ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

1961 Survey of Cathode Ray Oscilloscopes

Performance specifications on more than 150 types made by 29 manufacturers

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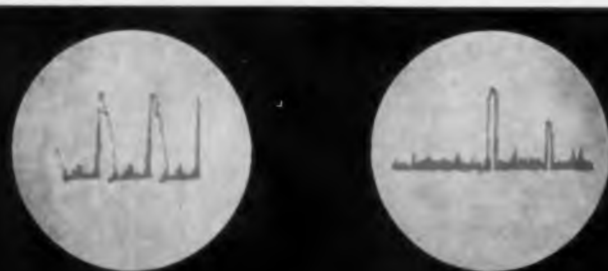
Also in This Issue:

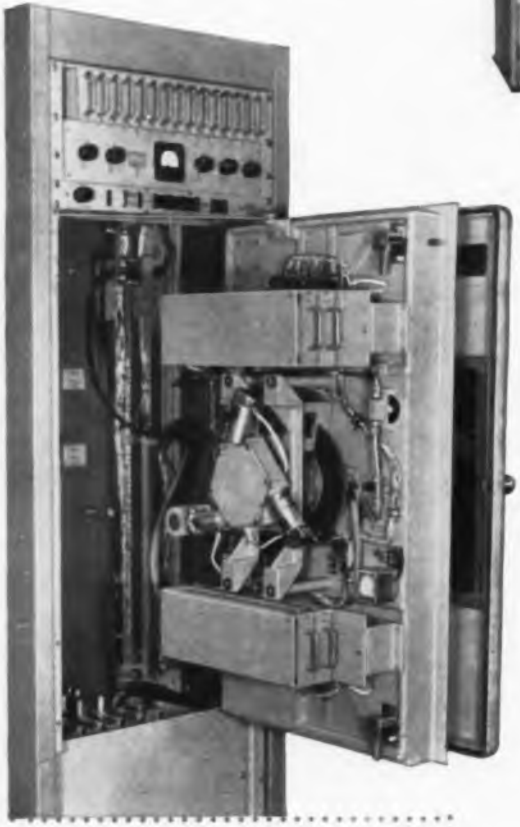
- **Applying Dot Components to Electronic Packaging**
- **Interpreting Transistor Noise Performance**
- **Preview of 17th Annual National Electronics Conference**

Complete Contents pages 2 and 3



October
1961

a new concept in speed control



SANGAMO 460-SERIES MAGNETIC TAPE INSTRUMENTATION

Sangamo's Hare Tape Synchronized speed control reduces instantaneous and long term record-playback speed deviations to a level several times lower than other speed control systems. As a result, it is now possible to achieve magnetic tape instrumentation system accuracies heretofore considered unattainable. The Sangamo 460-Series is a fully transistorized magnetic tape Recorder/Reproducer for application in direct analog, wide band FM, PDM, and PCM instrumentation systems.

The Hare Tape Synchronized servo speed control outperforms other servo speed controls in speed of response and range of control. Since a high torque to inertia ratio is designed into the capstan drive, the servo system can respond more rapidly to changes in tape reference signal frequency than drive systems utilizing massive flywheels. For example, an instantaneous change in record tape speed of several percent will be corrected on playback in less than 40 milliseconds. Furthermore, the control is completely damped, eliminating overshoot or the necessity to average the speed. In addition, the Hare servo speed control range is ±15% without loss of synchronism, while conventional tape speed servos have a range of only ±2.5%.

The Sangamo 460-Series Recorder/Reproducer can instantly be changed from reel to loop operation without rehandling the tape or making any changes in the transport. Exclusive vacuum tensioning and tape guiding provides gentle but firm and precise control of tape position and head-to-tape contact. This design, in addition to a long tape path, results in the extremely low interchannel time displacement error specified. In addition, the vacuum pad removes loose particles from the tape before it passes over the head, thus substantially reducing dropouts and oxide build-up on the head.

The tape transport and fourteen (14) tracks of Record/Reproduce electronics are contained in a single standard 19″ W x 71″ H cabinet. This unusual compactness is achieved through transistorized electronic circuitry. The solid state circuitry means greater reliability, reduced weight, lower heat dissipation, and lower power consumption.

For the name of the technically qualified Sangamo representative nearest you, and for complete details on the Sangamo 460-Series, please write for Bulletin 3400.

SANGAMO 460-SERIES PERFORMANCE and CHARACTERISTICS

Start Time: 1.0 second to synchronism @ 60 ips with servo speed control and 1″ wide tape.

Stop Time: 0.2 seconds from 60 ips.

Instantaneous Time Displacement Error: Less than 25.0 microseconds (including flutter) @ 60 ips.

Long Term Time Displacement Error: ±0.01% standard. Higher accuracies available.

Interchannel Time Displacement Error: ±2.0 microseconds @ 60 ips between outside tracks on 1″ tape.

Servo Speed Control Range: ±15% nominal tape speed.

Servo Speed Control Response: ±15% speed change per second.

Tape Widths: Standard sizes from ¼ to 2″.

Reel Sizes: 14″ or smaller.

Mounting: 1 standard 19″ equipment rack for a complete 14 track record/reproduce system with power supplies and servo speed control.

Power Requirements: 117 volts, 60 cps ±10% single phase. All D C drives. 7.0 amperes load for 14 track system.

Weight: Approximately 500 pounds for 14 track system.

