield the primary of the transformer from the secondary to achieve ac isolation and rejection.

The function of these shields are as follows:

The #1 shield in Fig. 4 prevents the modulation of common mode signals by the input chopper. If common mode signals are modulated at the chopper frequency, the amplifier cannot distinguish any difference between the modulated common mode signal and the modulated normal mode signal, therefore both are amplified as signal.

Shield #2 prevents the flow of common mode currents in input signal lines so that line resistance will not produce a common mode to normal mode conversion.

Shield #3 prevents pickup in the secondary due to capacitive coupling of any common mode potential on shield #2.

Any common mode voltage produced between shield #3 and "guard shield" as shown in Fig. 4, does not produce a current flow, and therefore does not produce a voltage on input signal lines by common mode to normal mode conversion.

The ac common mode rejection figure of an amplifier actually is derived, nearly in its entirety, from the measures taken in design and shielding of the input circuit.

DEFINITIONS

Differential Amplifier—an amplifier whose input leads are related to circuit ground and responds to differential signals.

Isolated Amplifier—a differential amplifier whose input signal lines are conductively isolated from the output signal lines and chassis ground. An isolated amplifier is a differential amplifier. The reverse is never true.

Common Mode Rejection—the ability of an amplifier to reject a signal, common to both its input signal lines.

Common Mode Voltage—that amount of voltage common to both input lines. Usually, a maximum voltage is specified which may be applied without breaking down insulation between the input circuit and ground.

Common Mode Resistance—resistance between input signal lines and output signal lines or circuit ground. In an isolated amplifier, this is its insulation resistance. Common mode voltage and common mode resistance have no connection with the Common Mode Rejection.

Normal Mode Voltage—actual signal voltage developed by a transducer or the difference voltage between input signal lines.

Instrument Ground—any point on earth, aircraft or missile chosen as a reference.

Guard Shield—a shield which surrounds the input circuit of an amplifier.

Ground Loop—a path through which current may flow from any starting point through a system and back to the original starting point.

REFERENCE PAGES

The pages in this section are perforated for easy removal and retention as valuable reference material.

SOMETHING NEW HAS BEEN ADDED

An extra wide margin is now provided so as to permit them to be punched with a standard three-hole punch without obliterating any of the tear. They can then be filed in standard three hole notebooks or folders

In theory, an input transformer can be built which will produce an infinite amount of common mode rejection at any frequency. Practically, this design is limited by cost, size and weight.

Differential Amplifier

At this point, a word should be said regarding direct coupled differential amplifier approach and input signal line unbalance. In any practical installation, it is impossible to achieve perfect input signal line balance. These line unbalances can amount to several hundred ohms.

Fig. 5 shows a direct coupled differential amplifier. These amplifiers can achieve ac common mode rejection as high as 200,000 to 1 as long as the input lines remain perfectly balanced. Let us assume, however, an input impedance from either side to ground of 100,000 ohms with a 100 ohm unbalance in the input lines. Assuming a common mode rejection of 10^5 for the amplifier with balanced lines, the 100 ohm line unbalance decreases the common mode rejection to 1000 to 1 at ac as well as dc. The reason is that on one line, the common mode signal is attenuated by 0.1% while not attenuated on the other line. This difference in attenuation allows the conversion of 0.1% of the common mode signal as normal mode signal. Thus one can say that in a straight forward differential amplifier, the common mode rejection capability of the amplifier is largely a function of the line balance.

Will an isolated amplifier solve all our common mode problems? No, not necessarily.

In Fig. 6, a guard shield has been brought out from the amplifier to a point just downstream from the reference couple. Some amount of distributed line capacitance will be present between input lines and the common mode generator. In this case, we have an RC filter with a 60 CPS path as shown by arrows which will cause ground loop currents to flow through the line resistances. If the RC networks are not identical in each line as is the case shown in Fig. 6, a common mode voltage drop will occur across these unequal resistances and will produce a normal mode signal from the common mode signal. No matter how good the amplifier, a common mode to normal mode conversion will occur and the system installation will be no better than the conditions imposed by the unbalanced line conditions.

"Do's and Don'ts"

Fig. 7 illustrates some of the "do's" and "don'ts" for input instrumentation system installations.

Fig. 7a shows transducers with input signal lines totally shielded. The guard shield is grounded at the transducer, the power supply and to the transducer case.

This installation is the ultimate insofar as elimination of stray pickup and common mode to normal mode conversion is concerned. The common mode rejection of this installation can approach the capability of the amplifier.

Fig. 7b illustrates an installation which is usually satisfactory and can achieve a common mode rejection better than 250,000 to 1. This setup can be used since the line resistances in thermocouples are usually very low.

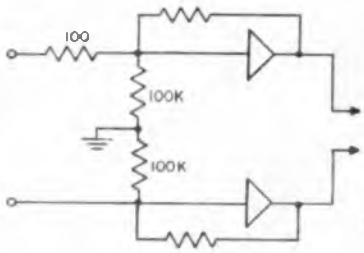


Fig. 5: Common mode rejection ratios of direct coupled differential amplifiers depend on input balance.

Fig. 7c is an example of an installation in which it is impossible to expect better than 10,000:1 common mode rejection. In this instance, the distributed capacity between input lines and ground will be in excess of 1000 μμf which will deteriorate installation common mode rejection even with the ultimate in isolated amplifiers.

Fig. 7d is an example of the "don't." In this case, by grounding the shield at the amplifier, little, if any installation common mode rejection can be achieved no matter how good the amplifier. System accuracy is anybody's guess since the guard shield degrades the input circuit instead of minimizing common mode pickup. No matter what else is done in installation the guard shield should be connected to the input lines if it is not used as in Fig. 7a.

Rules

From these examples, some rules naturally follow for obtaining the best possible installation accuracy using isolated amplifiers.

1. Always connect the guard shield to the source of common mode voltage, if possible. If not, connect

Fig. 4: Amplifier isolation is entirely dependent on input circuit.

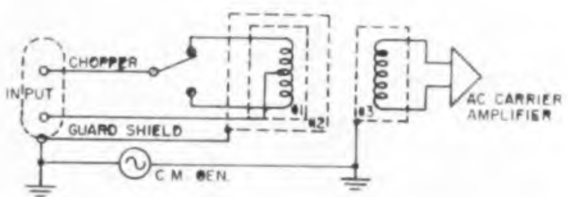
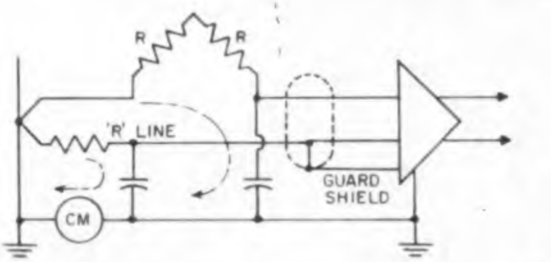


Fig. 6: When RC networks are not identical in each line, a common mode voltage drop occurs across these unequal resistances and produces a normal mode signal, no matter how good the amplifier may be.



Low Level Inputs *(Continued)*

the guard shield to the input lines as close as possible to the transducer.

2. Ground the guard shield and the transducer case to the low side of the power supply.
3. Never leave the shield floating. Never ground the shield at the amplifier.
4. Always use well shielded, tightly twisted pair for input cable.

From the previous discussion, it is apparent that the utmost care and thought must be given to input system installation techniques to achieve the ultimate in data acquisition accuracy.

Test Procedures

Directly related to the general problems of low level input instrumentation systems, are amplifier check-out and evaluation procedures. Since the amplifier bears such an important relationship to the problems associated with common mode, the following test set-ups and procedures are strongly recommended for isolated amplifier test and evaluation.

If a large number of amplifiers are to be tested, the construction of a test box is suggested. All grounds in the test box should common at one spot and then tie to the chassis. Pick up of 60 CPS fields are assured if no thought is given to proper grounding and erroneous readings are the result. This particularly applies to ac common mode rejection and noise tests. In the following test set-ups, the divider networks shown are used for several reasons.

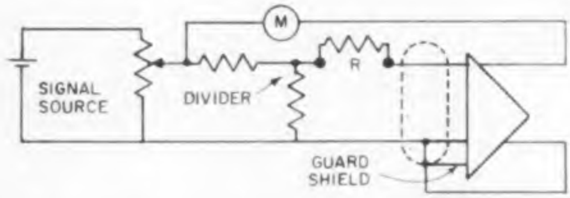


Fig. 8: Setup to be used for input and output impedance measurements.

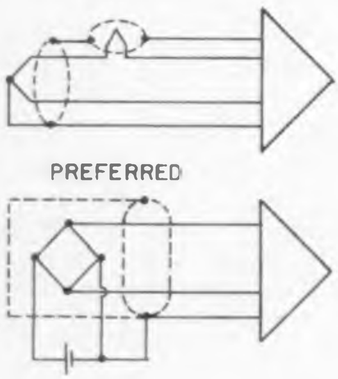


Fig. 7a: Transducers with their input signal lines totally shielded.

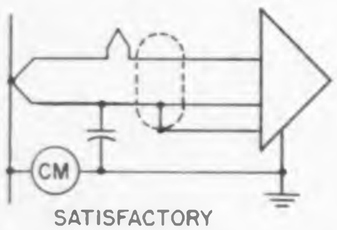


Fig. 7b: Since thermo-couple line resistance is very low, this setup is satisfactory.

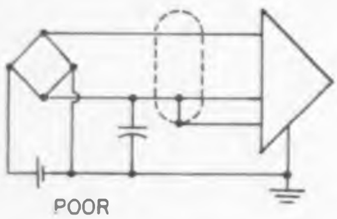


Fig. 7c: Even with the ultimate in isolated amplifiers, the installation common mode rejection deteriorates.

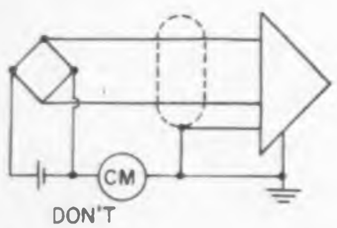


Fig. 7d: By grounding the shield at the amplifier, little, if any, installation common mode rejection can be achieved, no matter how good the amplifier.

They allow the use of a signal source voltage equal to the amplifier output voltage such that the two voltages can be bucked. This, in turn enables the use of the meter as a null indicator. With the signal source voltage bucked against the amplifier output voltage, any variations in the signal source varies both the signal and amplifier output voltage. The meter thus measures only errors due to the amplifier.

Input Impedance

Refer to Fig 8 for the input impedance measurement set-up.

1. Adjust amplifier zero.
2. Set the signal source voltage equal to full scale amplifier output voltage.
3. Adjust amplifier gain control for meter null.
4. Insert R until 0.1% of amplifier full scale output appears on meter.
5. Input resistance approximately equal to 1000 R.

Output Impedance

Measurement for impedance output uses the same set-up as for input impedance.

1. Adjust amplifier zero.
2. Set the signal source voltage equal to full scale amplifier output voltage.
3. Adjust amplifier gain control for meter null.
4. Apply a 1000 ohm load to the amplifier output.
5. Output impedance approximately equal to

$$1000 \frac{\Delta E_{out}}{E_{out}}$$

Linearity

Measurement for linearity again uses the same set-up as for input impedance.

1. Adjust amplifier zero.
2. Set the signal source voltage equal to full scale amplifier output voltage.

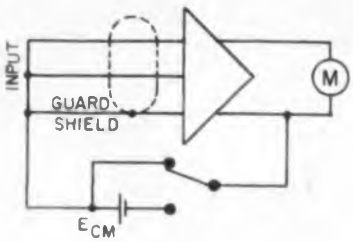


Fig. 9: Setup to be used for ac and dc common mode rejection.

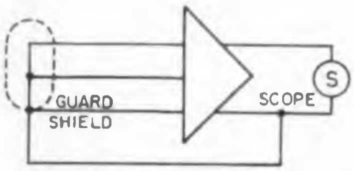


Fig. 10: Test setup for amplifier noise.

3. Adjust amplifier gain control for meter null.
4. Vary the input signal from zero to full scale and record meter output displacement error.
5. Linearity equal to

$$\pm \frac{\text{displacement error}}{2}$$

DC Common Mode Rejection

For testing dc common mode rejection, a dc voltage source and switch is placed between amplifier input and output lines. Fig. 9.

1. Short input lines to guard shield.
2. Connect meter to output.
3. Inject dc common mode signal as shown and measure output voltage change.
4. DC common mode rejection equal to

$$\frac{E_{CM} \times \text{Gain}}{\Delta E_{out}}$$

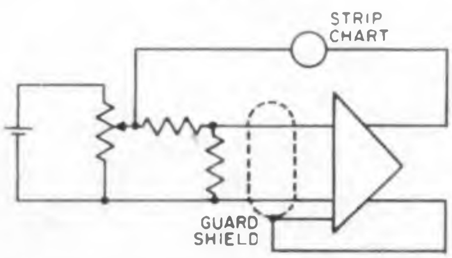


Fig. 11: In the measurement of high gain stability use this setup.

AC Common Mode Rejection

AC common mode rejection uses the same test set-up as for dc common mode rejection. Replace dc common mode voltage with an ac common mode generator. Replace meter on the output with a scope.

1. Short input lines to guard shield.
2. Inject ac common mode signal.
3. AC common mode rejection equal to

$$\frac{E_{CM} \times \text{Gain}}{\Delta E_{AC\ out}}$$

Noise

The test for amplifier noise referred to the input uses Fig. 10.

1. Short input lines to guard shield and to amplifier output.
2. Connect scope to the output and read noise.
3. Noise referred to input equals

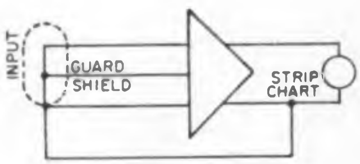
$$\frac{E_{noise}}{\text{gain}}$$

Gain Stability

In the measurement of gain stability use the set-up outlined in Fig. 11. Both zero drift and gain stability are obtained on the stripchart recorder. It is difficult to differentiate the two parameters in any test set-up. Therefore, a number of manufacturers combine the gain stability and zero drift specification.

1. Adjust amplifier zero.
2. Adjust signal source voltage equal to full scale amplifier output voltage.
3. Adjust amplifier gain control for null on the stripchart.
4. Monitor stripchart.

Fig. 12: In the measurement of zero drift, this setup is used.



Zero Drift

Use the set-up in Fig. 12 for zero drift measurement.

1. Adjust amplifier zero.
2. Short input lines to guard shield and to amplifier output.
3. Monitor stripchart.

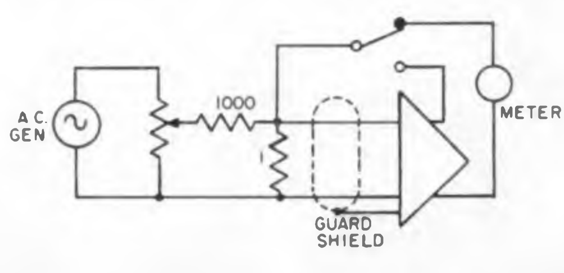
Frequency Response

The set-up in Fig. 13 is used for frequency response measurement.

1. Adjust amplifier zero.
2. Set signal source voltage at convenient level within linear output range of amplifier.
3. Adjust amplifier gain control for identical reading on meter at output of amplifier.
4. Observe meter reading and repeat steps 2, 3 and 4 at the next highest frequency.

Note: In this test, the meter is switched back and forth to take all readings on the same meter scale. By taking all readings on the same scale, meter inaccuracies due to changing scale are eliminated.

Fig. 13: Setup to be used for the measurement of frequency response.



This article is an experiment. Instead of presenting a short discussion for those familiar with Jacobians, and a long table of results for those who are not, the entire article contains only one simple network—so simple that results can be verified intuitively.

Using Jacobians for

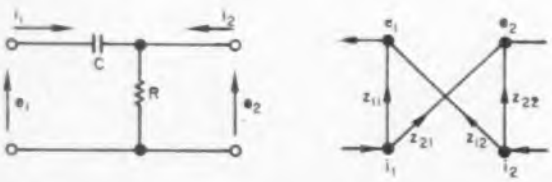


Fig. 1: The first R-C network z-parameters are the open-circuit type.

TWO R-C combinations in cascade have been selected for network analysis. The objective is to write the Jacobians of each of the component networks; then, calculate the Jacobians of the combined network; and, finally, demonstrate the usefulness of operations concerning their frequency dependence.

Since all the z-parameters of the first network, Fig. 1, are of the open-circuit type (i_1, i_2 independent variables, arrows *into* the flow graph), they can very easily be written from inspection. For example, z_{12} is $\left.\frac{\partial e_1}{\partial i_2}\right|_{i_1}$; and at constant i_1, the effect on e_1 of a variation in i_2 is represented by $e_1 = i_2 \cdot R$, so $z_{12} = R$. Letting the Jacobian $\mathbf{z} = 1$, the Jacobians of the network can be written.[1, 2] Since the Jacobians can be multiplied throughout by any quantity, a multiplier of sC can be selected in order to make the expressions easier to handle. These steps are shown in Table 1.

In the same way, Jacobians of the second network, Fig. 2, are calculated, Table 2.

Note that the calculation can be checked by verifying the uniqueness condition $\mathbf{ab} + \mathbf{gh} = \mathbf{yz}$. The operator s is used for $j\omega$. As a general rule, Jacobians should be written to include the product CR, since this represents a time constant τ which has a very practical meaning.

By placing the networks of Figs. 1 and 2 in series, the network of Fig. 3 is formed.

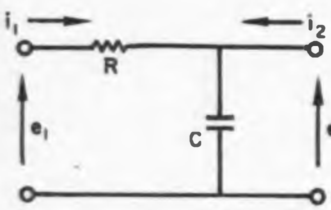


Fig. 2: The Jacobians for this particular network are calculated in Table 2.

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

Table 1

z — Parameters From Inspection	Jacobian Ratios	Jacobians (With $\mathbf{z} = 1$)	Jacobians (With $\mathbf{z} = sC$)
$z_{11} = \left.\frac{\partial e_1}{\partial i_1}\right\|_{i_2} = (1/sC) + R$	$= \mathbf{g}/\mathbf{z}$	$\mathbf{a} = R$	$\mathbf{a} = sCR$
$z_{12} = \left.\frac{\partial e_1}{\partial i_2}\right\|_{i_1} = R$	$= -\mathbf{b}/\mathbf{z}$	$\mathbf{b} = -R$	$\mathbf{b} = -sCR$
$z_{21} = \left.\frac{\partial e_2}{\partial i_1}\right\|_{i_2} = R$	$= \mathbf{a}/\mathbf{z}$	$\mathbf{g} = \frac{1 + sCR}{sC}$	$\mathbf{g} = 1 + sCR$
$z_{22} = \left.\frac{\partial e_2}{\partial i_2}\right\|_{i_1} = R$	$= \mathbf{h}/\mathbf{z}$	$\mathbf{h} = R$	$\mathbf{h} = sCR$
$\Delta^z = z_{11} \cdot z_{22} - z_{12} \cdot z_{21} = \left(\frac{1}{sC} + R\right) R - R^2 = R/sC$	$= \mathbf{y}/\mathbf{z}$	$\mathbf{y} = R/sC$ $\mathbf{z} = 1$	$\mathbf{y} = R$ $\mathbf{z} = sC$

(Check: In the last column, $\mathbf{ab} + \mathbf{gh} = \mathbf{yz}$.)

T. R. Nisbet

Dr. W. W. Happ

By **THOMAS R. NISBET**
Electronic Research Engineer
and DR. WILLIAM W. HAPP
Staff Scientist
Solid State Electronics
Lockheed Missile and Space Div.
Palo Alto, California

Frequency - Selective Networks

Note that the same values of R and C are used in each network; this is done to simplify the evaluation and to highlight the Jacobian technique rather than the algebra.

As indicated in the formulas previously developed for the Jacobians of cascaded networks,[4] the required starting condition is $-\mathbf{a}' = \mathbf{b}''$; and to meet this condition, each of the Jacobians as evaluated in the last column of Table 1 must be divided by sCR.

In Table 3 are shown the Jacobians of the two individual networks, in form suitable for cascading ($-\mathbf{a}' = \mathbf{b}''$), and the calculated values of the Jacobians of the combined network are shown on the right.

Examples and verifications of the calculations follow:

$$\mathbf{g} = \mathbf{g}'\mathbf{g}'' + \mathbf{y}'\mathbf{z}'' = (1 + 1/sCR)(1 + sCR) + (1/sC)\,sC$$
$$= 3 + sCR + 1/sCR$$

$$\mathbf{z} = \mathbf{z}'\mathbf{g}'' + \mathbf{h}'\mathbf{z}'' = (1/R)(1 + sCR) + (1)\,sC = 1/R + 2sC$$

Verify calculations from uniqueness condition $\mathbf{ab} + \mathbf{gh} = \mathbf{yz}$

Verify from inspection of Fig. 3, $z_{11} = 1/sC + R \,||\, (R + 1/sC)$

which simplifies to $\left[1 + 3sCR + (sCR)^2\right]/sC\,(1 + 2sCR)$.

The same result is obtained from $z_{11} = \mathbf{g}/\mathbf{z}$

From the Jacobians of the composite network, Table 3, any desired parameters or transfer functions can readily be calculated. These uses have been covered in earlier articles.[1, 2, 3]

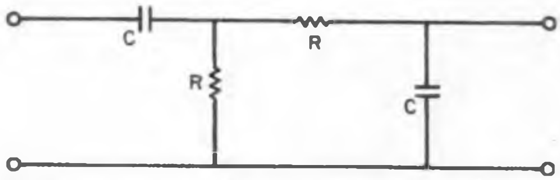


Fig. 3: The networks of Figs. 1 and 2, in series, form this circuit. The Jacobians for this composite circuit are shown in Table 3.

Frequency Dependency

A Jacobian by itself has no specific amplitude. Nevertheless, its frequency response can be plotted usefully. This is because, using log-log paper, Jacobian ratios become the difference between two curves, and this "difference curve" has a slope that is independent of the component curves, as illustrated in Fig. 4.

For convenience, the frequency is regarded as s, although the number of cycles per second is, of course, $s/2\pi$. The slope of the curve of a quantity such as sC or sCR is obviously 1 decade per decade (or, in more familiar terms, 20 db/decade or 6 db/octave). A number can be written against each curve to represent its slope in db/decade. In subtracting two curves to find

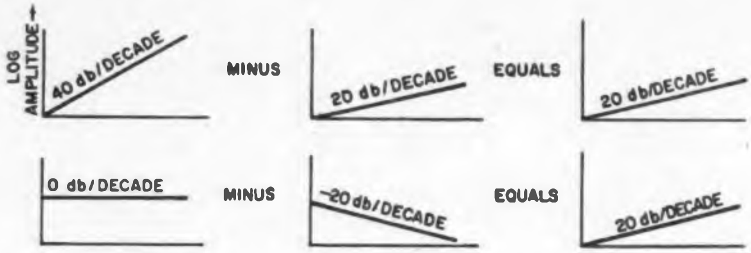
Table 2

z — Parameters From Inspection	Jacobians (With $\mathbf{z} = 1$)	Jacobians (With $\mathbf{z} = sC$)
$z_{11} = (1/sC) + R$	$\mathbf{a} = 1/sC$	$\mathbf{a} = 1$
$z_{12} = 1/sC$	$\mathbf{b} = -1/sC$	$\mathbf{b} = -1$
$z_{21} = 1/sC$	$\mathbf{g} = (1/sC) + R$	$\mathbf{g} = 1 + sCR$
$z_{12} = 1/sC$	$\mathbf{h} = 1/sC$	$\mathbf{h} = 1$
	$\mathbf{y} = R/sC$	$\mathbf{y} = R$
$\Delta^z = R/sC$	$\mathbf{z} = 1$	$\mathbf{z} = sC$

Table 3

First Network (Fig. 1)	Second Network (Fig. 2)	Combined Network (Fig. 3)
$\mathbf{a}' = 1$	$\mathbf{a}'' = 1$	$\mathbf{a} = 1$
$\mathbf{b}' = -1$	$\mathbf{b}'' = -1$	$\mathbf{b} = -1$
$\mathbf{g}' = 1 + 1/sCR$	$\mathbf{g}'' = 1 + sCR$	$\mathbf{g} = 3 + sCR + 1/sCR$
$\mathbf{h}' = 1$	$\mathbf{h}'' = 1$	$\mathbf{h} = 2$
$\mathbf{y}' = 1/sC$	$\mathbf{y}'' = R$	$\mathbf{y} = R + 2/sC$
$\mathbf{z}' = 1/R$	$\mathbf{z}'' = sC$	$\mathbf{z} = 1/R + 2sC$

Fig. 4: The Jacobian ratios, the difference between two curves, have a slope which is independent of the component curves.



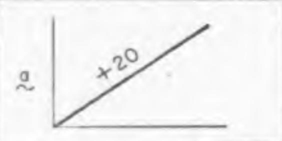
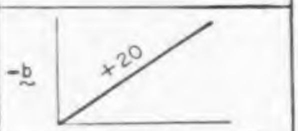
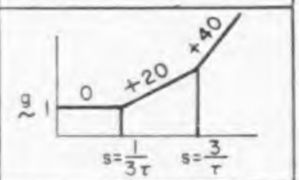
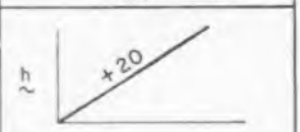
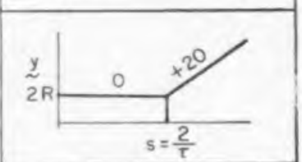
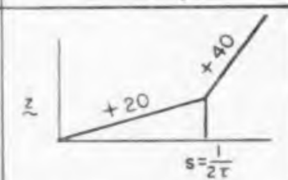
Jacobians *(Continued)*

the curve of a ratio of two Jacobians, all that need be done is to subtract the numbers representing the slopes, Fig. 4.

The Jacobians as evaluated for the composite network need not be retained exactly but may be multiplied by any quantity, whether frequency-dependent or not. This manipulation can be performed with the object of simplifying the expressions and getting them as far as possible into terms of s and τ.

Assessing the frequency dependence of a quan-

Table 4

JACOBIAN AND FORMULA	ASYMPTOTES*
$g = s\tau$	
$-b = s\tau$	
$g = 1 + 3s\tau + s^2\tau^2$	
$h = 2s\tau$	
$y = 2R + s\tau R$	
$z = sC + 2s^2\tau C$	

* LOG-LOG PLOT OF JACOBIANS VS. FREQUENCY, WITH SLOPES SHOWN IN db/DECADE

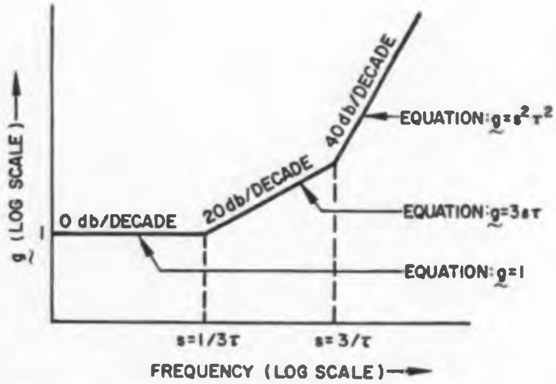


Fig. 5: Plot of individual portions of the curve for g in Table 4.

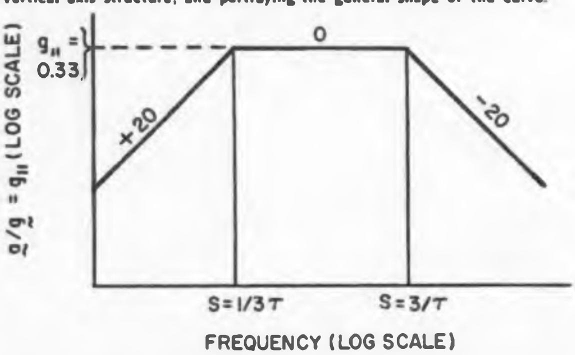
REFERENCE PAGES

The pages in this section are perforated for easy removal and retention as valuable reference material.

SOMETHING NEW HAS BEEN ADDED

An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed in standard three-hole notebooks or folders.

Fig. 6: Flat top of curve, neither asymptotic or tangent of the true curve of g_{11} serves a useful purpose in locating the rest of the vertical axis structure, and portraying the general shape of the curve.



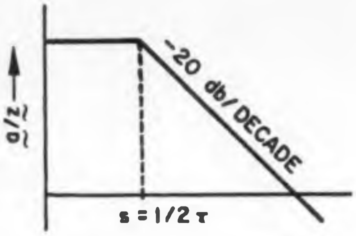


Fig. 7 (left): Subtracting curve z from a of Table 4 gives the frequency response.

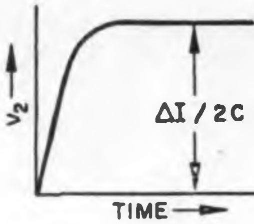


Fig. 8 (right): Waveform of the output voltage.

tity $y = 2R + sCR^2$ is done quite simply; the amplitude y at $s = 0$ is obviously $2R$, and at $s \to \infty$ it becomes sCR^2 with the curve finally attaining a 20 db/decade slope. The intersection of the asymptotes occurs at the solution of $y = 2R$ and $y = sCR^2$, i.e., at $s = 2/\tau$. This gives the "frequency break point" in the asymptotic approximation of the curve, see y, Table 4.

A quantity with a term in s^2 has a 40 db/decade slope at $s \to \infty$. An example arises in the quantity $g = 1 + 3s\tau + s^2\tau^2$. Beginning at $s = 0$, the curve has zero slope, and the asymptote is simply $g = 1$. If $3s\tau$ is the dominant component, the slope of the center portion of the asymptote will be the same as for $g = 3s\tau$; that is to say, the intersection of the asymptotes will occur at $3s\tau = 1$ or $s = 1/3\tau$, and the equation of the inclined asymptote will be $g = 3s\tau$. When $s^2\tau^2$ is the dominant component, the equation of the limiting asymptote will be $g = s^2\tau^2$. The intersection of these two asymptotes will occur when $3s\tau = s^2\tau^2$ or $s = 3/\tau$. These details are shown in Fig. 5 and are repeated for g in Table 4.

The Jacobians of the composite network, Table 3, can be simplified by multiplying throughout by sCR and by writing $\tau = CR$. They are then as given in Table 4, where their individual frequency dependence is also shown.

The transfer function which is conventionally written as g_{21} or $e_2(s)/e_1(s)$ may be expressed as the Jacobian ratio $(e_2, i_2)/(e_1, i_2)$ or a/g. Its frequency dependence may be found by subtracting the curve g in Table 4 from that of a, with the result shown in Fig. 6.

Portions of a curve, such as that of g in Table 4, can be associated at a glance with the relative portions of the equation if the latter are arranged in ascending terms of s. Fig. 5 shows these portions individually, and it is clear that to find the height of the asymptotic structure for a/g, it is necessary only to consider the frequency corresponding to $s = 1/3\tau$, where the ordinate value for g is 1 and $a = s\tau$, as in Table 4. The height of a/g is therefore 0.33, Fig. 6.

The flat top of Fig. 6 is in fact neither an asymptote nor a tangent of the true curve of g_{11}. It serves a useful purpose, however, in locating the rest of the structure on the vertical axis, and in portraying the general shape of the curve of g_{11}. The maximum height of the true curve can be found by equating the first derivative to zero, and in this case it arises at $s = 1/\tau$ and $g_{11} = 0.2$ (instead of 0.33 as in Fig. 6).

Transient Response

Suppose that it is required to assess the transient response of output voltage to a step of input current. First, the function $\partial e_2/\partial i_1 \mid i_2 = (e_2, i_2) / (i_1, i_2) = a/z$ is examined. Subtracting curve z from curve a of Table 4 gives the frequency response, Fig. 7.

From the formulas in Table 4,

$$\frac{a}{z} = \frac{s\tau}{sC + 2s^2\tau C} = \frac{R}{1 + (2CR)s}.$$

The transfer function required is therefore

$$\frac{e_2(s)}{i_1(s)} = \frac{R}{1 + (2CR)s}$$

and if a step of current ΔI_1 is applied, then $\Delta I_1/s$ can be substituted for $i_1(s)$ and the output voltage becomes

$$e_2(s) = \left(\frac{\Delta I_1}{s}\right)\frac{R}{1 + (2CR)s} = \Delta I_1 R\left[\frac{1}{s(1 + [2CR]s)}\right].$$

Taking the inverse Laplace transform,

$$e_2(t) = \frac{\Delta I_1}{2C}\left[1 - e^{-2CRt}\right]$$

The waveform of the output voltage is therefore as shown in Fig. 8.

It is of interest that, in spite of the fact that there is a series capacitor in the circuit, Fig 3, there is a response at zero frequency (or a steady-state amplitude in the pulse waveform). This is because a current generator has been specified by using I_1 as the independent variable.

Synthesis of networks to give a specific frequency response is made easier by the use of Jacobians, since the complexity of the calculation is reduced by treating the Jacobians individually. In many areas where Jacobian analysis can be applied, this technique offers a substantial bonus in the form of extended capability.

References

1. W. W. Happ, "Dynamic Characteristics of Four-Terminal Networks," *IRE Convention Record, PGCT*, 1954.
2. T. R. Nisbet and W. W. Happ, "Jacobians—A New Computational Tool for Converting Transistor Parameters," *Electronic Industries*, Nov. 1958.
3. T. R. Nisbet and W. W. Happ, "Asymptotes Solve Transistor Design Problems," *Electronic Industries*, Aug. 1959.
4. T. R. Nisbet and W. W. Happ, "Compound 2-Ports Systematized," C. P. 60-1127, AIEE Pacific General Conference, San Diego, 1960.

Monitor Systems, Inc., engineers (L to R), S. G. Billings, L. A. Meeks, and R. J. Margraff, check company's high-speed, automatic monitor system (HAM). It will be used to improve reliability, accuracy, and economy of GE's Hanford nuclear control system.

What's New

High-Speed Automatic Monitor System

AN ultra reliable 120 point High-Speed Automatic Monitor (HAM) System with a scanning rate of up to 5,000 inputs a sec. (200 μsec/point) which incorporates self-checking features has been developed by Monitor Systems Inc., Fort Washington, Penna. The monitor is designed for GE's Hanford Atomic Products Operation. It can monitor, at high speeds, thousands of temperatures with such high reliability that no more than a single false temperature alarm and/or a single failure to alarm is anticipated per year. This is achieved by having circuits built into the monitor to detect irrational input and prevent generation of false alarms.

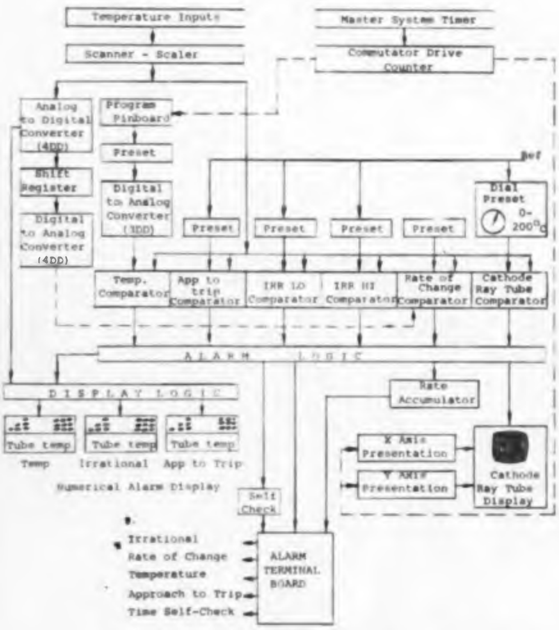
Purpose of the new monitor system is to demonstrate the complete practicability of high speed solid-state serial scanning systems for on-line process instrumentation of nuclear reactors. Reliability was a prime consideration. False alarms are prevented by self-checking every 0.8 sec. Logic of the checking channels has been extended to provide automatic localization of failures.

A worst-case design policy was adopted in designing and building the system. Circuitry is designed to provide reliable operation despite combined changes in transistor and diode characteristics and transistor, capacitor, and power supply drifts. All components are considerably derated.

Reliability was established by an acceptance test of unprecedented severity. Continuous operation for 1,250 hours was required with not more than a single high temp false alarm or more than two false alarms of other types. In other words, only one or two false alarms (depending on the type) were permitted in a total of 22,500,000 readings. System is expandable to 3,600 inputs.

New monitor system will be used at General Electric's Hanford Atomic Products Operation (below). Plant makes plutonium, an artificial and radioactive metallic element, a basic ingredient for the atomic bomb. Close control of the process is an absolute necessity.

(Right) Block diagram of HAM system. Reliability is in the order of 50 million component unit hrs. Unit was shipped Dec. 2.



Resonant Reed Frequency Measurement

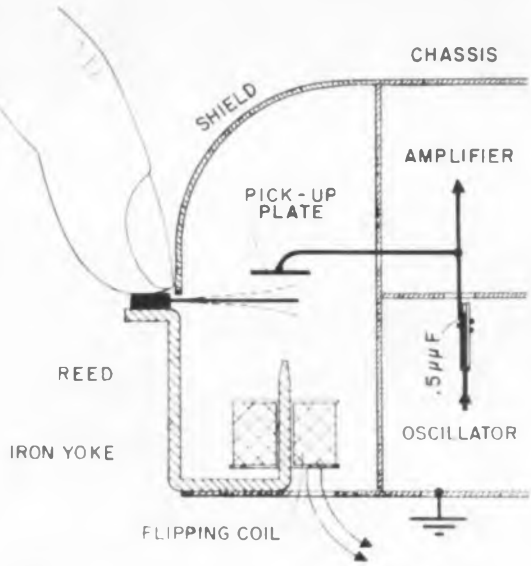


Fig. 1: Varying capacity between reed and pick-up plate modulates r-f carrier.

By **KLAUS H. JAENSCH**
Senior Electronic Engineer
Stromberg-Carlson Co.
Rochester, N. Y.

THIS instrumentation measures the resonant frequency of reeds before they are assembled as parts of a resonant reed relay. The reeds are strips of special steel, with one end fixed in a zinc cast slug. Different types have approx. ⅝ to ½ in. free reed length, with corresponding resonant frequencies from 160 CPS to 300 CPS.

Vibrating Reed Modulates R-F

The reed is held by hand in the test jig, Fig. 1. A Pick-up Plate is mounted close to the free end of the reed. Capacity between pick-up plate and vibrating reed varies periodically. This varying capacity is used to amplitude-modulate an r-f carrier.

R-f frequency of approximately 500 KC is produced by a simple, multivibrator type Oscillator. Frequency stability, wave shape, and amplitude of r-f are not critical. Oscillator output is fed into the following circuit through a capacity in the order of ½ mmfd. This tiny capacitor is made up simply by winding two turns of the bare wire, serving as one connection, around the end of plastic insulated wire of the other connection (See Fig. 1). To avoid additional stray from wires, this capacitive joint is located in the hole through the wall shielding the oscillator from the other circuit. For efficient modulation, it is further necessary to keep ground capacity of the wiring from pick-up plate to grid of Cathode Follower as small as possible.

The audio frequency achieved by demodulating the resulting signal represents the mechanical vibration of the reed. This a-f is amplified and finally shaped to a square wave. The duration of periods of this square wave is measured by an electronic counter.

Reed Flipped

For actuating the reed, Push-Button (Fig. 2) is pressed. Capacitor C_1 is normally charged to +48v through surge limiting resistor R_1. By operating S_1 of push-button, C_1 now discharges through "Flipping Coil" located in the test jig (Fig. 1). The magnetic field of the coil generated by the discharging current causes the free end of reed to flip momentarily. This flipping is followed by a damped oscillation of the reed at its resonant frequency (Fig. 3A). On a reed with Q= 300, amplitude of vibration is down to 20% after 154 periods, and to 10% after 220 periods.

Frequency Measurement

Normally, the counter is held inoperative with "Inhibit Reset" line grounded through the relay contact (Fig. 2). Contact S_2 of push-button operates the relay, which in turn unblocks the counter. But operation of the relay is delayed due to the time constant of C_2 and R_2. The latter is adjusted to pick out the part of damped wave train for

(*Continued on page* 195)

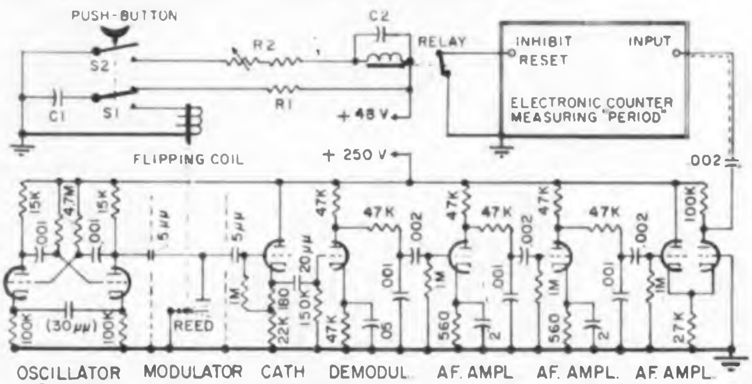


Fig. 2: Counter is held inoperative with "Inhibit Reset" line grounded through relay contact.

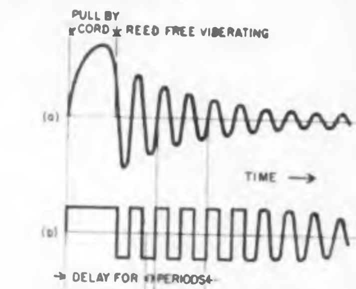
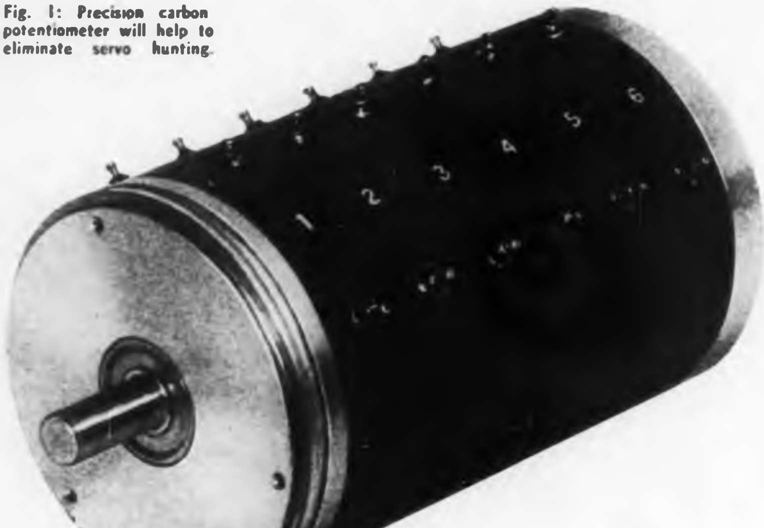


Fig. 3: With Q of 300, amplitude is down 20% after 154 periods.

Fig. 1: Precision carbon potentiometer will help to eliminate servo hunting.



By HERBERT ADISE
President
Computer Instruments Corp.
Hempstead, L. I., N. Y.

One Solution to

SERVO positioned potentiometers are widely used in all types of analog computers, similators, and the like, throughout the fields of industrial instrumentation and control, as well as military flight guidance and fire control.

Typically, the potentiometer is driven by a servomotor through a gear train. The motor is driven by an amplifier which receives and compares two signals—an input voltage from some external source and a feedback voltage from the potentiometer, as shown in Fig. 2.

Ideally, the motor drives the potentiometer in such a manner that at all times the input voltage is exactly matched by the feedback voltage. In effect, this servomechanism performs the basic function of causing the position of the potentiometer shaft or any other shaft geared to the motor to follow an input signal. If the input voltage is the result of a shaft position, such as from another potentiometer, this servomechanism, in effect, slaves an output shaft to an input shaft.

Despite careful design, it is not an unusual experience for the engineer to find that his breadboard servo system has a tendency to jitter or oscillate with low amplitude about the null position. The servo seems to be hunting for a true null. By decreasing the amplifier gain or introducing friction into the system, this hunting may be eliminated, but at the obvious expense of increased system error and reduction of high frequency response.

Servo Hunting

Why does a servo hunt? The mathematically inclined might answer that the characteristic equation of the system has roots that do not have negative real parts. This implies that the system is adequately described by linear differential equations with constant coefficients; i.e., that the hunting is caused by parameters that are independent of input amplitude.

Powerful analytical and graphical techniques exist for determining the response of a servo which can be considered linear[1, 2, 3]. These are mainly concerned with the frequency characteristics of the open loop transfer function. They lead not only to stability criteria but also to a full description of system response.

In cases where non-linear effects are present, the question of stability in response to small amplitude input signals can be settled by a frequency analysis based on the assumption of linearity for incremental values close to reference points of interest[2].

There are, of course, certain non-linear effects that cannot be meaningfully treated in this manner. For example, the effect of the dead band encountered in a relay servo. However, an analytic expression has been developed for this type of servo. It allows the frequency and amplitude of oscillations to be predicted on the basis of the transfer function of the linear portion of the loop and the characteristics of the dead band.

In summary, the literature of servomechanisms is rich in analytical and graphical methods for settling questions of stability and describing performance characteristics for all types of systems, from the most simple to the most sophisticated.

The use of analytical methods for servo design

Usually a servomotor drives a potentiometer so that the input voltage exactly matches the feedback voltage. With precision wire-wound pots this is not always possible because of the voltage difference between windings. Precision carbon film pots seem to be the answer in many cases.

Servomechanism Hunting

presupposes a full knowledge of the characteristics of all components that are under consideration for use in the servo loop. Here, again, the literature[4, 5]—and the catalog information of the component manufacturers—is generally most helpful. However, there are certain difficulties that can arise in connection with the use of particular components that are not often discussed. This article is mainly concerned with one such difficulty that can arise in connection with the use of precision potentiometers as the pick-off or follow-up element in a servo.

Instability

Most causes of hunting, whether linear or nonlinear, are the result of time lags which result, essentially, in regenerative feedback around the closed loop. On the other hand, static instability can result from the limited resolution of the pick-off element. From the mathematical point of view, this is a trivial case of instability. But, nevertheless it can limit the allowable gain in the servo loop and prevent the realization of design objectives which could otherwise be obtained. The following example may serve to illustrate this point.

A simple viscous damped servo in which the follow-up element is a 1-turn, 2-inch diameter potentiometer is shown in Fig. 2. The parameters of this servo are assumed to be as follows:

J_o = 0.0125 slug-ft²
F_o = 0.5 ft-lb per radian/sec.
E_{cf} = 115 volts
T = 0.028 ft-lb
E_p = 100 volts
N = 100/1

where:

J_o = Servo moment of inertia referred to output shaft
F_o = Servo friction referred to output shaft
E_{cf} = Rated voltage of motor control field winding
T = Torque at motor shaft with full voltage supplied to control field
E_p = Excitation voltage supplied to follow-up potentiometer
N = Speed ratio between motor and output shaft

It is further assumed that the desired response requires a damping ratio of

$$c = 0.25$$

Then the natural frequency of the servo is

$$\omega_n = \frac{F_o}{2cJ_o} = \frac{0.5}{(2)\ (0.25)\ (0.0125)} = 80.6 \text{ radians/sec} \quad (1)$$

and the required torque referred to the output shaft is

$$K_o = \omega_n^2 J_o = 80.5 \text{ ft-lbs/radian} \quad (2)$$

But the torque can be described in terms of torque

Fig. 2: Typical servo loop diagram shows the feed-back path.

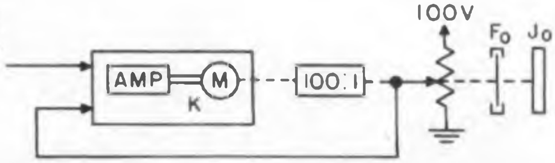
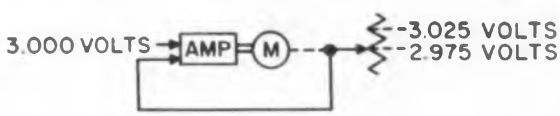


Fig. 3: Wire-wound pot has a 0.05v difference between turns.



Servo Hunting *(Continued)*

per volt output of the servo motor, the voltage gradient of the potentiometer and the gain of the amplifier as:

$$K_v = 80.5 = \frac{TNE_pG}{E_{cf}2\pi} \qquad (3)$$

Substituting the assumed values into Eq. 3 and solving for G yields,

$$G = 206$$

It is now in order to consider the maximum null position error that can arise as a result of the finite resolution of the follow-up potentiometer. Assuming that a wire-wound potentiometer of 2 in. diameter case size is used and that the resistance of the potentiometer can be 10k or more, a reasonable value of resolution would be 0.05%. To a first approximation, this would imply a potentiometer mandrel having 2000 turns of wire. Actually, such a potentiometer would have a slightly better resolution because of the interpolation provided by the shorting of turns as the slider advances over the winding. However, for a resolution on the order of magnitude of 0.05% this effect is not very significant. Thus, for the purpose of testing stability it is satisfactory to consider the slider as the arm of a switch which can be connected in turn to each of the turns of the winding. This is shown in Fig. 3.

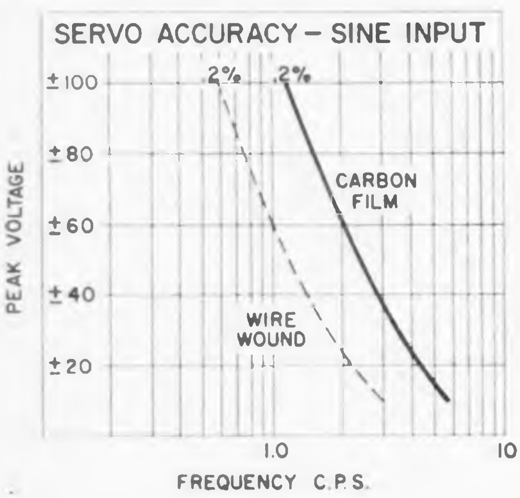
Winding Voltage Differences

Referring to the figure, it can be seen that there is a potential difference of 0.05 v between adjacent turns of the winding. This corresponds to 100 v/2000 turns. For purposes of discussion, the potentials existing on two particular adjacent turns are assumed to be 3.025 v and 2.975 v respectively. It is further assumed that a command input of 3.000 v is applied to the servo. Under this condition, the potentiometer cannot drive to a position where the error input to the servo amplifier is reduced to zero. Specifically, the slider can drive to the turn which is at 3.025 v or to the turn which is at 2.975 v. In either case, a null voltage of 0.025 v will appear at the servo amplifier input.

The question of stability then, depends on whether a 0.025 v input to the servo amplifier is sufficient to start the servo motor. For, if it is, then the servo will wire hop back and forth between the two windings for as long as the input remains at 3.000 v. Even if sustained oscillations of this type can be tolerated from a system point of view, they will seriously diminish the life of the potentiometer.

The required gain of the amplifier was previously found to be 206. Thus, with 0.025 v appearing at the servo amplifier input, 206 × 0.025 = 5.15 v will be supplied to the control field of the servo motor. Typically, between 3 and 4 volts will start a servo motor having a 115 v control winding under no load conditions. For this type of servo under discussion, the torque developed by the 5.15 v will be sufficient to start the motor and the load and thus under unfavorable input conditions sustained oscillations will occur.

Fig. 4: Servo accuracy increases with carbon potentiometers.



Carbon Film Pots

On the other hand, if a carbon film potentiometer, such as the one shown in Fig. 1, of the same diameter is used in this servo, this difficulty does not arise. The carbon film potentiometer presents a continuous surface to the wiper rather than a series of turns. Thus, the effect which limits the resolution of wire-wound potentiometers is entirely absent in the case of the carbon film units. Instead, much smaller effects of bearing play and wiper bounce, present in both types of potentiometers, determine the resolution of carbon film potentiometers. The result is that the resolution of a carbon film potentiometer is better than that of a wire-wound potentiometer of the same size by a factor of about 50.

The 2-inch diameter carbon film potentiometer, then, would have a resolution on the order of 0.001%. In the servo under consideration, the voltage error would be 0.0005 v. Thus, the maximum null input voltage to the servo motor control field under the most unfavorable condition would be 0.0005 × 206 = 0.1030 v which would not start the motor even under no-load conditions.

The tremendous improvement in servo system resolution resulting from the use of carbon film potentiometers allows marked increase in system gain without loss of system stability. In addition, because of the smooth surface presented by the resistance element to the wiper, carbon film potentiometers do not suffer from wiper bounce problems at higher operating speeds. The servo accuracy and response curves shown in Figs. 4 and 5 demonstrate the improvements achieved in a typical servo multiplier when the wire-wound potentiometer was replaced by a carbon film unit. Notice that, equipped with a carbon film potentiometer, the servo can operate at twice its former speed and with but a fraction of its former error.

In addition to elimination of the hunting problem,

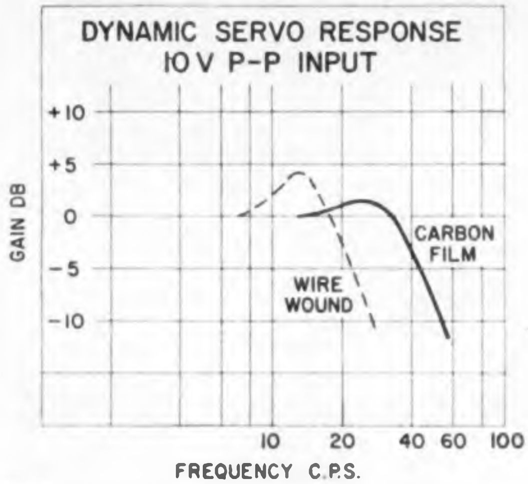


Fig. 5: Servo response curves show one advantage of carbon pots

the use of carbon film potentiometers results in numerous other advantages.

The carbon film resistance element is much more reliable than the wire resistance winding. The film is several times thicker and about 100 times as wide as typical resistance wire. The slider, as it moves, contacts only a small fraction of the width of the element. The integrity of the element does not depend upon the integrity of the portion subjected to wear. Sudden unpredictable failure of the element—typical of the wire winding—is ruled out.

The carbon film resistance element has a longer service life than the wire resistance winding. The smoothness of the path that it offers to the wiper minimizes wear. In addition, there is no hot spot problem as there is in a wire winding, where constriction of the winding at the point where it is traversed by the wiper causes local heating with a consequent shortening of life. As the carbon film element wears, a warning of impending failure is given since the potentiometer begins to exhibit local output voltage irregularities and, ultimately, local opens. However, even when this occurs, the useful life of the potentiometer is not at an end. Relocating the wiper path restores the potentiometer output to its original quality.

The carbon film resistance has much better shelf life characteristics than the wire resistance winding which may develop an opened output or shorted turns due to corrosive products.

The carbon film resistance element is non-inductive. Moreover, the problem of capacitance between the winding and the core which reduces the ac accuracy of wire-wound potentiometers is not present.

Wire is traditionally associated with precision resistance applications because it has a low temperature coefficient of resistance. However, in most potentiometer applications, linearity or conformance is the parameter of interest rather than absolute resistance. Thus, in these applications, arguments in favor of the carbon film potentiometer are overpowering.

The solution of the hunting problem through the use of carbon film potentiometers, then, turns out to be a most happy one, since it is accompanied by improvements in system performance, life, and reliability.

References

1. "Control Engineer's Handbook," J. C. Truxal, editor, *McGraw-Hill*, 1959.
2. "Servomechanisms and Regulating System Design," Chestnut & Mayer, *Wiley*; Vol. 1, 1951, Vol. 2, 1956.
3. "Design of Position and Velocity Servos for Multiplying and Function Generation," E. O. Gilbert, *IRE Transactions on Electronic Computers*, September, 1959.
4. "Control System Components," J. E. Gibson & Tuteur, *McGraw-Hill*, 1958.
5. "Picking a Potentiometer, Film or Wirewound," H. H. Adise, *Electronic Design*, November 11, 1959.

Thin-Route Microwave

Microwave manufacturers are divided into two basic groups. One group develops high-density equipment (say 120 to 720 channels) and the other produces thin-route equipment for use in conjunction with high density equipment and for application where lower channel capacity is sufficient. Thin-route systems are used, for example, as extensions of high-density systems or as an auxiliary facility paralleling a high-density system.

Principal manufacturers of thin-route equipment are Budelman Electronics Corp., 375 Fairfield Ave., Stamford Conn., and Farinon Electric Co., 416 D St., Redwood City, Calif.

Budelman makes equipment for both the 960 and 2000 MC bands. The 960 equipment can also be adapted for the 450 MC band. A terminal (Budelman's type 14BW equipment) consists of a transmitter and receiver—a pair of each when full standby is required. For repeater operation, two terminals are connected back-to-back. The transfer of modulation from receiver to repeater transmitter is at the subcarrier frequency.

Conventional telephone carrier equipment is used for deriving individual voice channels. Either SSB, suppressed carrier, or Budelman double sideband AM carrier equipment may be used. Coded tone signals for telegraphy, teleprinter, control or data transmission may be applied via telegraph carriers to the baseband below the telephone carriers or into one of the telephone channels. Transmitter frequency stability is better than ±0.0005% (anticipating further tightening of FCC standards).

Type 14BW Terminal, 960 MC, with Type 108B Power Amplifier and R-F Duplexer. Type 149B. Receiver and transmitter each occupy 10½ inches.

With more and more emphasis being placed on the operational status of missiles and space vehicles, the problem of simplifying fuel level sensing for field use magnifies. The high sensitivity of the thermistor makes it a leading contender for the detector.

Level Gauges in the Liquid

TWO factors make thermistors attractive as sensing elements in the liquid helium—liquid oxygen temperature range. First, their high sensitivity increases nearly proportionally to $1/T^2$; second, their resistivity increases with decreasing temperature. The latter eliminates the need of corrections for lead resistance and offers the possibility of remote measurement and control, even over a large distance.

While the resistance of a platinum, or other metal, resistance thermometer drops in liquid hydrogen ($\sim 20°K$) to less than 0.5% of its initial value at 0°C (273.50°K)—even lower in liquid helium (4.2°K)—thermistors possess resistance values of 5 to 5000 K ohms in this range. Their temperature sensitivity increases from approximately 30%/°K in liquid hydrogen to approximately 1000%/°K at a temperature slightly above the boiling point of liquid helium.

This steep increase of resistance with decreasing temperature at first presented a great problem, even at moderately low temperatures.[1, 2]

Table 1

Heat Capacity of Midget Disk Thermistors

Absolute Temperature °K	Heat Capacity in mw sec./degree	Temperature Increase Produced by 1 mw sec. Energy Input Under Adiabatic Conditions (No heat exchange with the environment.)
5	0.092	10.9
10	0.180	5.6
15	0.293	3.4
20	0.390	2.6
30	0.585	1.7
40	0.836	1.2
50	1.090	0.92
60	1.380	0.72
70	1.800	0.56
80	2.18	0.46
90	2.68	0.37
293	11.2	0.09

The corresponding heat capacities for standard disk thermistors can be obtained by multiplication with factor 10.

A systematic decrease of the energy gap in semiconducting materials, with an increasing reduction of their resistance *versus* temperature dependence to realistic values, at low temperatures brought the resistivity back again into practical acceptable levels of the order of 30 to 10,000 ohm • centimeter for liquid oxygen (90°K) and 3000 to 50,000 ohm • centimeter in liquid hydrogen.[3, 4, 6]

With a favorable geometric shape (disk) at 8°K resistance values of the order of 100 megohm could be obtained.[5] More recently, the resistance at this temperature could be decreased approximately by a factor 50, thus shifting the low temperature frontier for thermistors another few degrees toward liquid helium. More details on this development will be reported separately.

Low Temperature Level Gauges

An important application of thermistors in general, but especially for low temperature units, is in liquid level gages. Here the thermistor is self-heated by an electrical input to a temperature above its environment. Normally, a temperature increment of more than 10° is desirable to produce a large electrical signal by the transition from vapor to liquid. This implies a certain heat input into the system liquid-vapor, which, in cryogenic applications, should be kept to a minimum to avoid extensive evaporation losses of the valuable liquid phase.

Therefore, the heat input to the thermistor should be kept as small as possible. Two factors are very favorable to accomplish this goal:

(a) The enormous temperature coefficient in the liquid hydrogen-liquid helium range permits reduction of this temperature difference to a few degrees, and

(b) the specific heat necessary to raise the temperature 1°K for one mass unit of thermistor material (its specific heat) drops drastically at temperatures below 150°K.

According to Debye, the specific heat of solids changes with the cube of the absolute temperature according to the relation $c_p = A\left(\frac{T}{\theta}\right)^3$ where, θ

By DR. H. B. SACHSE
Research Director
Keystone Carbon Co.
St. Mary's, Pa.

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

Helium—Liquid Oxygen Range

stands for a characteristic temperature (Debye temperature) which is specific for each solid body and T is the absolute temperature at which the specific heat is measured.

The constant A has a universal character, almost independent of the type of material. For practical application, it was necessary to find the temperature dependence of the specific heat for the low temperature thermistors used in liquid gauges.

Table 1 shows in an impressive manner the very drastic drop of the heat capacity of small disk thermistors with a mass of approximately 20 mg.

The figures of Table 1 give the mw sec./temperature increase relationship for adiabatic heating, e.g., in a diluted gas or in vacuum. At liquid hydrogen temperature (20°K), the temperature increase/mw in one second would be 2.6°K, at 5°K (near liquid helium) even 10°K. The corresponding resistance changes would be approximately 80% at 20°K or several thousand per cent at 5°K, depending upon the constant B defined by the relation

$$B = \log \frac{R_1}{R_2} \left(\frac{T_1 T_2}{T_2 - T_1} \right) 2.303$$

Dissipation Constant

In liquefied gases, conditions are far away from being adiabatic. The dissipation constant will partially be determined by their exaporation heats which are listed in Table 3.

The formation of gas bubbles on the surface of the thermistors somewhat obscures, and decreases, the true dissipation constant. Therefore, it cannot be expected that the measured values follow truly the trend of the evaporation heats.

Some data have been determined in liquid hydrogen, nitrogen and oxygen for thermistors of the surface area 10^{-6} m^2.

The large spread of the dissipation constant in Table 2 is not surprising, since it is influenced by the degree at which the thermistor is covered with gas bubbles. The large increase of the dissipation constant with the electrical input is probably also caused by this effect.

Normally the wattage dissipation under equilibrium conditions should be proportional to the produced temperature difference between the self-heated thermistor and its environment resulting in a nearly constant wattage/temperature ratio increase. In nonboiling liquids and other media, this condition is approximately fulfilled.

High inputs apparently do not only promote bubble formation on the interface between thermistors and bath, but also bubble migration to the surface level of the liquid. Thus the temperature difference between thermistor and liquid bath is reduced.

Coated Thermistors

One might expect a decrease of the dissipation constant for thermistors, silicone-coated to protect them mechanically and to insulate them electrically. This coating is approximately 0.005 in. thick. It is surprising that no decrease of the dissipation constant was observed with coated thermistors. At first, this led to belief that the dissipation is mainly determined by the heat conduction through the lead wires, which, submerged in the liquid, will also generate gas bubbles. However, in a transparent Dewar-container, bubble formation was always observed only at the thermistor disk when submerged in the liquid gas. Bubble formation was more active at uncoated thermistors even if no electrical input was applied. Some

Table 2

Dissipation Constant

Electrical Input In Milliwatt	Dissipation Constant in Milliwatt/°K in H_2		N_2	O_2
0.1	1.4		1 – 5	0.7 – 1
1.0	2.0	2.8*	2 – 7	2 – 4
10.0	4.5	11*	4 – 14	5 – 15
100.0	35.0	69*	18 – 30	26 – 75

* Found with long probes surrounded by sleeve acting like a chimney.

Thermistors *(Continued)*

exploratory experiments and estimations may help to clear this question.

The heat conduction through the silver leads, 0.007 in. diameter, would dissipate 0.100 mw/°K if the ends of the 2 in. leads were connected to a heat sink with the temperature of the bath. For all practical purposes this was accomplished by submerging the thermistor with its leads ¾ to 1 in. below the liquid level. No distinct trend to higher dissipation constants was found if the submersion depth was varied from ¼ to 1 in.

Increasing the heat capacity of the sink by submerging the major part of the test clamp into the liquid also did not affect the dissipation constant, at least not in LOX.

These facts lead to the conclusion that the dissipation of the thermistor in a liquid bath is still determined mainly by the heat exchange between thermistor and the bath. With this in mind, it must be assumed that the heat resistance of the coating is negligible.

This is also confirmed by two other facts:

(a) The time constant of cooling the units in the liquid bath for coated units was found to be smaller than for uncoated units. In this case also, a small decrease of the dissipation constant was observed. An explanation of this apparently paradoxical effect is given in the last paragraph.

(b) Finally, it might be worthwhile to mention that the observed dissipation constant is rather independent on time. If the electrical input is applied for different time intervals, thermal equilibrium is reached within ten seconds, whether the unit is coated or not.

Heat Transfer Coefficients

The dissipation constant of the thermistor is mainly determined by the heat transfer coefficient between its surface and the surrounding liquid. No explicit data are available for the transfer coefficient in liquid helium, hydrogen, deuterium, nitrogen and oxygen.

However, certain conclusions can be drawn from data for other liquids such as water. The heat transfer coefficient α for nonboiling water is 2.1×10^6, for boiling water 8.4 to 25×10^6 mw seconds/m² hour °K. These figures not only illustrate clearly the large increase in the heat dissipation when boiling is induced by heavy input, but also explain the possible spread in the dissipation constant due to fluctuations in the boiling process (retarded bubble formation).

The following considerations aim at an estimate of the transfer coefficients in various liquid gases. They should only be used to estimate ratios of dissipation constants.

The heat transfer coefficient is determined by the following properties of the liquid: density; specific heat; heat conductivity; viscosity and, for the boiling condition, its evaporation heat.

Table 3 compiles data on liquefied gases, as far as available.

Table 3

Properties of Liquefied Gases Which Determine Their "Cooling Capacity" At Their Boiling Points Under Normal Pressure

		He^4	H_2	D_2	N_2	O_2	H_2O
Density g/ml	δ	0.121	0.076	0.164	0.81	1.16	0.958
Specific Heat Capacity Watt sec./g °K	c_p	4.2	10	6.2	1.98	1.65	1.006
Heat Conductivity Watt/cm °K	λ	.0C03	0.0012	0.0013	0.0014	0.00172	0.007
Viscosity in Micropoise	η	30	144	296	1580	1900	2810
Evaporation Heat Watt sec./gr.	L	21	452	312	196	212	2260

It was mentioned before that heat dissipation from a thermistor in liquefied gas will be related to its evaporation heat. However, before evaporation can take place, the necessary energy to produce the transition from liquid to gas (formation of bubbles) must be transferred from the thermistor to the liquid. For this process the heat transfer coefficient has to be known in each case. Assuming nearly turbulent conditions in the liquid, the heat transfer coefficient α can be approximated by

$$\alpha = \text{constant} \cdot \left(\frac{1}{\eta}\right)^{2/3} \cdot \delta^{3/4} \cdot \left(\frac{c_p}{\lambda}\right)^{1/3}$$

with η = dynamic viscosity, δ = density, c_p = specific heat and λ = heat conductivity of the liquid. The constant is determined by the geometrical shape and size of the thermistor and the container in which it is measured, since the latter determines the degree of turbulence produced by the spontaneous boiling of the liquid. For practical applications with a given design the same constant is valid and the behavior in various liquids is characterized by the ratio $\frac{\alpha}{\text{constant}}$ which determines also the dissipation constant. A few values of $\frac{\alpha}{\text{constant}}$ have been calculated and are listed in the following table:

Table 4

Liquid	He^4	H_2	D_2	N_2	O_2	H_2O
$\frac{\alpha}{\text{constant}}$	1.27	0.45	0.21	0.42	0.54	0.21

Based on the measured dissipation constant in liquid hydrogen, Table 2, for liquid He^4 a value approximately three times higher can be expected. In other words, the thermistor should be sensitive enough to "feel" the difference between liquid and gas.

Grassmann and Karagounis[7] have measured the heat dissipation of 20 μ Pt-wires in several liquefied gases. In liquid He^4 they found a heat dissipation of 200 watts/meter^2 for 0.1° temperature difference between wire and liquid, 5×10^4 watts/meter^2 for 1°. With these data one would obtain for a midget disk thermistor of $\sim 10^{-5}$ meter^2 surface dissipation constants of 20 or 500 mw/°K which are much higher than estimated. The corresponding values for H_2 and O_2 would be 25 and 40 mw/°K, respectively, with 1°K temperature difference, in reasonable agreement with the data in Table 2 and considering the fact that the geometry of the heated objects was rather different.

Time Constant

Till now only stationary conditions were discussed. For practical applications, the response time of the thermistor, when dipped in the liquefied gas is of great interest. Starting from ambient, the time constant is 2 to 3 seconds (for 63% of the final resistance value in the liquid), cooling from LOX to liquid nitrogen it is 0.6 ± 0.3 seconds. This value includes the manual transfer time from one liquid to the other which also explains the relatively large spread.

In former publications the point was stressed that the formation of gas bubbles makes the time constant always too high compared to the theoretical value given by the heat capacity of the thermistor and the heat transfer coefficient.

It can be shown that the time constant "ambient to LOX" drops 20 to 25 % if the thermistor is coated. In this case, spontaneous bubble formation is very much retarded up to an input threshold of 10 to 20 mw.

Acknowledgment

The author wishes to thank Mr. D. B. Chelton, Cryogenic Engineering Laboratory, National Bureau of Standards, Boulder, Colo., for his critical discussion and Mr. G. A. Mahoney for his assistance in the measurements.

References

1. Sachse, H. B., "Low Resistance Thermistors As Ultra-Cold Thermometers," *Electronic Industries*, Jan. 1957, pp. 55, 142, 143, 146, 147.

2. Sachse, H. B., "Temperature Measurements Near Absolute Zero," *Electronic Industries*, Sept. 1957, pp. 58-9, 106-8, 112.

3. Sachse, H. B., "Design Data for Ultra Low Temperature Thermistors," *Electronic Design*, April 30, 1958, pp. 30-33.

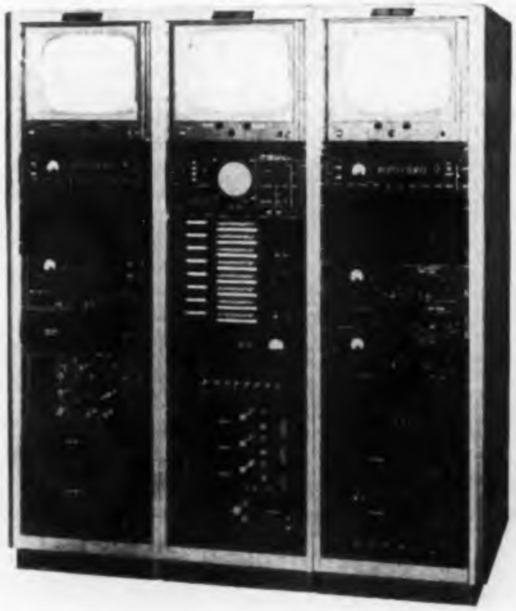
4. Sachse, H. B., "Thermistors As Sensing Elements for Low Temperatures," *Bulletin de l'Institut International du Froid*, Annexe 1958, pp. 145-154.

5. Sachse, H. B., and Vollmer, G. W., "Thermistor Sensing Elements for −445°F," *Electronic Industries*, Feb. 1959, pp. 67-68.

6. Sachse, H. B., "Thermistors, 10-600°K," *Electronic Industries*, Oct. 1959, pp. 81-83.

7. Grassman, P., Karagounis, A., *Proc. of Fifth Intl. Conf. on Low Temperature Physics and Chemistry*, 1958, pp. 41-45.

TV SYSTEM for PENTAGON



Three 72-inch panels form the nerve center of the Pentagon Video Audio System. System gives the military news as it happens.

A LARGE TV system, equivalent to a complete broadcast station video system, has been engineered and installed in the Joint War Board, Emergency Action and Conference Rooms at the Pentagon by Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N. J.

It is for observing world-wide events and news as it happens. It gives military hdqts. the means of viewing the programs of 4 TV networks, Weathervision terminal information, messages of Communications Room teleprinter machines, video tape information, and a special system for Joint War Board surveillance.

By manipulating any of 72 push button switches on a high-speed video-audio electronic Switcher Console, a Joint War Board action officer may present instantly any one of 9 complete programs to any one of 8 different sets of video picture monitors or 12 sq. ft. projection wall screens, and loudspeakers in the several strategic Joint War Board rooms.

International news arriving over a national or international teletype circuit, can be seen on the same system. Secret information arriving over long network lines or radio channels leased from the American Telegraph and Telephone Co. or other world-wide communications nets may be presented as

(*Continued on page* 195)

Special transducers must be developed to handle dynamic measurements of electronic hardware under vibrational environments. These devices should be "throw-aways" which can be left in the equipment after the measurements are made. Size and weight are also critical since they affect the data. Here is the procedure followed in the development of a satisfactory, lightweight transducer for this application.

Part One of Two Parts

Designing a Lightweight Vibration Transducer*

By THOMAS D. SMITH and HARRY R. SPENCE

Members of the Technical Staff
Space Technology Laboratories, Inc.
P. O. Box 95001
Los Angeles 45, Calif.

T. D. Smith

H. R. Spence

** Patent application filed.*

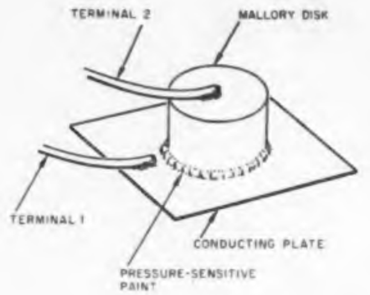


Fig. 1: Application using a weight on pressure - sensitive paint during vibraton.

To examine the dynamics of missile electronic hardware under various vibrational environments, dynamic measurements within assembled electronic packages are essential. These measurements are made using an accelerometer as the monitoring device. Depending on the size and complexity of the equipment, the number of positions to be monitored varies from 10 to 20. Since the tendency of airborne electronics is toward miniaturization, the weight, size and shape of the accelerometer become major considerations. In some applications, the weight of the accelerometer assumes an appreciable part of the weight of the component under examination, thus invalidating the test data. Moreover, size and shape may occasionally prohibit measurements in congested areas. For convenience, the accelerometer should be amenable to a quick, simple method of attachment. This would eliminate the time-consuming process of preparing the package for testing, and decrease the possibility of improper bonding between the accelerometer and the equipment under test, which could result in erroneous data. Once the data is acquired, the accelerometer should remain in the equipment, eliminating the time and expense involved in disassembly and reassembly of the equipment.

Accelerometers presently available are too expensive for use as a "throw-away" item. Also, size and weight prohibit their use in examining the dynamics of small components.

A special transducer must be developed to satisfy the unusual requirements of these dynamic measurements. Expendability, weight, dimensional size, sensitivity, and frequency response must be considered. Here is a program that led to such a device.

The First Approach

The first approach was to use the reaction of a weight on pressure-sensitive paint during vibration. The electrical resistance of the paint may be varied by subjecting it to a varying pressure. It was hoped that the variation in resistance could be used to indicate vibrational acceleration. Since a high pressure per unit area was desired and a small size required,

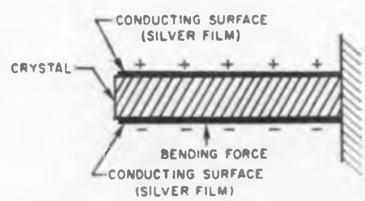


Fig. 2: Charges produced on a piezoelectric crystal by a bending force.

Mallory metal (0.6 lb/in.^{3}) was selected for the mass from which various sizes of disks were made. The disks varied from ⅛ to ¼ in. in dia., and $\frac{1}{16}$ to ¼ in. in thickness. The paint was applied to the surface of a conducting plate which was used as one of the electrical terminals; the Mallory disks which acted as the second terminal were attached to the paint. (Fig. 1.) During static checks, the resistance change for different pressures was easily measured. Excited by an MBC-10E vibration table, this assembly was subjected to a vibration of 10 g's. Unfortunately, output sensitivity was too low, i.e., $\Delta R/R$ was negligible. To improve this ratio, the logical solution appeared to be an increase in the weight of the metal disk; however, an addition in weight would conflict with the lightweight specification (the greatest weight of the original assortment of disks exceeded 3 gm), so larger disks were not tried.

Many crystal configurations have been tried and discarded for improved sensitivity and linearity. One configuration is the simple bender or cantilever crystal. Since a linearity between various g levels of 10% was considered satisfactory and a sensitivity of 4 mv/g wanted, the cantilever method was examined. Simplicity in fabrication and economy were considerations here. A ±2-db variation in the frequency response in the 30 to 2000 cps range was regarded as tolerable.

ΔQ_t; thus, the force exerted on the test charge by q_2 will also become small, ΔF. Therefore:

$$\lim_{\Delta Q_t \to 0} \frac{\Delta F}{\Delta Q_t} = \frac{dF}{dQ_t} = \frac{kq_2}{r^2} = E \cdot \tag{3}$$

Work is defined as the product of the force and the distance a body is moved during the application of this force (the direction of movement and force are the same). Thus:

$$W = F\,r \tag{4}$$

where W represents the work; F is the force applied; and r is the distance. In an electric field produced by a point charge, as a test charge Q_t is moved radially with respect to the charge producing the field, the force upon Q_t varies. It is, therefore, necessary to consider the summation of the increments of work done on this test charge:

$$dW = F\,dr = E\,Q_t\,dr = \frac{kq_2\,Q_t\,dr}{r^2} \cdot \tag{5}$$

In (5) dW represents the incremental amount of work accomplished in moving the test charge an incremental distance dr. Therefore:

$$W = kq_2\,Q_t \int_{r_1}^{r_2} \frac{1}{r^2}\,dr \tag{6}$$

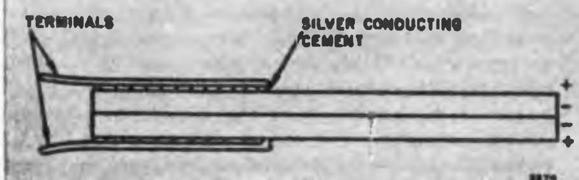


Fig. 3 (left): Polarized Bi-Morph crystal assembly.

Fig. 4 (right): Charges created by bending stress.

Piezoelectric Theory

A brief discussion of the relationship between charges and resulting voltages due to the piezoelectric effect is perhaps necessary. Coulomb's law states that the force of attraction or repulsion exerted on one charged body by another is proportional to the product of their charges and inversely proportional to the square of their separation. Therefore, the force of attraction between two unlike charged bodies is:

$$F = k\,\frac{q_1\,q_2}{r^2} \tag{1}$$

where F is the force between the charged bodies, q_1 and q_2 are the charges on the bodies, r is the distance between these bodies, and k is a proportionality constant. The electric field intensity at a point due to an electric field is defined as the force per unit charge on a positive charge when placed at the point in question. If q_1 of Eq. 1 is a unit test charge Q_t, and E represents the electric field intensity, then:

$$E = \frac{F}{Q_t} = \frac{kq_2}{r^2} \tag{2}$$

To ensure that the test charge Q_t does not disturb the electric field produced by q_2, let Q_t become very small,

where W is the total work necessary to move Q_t between the points r_1 and r_2, these points being on a common radial line to the charge q_2 producing the electric field. The potential difference between two points in an electric field is the work per unit charge necessary to carry a positive charge from the point of lower potential to that of higher potential. From (6) and the above definition we have:

$$V = \frac{W}{Q_t} = kq_2 \int_{r_1}^{r_2} \frac{1}{r^2}\,dr = kq_2\left(\frac{1}{r_2} - \frac{1}{r_1}\right) \cdot \tag{7}$$

or, for any given electric field produced by a point charge, the voltage difference between two points will be proportional to the charge producing the electric field. Thus:

$$V = k_1\,q \tag{8}$$

where V is the potential difference, q is the charge producing the electric field, and k_1 is a proportionality constant. It can be shown that in the special case of two flat, parallel charged plates, the electric field intensity is uniform between the plates, and the resulting voltage remains proportional to the charge producing this field.[3]

Since in a piezoelectric material a variation in strain

Transducers *(Continued)*

produces a proportional charge, it follows that the voltage produced by the charge will also be proportional to the strain, or:

$$\text{strain} = k_2 q = k_3 V \qquad (9)$$

where k_2 and k_3 are the proportionality constants, q and V are the resulting charge and voltage produced. Because of the relationship in (9), the main concern will be devoted to the strain developed in the crystal during bending. If Fig. 2 is the cross section of a piezoelectric crystal, a bending force normal to the surface of the crystal will produce charges on the surfaces which result in a voltage differential between the surfaces.

A Piezoelectric Crystal Tried

In trying to get greater sensitivity, the paint was replaced by a piezoelectric material. Piezoelectricity is an electric polarization or charge produced by a mechanical strain on certain types of crystal. This polarization or charge is proportional to the strain, and changes sign with it. Because of its high sensitivity, Rochelle salt was considered as the generating element. It was eliminated because of its low melting point (55°C). Also, the response of this material has an affinity for noise. Quartz crystal was considered, but the sensitivity was too low.

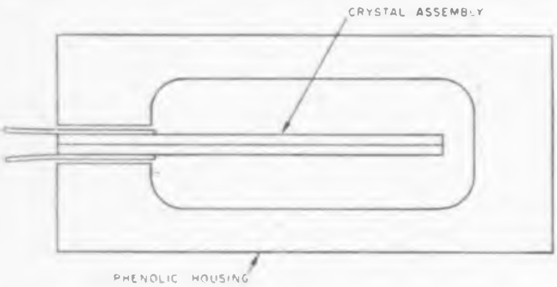


Fig. 5: Transducer assembly.

Although it is in the electrostriction category, barium titanate was tried. When an electric field is applied to a dielectric, a mechanical deformation will result which is proportional to the square of the applied field.[1] If barium titanate is polarized with a dc field of approx. 30 kv/cm, the dc field may then be removed, and a remanent polarization will be maintained by the crystal. The polarized element will then react similarly to the piezoelectric material—a variation in strain will produce a charge substantially proportional to the strain.[2]

Various sizes of barium titanate disks (in the dia. range of the Mallory disks) were used. The titanate disks were attached to a plate, which was used as one of the terminals, with conductive cement. The Mallory disks were attached to the top of the titanate, and a second terminal brought out in a manner similar to the application with the pressure-sensitive paint. The output with a varying pressure was observed on an oscilloscope. As before, when subjected to a 10-g vibration excitation, the weight of the Mallory disk was not enough to produce a satisfactory output from the barium titanate crystal. Apparently a different approach was necessary.

The Cantilever Beam Construction

In studying the cantilever beam construction, barium titanate was again used as the active element. Not only does barium titanate provide a large output compared to other types of crystals but, due to its polycrystalline structure, it may also be shaped in complicated forms and sizes. This would be impossible, or at least difficult, to attain with single crystals. For the first attempt, a crystal (conveniently obtained from a standard phonograph cartridge) was mounted in a phenolic housing. This crystal, was made of two parts separated by a thin metal strip and polarized in opposite directions. See Fig. 3. This is commonly referred to as a bi-morph construction. Two terminals were secured to the crystal with a conducting silver cement. Assume that the polarization of the crystal is such that, under a tensional strain, the charge developed is positive and under a compressional strain the developed charge is negative. During bending in a downward direction (see Fig. 4) the top half is in tension and the lower half is in compression. The generated charges on both halves due to bending are additive. If this were not the case (i.e., if the halves were polarized in the same direction), the generated charges would tend to cancel each other.

To ensure that the mechanical resonance frequency remained well beyond the desired operational frequency range of this device, which was 30 to 2000 CPS, calculations were made to determine the max. length of the crystal which was allowed to protrude from the mounted or fixed end. The calculated length permitted the lowest mechanical resonance to occur in the proximity of 3000 CPS. If this had not been done, the frequency response curve would have been unsatisfactory as mechanical resonance was approached. The crystal was cemented in a phenolic block, allowing this correct length to extend from the fixed end. (See Fig. 5.) A number of these assemblies was constructed and tested. (Fig. 6e.) In testing, amplitude data were recorded at predetermined g levels. The input g level was varied only after sufficient data had been obtained over each frequency range. Although electrical output was approx 2.5 mv/g input and frequency response was unsatisfactory, the results were encouraging. Fig. 7 shows the frequency response indicating that a variation of 10 db resulted. A perfectly flat frequency response is not required; however, for data evaluation the response curve should remain within ±2 db of the normalized value over the operating frequency range. The normalizing frequency is simply that frequency at which the reference output sensitivity is determined. Here, the normalizing frequency was chosen in the proximity of either 30 CPS or 1000 CPS, depending on the shape of the curve. Due to the noise level usually encountered in and around electronic equipment, it is virtually impossible to distinguish between noise and signal response at excitation inputs less than 0.5 g if the 4 mv/g sensitivity is not maintained. An acceptable result of this design was the less than

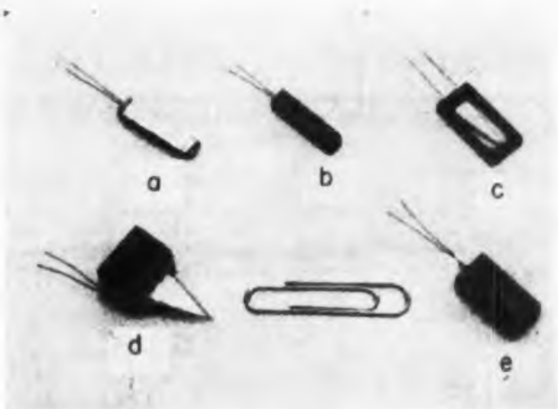


Fig. 6: Transducers.

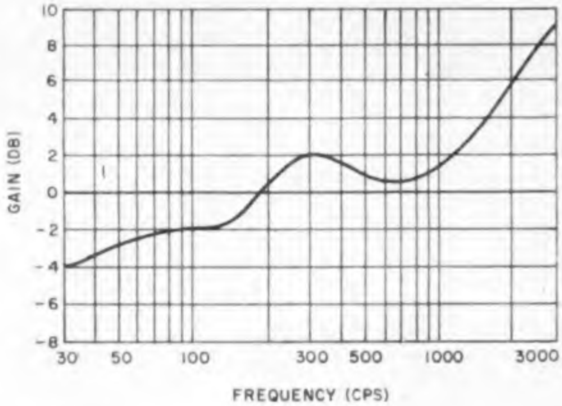


Fig. 7: Freq. response of transducer (see Fig. 6e).

10% linearity deviation obtained as the g level was varied.

Improving Sensitivity & Frequency Response

In trying to increase sensitivity and improve frequency response, a new crystal configuration was sought. Barium titanate was still used, but the shape was changed from rectangular to triangular. (See Figs. 6c and 6d.) This design evolved from this line of reasoning. In the first crystal, the strain at the mounted end is greater than that at the free end due to its equally distributed weight. Therefore, the charge developed per unit area varies. But the surface of the crystal must remain at equipotential values due to the conducting silver film on the surface, so the voltage tends to remain at a lower average than that which would be caused by the infinitesimal area of greatest strain. Now, if at all points on the crystal an equal charge was generated, the voltage for each infinitesimal area would be equal. Consequently, a max average would occur on the crystal surface during flexure. The mechanics of bending indicate that a cantilevered beam with a concentrated weight at the end will tend to produce strains throughout the beam which are more nearly equal if the beam approaches a hyperbolic shape. For ease of fabrication, a triangular configuration was used to indicate feasibility. One objection was the decrease in the mechanical resonance frequency as the concentrated weight at the end of the crystal was increased. Therefore, the weight could not be made as large as required. A weight was not used with the rectangular crystal to increase the strain for a given input level because the stiffness was less than that of the triangular shape, causing a greater rate of decrease in the mechanical resonant frequency as the weight was increased.

Results from this configuration which demonstrated a sensitivity of 3.9 mv/g (see Fig. 8) were satisfactory. Because of the shape, these crystals were handmade. This factor was held accountable for extremely low repeatability of performance among the transducers. The crystals were also very fragile and quite easily broken even before use. To improve mechanical strength, a change from barium titanate to lead zirconium was tried. This did not, however, achieve the anticipated results.

The primary emphasis was placed on obtaining an existing crystal element rather than on a crystal development program. Reverting to the previously tried rectangular configuration (Fig. 6e), an attempt was made, through a dimensional reduction, to eliminate any isolation or detrimental effects that may have been caused by the original transducer housing. This resulted in a very small unit weighing approx 0.35 gm and measuring 0.156 x 0.141 x 0.704 in. (See Fig. 6b.) Weight was reduced twofold. This was a great advantage, because it permitted use of the unit in small areas. A variation was made in how the terminals were attached to the crystals. Instead of using a conducting cement, the leads were soldered to the crystals. This eliminated resistance variation between the conducting surface and the terminal leads.

(Continued Next Month)

Fig. 8: Response of triangular-shaped transducer configuration.

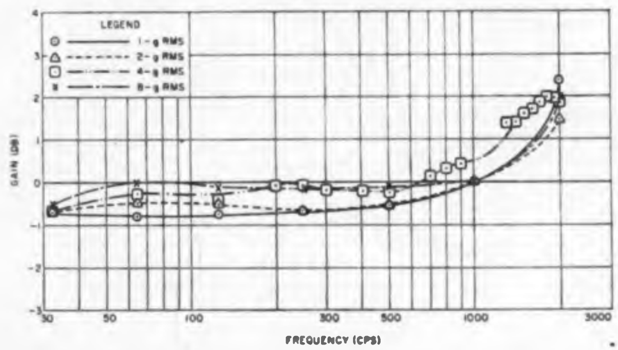
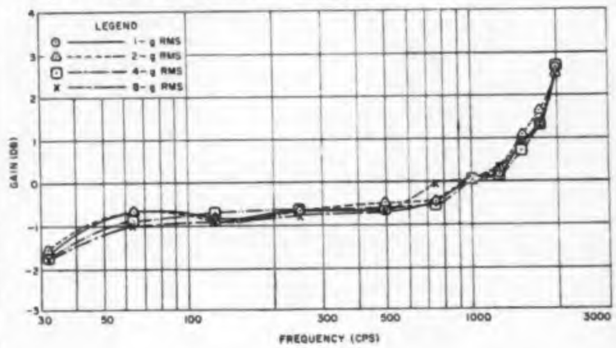


Fig. 9: Response of transducer (see Fig. 6b).



New Products ...for the Electronic Industries

POWER SUPPLY

Model PI 12-2 sealed power supply can operate continuously at full power without forced air cooling or external heat dissipation. It is for applications requiring high power output, close regulation and resistance to environ-

ments such as those in missile ground support equipment. It delivers 2 a at 12 v. in still air to 40° C and can be operated at higher amb. with forced air cooling. Regulation is 0.05% for 0 to full load changes and 0.02% for ± 10% line variations. Ripple is less than 1 mv RMS. Overshoot does not exceed 1% and recovery is less than 50 μsec. An overload circuit limits current in the event of a short circuit. Input is 105-125 vac, 50-440 CPS, single phase. Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J.

Circle 229 on Inquiry Card

SNAP SWITCH

New Snap Switch is designed to solve space limitation problems and offer increased flexibility in engineering tolerances. Total plunger travel is ½ in., of which a full ⅜ in. is overtravel. Both SPDT and SPST versions of the switch are available with a snap-in bezel for front mounting or threaded bushing for back mounting. It has heavy duty construction and coin silver contacts. All termina-

tions are located at one end. Options available in plunger length and color and in bezel finish. UL approved for 10 a, 125 vac; or 5 a, 250 vac. The Ucinite Co., Div. of United-Carr Fastener Corp., Newtonville 60, Mass.

Circle 230 on Inquiry Card

TRANSDUCER EQUALIZER

New transducer equalizer to receive and observe in real time, and to accurately record analog data otherwise masked and destroyed by the limitations of the measuring system. It directly analyzes and accurately records

high-speed changes in pressure, acceleration, temp. and luminosity. Input impedance, 200,000 ohms shunted by 20 μμf; input signal, nom± 5 v. at gain of 1; output impedance, less than 1000 ohms; output signal, ±15 v. max.; output load, max., 10,000 ohms resistive, 100 μμf; gain, 1, 2, 5, 10; output noise level, 20 mv. RMS; signal delay, 0.3 μsec; pulse response, sufficient to equalize pulses with rise times as short as 0.5 μsec. Data Instruments Div., Telecomputing Corp., 12838 Saticoy St., No. Hollywood, Calif.

Circle 231 on Inquiry Card

VARIABLE TRANSFORMER

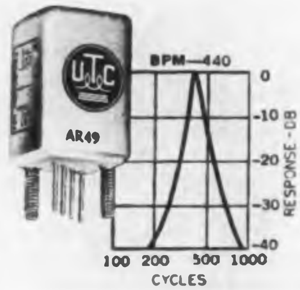
Portable, variable transformer, the VT8G, features an overvoltage-no-overvoltage selection switch. User can limit the max. output of the transformer to the line voltage (120 v.) or to the overvoltage rating (140 v.). The face carries 2 sets of voltage calibrations in 2 different colors to match the output indications on the selection switch. The VT8G is rated at 7.5 a and incorporates a circuit breaker for

protection. It is housed in grey crackel finish case and has a natural aluminum and black control panel. Underwriters Laboratories, approved. Ohmite Mfg. Co., 3627 Howard St., Skokie, Ill.

Circle 232 on Inquiry Card

BAND PASS FILTERS

Expansion of the BPM line. These are miniaturized Band Pass Filters. New units pass frequencies of 440, 500, 600, 3000, 4000, and 5000 CPS. For low level operation, attenuation is 35 db per octave. Filters are metal



cased and hermetically sealed to MIL-T-27A and MIL-T-18327A. Units are MIL type FR4RX22AF. Straight pin terminals are provided for printed or standard circuits. Units have 2:1 gain. Attenuation is approx. 2 db ±3% from center frequency. Input 10,000 ohms, output to grid, tapped for 10,000 ohms to provide for transistor circuits. For tube circuits continuity is on grid side, for transistor use continuity is on input side. Dimensions: ¾ x ¾ x 1⅛. Weight: 1 oz. United Transformer Corp., 150 Varick St., N. Y. 13, N. Y.

Circle 233 on Inquiry Card

GENERATOR-DETECTOR

Model 800-R generator-detector is a combination of a variable power supply and a sensitive microvoltmeter. The generator provides 6 output ranges to match loads from 1 ohm to 100 kilohms. Output is continuously variable from 0 to 1 w into a matched load. Isolation and guarding make it applicable to high accuracy bridge measurements. The detector consists of a modulator type

calibrated dc microvoltmeter, with ranges from 0.2 μv per dial to 1,000 v full scale. Electro Scientific Industries (formerly: Electro Measurements, Inc.), 7524 S. W. Macadam, Portland, Ore.

Circle 234 on Inquiry Card

New Products . . . for the Electronic Industries

SQUARE TRIMMERS

Two new trimming potentiometers in square configuration, Models 50 and 60, ⅝" and ½" square respectively. A feature is humidity proof construction in accordance with MIL-STD-202A, Method 104, Condition A

and MIL-E-5272C, Procedure I. Model 50 is available from 50 to 20K ohms and Model 60 from 50 to 50K ohms. Model 50, weighs 1 gm, is rated at 1 w at 50°C and Model 60, weighs 2 gm, rated at 2 w at 40°C. The 25 turn units meet all applicable military specifications for altitude, fungus, salt spray, humidity, sand and dust, temperature cycling, shock and vibration. Spectrol Electronics Corp., 1704 S. Del Mar Ave., San Gabriel, Calif.

Circle 235 on Inquiry Card

DIODE SWITCH

A single diode switch for K-band applications, this silicon device is capable of switching greater power than 0.2 w at speeds of several mμsec. Total modulation voltage needed is 1.0 v. peak. The on-off ratio is 20 db with

an insertion loss of 2 db. Although designed for K-band, other bands are available with very little change in specs except size. (2½ x 1-¾ x ⅞ in. for K-band unit). If a greater on-off ratio is required, these units can be cascaded in series. A dual unit is available with the same dimensions which had an on-off ratio of 40 db with an insertion loss of only 4 db. The Bendix Corp., York Div., York, Pa.

Circle 236 on Inquiry Card

ZENER REFERENCE

Hermetically sealed IN429 silicon zener reference elements provide voltage stability of ±1% or better from −55°C to +100°C. The IN429 has a 6.2 v operating voltage, making it suitable for precision instrumenta-

tion, computer and other data processing equipment where precise low voltage regulation is required. Diodes may be used in series for higher reference levels. Rated at 200 mw power dissipation at 25°C, it has a max. dynamic impedance of 20 ohms at 7.5 ma, and a power derating factor of 1 mw/°C. Units measure 0.330 x 0.230 in. (dia) max. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle 237 on Inquiry Card

STAGING SWITCH

The EDC 2-184 Solid State Staging Switch is a Solid State "relay" designed for channel switching to increase the capacity of telemetering systems. Characteristics: Input power, 28 vdc, 70 ma, four double throw signal poles, two double throw monitoring and indicating poles; complete isolation between all poles, power and actuating circuits; uses all

silicon transistors, and qualified for ballistic missile environment. The 2-184 can be provided with any number of isolated signal or power poles. Electro Development Corp., 3939 University Way, Seattle 5, Wash.

Circle 238 on Inquiry Card

ANGULAR DIVIDER

Angular Divider tests (out of the system) those inertial components which rely upon gimbals for precise concentric separation. The component under test is indexed with better than 20 sec.-of-arc absolute accuracy and 10 sec.-of-arc repeatability. Mechanical distortion forces negligible. With this instrument, electrical error and nulls are measured. It is also

used to simulate the output signals from a gyroscopic system. Specs: Size, 12 in. dia. x 5¾ in. high. Range, 360°. Direct reading in deg., min., and sec. Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.

Circle 239 on Inquiry Card

PANCAKE RESOLVER

New pancake resolver has a functional accuracy of 10 sec. of arc. Resolver, which has a repeatability of 2-sec., is of integral bearing design, permitting direct gimbal mounting. Either the primary or secondary member can be rotated, with the other member fixed. It is suited for use in stable platforms of inertial guidance systems. Units available in beryllium

housings for operation in systems experiencing a wide range of temp. Aluminum housings can also be supplied. Components Marketing Div. of Reeves Instrument Corp., Garden City, N. Y.

Circle 240 on Inquiry Card

New Products . . . for the Electronic Industries

POTENTIOMETERS

Series of ½ in. dia. linear motion potentiometers for servo control systems and instrumentation transducers. The series, Types 3239 and 3209 meet MIL environmental specs. They offer independent linearities of

±0.5% or better, and are available with element resistances ranging from 1K to 20K ohms. Type 3239 has a shaft stroke length of 1.587 in., and Type 3209, a shaft stroke length of 0.600 in. Potentiometers withstand as much as 1000v RMS without dielectric failure. Structural feature permits coaxial mounting to meet design configurations such as are found in pneumatic and hydraulic systems. Markite Corp., 155 Waverly Place, New York 14, N. Y.

Circle 241 on Inquiry Card

TRIMMER RESISTORS

New 42-turn ½ in. square trimmer resistor (Series 170) and a new 25-turn rectangular trimmer resistor (Series 180) added to metal-ceramic CeraTrols line. Both units have infinite resolution, complete resistance

range from 100 ohms thru 1 megohm and stability under all environmental conditions. Series 170 has 42 turns continuous rotation, 150°C high operating temp, power rating of 1 w at 50°C derated lineally to zero load at 150°C and high temp construction. Series 180 has 25 turns with slip clutch at end of rotation, 200°C high operating temp, power rating of 1 w at 125°C derated lineally to zero load at 200°C and high temp construction. CTS Corporation, Elkhart, Indiana.

Circle 243 on Inquiry Card

SERVO AMPLIFIER

The 60 CPS solid state servo amplifier, Model 122, is a 20 w 60 CPS general purpose servo amplifier for use with both dc and ac input signals. A 100 mv input will cause 115 v., 60 CPS output to rated load. The unit is self

protecting from overload due to excessive input signal. Input impedance is over 300 k for signal input and is 25 k for tach input. Output impedance is less than 100 ohms. Noise output is negligible and the waveform shows less than 10% harmonic distortion. Gain, zeroing, output, level and tach controls are provided, plus an additional control to adjust an internal damping network for dc signals. K-F Products, Inc., 3100 E. 43rd Ave., Denver 16, Colo.

Circle 245 on Inquiry Card

R-F POWER METERS

Additions to line of low power r-f Power Meters. Masuring from 0.2 to 700 MC, they include Model PM-4, 150 and 600 mw full scale, Model PM-5, 500 and 1500 mw full scale and Model PM-6, 1.5-6 w full scale. They are absorption-type consisting of an air-cooled, coaxial load resistor and a calibrated voltmeter. They are for use as field or lab. test instruments, are completely shielded and non-radiating,

permitting transmitter testing and adjustment without interference. No correction curve is necessary to cover the freq. range. Accuracy is ±5%. Electro Impulse Laboratory, Inc., 208 River St., Red Bank, N. J.

Circle 242 on Inquiry Card

MICROWAVE AMPLIFIERS

New K -band solenoid-focused traveling-wave amplifiers power output rating is 1 w min.; however, the tubes have shown test capabilities up to 6 w output in the center of the frequency band. The standard freq. range is 12 to 18 KMC with a min. small signal gain of 30 db. The small signal gain variation over the band is less than 8 db. Metal-ceramic construction is used. Encapsulated tube

weighs 1-¾ lbs. and is 1-⅛ in. in dia. and 14-¾ in. long, including input and output waveguides. Tube is designated the M2405-A. Microwave Electronics Corp., 4061 Transport St., Palo Alto, Calif.

Circle 244 on Inquiry Card

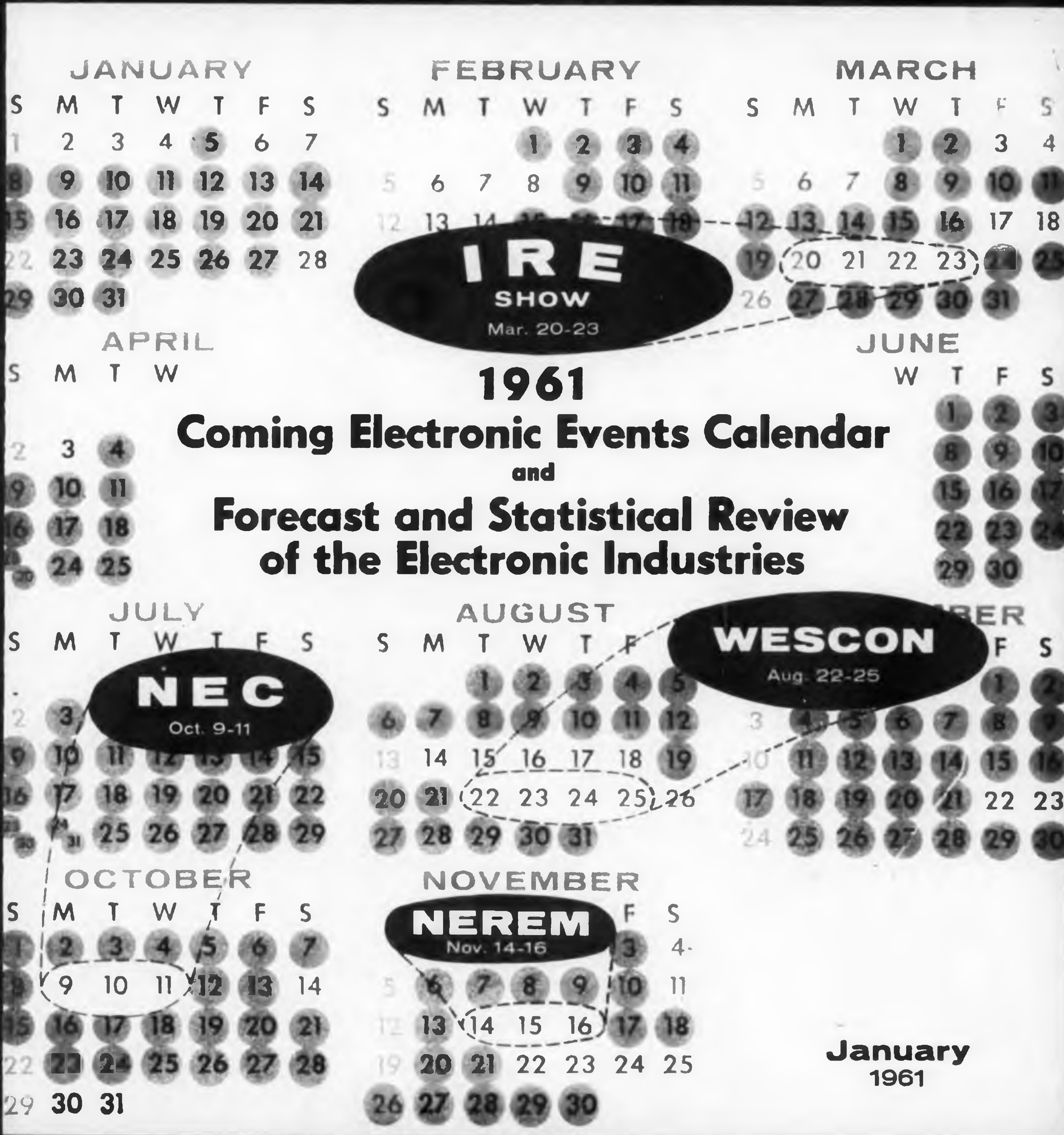
COMPUTER DELAY LINES

Modular type electromagnetic delay lines which may be gauged for printed circuit board applications. Specified as Series DL-251, units are constructed on non-nutrient, flame retarding, plastic materials. Impedances range from approx. 300 to 600 ohms with delay times of 0.1 to 0.8 μsec. Dimensionally the units are 0.625 in. wide and run from 2 to 4 in. in length. Delay time to rise time

ratios of up to 10:1 available depending upon unit impedance and size. The operating temp. range is −55°C to +105°C. IMC Magnetics Corp., Gray & Kuhn Div., 570 Main St., Westbury, L. I. N. Y.

Circle 246 on Inquiry Card

A CHILTON PUBLICATION



1961 Coming Electronic Events Calendar and Forecast and Statistical Review of the Electronic Industries

January 1961

ELECTRONIC INDUSTRIES'

1961 Coming Events Calendar

Portraying important electronic events for the year ahead

A listing of meetings, conferences, shows, etc., occurring during the year 1961 that are of special interest to electronic engineers. The events are listed chronologically and by the area— East, Midwest, and West—in which they occur. ONLY the opening day of each meeting is marked on the calendar.

JANUARY

East

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Midwest

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

EAST

Jan. 5: Annual Business Mtg., Veteran Wireless Assoc., Inc. (VWOA), 117 Liberty St., N. Y. C.

Jan. 8: 3rd Mech. Working Conf.—Bar and Shaped Products, Metallurgical Soc. of AIME, Penn-Sheraton Hotel, Pittsburgh, Pa.

Jan. 8-11: Southern Regional Mtg., Nat'l Assoc. of Electrical Distributors, Palm Beach Biltmore, Palm Beach, Fla.

Jan. 8-12: Nat'l Retail Merchants Assoc., Annual Conv., 50th Anniv. Observation, Hotel Statler, N. Y.

Jan. 9-11: 7th Nat'l Symp. on Reliability & Quality Control, IRE, ASQC, AIEE, EIA, Bellevue-Stratford Hotel, Phila., Pa.

Jan. 12-13: Conf. on Reliability of Semiconductor Devices, Dir. of Defense Res. & Eng'g (working group on Semiconductor Devices — Advisory Group on Electron Tubes), Western Union Audit., N. Y. C.

Jan. 19: Space Simulators Mtg., IES (N. Y. Metropolitan Chapter), Busto's Restaurant, N. Y. C.

Jan. 23-25: 29th Annual Mtg., IAS, Hotel Astor, N. Y. C.

Jan. 24-27: Mtg., American Mathematical Soc., Washington, D. C.

Jan. 24-27: 17th Annual Tech. Conf. & Tech. Mtg., Soc. of Plastics Engineers, Inc., Shoreham Hotel, Washington, D. C.

Jan. 29-Feb. 3: Winter Gen'l Meeting, AIEE, Hotel Statler, N. Y.

MIDWEST

Jan. 8-12: Symp. on Thermoelectric Energy Conversion, IRE, ANS, AIEE, AIME, et al, Statler Hilton Hotel, Dallas, Tex.

Jan. 13-15: Annual Conv., Nat'l Appliance-Radio TV Dealers Assoc., Palmer House, Chicago, Ill.

Jan. 17-19: Instrument-Automation Conf. & Exh., ISA, Sheraton-Jefferson Hotel & Kiel Municipal Audit., St. Louis, Mo.

Jan. 23-26: Plant Maintenance & Eng'g Show & Conf., Int'l Amphitheatre, Chicago, Ill

Jan. 23-26: 14th Annual Symp. on Modern Methods of Analytical Chemistry, Louisiana State Univ., Baton Rouge 3, La.

Jan. 30-Feb. 3: Committee Week, ASTM; Netherlands Hilton Hotel, Cincinnati, Ohio

Jan. 31-Feb. 2: Cleveland Electronics Conf., Cleveland Eng'g Soc., IRE, AIEE, ISA, Cleveland Physics Soc., Case Institute of Tech., Western Reserve Univ., Cleveland Eng' & Scientific Center, Cleveland, Ohio.

ABBREVIATIONS USED IN THIS CALENDAR

ACM—Association for Computing Machinery
ACS—American Ceramics Society
AFOSR—Air Force Office of Scientific Research
AIChE—American Institute of Chemical Engineers
AIEE—American Institute of Electrical Engineers
AIME—American Institute of Mining, Metallurgical, & Petroleum Engineers
AIP—American Institute of Physics
AMA—American Management Association
AMS—American Mathematical Society
APS—American Physical Society
ARRL—American Radio Relay League
ANS—American Nuclear Society
ARS—American Rocket Society
ASA—American Standards Association
ASM—American Society for Metals
ASME—American Society for Mechanical Engineers
ASQC—American Society for Quality Control
ASTM—American Society for Testing Materials
AWS—American Welding Society
EIA—Electronic Industries Association (formerly RETMA)
ERA—Electronic Representatives Association
IAS—Institute of Aeronautical Sciences
IES—Institute of Environmental Sciences
IRE—Institute of Radio Engineers
ISA—Instrument Society of America
NAB—National Association of Broadcasters
NARM—National Association of Relay Manufacturers
NBS—National Bureau of Standards
ONR—Office of Naval Research
SMPTE—Society of Motion Picture & TV Engineers
SPE—Society of Plastics Engineers
WEMA—Western Electronic Manufacturers Association

The smooth, easy insertion and extraction action, the self-wiping, self cleaning features and the double-sided, flexing action of both mating contact members make Micro-Ribbons the first miniature connectors to provide reduction in size with added reliability.

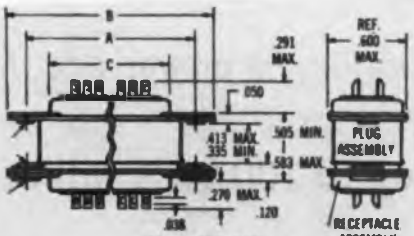
CINCH MINIATURE BLUE RIBBON CONNECTORS

Bodies are molded of an improved Diallyl-Phthalate with extremely high impact strength and excellent dielectric features. (type MDG per MIL-M-14E) Contacts are plated .0002 silver plated plus .00003 gold. Shells are brass cadmium plated plus either clear chromate or yellow chromate per QQ-P-416 Type 2 Class 2.

CABLE-TO-CHASSIS MOUNTING TYPES

The compact housings are equipped with sturdy spring type latches on the receptacles which are guided and held by cut-outs in the plug flanges.

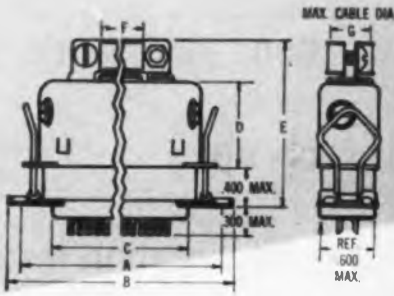
Receptacle shells have floating bushings allowing a float of .020 in each direction.



RACK & PANEL TYPE

DIMENSIONS

		14 Contacts	24 Contacts	36 Contacts	50 Contacts
BOTH TYPES	A	1.417	1.842	2.352	2.947
	B	1.750 REF.	2.175 REF.	2.685 REF.	3.280 REF.
	C	.910 REF.	1.335 REF.	1.845 REF.	2.440 REF.
CABLE TO CHASSIS TYPE ONLY	D	.843	.843	.905	1.000
	E	1.668 MAX.	1.668 MAX.	1.730 MAX.	1.825 MAX.
	F	.386 MAX.	.473 MAX.	.640 MAX.	.766 MAX.
	G	.422 MAX.	.473 MAX.	.473 MAX.	.473 MAX.

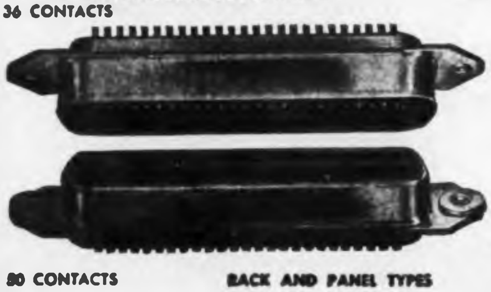


CABLE TO CHASSIS TYPE


14 CONTACTS


24 CONTACTS


36 CONTACTS


50 CONTACTS

RACK AND PANEL TYPES

Cinch ELECTRONIC COMPONENTS ®

CINCH MANUFACTURING COMPANY

1026 South Homan Ave., Chicago 24, Illinois

Division of United-Carr Fastener Corporation, Boston, Mass.

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.

RACK AND PANEL CODE NOS.

CONTACTS	PLUG	SOCKET
14	57-10140	57-20140
24	57-10240	57-20240
36	57-10360	57-20360
50	57-10500	57-20500

CABLE-TO-CHASSIS CODE NOS.

	PLUG WITH CAP	SOCKET WITH LOCK
14	57-30140	57-40140
24	57-30240	57-40240
36	57-30360	57-40360
50	57-30500	57-40500

NOTE: Above code nos. have shells cadmium plated plus clear chromate. For cadmium plus yellow chromate Add -1 to the nos. shown.

ELECTRONIC DOT ASSEMBLIES

✱ Manufactured by agreement with Amphenol-Borg Electronics Corporation

FEBRUARY

East

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

Midwest

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

West

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

EAST

Feb. 1-4: Meeting, American Physical Soc., N. Y. C.

Feb. 1-4: Annual Meeting, American Inst. of Physics, Hotel New Yorker, New York, N. Y.

Feb. 15-17: Int'l Solid State Circuits Conf., IRE, AIEE, Univ. of Penna., Univ. of Penna. and Sheraton Hotel, Phila., Pa.

Feb. 16: Mechanical Impedance Testing Mtg., IES (N. Y. Metro. Chpt), Busto's Restaurant, New York, N. Y.

Feb. 22: American Mathematical Soc. Mtg., Yeshiva Univ., New York, N. Y.

Feb. 25: Annual Dinner Cruise, Veteran Wireless Operator's Assoc., Inc.; Edison Hotel, New York, N. Y.

Feb. 26-28: NAMM Southeast Regional Conf., Nat'l Assoc. of Music Merchants, Inc., Hotel Denkler Plaza, Atlanta, Ga.

MIDWEST

Feb. 1-2: 7th Annual Midwest Welding Conf., Ill. Inst. of Tech., Technology Center, Chicago, Ill.

WEST

Feb. 1-3: 1961 Winter MIL-E-CON—Military Electronics Conv., IRE, PGME (Los Angeles Sect.), Biltmore Hotel, Los Angeles, Calif.

Feb. 1-3: Solid Propellant Rocket Conf. ARS, The Hotel Utah, Salt Lake City, Utah

Feb. 1-4: 2nd Annual Conv. ERA, Ambassador Hotel, Los Angeles, Calif.

Feb. 9-11: Winter Mtg., Nat'l Soc. of Prof. Engrs., Hotel Hilton, Denver, Colo.

Feb. 22: Reliability Symp., ASQC (Los Angeles Sect.), Univ. of Calif. & Statler Hotel, Los Angeles, Calif.

Feb. 22-24: Pacific Coast Show, Material Handling Inst., Cow Palace, San Francisco, Calif.

Feb. 26-Mar. 1: Pacific Electronic Trade Show, Western Distributor Segment of the Industry, Great Western Exh. Ctr., Los Angeles, Calif.

MARCH

East

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Midwest

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

West

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

EAST

Mar. 8: Data Processing Show & Conf., American Management Assoc., Statler Hilton Hotel, New York, N. Y.

Mar. 8-10: 11th Annual Conf. on Instrumentation for the Iron & Steel Industry, ISA, Roosevelt Hotel, Pittsburgh, Pa.

Mar. 9-10: Symp. on Eng. Aspects of Magnetohydrodynamics, IRE (PGNS), AIEE, IAS, Univ. of Penna., Phila., Pa.

Mar. 15: Committee & Section Mts., EIA, Statler Hilton Hotel, Washington, D. C.

Mar. 16: Div. Exec. Comm. Mts., EIA, Statler Hilton Hotel, Washington, D. C.

Mar. 20-23: IRE Int'l Conv., IRE, Coliseum & Waldorf Astoria Hotel, New York, N. Y.

MIDWEST

Mar. 1: Machine Design Conf., Cleveland Eng'g Soc., Machine Des. Div., Cleveland Eng'g & Scientific Center, Cleveland, Ohio.

Mar. 1-2: Annual Tech. Symp., Soc. of Vacuum Coaters, Conrad Hilton Hotel, Chicago, Ill.

Mar. 9-10: Nat'l Flight Propulsion Mgt. (Classified), Cleveland, Ohio.

Mar. 15-16: ASTME Plastics Tooling Seminar, ASME, SPE, Statler-Hilton Hotel, Detroit, Mich.

Mar. 21-23: 23rd Annual American Power Conf., Ill. Inst. of Tech., ASME, Hotel Sherman, Chicago, Ill.

Mar. 24-25: ARRL Mich. State Conv., ARRL, Wanona Hotel, Bay City, Mich.

Mar. 27-31: 3rd Symp. on Temp.—its Measurement and Control in Science & Industry, ISA, AIP, NBS, Veterans Memorial Hall & Deshler Hilton Hotel, Columbus, Ohio.

WEST

Mar. 12-16: Aviation Conf., ASME, Statler Hilton Hotel, Los Angeles, Calif.

Mar. 13-15: Testing Conf., ARS, Biltmore Hotel, Los Angeles, Calif.

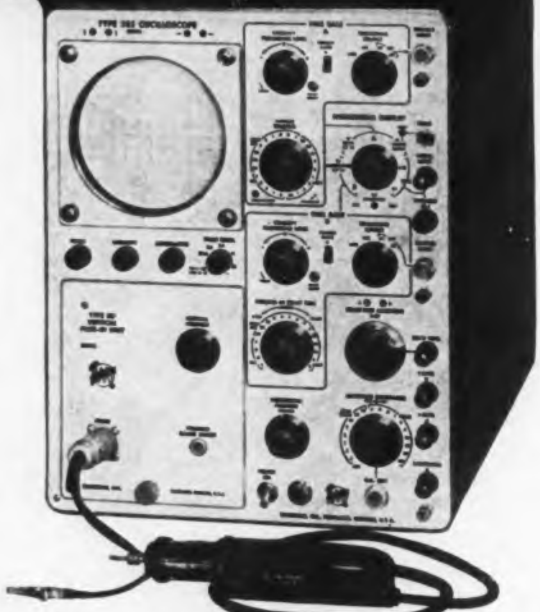
Mar. 19-21: Northwest Reg. Conf., Nat'l Assoc. of Music Merchants, Hotel Benson, Portland, Ore.