SANGAMO

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

ES61-1

Circle 1 on Inquiry Card

ELECTRONIC INDUSTRIES

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

Opportunity on the Horizon . . . . Electronic Teaching!

THERE is no more imaginative vista in the electronic field than that offered by modern education techniques. Through computer analysis of performance, and teaching machines, a new concept of learning has emerged. At the present time, the application of electronic equipment to education processes is still largely in the laboratory stage. Nevertheless, the principles are laid down and the experimental programs well under way. In industry and schools, this new art is making a revolutionary breakthrough.

Teaching machines are based on the theories of programmed learning. The first concepts of this art grew from a series of test questions—in the classical Socratic method—and developed to the present question-answer-reward pattern, in a step-by-step process.

The scientific terms for these processes are of no great importance. The vital thing is that these methods work, and have shown remarkable success in all levels of education.

The name teaching machine is misleading, as the actual process of learning is through programmed teaching by questions. The machine came into the picture when it was found advantageous to have the answers concealed until the question was answered. When a programmed course was placed in a box which allowed the student to take each question a step at a time, and write the answer in a provided aperture, then the name "machine" was used.

This principle which was begun by Dr. B. F. Skinner only a few years ago has developed to the point where laboratory experimenters have computerized installations capable of analyzing a student's work, and issuing him "homework" to do before he continues with the next part of the study.

As in all revolutions, there are those who decry the innovation of teaching machines. Actually, it is an irrefutable fact that it is a major breakthrough in the need to improve our educational system. Space does not allow us to present a full description of all the amazing developments to date, but there appears no doubt that this is going to be a new gigantic market for the electronic industries.

At the moment programs are used in industry to train salesmen in new techniques and product engineering; for basic computer training; teaching telephone operators; or in schools for teaching algebra; basic electronics; trigonometry and almost any subject desired, including languages.

In addition, the new teaching technology embraces audio-visual aids, such as films and recordings. Most of the material is programmed by educational psychologists to increase the depth of teaching and to increase the speed of assimulating information. Such methods help to release the teachers from humdrum tasks, and allow them to devote their valuable time to more creative education. The overall effect of these concepts gives the student a higher quality education, and the teacher better and more precise tools to communicate knowledge.

Our present crisis in the communication of information is in many respects a reflection on the educational problems. We are multiplying these problems every day as technology advances and civilization becomes more complicated.

The shortage of skilled teachers is acute. We have at present over 1.5 million teachers and 37 million students. Ours is one of the best educated nations in the world, but consider also Asia and Africa, where educational problems must be staggering. Even in this country with the expanding population growth, the market for education is impossible to saturate. Estimates are for more than $30 billion to be spent in the next year alone.

The time is very near when the art of teaching technology and the alliance with the electronic industries will click . . . and a vital new concept will emerge in the world of education.

We have this market under study and we shall soon again be reporting details.

ELECTRONIC INDUSTRIES, October, 1961. Vol. 20, No. 10. A monthly publication of Chilton Company. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. Controlled circulation postage paid at Philadelphia, 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. 10 **October, 1961**

COVER: Of all electronic instruments the cathode ray oscilloscope is probably the most versatile and informative. Illustrated to the left are some typical oscilloscope patterns, and across the bottom, some patterns that are typical of specific CRO applications. The cover was designed to attract attention to a very important engineering reference feature beginning on page 120 . . . our 1961 Survey of Cathode Ray Oscilloscopes.

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

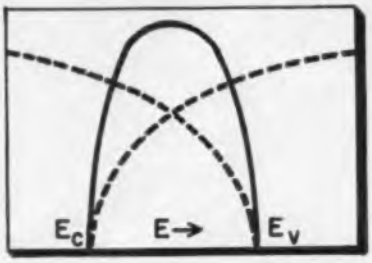
DEPARTMENTS

BPA NBP

Highlights

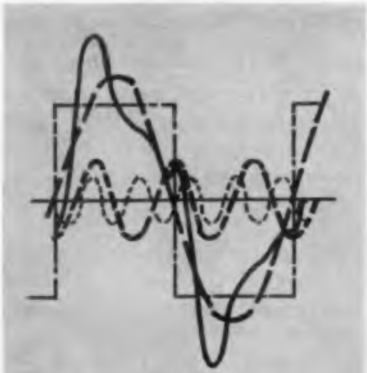
of this issue

Dot Components



Tunnel Diode

Turntable Operation



Phase Equalization

National Electronics Conference

RADARSCOPE

MOON VEHICLE

Advanced model of the Ranger spacecraft and the lunar capsule it will carry to the vicinity of the moon is studied by Dr. D. B. Duncan (l), general operations manager of Space Systems Operations at Aeronutronic Division of Ford Motor Co., where the capsule is being developed; and James D. Burke, Ranger project manager at the Jet Propulsion Laboratory.

A NUMBER OF CONGRESSMEN have petitioned President Kennedy to order the FCC and other Federal agencies to review their position in regard to ownership and control of the communications satellite program.

CANADIAN ELECTRONIC INDUSTRY exployment declined 28% between 1956 and 1960, reflecting a loss of half its radio receiver market and 29% of its electron tube sales. Japanese competition did the damage.