Mar. 20-24: 12th Western Metal Congress & Expos., ASM, Pan-Pacific Audit., Los Angeles, Calif.

Flexible SWEEP DELAY

DC-TO-100 MC RANGE

with the Tektronix Type 585 Oscilloscope



Highly adaptable, the Type 585 fits most precision-measurement applications in the dc-to-100 mc range —when used with a Type 80 Plug-In Unit and P80 Probe. The three-way combination features:

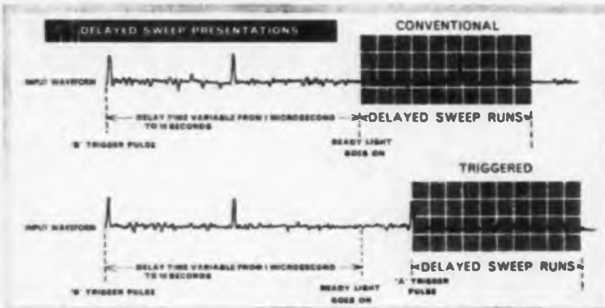
1... slow sweeps as well as fast sweeps and *versatile main sweep triggering facilities compatible with the bandwidth capabilities*—for general-purpose laboratory work;

2... 3.5 nsec risetime, 0.1 v/cm sensitivity, 10 nsec/cm sweeptime—for high-speed pulse analysis;

3... two modes of calibrated sweep delay: either Conventional (when the delayed sweep is started at the end of the delay period by the delayed trigger) or Triggered (when the delayed sweep is started after the delay period by the signal under observation)—for a wide variety of specialized applications.

For example, the delayed-sweep enables you to observe the start of the horizontal sweep from 1 microsecond to 10 seconds after receipt of a triggering signal . . . to make precise incremental measurements along a complex waveform . . . to obtain high magnification of a selected portion of an undelayed sweep—with jitter-free magnification up to 10,000 times.

Further, the exact portion of the display on the delaying sweep that will appear on the faster main sweep is positively identified by trace brightening, and the Single-Sweep feature facilitates photographic recording of most one-shot phenomena.



TYPICAL DELAYED SWEEP APPLICATIONS

- Display separate channels of a PTM system, with effects of time jitter removed, determining pulse amplitude and shape under conditions of modulation.
- Measure pulse-to-pulse intervals and amount of jitter on computer signals or any train of pulses.
- Determine accurate time-difference measurements between pulse-in and pulse-out through an amplifying system.
- Select any individual line of a television composite signal.
- Show time displacement, wave shape, and amplitude of individual channels in a telemetering system.

TEKTRONIX PLUG-IN FEATURE
further enhances the versatility of the oscilloscope

Designed for interchangeable preamplifiers, the Type 585 will also accept the present 16 "letter-series" plug-in units without loss of bandwidth or basic sensitivity of the plug-in —*when used with the Type 81 Adapter.*

TYPE 585, without plug-in unit	$1675
Type 80 Plug-In Preamplifier	50
P80 Probe	100
Type 81 Plug-In Adapter	125

Prices f.o.b. factory

Note: Both the Type 80 Plug-In Preamplifier and P80 Probe are necessary for dc-to-100 mc operation. The Adapter allows insertion of Tektronix "letter-series" plug-in units.

Tektronix, Inc.

P. O. Box 500 • Beaverton, Oregon
Phone Mitchell 4-0161 • TWX—BEAV 311 • Cable: TEKTRONIX

Call your Field Engineer for a demonstration of the versatile Type 585 in your own delayed-sweep application.

TEKTRONIX FIELD OFFICES: Albuquerque, N. Mex. • Atlanta, Ga. • Baltimore (Towson, Md.) • Boston (Lexington, Mass.) • Buffalo, N.Y. • Chicago (Park Ridge, Ill.) • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio • Denver, Colo. • Detroit (Lathrup Village, Mich.) • Endicott (Endwell, N.Y.) • Greensboro, N.C. • Houston, Texas • Indianapolis, Ind. • Kansas City (Mission, Kan.) • Los Angeles Area (East Los Angeles, Calif., [illegible] • [illegible]) • Minneapolis, Minn. • New York City Area (Albertson, L.I., N.Y. • Stamford, Conn. • Union, N.J.) • Orlando, Fla. • Philadelphia, Pa. • Phoenix (Scottsdale, Ariz.) • [illegible], N.Y. • San Diego [illegible] • San Francisco (Palo Alto, Calif.) • St. Petersburg, Fla. • Syracuse, N.Y. • Toronto (Willowdale, Ont.), Canada • Washington, D.C. (Annandale, Va.).

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations.

In Europe please write Tektronix Inc., Victoria Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country.

APRIL

East

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
	10	11	12	13	14	15
16	17	18	19	20	21	22
23/30	24	25	26	27	28	29

Midwest

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23/30	24	25	26	27	28	29

Midwest

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23/30	24	25	26	27	28	29

EAST

Apr. 4-6: Int'l Symp. on Electromagnetics & Fluid Dynamics of Gaseous Plasma, Polytechnic Inst. of Bklyn, Auditorium of Eng'g Soc. Bldg., 33 W. 39th St., New York, N. Y.

Apr. 5-7: Annual Conv., Inst. of Environmental Sciences, Hotel Sheraton-Park, Washington, D. C.

Apr. 5-7: Symp. on Materials & Electron Device Processing, ASTM Committee F-1 on Materials for Electron Tubes & Semiconductor Devices, Franklin Inst., Phila., Pa.

Apr. 6-7: Management Eng'g Conf., ASME, SAM, Statler Hilton Hotel, New York, N. Y.

Apr. 8-9: ARRL Southeastern Div. Conv., American Radio Relay League, Cherry Plaza Hotel, Orlando, Fla.

Apr. 10-12: 44th Nat'l Open Hearth Steel Conf. & Blast Furnace, Coke Oven, and Raw Material Conf., AIME, Sheraton Hotel, Phila., Pa.

Apr. 10-19: Annual Assembly of Int'l Inst. of Welding, AWS, Sheraton-Atlantic Hotel, New York, N. Y.

Apr. 11-13: Conf. on Ultra-purification of Semiconductor Materials, AFRD, ARGDC, USAF, New England Mutual Hall, Boston, Mass.

Apr. 12-14: Int'l Symp. on Agglomeration, AIME, Sheraton Hotel, Phila., Pa.

Apr. 17-21: Annual Mtg. & Welding Expos., AWS, Hotel Commodore & Coliseum, New York, N. Y.

Apr. 17-21: The Business Equip. Expos., Office Equip. Mfrs., New York Coliseum, New York, N. Y.

Apr. 23-26: Metals Eng'g Conf., ASME, Penn Sheraton Hotel, Pittsburgh, Pa.

Apr. 23-27: Annual Mtg., Scientic Apparatus Makers Assoc., The Greenbrier, White Sulphur Sprgs., W. Va.

Apr. 24-27: Mtg., American Physical Soc., Washington, D. C.

Apr. 26-28: Detonation & Deflagration Phenomena Conf., ARS, Palm Beach Biltmore, Palm Beach, Fla.

MIDWEST

Apr. 4-6: 10th Annual Mtg. & Conf., Nat'l Microfilm Assoc., Sherman Hotel, Chicago, Ill.

Apr. 5-7: SE District Mtg., AIEE, Jung Hotel, New Orleans, La.

Apr. 7-9: ARRL Delta Div. Conv., ARRL, Read House, Chattanooga, Tenn.

Apr. 11-13: 33rd Annual Conv., Petroleum Elec. Supply Assoc. & Petroleum Industrial Elec. Assoc., Moody Center, Galveston, Tex.

Apr. 12-14: Symp. on Information & Decision Processes, Purdue Univ., Lafayette, Ind.

Apr. 16-18: NAMM Southwest Reg. Conf., Nat'l Assoc. of Music Merchants, Inc., Shamrock-Hilton Hotel, Houston, Tex.

Apr. 17-19: 7th Nat'l ISA Symp. on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, Tex.

Apr. 19-21: Great Lakes District Mtg., AIEE, Minneapolis, Minn.

Apr. 19-21: SWIRECO—S.W. IRE Reg. Conf. & Elec. Show, IRE (Region 6), Dallas, Tex.

Apr. 25-27: 9th Nat'l Conf. on Electromagnetic Relays, NARL, Student Union Bldg., Oklahoma State Univ., Stillwater, Okla.

Apr. 26-27: Tech. Conf. on High-temp Materials, AIME, Carter Hotel, Cleveland, Ohio

Apr. 29-May 3: 53rd Annual Conf., Nat'l Assoc. of Electrical Distributors, Cobo Hall, Detroit, Mich.

Apr. 30-May 4: Spring Mtg., Electrochemical Soc., Inc., Claypool Hotel, Indianapolis, Ind.

Apr. 30-May 4: 7th Nat'l Aero-Space Instrumentation Symp., ISA, Adolphus Hotel, Dallas Tex.

WEST

Apr. 5-7: Lifting Reentry Vehicles, Structure, Materials & Design Conf., ARS, El Mirador Hotel, Palm Sprgs., Calif.

Apr. 5-7: Mtg., Radio Tech. Comm. for Marine Services, Sheraton-Palace Hotel, San Francisco, Calif.

Apr. 13-14: 8th Annual STWP Conv., Soc. of Tech. Writers & Publishers, Mark Hopkins Hotel, San Francisco, Calif.

Apr., 18-20: Symp. on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Res. Inst., San Francisco, Calif.

Apr. 22: Mtg., American Mathematical Soc., Stanford, Calif.

Apr. 26-28: 7th Region Tech. Conf. & Trade Show, IRE (Region 7), Westward Ho Hotel, Phoenix, Ariz.

MAY

East

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

EAST

May 4-7: Conv., American Women in Radio & Television, Inc.; Statler Hilton Hotel, Washington, D. C.

May 7-11: 39th Annual Conv. & Broadcast Eng'g Conf., NAB; Shoreham & Sheraton Park Hotels, Washington, D. C.

May 9-11: Eastern States Show, Material Handling Inst.; Convention Hall, Phila., Pa.

May 9-11: Power Sources Symp., U. S. Army (Sig. R&D Labs), Shelburne Hotel, Atlantic City, N. J.

May 11-13: Meeting, American Radium Soc., Colorado Springs, Colo.

May 15-17: Microwave Theory & Tech. Nat'l Symp., IRE (PGMTT), Sheraton Park Hotel, Washington, D. C.

May 17-19: North Eastern District Mtg., AIEE, Statler Hotel, Hartford, Conn.

May 18: Tour of Environmental Facilities, IES (N. Y. Metro Chptr), Bklyn Navy Yard, Bklyn, N. Y.

May 22-26: Annual Conf., Soc. Photo. Scientists & Engrs, Arlington Hotel, Binghamton, N. Y.

May 23-25: Symp. on large Capacity Memory Techniques for Computing Systems, ONR (Information Systems Br), Dept. of Interior Auditorium, Washington, D. C.

May 31-June 2: Freq. Control Symp., U. S. Army (Sig. R&D Labs), Shelburne Hotel, Atlantic City, N. J.

GET A-HEAD

think small...

At Burnell & Co., our engineers devote a big part of their thinking to shrinking—reducing the size (and cost) of components to the least common denominator consistent with high performance standards. From this staff have come such components as:

The Kernel ATE Adjustoroid®—This variable toroid contains an actual complete toroid with all the excellent characteristics of the non-adjustable type. Valuable in oscillators, discriminators, variable tuned circuits, etc.

MLP and MHP MICROID® Filters—Microminature counterparts of the popular Burnell TCL and TCH low pass and high pass filters, they range from .5 kc to 100 kc with a standard impedance of 10k ohms. Cascading the MLP with the MHP produces excellent response band pass characteristics.

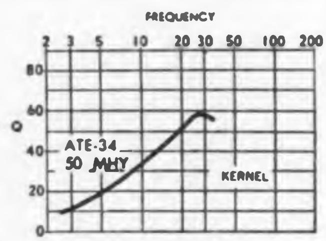
"Cheerio" Toroids — Subminiature high Q coils in a range of frequencies that make them ideal for transistorized equipment.

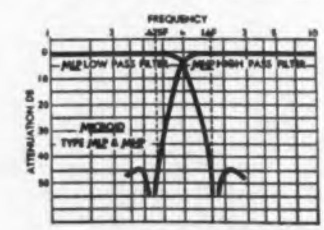
Crystal Filters—Advanced engineering techniques enable Burnell to offer at nominal cost, high selectivity, high attenuation crystal filters covering the extraordinary range of 1 kc to 30 mcs with considerable latitude in impedance.

Pulse networks, interference filters, active networks and magnetic amplifiers are among the newer additions to our product line.

Write for latest catalog.

Burnell & Co., Inc., has a number of positions available for engineers capable of thinking big and shrinking small. Inquiries are invited.





If you haven't already done so—send for your free membership in the Space Shrinkers Club.

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
DEPT. I-30
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TELETYPE PELHAM 3633

PACIFIC DIVISION
DEPT. I-30
720 MISSION ST.
SOUTH PASADENA, CALIF.
MURRAY 2-2841
TELETYPE PASACAL 7578

Mfd. in Canada by Edo (Canada) Ltd., Cornwall, Ont. • WEllington 2-6774

MAY *(Continued)*

Midwest

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	**8**	9	**10**	11	**12**	13
14	15	16	17	18	19	20
21	**22**	23	**24**	25	26	27
28	29	30	31			

May 7-8: 5th Midwest Symp on Circuit Theory, IRE (PGCT), Allerton Park & Urbana Campus of Univ. of Ill., Urbana, Ill.

May 7-11: 42nd Int'l Conf. & Office Expos., Nat'l Office Management Assoc, Sheraton-Jefferson Hotel & Kiel Auditorium, St. Louis, Mo.

May 8-10: 4th Nat'l ISA Power Instrumentation Symp., LaSalle Hotel, Chicago, Ill.

May 8-10: Nat'l Aeronautical Electronics Conf., IRE (PGANE) Dayton Sect., Miami & Dayton Biltmore Hotels, Dayton, Ohio

May 10-12: Pulp & Paper Instrumentation Symp., ISA, Northland Hotel, Green Bay, Wis.

May 12: Meeting (Exec. Comm. & Nat'l Board of Governors), ERA, Hilton Hotel, Chicago, Ill.

May 22-24: Electronic Parts Distributors Show, Electronic Industry Show Corp., Conrad Hilton Hotel, Chicago, Ill.

May 22-24: 5th Nat'l Symp. on Global Communications (GLOBECOM V), IRE (PGCS), AIEE, Sherman Hotel, Chicago, Ill.

May 22-24: Nat'l Telemetering Conf., IAS, IRE, AIEE, ARS, ISA, Sheraton-Towers Hotel, Chicago, Ill.

May 22-25: Design Eng'g Show & Conf., ASME, Cobo Hall, Detroit, Mich.

May 24-26: 37th Annual Conf., EIA, Pick-Congress Hotel, Chicago, Ill.

West

S	M	T	W	T	F	S
	1	**2**	3	4	5	**6**
7	8	**9**	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	**26**	27
28	29	30	31			

May 2-4: Electronic Components Conf., IRE (PGCP), AIEE, EIA, WEMA, Jack Tar Hotel, San Francisco, Calif.

May 6-10: Mtg., The Electrochemical Soc., Inc., Statler Hotel, Los Angeles, Calif.

May 9-11: Western Joint Computer Conf., IRE (PGEC), AIEE, ACM, Ambassador Hotel, Los Angeles, Calif.

May 26-29: Southwestern Div. Conf., The American Radio Relay League, Westward Ho Hotel, Phoenix, Ariz.

JUNE

East

S	M	T	W	T	F	S
				1	2	3
4	**5**	6	7	**8**	9	10
11	**12**	13	14	15	16	17
18	19	20	21	22	23	24
25	**26**	27	28	29	30	

West

S	M	T	W	T	F	S
				1	2	3
4	5	6	**7**	8	9	**10**
11	**12**	13	14	15	16	17
18	19	**20**	21	22	23	24
25	26	27	**28**	29	30	

EAST

June 1: Meeting, Bus. Management Inst. (Eastern Sect), American Univ., Washington, D. C.

June 4-8: Nat'l Mtg., American Nuclear Society, Pittsburgh, Pa.

June 5-6: 5th Nat'l Conf. on Product Eng'g & Production, IRE (PGPEP), Phila., Pa.

June 8-10: Annual Mtg., Gen'l Business, Mfg Chemists' Assoc., Inc., Greenbrier, White Sulphur Sprgs., W. Va.

June 12: Air Pollution Instrumentation Symp., ISA, APCA, Hotel Commodore, New York, N. Y.

June 12-16: 9th Annual Tech. Writers' Inst., Rensselaer Polytechnic Inst., Troy, N. Y.

June 18-23: 48th Annual Conv., American Electroplaters Soc., Statler Hilton Hotel, Boston, Mass.

June 18-23: Summer Gen'l Mtg., AIEE, Statler Hall, Ithaca, N. Y.

June 26-28: 5th Nat'l Conv. on Military Electronics, IRE (PGME), Shoreham Hotel, Washington, D. C.

Midwest

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	**13**	**14**	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

MIDWEST

June 13-16: 3rd Biennial Int'l Gas Chromatography Symp., Mich. State Univ., Kellogg Center, E. Lansing, Mich.

June 14-16: Meeting, ASME Applied Mechanics Div., Illinois Inst. of Tech., Technology Center, Chicago, Ill.

WEST

June 7-9: Semi-Annual Mtg., ARS, Statler-Hilton Hotel, Los Angeles, Calif.

June 10-17: Conv., American Soc. of Medical Technologists, Olympic Hotel, Seattle, Wash.

June 11-14: 28th Annual Conv., Electrical Apparatus Serv. Assoc. (formerly Nat'l Industrial Serv. Assoc.), Jack Tar Hotel, San Francisco, Calif.

June 11-15: Annual Summer Mtg., ASME, Statler Hilton Hotel, Los Angeles, Calif.

June 12-15: Int'l Conf. on the Physics of Electronic & Atomic Collisions, AFOSR/SRYP, Univ. of Colo., Univ. of Colo., Boulder, Colo.

June 20-23: 10th Annual Conv. & Trade Show, Nat'l Community TV Assoc., Inc., Jack Tar Hotel, San Francisco, Calif.

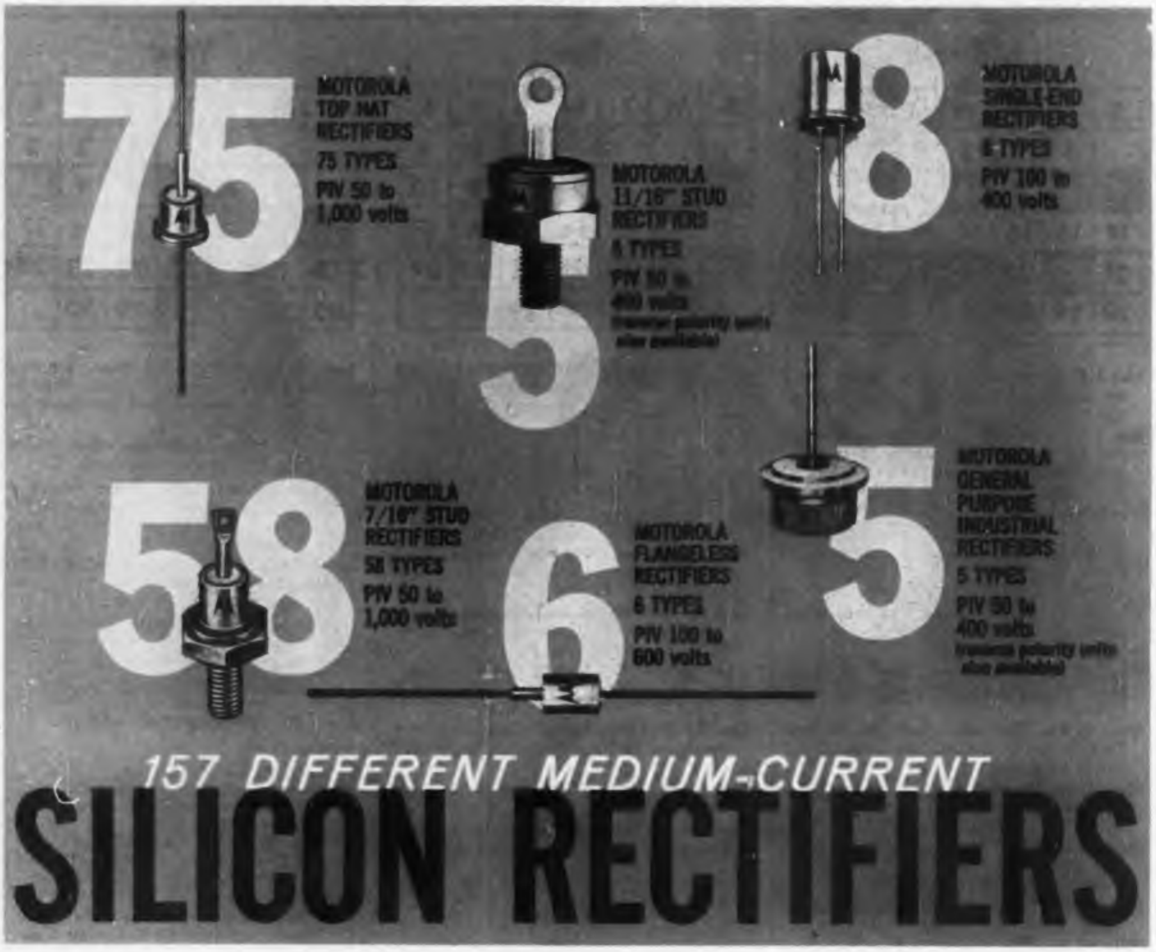
June 28-30: Joint Automatic Control Conf., IRE, AIEE, ASME, ISA, AIChe Univ. of Colorado, Boulder, Colo.

IRE PROFESSIONAL GROUPS

PGA—Audio
PGB—Broadcast
PGAP—Antennas & Propagation
PGCT—Circuit Theory
PGNS—Nuclear Science
PGVC—Vehicular Communications
PGRQC—Reliability & Quality Control
PGBTR—Broadcast & TV Receivers
PGI—Instrumentation
PGTRC—Space Electronics & Telemetry (Formerly Telemetry & Remote Control)
PGANE—Aeronautical & Navigational Electronics
PGIT—Information Theory
PGEM—Engineering Management
PGIE—Industrial Electronics
PGED—Electron Devices
PGEC—Electronic Computers
PGMTT—Microwave Theory & Techniques
PGME—Medical Electronics
PGCS—Communications Systems
PGUE—Ultrasonics Engineering
PGCP—Component Parts
PGPT—Production Techniques
PGAC—Automatic Control
PGME—Military Electronics
PGE—Education
PGEWS—Engineering Writing & Speech
PGHF—Human Factors in Electronics
PGRFI—Radio Frequency Interference

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

now available from MOTOROLA



- Peak surge currents up to 250 amps
- Conservative ratings assure extra margin of safety
- Variety of hermetically-sealed package styles
- Military types available

Motorola now offers an extensive line of medium-current diffused-junction silicon rectifiers which exhibit the same high-quality performance that has made Motorola zener diodes a standard for the industry. In order to insure this same standard in its silicon rectifiers, Motorola has established comprehensive quality assurance programs to guarantee stable operation and continued reliability for each Motorola rectifier – even under rugged military-type environmental conditions. With reliability as the primary goal, these rectifiers incorporate the same advanced silicon processing techniques which have made possible so many new silicon diode developments at Motorola.

For your copy of the new Motorola silicon rectifier catalog, write for Data Sheet #DS 1002-1. Please address inquiries to MOTOROLA SEMICONDUCTOR PRODUCTS INC., Technical Information Department, 5005 E. McDowell Road, Phoenix, Arizona.

MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA, INC.

5005 EAST McDOWELL ROAD • PHOENIX, ARIZONA

JULY

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23 30	24 31	25	26	27	28	29

EAST

July 16-22: 4th Int'l Conf. on Medical Electronics & 14th Conf. on Elect. Tech. in Medicine & Biology, IRE (PGME), IFME, JECMB, Waldorf Astoria Hotel, New York, N. Y.

MIDWEST

July 16-20: Nat'l: Music Industry Conv. & Trade Show, Nat'l Assoc. of Music Merchants, Inc., Palmer House, Chicago, Ill.

July 22-25: Mtg. Conv. & Exh., Nat'l Audio-Visual Assoc., Morrison Hotel, Chicago, Ill.

WEST

July 3-8: Annual Mtg., Nat'l Soc. of Prof. Engrs., Olympic Hotel, Seattle, Wash.

July 10-14: 4th Annual Inst., in Tech. & Industrial Communications, Colorado State Univ. Campus, Ft. Collins, Colo.

July 31-Aug. 4: Differential Equations in Non-Linear Mechanics, AFOSR/Aeronautical Sciences Directorate & RIAS, Air Force Academy, Colo.

AUGUST

East

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Midwest

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

West

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

EAST

Aug. 21-23: Int'l Hypersonics Conf., ARS, Mass. Inst. of Tech., Cambridge, Mass.

Aug. 21-24: Photo Conductivity Conf., Cornell Univ. Committee on Conf., Willard Straight Hall, Ithaca, N. Y.

Aug. 27-30: Eastern Region Mtg., Nat'l Assoc. of Electrical Distributors, Saranac Inn, Saranac, N. Y.

MIDWEST

Aug. 23-25: Biennial Gas Dynamics Symp., ARS, Northwestern Univ., Evanston, Ill.

Aug. 27-Sept. 1: 6th Int'l Conf. of Coordination Chemistry, AFOSR/Chemical Sciences Directorate & American Chemical Soc. (Inorganic Chemistry Sect.), Wayne State Univ., Detroit, Mich.

WEST

Aug. 19-24: Naval Aviation Mtg., IAS, Navy, San Diego, Calif.

Aug. 22-25: WESCON, Western Electronic Show & Conv., WEMA, IRE (L. A. & S. F. Sect.), San Francisco, Calif.

Aug. 23-25: Pacific General Mtg., AIEE, Salt Lake City, Utah.

Aug. 28-Sept. 1: Int'l Heat Transfer Conf., IAS, Boulder, Colo.

SEPTEMBER

East

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Midwest & West

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

EAST

Sept. 6-8: Annual Mtg. (Joint), Assoc. of the U. S. Army, Army Aviation Assoc. of America, Sheraton-Park Hotel, Washington, D. C.

Sept. 6-8: Int'l Symp. on Transmission & Processing of Information, IRE (PGIT), Mass. Inst. of Tech., Cambridge, Mass.

Sept. 6-8: Joint Nuclear Instrumentation Symp., ISA, AIEE, IRE, North Carolina State College, Raleigh, N. C.

Sept. 14-15: Eng'g Management Conf., ASME, Roosevelt Hotel, New York, N. Y.

Sept. 15-17: ARRL N. Y. State Conv., ARRL, Hotel Niagara, Niagara Falls, N. Y.

Sept. 20-21: Industrial Electronics Symp., IRE (PGIE), AIEE, Boston, Mass.

Sept. 27-30: Materials & Equip.—White Wares Divs., ACS, Bedford Springs Hotel, Bedford, Pa.

MIDWEST

Sept. 13-15: Annual Mtg., Human Factors Soc., Ohio State Univ., Battelle Memorial Inst., North American Aviation, Inc., Ohio State Univ., Columbus, Ohio

Sept. 25-28: Nat'l Fall Meeting, American Welding Soc., Hotel Adolphus, Dallas, Tex.

WEST

Sept. 6-8: Annual Mtg., ACM, Statler Hilton Hotel, Los Angeles, Calif.

Sept. 6-8: Nat'l Symp. on Space Electronics & Telemetry, IRE (PGSET), Albuquerque, N. M.

Sept. 11-15: Fall Instrument-Automation Conf. & Exh., & 16th Annual Mtg., ISA, Sports Arena, Los Angeles, Calif.

Sept. 16-20: Western Region Conv., Nat'l Assoc. of Electrical Distributors, Jack Tar Hotel, San Francisco, Calif.

You can place the utmost confidence in Dale precision resistors even when today's new and unprecedented standards of "missile reliability" are the goals towards which you are designing.

Under any and all conditions, Dale resistors retain their stability because it has been "firmly infixed" by Dale design and methods of manufacture . . . methods which have now reached new levels of achievement as part of Dale's super-high reliability development program.

SPECIAL PROBLEMS? Let us help you with your requirements for special resistance products. We make modifications of standard products, resistor networks, matched pairs, etc. Send us your specs.

PROMPT DELIVERY. Whether your need is for a short "test run" or a large production release, Dale offers prompt service, direct from the factory and through a widespread network of distributors.

Write for Bulletins R-23, R-25 and R-30 with handy cross-reference file cards

Hathaway Instruments Inc.

DALE ELECTRONICS, INC.

1304 28th Ave., Columbus, Nebraska, U.S.A.

A subsidiary of HATHAWAY INSTRUMENTS, INC.

DALE TYPE RS RESISTORS

WIRE WOUND • PRECISION • POWER

Designed for advanced electronic circuits where space is at a premium. Three configurations: Type RS with axial leads and in most ratings and resistances shown; Type RLS with radial leads; Type RSE for clip mounting.

- Rated at ½, 1, 2, 2½, 3, 5, 7, 10 watts
- Resistance range from .05 ohm to 175K ohms, depending on type
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%
- Temperature coefficient within 0.00002/degree C.
- Operating temperature range from —55° C. to 275° C.
- Smallest in size, ranging from 5/64" by 5/16" to 3/8" by 1-25/32". Ten choices
- Completely protected, impervious to moisture and salt spray
- Complete welded construction from terminal to terminal
- Silicone sealed, offering high dielectric strength and maximum resistance to abrasion
- Meet functional requirements of MIL-R-26C

OCTOBER

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

EAST

Oct. 2-4: 7th Nat'l Communications Symp., IRE (PGCS), Utica, N. Y.
Oct. 2-6: 90th Semiannual Conv., Soc. of Motion Picture & TV Engrs, Lake Placid Club, Lake Placid, N. Y.
Oct. 5-7: Meeting, Refractories Div., ACS, Bedford, Pa.
Oct. 9-10: Meeting, Basic Science Div., ACS Soc., Hotel Van Curler, Schenectady, N. Y.
Oct. 9-11: Nat'l Fall Conf. & Expos., Nat'l Office Management Assoc., Bellevue-Stratford Hotel, Phila., Pa.
Oct. 9-13: ARS Space Flight Report to the Nation, ARS, Coliseum, New York, N. Y.
Oct. 11-13: Meeting, Glass Div., ACS, Bedford Springs Hotel, Bedford, Pa.
Oct. 18-21: Meeting, Structural Clay Prod. Div., ACS, Mellon Inst. & Webster Park Hotel, Pittsburgh, Pa.
Oct. 19-21: Fall Mtg., Nat'l Soc. of Prof. Engrs., Roanoke Hotel, Roanoke, Va.
Oct. 23-25: East Coast Conf. on Aero & Navigational Electronics, IRE (PGANE), Lord Baltimore Hotel, Baltimore, Md.
Oct. 30-Nov. 1: Radio Fall Mtg., EIA, IRE, Hotel Syracuse, Syracuse, N. Y.

MIDWEST

Oct. 1-5: Mtg., The Electrochemical Soc., Inc., Statler Hotel, Detroit, Mich.
Oct. 8-10: Meeting, Int'l Municipal Signal Assoc., Netherland Hilton Hotel, Cincinnati, Ohio
Oct. 9-11: Nat'l Electronics Conf. (NEC), IRE, AIEE, EIA, SMPTE, Chicago, Ill.
Oct. 10-12: 12th Nat'l Conf. on Standards, ASA, Rice Hotel, Houston, Tex.
Oct. 15-20: Fall General Mtg., AIEE, Detroit, Mich.
Oct. 23-26: Fall Mtg., The Metallurgical Soc. of AIME, Pick-Fort Shelby Hotel, Detroit, Mich.
Oct. 23-27: Detroit Metal Show (43rd Nat'l Metal Congress & Expos.), ASM, Cobo Hall, Detroit, Mich.
Oct. 24-26: 1961 Mich. Industrial Electronics Expos., Electronic Representatives, Inc., Detroit Artillery Armory, Detroit, Mich.

WEST

Oct. 25-28: Mtg., Electronics Div., ACS, Jack Tar Hotel, San Francisco, Calif.

NOVEMBER

East

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Midwest

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

EAST

Nov. 14-16: Northeast Res. & Eng. Mtg. (NEREM), IRE (Region 1), Boston, Mass.
Nov. 20-21: 1961 Electron Devices Mtg., IRE PGED), Shoreham Hotel, Washington, D. C.
Nov. 26-Dec. 1: Winter Annual Mtg., ASME, Statler Hilton Hotel, New York, N. Y.
Nov. 27-Dec. 1: 28th Expos. of the Chemical Industries, Coliseum, New York, N. Y.
Nov. 30-Dec. 2: Conf.—Tech. Progress in Communication — Wire & Cables Symp., U. S. Army (Sig. R&D Labs), Berkeley-Carteret Hotel, Asbury Park, N. J.

MIDWEST

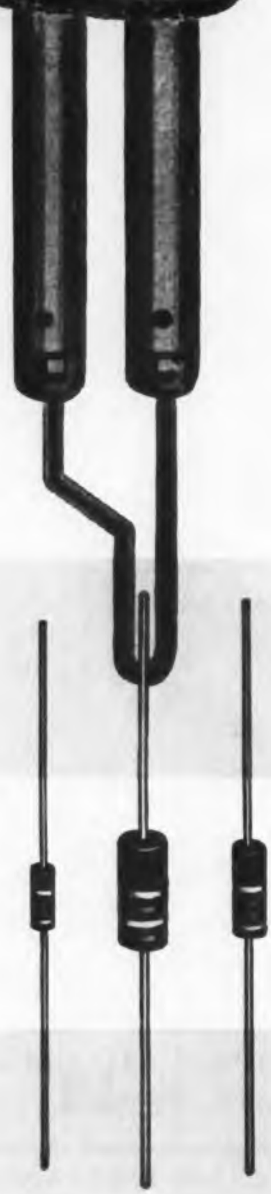
Nov. 6-9: Atom Fair, Atomic Industrial Forum, ANS, Conrad Hilton Hotel, Chicago, Ill.
Nov. 7-10: Packaging Machinery Mfgs. Inst. Show of 1961, Cobo Hall, Detroit, Mich.
Nov. 7-10: Winter Mtg., American Nuclear Soc., Chicago, Ill.
Nov. 14-16: MAECON (Mid-America Elec. Conf.), IRE (Kansas City Sect.), Kansas City, Mo.
Nov. 17-18: Meeting, American Mathematical Soc., Milwaukee, Wis.
Nov. 30-Dec. 1: Conf., Prof. Group on Vehicular Communications, IRE, Hotel Leamington, Minneapolis, Minn.

Check ELECTRONIC INDUSTRIES' monthly Coming Events Page for announcements of new events or changes in date or location of previously announced events.

Highlights of 1962

Feb. 13-15: Tutorial Inst. in Industrial Writing Improvement, American Industrial Writing Inst.; Hotel Statler-Hilton, Los Angeles, Calif.
Mar. 26-29: IRE International Convention; Coliseum & Waldorf-Astoria Hotel, New York, N. Y.
Apr. 18-20: 5th Annual Industrial Mutual Aid & Disaster Control Seminar, Nat'l Inst. for Disaster Mobilization; Shamrock-Hilton Hotel, Houston, Tex.
Apr. 20-22: 76th Annual Conv., Illinois Soc. of Professional Engrs.; Peoria, Ill.
April 30-May 9: Hanover Int'l Fair; Hanover, West Germany.
May 8-10: Electronic Components Conf., IRE, AIEE, EIA, WEMA; Washington, D. C.
May 14-16: NAECON, IRE; Dayton, Ohio.
May 23-25: National Telemetering Conf., IRE, AIEE, IAS, ARS, ISA; Sheraton Park Hotel, Washington, D. C.
June 27-29: Conf. on Standards & Electronic Measurements, IRE, NBS, AIEE; NBS Boulder Labs, Boulder, Colo.
Aug. 21-24: WESCON, IRE, WEMA; Los Angeles, Calif.
Sept. 8-10: Chicago High Fidelity & Home Entertainment Show; Palmer House, Chicago, Ill.
Oct. 1-3: 8th National Communications Symp., IRE; Utica, N. Y.
Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Chicago, Ill.
Oct. 18-19: Electron Devices Meeting. IRE; Shoreham Hotel, Washington, D. C.
Nov. 13-15: NEREM, Northeast Res. & Eng. Mtg., IRE; Boston, Mass.
Dec. 4-7: Eastern Joint Computer Conf., IRE, AIEE, ACM; Bellevue-Stratford Hotel, Phila., Penna.

Immediate Local Deliveries
for small runs, production emergencies or design needs . . . from over 30 strategically located parts distributors . . . At factory prices in lots up to 1000 of a value.



Would you buy fixed resistors just because they're the **easiest to solder?**

Of course you wouldn't!

But when you add the highest degree of "solderability" of any resistors on the market to top-notch reliability in other physical and electrical characteristics — well, that's something else. Like a lot of other cost-conscious producers, you'll then be using Stackpole Coldite 70+ Resistors!

Stackpole Coldite 70+ "solderability" saves time and money in your production. It assures perfect connections that eliminate a lot of possibilities for costly field service later on.

Coldite 70+ performance fully matches the "solderability" of the leads. They're designed to meet or excel MIL-R-11 in every respect. And they're tops in load life, humidity and moisture tests!

Electronic Components Div.—**STACKPOLE CARBON CO.,** St. Marys, Pa.

STACKPOLE
Coldite 70+®
fixed composition resistors

CERAMAG® FERRITE CORES • VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • ELECTRICAL CONTACTS GRAPHITE BEARINGS, SEAL RINGS, ANODES • HUNDREDS OF RELATED CARBON & GRAPHITE PRODUCTS.

DECEMBER

East

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24/31	25	26	27	28	29	30

EAST

Dec. 3-7: Eastern Joint Computer Conf., IRE (PGEC), AIEE, ACM, Sheraton-Park Hotel, Washington, D. C.

Dec. 6-8: 65th Annual Congress of American Industry, NAM, Waldorf Astoria, New York, N. Y.

Dec. 6-8: 19th Electric Furnace Conf. AIME, Penn-Sheraton Hotel, Pittsburgh, Pa

Dec. 18: Wright Bros. Lecture, IAS, Washington, D. C.

Foreign Events

Jan. 8-11: 59th Annual Conv., The Canadian Ceramic Soc., Chantecler Hotel, Ste. Adele, Quebec, Canada

Jan. 16-21: 45th Physical Soc. Exh. of Scientific Instruments & Apparatus, The Physical Soc., Royal Horticultural Soc. Halls, Westminster, London, S.W 1, England

Feb. 17-21: 4th Int'l Exh. of Electronic Components (Components. Valves, Semiconductors, Electronic Accessories), Parc des Expositions, Porte de Versailles, France

Feb. 20-25: Int'l Conv. on Semiconductor Devices. French Radio-Engrs. Assoc., French Nat'l Electronic Industries Assoc., Paris, France

Mar. 9-14: 3rd Int'l Audio Hi-Fi and Stereo Exh., Federation Nationale des Industries Electroniques, & Syndicat des Industries Electroniques de Reproduction et d'Enregistrement, Palais d'Orsay, Paris, France

Mar. 21-25: Electrical Engrs. Exhib., Earl's Court, London, S.W. 5, England

Apr. 20-May 4: Engineering, Marine, Welding, & Nuclear Energy Exh., Olympia, London, W. 14, England

Apr. 23-27: 63rd Annual Mtg., The American Ceramic Soc., Royal York Hotel, Toronto, Canada

May 8-12: 89th Semi-Annual Conv., Soc. of Motion Picture & TV Engrs., King Edward Hotel, Toronto, Canada

May 10-12: Production Eng'g Conf. & Show, ASME, Royal York Hotel, Toronto, Canada

May 19-June 4: British Trade Fair, Sokolnicki Park, Moscow, USSR

May 30-June 2: Electronic Components Show, Grand Hall, Olympia, London, W. 14, England

June 6-8: ISA Summer Instrument-Automation Conf. and Exhibit, Queen Elizabeth Hall & Royal York Hotel, Toronto, Ont., Canada

June 12-17: Conf. on Components & Materials used in Electronic Eng'g, Inst. of Electrical Engrs. (Brit.), Central Hall, Westminster, London, England

June 22-24: Meeting, American Physical Soc., Mexico City, Mex.

July 7-29: Russian Trade Fair, Earl's Court, London, England

Aug. 1-12: Sydney Trade Fair, Sydney, Australia

Sept. 4-9: 5th Int'l Conf. on Ionization Phenomena in Gasses, Technische Hochschule Karlsruhe, Munich, Germany

Sept. 28-Oct. 1: Symp. on Radioactive Metrology, Nat'l Physical Lab., Advisory Comm. on Radioactive Standards & Sub-Comm. on Measurements and Standards of Radioactivity of the U. S. Nat'l Res. Council, Oxford, United Kingdom

Oct. 3-12: British Electronic Computer Exhib., Olympia, London, England

Oct. 4-6: IRE Canadian Conv., IRE (Region 8), Automotive Bldg., Exhib. Park, Toronto, Canada

Nov. 8-10: Conf. on Non-Destructive Testing in Electrical Eng'g, Institution of Electrical Engrs. (Brit.), London, England

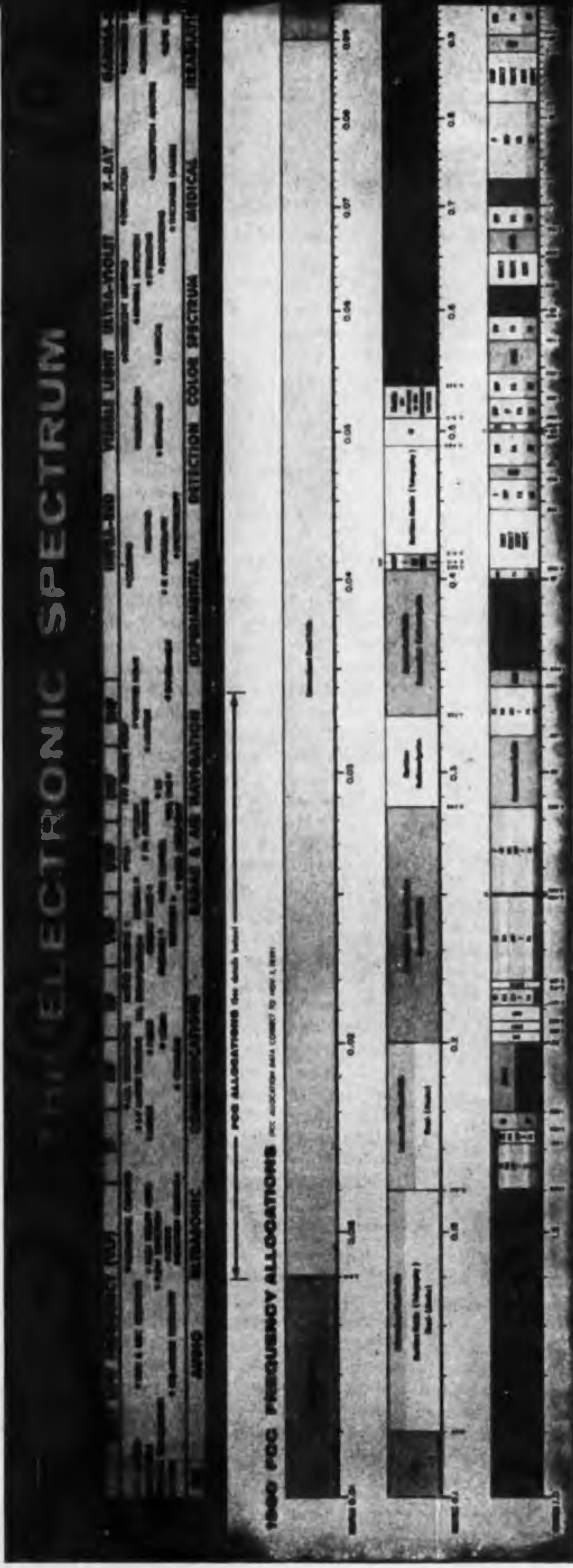
Nov. 13-18: 9th Factory Equip. Exhib., Earl's Court, London, England

HIGH SPEED SILICON COMPUTER DIODES with uniformly typical recovery time of 2 millimicroseconds were first made available in commercial quantities one year ago by Microwave Associates.

Today, Microwave Associates silicon mesa switching diodes are setting the computer industry standard. Extremely low reverse leakage (even at elevated temperatures), excellent forward characteristics, and superb reliability under severe mechanical and environmental conditions make these diodes suitable for a very wide range of applications. Major users have called these diodes excellent "universal switching diodes."

Production quantities are now replacing germanium and silicon computer diodes of both standard and newer types. They are priced competitively for large volume orders and delivery is off-the-shelf.

Faster, more sophisticated diodes for tomorrow's computers are on the way from Microwave Associates. Our leadership in this field is the result of years of experience with silicon semiconductor devices which operate at tomorrow's speeds. This experience, added to your own, will accelerate your computer progress.


ELECTRONIC SPECTRUM
1960 FCC FREQUENCY ALLOCATIONS

Looking Ahead . . .

EI editors assess the present and future for the four key segments of the electronic industries. Included is a statistical summary of 1960 and predictions for the amount of business to be done in 1961.

SEMICONDUCTORS

The **semiconductor segment** of the electronic industry continues to grow. With techniques in germanium and silicon well established, there will be fewer "breakthroughs." **Progress will be moderate** but steady. Characteristics—in frequency and power ranges—will be extended slowly.

Improvement will be mostly in production and engineering areas. Look for more **automated production techniques.** Why? **Competition** is one reason—the relative stable state-of-the-art another. Another reason is that semiconductor devices in many cases are now more sophisticated than the equipment or circuits they are used in. Semiconductor makers will have a breather while other technologies catch up.

Foreign competition in this field is also causing manufacturers to take a hard look at their production techniques. There is little likelihood the U. S. Government will step in to help American makers, despite recent publicity. Many feel that with a little work, the American product could snow the Jap product under, both in price and quality.

With **lower prices** all but inevitable, look for many new applications for semiconductors. One example from many: an entire new market could be established in the automobile industry. Transistorized auto ignition systems are on the drawing board.

With competition real, look for relatively **few new companies** entering the semiconductor field. A new company will need heavy investments in technical and sales staff to capture any important share of the market. Most probable development: large companies contemplating using large numbers of semiconductor devices in their product starting their own semiconductor facilities.

Epitaxial deposition techniques in both germanium and silicon devices will be widely used. Process offers much better control of quality and higher yields. Silicon devices will get a bigger share of the market. Cost reduction and better qualities are promised.

The **search for new materials** continues. Compounds of materials in Groups III and V of the periodic table offers promise. Problem here is that a systematic theoretical approach is difficult. An empirical approach is generally necessary and progress comes in the form of "breakthroughs."

Mixed feelings are reported on the value of **organic semiconductors.** Much must be done before a definite role—if any—can be assigned these materials. Not much promise for 1961.

Computer market, long heralded as the major potential market for semiconductors, is finally opening up. Not only computers but all kinds of data processing systems, process control systems, etc., are expected to start moving. This—and a steadily increasing military electronic procurement—will open up a whole new market for silicon devices; place more emphasis on switching speeds, high temperature operation, and reliability.

Just some of the new materials being studied are silicon carbide—for extremely high temperature operation—gallium phosphide, niobium pentoxide. Silicon carbide transistors for operation above 650°F have been announced and will probably reach the market late in 1961.

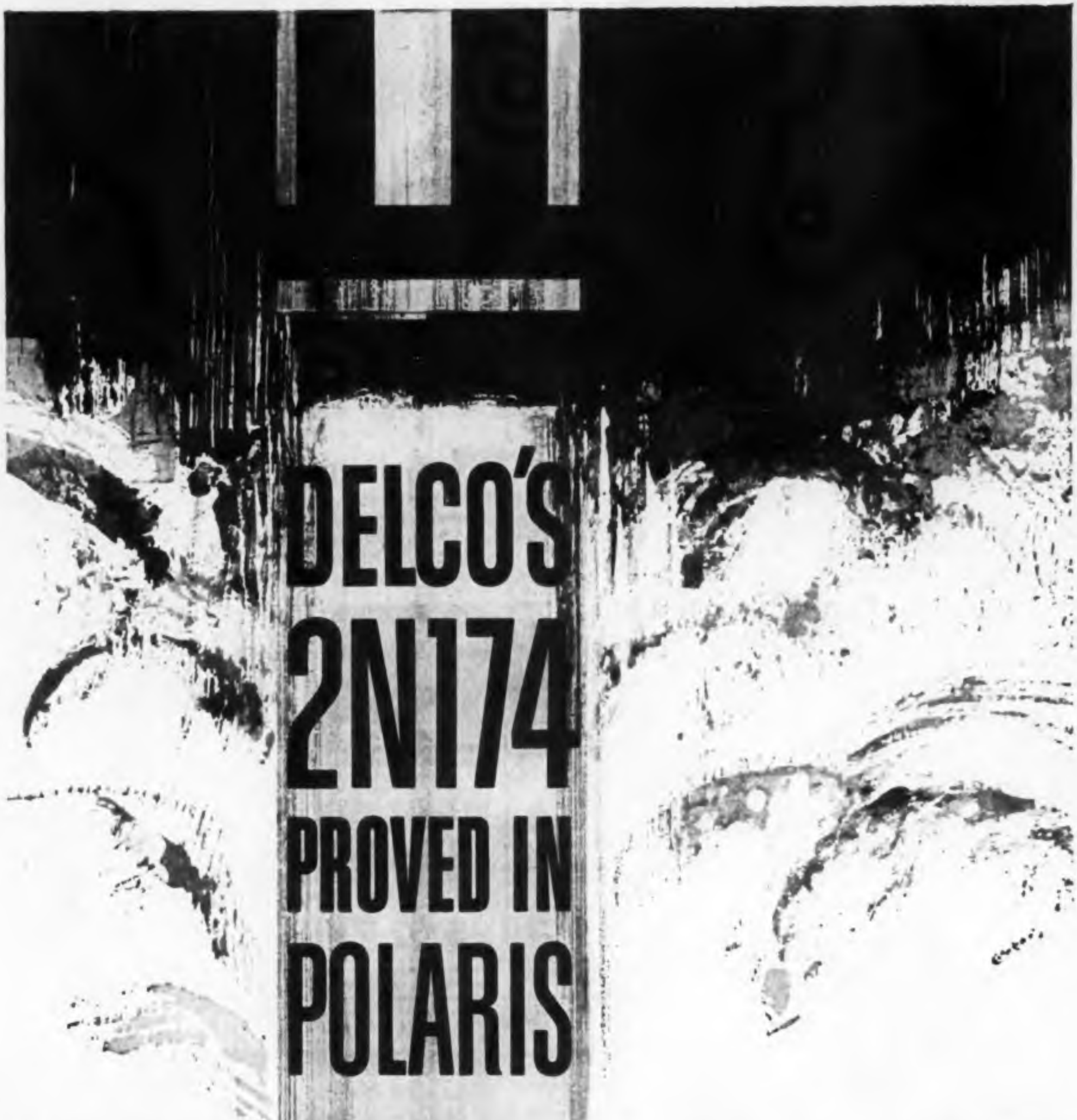
Tunnel diode is still the best hope for high frequency operation. And, despite recent bad publicity, gallium arsenide still looks like the best material. Difficulties probably stem from going ahead too fast—producing devices before technology was well established. An industry source indicates that reliable Ga As tunnel diodes will probably be on the market this year. Recent price cuts in basic material will spur development.

Original timetables in **molecular electronics,** solid state circuitry, etc., have been revised. Despite appearance of some devices recently, improvements are needed before widespread use develops. Some problems: A wider range of device functions must be designed; techniques must be improved for better control of parameters to improve yield and lower cost. It will be interesting to see which firms become the major producers to this field; i.e., will components manufacturers jump in to save dwindling component sales (if the situation ever reaches that stage) or will equipment manufacturers look at it as a logical extension of equipment building?

Problems of **thermoelectric application** remain the same. No one is quite willing to say that their material is the optimum for TE purposes though many say they have the present best. Several cooling and power devices have been produced—expect more in 1961. Biggest market is still the military. A good high temperature material has yet to be found although several very promising avenues are being explored. Experimental approach here is also empirical. Big problem is measurement and standards.

Other areas of semiconductor technology — thermistors, piezoelectric devices, cryosars, photoconductive devices, Hall effect device, masers, lasers, parametric amplifiers, solar cells, etc., will follow a steady growth pattern. Problems here are often in associated equipment, such as heat sinks, collectors, mounting techniques, cryogenic coolers, etc.

(*Continued on page* 127)



DELCO'S 2N174 PROVED IN POLARIS

. . . and Minuteman and Talos and Atlas and Jupiter and Thor and Titan and Bomarc and Zeus and Pershing and hundreds of other military and industrial applications.

For Delco Radio's highly versatile family of 2N174 power transistors meet or exceed the most rigid electrical and extreme environmental requirements.

Over the past five years since Delco first designed its 2N174, no transistor has undergone a more intensive testing program both in the laboratory and in use, in applications from mockups for commercial use to missiles for the military. And today, as always, no Delco 2N174 leaves our laboratories without passing at least a dozen electrical tests and as many environmental tests before and after aging.

This 200 per cent testing, combined with five years of refinements in the manufacturing process, enables us to mass produce these highly reliable PNP germanium transistors with consistent uniformity. And we can supply them to you quickly in any quantity at a low price.

For complete information or applications assistance on the Military and Industrial 2N174's or other application-proved Delco transistors, just write or call our nearest sales office.

Newark, New Jersey	**Santa Monica, California**	**Chicago, Illinois**	**Detroit, Michigan**
1180 Raymond Blvd.	**726 Santa Monica Blvd.**	**5750 West 51st Street**	**57 Harper Avenue**
Mitchell 2-6165	**UPton 0-8807**	**POrtsmouth 7-3500**	**TRinity 3-6560**

DELCO RADIO
DEPENDABILITY · RELIABILITY

Division of General Motors · Kokomo, Indiana

Circle 63 on Inquiry Card

here's why Amperex®

VHF P·A·D·T High-Gain Transistors ARE BETTER...for AM/FM, mobile communications, car radio, and instrumentation!

1 Maximum Uniformity and Interchangeability By combining the best qualities of both the alloy and the diffusion approaches to transistor construction – and by means of special "self-jigging" techniques – the Amperex Post Alloy Diffusion Process achieves maximum yield and uniformity, virtually eliminating the need for "selection". From drawing-board to final quality control checkpoint. the PADT process rigidly maintains the specifications of each transistor you require, not only to provide hitherto unattainable uniformity, but also maximum interchangeability with competitive types – plus . . .

2 High Beta The revolutionary PADT process provides a guaranteed *minimum* beta of 40 . . . an average of 150 . . . with resultant high power gain! Therefore, PADT transistors can now guarantee . . .

3 Maximum Design Freedom for Engineers The unprecedented characteristics of PADT transistors provide easier temperature stabilization, lower bias circuit loss, higher dissipation reserve, superior K factor, high alpha cut-off frequencies and safe, extremely conservative collector voltage ratings.

7 NEW P·A·D·T PNP TYPES specifically designed for specific applications – and now in mass production at the new Amperex semiconductor plant in Slatersville, Rhode Island

APPLICATION	TYPE NO.	FUNCTION	FEATURES
CAR RADIO	PADT-23	RF amplifier in 6 or 12 volt car radio applications from .5 to 1.5 mc, or in portable broadcast receivers.	Low leakage and high current gain minimizes AGC current requirements. Improved noise figure. High base-to-emitter voltage rating minimizes danger of breakdown.
	PADT-24	IF amplifier (455 or 262.5 kc), or in mobile communication receivers; at 6 or 12 volts.	Low collector-to-base capacitance; plus extremely small collector cut-off current. Minimum Beta of 40 to facilitate the design of AGC circuits.
	PADT-27	Mixer, oscillator or converter, 455 or 262.5 kc; at 6 or 12 volts.	Low mixer noise averaging only 3 db at 1 mc. Low leakage, less than 50 μa at 60°C.
MOBILE COMMUNICATIONS	PADT-25	High frequency IF amplifier in mobile communication and airborne receivers.	Unusually high output resistance for improved receiver selectivity. Less than 50 μa leakage at 60°C improves AGC operation.
	PADT-26	RF or IF amplifier, or mixer, in receivers operating up to 100 mc.	Typical power gain greater than 14 db at 100 mc, with a noise figure less than 9 db. High base-to-emitter breakdown voltage for extreme safety.
	PADT-28	RF amplifier for service in the 175 mc region.	Typical gain of 14 db at 200 mc. Noise figure, 5.8 db. Maximum frequency of oscillation, 700 mc. Extremely low base resistance.
	PADT-31	Mixer, oscillator, or frequency multiplier at frequencies up to 60 mc.	High output resistance (30,000 ohms typical at 10.7 mc). Power gain – more than 14 db at 60 mc. Conversion gain 20 db min. at 27 mc.

In stock at the following Amperex distributors and others:

ADLETA COMPANY
DALLAS 1, TEXAS
FORT WORTH, TEXAS

BRILL SEMICONDUCTOR CORP.
OAKLAND 6, CALIF.

ELMAR ELECTRONICS INC.
OAKLAND 7, CALIF.

INTERSTATE RADIO & SUPPLY
DENVER 4, COLORADO

MILO ELECTRONICS
NEW YORK, N. Y.

NEWARK ELECTRONICS CORP.
CHICAGO, ILL.

RADIO SHACK CORP.
BOSTON, MASS.
STAMFORD, CONN.
W. HARTFORD, CONN.
NEW HAVEN 10, CONN.

ROME ELECTRONICS
ROME, N. Y.

R. V. WEATHERFORD COMPANY
GLENDALE 1, CALIF.

THUROW ELECTRONICS, INC.
COCOA, FLA.
JACKSONVILLE, FLA.
MIAMI, FLA.
ORLANDO, FLA.
PENSACOLA, FLA.
TAMPA, FLA.

P·A·D·T TRANSISTORS 'COMPARISON-TESTED' WITH COMPETITIVE CAR RADIO BRANDS

Stage	Parameter	Amperex PADT Transistor	Brand X	Brand Y
ALL	[illegible]	[illegible]	[illegible]	[illegible]
RF	Maximum Available Power Gain 1.5 mc	[illegible]	[illegible]	—
IF	Maximum Available Power Gain 455 kc	[illegible]	[illegible]	[illegible]

(1) Calculated on the basis of f_{max} [illegible] substituted in the following equation [illegible]
(2) Calculated value based on a maximum available power gain of [illegible] and a power fall of [illegible]
(3) Based on P_c at 25°C [illegible] derating factor which is [illegible]
(4) Calculated by the following equation [illegible]

Coming soon! New P·A·D·T Switching, UHF and Power types!

ask Amperex

for detailed data and applications assistance (including complete circuits designed to your specifications)

AMPEREX ELECTRONIC CORPORATION
230 DUFFY AVENUE, HICKSVILLE, L. I., NEW YORK
In Canada: Rogers Electronic Tubes & Components 116 Vanderhoof Ave., Toronto 17, Ont.

TEST EQUIPMENT

The incorporation of **digital readout devices** on test equipment is growing. While digital readouts are already being used on frequency meters and voltmeters, look for applications on many other types of test equipment. In the past year, at least one company has added digital readouts to an oscilloscope.

Digital readouts permit non-technical people to use the equipment. Generally, digital readout equipment has attachments available for automatically punching cards that can be used later to tell how the product shows up under tests. These punched cards are also useful for accounting purposes and for production records.

A few manufacturers are making test equipment which is entirely **solid-state.** While many of the test equipment manufacturers used some semi-conductors in their equipment, none until recently used full solid-state in their equipment. With a new generation of semiconductors appearing, look for many more types of test equipment to become fully solid-state.

With the anticipated microwave boom, **microwave test equipment** manufacturers will probably have their best years in the very near future. This new boom can be attributed to the FCC allocating bands of frequencies for private use. All types of microwave test equipment will be in demand.

Test equipment, especially the more complex units, are becoming **more modular in construction.** The benefits include ease of maintainability and repair. In the larger pieces of test equipment if a component or section should fail, a module can be borrowed from another unit without having to physically move the whole unit.

Along the modular line, many pieces of test equipment, such as scopes and meters, have a basic section and **modular plug-in units** which adapt the equipment to many needs. This is of benefit to the purchaser. Instead of a large outlay of money to buy test equipment for projected needs, the purchaser may buy a basic unit and as his needs grow, buy various plug-in modules for the unit. This also keeps his equipment from becoming obsolete.

Work is being done toward applying **fibre optics** to scope faces, to achieve higher resolution, elimination of parallax and halation and much better photography of the scope presentations. However, the cost of a scope tube with a fibre optic face will be quite expensive.

One trend today is to design electronic systems that **automatically test and locate their own troubles**. For some of the complex systems and units being used today, this is a necessity to decrease down time. While test equipment will still be used as an integral part of the systems, the test equipment manufacturers will have to think in terms a little different than most of them do today. Instead of just designing individual pieces of test equipment, many of them will have to swing over to the systems type concepts. They will quite likely be used as a service team. In these large systems, their engineers will be called in to help design the self-testing features of the equipment and then supply the test equipment required.

We may see some breakthroughs on **panel-type meters** in the future. For higher accuracy, digital type readouts are being used in place of meters. Meters by their inherent nature of operation, generally electromechanical operation, have limited accuracies. As meter manufacturers know, meters do not maintain the same accuracy across the whole scale. The best accuracy is usually obtained from mid-scale to full-scale deflection.

Automated test equipment and testing systems are drawing a great deal of interest and research. There is a need for test equipment that will automatically check-out complete systems, and also equipment ranging all the way down to a few stage radio receiver. There are already universal-type test stations for testing components. The equipment is programmed by means of a specially prepared tape. With automation the keynote today, automatic testing should grow by leaps and bounds provided cost does not become exorbitant.

Non-destructive testing is an area that is growing. Ultrasonics is one of the newer tools that are being applied to this area. With ultrasonics, flaws can be detected in most solids quite rapidly. As an example, railroads have been using these to rapidly test miles and miles of rails on their tracks for flaws.

We have heard complaints from purchasers of test equipment about need for **standardizing specification** for various types of test equipment. Complaints are often heard regarding oscilloscopes. When potential purchasers start to dig into specifications of the various oscilloscope manufacturers, they felt that they had no real way of comparing one company's scope with another, except by bench comparison. We suspect in the near future an industry committee will be set up to overcome some of these obstacles. As we mentioned, this is also true of several other areas of test equipment.

Semiconductor test equipment demands will be rising rapidly. With consumer items swinging from tubes to transistors, the various repair agencies and technicians will require semiconductor test equipment. Up to now they have managed to squeeze by without this equipment. However, this is not going to last much longer.

Semiconductor production test equipment is a highly specialized segment of semiconductor test equipment. At present, most manufacturers have designed their own or incorporated some of the equipment that is already available. However, these manufacturers have tight security on what they are using and how they are using it for the production of semiconductors. Most companies have their own pet methods and are not talking about them. In fact, in many cases the production test equipment is classified even higher than Government security classifications.

(*Continued on page* 128)

MICROWAVE COMPONENTS

The microwave field is riding the crest of a wave. Principal impetus is coming from the **stepped-up military activity** in the microwave region. but there has been also a very significant increase in sales to private firms. Most of the obstacles to expansion of microwave services — tied up in appeals to the FCC—have been removed during the past year and an explosive growth of the industry is expected during 1961.

Activity continues to be **centered around the New York area** and small establishments employing less than 500 workers contribute the bulk of total output.

The major research effort in the microwave field is aimed at new amplyifying techniques that will provide lower noise figures. **Solid state devices** are showing considerable promise.

The principal areas being investigated are in **parametric amplifiers, masers** and variations on the **traveling wave** techniques.

Where formerly it was believed that maser action could be achieved only in extremely low temperatures, approaching absolute, it is now known that maser action can be obtained at temperatures as high as 60°K. This range can be quite easily obtained with small scale liquefiers using compressed gas, and small closed-circuit liquefiers.

A **maser** amplifier has been used in **X-band radio astronomy** where it effected an improvement in sensitivity of more than 12 times. In another application a maser added to an X-band radar produced an effective overall temperature of 65°K.

The field of parametric amplifiers is looking to the development of new diodes. The upper frequency limit for parametric amplifiers is now about 10 KMC.

A ferrite variable inductor-type traveling wave amplifier has been proposed which could incorporate its own isolator. But the pump power required would be extremely large — on the order of kilowatts.

With **traveling wave tubes**, it has been widely thought that beam noise cannot be reduced below about 6 db in S-band. But recent research aimed at reducing the noise in the beams, suggests that perhaps noise figures at S-band of 1 db are now possible.

Just recently a new type of **miniature parametric amplifier** has been introduced which uses a helix as a slow wave structure. Designed for satellite communication systems in telemetry and radar, the new device is said to permit increased bandwidth, fewer diodes in the transmission line, miniaturized circuits and more stable performance. The amplifier has an insertion loss of aproximately 30 db between the input and output of the helix before application of the pump signal.

The new **"Cretatron" traveling-wave amplifier,** which gains results from beating two r-f waves of unchanging amplitude but unlike phase velocities, has been operated in the 2 to 4 kmc band at pulse levels up to 1300 w. The interaction length is 3 in.

It is expected that self-contained liquid helium liquefiers occupying about a 1 ft cube will soon be available, and these should give a decided push to the whole low temperature field, and the general field of superconductivity and cryogenics as well.

It can be expected that masers will soon be built that will not require magnets. The so-called **zero field masers** will utilize crystals having assymetrical structures.

Strip-transmission line, after the initial burst of enthusiasm, has found a small, but secure place in the industry. It has been found to be well suited for use in complete microwave circuits, particularly in components having coaxial connectors at the ports. It has also found some acceptance in many types of filters, where requirements are not too rigid.

It seems assured that strip line, because it offers significant economies, lightness and compactness, will find application in a substantial number of assemblies. But waveguide and coaxial line will continue to be the most widely used.

Let's look at what is in the wind, component-wise, for the immediate future—1961. Are components giving way to micro-circuitry?

Basically, there are three steps, currently known, which lead to the ultimate in miniaturization. They are (1) packaging, (2) smaller components, and (3) micro-miniature components and packaging. This last step is the so-called **molecular electronics** and **micro-circuitry.** Quite obviously, as the packages get smaller, they become more expensive.

It is still highly debatable whether components will give way to micro-circuitry. They will definitely do so in some areas, but it is highly unlikely to occur in all areas. In the long run, economics will be the determining factor.

We are presently at the second step—**miniaturization.** New smaller transistors were the first components available. Now the other devices are striving to achieve the same degree of smallness.

For the immediate general needs of the electronic industries, miniaturization using the present resistors will continue to fill the bill.

But those parts of our industry which are further advanced—missile guidance and control, computers, etc.—will be putting more and more pressure on the resistor manufacturers for **smaller, more reliable units.**

The component makers have come up with the **miniature metal film resistor**—available **with or without leads.** The leadless style, terminated with an intermediate range solder, is provided for insertion directly into a printed or etched circuit board and can be completely immersed in solder.

Very few of the major manufacturers have the miniature metal film resistors available in production quantities. Some small companies have developed them and sell them locally in small quantities. Most of the major equipment manufacturers have research programs in which they have developed similar units, but these are used mainly to check the feasibility of their design concepts.

(Continued on page 132)

Circle 65 on Inquiry Card ⟶

A MAJOR CAUSE OF FAILURE ELIMINATED BY BUILDING A TRANSISTOR INSIDE ITS OWN SHELL

Most transistor failure is not abrupt. It consists of surface changes causing a gradual shift in parameters. While the whole industry has sought answers, Fairchild has followed a research and development course of its own. We can now reveal a unique solution.

Called "PLANAR STRUCTURE," this Fairchild answer uses a passivated surface — a hard, passive coating of silicon oxide — not new in theory, but new in the way it is done. Fairchild oxidizes the surface first. Then the transistor's junctions are diffused **under the oxide.** Contaminants cannot reach them during process or after. Result: performance is unchanged by time, use, environment or even exposure to foreign matter.

Planar is the answer: for system reliability where thousands of transistors must all be operative at an instant — for fast, simple circuits tightly packed in minimum space — for carefully matched pairs, triplets or quads that must stay exactly in balance — and for leakage reduction by a factor of one-hundred. And planar is the answer even for simpler circuit requirements where high assurance has a value.

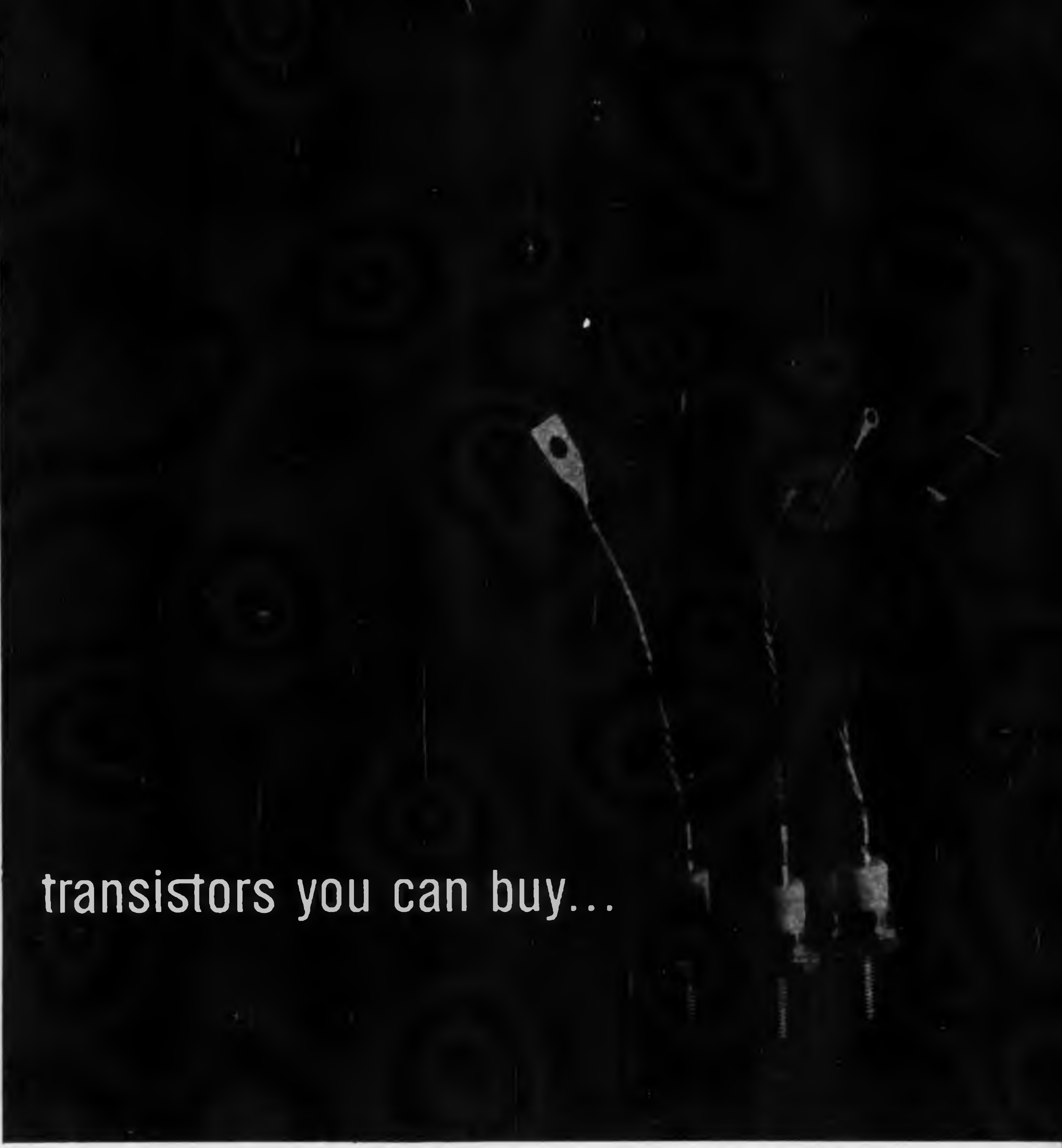
These advantages apply to planar diodes, too. Of course, Fairchild planar silicon transistors and diodes are available in production quantities. A new 12 page brochure explains the process and results more fully. May we send you a copy?

FAIRCHILD
SEMICONDUCTOR CORPORATION

Westinghouse 30-amp silicon "rock-top" power transistors

New 30-amp ratings, the industry's highest! These latest Westinghouse Silicon Power Transistors are especially designed for those applications where you need more transistor power, extra long-life and extra stability under all operating conditions. Your choice of nine devices in this new family—each rated at 30 amps.—for greater flexibility of circuit design in high-power applications. Other Westinghouse high-performance features include: • Exclusive "rocktop" ceramic construction for greater reliability • Voltage ratings to 200 volts • Double-ended case design • Low saturation resistance • 250 watts power dissipation.

Circle 66 on Inquiry Card



Production quantities of the type 115 family are now available. Westinghouse also offers the 2N1015 and 2N1016 series of Silicon Transistors, ideal as companion drivers. Military and industrial applications include: power supplies/regulators/amplifiers/high-power switching/inverters.

For more information call your nearest Westinghouse representative or semiconductor distributor. Or write: Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Pa. SC-1012

You can be sure . . . if it's

Westinghouse

For immediate "off-the-shelf" delivery, order from these Westinghouse Distributors:

EASTERN

ACK SEMICONDUCTOR, INC. Birmingham 5, Ala./FA 2-0588

CAMERADIO Pittsburgh, Pa./EX 1-4000

CRAMER ELECTRONICS, INC. Boston, Mass./CO 7-4700

ELECTRONIC WHOLESALERS, INC. Melbourne, Florida/PA 3-1441

GENERAL RADIO SUPPLY CO. Camden, N.J./WO 4-8560

GENESEE RADIO PARTS CO. Buffalo, N.Y./DE 9661

KANN-ELLERT ELECTRONICS, INC. Baltimore, Md./TU 9-4242

MILGRAY ELECTRONICS New York, N.Y./RE 2-4400

RADIO & ELECTRONIC PARTS CORP. Cleveland, Ohio/UT 1-6060

SCHWEBER ELECTRONICS Long Island, N.Y./PI 6-6520

MIDWESTERN

ELECTRONIC COMPONENTS FOR INDUSTRY CO. St. Louis, Mo./WO 2-9917

INTER-STATE RADIO & SUPPLY CO. Denver 4, Colo./TA 5-8257

LENERT CO. Houston, Texas/CA 4-2663

RADIO DISTRIBUTING CO. Indianapolis, Ind./ME 7-5571

SEMICONDUCTOR SPECIALISTS, INC. Chicago, Ill./NA 2-8860

S. STERLING CO. Detroit, Mich./BR 3-2900

UNITED RADIO, INC. Cincinnati, Ohio/MA 1-6530

WHOLESALE ELECTRONICS SUPPLY Dallas, Texas/TA 4-3001

WESTERN

ELMAR ELECTRONICS Oakland, Calif./TE 4-3311

HAMILTON ELECTRO SALES Los Angeles, Calif./BR 2-9154

NEWARK ELECTRONICS CO. Inglewood, Calif./OR 4-8440

1960-61 Electronic Industry Statistics

1961 ELECTRONIC MARKETS (EST.)

CONSUMER GOODS (Retail)	3,100,000,000
MILITARY & GOVERNMENT	5,000,000,000
INDUSTRIAL	1,750,000,000
REPLACEMENT PARTS	900,000,000
	10,750,000,000

SERVICE

During 1960 the annual retail bill for servicing of home electronic appliances was as follows:

178,000,000 replacement receiving tubes	$ 330,000,000
7,400,000 replacement picture tubes (includes rebuilds)	280,000,000
Antennas, components, parts, instruments	930,000,000
Labor	1,400,000
Total servicing bill	$2,940,000,000

SEMICONDUCTOR SALES—1960

	Factory Sales	Factory Sales $
Transistors	111,500,000	270,500,000
Rectifiers/Diodes	180,000,000	177,300,000

PHONOGRAPH SALES—1960

Type	Factory Sales (units)	Retail Sales (units)
Monaural	961,000	894,000
Stereo	2,950,000	2,790,000

VITAL TELEVISION STATISTICS 1946-1960

	Total TV Sets Manufactured		Receiving Tubes Used in New TV Sets and for Replacements		Total TV Picture Tubes Manufactured		Total AM-FM-TV Receiving Sets Manufactured	TV Stations on the Air	Total TV Sets in Use in U. S.	At Close of
	Number	Retail Value	Number	Retail Value	Number	Retail Value				
1946	10,000	$ 6,000,000	300,000	$ 800,000	20,000	$ 1,000,000	14,010,000	6	8,000	1946
1947	200,000	100,000,000	8,000,000	18,000,000	300,000	16,000,000	17,200,000	20	250,000	1947
1948	1,000,000	300,000,000	32,200,000	63,000,000	1,000,000	75,000,000	17,000,000	41	1,000,000	1948
1949	3,000,000	900,000,000	87,000,000	148,000,000	3,000,000	210,000,000	13,000,000	100	3,000,000	1949
1950	7,500,000	2,700,000,000	225,000,000	375,000,000	6,000,000	400,000,000	22,100,000	107	10,000,000	1950
1951	5,000,000	2,100,000,000	161,000,000	270,000,000	6,000,000	300,000,000	19,100,000	108	16,750,000	1951
1952	6,300,000	2,300,000,000	168,000,000	330,000,000	8,000,000	280,000,000	16,300,000	123	21,000,000	1952
1953	7,300,000	1,675,000,000	218,000,000	403,000,000	9,000,000	300,000,000	20,700,000	300	28,000,000	1953
1954	7,300,000	1,270,000,000	215,200,000	400,000,000	10,200,000	300,000,000	17,700,000	415	33,000,000	1954
1955	7,800,000	1,263,000,000	225,000,000	467,000,000	10,000,000	371,000,000	20,000,000	457	39,400,000	1955
1956	7,000,000	1,237,000,000	200,000,000	400,000,000	11,000,000	318,000,000	21,000,000	491	42,300,000	1956
1957	6,500,000	1,270,000,000	175,000,000	371,000,000	10,000,000	340,000,000	22,000,000	519	45,000,000	1957
1958	5,150,000	812,000,000	128,000,000	278,000,000	8,200,000	232,000,000	18,300,000	570	50,000,000	1958
1959	6,200,000	1,070,000,000	180,000,000	318,000,000	9,000,000	300,500,000	21,000,000	564	53,000,000	1959
1960	5,900,000	1,020,000,000	180,000,000	300,000,000	9,000,000	220,000,000	22,000,000	583	57,000,000	1960

U. S. PRODUCTION OF RADIO SETS—1922 TO 1960

	Total Radio Sets Manufactured		Total Receiving Tubes Manufactured		Automobile Sets Manufactured		Auto Sets in Use	Homes with Radio Sets	Total Radio Sets in Use in U. S.	
	Number	Retail Value	Number	Retail Value	Number	Retail Value	Number	Number	Number	
1922	100,000	$ 5,000,000	1,000,000	$ 6,000,000	....	....	....	260,000	400,000	1922
1923	550,000	30,000,000	4,000,000	12,000,000	....	....	....	1,000,000	1,100,000	1923
1924	1,500,000	100,000,000	12,000,000	36,000,000	....	....	....	2,500,000	3,000,000	1924
1925	2,000,000	165,000,000	20,000,000	48,000,000	....	....	....	3,500,000	4,000,000	1925
1926	1,750,000	200,000,000	30,000,000	58,000,000	....	....	....	5,000,000	5,700,000	1926
1927	1,350,000	168,000,000	41,200,000	67,300,000	....	....	....	6,500,000	7,000,000	1927
1928	3,281,000	400,000,000	50,200,000	110,250,000	....	....	....	7,500,000	8,500,000	1928
1929	4,428,000	600,000,000	69,000,000	172,500,000	....	....	....	9,000,000	10,500,000	1929
1930	3,827,000	300,000,000	52,000,000	119,000,000	34,000	$ 3,000,000	....	12,048,762	13,000,000	1930
1931	3,420,000	225,000,000	53,000,000	69,550,000	108,000	5,940,000	100,000	14,000,000	15,000,000	1931
1932	3,000,000	140,000,000	44,300,000	48,730,000	143,000	7,150,000	250,000	16,809,562	18,000,000	1932
1933	3,806,000	180,500,000	59,000,000	49,000,000	724,000	28,598,000	500,000	20,402,369	22,000,000	1933
1934	4,084,000	214,500,000	58,000,000	38,000,000	780,000	28,000,000	1,250,000	21,456,000	26,000,000	1934
1935	6,026,800	330,192,480	71,000,000	60,000,000	1,125,000	54,562,500	2,000,000	22,869,000	30,500,000	1935
1936	8,248,000	450,000,000	98,000,000	69,000,000	1,412,000	69,188,000	3,500,000	24,600,000	33,000,000	1936
1937	8,064,780	450,000,000	91,000,000	85,000,000	1,750,000	87,500,000	5,000,000	26,666,500	37,600,000	1937
1938	6,000,000	210,000,000	75,000,000	83,000,000	800,000	32,000,000	6,000,000	28,000,000	40,800,000	1938
1939	10,500,000	354,000,000	91,000,000	114,000,000	1,200,000	48,000,000	6,500,000	28,700,000	45,300,000	1939
1940	11,800,000	450,000,000	115,000,000	115,000,000	1,700,000	60,000,000	7,500,000	29,200,000	51,000,000	1940
1941	13,000,000	460,000,000	130,000,000	143,000,000	2,000,000	70,000,000	8,750,000	29,700,000	56,000,000	1941
1942	4,400,000	154,000,000	87,700,000	94,000,000	350,000	12,250,000	8,000,000	30,800,000	59,340,000	1942
1943	....	....	17,000,000	19,000,000	....	....	8,000,000	32,000,000	58,000,000	1943
1944	....	....	22,000,000	25,000,000	....	....	7,000,000	33,000,000	57,000,000	1944
1945	500,000	20,000,000	30,000,000	35,000,000	....	....	6,000,000	34,000,000	56,000,000	1945
1946	14,000,000	700,000,000	190,000,000	200,000,000	1,200,000	72,000,000	7,000,000	35,000,000	60,000,000	1946
1947	17,000,000	800,000,000	220,000,000	200,000,000	3,200,000	184,000,000	9,000,000	37,000,000	66,000,000	1947
1948	14,000,000	600,000,000	250,000,000	230,000,000	4,100,000	250,000,000	11,000,000	40,000,000	74,000,000	1948
1949	10,000,000	500,000,000	190,000,000	300,000,000	3,500,000	240,000,000	14,000,000	42,000,000	81,000,000	1949
1950	14,600,000	721,000,000	383,000,000	644,000,000	4,750,000	248,000,000	17,000,000	45,000,000	90,000,000	1950
1951	13,000,000	605,000,000	430,000,000	640,000,000	4,800,000	255,000,000	20,000,000	45,850,000	100,000,000	1951
1952	10,000,000	500,000,000	330,000,000	740,000,000	2,750,000	143,500,000	25,000,000	46,000,000	114,000,000	1952
1953	13,400,000	530,000,000	410,000,000	825,000,000	4,800,000	250,000,000	29,000,000	46,000,000	120,000,000	1953
1954	10,000,000	400,000,000	400,000,000	800,000,000	4,300,000	220,000,000	32,000,000	50,000,000	127,000,000	1954
1955	14,400,000	500,000,000	481,000,000	882,000,000	6,800,000	346,000,000	35,700,000	52,000,000	138,700,000	1955
1956	14,000,000	563,000,000	465,000,000	905,000,000	5,000,000	256,000,000	37,000,000	52,200,000	143,500,000	1956
1957	15,500,000	563,000,000	480,000,000	882,000,000	5,500,000	303,000,000	39,000,000	53,450,000	146,400,000	1957
1958	12,550,000	400,000,000	330,000,000	729,000,000	3,870,000	183,000,000	41,000,000	53,650,000	165,200,000	1958
1959	15,300,000	540,000,000	430,250,000	731,700,000	5,620,000	304,000,000	43,000,000	61,350,000	175,000,000	1959
1960	16,920,000	600,000,000	460,000,000	530,000,000	6,480,000	350,000,000	45,000,000	68,350,000	180,000,000	1960

OUR NEW HOME, DOUBLING OUR FORMER CAPACITY

Watch Master ELECTRONICS

Precision FREQUENCY STANDARDS AND FORK OSCILLATOR UNITS

Our instruments, 40 to 30,000 cycles, are used extensively by industry and on government projects where enduring accuracy and maximum durability are required. Your inquiries on related products are invited.

PRECISION FORK OSCILLATOR UNITS

TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.

Frequencies: 200 to 4000 cycles

Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)

Double triode and 5 pigtail parts required.

Input, Tube heater voltage and B voltage

Output, approx. 5V into 200,000 ohms

TYPE 2007-6

TRANSISTORIZED, Silicon Type

Size 1½" dia. x 3½" H. Wght. 7 ozs.

Frequencies: 360 to 1000 cycles

Accuracies:
2007-6 (± .02% at —50° to + 85°C
R2007-6 (±.002% at +15° to + 35°C
W2007-6 (±.005% at —65° to + 85°C

Input: 10 to 30 Volts, D. C., at 6 ma.

Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles

Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28

B voltage, 100 to 300 V., at 5 to 10 ma.

ACCESSORY UNITS FOR 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.

D—For low frequencies counter type, 40-200 cy.

H—For high freqs, up to 30 KC.

M—Power Amplifier, 2W output.

P—Power supply.

PRECISION FREQUENCY STANDARDS

TYPE 2005A

Size 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies:
50 to 400 cycles (Specify)

Accuracy:
±.001% from 20° to 30°C

Output, 10 Watts at 115V

Input, 115V. (50 to 400 cy.)

TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt

Accuracy:
±.001% 20° to 30°C

Input,
115V (50 to 400 cy.)

TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cy.

Accuracy:
(±.002% at 15° to 35°C)

Output: 115V, 75W.

Input: 115V, 50 to 75 cy.

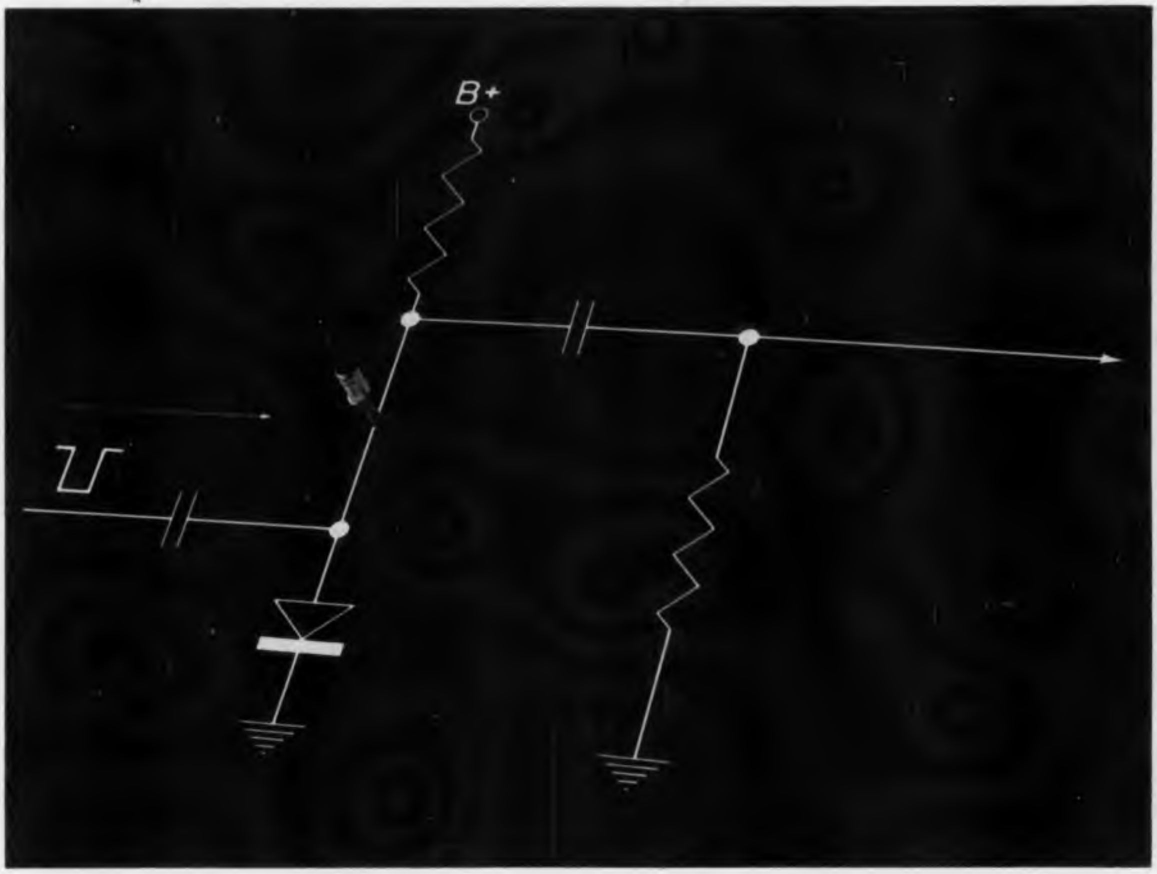
WHEN REQUESTING INFORMATION, PLEASE SPECIFY TYPE NUMBER

ATP
American Time Products
Inc.
61-20 Woodside Avenue
Woodside 77, N. Y.

SHIPMENTS OF ELECTRONIC COMPONENTS OF U. S. MANUFACTURERS[1]

	QUANTITY			VALUE		
	1st QUARTER	2nd QUARTER	TOTAL	1st QUARTER	2nd QUARTER	TOTAL
POWER AND SPECIAL PURPOSE TUBES	3,211.3	3,218	6,429.3	62.5	64.8	127.3
High vacuum tubes	928	958	1,886	14.4	15.2	29.6
Diodes	120	110	230	1.4	1.3	2.7
External anode, except diodes, 100 w or less	225	204	429	3.7	3.5	7.2
External anode, except diodes over 100 w	72	102	174	5.5	6.6	12.1
Internal anode, except diodes	511	542	1,053	3.8	3.8	7.6
Gas and vapor tubes	634	661	1,295	7.1	7.3	14.4
Diodes	199	154	353	1.1	0.9	2.0
Thyratrons, ignitrons	373	449	822	3.6	4.1	7.7
Gas switching devices[2]	62	58	120	2.4	2.3	4.7
Klystrons	45	28.5	73.5	12.7	12.7	25.4
Reflex klystrons (1 w and under)	42	25	67	5.4	4.2	9.6
Other, cw and pulsed (over 1 w)	3	3.5	6.5	7.3	8.5	15.8
Magnetrons	23	21	44	10.9	11.3	22.2
Forward wave devices	2.1	2	4.1	4.1	4.8	8.9
Backward wave devices	0.8	0.5	1.3	1.3	0.7	2.0
Light sensing tubes	281	251	542	3.5	4.0	7.5
Light emitting tubes	86	84	170	2.0	2.6	4.6
Storage tubes	1.4	1	2.4	1.6	1.2	2.8
Other[3]	1,210	1,211	2,421	4.9	5.3	10.2
RECEIVING TUBES	106,962	100,198	207,160	95.2	13.1	108.3
Subminiature	1,988	1,954	3,942	6.9	6.6	13.5
Miniature	78,189	73,033	151,222	61.2	57.4	118.6
Military reliable	3,922	4,259	8,181	6.9	7.6	14.5
All other types	74,267	68,774	143,041	21.5	20.0	41.5
Other (metal, ceramic, lock-in, etc.)	2,963	3,084	6,047	4.1	3.0	7.1
TELEVISION PICTURE TUBES	3,070	2,203	5,273	61.9	66.0	127.9
SEMICONDUCTOR DEVICES	63,507	75,959	139,466	129.0	134.7	263.7
Diodes, rectifiers and related devices	32,847	46,338	79,185	48.6	57.4	106.0
Germanium diodes and rectifiers	13,435	24,661	38,096	8.1	13.7	21.8
0–30 ma	8,344	14,199	22,543	4.7	7.2	11.9
31–100 ma	3,642	8,866	12,508	2.0	5.2	7.2
Over 100 ma	1,449	1,596	3,045	1.4	1.3	2.7
Silicon diodes and rectifiers	16,417	19,467	35,884	30.2	32.4	62.6
0–30 ma	1,074	3,291	4,365	2.5	5.0	7.4
31–100 ma	4,156	3,524	7,680	9.1	7.0	16.1
101–550 ma	6,039	6,703	12,742	8.4	9.3	17.7
551 ma–3 a	3,635	4,151	7,786	5.3	5.5	10.8
Over 3 a–35 a	1,380	1,664	3,044	2.8	3.4	6.2
Over 35 a	133	136	269	2.1	2.2	4.3
Zener diodes	1,379	1,458	2,837	6.1	6.4	12.5
Microwave diodes	282	298	580	1.2	1.3	2.5
Infra-red and other semiconductor photo cells, except solar cells	65	44		0.6	0.7	1.3
Other[4]	1,269	408	1,677	2.4	2.8	5.2
Transistors	30,660	29,621	60,281	80.4	77.3	157.7
Germanium	28,603	27,591	56,194	55.4	51.2	106.6
0–125 mw	13,214	10,840	24,954	24.1	20.1	41.5
126–999 mw	12,199	13,445	25,644	22.6	21.7	44.3
1 w and over	3,190	3,306	6,496	8.4	9.4	17.8
Silicon	2,057	2,030	4,087	25.0	26.1	51.1
CAPACITORS	328,585	313,188	641,773	65.5	64.5	130.0
Paper dielectric	65,950	59,183	125,133	19.0	17.6	36.6
Metal case	13,353	14,495	27,848	14.0	13.7	27.7
Non-metal case	52,597	44,688	97,285	5.0	3.9	8.9
Film dielectric	16,888	18,195	35,083	4.1	5.0	9.1
Metal case	751	872	1,623	1.0	1.1	2.1
Non-metal case	16,137	17,323	33,460	3.1	3.9	7.0
Metallized paper or film dielectric	3,215	3,137	6,352	1.5	1.6	3.1
Electrolytic	28,143	28,665	56,808	21.7	22.8	44.5
Aluminum	23,137	22,873	46,010	12.1	11.9	24.0
Tantalum	5,006	5,792	10,798	9.6	11.0	20.6
Mica, glass, and vitreous enamel dielectric, fixed	36,503	31,356	67,859	5.8	5.3	11.1
Ceramic, dielectric, fixed	164,768	158,478	323,246	7.4	6.6	14.0
Temperature compensating	50,851	46,613	97,464	2.5	2.1	4.6
General purpose	113,917	111,865	225,782	4.9	4.5	9.4
Variable (mica, ceramic, glass, and air dielectric)	13,118	14,174	27,292	6.0	5.7	11.7
COMPLEX COMPONENTS[6]	10,093	9,452	19,545	5.2	5.5	10.7

(Continued on page 136)



Circle 68 on Inquiry Card

SHIPMENTS OF ELECTRONIC COMPONENTS OF U.S. MANUFACTURERS

(Continued from page 134)

	QUANTITY			VALUE		
	1st QUARTER	2nd QUARTER	TOTAL	1st QUARTER	2nd QUARTER	TOTAL
CONNECTORS	27,612	23,751	51,363	43.1	43.4	86.5
Coaxial (r-f)	5,281	6,011	11,292	4.7	5.3	10.0
Cylindrical	7,196	7,042	14,238	17.1	16.1	33.2
Multiple contact (rack and panel)	4,711	5,138	9,849	9.1	10.9	20.0
Printed circuit	2,644	2,134	4,778	3.9	3.4	7.3
Other	7,780	3,426	11,206	8.3	7.8	16.1
QUARTZ CRYSTALS	1,646	1,520	3,166	4.8	5.3	10.1
Hermetically sealed, glass or metal cases	1,633	1,506	3,139	4.7	5.2	9.9
Clip-mounted—plated	1,353	1,225	2,578	2.7	2.9	5.6
Clip-mounted—plated	1,353	1,225	2,578	2.7	3.0	5.7
Less than 2 mc/s	204	213	417	0.5	0.6	1.1
2 mc/s through 12 mc/s	566	551	1,117	1.1	0.4	1.5
Over 12 mc/s	583	461	1,044	1.1	1.1	2.2
Pressure and wire mounted	280	281	561	2.0	2.3	4.3
Unsealed, plastic case	13	14	27	0.1	0.1	0.2
RELAYS (FOR ELECTRONIC APPLICATIONS)	10,377	9,480	19,857	48.8	48.7	97.5
Electromagnetic, except coaxial and stepping switches	8,202	7,973	16,175	39.6	39.3	78.9
Sealed	1,657	1,399	3,056	17.2	17.3	34.5
Through 100 mw actuating power	313	267	580	3.6	3.5	7.1
Over 100 mw actuating power	1,344	1,132	2,476	13.6	13.8	27.4
Unsealed	3,277	3,394	6,671	11.9	12.0	23.9
Through 100 mw actuating power	360	427	787	1.3	0.3	1.6
Over 100 mw actuating power	2,917	2,967	5,884	10.6	10.8	21.4
Telephone types	3,268	3,180	6,448	10.5	10.0	20.5
Scaled	341	330	671	2.6	2.5	5.1
Unsealed	2,927	2,850	5,777	7.9	7.5	15.4
Other[7]	2,175	1,507	3,682	9.2	9.4	18.6
RESISTORS	532,771	497,760	1,030,531	61.2	60.7	121.9
Fixed composition	421,819	391,235	813,054	11.8	11.1	22.9
Fixed, deposited carbon and boro carbon	28,976	30,641	119,617	5.6	5.9	17.0
Insulated and uninsulated	27,512	28,607	56,119	4.7	4.7	9.4
Hermetically sealed	1,464	2,034	3,498	0.9	1.2	2.1
Fixed, metal film	6,496	7,419	13,915	1.9	2.4	4.3
Fixed, wire-wound	25,860	20,928	46,788	8.0	7.6	15.6
Non-precision (fixed and adjustable)	20,676	16,645	37,321	4.2	3.8	8.0
Precision, unsealed	2,737	2,730	5,467	1.8	1.9	3.7
Precision, sealed	2,447	1,553	4,000	2.0	1.9	3.9
Variable, non-wire wound	31,171	29,235	60,406	12.3	11.9	34.2
Non-precision[8]	31,041	29,129	60,170	10.3	9.9	20.2
Precision[9]	130	106	236	2.0	2.0	4.0
Variable, wire-wound	4,901	5,022	—	16.7	16.9	33.6
Non-precision	3,949	4,056	8,005	3.8	3.9	7.7
Precision and semi-precision	952	966	1,918	12.9	13.0	25.9
Single turn	276	278	554	6.5	6.7	13.2
Multi-turn (linears)	161	173	334	3.6	3.4	7.0
Rectilinear and toroidal wound	515	515	1,030	2.8	2.9	5.7
Other (attenuators, varisters, thermisters, etc.)	13,548	13,280	26,828	4.9	4.8	9.7
TRANSFORMERS AND REACTORS	10,294	8,409	18,703	46.4	48.5	94.9
Pulse types	432	516	948	2.3	2.6	4.9
Toroidal types	650	887	1,537	4.3	5.7	10.0
Other transformers and reactors	9,212	7,006	16,218	39.8	40.2	80.0
Under 2 oz.	812	960	1,772	4.0	4.8	8.8
2 oz. to 30 lbs.	8,311	5,947	14,258	30.0	29.0	59.0
Over 30 lbs.	89	99	188	5.8	6.3	12.1

[1] Estimated total industry shipments including intra-plant and inter-plant transfers.

[2] Includes TR, ATR, Pre-TR, discharge, spark gaps, noise sources, and other switching devices.

[3] Includes radiation detection tubes; beam deflection tubes; decade counters, electronic switches; orbital beam tubes; and vacuum capacitors, switches and gauges; excludes X-ray tubes.

[4] An insignificant quantity and value of shipments of TV picture tubes for military applications are combined with non-military shipments to avoid disclosure of proprietary information.

[5] Includes diodes and rectifiers made from materials other than silicon and germanium, tunnel diodes, controlled rectifiers, solar cells, and other special semiconductor devices which must be combined to avoid disclosure of proprietary information.

[6] Includes packaged component assemblies (PEC's, PAC's, couplates, etc.), modules assembled from purchased components, and modules manufactured from components which were fabricated during the manufacturing process.

[7] Includes coaxial, stepping switches, thermal, motor driven, and other relays.

[8] Includes composition (film), moulded carbon, and metal film.

[9] Includes deposited carbon, conductive plastic, and metal film.

[10] A small quantity (and value) of shipments for non-military applications are combined with military shipments to prevent disclosure of proprietary information.

Source: The quarterly Joint Survey of Production Capabilities for Electronic Parts conducted by the Electronics Production Resources Agency of the Department of Defense, and the Electronics Division, BDSA.

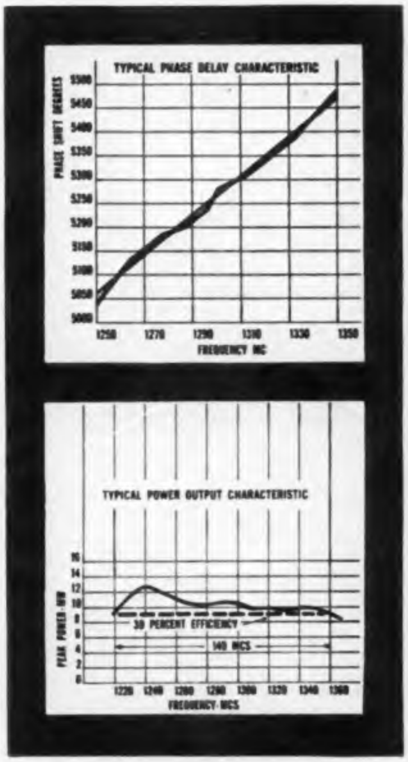
New Broadband Klystrons

140 MEGACYCLES - (1db) BANDWIDTH AT L-BAND
10 MEGAWATTS - PEAK POWER OUTPUT

New additions to the Litton Industries Broadband Klystron family extend broadband performance to even higher power levels as shown in the typical performance curves to the right. These tubes, like all those produced by Litton Industries, are conservatively designed and rated; and rigorously processed to provide many thousands of hours of reliable operation. Using Litton developed broadbanding techniques, it is now possible to achieve wide bandwith, high peak and average rf power output and linear phase shift versus frequency characteristics simultaneously. This latter feature enables the radar equipment designer to utilize pulse compression techniques to attain improved system performance.

Litton Klystrons providing these outstanding performance characteristics can be supplied in both the L and S-bands at peak rf power levels ranging from 2 to 20 megawatts. Typical of the performance obtained with Litton Klystrons is that of the L-3035, a 2.2 megawatt L-band Klystron, whose average operating life in field service is approaching 3,000 hours. Some of these tubes are continuing to provide excellent service after having operated for more than *17,000* hours.

Should you require high power broadband amplifier tubes to satisfy your system requirements, please write to us at Litton Industries, Electron Tube Division, 960 Industrial Road, San Carlos, California. Our telephone number is LYtell 1-8411.



LITTON INDUSTRIES
Electron Tube Division
MICROWAVE TUBES AND DISPLAY DEVICES

"Capability that can change your planning"

Please write direct to the above advertiser

New Tech Data for Engineers

Medical Electronics

Information on their new B-30ATP Bio-pack from the Medical Electronics and Bionics group, Litton Systems, Inc., 5500 Canoga Ave., Woodland Hills, Calif. New unit is the first in a series of miniaturized instruments for medical electronics application and is a self-contained package incorporating a subminiature transistorized differential amplifier and a companion FM transmitter.

Circle 160 on Inquiry Card

Timing Motors

Description of the new Series MD-83 Direct-Current Timing Motor. The new motor is a permanent magnet type employing commutator and brushes of improved construction. Folder gives construction features and operating advantages of the new Haydon Timing Motor. Dimensional data drawings and complete information on ratings and availability of components are also included. Haydon Div., General Time Corp., 245 East Elm St., Torrington, Conn.

Circle 161 on Inquiry Card

Connectors

A 4-page bulletin on electrical connectors, receptacles, switches and lighting products. Included in Bulletin B81 are illustrations, specs and suggested applications for standard and custom - built electrical connectors. Also featured are general descriptions of lighting products, including lamps, sockets and connectors, information on pushbutton switches in 2, 4 and 6 button and toggle-switch styles, and cable vulcanizers, both stationary and portable types. Joy Mfg. Co., Electrical Products Div., 1201 Macklind Ave., St. Louis 10, Mo.

Circle 162 on Inquiry Card

Solid State Switching

Brochure discusses "Resonant Transfer" technique for generating or detecting pulses in time division solid state switching. It discusses the advantages of time division switching, compares it to space division and electro-mechanical switching, and presents a comprehensive explanation of its function, operation and maintenance. North Electric Company, Galion, Ohio.

Circle 163 on Inquiry Card

Transistors

Specifications sheet on PNP Alloy junction transistors covers types 2N1118, 2N1118A and 2N1119. It describes the electrical and physical characteristics of these transistors and lists min. and max. ratings of the parameters. Sperry Semiconductor Div., Sperry Rand Corp., Norwalk, Conn.

Circle 164 on Inquiry Card

Thermal Analog Tube

THERMION Technical Report 7-8-9, 4-pages brochure describes Thermion's value in determining thermal reliability for vacuum tubes. Tube Equivalence Chart included. Rescon Electronics Corp., 151 Bear Hill Rd., Waltham, Mass.

Circle 165 on Inquiry Card

Display Devices

Brochure compares electro-mechanical characteristics of industrial cathode ray tubes and recording storage tubes. Entitled "Display Devices," it details 65 industrial CR tube types and 7 single and dual-gun, recording storage tube types. A chart lists types offered by all manufacturers in numerical order, indicating the physical and electrical characteristics, typical applications and operating conditions of each. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass.

Circle 166 on Inquiry Card

Focus Coil

Advance Technical Bulletin gives dimensional drawing, electrical data tables, and description of new Type F40 dynamic focus coil which provides sharp overall focusing for 1½" neck dia flat faced large angle CR tubes used in high resolution applications such as 1000 line TV, radar, and advanced photo displays. Syntronic Instruments, Inc., 100 Industrial Rd., Addison, Ill.

Circle 167 on Inquiry Card

Cable Ties

Nylon cable ties and straps for securing and identifying wiring bundles are described in a new 4-page bulletin, TR 3. It shows applications, lists the complete line, and gives installation instructions. The Thomas & Betts Co., 36 Butler St., Elizabeth, N. J.

Circle 168 on Inquiry Card

Potentiometers

A 2-color, 6-page brochure outlines precision wire wound potentiometers and turns counting dials. It contains complete tech specs and dimensioned mounting diagrams. Spectrol Electronics Corp., 1704 South Del Mar Ave., San Gabriel, Calif.

Circle 169 on Inquiry Card

Filters

Reference data sheet (folio 14) from Sangamo Electric Co., Springfield, Ill., ties down the meanings of the terms, Transducer Loss and Insertion Loss. These are power loss measurements of interest in filter work. The article includes circuit diagrams and necessary math.

Circle 170 on Inquiry Card

Phosphorescent Molecules

New 16-page bibliography of phosphorescent compounds lists over 200 compounds as a guide to identifying solutions through their phosphorescent properties. Bibliography lists the compound, its excitation and emission wavelengths, wavelength mean lifetime, concentration, solvent, excitation source, temp., and information reference source. Also Bulletin 2334, which describes the Aminco-Keirs Spectrophosphorimeter in detail. American Instrument Co., Inc., 8030 Georgia Ave., Silver Spring, Md.

Circle 171 on Inquiry Card

Transistor Manual

The 5th edition of GE's Transistor Manual ($1.00). New edition contains 4 new chapters and is expanded to 339 pages. New chapters include tunnel diode theory and switching circuits, tunnel diode amplifiers, feedback and servo amplifiers and test circuits. Chapters on silicon controlled rectifiers, power supplies, transistor specs and rectifier specs are expanded and revised. Transistor specs chapter contains a current listing of American JEDEC-registered transistor types with specs and interchangeability information. Semiconductor Products Dept., General Electric Co., Kelly Bldg., Liverpool, N. Y.

Circle 172 on Inquiry Card

Channel Shifters

Audio channel shifters and restorers for use primarily with double or single-sideband radio systems are described in bulletins from Westrex Communications Equipment Dept., 540 W. 58th St., New York 19, N. Y. The Type 86 multiplexes two 3-kc voice channels, one occupying 250-3000 CPS and the 2nd heterodyned upward to 3250 to 6000 CPS. Composite transmitted signal is received normally and receiver audio output is fed to a Type 526 restorer which separates and restores both channels to intelligible form. Complete descriptions, including specs included.

Circle 173 on Inquiry Card

Angle Indicator

Tech data sheet, C02721027, from Kearfott Div., General Precision, Inc., Little Falls, N. J., describes a precise Angle Indicator which provides accurate numerical indication of the angular position of any mechanical device to which remote two-speed dual transmitters can be coupled. Some specs (Single-speed and 2-speed in order): Accuracy, ±6 min.—±15 sec; Repeatability, 1.2 min.—12 sec.; Resolution, 6 sec. (direct); Power, 115 v., 400 CPS, 1-phase, 30 va.

Circle 174 on Inquiry Card

ELECTRON TUBE NEWS ...from SYLVANIA

3 new Gold Brand types expand industry's widest line of 26.5V SUBMINIATURE TUBES

Sylvania Gold Brand 26.5 Volt Subminiature Tubes afford dramatic opportunities for improved design of compact, reliable communications, telemetering and guidance equipment using a 26.5 volt energy source. Now, the Sylvania premium subminiature tube line includes 3 new types *featuring:* New Rugged-Design 26.5V Heater • High Uniformity, Stability • Shock Resistance to 750g • Thermal Resistance to 220°C • Intense Radiation Resistance *and offering:* Compact Equipment Design • Significant Circuit Economies • Improved Equipment Reliability.

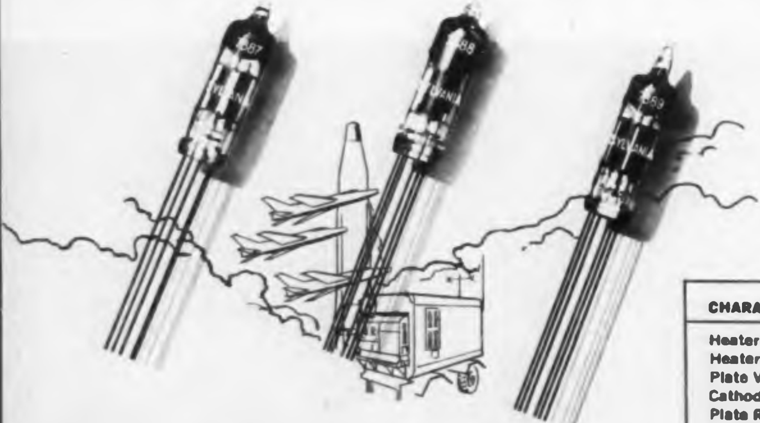
At the heart of each Gold Brand Tube is a remarkable advance in 26.5 volt heater design. This new Sylvania design makes practicable quantity-produced heaters with low heater-power requirements and high mechanical strength. The heater base is a heavy support rod (mandrel) coated with a high-temperature insulator. Extremely fine heater-wire is wound over the base, and the entire assembly recoated to form an efficient folded coil heater. In addition to utilizing the new heater design for 26.5 volt *heater* operation, five Gold Brand subminiature types operate with a B-supply of 26.5 volts, making them ideally suited for hybrid designs.

Sylvania 26.5 volt subminiature tubes simplify circuitry and reduce or eliminate components ordinarily required for the conversion of the "natural" supply voltage. Series string and associated problems can be eliminated. Too, inherent tube resiliency to plate and screen voltage surges eliminates the need for compensating circuits. Result: enhanced equipment reliability, significant cost reductions.

New, Improved Specifications assure uniform, reliable, high-performance tubes capable of withstanding impact acceleration tests of 750g, fatigue tests of 2.5g and ambient bulb temperatures of 220°C. All Sylvania Gold Brand Subminiature Tubes are rigidly disciplined by tighter controls on lot variables, improved AQLs and increased test requirements. As an example, plate current and Gm must meet an AQL of 0.4%. Life tests for 100, 500 and 1000 hours provide a quantitative determination of end-points such as shorts, heater current, plate current, Gm, insulation resistance, interface impedance. Further, Gold Brand subminiature types are capable of withstanding radiation dose rates (fast neutrons) of 10^{12}NV and accumulated radiation of 10^{16}NVT.

Specify Sylvania Gold Brand Subminiature Tubes. Other Gold Brand types that can be designed with the Sylvania 26.5 volt heater include prototypes: 5719, 5899, 5977, 6205 and 6206. Learn more about the advantages of Sylvania subminiature types for your critical design from your Sylvania Sales Engineer.

For data on specific types, write for the FREE 84-page Gold Brand 26.5 Volt Subminiature Tubes Booklet to Electronic Tubes Division, Sylvania Electric Products Inc., Dept. M, 1100 Main Street, Buffalo 9, N. Y.



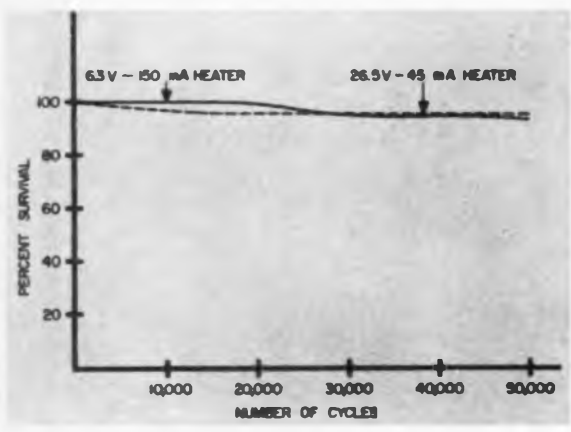
SYLVANIA—7887. Medium-mu double triode; 26.5V, 90mA heater with 100V Eb; designed for oscillator, amplifier and low-power servo circuits.

SYLVANIA—7888. High Gm, medium-mu triode; 26.5V, 45mA heater with 100V Eb; designed for use as a UHF oscillator as well as low-frequency oscillator and amplifier applications.

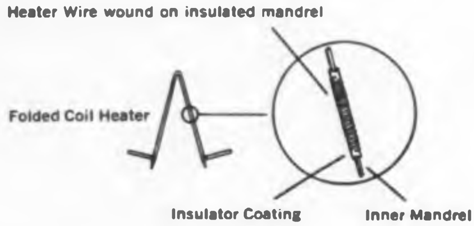
SYLVANIA—7889. High-mu double triode; 26.5V, 45mA heater with 100V Eb; intended for low level audio circuits.

CHARACTERISTICS	7887*	7888	7889*	UNITS
Heater Voltage	26.5	26.5	26.5	V
Heater Current	90	45	45	mA
Plate Voltage	100	100	100	Vdc
Cathode Resistor	220	150	1500	Ohms
Plate Resistance	4000	—	—	Ohms
Transconductance	5000	5800	1800	µmhos
Amplification Factor	20	27	70	—
Plate Current	8.5	8.5	0.8	mAdc
Grid Voltage				
Ib = 100 µAdc Max.	−9	−7	—	Vdc
Ib = 50 µAdc Max.	—	—	−2.8	Vdc

*Each Section



Typical test results for the Sylvania 26.5 volt heater compare very favorably with a 6.3 volt heater of known high reliability. Testing for both types was performed at 120% of rated heater voltage.

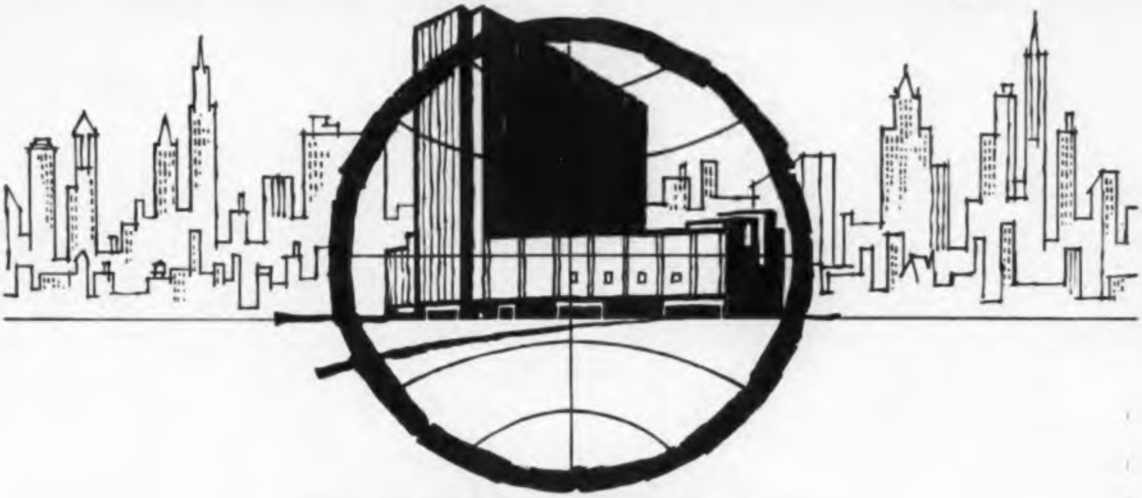


Sketch shows enlarged view of new Sylvania 26.5V heater.

SYLVANIA

N-9171-3 *Subsidiary of* **GENERAL TELEPHONE & ELECTRONICS**

NEW YORK • WORLD CENTER FOR RADIO-ELECTRONICS • 1961



INTERNATIONAL CONVENTION □ □ AND IRE SHOW

□ □ MARCH 20-23 □ □

Visitors from all over the world will converge on the Coliseum, March 20-23, for IRE's big Show and International Convention. Join the more than 65,000 radio-electronics engineers who will attend! □ On the Coliseum's **4** gigantic floors you'll see the latest production items, systems, instruments and components in radio-electronics; in radar; in complex air traffic control; in space communications — in any and every field of radio-engineering you care to name. □ At the convention, you'll trade ideas with brilliant delegates from the world of radio-electronics, and choose from amongst scores of papers to be read by experts in their field. Like the IRE show, the convention is both a summing-up and a look into the future!

Registration: IRE members $1.00—non-members $3.00
No one under 18 years of age will be admitted.

Remember the occasion, the time, the place:

INTERNATIONAL CONVENTION and IRE SHOW • WALDORF-ASTORIA HOTEL • COLISEUM • NEW YORK CITY

MARCH 20-23 1961

The Institute of Radio Engineers
1 East 79th St., New York 21, N. Y.

REMEMBERS THE MAN

IRE

 Circle 80 on Inquiry Card

New Tech Data for Engineers

Systems Engineering

Application notes describe how to assemble systems for precision measurement of pressures, forces, and temperatures, and determination of ratios, summations, integrals, mass flow rates, and center-of-gravity are contained in a 44-page Systems Engineer's Handbook. Includes specifications of compatible FM system building-block components. Wiancko Engineering Co., 255 N. Halstead, Pasadena, Calif.

Circle 175 on Inquiry Card

Microwave Measurements

Application Note #5, "Microwave Antenna Pattern Measurements with the BA-7 Video Crystal Receiver", from Weinschell Engineering, 10503 Metropolitan Ave.. Kensington, Md., It describes simple antenna pattern measuring instrumentation based on this model Video Crystal Receiver. It is easier to operate and of equal or broader frequency coverage than instruments based upon either barretter or heterodyne receivers.