THE TV INDUSTRY reported total broadcast revenues of $1,268.6 million for calendar year 1960, 9% above the 1959 total of $1,163.9 million. (Total broadcast revenues comprise the sale of time, talent, and program material to advertisers.) Total broadcast expenses of the TV industry for 1960 were $1,024.5 million, an increase of 8.8% over the $941.6 million in 1959.

SALES OF COMMUNICATIONS equipment increased about 5% during the first half of 1961 over the corresponding period of 1960, the business and Defense Services Administration, U. S. Dept. of Commerce, reports.

IF RUSSIA'S STEPPED-UP PRODUCTION of business machines—including "mass production of electronic computers"—reaches the goal announced in the current Soviet Seven-Year Plan, the USSR will have a threefold increase in calculating machines during the 1959-65 period.

ELECTRON BEAM PROCESSING holds promise as a technique for fabricating semiconductor devices, according to CBS Labs.

ULTRAMINIATURE TRANSISTOR has been developed by RCA. Still in experimental stage, transistor is made by depositing thin films of cadmium sulfide and metal on an insulating base. This technique fits in with present methods of making thin-film devices of other types, indicating possibility of low-cost mass production of entire transistorized circuits.

BRAKES SHOULD BE APPLIED to imports "whenever they seriously threaten any segment of the American economy," says Robert C. Sprague, chairman of Imports Committee. The best way to slow electronic imports, he says, would be to establish quotas on specific products or industry sectors, "as the need arises," rather than on a broad basis.

AIR DEFENSE SYSTEM

The U. S. Army's BIRDIE air defense coordination system, developed and produced by The Martin Company's Orlando Division, coordinates the firing of guided missile batteries around cities and military installations. System uses data from its own radar and correlating inputs from external sources such as SAGE.

WORLD'S PUREST BERYLLIUM has been produced by Franklin Institute, now making it possible to form the material by the drawing process. According to a Defense Metals Information Center the Institute has produced beryllium exceeding the 99.987% purity reported by the Soviet scientists.

SOLID-STATE IR DETECTOR eliminates cryogenics. Under development at Armour Research Foundation, process involves neutral transfer of energy in cadmium sulfide crystals. Visible light, entering crystal at one end, causes photoconductive response across electrodes placed at other end of crystal. Long wavelength radiation striking crystal between the incident visible radiation and electrodes causes the photoconductive response to be quenched. A signal is produced upon absorption of radiation.

NEW EXPERIMENTAL ELECTRONIC SYSTEM helps a composer create new music by suggesting variations and new tone combinations based on his own musical ideas. Experimental unit is special-purpose type of computer known as a "random probability" system. This is an arrangement of circuits designed to select notes in random fashion from many choices, with the probability of choice determined by the frequency with which various note sequences occur in style favored by composer.

A HIGH VOLUME PRODUCTION SYSTEM for the continuous manufacture of thin film subassemblies, will be developed for the Navy by IBM. IBM plans either to market the thin film production equipment, or to establish one or more sources for the marketing and fabrication of this equipment. The Navy will encourage other companies to install duplicate production lines as part of its industrial readiness plan.

THE RENEGOTIATION BOARD has revised its regulation so that contractors faced with a refund can present their case directly to those charged with the responsibility of decision. Each contractor has the right to meet with a panel of the regional board, and if it is not satisfied with the regional board determination, with a division of the statutory board.

CRYOGENIC TRANSFORMER is now operating at 15-kw level. Superconducting transformers, utilizing ability of some metals to conduct electricity without resistance near absolute zero (—459°F), have been tried before, but magnetic fields above certain trigger strengths have quenched the superconducting state. Dr. R. McFee, of Arthur D. Little, Inc., discovered total magnetic-field strength could be kept below critical level by interweaving layers of primary and secondary windings. Current in the adjacent layers flows in opposite directions. Result: fields nearly cancel each other. Only the coils are cooled in the new transformer, keeping cost of refrigeration reasonable.

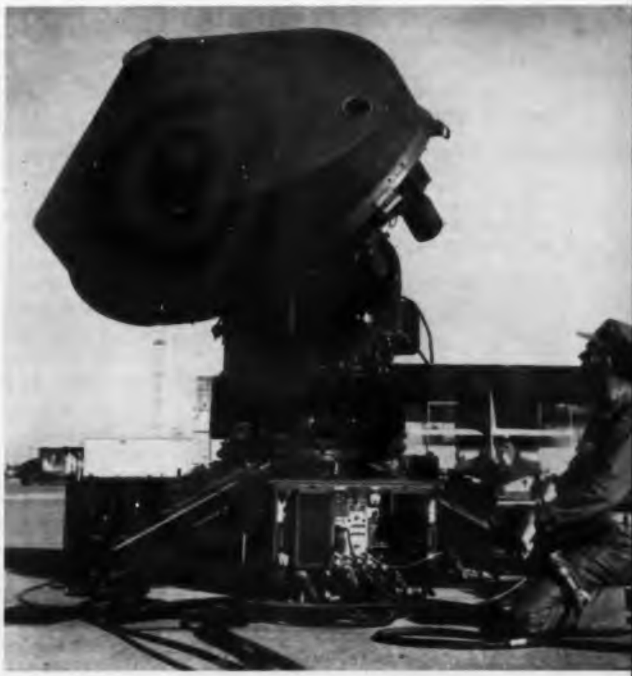
SOLID-STATE MICROWAVE TRANSMITTER, developed for space communications by Sylvania Electric Products, reportedly has 11 times the life expectancy and 10 times the frequency stability of conventional transmitters. Engineering model has been operated with two watts of output power within the S-band (1,700 to 2,300 mc). Transmitter could be linked with solid-state radio receiver to form complete space communications system.

ARMY MODERNIZATION can be expected by 1970 to boost by many millions of dollars the sums now being spend for procurement of electronic equipment for aviation. Reflecting tactical needs imposed by dispersal of modern armies over battlefields 200 miles deep, expenditures for electronics will rise from 5 to 10% of the fly-away cost of aircraft, said L. G. Regan, defense requirements specialist for Douglas Aircraft Co. In the case of deep-penetration surveillance aircraft, 30% of cost will be represented by electronics, Mr. Regan said.

For More News On Industry Developments Turn To "As We Go To Press"—on page 6

LANDING SYSTEM FOR SPACECRAFT

This radar (AN/TPQ-10), originally developed by GE's Heavy Military Electronics Dept. for U. S. Marines, will be used to guide space vehicles back to earth in a system under development by GE's Defense Systems Department, Syracuse, New York.



As We Go To Press . . .

RACEP Provides Gains In Spectrum Efficiency

After three years of investigation and research, The Martin Co., Orlando, Fla., has developed an approach and equipment to help solve the problem of the crowded frequency spectrum. RACEP Discrete Address communications system (Random Access and Correlation for Extended Performance) puts to use the pauses and breaks in normal conversation and the idle time between calls. This is done by disintegrating and coding scores of speech signals into microsecond bits, combining them randomly, and simultaneously transmitting them over the same channel to a receiver which then selects the properly coded signal and reconstructs the bits into normal flowing conversation.

With this system, the user may call (discretely address) any one of some 700 users, either singly or collectively. Future developmental work on the system could increase the number of users considerably.

RACEP is a low-duty-cycle all-purpose system, as opposed to a cw system, which gives it the capability of random access and increases its efficiency over conventional systems. It has already stimulated a number of other research organizations to investigate this type of communications.

SOLAR ENERGY CONVERTER

Converter follows the sun, generating electricity with silicon solar cells. Engineer R. White points out the separate bank of cells which operates the tracking motor. Self-powered unit is made by Hoffman Electronics Corp., Los Angeles, Calif.

Arctic Weather Research System

A 20 channel system for measuring and recording information on Arctic weather is being designed by Datex Corp., Monrovia, Calif., for use by the Army Signal R&D Laboratory in Greenland. Called a Temperature and Radiation Integrating System, the equipment will provide and receive eight differential temperature signals, two absolute temperature signals, and ten radiation signals. Each of the input variables will be measured 100 times each hour. Data will be recorded on a punched tape at the end of each hour. A computer will be used to analyze the data on the tapes.

Infrared Device Contract Awarded

A $1.8 million contract for the production of a new infrared device which measures very small changes in temperatures has been awarded the Hughes Aircraft Co. by the Bureau of Naval Weapons The device is so sensitive that it has measured the cooling of the moon during a total eclipse.

The detector operates at −452°F. It incorporates a miniature refrigerating device which uses liquid helium as the refrigerant. The cooling unit, called a cryostat, weighs 27 pounds and has a volume of less than one cubic foot.

Project ALARM Being Evaluated

Department of Defense has announced that electronic checkout techniques similar to those used in missile launchings are being tested on Army aircraft to determine if the planes are safe for flight. Research into the feasibility of this concept is being carried out by the York, Pa., division of the Bendix Corp. under a contract with the U. S. Army Transportation Research Command, Fort Eustis, Va. The Army may adopt this system to check on the safety of its aircraft. Known as Project ALARM (Automatic Light Aircraft Readiness Monitor), the concept envisions the use of strategically placed sensors to forecast electronically the condition of various critical mechanical and structural components.

ELECTRONIC RESERVATIONS

M. L. Perry (l), director of reservations for United Airlines, explains the function of "Instamatic" equipment to R. G. Petitte (c), director of reservations for Trans World Airlines, and E. K. Rhatigan, director of reservations for American Airlines. "Instamatic" is the largest electronic reservations system in the air transport industry. Unit shown is at United's Reservations Control Center in Denver.

Joint Use of Radar Saves $15 Million

More than $15 million in equipment costs has been saved by the Federal Aviation Agency and the U. S. Air Force since 1957 through joint use of long range radar. The joint use program was worked out by an FAA/ADC Joint Radar Planning Group.

Under the joint use plan long range radar units are adapted to serve both military and FAA functions. This is accomplished by transmitting radar signals to display scopes at both the military sites and FAA Air Route Traffic Control Centers. There are now 15 radars in joint use with 33 additional to be used jointly by Dec., 1963. Each joint use radar saves approximately $1 million in establishment costs.

In addition to the initial savings from purchasing and installing the radars the FAA/ADC Joint Radar Planning Group has found other benefits. One of the most important is the reduction or elimination of radar interference that would result from two nearby radar installations operated separately.

More News On Page 8

TINY... TAN... TERRIFIC!

TINY...

Latest space-maker for size-conscious designers of transistorized commercial and entertainment equipment is the new _Sprague Type 157P Molded-case Filmite® "E" Capacitor,_ which combines unusual compactness with exceptional performance characteristics.

TAN...