Circle 176 on Inquiry Card

Constant Current Supply

Spec sheets from Quan-Teck Laboratories, Inc., Po. Box 187,60 Parsippany Blvd., Boonton, N. J. describe their Model 151B Constant Current Supply. It features constant, highly regulated current output from 0.05 to 500 ma; max. open circuit voltage variable from 2 to 20 v; transistorized circuitry; current and open circuit voltage indicated on meter; capable of external ac modulation, and excellent stability.

Circle 177 on Inquiry Card

Tunnel Diode Applications

Four-page application bulletin (# 2106) deals with the charcteristics and applications of tunnel diodes. It discussed the significant characteristics of tunnel diodes and their application in amplifiers, oscillator, and high speed switches. Methds of obtaining parameters are described and several basic circuit designs are presented. Sperry Semiconductor Div., Sperry Rand Corp., Norwalk, Conn.

Circle 178 on Inquiry Card

Instruments

Thirty-page catalog from Ideal-Aerosmith Div., Royal Industries, Inc., 3913 Evans Ave., Cheyenne, Wyoming, describes the Company's line of barometers, and rate and motion tables. Included are operating principles, design principles, specifications, etc.

Circle 179 on Inquiry Card

Power Switches

Power class vacuum switches (high voltage interrupter devices) use a vacuum as a dielectric. These switches are described in a brochure from Jennings Radio Manufacturing Corp., Vacuum Electronic Components, 970 McLaughlin Ave., P. O. Box 1278, San Jose 8, Calif. Advantages include: reduction in size and weight, rapid recovery of very high dielectric strength on current interruption so that only ½ cycle or less of arcing occurs, positive current interruption, nonflammable, nontoxic, nonexplosive, visible but enclosed and sealed contacts and arc, etc. Information includes graphs, tables, etc. for preliminary design.

Circle 180 on Inquiry Card

Ceramic Magnet

Bulletin F-600 from D. M. Steward Mfg. Co., Chattanooga, Tenn., (single-page) describes their new high intrinsic coercive force ceramic magnet. The material is specifically for making stacks for periodically focused traveling wave tubes. F-600 ceramics have a coercive force, Hc, of 2650 Oersteds, an intrinsic coercive force, iH_c, of 3550 Oersteds, and a residual induction, Br, of 2750 gausses. Temp. coefficient of residual induction is —0.18%/°C.

Circle 181 on Inquiry Card

Insulation Chart

A quick informational reference on high-temperature insulation materials for electrical, electronic, avionic, and nuclear applications from Mycalex Corp. of America, 125 Clifton Blvd, N. J. It details the commonly-used plastic and ceramic insulating material. It also lists fahrenheit temp. limits for 88 materials and a table of thermal expansion coefficients of 57 insert metals and insulating materials.

Circle 182 on Inquiry Card

Powder Core Manual

New edition of its standard Powder Core Manual from Magnetics, Inc. Butler, Penna. It includes practical and tech data on applications of moly-permalloy powder cores. The 43-page manual (PC-203-R) has been arranged to aid filter designers in selecting cores for inductors throughout the audio and low frequency ranges. Dimension data on the company's line is included. Also tables and curves covering temp., inductance dc winding resistance, and other electrical characteristics.

Circle 183 on Inquiry Card

Travel Switch

This 2-page data sheet covers adjustable differential travel switch, 10BS210, which has a 0.0025 in. min. differential travel adjustable to 0.007 in. Sheet includes dimension drawing, operation diagrams, and electrical and operating characteristics. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 184 on Inquiry Card

Silicon Diodes

A new line of silicon Micro Mesa Diodes with reverse recovery as fast as 2 nanosec. and 2 picofarad capacitance described in brochure from Pacific Semiconductors, Inc., 12955 Chadron Ave., Hawthorne, Calif. Eleven types, including electrical equivalents of EIA types 1N904 through 1N916, make up the line. Brochure has curves, characteristics, and ratings.

Circle 185 on Inquiry Card

Variable Resistors

Catalog sheet describes line of Model 7 linear motion variable resistors. It describes the 6 basic types and 60 models. Both wirewound and composition types are covered with printed circuit and Teflon leads. Centralab, The Electronics Div. of Globe-Union, Inc., 900 East Keefe Ave., Milwaukee 1, Wisconsin.

Circle 186 on Inquiry Card

Computer Diodes

Information available from Hughes Aircraft Co., Semiconductor Div., 500 Superior Ave., Newport Beach, Calif., on their new gold-bonded silicon diode which has a guaranteed recovery time of half a nanosec. It can switch and recover so fast its actual storage time cannot be measured on the finest laboratory traveling wave oscilloscope—the guarantee is only to accommodate the measuring limits of standard sampling scopes. Typical capacitance for the total diode is 0.7 picofarads. Rectification efficiency is 25% at 13.5 KMC.

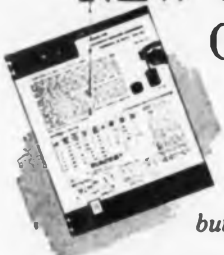
Circle 187 on Inquiry Card

Microwave Filters

Latest issue of "PRD Reports", Vol. 7, No. 1, is entitled "Microwave Filters." The 12-page paper discusses the present state-of-the-art of microwave filter design. Various techniques for designing filter are described and their advantages and limitations are considered. A bibliography is included. PRD Electronocs, Inc., 202 Tillary St., Brooklyn, N. Y.

Circle 188 on Inquiry Card

NEW DESIGN DATA ON MAGNETIC AMPLIFIERS



—latest ARNOLD folder enables you to design and build a unit to your exact needs.

Armed with the data in this folder, you can create an optimum design for a 12-watt magnetic amplifier . . . get the closest possible control over its design and construction . . . for control of servo motors, regulated power supplies, etc.

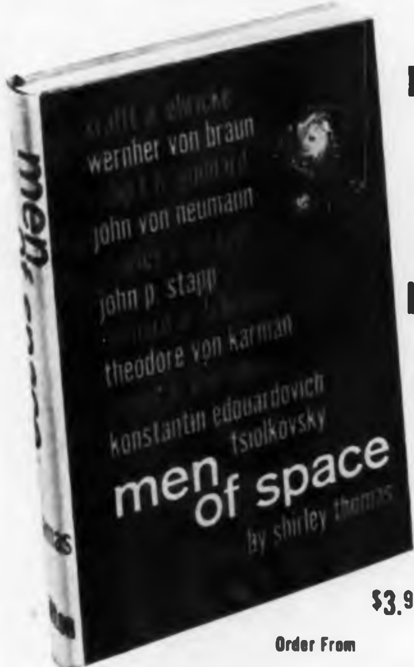
You build the amplifier around its basic component — the saturable reactor. Twenty-four ARNOLD saturable reactors are described in the folder. There's full information as to what associated components are necessary, and how to use the components in a proper magnetic amplifier circuit.

In buying just the saturable reactor, you get far more latitude than in buying a whole black box. And you won't have to prepare comprehensive specs., or depend on an outside source for the complicated designs.

Write for new Arnold Catalog. It's yours for the asking.

ARNOLD MAGNETICS CORP.
6050 W. Jefferson Blvd., Los Angeles 16, Calif.
VErmont 7-5313

Circle 70 on Inquiry Card



10 Profiles of World Space Leaders

$3.95

Order From

Chilton Company • Book Division

Chestnut at 56th Street, Philadelphia 39, Pa.

TIMES

DATACABLE

A COMPLETE SERIES OF DATA-PROCESSING AND TRANSMISSION CABLE

TIMES' Datacable is the first full line of engineered cable to meet every data-system requirement, and includes—

- Miniature low-capacitance coaxial cables.
- Low mutual capacitance twisted and multi-pair cables.
- Miniature low attenuation 95 ohm system cables.
- U/L approved Teflon® insulated backpanel wire.
- Wide-band matched impedance coaxial cables.
- Large multi-conductor cables incorporating any or all of the above types.

Datacable is the result of TIMES' years of experience in cable application and design engineering for the computer industry. Select the cable for your application from the many "standard" Datacables, or let our engineers assist you in developing or adopting a cable to your special requirements.

® DuPont

TIMES WIRE & CABLE DIVISION
The International Silver Company
WALLINGFORD, CONNECTICUT U.S.A.

Clip This Coupon To Your Calling Card or Letterhead

Please rush FREE literature on:

- ☐ Coaxial Cables
- ☐ Data Transmission Cables
- ☐ Multi-Conductors & Hook-up Wire
- ☐ For Info. Only ☐ Have Rep. Call

Circle 71 on Inquiry Card

New Tech Data for Engineers

Anechoic Chamber

Brochure describes the simplest box type anechoic chamber as well as the transverse baffle type, aperture type, and the latest longitudinal baffle type, with details of construction with illustrations of each type of chamber built by the Company to meet requirements of frequency range, working conditions, etc. Typical specs are included. Emerson & Cuming, Inc., Canton, Mass.

Circle 189 on Inquiry Card

Fasteners

Catalog No. 960, a 64-page design manual, focuses attention on reduced dimension, lightweight types of self-locking fasteners. It provides the design engineer with a package of nut shapes useful in the assembly of units for avionic and electronic end use. Special emphasis is placed on clinch types including a new floating type of blind fastener and 2 new right angle bracket nuts for panel and cover assemblies. Instructions on "how to install" are presented; tools and production methods illustrated. Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J.

Circle 190 on Inquiry Card

High Vacuum Line

New short-form catalog describes the high vacuum equipment line of the company's vacuum tube products division. Included are descriptions of gauge tubes and controls and ion pumps. Hughes Aircraft Co., Vacuum Tube Products Div., Marketing Dept., 2020 Short St., Oceanside, Calif.

Circle 191 on Inquiry Card

High Voltage Capacitor

Booklet ED-T101 describes a new glass cased high voltage capacitor series called Efcon "Glasscon" Type AG. For high voltage dc use, 600 to 60,000, these capacitors are hermetically sealed in heavy walled glass (or ceramic) tube. Operational factors covered include temp. range, ripple voltage, dielectric strength, power factor, insulation resistance and capacitance change. Rating and selection charts included. Efcon, Inc., Patterson Place, Roosevelt Field, Garden City, L. I., N. Y.

Circle 192 on Inquiry Card

Facilities

New 12-page, 2-color brochure describes facilities of Monitor Systems, Inc., a subsidiary of Epsco, Inc., Dept. 8, Ft. Washington Industrial Park, Ft. Washington, Pa., for engineering and production of advanced systems for high speed process monitoring, production testing, and automatic check-out.

Circle 193 on Inquiry Card

Voltage Comparators

Two-color, 6-page bulletin on NLS Series 50 transistorized voltage comparators used for critical go/no-go applications. Bulletin describes the Model 50 voltage comparator and the Model 51 voltage comparison amplifier. Uses of voltage comparators are discussed and applications listed. A problem and solution section shows how to design complete go/no-go testing systems and how to select the correct voltage comparator or comparison amplifier for numerous applications. Features are covered as well as detailed tech. information, specs and operation information. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 194 on Inquiry Card

Temperature Chambers

Four-page folder describes 1 to 10 ft.^{3} units designed for lab and job shop where temps. from −150 to +300°F are required. Space saving, low cost mechanical units are pictured, along with accessories and special controls. Also: A new 12-page tech. article on sub-zeroing and its benefit to gear and pinion production. Cincinnati Sub-Zero Products, 3930 Reading Rd., Cincinnati 29, Ohio.

Circle 195 on Inquiry Card

Relays

Engineering bulletin covers Series "V" subminiature relay. The new relay, is designed to meet severe environmental requirements of present-day prototype missiles. Bulletin includes features, applications, specs, mounting styles, type designation and detail data. Filtors, Inc., Port Washington, N. Y.

Circle 196 on Inquiry Card

Electromagnets

Technical brochure on laboratory electromagnets from Varian Associates, Instrument Div., 611 Hansen Way, Palo Alto, Calif. Included are documented tech. specs and graphic illustrations showing performance. A special section, with dozens of illustrative magnetic field homogeneity plots, describes obtainable performance with numerous pole cap configurations on Varian Electromagnets. The pole cap section concludes with a discussion of pole cap selection for particular performance characteristics.

Circle 197 on Inquiry Card

DC Blowers

Two-page bulletin 540 describes VAX-3-BD vaneaxial dc blowers that produce 65 cfm at 1.6 in. H_2O, weigh 1 lb., and are 3 in. in diameter. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 198 on Inquiry Card

Transistor Amplifier

Harco Laboratories, Inc., New Haven, Conn., offers Bulletin 204, which illustrates and describes their new high gain, low power drain, plug-in type transistor amplifer for thermocouple null device application in environmental temps from −10°F to +175°F. Features, performance data, and specs provided.

Circle 199 on Inquiry Card

Coaxial Filters

A 4-page illustrated brochure of coaxial microwave filters describes ganged or individually tuned coaxial resonant cavity devices which operate over 2.1 to 5.9 KMC. A description elaborates on techniques used for miniaturization, frequency stability, diplexing and mixing functions as well as special system requirements. Series of standard coaxial bandpass filters are described with tech. data. Other multisection filters are illustrated. Waveline Inc., Caldwell, N. J.

Circle 200 on Inquiry Card

Video Amplifier

A 4-page application note, "Video Amplifiers Using the 2N741 Mesa Transistor," describes design of high-quality video amplifier circuits. The 2-color note includes circuit schematics, performance curves, and photographs of a completed 10-mc amplifier. Eleven illustrations supplement the text. Technical Information Center, Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Ariz.

Circle 201 on Inquiry Card

Multiple Connectors

Illustrated 6-page folder describes a complete line of pin-and-socket type multiple connectors. Folder details electrical and mechanical characteristics of the pin-and-socket connector line (called AMPin-cert). It also lists features of the 5 types of contacts available in the AMPin-cert line, and the features of the connector shells and inserts. A list of AMPin-cert connector accessories available is also given. Two of the 6 pages describe AMP solderless techniques. AMP Inc., Harrisburg, Pa.

Circle 202 on Inquiry Card

Servo Motors

Technical data sheet on Type E 131A, size 15, precision hi-temp, low interia servo motor. It meets military environmental specs. Included are torque curves, outline drawing, schematic, illustration of motor and mechanical, physical and electrical performance characteristics. John Oster Mfg. Co., Avionic Div., Racine, Wis.

Circle 203 on Inquiry Card

NEW

a NEW of user benefits...

MODEL 801H

0 to 500V

INFINITE INPUT RESISTANCE AT NULL

UNKNOWN VOLTAGE

REFERENCE VOLTAGE

NEW! **1MV FULL SCALE NULL SENSITIVITY—RECORDER OUTPUT—AUTOMATIC LIGHTED DECIMAL—IN-LINE READOUT—TAUT BAND SUSPENSION METER**

precision DIFFERENTIAL DC VOLTMETER

PARTIAL 801 H SPECIFICATIONS

Voltage Ranges:	0.5, 5, 50 and 500V DC
Accuracy:	0.05% from 0.1 to 500V 0.1% or 50uv, whichever is greater, below 0.1V
Null Sensitivity Ranges:	10V, 1V, 0.1V, 0.01V and 0.001V
Maximum Meter Resolution:	5uv
Input Impedance:	Infinite at null
Dimensions:	Cabinet 9¾" W x 13½" H x 14" D Rack 19" W x 8¾" H x 13¼" D
Weight:	Cabinet 25 lbs., Rack 28 lbs.
Price:	Cabinet $555.00, Rack $575.00 Prices F.O.B. factory, Seattle

Extreme accuracy and stability are achieved by advanced circuit design which incorporates a chopper stabilized null amplifier and a standard cell reference.

Write for complete specifications.
Also ask for information on the jf A-70 recorder, companion to the 801H, and the Model 803.

JOHN FLUKE MFG. CO., INC.
P. O. BOX 7161 SEATTLE 33, WASH.

New Products . . . for the Electronic Industries

HYBRID JUNCTION TEES

Series of matched and unmatched Hybrid Junction Tees (also known as E/H or Magic Tees) consist of a section of waveguide upon which a series and shunt waveguide arm are mounted at the exact midpoint. Matched

tees are equipped with appropriate iris or ramp matching devices. Design and fabrication techniques result in excellent reduction of VSWR values relatively wide bandwidths. Also isolation between the shunt and series arm is greater than 35 db over the applicable freq. range. Units are constructed of silver brazed brass which is silver plated and finished in instrument grey enamel and all arms are provided with standard waveguide cover flange connectors. Waveline Inc., Caldwell, N. J.

Circle 217 on Inquiry Card

POWER DIVIDER

A 6-way resistive power divider consists of 7 symmetrical arms (1 input, 6 output) spaced radially about a hub. Resistive networks within the arms provide impedance matching up to 3000 MC. Unit is electrically symmetrical, and any arm or arms can be used as inputs, the remaining arms for outputs. Dividers are normally furnished with all female connectors in either the N, BNC, TNC, C, or HN series but can be supplied with any combination of male and female con-

nectors. They have an input and output VSWR of 1.2, and impedance of 50 ohms, a power rating of 2 w, and meet MIL-E-5272. Microlab, 570 West Mt. Pleasant Ave., Livingston, N. J.

Circle 218 on Inquiry Card

PRECISION SWITCHES

Silicone boot provides flexible seal between case and operating pin and with a permanent seal between base and cover of switch case, the 2HL260 series of precision switches gives long, reliable service under adverse en-

vironmental conditions. It is listed by Underwriters' Labs., Inc. for single-pole, double-throw operation at 2 hp 250 vac, 1 hp 125 vac, 20 a 125 vac. Basic switch is 11/16 in. wide, 1-15/16 in. long, 13/16 in. high and has 2 mounting holes on 1-in. centers. Series also includes leaf, roller-leaf, and hinged-lever actuator styles. Switches can be furnished with solder-lug, screw-type, or snap-on terminals. UNIMAX Switch Div., The W. L. Maxson Corp., Ives Rd., Wallingford, Conn.

Circle 219 on Inquiry Card

XY RECORDER

New Model HR-93 XY Recorder has an electric pen lift mechanism allowing point plotting, family curve tracing and rapid non-recording pen indexing. The pen lifter can be operated with the hand held manual control box or can be tied into test circuitry for automatic operation. A load-operate switch automatically picks up the pen and indexes it away from the chart area so that the graph paper may be loaded easily with no trace appearing on the chart. After

loading, the pen is held so that no trace appears when indexing back to the original position. Accuracy is ½% with 7½ in/sec. pen speed on both axes. Houston Instrument Corp., P. O. Box 22234, Houston 27, Texas.

Circle 220 on Inquiry Card

CARBON POTENTIOMETER

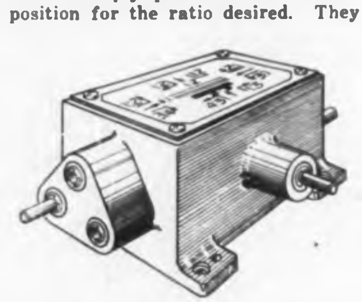
New Resiston® carbon Trimpot® potentiometer provides reliability at operating conditions up to 150°C. Model 3051, features a high temp. carbon deposited on an inert and moisture proof ceramic base. It is completely

sealed against humidity, exceeding requirements of MIL-STD-202A, Method 106. The total resistance shift is less than 5% and insulation resistance is 100 megohms min. Specs: Resistance range, 20K to 1 Meg; End settings, 1.0% max. voltage ratio; Power rating, 0.25 w at 50°C; Resolution, infinite; Operating temp., −65 to +150°C; Mechanical life, over 200 cycles; Size, 1.25 x 0.32 x 0.19 in.; Weight, approx. 0.1 oz. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

Circle 221 on Inquiry Card

MULTI-RATIO GEAR BOX

Universal Multi-Ratio Gear Box, a developmental speed reducer and increaser, with 10 basic ratios (5 reductions and 5 increases), eliminates the need for a number of single ratio units. Standardized mounting dimensions insure quick, accurate assembly with all hangers, breadboard plates and development components. No tools or critical adjustments are necessary when changing ratios—the box is simply placed in the correct position for the ratio desired. They



are in ⅛, 3/16 and ¼ in. shaft sizes, with ball or oil-less bearings. Assemblies have less than 30 min. backlash through the entire gear train. PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.

Circle 222 on Inquiry Card

TWO GREAT NEW RECTIFIERS from PSI...

MICRO-RECTIFIERS

UP TO 10,000 PIV IN A .075 CUBIC INCH PACKAGE!

Type	PIV	RMS In	I_o@25°C	I_o@100°C
PS2422	2000	1400	50	25
NINE TYPES PS2422 THRU PS2430				
PS2430	10000	7000	50	25

- No voltage derating to 150°C
- 1/5th size of comparable units
- Reliability ≥ conventional size
- Easy mount – printed circuits

SUPER FUSE CLIP RECTIFIERS

.5AMP @ 1500V thru .2AMP @ 20,000V PIV!

Type	PIV	RMS In	I_o@25°C	I_o@100°C	Power
PS1441	1500	1050	500	250	2.8
TWENTY TYPES PS1441 THRU 1460					
PS1460	20,000	14,000	200	100	8.6

- No voltage derating to 175°C
- Optional wiring terminals
- Shatter-proof body
- Excellent moisture integrity

- **ALL WELDED CONSTRUCTION**
- **EXCEEDS MIL-S-19500B REQUIREMENTS**
- **IMMEDIATE DELIVERY ALL TYPES**

The above types are examples of the broad line of PSI Special Assemblies. This line features 1N1730–1N1734, 1N2382–1N2385, 1N430, 1N430A and many Bridges, Rectifiers and Regulators in Micro and conventional sizes.

For further information phone, wire or write any PSI sales office or authorized distributor. Ask for new 24-page "PSI Special Assemblies Brochure".

PSI *Pacific Semiconductors, Inc.*

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE, INC.

12955 CHADRON AVENUE, HAWTHORNE, CALIFORNIA

Facilities in Hawthorne, Culver City and Lawndale, California

Circle 73 on Inquiry Card

New Products . . . for the Electronic Industries

VACUUM TUBE VOLTMETER

Vacuum Tube Voltmeter, Model 850, features Superior Voltage Measuring capabilities, plus resistance ranges to 1000 Megohms; 5 v full scale range on dc; Useful in low voltage transistor circuits; Meter is

connected in cathode circuit of 12AU7 for stability; Long full view scales, Scales 7" long at top arc; Electrical protection of meter against burnout; Frequency Range-from 15 CPS to 3 MC; Separate scale for peak-to-peak readings; Single Unit Probe — with built-in switch for AC/DC/OHMS; 11 Megohm input resistance on all dc voltage ranges Ac impedance is min. 0.83 megohm. The Triplett Electrical Instrument Co., Bluffton, Ohio.

Circle 223 on Inquiry Card

LIGHT IMAGE INTENSIFIER

New high vacuum tube — type WX-4047—intensifies light radiation. It produces an image of reduced size whose brightness is increased by a factor of 2500 (min.) for actinic blue input radiation, by 1,000 for input radiation at a color temp. of 2870°K. It uses a short-persistence P15 phosphor. Brightness decays to 10% in 2.0 µsec. Input resolution is 75 line pairs/in. and its threshold for imaging is approx. 10^{-7} foot-candles. Max. ratings are 30 kv (anode screen to

photocathode) and a 1 ma peak pulse anode screen current. Weight is 6⅛ lb. Max. dia is 8-11/16 in. Length is 15¾ in. Westinghouse Electronic Tube Div., P. O. Box 284, Elmira, N. Y.

Circle 224 on Inquiry Card

DIGITAL READOUT

Sub-panel mounted, miniaturized digital readout is mounted 13/16 in. behind a lucite viewing screen. Readout rear-projects the digit onto the viewing screen. The Series 120ooo digital readout for use with digital

computers, control equipment, instruments, aircraft equipment, production and inventory controls, and other electronic or electrical test equipment. Size of the character displayed is ⅝ in. high. The light source comes from subminiature lamps, No. 327, 328 or 330. Voltage is from 6 v. to 28 v. Dimensions are 3⅛ x 1 x 1 5/16 in. Weight, 3¼ oz. Industrial Electronic Engineers, Inc., 5528 Vineland Ave., N. Hollywood, Calif.

Circle 225 on Inquiry Card

BAND PASS FILTERS

Series of miniaturized, tuneable and rugged band pass filters. Available at center freq. from 100 to 4000 MC in dual or triple section units and with either type BNC, TNC, N or C connectors. Specs: Insertion loss 1.0 db max. and VSWR 1.10 max. at the center freq.; band pass ripple ± 0.5 db, power handling 100 w CW, impedance 50 ohms, nom. tuning range ±5% times the center freq. and the bandwidth at the 3 db points is from 1 to 5% depending on the center freq. Skirt selectivity for the dual

section is 25 db min. at 1.25F° and 35 db min. at the sec. harmonic and for the triple section is 35 db min. at 125F° and 55 db min. at the sec. harmonic. Maury & Associates, 10373 Mills Ave., Montclair, Calif.

Circle 226 on Inquiry Card

PC TEST JACK

Short, printed circuit test jack for closer back-to-back mounting of printed circuit boards. The new unit can be mounted closer because the length of the contact sleeve below the printed circuit board has been re-

duced. It includes a small diameter nylon insulator (in 9 standard colors), a beryllium-copper, spring-pin contact, and a silver and gold-plated contact sleeve for ease in soldering. Constructed to military material specs, the units are easily mounted by inserting them into pre-drilled circuit board holes and connected by dip-soldering. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass.

Circle 227 on Inquiry Card

SLIDING PISTON

A new type of variable trimmer capacitor with a sliding piston for use with cam driven mechanisms for fine tuning action and long life. Trimmers available in capacitance values from 0.6 to 90 pf in glass or quartz dielectric, in standard, differential, split stator, open or sealed construction. Other features: Stability—quartz and invar construction has zero temp. coefficient. Low loss and low inductance for high freq. use. No derating up to 125°C for glass dielectric (150°C for quartz). Shock and

vibration resistant. Gold plating over special alloy for r-f conductivity and freedom from silver migration. High Q dissipation factor. JFD Electronics Corp., 6101 16th Ave., Brooklyn 4, N. Y.

Circle 228 on Inquiry Card

Please write direct to the above advertiser

New Products

FEED-THRU CONNECTOR

For use with Printed Circuit Boards or Plyo-Duct (flat multi conductor cabling), feed-thru connector, series FTD 1500, employing a trifucated contact which can withstand and exceed vibration requirements of

MIL-E-5272. Presently available in 15 contacts on 0.100 in. centers for a nom. card opening of 0.062 in., and employing glass filled Diallyl Phthalate as a Dielectric. Methode Mfg. Corp., 7447 W. Wilson Ave., Chicago 31, Ill.

Circle 261 on Inquiry Card

UNIVERSAL COUNTER-TIMER

All transistor, dc to 20 MC, Universal Counter-Timer, Model 728A, provides increased reliability, reduced power consumption, size and weight. Unit is direct reading. Heterodyning techniques are not used. Power consumption is 50 w, weight is 27 lbs. Size is 7 x 17 x 12 in. It consists of 3 input channels, a special decade count-down time base which eliminates the need for divider adjustment, and a series of plug-in transistorized decade counting units. Output information from each DCU will operate digital printers, punches, inline readouts and other data processing equipment. Measurement ranges are dc to 20 MC (freq.); 0.1 μsec to 10^7 sec. (time in-

terval); 0.1 μsec (period). Accuracy is ±1 count ± oscillator stability. Sensitivity is 0.25 v. RMS; input impedance is 25 k ohms/v. Computer-Measurements Co., 12970 Bradley Ave., Sylmar, Calif.

Circle 262 on Inquiry Card

. . . *by turning FIRST to BUSS for fuses of unquestioned high quality*

By relying on BUSS as your source for fuses, you can quickly and easily find the type and size fuse you need. The complete BUSS line of fuses includes: dual-element "slow-blowing", single-element "quick-acting" and signal or visual indicating types . . . in sizes from 1/500 amp. up — plus a companion line of fuse clips, blocks and holders.

BUSS fuses are made to protect — not to blow needlessly

When you specify BUSS fuses — users of your equipment receive maximum protection against damage due to electrical faults. And just as important, users are safeguarded against irritating, useless shutdowns caused by faulty fuses blowing needlessly.

A component part that operates as intended helps to maintain the reputation of your equipment for quality and service. That's why it pays to rely on dependable BUSS fuses.

If you should have a special problem in electrical protection . . . the world's largest fuse research laboratory and its staff of engineers are at your service — backed by over 46 years of experience. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be easily serviced.

For more information on BUSS and Fusetron small dimension fuses and fuseholders . . . Write for bulletin SFB.

BUSSMANN MFG. DIVISION,
McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.

161

BUSS fuses are made to protect not to blow, needlessly.
BUSS makes a complete line of fuses for home, farm, commercial, electronic, electrical, automotive and industrial use

FUSETRON · TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION · BUSS · McGRAW EDISON

Circle 76 on Inquiry Card

New Products

ACCELEROMETER

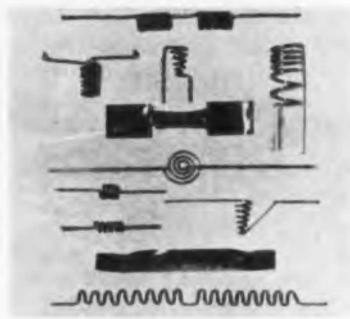
Model AA-1220, has a resonant frequency of 125 KC, providing a useful freq. range to 25 KC. It can be used to measure acceleration levels up to 15,000 g. Design minimizes dc shift in both axes. Transverse response is

less than 3%. Specs: Acceleration range: 2 to 500 g (10 ms pulse); 500 to 2,000 g (1 ms pulse); 2,000 to 15,000 g (0.25 ms pulse). Frequency Range (into 100 megohm load): 10 CPS to 25 KC. Sensitivity (min. with 4 ft. cable): 0.3 mv (RMS)/g(RMS). Capacitance (min. with 4 ft. cable): 750 μμf. Transverse acceleration: 7,500 g max. Transverse Response: 3% max. Linearity: ±2%. Operating temp.: −65° to +250°F, less than ±10% change in sensitivity from room amb. Seismic system: Bender. Standard calibration: 20 to 10,000 CPS, resonant freq. and capacitance with cable. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Circle 263 on Inquiry Card

FILAMENTS—BOATS

New line of tungsten, tantalum and molybdenum filaments and boats in a variety of sizes and shapes. For use in high vacuum as an evaporation source, they are processed to maintain a high standard of purity and accuracy. All parts are stress relieved. Primary uses include: elec-



tronic component processing, coating of optics, precision instrumentation manufacturing, and vacuum metalizing in basic research labs. Electronics Div., Allen-Jones, Inc., 1345 Gaylord Ave., Long Beach, Calif.

Circle 264 on Inquiry Card

Now Eimac's 2C39A gives you more ruggedness than any other competitive tube. *Plus* a higher maximum temperature rating of 250°. . . and less dielectric loss at higher frequencies for increased efficiency, power output. *And all at no increase in cost!* Get the only ceramic tube built to 2C39A specifications. Get it only from Eimac...world leader in power tubes, microwave tubes, amplifier klystrons. Contact your local Eimac representative for quantity price quotations. Eitel-McCullough, Inc., San Carlos, California.

New Products

RECEIVER-TRANSMITTER

New 12,000 MC microwave receiver-transmitter. The r-f equipment, Model MR-40, provides broad-band communications for very high speed data transfer and transmission of conventional telephone and teletypewriter mes-

sages. It can carry data at 62,000 characters/sec. when used with Motorola's new data transmission multiplex system. It can also handle voice, facsimile and teleprinter transmissions and control and monitor functions with 600 or more multiplexed channels. It provides 100 mw power output. Basic components are 2 reflex klystrons, one in the receiver—one in the transmitter. Each has a life expectancy of 20,000 hrs. continuous operation. It can be used with both directly aimed dish antennas and tower-mounted passive reflector configurations. Motorola Communications Div., 4501 West Augusta Blvd., Chicago 51, Ill.

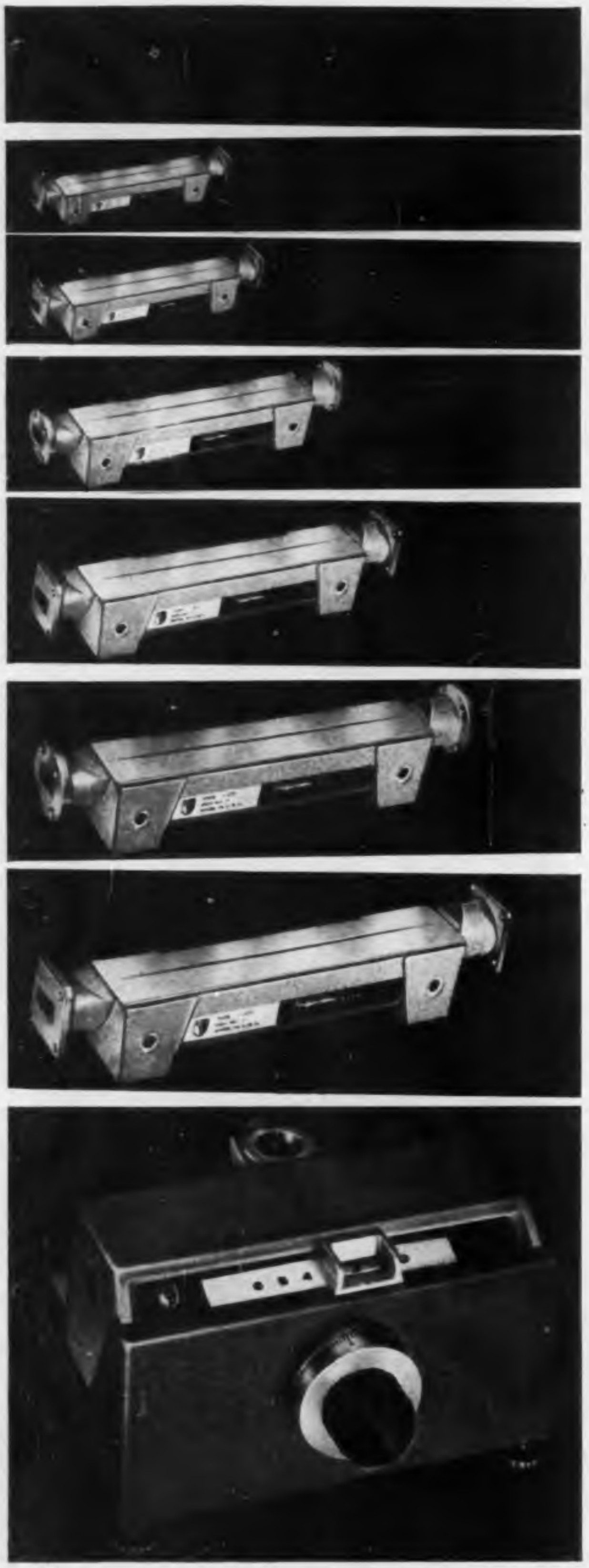
Circle 265 on Inquiry Card

MOBILE RADIO FILTER

New 455 kc Mobile Radio I-f Filter, Model F-124. Designed for mobile radio equipment, it is a low-cost unit of rugged construction and reduced size. Specs on the new filter are: Center frequency, 455 KC ±1 KC; Insertion loss, 23 db (max.); Band-

width, at 6 db, 10.5 KC, at 60 db, 31 KC; Max. ripple, 0.5 db within the pass band; Dimensions, 3-¼ x 1-1/16 x 1-3/16 in.; Connections are coaxial cables. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 266 on Inquiry Card



and ALL NEW

Completely covers the frequency range from 4.0 to 40.0 KMC/S with only one probe carriage.

The new PRD 230 Universal Probe Carriage represents a major achievement in accurate standing wave and impedance measurements. Here is a precision instrument which features bold, rugged styling with laboratory accuracy. The position of the probe holder can be quickly determined to 0.01 mm.

A complete series of Waveguide and Coaxial Slotted Lines are available for snap-in convenience and low VSWR performance. Unusual features include a scale calibrated directly in dial revolutions and self-contained slope adjustment of the U, K, and A band Slotted Lines.

PROBE CARRIAGE: Accepts both PRD 250-A Broadband probe for 4.0 to 12.4 KMC/S and PRD 253 Fixed Tuned Probe for 12.4 to 40 KMC/S.

VSWR: PRD 231 Waveguide Slotted Lines have a maximum residual VSWR of 1.01.

VERNIER RESOLUTION: 0.01 mm.

PROBE TRAVEL: 6 cm.

PRD 231* SERIES SLOTTED LINES

PRD Type	Frequency Range (kmc/s)	Transmission Line Size (inches)	Length (inches)	Coupling Type
N231	4.0-10.0	3/8" Coaxial	9-1/4	**
X231	8.20-12.4	1 x 1/2	9	UG-39/U
U231	12.4-18.0	.702 x .391	9	UG-419/U
K231	18.0-26.5	.500 x .250	9	UG-425/U
K231-F1	18.0-26.5	.500 x .250	9	UG-595/U
A231	26.5-40.0	.360 x .220	9	UG-381/U
A231-F1	26.5-40.0	.360 x .220	9	UG-599/U

*Available in WR waveguide sizes on special order.

**Normally supplied with Type "N" male and female adapters (PRD 367 and 368).
Adapter for Type "C" male and female (PRD 3354 and 3355).
Adapter for "TNC" male and female (PRD 3395 and 3396).
Adapter for "HN" components (PRD 3368 and 3369).

We have many interesting openings for engineers ... contact Mr. John R. Zabka.

PRD ELECTRONICS, INC.
A Subsidiary of Harris-Intertype Corporation
Formerly Polytechnic Research & Development Co., Inc.
HARRIS INTERTYPE CORPORATION

202 Tillary Street, Brooklyn 1, New York, ULster 2-6800
1608 Centinela Avenue, Inglewood, Calif., ORegon 8-6922

GET THE FACTS!

USE THIS FREE READER SERVICE CARD

Keep up to date—get the facts about the new products and equipment as they hit the market. ELECTRONIC INDUSTRIES' advertisers will be glad to send you complete literature giving specifications and data relating to those products advertised in this issue. To help you, the new product items, new literature and advertisements in this issue are numbered consecutively, from the front to the back of the book. The extra cards are for the use of your associates with whom you share your copy of ELECTRONIC INDUSTRIES.

Mail Card Below Today For Quick Information On New Products Described in This Issue. No Postage Needed.

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES
The Computer Center
P. O. Box 8221
Philadelphia 4, Pennsylvania

Circle the item number, fill in your name, title, company; detach and mail.

YOUR NAME ....TITLE.......................... **JAN. 1961**
FIRM ....
FIRM ADDRESS ....
CITY OR TOWN...ZONE...................STATE..................

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
															361	362	363	364	365

Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

Please send me further information on the items I have circled above.

ALPHABETICAL LISTING OF

CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

A

30 ADC Incorporated—Plugs, jacks, patch cords & jack panels

90 Aerovox Corporation—Solid tantalum capacitors

122 Alford Manufacturing Company—Line stretchers

82 Allied Control Company, Inc.—2 Amp relay

88 Alpha Metals Inc. — Flux-filled solder washers

130 American Electrical Heater Company—Electric soldering irons

67 American Time Products Inc. — Frequency standards and fork oscillator units

45 AMP Incorporated—Wire terminations

64 Amperex Electronic Corporation—Transistors

78 Amphenol Connector Division Amphenol-Borg Electronics Corp. — Connectors with Poke Home contacts

100 Andrew Corporation—Fixed station antenna

37 Arnold Engineering Company — Iron powder cores

70 Arnold Magnetics Corp.—Magnetic amplifiers

146 Associated Research Inc.—High potential testing equipment

127 Avnet Electronics Corp. — Electronic component distribution

B

48 Ballantine Laboratories Inc.—Calibrator

33 Beckman Berkeley Division — Digital voltmeter

114 Beckman Instruments/Helipot Division—Potentiometer catalog

124 Bendix Corporation Tube Division — Microwave tubes

44 Bendix Corporation M.C. Jones Electronic Co., Inc.—RF load resistors

144 Bendix Corporation Pioneer-Central Division—Sonic energy cleaning

50 Bork Equipment Division—Miniaturized precision potentiometers

39 Bourns Inc. Trimpot Division—Carbon-film trimmer potentiometers

140 Braun Tool & Instrument Company Inc. —Beryllium copper component clips

151 Bruno-New York Industries Corp.—"Pig-Tailoring" machine

54 Brush Instruments Division of Clevite Corp.—Motion-sensing transducer

56 Burnell & Co., Inc.—Toroids, filters

76 Bussmann Mfg. Division, McGraw-Edison Co.—Fuses & fuseholders

C

29 CBS Electronics, Semiconductor Operations—Switching with CBS MADT transistors

47 Centralab, The Electronics Div. of Globe-Union Inc.—Switch visualizer, switch layout sheet & catalog

138 Chemplast Inc.—TEFLON spaghetti tubing

53 Cinch Manufacturing Company—Miniature connectors

9 Communication Accessories Company—Transformers high voltage

43 Clare Company, C. P.—Mercury-wetted relay

51 Clevite Transistor Products — Semiconductor devices

52 Clevite Transistor Products — Diffused silicon rectifiers

36 Computer Measurements Company — Transistorized frequency-period meter

42 Conrac, Inc.—Video monitors

91 Control Switch Division Controls Co. of America—Interlock lighted pushbutton switch

85 Corning Electronic Components Corning Glass Works—Tin oxide film resistors

152 Custom Components Inc.—Microwave absorber

D

58 Dale Electronics Inc. — Resistors wire wound, precision

105 Daven Co., The—Wire wound resistor networks

7 Delco Radio—Digital modules

63 Delco Radio—Power transistors

128 Design Tool Co.—Automatic production machine

25 Deutsch Company—Hermetic connectors

134 Dialight Corporation—Pilot lights

35 Dow Corning Corporation—Single crystal silicon

83 Dumont Laboratories, Allen B.—Cathode ray display tubes

E

153 EICO—EICO Electronic Catalog

69 Eitel-McCullough, Inc.—Ceramic tube

116 Elgin Advance—Crystal-can-size hermetically sealed relays

93 ESC Electronics Corp.—Miniature transponder delay line

F

18 Fairchild Controls Corp.—Fire control accelerometer

65 Fairchild Semiconductor Corp.—Planar structure silicon transistors

72 Fluke Mfg. Co., Inc., John—Differential DC voltmeter

150 Freed Transformer Co., Inc.—Constant voltage transformers, magnetic amplifiers

81 FXR, Inc.—Direct reading frequency meter

G

13 General Electrodynamics Corp. — Vidicons, scan conversion, image conversion, or display tubes

15 General Instrument Corp., Semiconductor Division—Zener diodes

142 General Products Corp. — Solid-block terminal boards

41 General Radio Company — Frequency meter and discriminator

11 Good-All Electric Mfg. Co.—Capacitors

101 Globe Industries Inc.—8" diameter vaneaxial blowers

154 Graphic Systems—Visual control board

94 Grayhill Inc.—Switches test clips, test jacks & binding posts

89 Gremar Mfg. Co., Inc.—RF connectors

155 G-V Controls Inc.—Thermal relay

H

27 Hewlett-Packard Company—Oscilloscopes with vertical time axes, plug ins

---

YOUR NAME .... **TITLE** .... **JAN. 1961**

FIRM ....

FIRM ADDRESS ....

CITY OR TOWN .... **ZONE** .... **STATE** ....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
															361	362	363	364	365

Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

Please send me further information on the items I have circled above.

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center
P. O. Box 8221
Philadelphia 4, Pennsylvania

ADVERTISERS IN THIS ISSUE

ADVERTISERS FROM WHOM YOU DESIRE FURTHER INFORMATION

84 Hill Electronics, Inc.—Electronic filters

87 Howard Industries, Inc.—Fractional H.P. motor

3 Hughes Aircraft Company Microwave Tube Division—Backward-wave oscillators

I

111 Ideal Industries, Inc.—Custom wire strippers

77 International Electronic Research Corp. —Transistor heat dissipator

PROFESSIONAL ENGINEERING OPPORTUNITIES

Circle number of company on card at right from whom you desire further information.

602 General Electric Electronics Laboratory

601 General Electric Missile & Space Vehicle Department

148 Illinois Condenser Company—Electrolytic capacitors

118 Industrial Electronic Engineers, Inc.—In-line digital readout

8 International Resistance Co. — Square trimmer potentiometers

80 Institute of Radio Engineers, The—1961 International Convention and IRE Show

J

76 Jennings Radio Mfg. Corp.—Vacuum relays

145 Jettron Products Inc.—Magnetron connectors

79 JFD Electronics Corp.—Trimmer capacitor

107 Johnson Co., E. F.—Variable capacitor

109 Jones Div., Howard B., Cinch Mfg. Co.—Plugs & sockets

K

149 Kay Electric Company—Audio, Video, VHF sweeping oscillator

135 Knights Company, The — Crystal-controlled transistorized oscillator

L

96 Lel Inc.—Microwave-mixer preamplifier

74 Lenz Electric Mfg. Co.—High voltage lead wire

M

23 Magnetic Shield Division Perfection Mica Co.—Shielded tape data containers

121 Marconi Instruments — FM deviation meter

60 Microwave Associates Inc.—Silicon computer diodes

24 Minnesota Mining & Mfg. Co., Mincom Division—Instrumentation recorder/reproducer

85 Motorola Semiconductor Products Inc.—Silicon Rectifiers

N

106 Newman Corp., M. M.—Miniature soldering iron

40 Nothelfer Winding Laboratories, Inc.—High frequency filament transformers

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 213 of ths issue.

Postcard valid 8 weeks only. After that use own letterhead describing item wanted. **JAN. 1961**

PROFESSIONAL ENGINEERING OPPORTUNITIES

Please send me further information on the engineering position I have circled below.

501	506	511	516	521
502	507	512	517	522
503	508	513	518	523
504	509	514	519	524
505	510	515	520	525

YOUR NAME .... TITLE ....

HOME ADDRESS ....

CITY or TOWN .... ZONE .... STATE ....

JAN. 1961

NEW Subscription Order

I wish a new complimentary subscription to ELECTRONIC INDUSTRIES ☐ Yes ☐ No

Company Name: ....

Name: .... Position ....

Company Address: ....

City: .... Zone State ....

Specific Products Manufactured ....

YOUR NAME .... TITLE .... **JAN. 1961**

FIRM ....

FIRM ADDRESS ....

CITY OR TOWN .... ZONE .... STATE ....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
															361	362	363	364	365

Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

Please send me further information on the items I have circled above.

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center
P. O. Box 8221
Philadelphia 4, Pennsylvania

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

CHESTNUT & 56th STS.
PHILADELPHIA 39, PA.

Chilton Company

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center
P. O. Box 8221
Philadelphia 4, Pennsylvania

300% INCREASE IN RANGE NO INCREASE IN SIZE!

JFD MAX-C® MINIATURE TRIMMER SEALCAP®

Now you can cut precious inches and ounces from your assemblies with space-saving, weight-saving MAX-C Sealcaps.

The surprising increase in range of the Max C trimmer capacitor is obtained by embedding the electrode band in the glass cylinder. This design provides the thin dielectric required for a large capacitance range while retaining the ruggedness and mechanical strength of a heavy wall glass tube.

Included in the Max C design is the Sealcap construction which provides the additional stability safeguard of a completely sealed interior.

MINIATURE PANEL MOUNT MAX-C SEALCAP SERIES

Model	Min.	Max. (PF)	Distance Beyond Panel	Maximum Diameter
MC601	1.0	14.0	29/64"	5/16"
MC603	1.0	28.0	11/16"	5/16"
MC604	1.0	42.0	29/32"	5/16"
MC606	1.0	60.0	1 5/32"	5/16"
MC609	1.0	90.0	1 3/4"	5/16"

The Max C retains all the advantages of glass tubular trimmers: Working voltage of 1000 VDC, Insulation Resistance of 10^6 megohms, Q of 500 at 1MC, operating temperature range of –55°C to +125°C, and high stability. It meets or exceeds the applicable performance and environmental requirements of Mil-C-14409A.

Escape from the design limitations of conventional trimmers by specifying JFD MAX-C Sealcaps for your current and projected circuitry. Write today for the complete catalog describing MAX-C Sealcaps and other JFD precision electronic components. Other JFD components are...

FOR PANEL MOUNTS AND PRINTED CIRCUIT MOUNTING

SEAL CAP TRIMMER CAPACITORS	MINIATURE TRIMMER CAPACITORS
GLASS OR QUARTZ DIELECTRIC	LUMPED CONSTANT DELAY LINES
DISTRIBUTED CONSTANT DELAY LINES	PULSE FORMING NETWORKS
FILTERS	METALIZED INDUCTORS
LC TUNERS	

Detailed data sheets on any of these components selected from the extensive J.F.D. line are yours for the asking. Our engineering staff is at your service for consultation on your particular application.

Pioneers in electronics since 1929

JFD ELECTRONICS CORPORATION

6101 Sixteenth Avenue, Brooklyn 4, New York

WESTERN REGIONAL DIVISION
7311 Van Nuys Boulevard, Van Nuys, California

JFD CANADA LTD
51 McCormack Street, Toronto, Ontario, Canada

JFD INTERNATIONAL
15 Moore Street, New York, N. Y.

Circle 79 on Inquiry Card

VARIABLE ATTENUATORS

Two new digital readout precision variable attenuators cover X and C Band. Operating over the full waveguide frequency range, they feature a digital counter that reads directly in decibels and tenths of decibels. No

interpolations are needed. Figures can be read at a glance. Units are constructed with a moveable "lossy dielectric" ridge that provides 0 to 60 db attenuation with flat freq. response. Ridge is driven by a spring-loaded precision cam and the digital counter is geared directly to the cam shaft, insuring freedom from backlash. The max. calibration error is ±2% or 0.2 db, whichever is greater to 50 db; ±3% from 50 to 60 db. Max. attenuation is approx. 65 db. Model 780 covers 8.2 to 12.4 KMC; Model 783, covers 3.95 to 5.8 KMC. Both have max. VSWR of 1.2. Narda Microwave Corp., 118-160 Herricks Rd., Mineola, L. I., N. Y.

Circle 267 on Inquiry Card

DC POWER SUPPLY

Regulated dc power supply rated at 0-36 v. and 0-20 a. Model CR-36-20, is regulated to 0.01% and requires 7 in. of panel height. Electrical features include ± 0.01% load regulation, 0.003 v. peak-to-peak ripple, 40 μsec recovery time from a full load step, 5 parts

per 10,000 per 24-hr. day stability, and electronic current-limiting. The finish is 2-tone gray enamel. Meters are standard equipment. Weight is approximately 70 lbs. NJE Corp., 20 Boright Ave., Kenilworth, N. J.

Circle 268 on Inquiry Card

DIRECT READOUT

DU MONT CHARACTER DISPLAY® TUBES...

DU MONT CHARACTER DISPLAY TUBES ARE USED IN SUCH APPLICATIONS AS:

- Target display and identification
- Air traffic control
- Reproduction of info from coded magnetic tape
- Harbor traffic control
- and many others

Write for complete technical details
Industrial Tubes Sales

enhance any system requiring versatility of rapidly formed characters for readout. A unique Du Mont CRT gun design enables alpha-numeric characters to be formed electrostatically in any size from ⅜" to over 1", and positioned electromagnetically anywhere on the screen — on any size screen from 5" to 19". Other background information, such as a separate radar display for target tracking, can be shown simultaneously through time sharing devices.

Du Mont tubes short-cut expensive system maintenance problems by permitting replacement of the *display* portion of a system *alone* — eliminating the necessity of replacing expensive integrated tube and character generator. For versatility, clarity and economy — look to Du Mont for character readout.

Available now at attractive prices!

DU MONT

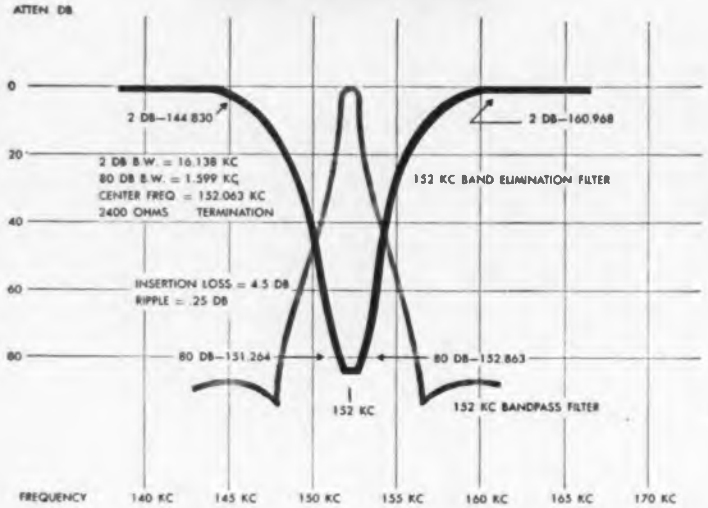
ALLEN B. DU MONT LABORATORIES, Clifton, N. J.

DIVISIONS OF **FAIRCHILD** CAMERA AND INSTRUMENT CORPORATION

Circle 83 on Inquiry Card

High selectivity,
attenuation and precision matching of . . .

NEW HILL FILTERS ASSURE FAST, PRECISE MEASUREMENT OF INTER-MODULATION DISTORTION



Actual operational curves, obtained from point-to-point readings, from Hill 34900 and 34800 filters developed to fulfill customers' specific requirements.

These two highly stable, precision-matched Hill Electronic filters permit fast, exceptionally accurate measurement of inter-modulation distortion in communications systems. A band elimination filter places a narrow, deep notch in the white noise being passed through the equipment under test. Distortion generated in the notch is then isolated for measurement by the narrow band filter.

The high degree of selectivity and attenuation of these filters, and the excellent alignment of one within the other are demonstrated in the actual operational curves shown above. Used together, these filters provide 80 db attenuation from 6 to 252 kc.

This is a typical example of Hill's creative engineering that develops outstanding solutions to customers' specific problems involving LC and crystal control filters as well as precision frequency sources and other crystal devices.

WRITE FOR BULLETINS 34800/900

They contain details and specifications concerning the filters described above.

HILL ELECTRONICS, INC.

MECHANICSBURG, PENNSYLVANIA

New Products

RESISTOR COMPOSITIONS

New line of resistor compositions offer varied resistance values. Compositions are in 3 resistance values (500, 3,500, 10,000 ohms/sq./mil thick film) which can be blended to obtain intermediate values. Applied to cer-

amic dielectric bases by ordinary dip, brush, or stencil screen techniques, the composition is then fired in a normal atmosphere to obtain a durable surface. Temp. coefficient, ±350 ppm°C from −55°C to +125°C; voltage coefficient, less than 0.02%/v. neg.; humidity exposure, ±1% change after 250 hrs. @ 95% relative humidity (unprotected film); overload, ±0.5% change with standard short time overload; temp cycling, ±1% change after (5 cyclings from −55°C to +125°C); load life, ±2% change after 1000 hrs. at 70°C at full load. E. I. Du Pont de Nemours & Co., Public Relations Dept., Wilmington, Del.

Circle 269 on Inquiry Card

TOGGLE SWITCH

New Universal swivel type toggle switch, the T203, can be actuated by applying a force on the toggle in any direction. Features include: A toggle throw of 20° in any direction, moisture proof construction, 25,000 operations minimum at rated load, anodized

toggle and casing. Also features adapter suitable for engraving. Ratings are 2-circuit at 10 a resistive and 5 a inductive or 3 a lamp, 28 vdc. Control Switch Div., Controls Company of America, Folcroft, Pa.

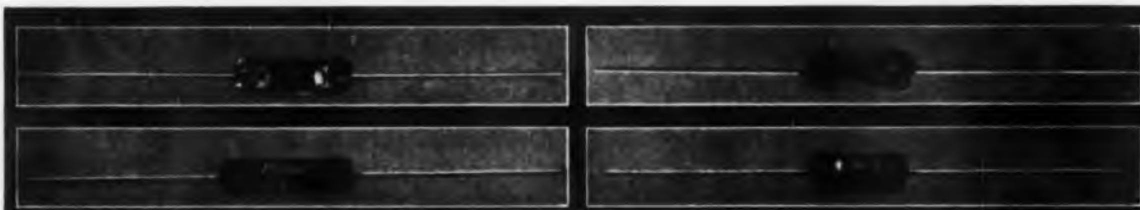
Circle 270 on Inquiry Card

COMPUTERS AND OTHER ELECTRONIC INSTRUMENTS demand resistors which give predictable performance in a small space and high ambient temperatures. This is a good description of Corning tin oxide film resistors, which are now competitive in price with other makes.

Tin oxide and glass are among the most stable materials. They are also low in cost.

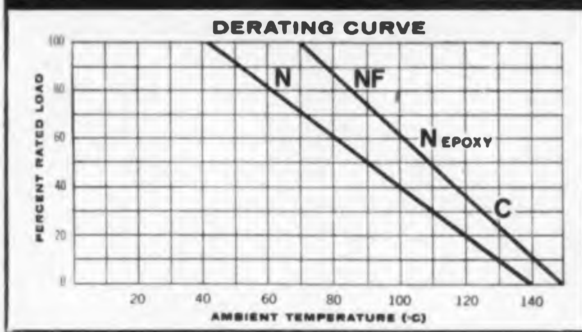
Couple these materials with exacting methods of manufacture, as we have done, and you have low-cost resistors meeting the pinching specifications required for computers and similar devices.

You have resistors with excellent reactive properties. With a shelf life of 0.1 to 0.2% per year. With noise levels lower than 0.1 microvolt per volt. And with typical values like these:



TYPE	DESCRIPTION	CORNING MODEL	WATTAGE	RESISTANCE (ohms)	TC	LOAD LIFE	OVERLOAD	MOISTURE RESISTANCE
NF	Glass ENCAPSULATED MIL-R-10509C, Char. B	NF60 NF65	1/8 1/4	100 100K 100 348K	150ppm/°C. −55 +150°C.	0.3%	0.03%	0.2% (Char. B)
N EPOXY	MIL-R-10509C, Char. B	N60 N65 N70	1/8 1/4 1/2	10 133K 10 499K 10 1Meg	150ppm/°C. −55 +105°C.	0.5%	0.03%	0.5% (Char. B.)
N	MIL-R-10509B, Char. X	N12 N20 N25 N30	1/4 1/2 1 2	100 133K 10 500K 10 1.5Meg 30 4.12Meg	150ppm/°C. −55 +105°C.	0.35%	0.1%	0.15% (Char. X)
C	Lowest cost film resistor; silicone insulation MIL-R-11C	C20 C32 C42	1/2 1 2	51 150K 51 470K 10 1.4Meg	150ppm/°C. −55 +125°C.	1.5%	0.2%	0.3%

Note: Noise level for all models is less than 0.1 uv/v of applied signal.



For quantities of less than 1000, contact the nearest distributor serviced by Erie Distributor Division. For data sheets on Corning Type NF, N, N-EPOXY or C resistors, write CORNING GLASS WORKS, 546 High St., Bradford, Pa.

CORNING ELECTRONIC COMPONENTS
CORNING GLASS WORKS, BRADFORD, PA.

Circle 85 on Inquiry Card

New Products

AMPLIFIER KLYSTRON

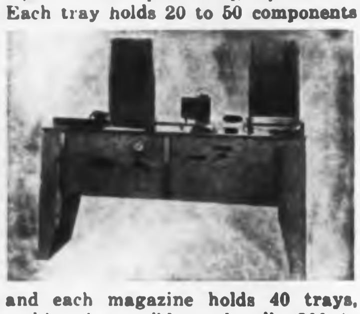
Lightweight, air-cooled and compact, new VA 834B amplifier klystron gives one kw of cw power tunable from 4.4 to 5.0 KMC. For transportable systems, air cooling and permanent magnet focusing of the power

amplifier tube allows savings in weight. Heat exchangers, magnet power supplies and their control circuits eliminated. Operating procedures are simplified by elimination of focusing and coupling adjustments. It is suited to tropospheric forward scatter communications and radar transmitters. Max. weight, including magnet, is 60 lbs. Max. dimensions are 12 x 13 x 15½ in. The tube tunes over a range of 600 MC. Synchronously tuned at 4.4 KMC, a gain of 57 db is obtained. Tuned for wide-band use, a bandwidth of 12 MC is obtained. Tube Div., Varian Assoc., 611 Hansen Way, Palo Alto, Calif.