Distinctive *tan coloring* identifies the Type 157P Capacitor and serves as your warranty of outstanding shock-and-humidity resistance. The tough molded armor also protects against possible damage during soldering operations, or changes in capacitance from mechanical pressure where wrapped capacitors are clamped or cast in assemblies.

TERRIFIC!

Standard operating temperature range is −40 C to +85 C. And with voltage derating, this outstanding capacitor may be operated to +105 C! Its high insulation resistance (due to the polyester film dielectric and molded housing) is another characteristic which qualifies the 157P Capacitor for critical coupling applications.

For complete technical data on Type 157P Filmite "E" Capacitors, write for Engineering Bulletin 2065 to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Mass.

SPRAGUE COMPONENTS

CAPACITORS
RESISTORS
MAGNETIC COMPONENTS
TRANSISTORS
INTERFERENCE FILTERS
PULSE TRANSFORMERS
PIEZOELECTRIC CERAMICS
PULSE-FORMING NETWORKS
HIGH TEMPERATURE MAGNET WIRE
CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES
FUNCTIONAL DIGITAL CIRCUITS

SPRAGUE®
THE MARK OF RELIABILITY

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Electronic SHORTS

▶ A contract for design, construction and test operations of a floating nuclear power plant to supply electricity to military installations or port cities cut off from normal service by peacetime disaster or wartime action has been awarded to the Martin Co. by the U. S. Army Corps of Engineers. The 10,000 kw plant will be installed in the hull of a reconditioned and modified surplus Liberty ship.

▶ A method which makes it possible to produce semiconducting diamonds has been discovered at the General Electric Research Laboratory at Schenectady, N. Y. Such diamonds are extremely rare in nature, accounting for less than one per cent of natural diamonds, but can now be grown at will in the laboratory using a high-temperature, ultra-high pressure process.

▶ A new system of communication, called CBS Radio NetALERT, will make it possible, for the first time, for CBS Radio affiliates from coast to coast, whether on or off the air, to be instantaneously alerted to receive urgent news bulletins, unscheduled on-the-spot news coverage or national emergency announcements.

▶ A Repetitively Pulsed Plasma Propulsion Engine (REPPAC III) has been fired continuously for 60 hours at a rate of 1000 firings a minute at GE's MSVD Space Sciences Lab in Phila. The engine was run in a 13-foot vacuum chamber that maintained a pressure of 5 x 10^{-6}mm of mercury so that there was no interaction between the plasma exhaust and residual gas in the test chamber.

▶ A. U. S. Army Signal Research and Development Laboratory contract to develop methods of generating relativistic plasma has been awarded to Stevens Institute of Technology, Hoboken, N. J. Relativistic plasma, the kind of matter composing the Van Allen radiation belts surrounding the earth, has never been produced in a laboratory under controlled conditions.

▶ NASA has awarded the J. W. Fecker Div. of American Optical Co., Southbridge, Mass., a contract to produce a vacuum chamber and optical bench with an ultraviolet monochrometer. It will be used to align the various optical systems to be launched in the orbiting astronomical observatory planned by NASA.

▶ A study contract for the design of an electronic method of transferring control of aircraft from an air route traffic control center to an airport control tower has been awarded the Orlando Div. of the Martin Co. by the FAA. The investigation is to define the most feasible methods and equipment required for interconnecting remotely separated radar scan converter TV marker hand-off equipments and adaptation of this equipment for presentation of data on various types of existing PPI displays.

▶ Radar and TV display device that can be used like a small telescope has been announced by Westinghouse. Dubbed the Private Eye because it can be used by only one person at a time, it is expected to make possible the installation of radar in places where the weight and bulk of conventional equipment would otherwise make it impractical.

▶ According to a survey by Motorola, 45% of all FM stations intend to add stereo service via FM multiplex. About 370 FM stations will have stereo programs on the air by the end of 1963. Ninety-two expect to be in operation by the end of this year.

▶ A $3 million prime contract for classified airborne Electronic Warfare Penetration Systems has been awarded the Hallicrafters Co. by the USAF. Award is the first of a new program for equipments aimed at increasing the penetration capabilities of the SAC Bomber Force.

▶ Development of an electronic "exerciser" that tests core memory units before installation in computers has been announced by the Radio Corp. of America. It functions by setting up a pattern for writing digital information into the memory unit and reading it back.

FAA Inaugurates DME Procedures

The Federal Aviation Agency is now using DME (Distance-Measuring Equipment) procedures on a nationwide basis to provide air traffic control service for an entire fleet of civil jets. FAA has had DME air traffic control procedures in effect since January, 1960, but their use has been limited by the small number of DME-equipped civil aircraft. Now, for the first time, one airline has its entire jet fleet equipped with DME and another airline will soon have jet fleet-wide DME installation.

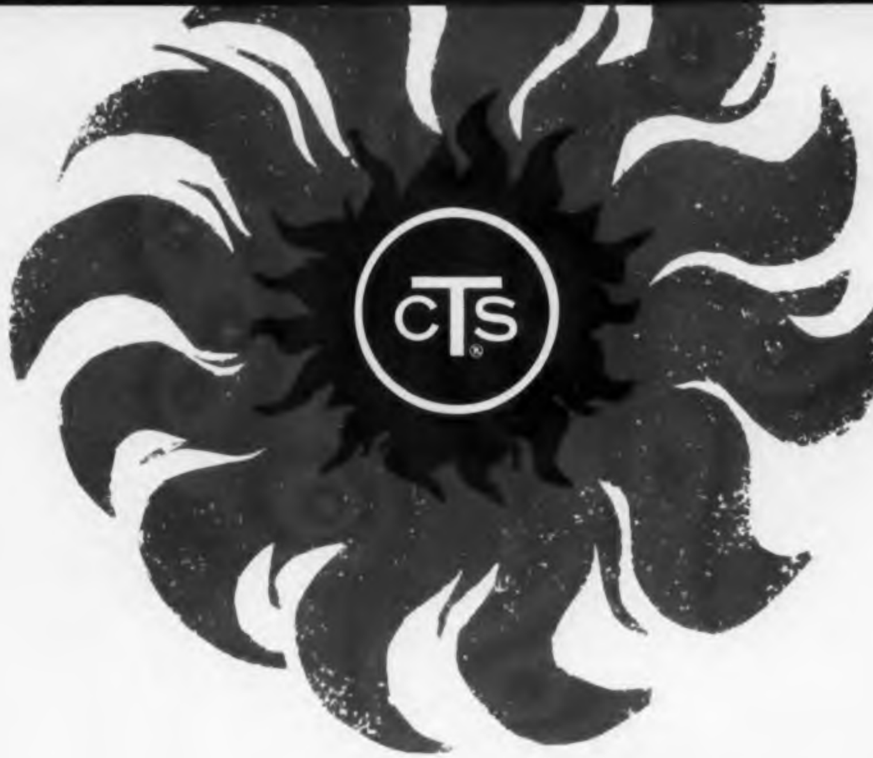
FAA Administrator N. E. Halaby said, "While no formal official requirement has as yet been established for all air carrier planes to carry DME, I see no reason to delay the application of our special DME procedures so long as we have properly-equipped aircraft and qualified pilots to use them."

DME will enable a pilot to orbit a thunderstorm or restricted area without losing navigational course. It will simplify his procedure for entering and remaining within a holding pattern area by indicating where turns are to be started, regardless of wind conditions.

DME promotes more efficient air traffic control service by enabling the controller to issue more exact and practicable clearances for pilots. Number of aircraft which can be safely and efficiently handled is increased. Finally, DME permits more efficient use of altitudes, facilitates aircraft transition between routes and reduces holding delays.

MOBILE RADIO TRYOUT

RCA's new 2-way mobile radio for business communications gets a tryout by Eileen Rafferty. Smaller unit contains control head, speaker and power supply. It mounts under vehicle's dashboard. Transmitter - receiver unit can be dash or trunk mounted. UHF "efficiency line" is available in a 12-v. model and a 6 or 12-v. model.



WHEN THE HEAT'S ON DEPEND ON THESE CTS CERMET RESISTORS

with Space Age 500° C High Stability Metal-Ceramic Element

CTS cermet resistors have exceptionally high stability and reliability . . . tested extensively and proven under extreme environmental conditions . . . achieved by a unique, rugged, hard-surfaced metal-ceramic element processed at over 600°C. Specially adaptable to miniaturization because of high load and heat capabilities in small areas. Wide resistance range.

CERADOT

Solid Cermet Fixed Resistors

- 50 ohms thru 100K ohms.
- .050" dia. x .030" L. Other sizes available with or without leads.
- Power rating: 1/10 watt at 125°C.

Kit of 8 different resistance values available at nominal cost.

Request Data Sheet 185 for technical specs.

CeraTrolS®

Series 400

3 Watt 1¾" dia. Semi-Precision Military Variable Resistor

- Interchangeable with Style RV4 MIL-R-94 but far exceeds temperature and stability requirements.
- Available with 1%, 2% or 3% linearity.
- Power ratings: 3 watts at 85°C, 2 watts at 125°C, derated linearly to zero load at 175°C.

Request Data Sheet 179 for technical specs.

CERAFER

Modular Fixed Resistors

- 5 to 300,000 ohms resistance per square. Resistance of 10 ohms to 1 megohm available in short straight paths without resorting to lattice or grid patterns.
- Unaffected by solvents, potting compounds or corrosive atmosphere.
- Resistant to nuclear radiation and high vacuum conditions.

Kit of 10 different resistance values—10 wafers with 2 identical resistors per wafer—available at nominal cost.

Request Data Sheet 181 for technical specs.

CeraTrolS

Series 500

1½ Watt ¾" dia. Semi-Precision Military Variable Resistor

- Interchangeable with Style RV5 MIL-R-94 but far exceeds temperature and stability requirements.
- Available with 1%, 2% or 3% linearity.
- Power ratings: 1½ watts at 85°C, 1 watt at 125°C, derated linearly to zero load at 175°C.

Request Data Sheet 180 for technical specs.

CERATRIM

Series 170

42-Turn 150°C Square Trimmer Resistor

- Available with wire leads or p.c. pins out bottom or side.
- Power Rating: 1 watt at 50°C derated linearly to zero load at 150°C.

Request Data Sheet 178 for technical specs.

CeraTrolS

Series 600

¾ Watt ½" dia. Military Variable Resistor

- Interchangeable with Style RV6 MIL-R-94B but far exceeds temperature and stability requirements.
- Power ratings: ¾ watt at 85°C, ½ watt at 125°C, derated linearly to zero load at 175°C.

Request Data Sheet 175 for technical specs.