Circle 259 on Inquiry Card

TRAY LOADER

Model TL-1 tray loader automatically takes empty specially designed trays or racks from a magazine, hoper feeds them with previously straightened components, and stacks the loaded trays into another portable magazine for transfer to coating, baking or other processing operations. Each tray holds 20 to 50 components

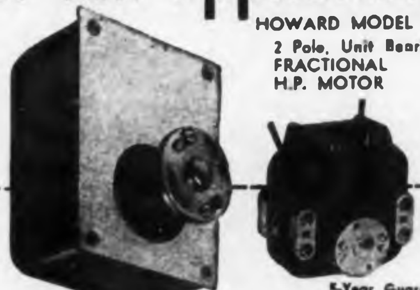


and each magazine holds 40 trays, making it possible to handle 800 to 2,000 components as a complete unit, depending upon the size of the component. Conforming Matrix Corp., 474 Toledo Factories Bldg., Toledo 2, Ohio.

Circle 260 on Inquiry Card

for fan applications

HOWARD MODEL 1085
2 Pole, Unit Bearing
FRACTIONAL
H.P. MOTOR



5-Year Guarantee

Available with Open or Closed Construction

MOUNTING: From rear or by special pads on front.
BEARING: Single, long-life, permanently lubricated.
STATOR: Vacuum varnish impregnated coil on molded nylon bobbin.
ROTOR: Dynamically balanced for ultra-quiet operation.
ROTATION: Unidirectional (CW or CCW as specified).
SHAFT-HUB: Assures positive and accurate location of connecting part (fan) which must run concentric. Can also be furnished with shaft extension from hub.

HP: 1/750 to 1/100
NO LOAD RPM: 3400
FULL LOAD RPM:* 2600-3200
INPUT WATTS: 8-30
VOLTS: 115 V, 60 cy. AC std.
*Lower full load speeds also available.

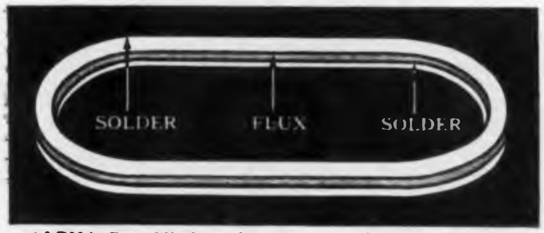
Send us your specifications or write for complete catalog.

POWERED BY HOWARD

HOWARD INDUSTRIES, INC.
1730 State Street, Racine, Wisconsin
Divisions: Electric Motor Corp., Cyclohm Motor Corp., Loyd Scruggs Co

Circle 87 on Inquiry Card

NEW solder development!



ALPHA flux-filled washers open a whole new field of automatic soldering opportunities!

Unique design insures maximum surface-to-surface contact on close-fitting parts, complete peripheral fluxing. Produced through a special ALPHA process, they provide, for the first time, completely new soldering opportunities.

ALPHA makes a wide range of flux-filled and solid preforms *Request information today!*

When dependability counts! **alpha metals** INC.
58J Water St., Jersey City 4, N. J.

In Los Angeles, Calif.: 2343 Saybrook Ave.
In Chicago, Ill.: ALPHALOY Corp., 2250 S. Lumber St.

Other ALPHA products:
Core and Solid Wire Solders • Fluxes • High Purity Metals

Circle 88 on Inquiry Card

MOST COMPLETE LINE!

Gremar makes more series of RF connectors and components than are available from any other source . . . and then some! Gremar exclusives include *Red Line* miniature RF connectors for use with MIL-type sub-miniature coaxial cables; power dividers; impedance transformers . . . and others.

MOST COMPLETE STOCKS!

Gremar always has more than 750,000 assembled RF connectors of more than 2000 types on the shelf . . . plus over 8,000,000 component parts always ready for speedy assembly of standard connectors or quick adaptation to your special requirements.

MOST COMPLETE SERVICE!

Because Gremar **connectronics*** concentrates engineering, production and quality control on RF connectors and components only, you can depend on Gremar to solve your design, delivery and reliability problems quickest. Try us and see. Address your inquiry to:

descriptive literature available on request

GREMAR
MANUFACTURING COMPANY, INC.
RELIABILITY THROUGH QUALITY CONTROL
Dept. E, Wakefield, Mass., CRystal 9-4580

Circle 89 on Inquiry Card

New Products

TRAVELING WAVE TUBE

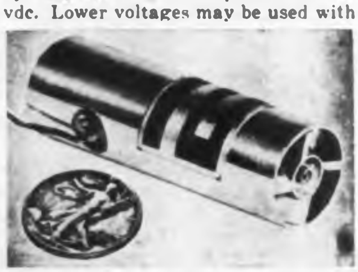
Type 55340 Traveling Wave Tube is guaranteed for a min. life of 6000 hrs. It is a broad band amplifier from 3800 to 4200 MC. It is suited for unattended microwave stations. It can deliver a saturated power output of 8w. Low level gain at 4200 MC, with

the output power at 100 mw, is better than 37 db. With the output power at 3 w, gain is better than 35 db. Noise figure is less than 30 db. The wave propagating structure is of the helical type. Electron beam focusing is with a permanent, uniform field magnet. The mount couples to standard rectangular waveguide WR 229. Tube is free air, convection cooled. It operates at 1100 v, which simplifies power supply problems. Amperex Electronic Corp., Microwave Tube Dept., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 271 on Inquiry Card

MINIATURE BLOWER

A new miniature dc blower, smaller in diameter than a 50¢ piece, is designed to move 10 cfm of air against 0.3 in. H_2O back-pressure. This tube axial blower is 1-⅛ in. in diameter by 2-¾ in. long and operates on 27 vdc. Lower voltages may be used with



different motor windings. Unit weighs 3.5 oz. Unit is typically used for spot cooling of critical components in a circuit. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 272 on Inquiry Card

New Products

MULTIPLIER

New dual electronic multiplier, Model 3735, offers single quadrant multiplication and squaring with accuracies of 0.01%. Four quadrant multiplication accuracy is 0.05% full scale. Units available in 2, 4 or 6

channels. Compatible with all analog computers, it can also be used on analog data and process control systems. Features include built-in division and square-root operation. Specs are: (Input) 4 independent voltages, X_1, Y_1, X_2 and Y_2 in the range of ±100 v. (Output) 2 independent products, $-0.01X_1Y_1$ and $-0.01X_2Y_2$, in the range of ±100 v at 10 ma max. load current. (Drift) less than 100 mv over 8 hrs. (Noise) less than 100 mv, peak. (Phase shift) less than 1° at 100 CPS. Zero error, with one variable = 0 and other ranging over ±100 v, max. error in product is 40 mv. Donner Scientific Co., a subsidiary of Systron-Donner Corp., 888 Galindo St., Concord, Calif.

Circle 273 on Inquiry Card

ELECTROLYTIC CAPACITORS

Miniaturized tubular electronic capacitors, Type BMT, in plastic cases, are dependable and have long life. Ranges available for all transistor applications. Dia., 3/16 in. up to ⅝ in. Capacity, 1 mfd to 2,000 mfd. Voltage, 3 v. to 50 v., inclusive. The

capacitors have an operating range of −30° to +65°C. The units have low impedence at +30°C and low leakage throughout the entire temp. range. Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill.

Circle 274 on Inquiry Card

ESC's new miniature Transponder Delay Line fits into just 6 cubic inches!

Custom variations available to your exacting specifications.

For modern airborne equipment, where space and weight are critical, ESC has created a new **Miniature Transponder Delay Line** — Model 52-44 . . . which embodies the most advanced techniques of weight and space reduction. It measures just 6 cubic inches total!

Specifications — Model 52-44, Lumped Constant Delay Line:

Impedance — 470 ohms
Delay Time — 20.3 ± .1
Rise Time — .6 (max.)
Temperature Coefficient — 65 ppm or better over a temperature range of −55°C to +125°C
Attenuation — 4 db
Size — 1" x 2" x 3"
Weight — 6 ounces
Tapped as required

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

exceptional employment opportunities for engineers experienced in computer components . . . excellent profit-sharing plan.

ESC ELECTRONICS CORP.
534 Bergen Blvd., Palisades Park, N. J.

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Step variable delay lines • Video transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies.

Circle 93 on Inquiry Card

I am to play an important part in all future Grayhill promotion of Miniature Electrical and Electronic components . . . in ads . . . in trade shows . . . in catalogs and literature. My prime concern and duty is to keep you posted on important new developments and products . . . and pertinent facts you may have overlooked about the broad line of Grayhill miniature push button and tap switches, test clips, test jacks, binding posts, push-posts, coil forms, transistor sockets, diode holders, etc., . . . every component designed to a need and produced to deliver the utmost in reliability. Let's get together on your component requirements . . . standard or *special*.

I will send you a copy of our **Current Catalog On Request.**

Grayhill INC.

Phone: FLeetwood 4-1040
543 Hillgrove Avenue, LaGrange, Illinois

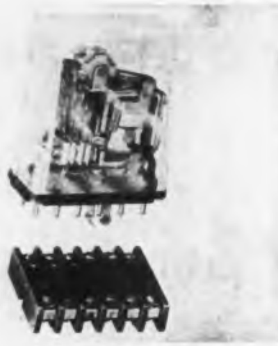
"PIONEERS IN MINIATURIZATION"

Circle 94 on Inquiry Card

New Products

SEQUENCE RELAY

Relay provides thousands of different control sequences. Similar to the Dunco 219 Frame general purpose industrial control relay and 1-⅛ in. higher, the new Frame 211 sequence type features a double cam movement



on each step. The cam rotates half a step when coil is energized and completes the step when deenergized. Make before break between 2 ST contacts results when one is adjusted to "make" when energized and the other adjusted to "break" when the coil is deenergized. Double-pole, single or double-throw contact types available. 8-tooth ratchets are standard-6-tooth ratchets available. Contacts are rated 5 a at 115 vac and 5 a at 24 vdc or 0.5 a at 115 vdc. They will carry 150% of rated loads. Max. amb. is 40°C and the relays have a life of 10 million operations, no load. Struthers-Dunn, Pitman, N. J.

Circle 275 on Inquiry Card

PHOTOELECTRIC RELAY

A rugged transistorized photoelectric relay, developed for industrial application, has a sturdy NEMA 12 enclosure to prevent dirt and vapors from entering the unit. A plug-in transistor circuitry utilizes Schmitt trigger to detect small changes in light level which operates a sealed

double pole- double throw relay. A silicon power supply is used. Operation is to 125°F. An encapsulator silicon solar cell is supplied with 8' of cable. Design Engineers Inc., 224 N. Desplaines St., Chicago 6, Ill.

Circle 276 on Inquiry Card

New Products

MONITORING SYSTEM

Model 1000-7 Servo-valve Monitoring System consists of 3 pressure transducers mounted on a thin manifold block which fits between the servo-valve being monitored and the hydraulic system manifold. A 3000

psi differential transducer gives constant readout of pressure difference between the 2 control ports of the servo-valve. A 3000 and a 300 psig transducer gives constant indications at the supply and return ports. Accuracy is the same as for the series SP2 pressure transducers. Typical specs.: Non-linearity and hysteresis combined, less than 0.25% of full scale; thermal zero and sensitivity drift each less than 0.015% of full scale/°F from −65°F to +275°F; combined errors from all sources less than 0.5% of full scale. Standard Controls, Inc., 1130 Poplar Place, Seattle 44, Wash.

Circle 277 on Inquiry Card

VOLTAGE REGULATOR TUBES

Two new glow discharge type voltage regulator tubes, Types VX62 and VX64 are enclosed in standard T-3 glass envelopes. Tubes provide a miniature and inexpensive means of regulating at 95 and 150 v. respectively with current ranges from 100 μa to 50 ma. A typical application is the regulation of the screen voltage

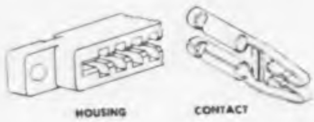
of a pentode which employs high plate voltage. Operation is from −55° to 75°C with min. life over 1000 hrs at recommended operating current. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 278 on Inquiry Card

New Products ...for the Electronic Industries

EDGE CONNECTOR

For printed circuit card applications in which frequent jumpering is necessary, or where many circuitry changes must be made, a 1-piece edge connector accommodates easy-to-insert, easy-to-remove taper pins. The



AMP Taper-in will mount all .070-.055 PC cards. The receptacles will receive AMP's "Series 53" taper pin line, including both pre-insulated and formed types. Connector permits 500 insertions and removals of the printed circuit card without damage to the foil pads, and without critical wear on the gold plating on the contacts. It has 22 contact positions, with contacts commoned for multiple-wire use. Contacts are of phosphor bronze, gold over nickel. Block is ester alkyd, glass-filled. Length: 4.281, with a .156 center-to-center spacing laterally between contacts. AMP Inc., Harrisburg, Pa.

Circle 282 on Inquiry Card

AMPLIFIER

New transistorized voltage comparison amplifier for critical go/no-go applications. Model 51 provides a precise, fast and reliable way to determine if an input voltage or series of input voltages is within preset

limits. It uses colored bulbs for visual indication and relays to operate external warning and control devices. Both indications occur within 90 msec after applying the voltage. It can also be used as a resistance comparator. The 51 has a sensitivity in excess of 500 µv and a voltage range of ±50 v (up to 100 v as long as limit-to-input differential does not exceed 25 v). The 51 is a component of the NLS Model 50, which has internal, manual limit setting. The Model 50 is limited to uses where limits do not have to be changed more than once every several min. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 284 on Inquiry Card

RESISTANCE BRIDGE

Militarized precision Resistance Bridge, ZM-40 ( ) MPM, is self contained. It is for measuring resistors or for other similar resistance measurements. It can be used as a limit bridge to compare resistors against

an internal or external standard, and indicate on a calibrated meter the deviation in percent, or it can be used as a null balance bridge to match pairs of resistors. It will operate on 115 v ±10% with a line frequency anywhere from 50 to 420 CPS. Power drain is approx. 25 w. Unit will measure from 1 ohm to 2 megohms with accuracy better than 0.25%. It will operate from −50°C to +65°C in 100% humidity environments. It meets MIL-T-945 for shock and vibration, and MIL-E-5272 for sand, dust, and rain. American Electronic Laboratories, Inc., 121 N. Seventh St., Phila. 6, Pa.

Circle 286 on Inquiry Card

POWER SUPPLY

Model 520A power supply, a compact 25 adc power supply is continuously variable (with no range switching) from 0 to 36 v. at any current from 0 to 25 a. A front panel current limit control permits a continuous adjustment of the max. output current, providing max. protection for any load device. Regulation for line and load combined is less than 0.5% of max. output. Ripple is less than 1%, and there is no voltage overshoot on

turn-on or turn-off. The line input is 105-125 vac, 60 CPS. Size is 7 x 16¾ x 19 in. Other features: Remote programming and sensing. Harrison Laboratories, Inc., 45 Industrial Rd., Berkeley Heights, N. J.

Circle 283 on Inquiry Card

INDICATOR LIGHTS

Ultra-miniature indicator lights, Data Cap Series No. 250, offer two new features: a clear lamp cartridge without a legend, and a lens cap with a colored cylindrical lens on which a legend may be hot-stamped. Should the cartridge burn out it may be quickly replaced. Cap and cartridge are assembled with Lampholder No. 7538 to make the complete unit. Lamp cartridge plugs into the base, and the lens cap screws onto the bushing. Lens is spring mounted and

rotatable. Lens is 0.425 in. in dia. and accommodates up to 3 digits, symbols or letters. Seven lens colors available. Size is approx. 1⅝ in length and ⅝ in dia. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 285 on Inquiry Card

DRIVE AMPLIFIER

Model 910 is a transistorized amplifier to drive dc torque motors. It will deliver 2 adc differential current into a 2-terminal Torquer. Input into the amplifier can be either dc or 400 cps depending on the type selected. Gain is 200 mv per 1 adc output current. Current feedback has been incorporated to minimize the effects of torquer inductance on servo response. Higher power and higher gain amplifiers available. Unit op-

erates from standard 28 vdc power and uses 400 CPS for reference. Operating temp −55°C to 71°C. Meets MIL-E-5272 environmentals. Control Technology Co., Inc., 1186 Broadway, N. Y. 1, N. Y.

Circle 287 on Inquiry Card

New Products ... for the Electronic Industries

FREQUENCY DOUBLER

Freq. doubler sets for low cost signal generation to 40 KMC. Models 938A and 940A, operate on harmonic generation principle and may be driven by klystrons, sweep oscillators or signal generators. Model 938A

supplies power from 18 to 26.5 KMC when driven by a 9 to 13.25 KMC source; Model 940A from 26.5 to 40 KMC when driven by a 13.25 to 20 KMC source. Both contain a power monitor and a 100 db attenuator for accurate power setting. Output power is 0.5 to 1 mw when driven by the -hp- 626A or 628A signal generators. Input is 10 mw (design center) and 200 mw (max.) Output monitor accuracy is ± 1 db to ± 2 db. Output attenuator accuracy is +2% of reading or 0.2 db, whichever greater. Attenuator range is 100 db. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 288 on Inquiry Card

SEMICONDUCTOR TESTER

Model TT8-100, semiconductor tester for evaluating and inspecting, transistors, zener diodes, rectifiers, and tunnel diodes. It features a current limited source to prevent damage to any semiconductor under test. Scope calibration voltages are 5 v for vertical and 80 v for horizontal. It will test transistors for breakdown voltage; gain, over dynamic range; voltage and current saturation characteristics; and leakage current. Zener diodes tested for breakdown voltage; dynamic impedance, at any current; drift against temp. or current. Rec-

tifiers tested for leakage and forward current characteristics up to 1 a. Tunnel diode tested for characteristics of tunneling current; valley current and forward voltage. PRL, Inc., Rahway, New Jersey.

Circle 289 on Inquiry Card

LATCHING RELAY

Dual-coil, micro-miniature latching relay having its smallest dimension perpendicular to the plane of its mounting surface. The relay, the FL, lies flat on a printed circuit board, its max. height is 0.485 in. Coils can be

supplied with up to 10,000 ohms resistance per coil at +25°C. DPDT bifurcated, gold-flashed silver-magnesium-nickel contacts are rated at 3 resistive. Relays withstand 100 gs a at 30 vdc or 2 a at 115 v. 60 CPS shock, 400 gs linear acceleration and vibration of 0.195 in. excursion from 10 to 55 CPS and 30 gs from 55 to 2500 CPS with no contact openings in either armature position. Operates on a 3 msec. pulse at nom. voltage @ +25°C. It meets MIL-R-25018, MIL-R-5757C, and ABMA-PD-R-187. Potter & Brumfield, Div., American Machine & Foundry Co., Princeton, Ind.

Circle 290 on Inquiry Card

ANGLE INDICATOR

The (CO2721027) high-accuracy precise angle indicator provides numerical indication of the angular position of any mechanical device to which remote 2-speed (25:1) dual transmitters can be coupled. Using double-speed transmission reduces errors inherent in synchros by a factor of 25. Instrument can be supplied having dual-sensor speed ratios from 18:1 to 75:1. A remote control feature enables unit to be operated as either a 2-speed or single-speed device. Specs (Single-speed and 2-speed): Accuracy: ±6 mi; ±15 sec.

Repeatability: ±1.2 min.; 12 sec. Size: 9-⅛ x 5¼ x 13 in. Slewing Speed: 180° in 9 sec. Power: 115 v., 400 CPS, 1Φ, 30 va. Weight: 9-½ lbs. Kearfott Div., General Precision Inc., 1150 McBride Ave., Little Falls, N. J.

Circle 291 on Inquiry Card

VOLTMETER

New laboratory standard voltmeter for measurement of voltages or calibration of ac voltmeters from 10 MC to 1000 MC at voltages of 0.5 v. to 300 v. Model 390 NBS A-T features stability of less than 1% deviation

from NBS calibration for at least one year. It consists of an adjustable waveguide below-cutoff attenuator feeding a UHF vacuum thermocouple. Dc output from thermocouple is measured on an external millivoltmeter. The unknown signal is connected to the input electrode, and the micrometer setting is adjusted to produce a standard reading on the millivoltmeter. The voltage is then obtained from the calibration chart which shows the input voltage for all settings of the micrometer at the frequency of measurement. Ballantine Labs, Inc., Boonton, N. J.

Circle 292 on Inquiry Card

MODULAR AMPLIFIERS

Type VA-P-101, a plug-in video distribution amplifier is for systems requiring a simple 1 input, 1 output unity gain unit. Eight amplifiers plug into a shelf 8¾ in. high which mounts in a standard relay rack. Filament and bias voltage is provided by the shelf and the only other power which must be supplied is 117 vac and regulated 28.5 vdc. The amplifiers may be used individually, or any number of units up to 8 may be "multed" together so as to provide a max. of 8 outputs from 1 input. Specs: Nom. input level, 1 v. Bandwidth is a flat

± 2% to at least 8.0 MC. 60 CPS sq. wv. tilt is 1% max. Differential gain at 1 v. out is 0.7% max. Differential phase at 1 v. out is 0.35° max. Approx. B+ drain is 50 ma. The Daven Co., Livingston, N. J.

Circle 293 on Inquiry Card

New Products . . . for the Electronic Industries

MICROWAVE FILTER

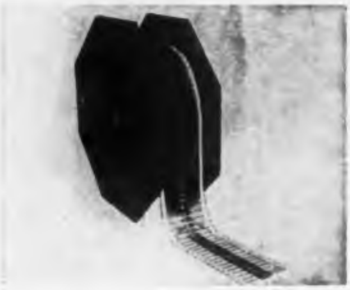
Four-channel filter, Model 1201, with built-in video detectors covers a wide input dynamic range. Each channel has a bandpass of 2600 to 3200 MC at a max. input VSWR of 2:1. Video detector in each channel has a

tangential sensitivity of −40 dbm (min.). Dynamic range is obtained with two Type 1N833 silicon diode detectors in parallel, one operated at full sensitivity and the other through a 14.5 db coupler. Dimensions (excluding connectors) are 6.15 in. dia., and 0.7 in. thick. R S Electronics Corp., 435 Portage Ave., Palo Alto, Calif.

Circle 247 on Inquiry Card

PACKAGED CAPACITORS

Two new capacitors packaged for automatic insertion or automatic cutting and forming of the leads. Style 309 available in 5 to 663 pf and Style 310 available in 14-1130 pf are lac-



quer-enamel coated, axial lead, tubular ceramic dielectric, capacitors available in both temp compensating or general purpose ceramic dielectric bodies. Packaging available is "Reel Pak," or "Ribbon Pak." Both are suitable for automatic insertion or automatic cutting and forming of the leads. Electronics Div., Erie Resistor Corp., 645 W. 12th St., Erie, Pa.

Circle 249 on Inquiry Card

MICROWAVE ABSORBERS

New and tougher TYPE T thin, flexible absorber has high electrical performance. It is available for the usual radar frequencies as well as for special frequencies. The metal foil

back of the absorber is covered with a rubberized cloth, meeting MIL-C-20696. Improved physical characteristics are: (1) about 30% lighter than before; (2) greater temp range: −70° to 270°F, (wider ranges on special order); (3) greater physical integrity and easier handling. Standard TYPE T is also available. McMillan Industrial Corp., Ipswich, Mass.

Circle 251 on Inquiry Card

LF PANORAMIC RECEIVER

New low frequency panoramic field intensity receiver continuously monitors LF radiation from 0.05 KC to 100 KC, operates unattended, and automatically produces panoramic photographic records. Designated the AN/URM-126, applications include precision measurement, display and recording of the intensities of noise and both modulated and unmodulated CW

signals. It meets specification MIL-E-16400. It receives and defines signals separated by only 15 cps. Motorola Inc., Military Electronics Div., 8201 E. McDowell Rd., Scottsdale, Arizona.

Circle 248 on Inquiry Card

SSB RECEIVER

New fixed tuned Model RSSB-59-1A Single-Sideband Receiver for AM broadcast. Applications include off-the-air relay broadcasts, monitoring in difficult reception areas and Conelrad. Minimum selective fading distortion, improved signal-to-noise and reduced adjacent channel interference are advantages over conventional AM reception. Completely transistorized,

Model RSSB-59-1A permits upper or lower sideband reception and operates on 110 vac or automatic emergency dc supply. Kahn Research Laboratories, Inc., 81 S. Bergen Pl., Freeport, L. I., N. Y.

Circle 250 on Inquiry Card

MAGNET SYSTEMS

Line of versatile laboratory magnet systems. These flexible general purpose magnet assemblies are for a variety of applications. Individually adjustable and replaceable poles and pole faces allow max. variation of the magnetic field configuration. Coupled with the continuously variable output power supply, these MHD magnet systems provide a flexible basic re-

search tool. Copper-wound coils are insulated with class B materials and are calculated for continuous duty without additional cooling. MHD Research, Inc., 1571 Placentia Ave., Newport Beach, Calif.

Circle 252 on Inquiry Card

New Products . . . for the Electronic Industries

STRAIN GAGE TRANSDUCER

Strain gage transducer, Model P318, is a micro-miniature, flush-diaphragm absolute pressure transducer featuring high frequency response. It is smaller than a dime, weighs 0.5 gms. Dimensions: 0.59 in.

dia., 0.050 in. thick. Ranges are 0-10 psi to 0-100 psi, available in absolute gage or differential. Excitation is 15 v. Output is 5 mv, full scale open circuit. The combined error due to non-linearity and hysteresis is less than ±1.0% of full scale. Amb. temp. limits are −65 to +150°F. Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles, Calif.

Circle 253 on Inquiry Card

TRANSISTOR TEST SET

Transistor test set Model TTS-100, for precision measurements of dc characteristics of power transistors. Leakage currents, dc gain, transconductance, input impedance, power conductance, saturation voltage and saturation resistance are measured.

Punch-through voltage is determined without damaging the transistor. Separate connections provided for measuring voltage at the terminals to eliminate errors in measuring saturation voltage. A heat sink base with adapters is an accessory. Command Systems, Inc., 1135 Stanford Ave., Los Angeles 59, Calif.

Circle 255 on Inquiry Card

FOR FUEL CELLS

Porous shapes in alumina or magnesia ceramics for experimental use in fuel cell research. These sections of membrane material may be modified, within reasonable limits, to the specifications of the researcher. They can

be fabricated in very thin flat sections. Consideration must be given to the mechanical strength required for the end use. Discs and plates up to 5 in. in max. dia. are practical. Larger sizes may be had. Ceramics are involved in research in both high pressure and low pressure fuel cells. American Lava Corp., Steatite Div. Lab., Chattanooga 5, Tenn.

Circle 257 on Inquiry Card

DISPLAY ASSEMBLY

Solid state display assembly, Model 2060 is for decimal display of a binary coded decimal parallel signal. It accepts up to 24 bits of parallel BCD information and converts signal to a 60-line decimal display using Burroughs-type Nixie tubes. Assembly is 3½ in. high, rack-mounted for visual display of parameter numbers using up to 6 decimal digits, derived from any of these 4-bit codes: Binary code decimal (1-2-4-8); decade counter code (1-2-2-4) or (1-2-4-2); gray code (cyclic code); binary complement coded decimal; binary 2 out 5 code; binary (1-2-4-7). Binary input may be either static or parallel pulses. Storage capability, conveniently re-

trieved through a multi-pin connector, is provided in the converting circuitry. Primary application is for displaying time where 17-bit time codes are used. Hermes Electronics Co., 75 Cambridge Pkwy., Cambridge 42, Mass.

Circle 254 on Inquiry Card

WATER-COOLER TRIODE

A general-purpose, water-cooled triode for 400 kw continuous output as a Class C amplifier or as an oscillator up to 30 MC. The ML-7560 delivers 2.5 megawatts in a pulsed r-f amplifier and can switch 14 megawatts in a pulse modulator at relatively long pulse duration with high duty factors. Anode incorporates an integral water jacket and can dissipate 175 kw. Low-inductance and high-dissipation r-f terminals are provided by a sturdy coaxial grid and cathode mounting structures. Cathode is a self-supporting, stress-free, thoriated-tungsten filament. Ceramic cylinders insulate the envelope. Max.

ratings are 20 kvdc plate voltage and 600 kw plate input up to 30 MC, although useful power output can be obtained up to 100 MC at reduced plate voltage and plate input. The Machlett Laboratories, Inc., 1063 Hope St., Springdale, Conn., U.S.A.

Circle 256 on Inquiry Card

DIFFERENTIAL PREAMPLIFIER

Ac coupled differential preamplifier with fixed gains of 10x, 100x, and 1000x. Noise level of less than 10 μv peak to peak over a max. bandwidth in excess of 60k. Common mode rejection of more than 100 db for measurements in strong interference. Input filter reduces TV pulse interference. Input impedance 10 megohms each grid to ground; low grid current for min. source loading. High frequency filter has nominal steps of 60KC, 10KC, 1KC, 250 and 50 cycles; low frequency is variable in increments of 0.01, 0.1, 1, 10, and 100 cycles. Cascode input with frame grid triodes; single interstage coup-

ling time constant has reset button. Low impedance push pull cathode follower output may be set to ground dc level. Provision for the introduction of time marker signals. Argonaut Assoc., Inc., P.O.B. 273, Beaverton, Oregon.

Circle 258 on Inquiry Card

New Products . . . for the Electronic Industries

DIGITAL VOLTMETERS

A new line of digital voltmeters designated the 200 series. It includes ac, dc, ratio and ohms measuring modules which may be utilized in any combination. Provision has also been

made to allow addition of dc preamplifier, digital printer or paper tape punch. Basic Model 231 specifications are ±0.02% stability, sampling rate 0 to 30/sec., range 0.0001 to 1100.0 v., resolution to 0.1 millivolt auto ranging and polarity, 1 megohm input impedance. Systron-Donner Corp., 950 Galindo St., Concord, Calif.

Circle 294 on Inquiry Card

TRANSISTOR TRANSFORMERS

Addition of 5 new micro miniature transistor transformers to line. Units have primary impedance ratings from 4,000 ohms C. T. through 25,000 ohms C. T. and secondary impedences of 150

ohms through 1500 ohms C. T. Operating level is approx. 22 dbm with frequency response of 200 to 15,000 cps. Items are in hermetically sealed construction with high compression glass terminals, or in epoxy molded construction or in open frame construction with channel mounting. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.

Circle 296 on Inquiry Card

SWITCHING TRANSISTOR

New general purpose switching transistor, similar to the type 2N697, exhibits substantially better performance characteristics. The new type 2N1837 has nearly half the collector

to emitter voltage drop of the 2N697. Additionally, the 2N1837 has nearly three times the small signal beta, half the collector capacitance and half the leakage current. All other characteristics are equal to or better than the 2N697. Pacific Semiconductors, Inc., 12955 Chadron Ave., Hawthorne, Calif.

Circle 298 on Inquiry Card

SUBMINIATURE RELAY

New, subminiature relay, Series V, is designed to meet the severe environmental requirements of present-day prototype missiles. The V relay header has improved bounce characteristics which increase contact life and reliability, and enhance relay performance under severe vibration and shock. There is no increase in relay motor size because the new relay mo-

tor has greatly increased efficiency. V-series relays are available with or without arc-inhibiting circuits and with either ac or dc relay motors. Filtors, Inc., 30 Sagamore Hill Dr., Port Washington, L. I., N. Y.

Circle 295 on Inquiry Card

WELDING HEAD

Model 1038 is a new, precision Welding Head which can perform single, series or parallel welds for electronic components assembly; joining fine wire, ribbon and foils; and for applications requiring a controllable fastening technique without the use of an interconnecting or bonding material. Ball-race vertical action of the dual upper electrodes permits exact placement of the welds with no

electrode wiping action. It features 500 watt-sec power rating; foot-pedal actuation; precisely controllable electrode pressure and automatic firing. Unitek Corp., 950 Royal Oaks Dr., Monrovia, Calif.

Circle 297 on Inquiry Card

PHOTOCOPIER

New compact photocopier will copy large-size documents. Model 114 will copy original documents up to 15 in. wide by any length — engineering drawings, accountants' work sheets, statistical data, reports, and artists' drawings, in sharp black-on-bone white, frequently better than the originals. Machine will make sharp, permanent copies of anything typed,

printed, duplicated, photographed, written or drawn, in any color, any ink, pencil or crayon. It makes copies under normal office lighting conditions. A. B. Dick Co., 5700 W. Touhy Ave., Chicago 48, Ill.

Circle 299 on Inquiry Card

New Tech Data for Engineers

Pressure Transmitter

New 4-page specification, S 230-1, outlines features, specs and ordering information on new Bellows Differential Pressure Transmitter. This instrument combines economical, convenient pneumatic transmission with a dry type bellows meter body. It can be used in any flow or open or closed tank liquid level application to transmit readings from a field location. It is available with a concentric scale for local indication at point of measurement or as a non-indicator. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Circle 204 on Inquiry Card

Tube Catalog

New, 25-page, condensed tube catalog from Amperex Electronics Corp., 230 Duffy Ave., Hicksville, L. I., N. Y. It contains descriptions and basic specs on the full line of Amperex Tubes, consisting of: cold cathode trigger tubes, entertainment and audio tubes, ignitrons, indicator tubes, klystrons, magnetrons, noise diodes, power tubes, photomultiplier tubes, "Premium Quality" (PQ) tubes, radiation counter tubes, rectifier diodes, subminiature tubes, thyratrons (hydrogen, mercury vapor and inert gas types), traveling wave tubes, UHF special purpose tubes, and voltage reference and regulator tubes.

Circle 205 on Inquiry Card

Diallyl Phthalate Resin

A descriptive booklet (26 pages) of the properties, uses, and molding requirements of compounds based on Dapon diallyl phthalate resins. It provides a guide to the capabilities and application techniques of these materials. Resins are used as molding materials for electrical and electronic applications in the missiles and rockets field. They are noted for dimensional stability, insulation resistance, and retention of electrical properties in extremely severe environments. Included are 13 tables giving performance data including physical and electrical properties, chemical and fungus resistance, and flame proofing. A section deals with the effect of mineral and synthetic fillers on molded properties. Another section deals with material handling, molds, molding temps and pressures, curing time, and tests for cure. A typical properties chart for molding compounds is included. Dapon Dept., Food Machinery & Chemical Corp., 161 E 42nd St., New York 17, N. Y.

Circle 206 on Inquiry Card

Magnetic Shields

Data Sheet 153 describes how multicellular magnetic shields permit more accurate low level signal source data evaluation. Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 23, Ill.

Circle 207 on Inquiry Card

Subminiature Switch

Two-page data sheet (#180) features the highly sensitive 11SM401 subminiature switch for use where close control sensitivity or response is mandatory. Switch features a 0.001 in. differential travel. Includes mounting dimensions, operating characteristics, and electrical rating. Micro Switch, Freeport, Ill.

Circle 208 on Inquiry Card

Dip Brazing

Aluminum dip-brazing facilities brochure available from John Gombos Co., Inc., Webro Rd., Clifton, N. J. Aluminum dip-brazing is a process that allows perfect joining of aluminum to form homogeneous parts. It offers a strength of weld equal to or better than the parent metal. Complete penetration of joints is accomplished and distortion is at a minimum. Brochure is called, "Simplified Fabrication of Complex Components with Aluminum Dip-Brazing."

Circle 209 on Inquiry Card

Transducers

New 8-page folder describes facilities, capabilities and transducer products of Lockheed Electronics Co. Individual sheets present specs, performance characteristics, and circuitry on the line of strain gages and multipliers, load cells, force washers, high sensitivity washers and position transducers. Lockheed Electronics Co., Avionics & Industrial Products Div., 6201 East Randolph St., Los Angeles 22, Calif.

Circle 210 on Inquiry Card

Oscilloscope Units

Colorful 32-page booklet gives detailed presentation of all 16 presently-available "A-to-Z" plug-in units. The booklet includes complete specs and performance characteristics with waveform patterns and other illustrative material for various measurement applications. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 211 on Inquiry Card

Oscillograph

Four-page bulletin, 5125, containing photos and specs describes the operation of a new, low-cost, portable recording oscillograph developed by the Electro Mechanical Instrument Div., Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. The unit (5-124) weighs 40 lbs.

Circle 212 on Inquiry Card

Control Design

Six ways to simplify control design are shown in bulletin NB-660 from Servo Corporation of America, 111 New South Rd., Hicksville, L. I., N. Y. It illustrates various Servoscope (R) analyzer models used for fast problem solving in servo system design, debugging, production, teaching, and testing. Included is a section on the new Servoflight (R) autopilot analyzer.

Circle 213 on Inquiry Card

Flexibility and Refinement

APR-20 rectangular antenna pattern recorder

APR-30 polar antenna pattern recorder

...The reason most antenna pattern recorders come from S·A

It's the little things that make the difference. Little things, refinements, "extras," and top-notch workmanship all add up to preference for S-A instrumentation.

Things Like Plug-In Balancing Potentiometers...

Series P plug-in pen balancing potentiometers

Series P potentiometers are used in both rectangular and polar coordinate pattern recorders. By interchanging potentiometers together with the appropriate pen function amplifier, different responses – linear, square-root, and logarithmic – are obtained. Interchanging these new self-aligning potentiometers can be accomplished in less than thirty seconds. Stocking spare units cuts downtime. Of dust and dirt proof construction, Series P plug-in balancing potentiometers are offered with exchange pricing.

DC Amplifiers...

DCA-21 amplifier for dc input signals

Scientific-Atlanta's DCA-21 amplifier lets APR 20/30 recorders accept dc input signals. A narrow band amplifier preceded by an electromagnetic chopper, the sensitive DCA-21 has a linear dynamic range of 80 db. The unit is directly interchangeable with Series CBA-20 Crystal-Bolometer amplifiers.

Recorder Pen Programmers...

Up to five different pen writing codes can be selected by adding the Model RPP-1 Recorder Pen Programmer to an APR 20/30 installation. Compact, lightweight, and rack mounted, the programmer provides solid line, dot, dash, dash-dot, and space-dot-dot codes at an adjustable code rate of 30 to 90 cycles per minute.

Modification C, Chart Compression...

Modification C, which must be ordered at the time of recorder purchase, provides both standard and compressed cycle charts from a single APR 20 Rectangular pattern recorder. Standard chart cycle is 20 inches, compressed 8 inches. Compressed recordings are conveniently sized to fit standard 8½ x 11 notebooks and reports.

Chart Paper, Recording Pens, Ink, and Accessories...

Scientific-Atlanta offers its customers one-day service by stocking, for immediate delivery, a wide variety of chart paper, recording pens, and other recording necessities.

But above all, it's the engineering philosophy of a company run by antenna engineers for antenna engineers.

Call your nearby S-A engineering representative for more information on S-A pattern recorders and accessories. For complete technical information, please write to Box 44.

Crystal Bolometer Amplifiers...

High gain, low noise crystal-bolometer antenna

Sensitive, narrow-band Crystal-Bolometer amplifiers are miniaturized units designed for use as preamplifiers in S-A polar and rectangular pattern recorders. Five models, CBA-21 through CBA-25 are available. Features include bolometer burnout protection, low noise figure, triaxial signal ground return, up to 108 db gain, 80 db linear dynamic range, adjustable bandwidth (CBA-23), high rejection (CBA-24), variable center frequency (CBA-25).

SCIENTIFIC-ATLANTA, Inc.

2162 Piedmont Road, N.E. • Atlanta 9, Georgia

TRinity 5-7291

7

International

Electronic Sources

Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering journals

CIRCUITS

Pulse FM Discriminators, V. L. Rytchka. "Radiotek" No. 10, 1960. 9 pp. Operation principles and basic relationships are analyzed for an FM discriminator of a pulse counter type. The advantages of several parameters of this circuit is proved over parameters of ordinary discriminators. Shortcomings and limitations of this circuit are pointed out. Various applications of the circuit are suggested. (U.S.S.R.)

Replacement of a Cascade of n Unequal Asymmetric Four-Terminal Networks with Equal Iterative Impedances by One Four-terminal Network, W. Herzog. "Nach. Z." Oct. 1960. 3 pp. Any number of unequal and asymmetrical four-terminal networks connected in a cascade, in which all of the networks have the same iterative impedance, are replaced by a single four-terminal network for which the impedance matrix is given. (Germany.)

Electromechanical Four Poles as Coupling Filters, E. Trzeba. "Hochfreq." June 1960. 8 pp. The advantages of an electromechanical filter as compared to the limitations of lumped element filters are pointed out. An electromechanical analogy is developed that enables the treatment of mechanical four poles according to bandpass filter theory. From six-pole equations of the electromechanical transducers the four pole equivalent circuits are derived that correspond to the presentation of the mechanical conductor. Using the combination of input transformer, mechanical connection, and output transformer, the desired parameters of the filter can be determined according to line filter theory. (Germany.)

Isolation of Output of a Pulse Generator, I. D. Pugsley and B. M. Johnstone. "Proc. AIRE." July 1960. 3 pp. Shielded r-f coupling to an isolated probe permits pulse stimulation of biological tissue without coupling to the pick up electrodes. Pulses of amplitude up to 50 v. and durations between 10 μsec and 100 msec are available. (Australia.)

Circuit Analysis of Feedback Transistor Amplifiers, A. E. Ferguson. "Proc. AIRE." Feb. 1960. 4 pp. Methods of analyzing transistor feedback amplifiers are examined. (Australia.)

Symmetrical Operation of Push-Pull Vacuum-Tube Oscillator Circuits, N. I. Stein. "Radiotek" No. 10, 1960. 2 pp. In this article, the operation of tubes in an oscillator is analyzed when they are arranged in a push-pull manner. The mutual influence of the tubes on each other is established as a result of changes in the driving voltages. The influence of various factors which cause asymmetrical operation in each of the two sections of the push-pull network are analyzed. Formulae are given for calculations of the oscillator power output, and power losses in the tubes in the asymmetrical case, and recommendations are offered to compensate for asymmetry. (U.S.S.R.)

Oscillator Circuits with Variable Parameters, E.-G. Woschni. "Hochfreq." June 1960. 5 pp. Starting with Hill's or Mathieus' equation and using already known results, simple approximations are developed for the range of lock in and the decrease in damping. This is done for sinusoidal changes in the capacitance and later for sinusoidal changes in the damping. The same results are obtained using intuitive physical concepts of energy and phase relationships. An observation of occurrences in the second lock-in region lead to the conclusion that harmonics are responsible for lock in and decreased damping in the lock-in regions of higher order. Through a known analogy the same consideration can be applied directly to mechanical systems. (Germany.)

Synthesis of Circuits with Operation Described by Time Boolean Functions. "Avto. i Tel." Oct. 1960. 4 pp. The synthesis methods for circuits which can be described by means of a special class of Boolean functions are considered. (U.S.S.R.)

A Simple Design Technique for High Performance Transistor AC Amplifiers, D. G. W. Mace and R. N. Blunt. "El. & Comm." Sept. 1960. 3 pp. A design technique for ac amplifiers which is deemed to have considerable merit. (Canada.)

Practical Transistor Circuits, A. Petitclerc. "el. & auto." Sept. 1960. 2 pp. Four simple circuits are introduced. They use semiconductors, namely diodes, transistors and Zener diodes. They are a 9-v. stabilized power supply, a 50 Hz oscillator with RC phaseshift circuit, a similar oscillator for 1,000 Hz, and an electronic flasher based on a 2-transistor multivibrator. (France.)

Printed Circuits Containing Resistors, Part 1, P. A. B. Toombs. "Brit. C&E." Sept. 1960. 5 pp. There is a demand for the provision of components as well as wiring in printed circuits. Vacuum deposition offers a means of producing both resistors and wiring. Germanium and germanium/metal alloy films were investigated as possible resistance materials. In the first part of this article, an account is given of the methods of production of these films. The second part, to be published next month, deals with their testing and protection. (England.)

COMMUNICATIONS

Certain Properties of Communication Systems with Fading, E. L. Bloch, A. A. Kharkevitch. "Radiotek" No. 9, 1960. 7 pp. The authors discuss aspects of general properties of communication systems which are affected by the fading type of a multiplying type of distortion. They compare these systems with those which have the usual additive distortions. An evaluation of the system carrying capacity for these systems and an analysis of the questions of application of corrective codes are also presented. (U.S.S.R.)

A Transistorized Channel Converter for Carrier Frequency Telephony Systems, H. Bode, et al. "Nach. Z." Oct. 1960. 5 pp. In the introduction the advantages of transistors

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
El. Tech. Electronic Technology
GEC J. General Electrical Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Bull. Fr. El Bulletin de la Societe Française des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
El. et Auto. Electronique et Automatisme
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Ubertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
Nach. Z. Nachrichtentechnische Zeitschrift
rt. Regelungstechnik
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Prace ITR. Prace Instytutu Tele-I Radiotechnicznegu
Roz. Elek. Rozprawy Electrotechnizne

USSR

Avto. i Tel. Avtomatika i Telemekhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad i Elek. Radiotekhnika i Elektronika
Iz. Acad. Bulletin of Academy of Sciences USSR.

- Photocopies of all foreign articles are available at 75 cents per page, remitted with order. **Unless otherwise indicated, articles appear in language native to country of origin.**
- A reprint of this section, "International Electronic Sources" is available without charge.

Requests for the above should be sent, on company letterhead, to:

Electronic Sources Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts.
Philadelphia 39, Pa.

in relation to valves are discussed; low power consumption, miniaturization and increased reliability. (Germany.)

The Application of Printed Circuit Techniques to Microwave Systems. K. Foster and A. C. Brown. "Brit. C&E." Aug. 1960. 6 pp. (England.)

Training of Personnel for Telecommunication Engineering. D. C. Bhattacharji. "J. ITE." April 1960. 12 pp. (India, in English.)

Analysis and Design of a Moving-Coil Microphone. D. L. Subrahmanyam and K. D. Pavate. "J. ITE." April 1960. 7 pp. (India, in English.)

Pulse Length Telemetering. A. O. Davies. "ATE J." Jan.-July 1960, 10 pp. The elements of a single indication system and its operating principles are first considered followed by a description of the transmitting and receiving equipments and their performance. Similar treatment for multiple indication systems follows and the article concludes with a reference to initiating equipment and applications other than the normal one of indication of varying quantities. (England.)

A Telephone Dictation Recorder System. S. Balmer. "ATE J." Jan.-July 1960. 12 pp. After briefly reviewing the basic requirements of a dictation recorder system and alternative methods of operation, the article then specifically described the A.T.E. system. After consideration of its integration with automatic telephone systems, details are given of its design, facilities and operation. (England.)

Continuous Signal Discrimination. A. A. Kharkevich. "Radiotek" No. 10, 1960. 3 pp. The author discusses the possibility of representing signals, which are continuous at the final time interval, by one or more numbers and the optimal selection of such number for best recognition of signals by comparison to a given set of possible functions. This possible technique resulted in connection with developments of recognition devices, intended to recognize continuous contours. (U.S.S.R.)

U.H.F. Telemetry and Control Links. J. Pierson. "Brit. C&E." Oct. 1960. 4 pp. In many industrial problems the use of line communication for control and data transmission is not economic and is prone to failure during periods of operational emergency, for instance during bad weather. The author describes in this article the requirements for a u.h.f. telemetry link, and the way in which it has been used in such diverse applications as television outside broadcasting, horse racing, and gas works data transmission. (England.)

Design Fundamentals of Super-High Frequency Discrete Signal Automation Systems. M. S. Neiman. "Radiotek" No. 10, 1960. 8 pp. This article deals with the fundamental design principles of AM, FM, PM, and mixed discrete signal systems. In particular, possible methods are briefly discussed, which permit to perform basic logic operations, and methods of amplifying information carrying radio pulses. In addition, certain general aspects are discussed of design and application of high-speed discrete signal automatic systems. (U.S.S.R.)

A Method of Reducing Distortion in FM Klystron Transmitters. A. F. Evers, et al. "Brit. C&E." Aug. 1960. 4 pp. Current methods of modulation in microwave links are reviewed, and a technique is described which offers considerable improvement in cost and conformity to recommended standards. (England.)

New Tape Tension Stabilizing Method for Recorders. E. Vollmer and W. Rank. "El. Rund." Oct. 1960. 8 pp. After discussing the requirement of constant tape tension in high-quality recorders and the methods so far employed to stabilize tension, the author describes a new method he has developed to control the tape tension by light where the light output is influenced by the tension. (Germany.)

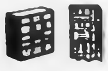
Overshoot Elimination in Carrier System Automatic Gain Regulations. G. Tamburelli. "Alta Freq." Aug. 1960. 22 pp. The conditions to be achieved for overshoot elimination in carrier system automatic gain regulators are determined. The cases of one, two and three time constants are examined and a theorem is given for the case of n time constants. The ideal characteristics of the automatic gain regulator are finally discussed. (Italy.)

Optical Maser Action in Ruby. T. H. Maiman. "Brit. C&E." Sept. 1960. 2 pp. The successful operation of microwave masers in the past few years has stimulated considerable current interest in extending the basic maser principles to the generation of much higher frequencies. (England.)

Constructive Tolerances of Submarine Cables with Submerged Repeaters. R. Monelli and E. Occhini. "Alta Freq." Aug. 1960. 40 pp. A statistical theory is outlined for calculating the constructive tolerances of a people of coaxial cable lengths to be used as amplification sections for a multichannel telephone cable with submerged repeaters. (Italy.)

A Unit Trunk Automatic Exchange. J. A. Scowcroft and L. F. Knott. "ATE J." Jan.-July 1960. 12 pp. This article describes an automatic trunk switching centre designed specifically to meet the needs of telephone networks employing radio, carrier or physical circuits. (England.)

A 75 cm Receiver for Radio Astronomy and Some Observational Results. C. L. Seegar, et al. "Phil. Tech" #11, 1960. 17 pp. (Netherlands, in English.)



COMPUTERS

Design Problems of Machine Classifying Elements According to Signs Unknown Beforehand. E. M. Braverman. "Avto. i Tel." Oct. 1960. 12 pp. A number of general conditions where the problem can be solved by machines with stimulation (i.e. machines which get some additional information from the operator) is pointed out. It is shown that sometimes machines without stimulation can be used for the same purpose. (U.S.S.R.)

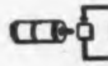
The Design of a Special Purpose Digital Computer. D. Halton. "ATE J." 33 pp. Jan.-July 1960. The equipment considered is a real time computer, designed to operate within timing limits imposed by an external system. The computer is a parallel, binary machine, using a single-address ordering system. (England.)

Test Circuits for Evaluation of Computer Amplifiers. A. Kley. "El. Rund." Oct. 1960. 2 pp. This paper describes a number of test circuits permitting to check without further accessories, the static and dynamic accuracies and the zero deviation of computer amplifiers. (Germany.)

The Choice of a Universal Logic Element. N. L. Carlson. "El. & Comm." Sept. 1960. 4 pp. The performance requirements of a static switching system designed to fulfill the needs of Canadian industry are presented in the following article. (Canada.)

Transistorized Analog Digital Converter for High Keying. K. Grieder. "El. Rund." Oct. 1960. 2 pp. An analog-digital converter for keying frequency of maximum 40 kc/s is described. (Germany.)

The Application of Computers in the Chemical Industry, Part II. Th. Ankel. "rt." Sept. 1960. 5 pp. (Germany.)



CONTROLS

Stability Analysis of Klystron Automatic Phase Control Circuit. L. A. Birger. "Radiotek" No. 10, 1960. 7 pp. Spurious feedback in automatic phase control systems of klystrons is analyzed. This feedback is one of the causes of self-oscillations in the system. Criteria are determined for balancing branches of the phase detector, to provide stable operation. (U.S.S.R.)

Regulating Behavior and Controllability of Typical Controlled Plants. P. Profos. "rt." Oct. 1960. 6 pp. In this contribution the author discusses generally a few properties and relationships describing the regulating behavior in servo-mechanisms and automatic process controls. (Germany.)

Automatic Control of a Filament-coiling Machine with the Aid of Preset Counters. F. Einramhof and P. Havas. "Phil. Tech." #10, 1960. 7 pp. (Netherlands, in English.)

Speed Control for Drives. W. Echner. "rt." Sept. 1960. 7 pp. In this contribution, first of all, the speed (slip)-torque characteristics are shown for the most common shunt motors and drives, followed by a discussion on starting, braking and transitory conditions for dc motors and non-synchronous motors. (Germany.)

A Digital Control Loop Obtaining a Great Number of Closely Stepped Frequencies. Part I. C. E. Nourney. "rt." Oct. 1960. 4 pp. Part I deals with the operating principle, the lay-out of the control loop and the qualitative analysis of working conditions. A theoretical study of the problem will be given in Part II which will be published shortly. (Germany.)

Optimum Performance of Two-Step Action Controllers with Feedback. W. Bottcher. "rt." Oct. 1960. 5 pp. The improved control by means of delayed or delayed reset feedback is explained by examples with an analog computer. (Germany.)

A Contribution to Regulation by Impulses. B. Neumann. "rt." Oct. 1960. 5 pp. A 3-step action relay system with delayed feedback and equipped with an impulse emitter for integral control, can be considered, by introducing certain simplifications, as a linear proportional-plus-integral controller. (Germany.)

Automatic Control of a Machine Saw. M. Seurot. "el. & auto." July 1960. 2 pp. This paper shows how the problem has been solved by a transistorized unit. (France.)

Industrial Applications of Solid State Thyratrons. R. Dablon. "el. & auto." July 1960. 5 pp. Principal characteristics and circuit design considerations are presented for the semiconductor thryatron. Several examples of industrial applications are given. (France.)

Automatic Control of Nuclear Power Stations. J. E. Westerlint. "el. & auto." July 1960. 6 pp. This introductory paper describes summarily some of the proven industrial solutions. (France.)

The n-Fold Control of Single-Loop Systems with m-Fold Coupling. R. Starkermann. "rt." Aug. 1960. 5 pp. Formula are given for a linearized system of n controlled variables with n controllers. After having duly determined the individual frequency responses of each transfer number, these formula result in the composite frequency response of the dissected system. (Germany.)

A Contribution to the Theory of Multiple-loop Control Systems. C. Kessler. "rt." Aug. 1960. 6 pp. The author describes a method of calculating multiple-loop systems by the cumulative use of the known sizing rules for

Bendix Craftsmanship at work for you

LARGEST LINE OF MILLIMETER WAVE LENGTH BWO

Bendix® BWO tubes for higher frequency transmission. These Backward-Wave Oscillator Tubes—exclusive with Bendix—generate microwave energy over the largest continuous frequency range. Ideal for advanced multichannel telephone and television systems, microwave spectroscopy, high definition short range radar, highly directive communications, and many other applications needing low power, voltage-tuned millimeter wave length radio frequency energy. Write today for complete information.

ELECTRICAL DATA

Frequency Range	30 KMC-120 KMC (see specific type)
Anode Voltage	1000-4000 volts
Power Output	Up to 20 mw average (depending on frequency)
Beam Current	10 MA
Magnetic Field	2000 gauss
Heater Voltage	6.3 ±10%

MECHANICAL DATA

Output Flange	Special adapter to RG-98/U (50-75 KMC)
Maximum Diameter	0.625"
Length	8"
Mounting Position	Any
Weight	5 oz.*

*Without magnet (tube only). Magnets are available.

ELECTRON TUBE PRODUCTS

Red Bank Division

EATONTOWN, NEW JERSEY

Bendix

single-loop control systems. By stepwise structural transformation multiple-loop systems can be converted into single-loop control systems of the same kind. (Germany.)

The Characteristic of a Control Loop with Insufficiently Filtered Controlled Variable, A. Macura. "rt." Aug. 1960. 4 pp. In a control loop with saturating elements the correction will generally be less accurate if the controlled variable has a periodic component. This article deals with the mathematical treatment of such control loops and ways are shown how the influence of the periodic component can be kept small. (Germany.)

Control of Servo Drive by Means of One Null-Indicator, V. D. Vershinin. "Avto. i Tel." Oct. 1960. 6 pp. A circuit for summation of accurate and approximate control signal with the help of which it is possible to control a servo drive and to check the strictness of automatic following realized by means of one null-indicator is considered. (U.S.S.R.)

Vector Calculation of a Class of Control Systems, S. M. Levin and L. G. Manusevich. "Avto. i Tel." Oct. 1960. 10 pp. A method of investigation of class of control systems is considered. The method is based on plotting vector diagrams and on determining reflection of parameter space on the gain-phase characteristic plane. (U.S.S.R.)

Stability of a Control System for Ailerons with Turbulent Disturbances, P. S. Landa and S. P. Strelkov. "Avto. i Tel." Oct. 1960. 13 pp. With the help of electronic analog computer there are found stability regions of an aircraft wing in the case when the control system for an aileron has nonlinear elements. It is shown that existence of a gap in the control circuit in a certain parameter area results in hard oscillations in the system. (U.S.S.R.)

GENERAL

Probability Density of the Duration of Overshoots in Fluctuating Functions, V. I. Tikhonov, I. N. Amiantov. "Radiotek." No. 9, 1960. Three methods for the calculations of the probability density of the overshoot durations in normal stationary fluctuations are briefly analyzed, and some experimental data are presented. The applicability scope of each of the three methods is determined by using each method to obtain the probability density and then by comparing these theoretical results with experimentally obtained results. (U.S.S.R.)

Nuclear Magnetic Resonance, D. J. Kroon. "Phil. Tech." #10, 1960. 14 pp. A concise exposition is given of the theory of nuclear magnetic resonance and of the specific absorption it causes of electromagnetic waves (usually measured at metre wavelengths) by atomic nuclei (especially hydrogen nuclei) placed in a magnetic field. (Netherlands, in English.)

A Transistor Cardiotachometer for Continuous Measurements on Working Persons, G. A. Harten and A. K. Koroncai. "Phil. Tech." #10, 1960. 5 pp. In the apparatus described the individual heart beats are converted into electrical pulses by arranging for a beam of light transmitted through the ear to fall on a phototransistor. Each pulse causes a miniature transistorized transmitter to transmit a note of 3000 c.s. on a carrier of 10-15 Mc/s. Together with aerial and Ni-Cd batteries, this part of the equipment weighs about 3 lbs and is carried on the back. (Netherlands, in English.)

Data Processing in the Chemical Industry, Part I, J. Hengstenberg and Th. Ankel. "rt." Oct. 1960. 6 pp. In this article a survey is carried out of the various fields of application of data processing in the chemical industry. A critical study of the use of data loggers and special purpose computers on the factory floor is followed, supported by selected examples, of a discussion relating to the most important tasks of centralized data processing. (Germany.)

Theoretical and Design Aspects of Magnetic Reproducing Heads, O. V. Poritzky. "Radiotek" No. 9, 1960. 4 pp. An approximated theoretical analysis is presented for reproduction of magnetic recordings by toroidal heads, taking into account the ultimate core reluctance of the heads. An expression is derived which approximately defines the magnetic flux distribution within the reproducing head. Experimental procedure is described and theoretical results are compared to experimental results. (U.S.S.R.)

The Number of Turns of the Root Locus Curve, O. Follinger. "rt." Sept. 1960. 4 pp. In this article a formula is derived for the number of encirclements of the Nyquist plot around the —1 point in the complex plane of the open loop gain. (Germany.)

Electronics in Electrophysiology, Mollie E. Holman. "Proc. AIRE." July 1960. 3 pp. A brief introductory review is given of the use of electronics in the study of nerve and muscle cells. (Australia.)

The Philosophy of Simulated Flight Training, J. Vivian. "Brit. C&E." Sept. 1960. 5 pp. This article attempts to survey the background of flight simulation as a vital tool of airline pilot training, showing how it enables the operators to meet the requirement for setting and maintaining the highest standards, thus replacing aircraft flight training as a more effective means of demonstrating many phases of flight and so competing successfully on economical grounds with the use of aircraft drawn from the revenue fleet. (England.)

An Airborne Teleprinter System, J. H. Court. "Brit. C&&E." Sept. 1960. 3 pp. It has now become apparent that with the ever increasing traffic on the world's air routes, some method of relief of the congestion of hg and vhf radio communication channels must be found. In particular the North Atlantic requires the most urgent attention. (England.)