CERATRIM

Series 180

25-Turn 200°C Rectangular Trimmer Resistor

- Available with p.c. pins or wire leads.
- Power Rating: 1 watt at 125°C derated linearly to zero load at 200°C.

Request Data Sheet 177 for technical specs.

Founded 1896

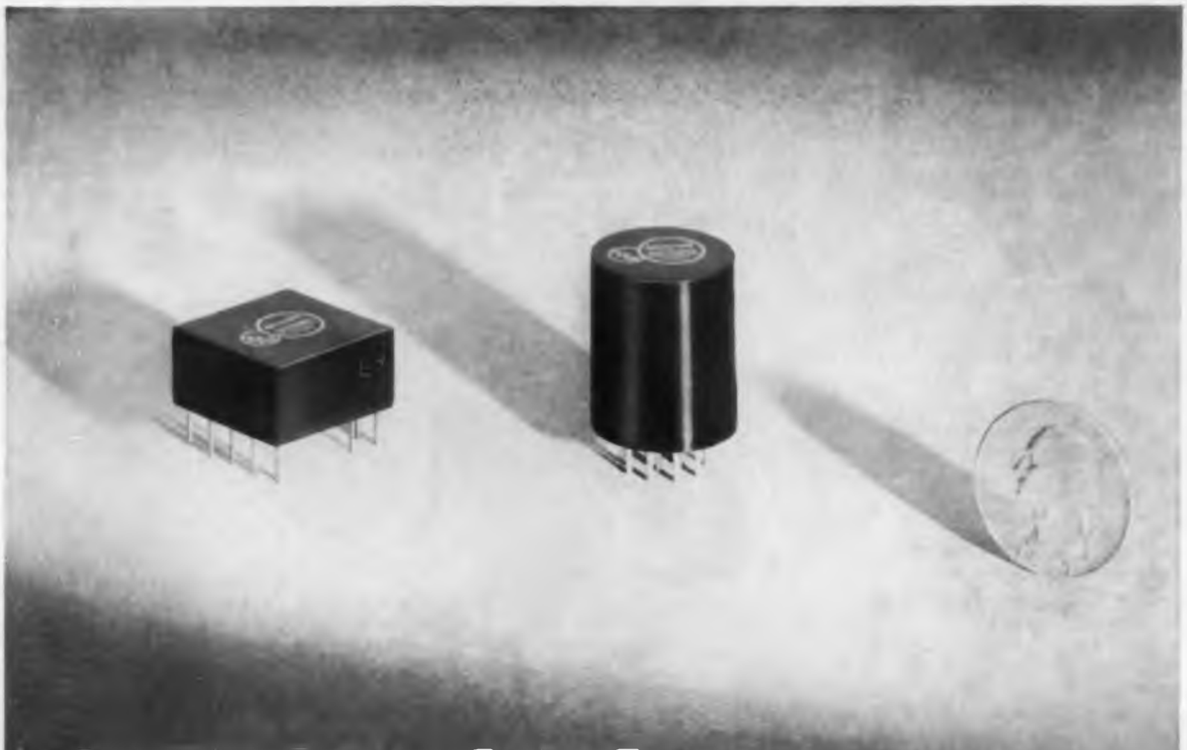
CTS Corporation

Elkhart, Indiana

Factories in Elkhart & Berne, Indiana; South Pasadena, California; Asheville, North Carolina and Streetsville, Ontario, Canada.

Sales Offices and Representatives conveniently located throughout the world. CTS specialists are willing to help solve your cermet resistor problems.

Circle 3 on Inquiry Card



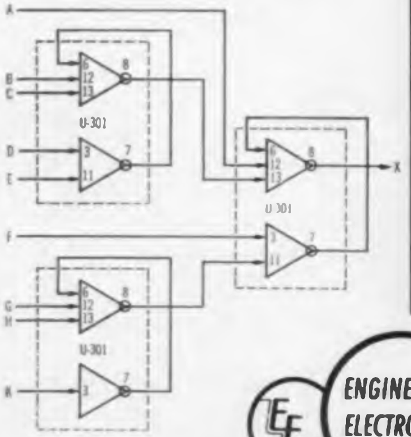
INTRODUCING . . .

EECO'S 1-MC ALL-WELDED NOR CIRCUIT MODULES

HOW WOULD YOU IMPLEMENT THIS EQUATION AT RATES UP TO 1 MEGACYCLE?

$$X = \bar{A}\,(B + C + \bar{D}\bar{E})\,(F + \bar{G}\bar{H}K)$$

HERE'S HOW YOU CAN DO IT USING EECO 1-MEGACYCLE, ALL-WELDED NOR CIRCUIT MODULES:



These new one-megacycle units form important additions to EECO's all-welded U-Series of NOR Circuit Modules. They feature:

- All-welded construction for increased reliability.
- Low cost.
- Extreme versatility—only a minimum number of basic unit types to stock.
- Standardized loading.
- Restored levels out of each gate.
- Choice of package styles.
- Miniaturized.

PACKAGING

Two packaging styles are available. Both use **ALL-WELDED** electrical connections and both are encapsulated. Rectangular units with wire leads (to simplify dip-soldering) are available for installation on circuit cards. Cylindrical units with pins are available for plug-in installation in tube-type sockets.

The cylindrical packages measure ⅞" diameter by 1.0" seated height. The rectangular packages measure 0.95" long by 0.95" wide by 0.5" seated height.