Phase Shift By the ATR Tubes in Balanced Duplexers, B. E. Rubinstein. "Radiotek" No. 10, 1960. 3 pp. The phase shift, which can be caused in the channel of a balanced duplexer by dual ATR tubes, is calculated. It is shown that the spread of parameters of resonant elements, which comprise the ATR's, can lead to a considerable increase in the duplexer losses in the receiving operating conditions. (U.S.S.R.)

Experimental Exploration of the Noise-Peak Durations, A. I. Velitchkin, V. D. Ponomareva. "Radiotek" No. 10, 1960. 6 pp. The probability density for the duration of peaks and the time intervals between the peaks of normal and Raleigh noise has been determined for various levels. On the basis of these results, it has been possible to conclude that the presently known approximate methods for the analysis of noise-peak duration, give satisfactory results only at high levels and for short peaks. In other cases, it becomes necessary to use experimental results. (U.S.S.R.)

Electronic Stimulators, G. Edsall. "Proc. AIRE." July 1960. 3 pp. The circuits and performance of electrical, photic and auditory stimulators are outlined. (Australia.)

New Microwave Amplifying Techniques—Applications and Developments, A.P.C. Thiele. "Brit. C&E." Oct. 1960. 8 pp. In the search for microwave amplifying techniques with lower noise figures, a number of solid-state devices have been developed in recent years. In this article the author surveys the progress made, and attempts some predictions about the future development and application of these amplifiers. (England.)

Simulators for Missiles and Space Vehicles, D. E. Cronin. "Brit. C&E."/ 4 pp. Analog computers have been familiar and essential tools in the design of homing guided missiles and aircraft control systems for many years. However, in studying the guidance and control of missiles having long times of flight, the limitations of analog methods begin to make themselves felt. In dealing with the positional accuracy of ballistic missiles, satellites and space vehicles, it may be necessary to forsake purely analog methods; yet general-purpose digital computers are not necessarily the ideal answer. The digital differential analyzer provides a suitable compromise in many cases between the conflicting requirements for high accuracy, real-time computation and adequate bandwidth. (England.)

Stability of Poly-Harmonic Operating Conditions in Self-Oscillating Systems With Many Tanks, G. M. Utkin. "Radiotek" No. 10, 1960. 3 pp. At the present time, operating conditions of oscillator systems with two degrees of freedom have been studied in the case of simultaneous oscillations. In this work, oscillation stability has been studied for simultaneous oscillations in systems with many degrees of freedom, such as: oscillator with several tanks, traveling wave tube with feedback, oscillators with delay lines in the feedback loop and others. (U.S.S.R)

Extension of a Theorem for Normal Passive Electric Bipoles and Steady Condition, I. Lunelli. "Alta Freq." Aug. 1960. 12 pp. A theorem demonstrated by R. M. Cohn (1950) is expounded covering the case of a normal passive bipole containing an internal passive network with n degrees of freedom, pursuant the reciprocity theorem. (Italy.)

Two Problems in the Theory of Reliability for Electronic Equipment, D. G. Polyak. "Radiotek" No. 10, 1960. 5 pp. Formulae are obtained for independent and series connected elements, which enable one to determine the optimum and most efficient distribution of the quantity of reserve elements. Reliability and the cost of a system are factors which determine the optimum selection of the reserve element distribution throughout a system. (U.S.S.R.)

Application of a Particular Mathematical Form of Inverse Fourier Transform to an Analysis of Transient Behavior of Linear Systems, B. A. Kravtchenko. "Radiotek" No. 10, 1960. A mathematical form of the inverse Fourier transforms is offered in the form of a series. This form of the Fourier transform permits the establishment of a simple grapho-analytic method of producing transient processes in linear systems. An illustrative example is given at the end of this article. (U.S.S.R.)

Recent Medico-Electronics Instruments, P. Pablo. "el. & auto." Sept. 1960. 3 pp. Among recent electronic developments for use in medical research, one can cite a microminiature amplifier, fully transistorized, an electronic piethysmograph for blood volume measurement, and finally the electronic neuron simulator, which allows the design of complex nervous systems. These three developments are fully described and methods of utilization are outlined. (France.)

The Fruits and Foundations of Solid-State Research, D. Polder. "Phil. Tech." #11, 1960. 6 pp. Principal contents of the address delivered by the author upon his inauguration as extra-mural professor at Delft. The author takes the work done on germanium to illustrate the enormous development of solid-state research. (Netherlands, in English.)

Minimum Description of Pattern by Coded Program Sweeping, V. A. Garmash. "Radiotek" No. 10, 1960. 4 pp. Aspects of minimum description of patterns are considered for automatic recognition. To minimize descriptive information required, it is proposed to use coded program sweeping of patterns. Elements of this technique are analyzed on the basis of the significance of the preceding element

Sources

A method to determine the sequence of the most informative element-cells is presented. (U.S.S.R.)

Estimate of Maximum Deviation from Known Trajectory, E. A. Barbashin. "Avto. i Tel." Oct. 1960. 11 pp. The technique given in a previous paper is used to estimate maximum deviation of the motion from the motion along the known trajectory. The way of selecting control functions and control vectors is proposed to decrease this deviation. The case of infinite time period is considered. The connection of the studied problem with the problem of disturbance accumulation is indicated. (U.S.S.R.)

Survey and Classification of Multiplying Devices, A. A. Maslov. "Avto. i Tel." Oct. 1960. 19 pp. The paper deals with systematization of various principles of designing multiplying devices in regard to the perspective of their further development in the direction of increasing their accuracy and high-speed. The ways of increasing accuracy and high-speed of the device in question are considered. (U.S.S.R.)

Study of Weak Surface Effect on Remagnetization of Ferro-Magnetic Plate, M. G. Vitkov. "Avto. i Tel." Oct. 1960. 8 pp. The paper deals with quantitative study of remagnetization of thin enough plane coils with rectangular hysteresis loop. (U.S.S.R.)

Automatization of a Cloud Chamber, F. Juster. "el. & auto." Sept. 1960. 5 pp. The possibilities of a classical Wilson chamber can be considerably enlarged through the addition of various electronic control circuits. (France.)

INDUSTRIAL ELECTRONICS

Electronics in the Automobile Industry, M. Cuiot. "el. & auto." July 1960. 3 pp. The use of semiconductors leads to worthwhile improvements in the field of electronic ignition. Numerous other applications are possible, as for example purely electronic RPM-meters and automatic speed regulators. (France.)

X-Ray Inspection of Hot Steel Billets During Rolling, W. J. Oosterkamp, et al. "Phil. Tech." #10. 1960. 5 pp. (Netherlands, in English.)

MATERIALS

Ferrite Filters With Variable Tuning, B. M. Beskorovainy, et al. "Radiotek" No. 9, 1960. 7 pp. Tuned RC and LC filters presently used in spectrum analyzers have many shortcomings, among which are limitations in the low-frequency audio ranges. Multi-section filters using ferrites with high permeability, whose reversible permeability depends very closely and rigidly on the magnetizing voltage, have considerably improved low-frequency audio response of spectrum analyzers. In this article, tunable filters are considered with ferrite core inductors. Tuning is accomplished by changing the magnetizing current. Temperature compensation of ferrite filters is presented. Data are given for a ferrite filter spectrum analyzer. (U.S.S.R.)

A Measuring Facility for the Determination of the Permeability Tensor and the Dielectric Constant of Ferrites at 3000 Mc, W. Novak. "Hochfreq." June 1960. 9 pp. A new measuring facility is described that is used to determine the properties of ferrites. The theoretical basis is given to establish the meaning of the permeability tensor of premagnetized ferrites, and methods for its measurement are discussed. The design of a new test facility for circularly polarised resonators is described. The measured bandwidth and center frequency of loaded and unloaded resonators are presented. (Germany.)

Standard Electronic Parts Specifications. L. F. Bennett. "Brit. C&E" Aug. 1960. 3 pp. This article deals with the use and advantages of standard specifications for electronic parts and materials. Their value to both user and manufacturer are briefly discussed. The aims and intent of the new high reliability specifications are included. (England.)

Zone Refining. E. F. G. Herington. "Endeavor" Oct. 1960. 6 pp. Zone refining is a process in which a rod of impure material is purified by heating it so as to cause a molten zone to pass along its length. It was originally developed for preparing germanium for transistors. Subsequently the technique, which has in certain applications marked advantages over both distillation and chromatography for the production of a virtually pure material, has been applied to a wide variety of substances. This article describes the theory of zone refining, the apparatus used, and some of its applications. (England.)

A Method of Growing Dislocation-Free Germanium Crystals. B. Okkerse. "Phil. Tech." #11, 1960. 6 pp. Dislocation-free germanium crystals can be produced by the pulling method of the diameter of the crystal grown from the seed is initially reduced to 1 or 2 mm. This diameter is maintained over a length of about 20 mm, after which it is gradually raised to the desired value. (Netherlands, in English.)

The Separation of Silicon in Vacuo by Thermal Decomposition of Silicon-Tetraiodide on a Hot Filament. H. Kern. "Vak. Tech." Sept. 1960. 7 pp. The speed of separation of silicon in vacuo by thermal decomposition of silicon-tetra-iodide has been measured. The measurements were carried out in an evacuated and sealed-off vessel, wherein 4 electrically heated tungsten wires were mounted. (Germany.)

New Developments in Permanent Magnets. J. L. Salpeter. "Proc. AIRE." Feb. 1960. 7 pp. The theory of magnetic domains provides an explanation of the magnetic properties of Ticonal and points the way to further improvements. (Australia.)

MEASURE & TESTING

Pulse Shifting in Magnetic Recorders. Y. P. Drobyshev. "Radiotek" No. 9, 1960. 3 pp. A method is described for pulse shifting in magnetic recorders to record high-frequency signals on magnetic tape. Several arrangements in the time relation between the shift pulse and the magnetic pulse are shown to produce varying sensitivities as illustrated in the hysteresis loop produced by the shifted pulse. In each case, the residual induction is proportional to the amplitude of the pulse, provided the shifting and signal pulses are synchronized. The result is that the frequency of the magnetizing current need not be several times the frequency of the signal, as is the case with other magnetizing methods, where the losses become too great in the high frequency range. (U.S.S.R.)

Synopsis and Comparison of Known Methods for the Detection of Periodic Pulses in the Presence of Noise. D. Haussig. "Hochfreq." June 1960. 9 pp. It is shown that almost all the methods now used to improve the S/N ratio in radar set work on the same principle. A comparison signal is introduced that is coherent to the useful signal but incoherent to the noise. Theoretical and practical investigations show that methods derived from the ideal integrator are superior to those that employ the short time cross correlation function. (Germany.)

Optimum Band for Spectrum Analyzers. N. I. Uryev. "Radiotek" No. 10, 1960. 5 pp. Simple formulae are presented which allow to perform preliminary design of an analyzer. These formulae establish the relationship and dependence among the basic parameters of the analyzer: the rapidity of the analysis, the static and the dynamic pass bands. (U.S.S.R.)

An Automatic Particle Counter and Sizer. H. A. Dell, et al. "Phil. Tech." #9. 1960. 15 pp. The problems involved in the automatic counting and sizing of particles are outlined in an introductory section to this article. Various possible scanning systems are described, together with various methods to avoid or allow for the effects of multiple or lumped counts. (Netherlands, in English.)

Transistorized Counter Using Lewis Cycle. P. Balaskovic. "el. & auto." Sept. 1960. 4 pp. The design of a decade counter and of the associated display circuitry can be simplified through the use of multistable circuits. (France.)

Measurement of Arterial Blood Pressure. J. R. Goding. "Proc. AIRE." July 1960. 2 pp. Arterial blood flow is described in terms of electrical analogue. It may be measured by a small transducer consisting of a moving territe core which varies the coupling between two coils. (Australia.)

Transistorized Industrial Detector. P. Sirven. "el. & auto." July 1960. 3 pp. Three examples, particularly interesting for industrial users are presented. They are an electronic timer, a temperature regulator and a photoelectric detector. (France.)

Automatic Measurement of Speed of Visual Reflexes. "el. & auto." July 1960. 3 pp. This article describes a measuring equipment using two industrial television cameras. Briefly, it records eye orientation and the speed with which this orientation varies as a function of external stimuli. It is based on the method of corneal reflection. (France.)

The Quantitative Measurement of Molecular Beams of Small Intensities by Partial Neutralization of the Electron Space Charge in a Diode. D. Fuchs. "Vak. Tech." Sept. 1960. 5 pp. In order to measure quantitatively impulse-modulated molecular beams a space charge diode by Kingdon was used which proved to be suitable as a general detector for molecular beams. (Germany.)

A Survey of Wave Analyzers and Distortion-Factor Meters. R. Brown. "Brit. C&E." Oct. 1960. 6 pp. Most of the wave analyzers and distortion-factor meters made in this country have been designed for use at audio frequencies. There are, however, several instruments available which have been designed for use at line carrier frequencies. There is one instrument which has been designed for use in the h.g. range, and one instrument which has been designed for use in the vhf range. (England.)

A Continuous Recording Method for Determining the Vertical Gradient of the Refractive Index in the Free Atmosphere. H. P. Barthelt and A. Rossbach. "Nach. Z." Oct. 1960. 3 pp. The verticle gradient of the refractive index has been examined by means of a continuous recording of meteorological data at a measuring station along a radio path 250 km long. (Germany.)

The Lower Cut-off Frequency of a Stabilised Amplifier Stage with a Transistor or a Pentode. W. Steimle. "Nach. Z." Oct. 1960. 2 pp. The loci curve of the mutual conductance in a transistor amplifier stage in a grounded emitter circuit with an RC network in the emitter line is explained and the lower cut-off frequency is calculated. (Germany.)

Radiation Detectors and Their Physical Fundamentals. F. H. Rinn. "El. Rund." Oct. 1960. 4 pp. The paper deals essentially with the design and mode of operation of ionization chambers and counter tubes. (Germany.)

Oscilloscopic Display of Counter Tube Characteristics. H. Schmidt and H. Schmidt. "El. Rund." Oct. 1960. 1 pp. A circuit permitting observation of the characteristic of a counter tube on the cathode-ray oscilloscope (CRO) screen is described. (Germany.)

Methods and Applications of Extreme-Value and Extreme-Location Selection. H. Kaltenecker. "rt." Sept. 1960. 5 pp. In some plants it is necessary to measure a variable in various places at the same time. If it is a question of automation the highest and the lowest measured values and the location of measuring are of particular interest. In this article the author discusses the problems involved in the selection of such extreme values and the principal methods applied. (Germany.)

Electronic Methods for the Interferometric Measure of Lengths. G. Ruffino. "Alta Freq." Aug. 1960. 23 pp. After a short mention of the general laws and proceedings of interferometry, the photoelectronic transducer is described, transforming the illumination of an interference pattern into an electrical signal. The description of the proceeding for length measurement using photoelectronic interferometric method adding optical paths is then given. (Italy.)

Problem of Most Rational Choice of Photoelectric Fluxmeter Circuit. I. G. Gutovsky. "Avto. i Tel." Oct. 1960. 9 pp. The theory of photoelectric fluxmeter—integrating amplifiers with photoelectrooptic amplification is given. Photoelectric fluxmeters of different types are compared. It is shown that the highest integration accuracy and high-speed are obtained in the derivative negative feedback photoelectric fluxmeter with the least time constants in the loop. (U.S.S.R.)

Semiconductor Strain Gauge. W. P. Mason. "el. & auto." Sept. 1960. 2 pp. In the course of a study of the transistor effect, conducted to provide a better understanding of the properties of semiconductors, physicists have measured the piezoresistive effect in elements like silicium and germanium. To their surprise, the piezoresistive effect turned out to be so large that it has permitted the design of highly sensitive devices for strain measurement. These new devices exhibit practically all the desirable characteristics of an ideal strain gauge. (France.)

RADAR, NAVIGATION

Altitude Telemetry in Conjunction with Air Traffic Control. D. G. Terrington. "Brit. C&E." Sept. 1960. 6 pp. It is true that radio altimeters are available for specific functions such as accurate height indication above ground on final approach to land and when navigating over mountainous terrain, but they are not in general use for navigation. (England.)

Prospects and Limitations in the Use of Low Frequencies in Active Sonar. G. Pazienza. "Alta Freq." Aug. 1960. 14 pp. The author examines the laws of variation of the different factors determining the range of a sonar. These laws are introduced in the sonar equation obtained in another report by the author and the ranges for frequencies between 2 and 30 kHz are calculated. (Italy.)

Telecontrol of Spatial Vehicles. M. Libovitz. "el. & auto." Sept. 1960. 6 pp. Space navigation will soon be a practical problem. Right now, proven practical solutions exist for the telecontrol of missiles and satellites. Guidance may be initial, median, terminal, or a combination of these types. Also, radar may be combined with inertial guidance to provide better overall performance. (France.)

* * *

EXTRA COPIES

A limited number of copies of the following articles from back issues of EI are available, free of charge. For copies write: Reader Service Dept., Electronic Industries, 56th & Chestnut Sts., Philadelphia 39, Pa.

JANUARY 1960 ISSUE

"Spectrum Analyzer Supplies Permanent Record"
"Applying Transistor 'T' Parameters"
"Thermal Characteristics of Silicon Diodes" (Part I & II)
"Printed Diode and Resistor Matrices" (Part I & II)
"The Case for DC Restoration"
"Transistor P-A Amplifier"
"The Importance of International Standards"

FEBRUARY 1960 ISSUE

"General Purpose Digital Computing Systems"
"TPR" Recording
"Nomographs Simplify Electron Tube Design" (Part I & II)
"Designing Input Trigger Circuits"
"100 KW Transmitter Has New Design Ideas"
"The R & D Personnel Administrator"

MARCH 1960 ISSUE

"Molecular Electronics"
"Controlling Alternator Frequency"
"Accurate Tracking for Radiotheodolites"
"The AC Potentiometer—New Circuit Component"
"Build a 'Suitcase' Studio"

APRIL 1960 ISSUE

"How Coriolis Works . . . When Watching Missile Remember"
"RC Filter Networks in Missile Control"
"Applying Microwaves to Space Problems"
"Thermistors . . . Key to Bio-Medical Measuring in Space"
"Selecting and Using Bonded Wire Strain Gages"
"RFI in Satellite Communications Systems"
"The Challenge of Space . . . What We Have and What We Need"

MAY 1960 ISSUE

"Encapsulating With Alkyd"
"A Double Coil Relay With One Working Gap"
"Heat Sinks for Power Transistors"
"Current Stabilizer Has Wide Dynamic Range"
"Radar Tester Needs Wide Band AFC"
"Predicting the Antenna's Role in RFI"
"Page from an Engineer's Notebook: No. 52—Rectification of Narrow Band Noise"
"Ultrasonic Welder Design Considerations"

JUNE 1960 ISSUE

"Introduction to Boolean Algebra"
"Selecting Coaxial Cable"

JULY 1960 ISSUE

"Calculating Bandwidths for Matching Networks"
"How to Analyze Control Systems with Time Lag"
"The Transistor Guard . . . A Solid State Circuit Breaker"
"Compactrons . . . New Series of Multifunction Tubes"
"Determining Cathode Warm-Up Time"
"Analysis of RFI in Transmission Lines and Filters"
"Searching for New Electronic Markets"
"Design for a Transistorized Closed Circuit TV Camera"
"How to Write Instruction Manuals"

AUGUST 1960 ISSUE

"The Search for New Electronic Markets"
"The Binistor . . . A New Semiconductor Device"
"New Uses for Fluxgate Principle"
"Determining Transistor Power Dissipation"
"Engineer's Notebook #55 . . . Conversion Chart"
"System Analysis Using Digital Computers"
"Build a WWV Time Signal Receiver"
"The 50th State . . . What Is It's Electronic Future?"
"Where Are We Going with Semiconductors and Molecular Electronics?"

SEPTEMBER 1960 ISSUE

"Conversion of Binary of Analog Codes"
"Mapping Small Magnetic Fields"
"Transistor Circuits . . . Driving the Beam Switching Tubes"
"Engineer's Notebook #56 . . . Amplifier Currents & Stabilization Factors"
"Engineer's Notebook #57 . . . Bandwidth Risetime Nomographs"
"For Computer Design . . . Storing with Thin Films"
"Controlling RFI Susceptibility in Receivers"
"Spectrum Analysis of Time Division Stereo"
"How to . . . Duplicate Technical Papers"

OCTOBER 1960 ISSUE

"Measuring Return Loss Accurately"
"Displaying Tunnel Diode Curves"
"With Double Balanced Design . . . Mixer Circuit Has Clean Output"
"Doploc Tracking Determines Orbit"
"Parametric Amplification by Junction Diodes"
"The FCC Controls Man-Made RFI"
"Calculate Impedance by Inspection"
"A New Field-Effect Device . . . The Alcatron"
"Assessing Maintainability"
"Build a Transistor Frequency Meter"

NOVEMBER 1960 ISSUE

"Future Trends in Microwave Beam Tubes"
"Determining Temperature Rise of Coaxial Lines"
"Designing a Mechanical Modulator"
"Finding Dielectric Constants"
"Finding Radar Pattern Equations with a Computer"
"Designing Rotary Waveguide Joints"
"Build Antenna Test Parabolas—Fast"
"Make Your Own Waveguide Bends"

Eastern Research Center

Robertshaw-Fulton has opened an Eastern Research Center on a 20-acre site in King of Prussia, Penna., 20 mi. from Philadelphia.

The $600,000 one-story structure has 18,000 square feet, providing laboratory, shop, office, library and receiving facilities.

Eastern Research employs about 50 persons, active in chemistry, physics, electronics, mechanics, control systems, gas technology, air-conditioning, product design, and the model shop.

Russians "Sterilized" Moon Rocket

An article from a Soviet magazine translated by the U. S. Dept. of Commerce, Office of Technical Services, says that the Russians were careful not to transport earthly microbes, which could contaminate the moon, when they made their moon shot in Sept. 1959. They hope "in the more or less near future" to determine whether there is some simple form of life now on the moon's surface or just under the surface.

The article, "The First Flight to the Moon OTS 60-31,250," (available from the Dept. of Commerce, Washington 25, D. C., for 50¢) says they also landed three pennants on the moon. The author did not say how the pennants were packaged to prevent damage.

One object of the shot was to determine whether the moon has a magnetic field and to measure the intensity of radiation. No magnetic field was determined nor were there radiation belts. Measurements of currents created by particles of ionized gas were made. There were regions between the earth and the moon where the concentration of ionized particles is less than 100 particles per cubic centimeter. These currents increased upon approaching within about 10,000 kilometers of the moon.

New Electronics Division

The J. C. Carter Co., 671 West 17th St., Costa Mesa, Calif., has formed a new electronics division. The division will market a line of instruments for precise measurement and control of magnetic fields. Products include current regulated power supplies ranging from 1 to 15 kw for generating magnetic fields and test instrumentation for magnetic fields ranging from low fields found in geophysical applications to very high intensity fields found in modern physics labs.

Cleaning Super-Clean

For "White Room" cleanliness, even dust-removal becomes a major project. The old dust-rag gives way to super-efficient chemically impregnated mops that not only remove dust but also lay down a film of bacteria-killing chemicals.

"Sani-Dust," manufactured by Talb Industries, Phila., Pa., is one that not only fulfills these functions but claims to cut cleaning time by one-third.

Circle 125 on Inquiry Card →

← Circle 126 on Inquiry Card

Pentagon TV

(*Continued from page* 99)

it arrives. Any data received can be recorded on video tape.

One output circuit feeds a wall-mounted 27-in. picture monitor-loudspeaker unit in the Emergency Action Room for off-the-air TV and Weathervision information. Another feeds two TV-type visual projectors for portrayal on the 12 sq. ft. wall screens, which also have associated loudspeakers. Another supplies a mobile twin 27 in. monitor assembly as a backup circuit for the projectors. Two video-audio electronic-switcher outputs feed 2 other mobile twin-monitor assemblies in the Conference Room. Each consists of 27-in. monitors with integrated audio amplifiers and loudspeakers. A spare output provides for checking all incoming programs over a separate 17-in. monitor and loudspeaker. A miniature transistorized camera with electronic viewfinder for live pickup will be used in the lecture and map rooms.

High Definition V-515 Camera in the Joint War Board Room.

Two high-definition V-515 Vidicon cameras, with 600-line resolution are suspended above the teleprinter machines continuously scanning incoming teleprinter copy. Outputs are connected through individual Control Units and Switcher to any of the monitor-loudspeaker units.

Reed Frequency

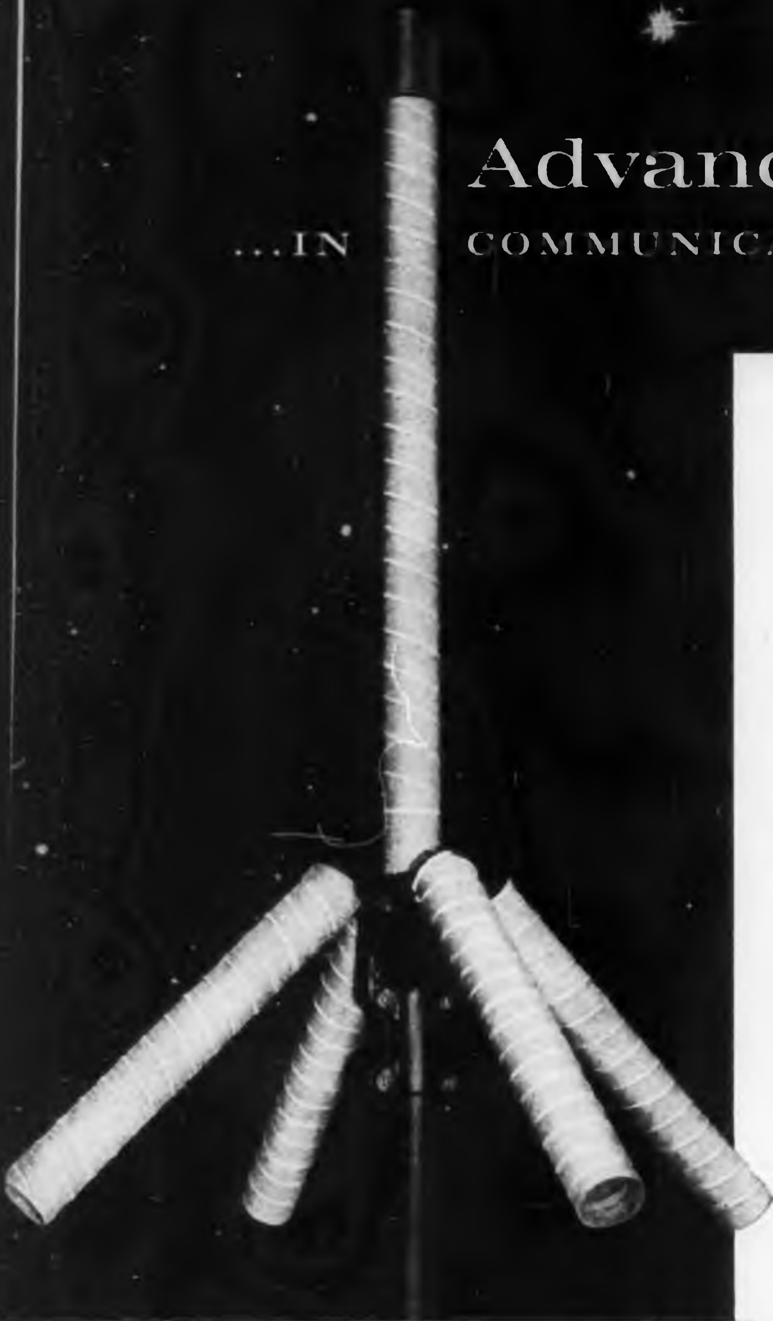
(*Continued from page 91*)

indication, which gives the most correct result (Fig. 3B).

For higher accuracy, the counter is set to measure ten periods. With the prototype, readings are reproducible within one tenth of a percent of frequency.

Advanced design

...IN COMMUNICATION ANTENNAS



HELIPOLE

The ANDREW Type 902 HELIPOLE* is the first basically new 30-50 mc fixed station antenna to appear on the 2-way radio scene in the past 12 years. Type 902 employs a new design concept that combines improved performance with mechanical convenience. It is the result of an extensive ANDREW development program.

HELIPOLE CONSTRUCTION

The foreshortened radiator employs a bifilar helical element which is encased in Fiberglass for strength, durability and corrosion resistance. One helix is grounded, providing a static drain path. The other is fed. Ground rods employ single helix conductors which also are embedded in Fiberglass. Size reduction is shown by comparing the 57 inch radiator of Type 902 with 101 inches of a conventional antenna at 30 mc. Ground rods are also shortened by a proportionate amount.

Lightweight and strong – with a maximum total weight of 13 pounds, Type 902 is designed to withstand 30 psf load with ½ inch of radial ice. The focal point of this mechanical strength is found in an aluminum casting to which ground rods and radiator are bolted with stainless steel hardware. Direct mounting is provided for members from 1¾ to 2½ inches in diameter. VSWR of this unity gain antenna is less than 1.5.

Economically priced ANDREW Type 902 is the best performing, corrosion resistant high wind load antenna on the market.

Write or call your ANDREW sales engineer for complete information or request Bulletin 8467.

*TRADE MARK

ANDREW

ABOVE ALL AN ANDREW ANTENNA...

Circle 100 on Inquiry Card

Andrew CORPORATION
P. O. BOX 807 • CHICAGO 42, ILLINOIS
Boston • New York • Washington • Los Angeles • Toronto

Tele-Tech's ELECTRONIC OPERATIONS

SYSTEMS—WISE . . .

▶ The National Aeronautics and Space Administration is planning a new lab facility to simulate outer space and atmospheric reentry. It will be part of NASA's new $18 million Goddard Space Flight Center at Greenbelt, Md. Design of the lab is being handled by Propulsion Test Facilities Div., MB Electronics, New Haven, Conn.

▶ Construction contracts for the world's longest microwave beam system have been awarded to Western Union Telegraph Co., New York. The coast-to-coast net will be completed late in 1961. It will provide a broad band to be leased to the U.S.A.F. as well as a capacity for more than 50,000,000 miles of telegraph channels for Western Union's wire and data processing systems, facsimile, etc.

▶ An IBM 704 Computer is being used at the Standard Oil Co. (Indiana) refinery in Whiting, Indiana. The unit is being used to keep a 140,000 barrel/day distillation unit operating at peak efficiency. Operating controls, based on computer figures, are now handled manually, but next year this operation will also be taken over by the computer. The distillation unit separates crude oil into 10 different streams supplying 6,000,000 gallons of products.

▶ An automatic telecommunications system links headquarters of Safeway Stores, Inc., with field offices on the west coast and with retail distribution centers from Arizona to British Columbia. The net consists of over 2,000 mi. of leased circuits. System, developed by Kleinschmidt Div., Smith-Corona Marchant, is used for inventory control.

▶ The General Electric Co.'s new "Discom" communications system enables pilots and airplane crews to see messages on their instrument panels. The system, designed by GE's Communication Prod. Dept., Lynchburg, Va., is for use where voice conversations might be indistinguishable because of poor signals or high noise conditions. It will be tested by the Air Force.

MISSILE TRACKING SYSTEM

Battery of precision antennas inside cluster of white radomes at Cape Canaveral, Fla., enables Air Force to track missiles with an accuracy of a few feet at hundreds of miles. System is the Azusa Mark II, developed by Convair Div. of General Dynamics Corp.

▶ Cubic Corp., San Diego, Calif., under contract to the Army Map Service, Corps of Engineers, has designed and built an electronic system called Geodetic SECOR (SEquential COllation of Range). It accurately pinpoints targets on the earth's various land-masses and provides global and space-vehicle navigation with more precise facts on the earth's shape and gravitational field.

NEW LASER SYSTEM

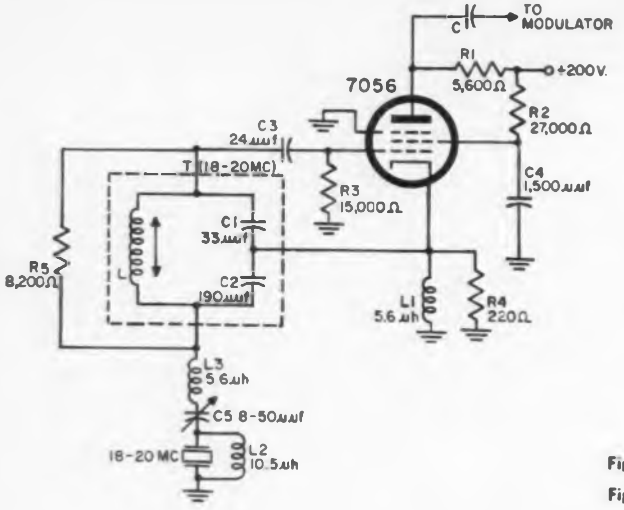
Raytheon Co.'s new optical system achieves laser action with less than 1/10 the power input formerly required. Ruby rod (center) and pencil-shaped flash tube (below) are positioned on focus lines of elliptical reflector. Nearly all light reaches ruby.

▶ A large-scale data acquisition and processing system built to handle high-speed test data at the Allegany Ballistics Lab near Cumberland, Md., has successfully completed acceptance tests. The Lab is one of the development centers for the two-stage submarine-launched Polaris missile. The system, built by Minneapolis-Honeywell Regulator Co., can sample 10,000 items of data per sec. in making 167 simultaneous measurements of variables.

▶ "Construction of North America's largest radar defense system, BMEWS, is essentially on schedule," says D. Brainerd Holmes, Manager of the project for the RCA Missile and Surface Radar Div. The system will consist of radar bases at Clear, Alaska; Thule, Greenland; and in the United Kingdom.

▶ Space Electronics Corp., Glendale, Calif., has a contract, $116,000, from the Air Force to conduct studies and experiments in sub-surface propagation of electromagnetic waves. The company has an experimental station buried deep in the desert. They will develop propagation theory, deriving mathematical expressions for the fields of a system where receiver and source are imbedded in the earth's crust.

▶ The Gulf States Utilities Co. is installing a solid-state Bailey 750 information system at the Sabine Power Station in Orange County, Texas. The system, built by Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, continuously scans, linearizes, ranges and digitizes all inputs and stores the digital values on a magnetic drum. Logging and alarm functions are included.



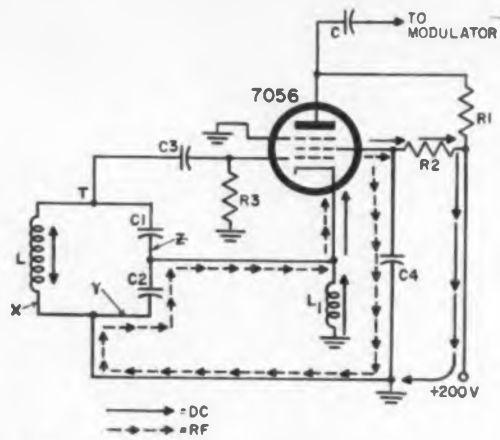


Fig. 1: Oscillator uses series-resonant overtone crystal.

Fig. 2 (above): Basic oscillator circuit is shown minus crystal.

Developing an Oscillator

THE demand for mobile radio communications has resulted in intensive use of all three of the land mobile frequency bands. (25-54, 144-174, 450-470 MC.)

Motorola recently introduced a new unit for operation on these channels. The equipment is new electrically and mechanically. Included in the features is a very stable series-resonant overtone crystal oscillator in the transmitter.

The three major goals in the oscillator development project were:

a. To design a very stable crystal control oscillator for the 450-470 MC transmitter used in mobile communication.
b. To reduce the crystal drive level to 2 mw or less in order to improve life and reliability of the crystal.
c. To design a circuit, which will have warp frequency ±60 parts per million, without degrading the stability and reliability of the oscillator.

Which Oscillator?

The initial decision, before proceeding with the circuit design, involved selection of either the series-resonant or parallel-resonant mode of crystal operation in the oscillator.

Parallel-Resonant crystal oscillators are used primariy with fundamental-mode crystals at frequencies below 20 MC. Series-Resonant crystal oscillators are most widely used for overtone operation and for higher frequencies. For maximum frequency stability it is generally preferable to operate a crystal unit at its series-resonant frequency.

System design dictated a multiplication factor of 24 from oscillator to final. In order to cover the 450-470 MC range, the oscillator had to operate from 18.7 to 19.6 MC. These frequencies are just on the border where series-resonant mode is more practical than parallel-resonant mode of crystal operation.

The frequency of a crystal varies inversely as to its thickness. For very high frequencies, the crystal would have to be very thin and might easily be broken. The frequency at which a crystal becomes too thin to be practical or durable will vary with the crystal material and the type of cut that is used. The practical limit for quartz crystals vibrating on a fundamental mode is approximately 15 MC; however, it is possible to grind a quartz plate to operate as high as 20 MC.

To meet FCC specifications, ±.0005% frequency stability was considered to be a primary objective. Because of better crystal producibility (yield), frequency of operation (18-20 MC), and maximum oscillator stability, a series-resonant overtone crystal oscillator was chosen. Besides being more economical, overtone crystals also have a higher Q than fundamental crystals. The schematic diagram of the oscillator appears on Fig. 1.

The Basic Circuit

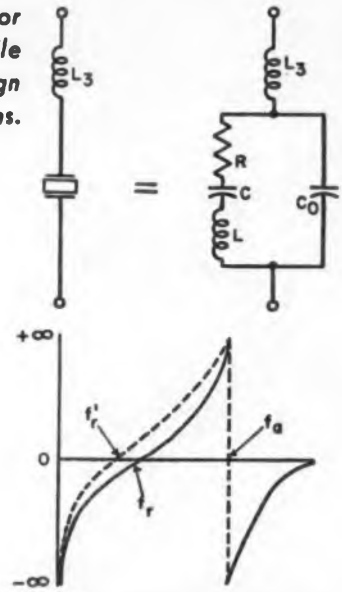
Selection of the basic oscillator configuration was next. It was decided to use the electron-coupled, grounded plate, Colpitts Oscillator. It is versatile, easy to operate, adaptable to a wide range of frequencies and it has somewhat better frequency stability than the Hartley Oscillator.

In this type of circuit, the screen grid serves as the anode. The r-f path to the capacitor C_2 (Fig. 2) in the tank circuit is completed through the screen-grid capacitor C_4. The plate of the tube serves only as an output electrode. Since the screen-grid capacitor blocks the dc voltage and passes the high-fre-

The design and development of a stable, reliable crystal oscillator is a problem made a little harder by new FCC regulations for mobile communications. Here is an engineer's thinking behind the design and development of an oscillator for use under rugged conditions.

By NICK GONCHAROFF
Communications & Industrial Electronics Div.
Motorola, Inc.
4501 W. Augusta Blvd.
Chicago 51, Ill.

for 450-470 MC



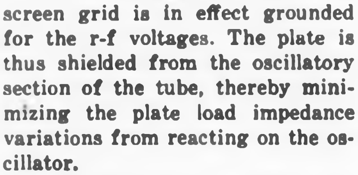
$(f_r - f'_r)$ = CHANGE OF SERIES RESONANT FREQUENCY DUE TO SERIES INDUCTANCE.

Fig. 4: Effect of adding series inductance.

quency alternating voltage, the screen grid is in effect grounded for the r-f voltages. The plate is thus shielded from the oscillatory section of the tube, thereby minimizing the plate load impedance variations from reacting on the oscillator.

Since the screen grid is constructed of mesh or fine wire, some of the electrons drawn to it will pass through. As the plate is maintained at a higher potential than the screen grid, these electrons will be drawn to the plate. The frequency of the ac component of the plate current is therefore the same as the oscillator frequency. Thus energy is delivered to the output load through an electron stream. Because the coupling medium is an electron stream, the circuit is called an electron-coupled oscillator.

Fig. 3: Equivalent electrical circuit of a quartz crystal in a holder.



In Fig. 2, the cathode, control grid, and screen, along with the tank circuit, act as a conventional triode Colpitts Oscillator in which the screen acts as a plate for the oscillator. The screen r-f bypass capacitor, C_4, isolates the triode section from the plate of the tube and supplies feedback across C_2, the ac cathode load.

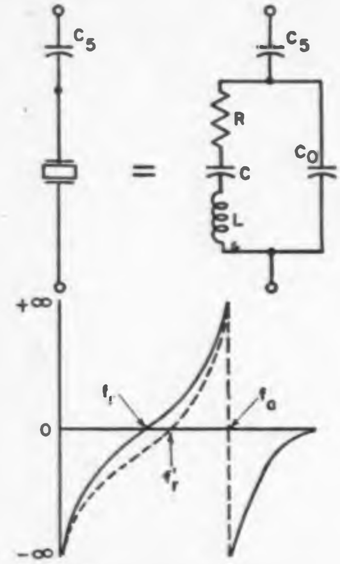
The tank circuit is C_1-C_2-L. The inductance of L is varied by means of a powdered iron slug to cover 18-20 MC range. The r-f choke, L_1, provides a dc return path to the cathode for the anode current, while providing a high r-f impedance.

Most of the electrons leaving the cathode reach the plate which is at a higher potential than the screen grid. The ac component of the plate current is coupled to the load by capacitor C, while R_1 blocks this same ac (r-f) current from the B+ supply.

Because the grounded-plate configuration furnishes no voltage gain, oscillation can occur only if a step-up transformer is inserted between the cathode and the grid. Tank T fulfills this requirement. It acts as auto-transformer; also it becomes a selective network for the third mechanical overtone of the crystal, when the crystal is added in the circuit of Fig. 2. The tuning range of the tank T is from 18 to 20 MC. By varying the capacitance of C_1 and/or C_2 the voltage across the tank circuit may be divided to produce the voltage drop required across C_1 for proper grid excitation.

During part of each cycle of alternating current in the oscillator the grid is driven positive. To prevent the tube from drawing an excessive amount of plate current during this portion of the cycle, practically all oscillator circuits employ grid-leak bias.

Any alternating voltage across the grid capacitor will vary the grid oscillation voltage. In order to limit the voltage across the grid to a minimum, the value of the capacitor should be as large as practical. The maximum value of capacitance is, however, limited by the time constant desired. The time constant should be small enough in relation to the period of the oscillating frequency, so that the bias voltage cannot attain a value high enough to stop oscillations. The grid-bias requirements for the particular tube used will determine the value of the grid resistor. Therefore, in order to



$(f'_r - f_r)$ = CHANGE OF SERIES RESONANT FREQUENCY DUE TO SERIES CAPACITANCE

Fig. 5: Effect of adding series capacitance

Crystal Oscillator
(Continued)

reduce the time constant, it becomes necessary to use a smaller value of grid capacitance.

Increasing the plate voltage of an electron-coupled oscillator will cause the frequency of oscillation to change. Increasing the screen-grid voltage of an electron-coupled oscillator will also cause the frequency of oscillation to change, but in an opposite direction to that caused by a plate voltage increase. If the voltage on the screen grid is obtained from a variable voltage divider, the screen grid voltage can be adjusted so that these two actions balance each other. The frequency of oscillation will then be practically independent of variations in the supply voltages.

After the tank circuit was built, which covered the necessary range (18-20 MC), and after the plate resistor R_1, and the screen resistor R_2 were adjusted for the best operation and the necessary ac output at the plate of the tube, the crystal was placed in the feed-back loop of the basic oscillator circuit shown on Fig. 2.

There are four possibilities of incorporating a crystal frequency control element in the basic oscillator circuit shown in Fig. 2: One between the tank circuit and the ground, the second between the tube cathode and the tank circuit, the third between screen and ground in series with C_4, the fourth in series with the tank and in positions of X, Y or Z as shown on Fig. 2.

The first possibility was chosen, since it offered several important advantages:

1. One side of crystal is grounded.
2. Distributed capacitance is minimized.
3. Improved oscillator stability.
4. Crystal drive level easily measured with VTVM.
5. Equipment servicing simplified.
6. Crystal fabrication tolerance easily checked.

Since the standard Motorola crystals, fabricated by the assembly line method, were planned to be used in this oscillator, it was necessary to consider their make tolerances. The specifications call for ±.0018% make tolerance (tolerance on nominal frequency), which is the same as ±18 parts per million. In other words, the crystal which is marked 20 MC can actually be as much, as 18 ppm below or above 20 MC. However, FCC regulation calls for not more than ±5 ppm variation from the assigned frequency in 450-470 MC frequency range.

Some way had to be found to adjust the frequency without changing the characteristics of the oscillator. For this reason, a variable reactance was necessary for adjusting the crystal circuit to the exact operating frequency. In addition to the crystal make-tolerance, there is a tolerance for the long term frequency stability (crystal aging), which calls for an additional ±30 ppm.

Thus the total possible variation according to the present specifications, is ±48 ppm. Because of this requirement, a choke and variable capacitor were added in the oscillator feedback loop, in series with the crystal, to provide for warping the crystal ±60 ppm across the entire 450-470 MC operational range of the equipment.

At this time, it is appropriate to mention a few words about the equivalent electrical circuit of a crystal. The crystal resonator is coupled to the electrical network by means of metal films on the quartz (Fig. 3a), which act as electrodes for applying potential gradients (electric fields) to the crystal. As the crystal must vibrate to produce oscillations, it must be connected to its supporting wires only at nodal points around the edge of the resonator plate.

As the vibration of the crystal will induce electrical charges on the two metal films, it is thus possible to consider the crystal and its mountings as an electrical resonant circuit such as shown in Fig. 3b. In this circuit, *the capacitor C is analogous to the elastic compliance of the crystal, the inductor L is analogous to its mass inertia, and the resistor R represents the resistance offered to the vibration by its internal friction and other losses.* The capacitor C_0 represents the capacitance formed by the two metal electrode films separated by the crystal as the dielectric, plus the stray capacitances of the holder assembly.

The reactances of L and C will be almost numerically equal to each other at the resonant frequency of the crystal. Since the crystal forms a low impedance circuit element, with a low impedance phase angle, maximum current will flow through the circuit at its resonant frequency, thus causing the magnitude of the crystal's vibrations to be maximum at this

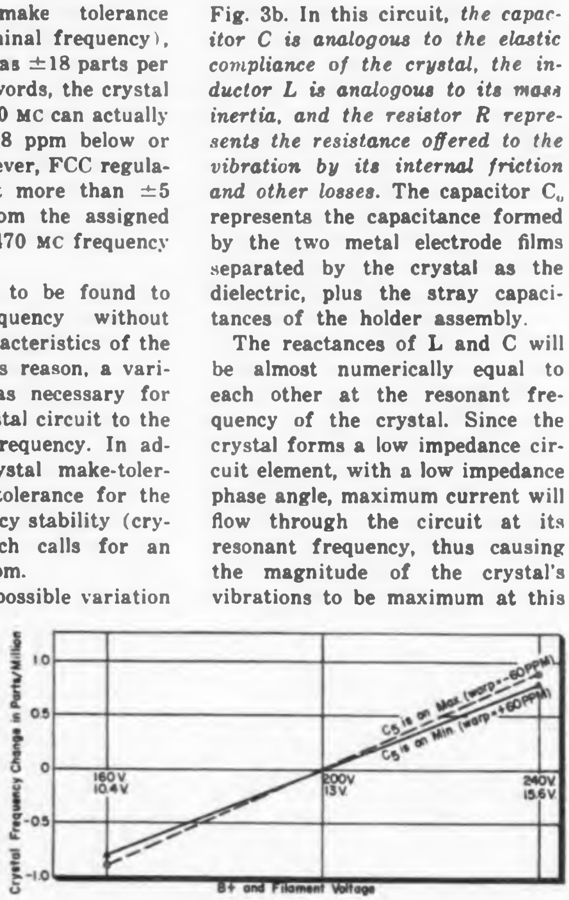


Fig. 6: Crystal oscillator stability over the total warp range vs. B+ and filament voltage.

frequency. When the crystal vibrates at its resonant frequency, the voltage drop across it will be almost minimum and will also be of the same value of frequency as the mechanical vibration.

The equivalent inductance of a crystal is very large in comparison with that of a practical wire inductor for any given frequency, and the capacitance and resistance of the equivalent series arm are correspondingly small.

Because of this high L/R ratio, the Q of a crystal circuit is many times greater than can be obtained from an electric circuit. Greater frequency stability and frequency selectivity are obtained because of the high Q and high L/C ratio of the series resonant circuit CLR, Fig. 3b.

One limitation which has been ascribed to crystal control is its inflexibility for those applications requiring a small frequency adjustment about a nominal value, and it is not always realized that controlled adjustment over a narrow band about the nominal frequency is practicable without seriously degrading the frequency stability of the oscillator. The change is accomplished with the aid of added reactance in series for circuits in which the crystal oscillates at series resonance and in parallel with the crystal for circuits in which the crystal oscillates at a frequency approaching anti-resonance. Considering the case where the crystal element employed in series resonance, the addition of series inductance or series capacitance will cause a change of oscillation frequency, as shown in Figs. 4 and 5. The amount of frequency swing possible with these arrangements is a function of the type of quartz element, mounting, and drive circuit.

The resulting circuit (Fig. 1) had frequency stability of better than ±.0001% with ±20% change in B+ and filament voltages across the entire warp range. This is shown in Fig. 6.

Besides the specifications for aging of the crystal and nominal frequency there are specifications for R and C_0 of the crystal. Maximum R for overtone crystals in the range of 15-55 MC is 40 ohms. Maximum C_0 of the crystal is 7 μμF. The majority of the crystals used in the oscillator circuit shown on Fig. 1 had C_0 between 5-6 μμF. Capacitance of the holder was around 1 μμF. Therefore, on the average, the capacitance of the crystal and holder was approximately 7 μμF. To neutralize this capacitance, it was necessary to employ the choke which was connected across the crystal. Thus the crystal was able to operate exactly on, or very near, the series-resonant frequency and was able to provide a better frequency stability.

Crystal Drive Level

The same Motorola specifications, which are compatible with military specifications for CR-32/U, call for 2 and 1 mw level of drive for frequencies between 10-25 MC and 25-55 MC respectively. Therefore, when frequency of the crystal is checked in the CI (crystal impedance) meter, the drive level has to be adjusted to 2 mw for frequencies between 10-25 MC and to 1 mw for frequencies between 25 and 55 MC. In order for the crystal to function properly and have a long working life, the crystal should be driven in the oscillator circuit with the drive level not more than 1 or 2 mw. If the crystal is driven harder than 1 or 2 mw, it will often degrade oscillator frequency stability vs. potentials and temperature.

As mentioned above, one of the advantages of this oscillator is the fact that one electrode of the crystal is grounded. This arrangement enables us to measure the voltage across the crystal when the crystal is vibrating at its series resonant frequency. It can be accomplished by connecting a VTVM across the crystal and varying the warping capacitor C_5 (Fig. 1) while observing a dip in the voltmeter reading, which occurs on the series-resonant frequency of the crystal. Knowing the resistance of the crystal, we can calculate power dissipated in the crystal using the formula:

$$W = \frac{E^2}{R}$$

When the crystal with its warping components L_3 and C_5 was inserted into the feedback loop of the basic oscillator circuit, the power dissipation in the crystal was more than 10 mw. To reduce level to 1 mw, it was necessary to add R_4 (220 ohms) in the cathode circuit and R_5 (8200 ohms) across the tank circuit. Besides reducing drive level on the crystal, R_5 also reduced the Q of the tank circuit, which in turn minimized frequency change due to changes in tank circuit elements with temperature changes.

After the addition of R_4 and R_5, the oscillator circuit was double-checked for free run, operating frequency range, warp frequency, ac output and frequency stability. When working on the development of a new oscillator circuit, it is advisable to measure every individual component separately and to check all tolerances of the component before placing it into the circuit. During the work on the warp and on the stability of this oscillator, it was noticed that the two different chokes which had 4μH and 3.85μH inductance respectively, acted in the circuit very differently. Not until the distributed capacitance of each choke was measured, was it known why they acted so differently. The distributed capacitance of the 4μH choke in this case was 4μμf, while the distributed capacitance of the 3.85μH choke was less than 1μμf.

Temperature Compensation

If one had to compensate an oscillator circuit which operated on one particular frequency and did not have any warping components, there would be no problem. But in this case it was required to compensate an oscillator circuit which covered the range from 18 to 20 MC; in addition it had the warp frequency of ± 60 ppm. Therefore, there was a necessity to check the compensation for at least three points (f_r, the resonant frequency of the crystal unit; f_r+60ppm; f_r−60ppm) at 18 MC and at least three points at 20 MC. Besides,

Crystal Oscillator

this information was needed for several oscillator circuits, to insure the repeatability and reliability of the oscillator performance.

Motorola has used oversized crystals for years to provide a better frequency stability. Because of a mass production, there are specifications and make-tolerances for the temperature turning point of the crystals, also tolerances for the oven's temperature. Specifications for the crystals are $+85\pm10$°C. Because of this, the crystals are being built with the temperature turning points varying anywhere between 75°C and 95°C. The ovens for the crystals are being built with the temperature setting anywhere between 80°C and 90°C.

It happened that an 85°C oven at room temperature could become an 83°C oven at -30°C or an 87°C oven at $+80$°C ambient. If this oven has a low turning point crystal or a high turning point crystal, the oven, together with the crystal can contribute to the frequency instability as much as ±2 ppm across the range of the temperature between -30°C and $+80$°C. Add to those two ppm, the contribution of the circuitry and pretty soon you'll have ±5 ppm, which is the limit set by F.C.C. In view of this situation, the compensation of the oscillator circuit becomes more important than ever before and also more difficult.

After it was realized that each different combination of the oven and the crystal had its own curve for frequency vs. temperature, the temperature curves were plotted for each combination used in development of the oscillator circuit. This step helped to determine how much instability is contributed by the oscillator circuit alone. After this procedure, it was possible to accurately compensate the circuit over the total warping range.

Frequency Stability

It was mentioned previously in this article, that the primary objective during the development of this oscillator circuit was the frequency stability. It was found that the frequency stability goes hand in hand with the drive level of the crystal, operating point of the tube, the amount of warp and location of the crystal in the circuit. In the described oscillator circuit, the frequency stability vs. ±20% variation of B+ and filament voltages did not vary more than .0001% across the total warping range of ±60 ppm.

Frequency stability vs. temperature for any setting of warp does not vary more than ±0.0002% for temperature range between −30°C and +85°C.

Bibliography:

1. Buchanan, J. P., "Handbook of Piezoelectric Crystals for Radio Equipment Designers."
2. Vigoreaux, J. E. P., and Booth, C. F., "Quartz Vibrators and Their Application."
3. Edson, W. A., "Vacuum-Tube Oscillators."
4. Slurzberg, M., and Osterheld, W., "Essentials of Radio."
5. Schure, A., "Crystal Oscillators."
6. Van Valkenburgh, "Basic Electronics."
7. Edelstein, H., "Selection and Application of Quartz Crystals," *Electronic Industries and Tele-Tech*, p. 56, Nov. 1956.
8. Gruen, H. E., "How to Design Colpitts Crystal Oscillator," *Electronics*, V. 30, No. 1, pp. 146-150, Jan. 1957.

The Next Step—A Girls' Engineering School

Students at most coeducational engineering schools are predominately male, but there are many attractive careers for women in the fields of engineering, science, and architecture. The big problem, it seems, is that most engineering schools offer very little collegiate life for women—except in the classroom and laboratory.

Rensselaer Polytechnic Institute (Troy, N. Y.) hopes to correct the situation with its new joint program with Russell Sage College (also at Troy). Russell Sage is a liberal arts school for girls. Essentially the program is this: RPI will admit girls to their engineering schools, but the girls will live at Sage. They can thus get their engineering degrees and at the same time enjoy the extracurricular life at both schools.

Since 1945, Rensselaer has conferred only 69 degrees on young women, but there are 9 girls in undergraduate classes now — an indication of growing interest. Each year the school has had to turn away about 100 female applicants because of the lack of facilities. No maximum limit has been established for the number of new students. They will be admitted in open competition with male applicants.

CUES for Broadcasters

A Gates FM 5-B Modification

NORMAN E. WOODS, Ch. Eng.
WUST & WJMD, Washington, D. C.

There exists in the Gates FM 5-B transmitter, a potentially dangerous hazard, because the HV shorting switch does not ground, but goes to R-612, which is a 10 ohm, 20 watt resistor. Should you apply HV, this resistor will probably "open" due to the 5000 v. at several amps. which exceeds the power rating considerably. Also, there is a good chance the filter will remain charged-up after the next attempt to apply HV, especially if the air interlock is open, thus the tubes cannot bleed off the voltage. The PA Plate meter may go out too, but what happened to me, was that S-603 arced across also.

The switch can be repaired easily, by moving over to the unused section of the 3-pole switch, all the associated jumper and connections to R-612. It was a job to take the switch out to discover the easy way to make the repair.

While you are changing the resistor, increase the power to at least 25 watts. This transmitter operates at about 1.5 a., which is more than 20 watts by the formula. I = sq. root of P (20 over R (10 ohms). The result of this formula is about 1.4 a., which is less than actually applied.

If you have not had this experience, use a gimmick that is standard practice on higher-priced transmitters. Take a piece of braid, and connect it to the screw near the shorting switch, and run the other end directly to the disc. To be sure of good contact, drill a hole in the edge of the disc to either pass or be threaded for a #6 screw. Align the disc with the braid connected so it is near the frame, and to prevent accidental contact with the HV terminal which contacts the disc. Apparently, Gates was afraid to use a braid, thinking it might contact, or that the resistor was sufficient.

Teletype Static Eliminator

I. A. ELLIOTT, Tech. Director
KATL, Miles City, Montana

For years we have had trouble at KATL with static-electricity building up a charge on the paper in our news room teletypes. Often, when this happens in the period between sign-off and sign-on there is a paper "jam" that has caused the ribbon to break and printer to be full of paper scraps and needing a complete cleaning. Of course, the most major problem is a complete lack of news until the machine can be put back in service.

The anti-static devices supplied by the wire service did not work.

We, until recently, found a chain of paper clips—or Christmas tinsel—hung in a loop across the glass door so it dragged on the paper just above the type bars was the only solution. The disadvantage to this method of static control is that a small bit of tinsel or a paper clip dropping into the machine can cause a failure.

We have now installed a loop of chain such as is sold in hardware or electrical stores for pull-chain, or bath tub plug, use. The type with the large balls is most effective as the balls roll easily with the paper. All that is needed for a Model 15 teletype is 14 inches of chain and two 1/8 to 3/16-in. cable clamps (General Cement #H502-F). Unscrew the two large thumbscrews at the top of the glass door. Put cable clamps under each nut, on the inside of the glass, with the ends of the chain under the clamps. Adjust length so that the bottom of the loop touches the paper at the third line above the copy being printed. Tighten clamps and cut off excess chain. Your static troubles will be over and the finished job looks far better than the chain of paper-clips seen in so many news rooms.

▶ Dr. A. M. Levine, vice-pres. of ITT's Missile & Space Systems Div., sees earth satellites as the means of solving the tremendous existing need for radio networks to span large bodies of water over which reliable communication is virtually impossible. He gave his views at a joint meeting of the Canadian Aeronautical Institute and the U. S. Institute of the Aeronautical Sciences.

▶ An emergency communication system for stranded motorists has been introduced by Radiation, Inc., Orlando, Fla. System consists of a central receiving site and strategically placed highway call stations. Power is obtained from batteries recharged by solar cells. Transmitter is FM, 1 w, and gives reliable communications up to 18-miles.

▶ Two Varian Associates VA 842 klystrons will power the transmitter for the DOD Ionospheric Research Facility, the world's largest and most powerful radar. Radar antenna will include a 1000 ft. dia. reflector being scooped out of a natural limestone bowl in Puerto Rico. Cambridge Research Labs directs the project.

▶ Stromberg-Carlson, San Diego, has developed an electronic reading and printing system for transmitting mail. System is being tried out by the Post Office Dept. between Wash. D. C. and Chicago. Scanner sends the image via TV-type communications lines. Printer uses Haloid Xerox, Inc., xerographic printing process. Intelex Corp. is systems manager.

▶ Goodyear Aircraft Corp. has been selected to develop a radar unit that will eliminate, or minimize, the possibility of ship collisions at sea. The project, for the Maritime Administration will use a computer to plot the projected courses of up to 10 ships simultaneously. It will sound an alarm when collision distances are indicated.

▶ The Greyhound Bus Co. has a new fully-automatic telecommunications system designed by Smith-Corona Marchant which links all terminals in the Central-Southwestern Region. There are 46 stations and 3 master control stations linked by over 4200 mi. of leased wire circuits.

Older Workers Getting Jobs More Easily—NAM

Workers in the 45 to 65 age bracket are finding jobs more easily today than they did several years ago says the National Association of Manufacturers. In a special report on "Employment of Mature Workers," the NAM said spot surveys have shown that the number of older workers employed have increased strikingly faster than the number of older workers available.

The report cites several reasons for this changing situation. One is that employers are realizing that the older worker has valuable knowledge and judgment gained through experience. Another is that machinery is now doing jobs that required muscle power—and older men can easily operate the machinery.

Pension plans have long been a stumbling block to hiring older workers. But, with increasing Social Security benefits and a more realistic approach to the regulations governing these plans, this deterrent is being overcome. Companies have also found that including older workers in pension plans is not as costly as they thought. Group life insurance costs, for example, were found to average only a cent an hour more for a 50-year-old worker than for a 30-year-old worker, and the lower accident rate for older workers reflects favorably in the charges for workmen's compensation insurance.

The report is available from the National Association of Manufacturers, 2 E. 48th St., New York 17, N. Y.

Established Research Grants

American Machine & Foundry Co.'s R & D Div., 261 Madison Ave., New York 16, N. Y., has established four $2,500 research grants-in-aid for graduate students and junior professors. Work will be in mechanical, electrical, and chemical engineering or in related research areas.

Grantees will be invited, at company expense, to present their findings at seminars of AMF Research and Development Div. senior scientists. Recipients will be free to publish and use project information as they wish, and grants involve no patent agreement or promise of future AMF employment.

WASHINGTON

News Letter

NEW ADMINISTRATION VIEWS—Recommendations on improving functioning of Federal regulatory agencies, including the FCC, has been presented by former Harvard Law School Dean James M. Landis to President-elect Kennedy. Mr. Landis proposed that the next administration strengthen its control over the agencies in terms of appointments of commission members and chairmen. It should also move toward more coordinated administration policies, particularly procedural revisions within existing statutes, than has been done in the past. Mr. Landis, who served as chairman of the Securities & Exchange Commission and Civil Aeronautics Board during the Roosevelt Administration, was appointed by the new President, shortly after his election, to survey the defects and problems of the regulatory agencies. He was named by President-elect Kennedy because of his wide experience in the Federal Regulatory field.

NO SWEEPING OVERHAUL—The Landis report to the President-elect, submitted in mid-December, did not favor a wholesale revamping of the regulatory commissions or the scrapping of the regulatory commission concept. Dean Landis did stress, however, that appointment of commissioners and key staff personnel should be made with treatment "substantially similar to the matter of judicial selection." Every effort should be made for lifetime service of such appointees. He felt that one of the major deficiencies in the work of these agencies has been "their lack of creative thinking." Another key problem is in the agencies' opinion-writing sections where the commissioners are too often relieved of the responsibility of determining their own top-level decisions.

REGULATORY DELAYS—The Landis report to the President-elect pointed up as key problems in Federal regulation the delays in commission decisions —a complaint particularly applicable to the FCC. Changes in budgetary thinking on commission appropriations by Congress to ensure adequacy of staff would aid this situation, together with the delegation of decision-writing to a single member of a commission and a program of making more examiners' decisions final. A current difficulty, in Dean Landis' opinion, is also the "too casual attitude toward the admission of evidence." His report emphasized the increasing costs of litigation in prosecution of cases before commissions.

SPACE POLICYPLANNING — Impetus to policy planning coordination by government agencies for space telecommunications should be given by Congress, the Senate Committee on Aeronautical & Space Sciences staff, headed by Vice President-elect Lyndon Johnson has urged. Congress, in its current session, is anticipated to give concentrated consideration to the problem of frequency allocation related to the space communications program and the responsibilities of the various government agencies engaged in this field. The report indicated that Congress will take a long, hard look at what direction the United States is going and will push for a program that will put the nation in the forefront of space communications. The Senate committee staff report stressed the need for the U. S. to formulate a unified policy position concerning frequency allocations prior to the 1963 Extraordinary Radio Administrative Conference of the International Telecommunications Union.

REVIEW GOVERNMENT SPECTRUM NEEDS — The Office of Civil & Defense Mobilization will review all requests of government agencies for frequencies of conventional use above 1000 megacycles. The OCDM advised that this program was instituted to ensure that the space communications problem is not complicated further and to avoid making ultimate space frequency problems more difficult. The OCDM action is in direct contrast to that of the FCC in the civilian-use frequency field. It provides for greatly broadened licensing of private point-to-point microwave systems. The OCDM plan was presented to the Interdepartment Radio Advisory Committee, which is the clearing house for government frequency requirements.

National Press Building *ROLAND C. DAVIES*
Washington 4

ATOMIC FREQUENCY STANDARDS — National Bureau of Standards is conducting developmental research on the precise measurement of frequency. Radio communications, satellite tracking, long-range rocket control and astronomical observations will require future timing accuracies of one part in a billion or better. Atomic Frequency Standards, which, potentially, are three orders of magnitude more precise for time-interval determinations than the rotation of the earth, are necessary in meeting the ever-increasing need for even greater accuracy. Recently, comparisons were made between two dissimilar cesium-beam atomic frequency standards constructed at the NBS Boulder Labs. The devices were tested independently, the pertinent parameters measured, and frequency comparisons subsequently made. Results of the experiments demonstrate that beam devices of rather modest length (55 cm between the oscillating fields for the shorter machine) can have precisions of ± 2 parts in 10^{12} for measurement periods of one to a few hours. Frequency difference between machines is 1.0×10^{-11}.

Give Engineers Credit as Prime Movers—Weber

The engineer is "the prime mover in modern civilization" and should receive "credit" for creating the "modern setting of society," says Dr. Ernest Weber, President of Polytechnic Institute, Brooklyn. And, "If we really want to assure recognition of the individual engineer at all levels by increased social, political, and community responsibility, we must do it through broader education."

Without compromising on the basic need for scientific engineering education at undergraduate and graduate levels, he continued, "we must devote at least one-quarter of the engineering student's bachelor's program to an intensive, integrated program that gives the evelution of mankind in broad strokes."

Dr. Weber gave his views before the AIEE's Fall General Meeting in Chicago where he was awarded the Society's Medal in Electrical Engineering Education.

Dr. Weber wondered why "the technologist has taken so little active part in government, and why so little credit—if any—goes to the engineer who creates this modern setting of society." He felt that "this has been the fault partly of the engineering profession itself because they are generally preoccupied with their profession, and partly the fault of engineering education for sacrificing the so-called humanities to the seemingly more important technological studies.

$4.4 Million Solid State Research At U. of Pa.

The Advanced Research Projects Agency (ARPA) and the University of Pennsylvania, Phila., Pa., have announced a $4.4 million research program in experimental and theoretical solid state physics, structural chemistry, inorganic chemistry, ceramics and all phases of metallurgy. The program will include: electrical engineering of solid state devices, studies in chemical engineering involving metals separation processes, high temperature kinetics, and corrosion.

The solid-state research will be concerned with thermal conductivity, ferromagnetism, ferroelectrics, inperfections, transport processes, magnetic phenomena in dilute alloys, photo-chemical processes, magnetic resonance, optical processes in the far ultraviolet, X-rays, internal friction, and many-particle theory.

Industry News

John M. O'Malley—named Superintendent of Manufacturing of Clarostat Mfg. Co., Inc., Dover, N. H.

Herbert Lawrence, Jr.—appointed to handle nationwide sales of The Victoreen Instrument Co.'s Nuclear Spectrometry Products.

Paul Lebenbaum, Jr.—appointed Manager of the Palo Alto, Calif., plant of ITT's Components Div.

Dr. **William E. Glenn**, Research Physicist at G. E.'s Schenectady, N. Y., Research Laboratory—selected as Georgia Tech's "Outstanding Young Alumnus of the Year" for 1960. He received the third annual George W. McCarty-ANAK Award. Dr. Glenn is the inventor of thermoplastic recording, G. E.'s new recording technique.

Dr. W. E. Glenn

F. L. Ankenbrandt

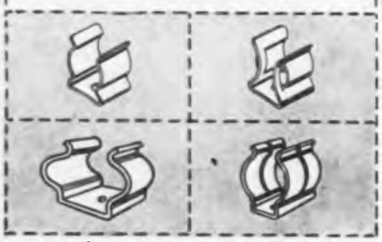
F. L. Ankenbrandt—appointed to new position of Manager, Product Assurance, RCA Defense Electronic Products, N. Y., N. Y.

William E. McKenna and **Crosby M. Kelly**—appointed new Vice Presidents of Litton Industries, Beverly Hills, Calif.

Maj. Gen. Raymond C. Maude, USAF (Ret.)—appointed Director of Field Operations for Philco Corp.'s Government and Industrial Group, Phila., Pa.

Captain William I. Bull (USN, Ret.)—appointed Assistant to the President for Semiconductor Operations at Hoffman Electronics Corp., Los Angeles, Calif.

N. J. MacDonald, President of The Thomas & Betts Company, Inc., Elizabeth, N. J., has been presented the Medal for Cooperation and Purse for 1960. **J. F. Lincoln**, Chairman of the Board of the Lincoln Electric Company, Cleveland, Ohio, and **Everett Morse**, President of Simplex Wire and Cable Co., Cambridge, Mass., each received a Manufacturers Medal and Purse for 1960. Awards were presented under the James H. McGraw Award for Electrical Men.



Industry News

Harry R. Gillespie—appointed Assistant General Manager for the Trimpot Div. of Bourns, Inc., Riverside, Calif.

Robert C. Berman — promoted to new position of Manufacturing Service Manager for Raytheon Co.'s Industrial Components Div., Newton, Mass.

Richard M. Johnson — appointed Sales Manager, Markite Corp., New York, N. Y.

Clarence H. Hopper — appointed president of CBS Electronics, Div. of the Columbia Broadcasting System, Danvers, Mass.

C. H. Hopper

H. M. Schiff

Hans M. Schiff, veteran electronics and aeronautical executive — joins Packard Bell Electronics, Los Angeles, as Vice President and General Manager of the Technical Products Div.

Genrik Sirvis — named Plant Manager, Bendix Computer Div., The Bendix Corp., Los Angeles, Calif.

George P. Whitbread—appointed to new position of Product Manager, Insulating Materials, and **Robert Poet**—appointed General Sales Manager at Telecomputing Corp.'s Narmco Industries Materials Div., Costa Mesa, Calif.

Richard A. Fletcher — appointed Corporate Planner - Market Research at Lockheed Electronics Co. in Plainfield, N. J.

Dr. **Kenneth M. Merz**—joins International Resistance Co., Phila., Pa., as Manager of Ceramic Research.

Richard J. Sparnon—appointed Advertising and Sales Promotion Manager for the Electronic Tube Div., Allen B. Du Mont Laboratories, Div.'s of Fairchild Camera and Instrument Corp., Clifton, N. J.

Elwood E. Parrish—appointed Director International Marketing, Keuffel & Esser Co., Hoboken, N. J.

Industry News

George Voigt—named to newly created post of Director of Government Relations for Military Products, Zenith Radio Corp. and its wholly-owned subsidiaries.

William H. Brown, Development Engineer—designated as East coast Technical Liaison Representative, Horkey-Moore Associates, a division of Houston Fearless Corporation.

J. Sanford Doughty—appointed Assistant to the President-Communications, Amphenol-Borg Electronics Corp., Broadview, Illinois. His responsibility will be in the areas of External and Internal Communications including Corporate Advertising and Public Relations.

J. S. Doughty

R. Clark

Robinson Clark—appointed Controller, Stromberg-Carlson Div., General Dynamics Corp., Rochester, N. Y.

Hardy G. Ross — named General Purchasing Agent, Western Electric Co., Inc., N. Y., N. Y., succeeding Gus F. Raymond, who retired.

J. F. "Ted" Miller—named Eastern Area Account Executive Manager, **Hoyt Stout**—appointed Regional Sales Manager in West Virginia, and **W. R. Corwin**—named Zone Sales Manager in Northern New England covering New Jersey, Delaware and Southeastern Pennsylvania, Motorola Communications and Electronics, Inc.

George M. Russell—named Eastern Regional Manager and Washington Representative, Elgin Micronics, a Div. of the Elgin National Watch Co., Elgin, Illinois.

James F. Orr, Jr.—joins Servo Corp. of America, Hicksville, L. I., N. Y., as Manager of Product Sales. He will be in charge of Servo System Test Equipment and Industrial control Systems Sales.

George F. Lewis, Vice President and Assistant Secretary—appointed General Manager of the Manufacturing Div., Varo Mfg. Co., Inc., Garland, Texas.

Opportunities at Hughes in

microwave research and development

Modern electronic systems demand a broad range of technical competence. The Hughes Microwave Laboratory has unusually extensive capabilities in the antenna, microwave component, and radome fields. Its activities are co-ordinated in a balanced program of fundamental research, development, design and production engineering.

ANTENNA RESEARCH—Included in current studies are: electronic scanning, its information transfer functions, and its relationship to system performance; surface waves and conformal surface antennas potentially useful on nose cones or low silhouette applications; and the theoretical aspects of transmission through small radomes.

ELECTRONICS RESEARCH—These investigations are concerned with basic phenomena such as amplification, harmonic generation, limiting and switching with ferromagnetic and dielectric materials, and superconduction in thin films at microwave frequencies.

MATERIALS RESEARCH—In the fields of Solid State Chemistry and Physics, studies are directed toward the synthesis and characterization of organic and inorganic compounds; new polymer systems; structural and electronic ceramics; and ferroelectric, ferrimagnetic and paramagnetic materials for electronic applications.

MICROWAVE ENGINEERING—the products of research are converted into advanced components, processes, and techniques for ultimate system application. Novel antennas, radomes, filters, and ferrite devices are being developed for the entire microwave and UHF spectra. New materials and processes are exploited for the production of ferrites and garnets, silicone plastics, ablative materials, high-temperature insulating and encapsulating materials, and electroluminescent panels. Research and engineering ideas are rapidly embodied in concrete forms through the facilities provided by a versatile design staff and a well-equipped shop.

Openings exist in each of the above areas. These positions offer excellent opportunities for qualified personnel in the fields of Physics, Chemistry and Engineering (Electrical—Microwave—Mechanical).

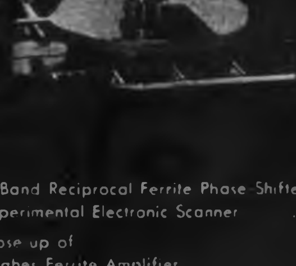
Please write: Mr. R. A. Martin, Supervisor, Scientific Employment
HUGHES AEROSPACE ENGINEERING DIVISION, *Culver City 6, California*

HUGHES *the West's leader in advanced electronics*

HUGHES AIRCRAFT COMPANY
AEROSPACE ENGINEERING DIVISION

A.

B.



C.

A. X-Band Reciprocal Ferrite Phase Shifter Experimental Electronic Scanner

B. Close up of Hughes Ferrite Amplifier

C. Apparatus for X-Raying Single Xtal Ferrites and Garnets

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers · Development Engineers · Administrative Engineers · Engineering Writers
Physicists · Mathematicians · Electronic Instructors · Field Engineers · Production Engineers

Starting Salaries Up

Starting salaries of engineering graduates—reported by the Univ. of Michigan, Ann Arbor, Mich.—are averaging $524 (bachelors) compared to $508 last year. Masters' starting salaries rose from $598 to $655.

Demand for engineering grads represented 33% of the Universities' total—a drop of about 4% from the 1958-59 figure. Areas of greatest demand were in electrical and mechanical engineering and in the natural sciences.

TRANSISTOR QUALITY

Army Signal Supply Agency admits Sylvania into its quality assurance program for "consistent high quality production." Brig. Gen. C. S. Hays inspects manufacture of high speed germanium switching transistors.

New Solar Test Facility

GE's Missile and Space Vehicle Dept. is planning to build a new solar test facility near Phoenix, Arizona. It will feature a large movable section that can be rolled away to expose equipment to the sun. Initially, solar collectors as large as 21 ft. in dia. may be housed in the movable section. The facility will be able to test the largest solar powered static generating systems now built for space applications. First equipment to be tested is a thermionic conversion system.

Weather was the main reason for selecting the site. There is an average of 210 clear days there compared to 94 days or less for the Philadelphia area (home of the MSVD).

Recruiting at Conventions Becoming a Real Problem

The average cost for recruiting an engineer or scientist in 76 firms doing business with the Federal Government is now $1,022. This was brought out by a survey made by the Manpower Utilization Subcommittee of the House Committee on Post Office and Civil Service. The average cost for firms whose business is primarily commercial is $751.

The recruiting problem is accented at trade shows and technical conventions where job hunters (often disgruntled employees) and manpower-hungry companies come face to face. The problem is two sided: Companies are becoming wary of sending key men to conventions because they may be "pirated" away, and other companies are spending so much time in recruiting activities that the main purposes of these conventions are being subverted. One company even gave their employees an expense-paid vacation during a recent major convention—but at a vacation resort far from the convention.

The directors of the shows recognize the problem and try to discourage recruiting, but they are generally unsuccessful, primarily because they have no control over

(Continued on page 221)

TE Research Extended

Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio, has extended its materials and techniques research on thermoelectric-cooling devices for two years. Continuing support for the program is assured.

Principal objective will continue to be the preparation of new compounds and the investigation of their resistivity, thermal conductivity, and thermoelectric power. Battelle's Switzerland facility (Geneva) is studying lattice thermal conductivity. Although the program is aimed at materials development, some device research of a basic nature is being conducted.

Battelle's scientists have found one compound that shows promise but it is still too early to say whether it is competitive with presently available TE materials. They have also developed techniques for screening and improving compounds and alloys which reduces the experimental work needed to predict the figure of merit.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 159.

VISUAL AID

Visual production system at Collins Radio Co.'s Cedar Rapids, Iowa, plant projects assembly instructions on photo in the stereo-type viewer.

Electronic tubes and semiconductor devices are parts of much larger equipments or systems. The demand for them depends on many diverse elements including consumer taste and U. S. defense and foreign policy. In this dynamic industry, a forecast cannot be an extension of past performance alone, but must also consider the impact of new developments. This forecast is based on such an analysis.

By JEROME KRAUS
Manager of Systems Engineering
ITT Laboratories
Nutley, New Jersey

Electron Tubes and

SEMICONDUCTORS have developed into a $377,000,000 (1959) a year market item and will probably reach $500,000,000 in 1960. The 1959 tube market was $775 million.[1] Together they represent a market of over $1.1 billion.

This 1961-1965 forecast will use statistical projections modified by other economic and technical knowledge.

THE STATISTICAL FORECAST

Data from the Electronic Industries Association and the Business and Defense Services Administration of the Dept. of Commerce is reproduced in Table 1.

No reasonably high correlation can be found between either tube and semiconductor sales and the Gross National Product, but the combined sales of both, exhibit a rather interesting characteristic. From 1954-59, the ratio of tube plus semiconductor sales to GNP increased at an almost linear rate (see Fig. 1 and Table 1) and the trend line has a coefficient of correlation greater than 0.75. By projecting the trend line $Y = 1.61 + .08(x)$ to 1965, the relationship between tube and semiconductor sales tends to be independent of cyclic variations. Table 2 is the predicted tube and semiconductor market based on 3% and 5% annual rise in GNP over the next 5 years.

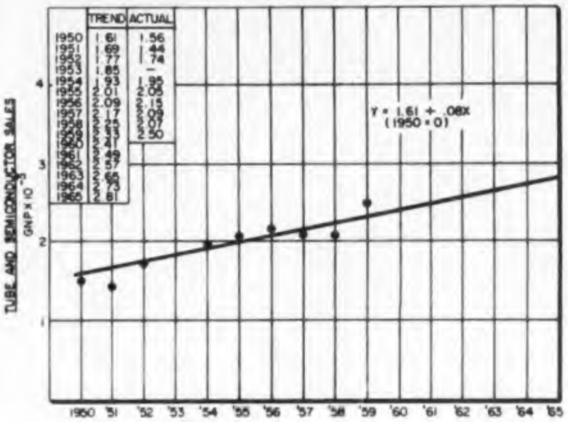
This neat linear predicting tool applied to the entire market becomes somewhat unsettled when applied to these segments of the market: Receiving Tubes; Power and Special Purpose Tubes; TV Picture Tubes; Transistors; and Semiconductor Diodes.

Receiving tubes (Table 1) have varied between 0.75 and 0.90 for

Table 1: 1950-1959 Statistics

Year	GNP $ billions (a)	Tubes + Semi. $ millions (b)	Tubes $ millions (b)	Semi. $ millions (b)	Receiving Tubes $ millions (b)	Transistors $ millions (b)	Semi. Diodes + Rectifiers $ millions (b)	Tubes + Semi. / GNP × 10^{-3}	Transistors / GNP × 10^{-3}	Receiving Tubes / GNP × 10^{-3}	Semi. Diodes / GNP × 10^{-3}	Picture Tubes $ millions (b)	Power + Special Purpose Tubes $ millions (c)
1950	284.6	443			250			1.56		0.88		210.7	
1951	329.0	473			261			1.44		0.79		122.2	
1952	347.0	604	585	19	259	2	17	1.74	.01	0.75	.05	170.7	
1953	365.4			26	304	5	21		.01	0.83	.06	234.9	
1954	363.1	708	682	26	276	9	17	1.95	.02	0.76	.05	206.1	152
1955	397.5	800	760	40	358	13	27	2.05	.03	0.90	.07	209.0	148
1956	419.2	853	740	113	374	37	76	2.15	.09	0.89	.18	196.2	161
1957	442.5	925	753	172	384	70	102	2.09	.16	0.87	.23	183.2	185
1958	441.7	914	688	226	342	113	113	2.07	.26	0.78	.25	163.5	214
1959	479.5	1,152	775	377	369	222	155	2.50	.46	0.77	.32	183.8	

(a) 1950-1958, National Industrial Conference Board, *Economic Almanac 1960*. 1959, U. S. Dept. of Commerce, *Survey of Current Business*.
(b) Electronic Industries Association.
(c) BDSA, U. S. Dept. of Commerce.



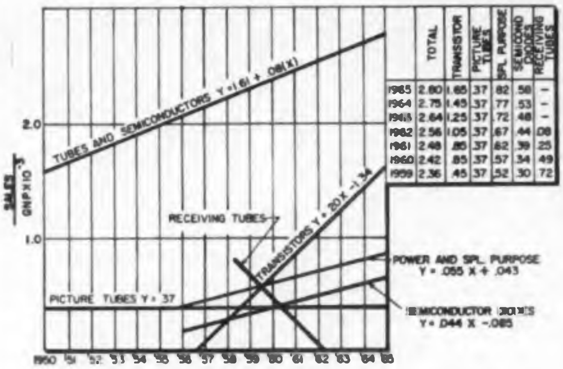


Fig. 1 (left): Trend of tube plus semiconductor sales, 1950-1965.
Fig. 2 (above): Linear trend projections.

Semiconductors—What's Ahead?

the past decade but preliminary information for 1960 indicates a fall considerably below that level. The added growth in semiconductors resulted in part from growth in areas noncompetitive with receiving tubes and in part from the opening up of new entertainment markets.

The transistor market has risen most precipitously. A continuation of the trend would result in a billion dollar market by 1965 (see Fig. 2).

Semiconductor diodes have also had an increasing market since 1954, but not as great as that of semiconductors.

The picture tube market, which has fluctuated widely, declined in terms of percentage of GNP in every year from 1953-1958. In 1959 it increased slightly.

The power and special purpose tube market has shown a steady increase since 1955.

A technique which seems worthwhile is to project current trends of the 5 types of components and to compare the totals with the trend $Y = 1.61 + .08(x)$ for the over-all market. The sum should equal $Y = 1.61 + .08(x)$.

For transistors, it is possible to use the ratios to GNP for 1958, 1959 and estimated 1960 to project a straight line out to 1965. See Fig. 2.

Picture tube sales, the most erratic, have bottomed out at a ratio of about 0.37. Because of their erratic behavior in the past, the projection for 1961-1965 has been $Y = 0.37$ in Fig. 2. A moderate increase in semiconductor diode and special purpose ratios based on linear trends can be calculated from 1956-1959 sales.

Receiving tubes have started a decided slump if preliminary 1960 data is substantiated.[2] A rapidly rising transistor market indicates a falling receiving tube trend if the initial assumption that the total equals the sum of the individual components is correct. But with the projected curves, the residual receiving tube sales would fall to zero at 1962 and be negative in 1963-65. It seems logical to reapportion the first 4 components to make room for receiving tubes. The most likely component which can offer room is transistors. It is tempting to "break" the rise in transistor sales at some point and project sales from that point to 1965 with zero slope. If the break is at the end of 1961, 0.25 will remain for receiving tubes, a very sharp fall off in 2 years from a level of 0.77 in 1959. Breaking the rise at the end of 1960 would leave receiving tubes with a 0.47 ratio in 1960, perhaps closer to reality. If the break point were mid-1960, a 0.57 ratio would remain for receiving tubes.

Fig. 3, a revised statistical forecast, attempts to resolve some of the problems raised by Fig. 2. The trend of tube plus semiconductor sales is retained as a basis for the revision but the distribution by types is altered. Transistor sales are held constant at 0.65, about the level of mid-1960 on the $Y = 0.20x - 1.34$ curve of Fig. 2, to permit receiving tubes to have residual values of 0.45 to 0.37 in 1961-65. Power and special purpose tubes, semiconductor diodes and picture tubes were assumed to have the same trends as in Fig. 2. The total of the 5 curves in Fig. 3 is equivalent to the total curve of tubes plus semiconductors/GNP x 10^{-3}.

The statistical forecast could have been developed in many ways. Nonlinear trends might have been used and one of the parameters other than transistors could be used to leave room for receiving tubes. A case may be built for permitting

Tubes and Semiconductors *(Continued)*

the transistor curve to rise steadily and to build receiving tube volume out of declining diode and power and special purpose tube sale. There seems to be no real basis for the latter course, however, and Fig. 3 represents as reasonable a forecast as can be made without investigating technical and economic factors considered in the next two sections.

TECHNICAL FACTORS

Receiving Tubes

Some trends in receiving tube design include: Smaller, lighter tubes; Lower power consumption; Greater ability to withstand high amb heat and high amb radiation.

For smaller, lighter designs, several schemes have been used. The RCA Nuvistor[3] and the GE TIMM[4] (Thermionic Integrated Micro-Module), for examples, use the tube enclosure as a mechanical support for the electrodes or other elements. Another scheme includes more than one tube unit within an envelope, a trend recently dramatized by GE's Compactron.[5]

The Nuvistor type will probably develop rapidly and further size reductions result. The micromodule will develop more slowly because of lack of flexibility and inexperience of designers. The Nuvistor, TIMM and Compactron all use much less power than conventional tubes and the TIMM can operate at very high amb temp.

Another tube technique appears promising for reducing size. The cold-cathode (magnesium oxide) tube developed by the Signal Corps and Tung-Sol requires only keep-alive electrode power.[6] Small heat dissipation makes possible smaller size and weight. This type of tube is competitive with transistors in low power dissipation.

A fourth new development (Westinghouse[7] and others) uses a semiconductor cathode rather than a semiconductor-coated cathode. This should result in a simpler tube type—no heater is required and a pin-point source of electrons is achieved.

The largest advances in production units may be achieved by the refined production methods of the Nuvistor and the cold cathode type tubes. The thermionic micromodule will probably find more limited application.

Transistors

Smaller size, higher temp and radiation resistance are also objectives of transistor design.[8] A much greater effort, however, is devoted to achieving higher frequency performance. The Micro Alloy Diffused Base transistor (Philco) and the epitaxial transistor (Bell Laboratories[9]) promise to make the transistor amplifier and oscillator useful in the UHF region. Commercially available designs are still limited to about 200 MC.

So far, the epitaxial transistor seems to be the best design possible for extensive use in the microwave region although commercial results have not yet been announced. It seems unlikely that in the 1961-65 period the transistor can capture a significant percentage of the microwave tube market as it has the receiving tube market, but other semiconductor devices (tunnel diode) may do so.

New materials such as silicon carbide and gallium arsenide may make higher temp performance beyond the 160°-200°C range of silicon possible. More difficult will be to protect transistors from radiation damage except by shielding. The tunnel diode may be used in high temp and radiation applications rather than the transistor.

Semiconductor Diodes

Crystal diodes have shown a steady growth since their introduction. The Esaki Diode[10] promises extensive application in high-speed switching.[11] Other tunnel emission devices will evolve and may preempt the high-speed switching field. Whether they will compete as amplifiers and oscillators with existing devices cannot be foreseen.

TABLE 2

Gross National Product, 1960-1965 In Billions of 1959 Dollars

	3% Annual Growth	5% Annual Growth
1960	494	504
1961	509	529
1962	524	555
1963	540	582
1964	556	611
1965	573	641

Certainly in the microwave region the tunnel diode which is operable at higher temps and radiation levels than transistors may limit further transistor development. As the market for control equipment grows, there should be an increasing use of solid state rectifying devices. Silicon-controlled rectifiers are replacing older devices in many applications.

Picture Tubes

Thinner picture tubes approaching 180° are in sight. Work on picture tubes in the next 5 years will also be directed to low power small dia tubes for portable sets. The color tube will also be improved.

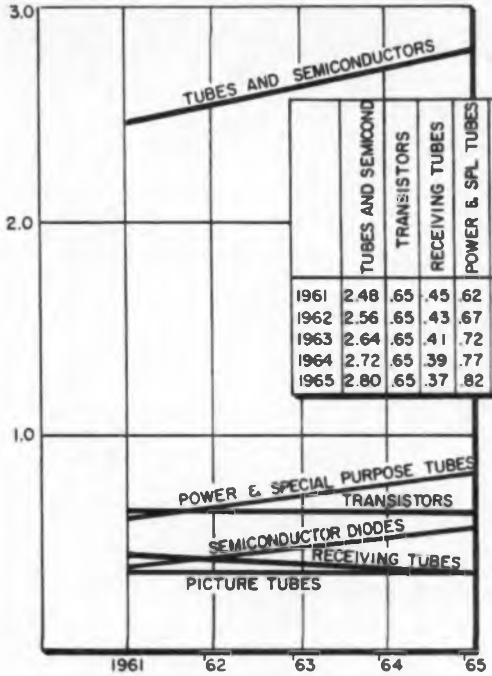
Power and Special Purpose Tubes

Power and special purpose tubes, as classified by the BDSA, Dept. of Commerce, include: High Vacuum Tubes; Gas and Vapor Tubes; Klystrons; Magnetrons; Forward and Backward Wave Tubes; Duplexers; UHF Planar Tubes; Cathode Ray Tubes (excluding TV picture tubes); and Miscellaneous Tubes.

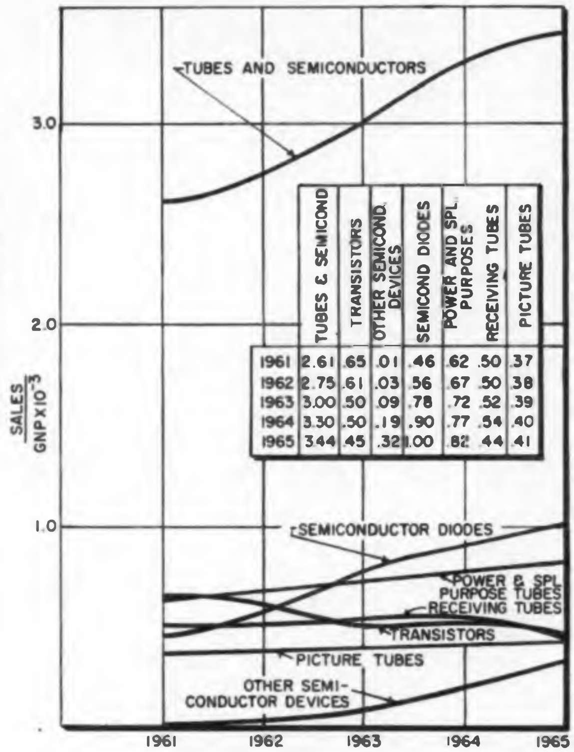
Using ceramics to replace glass envelopes in high[12] vacuum tubes has increased operating temps to over 400°C. Transistors are unlikely to replace this variety of tube—power requirements are high and transistors (silicon) cannot operate at junction temps substantially above 200°C.

Gas and vapor tubes include thyratrons, ignitrons and mercury pool tubes. Cold cathode regulator tubes operating in high temp environments are increasingly important in missile and space work.[13] Hydrogen thyratrons are used in high power pulsed radars. Development of improved models is continuing and an early objective is the production of a 100 megawatt peak tube. Gas-filled thermionic converters are also being studied for space vehicles use.

Cathode ray and storage tube development will capitalize on growing medical electronics and data



	TUBES AND SEMICOND	TRANSISTORS	RECEIVING TUBES	POWER & SPL TUBES	SEMICOND. DIODES	PICTURE TUBES
1961	2.48	.65	.45	.62	.39	.37
1962	2.56	.65	.43	.67	.44	.37
1963	2.64	.65	.41	.72	.49	.37
1964	2.72	.65	.39	.77	.54	.37
1965	2.80	.65	.37	.82	.59	.37



	TUBES & SEMICOND	TRANSISTORS	OTHER SEMICOND. DEVICES	SEMICOND DIODES	POWER AND SPL PURPOSES	RECEIVING TUBES	PICTURE TUBES
1961	2.61	.65	.01	.46	.62	.50	.37
1962	2.75	.61	.03	.56	.67	.50	.38
1963	3.00	.50	.09	.78	.72	.52	.39
1964	3.30	.50	.19	.90	.77	.54	.40
1965	3.44	.45	.32	1.00	.82	.44	.41

Fig. 3: Statistical forecast. 1961-1965.

Fig. 4 (right): Revised forecast. 1961-1965.

processing markets.[14, 15] Electron optic devices are evolving rapidly and we may see substantial improvements in vidicons, image orthicons, and photomultipliers shortly.

Improved microwave tubes (klystrons, magnetrons, TWT's, etc.) will provide higher power, lower noise, higher frequency operation and greater bandwidth. Electrostatic focussing techniques will be more widely used. New, extremely high power magnetrons and klystrons will meet needs of new communications and radar equipments.

Other Devices

The most significant long-run factor affecting the tube and transistor market is the slowly evolving field sometimes called molecular electronics.

The DOD has had a number of contractors, Westinghouse among them, working on circuit integration using molecular electronic techniques. Even though circuit integration may not be as complete as its proponents hope for, multi-function components will undoubtedly develop greatly within the next decade and profoundly influence the further development of tubes, transistors and other electronic components. These devices will capture an important share of the electronic component market by 1970 but they will not be significant in the early 1960's.[16]

ECONOMIC FACTORS

General economic factors affecting all industry in the 1961-1965 period are: Population growth: Defense and space expenditures; and Technological change.

Population Growth

The growth in population, particularly the great increase in the 18 to 24 year old group—that group born during the high birth-rate years of the early 1940's—will increase demand for consumer goods.

Space and Defense

Expenditures for defense and space exploration will increase. An increasing percentage of the defense dollar will be for electronics. Space exploration expenditures will rise rapidly. We stand on the threshold of commercial exploitation of space. Communications and TV satellites are feasible now and strong efforts of communications manufacturers to move into the satellite field in the 1961-65 period are anticipated.

Technological Change

The increasing rate of technological change is another factor to be considered. The transistor reached a sales level of $5 million[17]/year within 6 years of its announcement, but we may expect new devices and equipment to reach substantial sales levels within much shorter periods.

The three most substantial markets—consumer, military, and industrial — all have elements of strength and weakness. Radio, TV and phonographs are the bulk of the consumer electronics market. Forecasters have long predicted a break in the TV and home radio market. This break has not occurred, nor is it likely to occur. The TV market, particularly, has been thought to be saturated for some time. The popularity of the second set was difficult to predict, just as the interest in a light-weight portable is difficult to pre-

Tubes and Semiconductors

(Continued)

dict now. The three technical factors influencing the TV market: greater portability, thinner picture tubes and color.

The color market has been disappointing, but improved and lower-priced receivers and more color programs should improve TV picture tube sales somewhat. Better batteries and further miniaturization may extend the portable TV market. Thinner picture tubes may make wall TV mounting possible. Such a TV tube (from expansion of present techniques or from use of electroluminescent elements or fiber optics) will provide a new market for receiving tubes and transistors. A large percentage of TV sets are over five years old, so the tube replacement market should continue to be strong over the next decade. Significant breakthroughs in color or thinness of tube would encourage many owners to replace rather than repair old sets. Consumer radio market also seems to be saturated, but portables and auto radios will stabilize this market.

Not only do existing consumer markets present strength for the next five years, but electronics will undoubtedly expand into fields as yet untapped. We may expect increasing use of electronics, for example, in the automobile and home lighting markets. Coupled with a growing population, it is difficult to perceive how consumer electronics can do anything but expand at a rapid rate.

Expenditures for space exploration and the military will increase considerably over the next 5 years. Much of the increase will be for research, development, test and evaluation where the percentage of dollars assigned to electronics is high. A $3 billion annual increase in defense and space expenditures may result in a $1 billion increase in electronic expenditures and a $125 million annual increase for tubes and semiconductors. A $6 billion increase will probably increase annual tubes plus semiconductor sales by $250 million.

TABLE 3

Predicted U. S. Tube and Semiconductor Markets, 1961-1965

Based on $\frac{\text{Tubes + Semiconductors}}{\text{GNP} \times 10^{-3}}$ Trend

(millions of 1959 dollars)

	0% GNP Rise	3% GNP Rise	5% GNP Rise
1961	1,190	1,265	1,320
1962	1,230	1,345	1,430
1963	1,270	1,430	1,540
1964	1,310	1,520	1,670
1965	1,350	1,610	1,800

Industrial electronics, promising for many years, may at last become significant. Greater strides will be made in medical electronics, automation and data handling. The future of the computer, both all-purpose and specialized, is very promising with a host of applications in banking, merchandising and processing just over the horizon. One of the most promising areas for exploitation is modern communications systems.

THE REVISED FORECAST

We can now re-evaluate the forecast of Fig. 3. Transistors are unlikely to retain their level at 0.65 for four reasons: (1) A shake out in price, now under way, will reduce the unit price making total dollar volume more difficult to maintain, barring fairly elastic demand schedules. (2) Demand schedules may prove to be somewhat inelastic. The MADT and epitaxial transistors give some hope of opening up the microwave market, but large scale sales in any but the receiving tube market cannot be anticipated. (3) Continuous improvements can be expected in competitive devices. The new tubes may be more competitive in size and power consumption. Tunnel diode and other semiconductor devices (including molecular electronics) will compete with transistors not only for sales but also for technical talent and financing. (4) The impact of foreign competition has not yet been fully felt. Competition within the U. S. may be limited, but it cannot be destroyed. Foreign markets will become increasingly more difficult to pene-

TABLE 4

Estimated Value of Sales 1961-1965

	Transistors	Semiconductor Diodes	Other Semi. Devices	Receiving Tubes	Picture Tubes	Power and Special Purpose Tubes
1961						
0% GNP Inc.	$312	$221	$5	$240	$178	$298
3%	331	235	5	255	187	316
5%	344	244	5	265	196	328
1962						
0% GNP Inc.	293	269	15	240	182	322
3%	319	294	17	262	199	351
5%	338	311	18	277	211	372
1963						
0% GNP Inc.	240	374	43	250	187	346
3%	270	422	49	281	211	389
5%	291	454	52	302	227	418
1964						
0% GNP Inc.	240	432	91	259	192	370
3%	278	500	106	301	222	428
5%	305	550	116	330	244	470
1965						
0% GNP Inc.	216	480	153	211	197	394
3%	258	573	183	252	235	470
5%	289	641	205	282	263	525

MK — 3 CTP vehicle on mount for antenna pattern measurement.

Unique electronic components successfully flight tested on ICBM re-entry vehicle control systems.

A Diversity of Current Projects

Continuing an outstanding record of achievements that includes *the first recovery of a space vehicle from orbit,* and *the first flight demonstration of effective space vehicle stabilization control and navigation,* MSVD electronics engineers are currently working in such areas as:

Quick-launching Support Systems • Inertial Navigation Equipment • High Density Packaging • Stabilization Controls • Space-to-ground Communications Systems • Orbit Ejection Controls • Instrumentation for Nose Cones • Space Power Supplies • Satellite Telemetry Tracking & Command • Digital Computers • Circuit Design for Space Application • Electronic Navigation Techniques

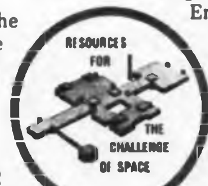
Analytical Studies in satellite orbit control and space navigation.

ELECTRONICS ENGINEERS

AT GENERAL ELECTRIC YOU CAN APPLY YOUR COMMAND OF ELECTRONICS TO THE NATION'S MOST ADVANCED SPACE PROBLEMS

Today, engineers with TV and radio experience are working on missile and space vehicle payload problems at GE's *Missile & Space Vehicle Department*... others are applying their knowledge of radar to space communications... men with aircraft navigation experience are concentrating on advanced guidance and control systems for interplanetary space vehicles... In fact, engineers with experience in practically every area of electronics have transferred their technical knowledge directly to space problems.

Whether or not you've had specific experience in space electronics, you may be able to go right to work at MSVD on some of the most sophisticated and technologically exciting projects in the entire space field—from ICBM re-entry vehicles to operational space craft.



The work here is at the very edge of the state of the art, transforming the latest research discoveries into workable engineering solutions. You'll be concerned with new advances in plasma physics, thermoelectric phenomena, telemetry... with radical new requirements in micro-miniaturization, space to weight reductions, performance efficiency... with an entirely new order of reliability specifications to assure systems' operation in space for a year or longer.

Excellent positions are currently open in four major areas at MSVD: Navigation and Control Engineering • Instrumentation and Communications Engineering • Ground Support Engineering • Advanced Systems Engineering

These positions will place you on the ground floor of the move of a large segment of the Department to the new Space Technology Center—located at Valley Forge Park, just 17 miles from Philadelphia.

Inquiries are invited from electronics engineers who are technically advanced in their own discipline, and are deeply interested in the related fields of space vehicle development. Write informally, or forward your resume to: D. G. Curley, Div. 24-MM.

MISSILE & SPACE VEHICLE DEPARTMENT

GENERAL ELECTRIC

3198 Chestnut Street, Philadelphia 4, Pennsylvania

Tubes and Semiconductors *(Concluded)*

trate as other countries expand production.

From the above, the transistor curve of Fig. 3 is too optimistic. The price shakeout and more severe competition from tubes is reflected in the 1961-1962 decline of Fig. 4, while the growing importance of "other semiconductor devices" and "Semiconductor Diodes" signals the 1964-65 decline.

Semiconductor Diodes

Semiconductor diode sales in Fig. 3 showed a steady increase from 1961 through 1965. Because of the increasing importance of this component, at least in computer technology, expect a more rapid rate of rise in 1961 and 62. The Esaki diode may limit transistors in the high speed computer field and possibly elsewhere.

Special Purpose Tubes

In Fig. 4, power and special purpose tubes have been plotted using the same trend as Fig. 3. Continuing markets for high frequency high-power generators and amplifiers and extension of microwave techniques to higher frequencies indicate a continuing market. R-f power tubes using ceramic construction seem capable of outperforming any other device on the horizon. Use of these in space vehicles and communication systems should increase greatly during 1961-65. Storage and display tubes also will grow in importance as more sophisticated attempts are made to solve data handling problems.

Receiving Tubes

Receiving tubes in Fig. 3 were the only category which showed a marked down turn. In Fig. 4, however, receiving tubes are steady during 1961, rise slightly in 1962 and 1963 and decline in 1964 and 1965. This relatively optimistic forecast for receiving tubes in spite of great competition from transistors reflects the following: (1) Receiving tube technology has seriously challenged transistors with new concepts which may provide lower cost circuits with reduced weight and power penalties. (2) High orders of reliability are achievable with the newer tubes. (3) During 1964 and 1965, the receiving tube market will decline as newer semiconductor devices, including molecular electronic modules become more prominent. The TIMM concept will not be able to stem the trend toward "grown" circuits.

Picture tubes are shown increasing at a slow rate in Fig. 4, whereas they were steady in Fig. 3. This more optimistic view of picture tubes is based on: (1) Greater number of new households (18-24 year old group) requiring new TV sets; (2) The growth of color TV; (3) A broader portable market; and (4) Obsolescence of old models.

The over-all curve of Fig. 4 is a summary of the 5 factors discussed above and the catchall "other Semiconductor devices" which includes integrated semiconductor circuits. Table 4 is a tabulation of the yearly market in 1959 dollars assuming 0, 3 and 5% cumulative increases in GNP.

References

1. Electronic Industries Association, *1960 Fact Book.*
2. Market Research. *Electronics,* 33-(32): 24, August 5, 1960, and earlier issues.
3. Steckler, L., "Nuvistor, New Kind of Vacuum Tube," *Radio Electronics,* 30:-40-1, June, 1959.
4. "Thermionic Integrated Micro-modules," *Electronics,* 32:80, May 15, 1959.
5. "New Tube Concept Simplifies Circuitry," *Electronics,* 33(28): 70-73, July 8, 1960.
6. "Major Advance in Tubes—The Cold Cathode Principle," *Electrical Engineering,* 78: 407-8, April, 1959.
7. "New Source of Electrons for Electronic Tubes," *Westinghouse Engineer,* 19: 189-90, November, 1959.
8. Electron Tube Information Council, *Tubes and Transistors, a Comparative Study,* (1960).
9. "Many New Type Semiconductors Studied," *Electronic News,* June 20, 1960, p. 32.
10. Esaki, L., "New Phenomenon in Narrow GE P-N Junctions," *Physical Review,* 109:603-604, January, 1958.
11. Holonyak, N., and Lesk, I. A., "Gallium Arsenide Tunnel Diodes," *Proceedings of the IRE,* 48(8): 1405-1409, August, 1960.
12. Meacham, D. D., "High Vacuum Power Tubes," *Electronics,* 33(18): 60-64, April 29, 1960.
13. Steiner, H. C., "Gas-Filled Tubes," *Electronics,* 33(18): 65-69. April 29, 1960.
14. Kramer, A. S., "Storage, Counting and Phototubes," *Electronics,* 33(18): 86-90, April 29, 1960.
15. VonArdenne, M., "Evolution of the Cathode Ray Tube Over Three Decades," *Wireless World,* 66: 28-32, January, 1960.
16. North, H. Q., "Where Are We Going with Semiconductors and Molecular Electronics," *Electronic Industries,* 19(8): 76-77, August, 1960.
17. *EIA Fact Book, 1960, ibid.*

* The views and opinions expressed in this article are those of the author only and are not necessarily those of ITT Laboratories.

New Microwave Division

A new division for the development and manufacture of electronic systems and subsystem has been established by Watkins-Johnson Co., Palo Alto, Calif. Initial work will be with low noise microwave amplifiers, reconnaissance systems, electronic countermeasures systems, microwave satellite communications systems and special test equipment used in microwave tube production and testing. Joseph G. Rubeson, formerly with Sylvania's Mountain View operations, will head the new division.

(Continued from page 213)
activities outside of the direct convention area. One approach to the problem is a "Career Center" like those operated by Careers, Inc.

At these centers, an engineer or scientist fills out a registration form which includes his education, experience, and interests, but not his name or company affiliation. The information is supplied to companies registered with the center. Those companies interested in the man send an interview invitation to him. This protects the job-seeker and saves time and effort for the company. Since the center is removed from the convention area, it helps to keep recruitment on the floor to a minimum.

The career center at WESCON this year drew 5,000 visitors. Fifteen hundred of these registered for job interviews with the 24 companies that paid to maintain recruiting staffs at the center.

Reliability & Quality Control Symp.—Jan. 9

How well engineered design, and production with strict controls of manpower, materials, methods, and machines is related to the functions of today's industrial and governmental operations will be discussed in the forthcoming Seventh National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Phila., Pa., on January 9, 10, 11, 1961.

The symposium is jointly sponsored by the American Society for Quality Control (ASQC), The Institute of Radio Engineers, Inc. (IRE), American Institute of Electrical Engineers (AIEE), and Electronic Industries Association (EIA).

The program includes many outstanding and nationally known representatives of industry, government and the military services, such as, Clifford M. Ryerson, Sr. Product Assurance Administrator, R. C. A.; H. L. Hoffman, President, Hoffman Electronics Corp.; Col. W. Scandrett, Office Chief R & D, U. S. Army; Maj. Gen. L. I. Davis, USAF, Commander, Patrick Air Force Base; and Capt. R. E. Foster, U. S. Navy, Bureau of Ships, who will present the latest and up to date information on such topics as System Reliability, Statistical Techniques, Accelerated Testing, Cost Considerations, Design Techniques, Reliability Prediction and Testing, Reliability Education and Management.

Personals

Dr. Remo Pellin—joins Motorola's Semiconductor Products Div. as Product Manager, Semiconductor Materials, Phoenix, Arizona.

John F. Hinchey, Electrical Engineer—appointed Director of Quality Control, Pacific Semiconductors, Inc., Lawndale, California.

Dr. Vincent R. Learned—appointed Manager, Electronic Tube Div., Sperry Gyroscope Co., Great Neck, N. Y. **Thomas D. Sege** becomes Chief Engineer.

Roland P. Andelson—appointed Assistant Manager in charge of Hughes Aircraft Co.'s Ground Systems Group Activities in Washington, D. C.

Dr. Lawton M. Hartman—appointed Associate Director of Research-Operations, Philco Corporation, Philadelphia, Pa.

Dr. L. M. Hartman

M. Spector

Morris Spector—named Electronics Staff Manager, Thompson Ramo Wooldridge International Div., Canoga Park, California.

Joseph T. Cimorelli — appointed Manager, Engineering, Receiving Tube Operations; **Kenneth G. Bucklin**—appointed to the newly created position of Manager, New Products Engineering, RCA Electron Tube Div., Harrison, N. J.

Irwin Klugler—joins Computer Systems, Information Technology Div. of Lockheed Electronics Company, Metuchen, N. J., as a Senior Mathematician in the Mathematical Analysis Dept.

James V. Crawford—promoted to Assistant Manager of the Los Angeles Div., Dr. **John Mason**—promoted to Chief Engineer; **Richard W. Winslow**—named Chief of Preliminary Design; at Garrett Corp.'s AiResearch Manufacturing Co., Los Angeles, California.

Louis Kahn — appointed Manager, Application Engineering, Aerovox Corp., New Bedford, Massachusetts.

Personals

Dr. Paul E. Ritt—named Director of Research, Robert S. Butts—becomes Technical Adviser to the Executive Vice President and General Manager, William C. Purple, Jr.—named Vice President of Engineering and Manufacturing, Melpar, Inc., subsidiary of Westinghouse Air Brake Co., Falls Church, Va.

Dr. Charles L. Register—named to new post of General Manager, Research Labs., R. V. D. Campbell—promoted to Director of Research, Staff Technical Director, Burroughs Corp., Paoli, Pa.

Dr. Ralph P. Ruth—appointed Senior Scientist, Hoffman Science Center, Santa Barbara, Calif.

Niles P. Gowell—appointed Engineering Manager, Industrial Components Div., Raytheon Co., Waltham, Mass.

N. P. Gowell

M. J. Bock

Marvin J. Bock—named Chief Engineer, Kearfott Div., General Precision, Inc., Van Nuys, Calif.

Dr. Seymour Stein and Dr. James E. Storer—appointed Senior Scientists, Sylvania's Applied Research Laboratory, Waltham, Mass.

Dr. Victor Hicka—joins Remington Rand Univac Military Dept., St. Paul, Minn., as Staff Scientist.

John Basarab, Jr.—new Supervisory Engineer, Shipboard Electronics Dept., Lockheed Electronics Co., Plainfield, N. J.

Dr. E. Robert Britton—named Director of Military Engineering, Airtronics International Corp., Ft. Lauderdale, Fla.

Samuel J. Davy—appointed Director of Engineering, National Co., Inc., Malden, Mass.

J. Pieter deVries—appointed Manager of Astrodynamics for the Space Sciences Laboratories of General Electric's Missile and Space Vehicle Dept., Phila., Pa.

News of Mfrs'

Representatives

REPRESENTATIVES WANTED

Electronic Connector Manufacturer seeks sales representatives in (1) North and South Dakota; (2) Montana, Idaho; (3) Washington, Oregon; (4) Northern California; (5) Southwestern United States. Manufacturer is located in the Midwest. Box 1-1, Editor, ELECTRONIC INDUSTRIES.

Robert L. Ringer and Tyler MacDonald will be speakers at the 2nd Annual Electronic Representatives Association Convention, Feb. 1-4, 1961, Ambassador Hotel, Los Angeles, Calif. Theme is "Planned Growth by Electronic Representatives."

Thomas H. Closs Co., Towson, Md.—franchised as sales engineering representative for Du Mont oscilloscopes, oscilloscope record cameras and other scientific instruments and accessories in the northern counties of Maryland, including Baltimore, by the Industrial Electronics Div., Allen B. Du Mont Labs, Divs. of Fairchild Camera and Instrument Corp., Clifton, N. J.

ITT's Distributor Products Div., Lodi, N. J., has named the following 24 manufacturers' representative organizations in 20 key market areas: **Anderson Sales Co.**, Boston, Mass.; **The Arthur H. Baier Co.**, Cleveland, Ohio; **E. L. Berman Co.**, Belmont, Calif.; **Cartwright & Bean**, Memphis, Tenn.; **Stan Cluphf & Associates**, Denver, Colo.; **W. Henry Cordray Sales Co.**; Bala Cynwyd, Pa.; **Delta Sales, Inc.**, Indianapolis, Ind.; **William J. Doyle Co.**; Chicago, Ill.; **R. W. Farris Co., Inc.**, Kansas City, Mo.; **Clark R. Gibb Co.**, Minneapolis, Minn.; **Carl Hower & Co.**, Scottsdale, Ariz.; **Johnson Associates of Florida**, Casselberry, Fla.; **Harry Levinson Co.**, Seattle, Wash.; **William Ferguson Co.**, Syracuse, N. Y.; **Lowery Associates Co.**, Wynnewood, Pa.; **J. W. Marsh Co.**, Los Angeles, Calif; **Massey Associates**, Riverside, Md.; **Maynard Sales Co.**, Dallas, Tex.; **C. L. Pugh Co.**, Columbus, Ohio; **James L. Semple Associates**, Rochester, N. Y.; **Samuel N. Stroum Co.**, Seattle, Wash.; **S. A. Shaw Co., Inc.**; Yonkers, N. Y.; **Jack M. Thorpe**, Detroit, Mich.; and the **John G. Twist Co.**, Chicago, Ill.

Allied International Corp., Chicago, Ill.—appointed sales representative for the Burton Mfg. Co., Santa Monica. Calif., in all international foreign markets.

James J. Backer Co., Seattle, Wash.—appointed sales representative for Columbus Electronics Corp., Yonkers, N. Y., in Washington, Oregon, Montana, Idaho and Alaska.

ELECTRONIC INDUSTRIES Advertisers—January 1961

This index is published as a convenience. No liability is assumed for errors or omissions.

For product information, use inquiry card

News of Mfrs' Representatives

RCA's Food and Beverage Equipment Section has named the following seven appointees and their area of responsibility: **William F. O'Brien**, Summit, N. J., covering metropolitan N. Y. and northern N. J.; **David Pollock Co.**, Ft. Lauderdale, Fla., covering North and South Carolina, Georgia and Florida; **Leonard Schwarz**, Hartford, Conn., covering the New England states; **Otis Whitehead**, Dallas, Tex., covering Louisiana, Oklahoma, Arkansas, New Mexico and Texas; **American Bottlers Equipment**, Baltimore, Md., covering Baltimore, Md.-Virginia, Maryland, District of Columbia, eastern Pennsylvania and southern New Jersey; **Banbury Equipment Co.**, Pittsburgh, Pa., covering western Pennsylvania, eastern Ohio, West Virginia and Buffalo, N. Y.; **Mark Powers Co.**, Birmingham, Ala., covering Tennessee, Mississippi and Alabama.

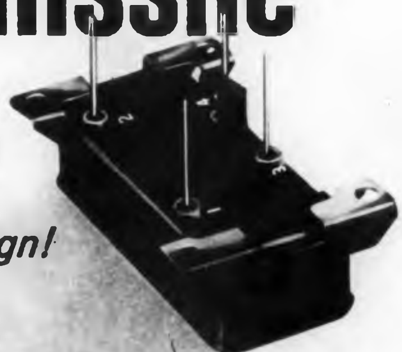
Five new regional sales representatives appointed by Hughes Aircraft Co.'s Vacuum Tube Products Div., Culver City, Calif., are: **Ecklund Electronic Sales Co.**, Ft. Worth, Tex., in Texas and Louisiana; **Dunbar Mid-States Co.**, Coffeyville, Kan., covering Kansas, Arkansas, Iowa, Nebraska, North and South Dakota, Missouri and Oklahoma; **R. G. Sidnell and Co.**, Cleveland, Ohio, covering Ohio and western Pa.; **J. L. Pierce Co.**, Detroit, Mich., covering Michigan; **Automation Sales Co.**, Rockland, Mass., covering Massachusetts, Connecticut, Maine, New Hampshire and Vermont.

Southwestern Engineering and Equipment Co., Dallas, Tex. — appointed sales representative for systems components by Systems Div. of Beckman Instruments, Inc., Anaheim, Calif., covering Texas, New Mexico, Oklahoma and Louisiana.

Syd Wimpie Associates, Mamaroneck, N. Y.—appointed sales representative for precision potentiometers and panel instruments in metropolitan N. Y., Long Island and New Jersey by the Electronics Div. of DeJur-Amsco Corp., Long Island City, N. Y.

R. F. Products Div. of Amphenol-Borg Electronics Corp., Danbury, Conn.—appoints the following firms to handle its radio frequency products: **Atcheson and Adams**, Greensboro, N. C.; **Eichorn and Melchior, Inc.**, San Carlos, Calif; **Hollingsworth and Still**, Atlanta, Ga.; **R. E. McClendon Co.**, Albuquerque, N. M.; **Jack F. McKinney Sales Co.**, Dallas, Tex.; **Premmco, Inc.**, Los Angeles, Calif.; **Don Smith Sales Co.**, Seattle, Wash.; **W. Ben Wimberly Co.**, Clearwater, Fla.

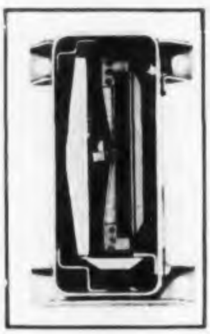
The most precise, sturdiest thermal relay ever built... best for missile applications



... from the leader in thermal relay design!

Now, for missile environments and for all applications where greater precision is necessary, G-V Controls offers the revolutionary new PT Thermal Relay—the most **precise** thermal relay ever built!

And the PT's **sturdiness** is unequalled in thermal relays. It withstands missile vibration and shock far better than any other thermal relay.



SPECIFICATIONS

Time Delay: 3 to 60 seconds (Factory Set)

Setting Tolerance: ±5% (±¼ sec. min.)

Temperature Compensation: Within ±5% over −65°C. to +125°C. range (±¼ sec. min.)

Heater Voltages: 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.

Power Input: 4 watts. Rated for continuous energization at 125°C.

Contacts: SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

Write for Product Data Bulletin #PD-1015

Insulation Resistance: 1,000 megohms

Dielectric Strength: 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.

Vibration: Operating or non-operating, 20 g up to 2000 cps

Shock: Operating or non-operating, 50 g for 11 milliseconds

Unidirectional Acceleration: 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.

Weight: 2 to 2¼ ounces.

G-V CONTROLS INC.
Livingston, New Jersey

Circle 155 on Inquiry Card