Our Application Engineering staff stands ready to serve you in implementing your digital systems block diagram. Write, wire, or phone today for detailed information on the EECO U-Series of NOR units or for information on any of our other families of digital circuit modules.

See us at the NEC Show Booths 533 & 535

ENGINEERED ELECTRONICS Company

ENGINEERED ELECTRONICS COMPANY

1441 EAST CHESTNUT AVENUE • SANTA ANA, CALIFORNIA
Cable Address: ENGELEX

Coming Events in the electronic industry

Oct. 9-11: 17th Annual Nat'l. Electronics Conf., AIEE, IRE, Ill. Inst. of Tech., Northwestern Univ., Univ. of Ill.; International Amphitheatre, Chicago, Ill.

Oct. 9-12: 11th Annual Instrument Symp., Nat'l. Institute of Health, Bethesda, Md.

Oct. 9-13: Annual AES Conv.; Hotel New Yorker, New York, N. Y.

Oct. 9-13: ARS Space Flight Report to the Nation; Coliseum, New York, N. Y.

Oct. 10-11: Symp. Mfg'g. with Space Age Metals, ASTME; Sheraton Hotel, Phila., Pa.

Oct. 10-12: 12th Nat'l. Conf. on Standards, ASA; Rice Hotel, Houston, Tex.

Oct. 11-13: Application of Digital Computers to Automated Instruction, ONR, System Development Corp.; Washington, D. C.

Oct. 14: NAB Fall Conf.; Atlanta, Ga.

Oct. 15-19: 17th Annual ISA Instrument-Automation Conf. & Exhib.; Coliseum, New York, N. Y.

Oct. 15-20: Fall General Mtg. of the AIEE; Detroit, Mich.

Oct. 16-17: Nat'l. Symp. on Engineering Writing & Speech, Kellogg Center for Continued Education; Michigan State Univ., E. Lansing, Mich.

Oct. 17: Workshop Seminar—Working With Your Sales Representative Effectively, AEPEM, Inc.; McCormick Place, Chicago, Ill.

Oct. 17: Annual Dinner, American Inst. of Consulting Engineers; New York, N. Y.

Oct. 18-20: Nat'l. Assoc. of Educational Broadcasters Conv.; San Francisco, Calif.

Oct. 18-20: Annual Mtg. of the Optical Soc. of America; Biltmore, Hotel, Los Angeles, Calif.

Oct. 19-20: Symp. on Electronics Engineering & Education, IRE (N. C. Sec.); Greensboro Coliseum, Greensboro, N. C.

Oct. 19-20: 16th Midwest Conf. of the ASQC; Hotel Chase-Park Plaza, St. Louis, Mo.

Oct. 19-21: Fall Mtg. of the Nat'l. Soc. of Prof. Engineers; Roanoke Hotel, Roanoke, Va.

Oct. 20: 2nd N. Y. Conf. on Electronic Reliability, N. Y. Metropolitan Chap. IRE (PGRQC); NYU's College of Eng'g., University Heights, New York, N. Y.

Oct. 23-25: East Coast Conf. on Aerospace & Navigational Electronics, IRE (PGANE); Lord Baltimore Hotel, Baltimore, Md.

Oct. 23-25: URSI-IRE Fall Mtg., URSI, IRE (PGAP); Univ. of Texas, Austin, Tex.

Oct. 23-27: 1961 Detroit Metal Show, ASM; Cobo Hall, Detroit, Mich.

Oct. 23-25: Conf. on Electrical Insulation, NAS, NRC; Pocono Manor, Pocono Manor, Pa.

Highlights of '61

Nov. 14-16: 1961 Northeast Electronics Research and Eng'g. Mtg. (NEREM), IRE; Commonwealth Armory and Somerset Hotel, Boston, Mass.

Dec. 12-14: 1961 Eastern Joint Computer Conf. AFIPS, IRE (PGEC), AIEE, ACM; Sheraton Park Hotel, Washington, D. C.

Oct. 24-26: 1961 Michigan Industrial Electronics Exposition, Electronic Representatives, Inc.; Detroit Artillery Armory, Detroit, Mich.

Oct. 25-26: Conf. on Reliability Assurance Techniques for Semi-conductor Specifications, AIA, ASQC, EIA, IRE, JEDEC; Dept. of Interior Auditorium, Washington, D. C.

Oct. 25-26: 1961 Computer Applications Symp., Armour Research Foundation; Morrison Hotel, Chicago, Ill.

Highlights '62

IRE Internat'l. Conv., Mar. 26-29, Coliseum & Waldorf-Astoria Hotel, New York, N. Y.

WESCON, Aug. 21-24, IRE, WEMA; Los Angeles, Calif.

Nat'l. Electronics Conf., Oct. 9-11, IRE, AIEE, EIA, SMPTE; Chicago, Ill.

NEREM (Northeast Res. & Eng. Mtg.) Nov. 13-15, IRE; Boston, Mass.

Oct. 26-27: The Organization of Bio-Medical Instrumentation and Engineering in Universities and Hospitals, AIEE, IRE; Sheraton-Fontenelle Hotel, Omaha, Neb.

Oct. 26-28: 1961 Electronic Devices Mtg., IRE (PGED); Sheraton Park Hotel, Washington, D. C.

Oct. 29-31: 15th Conf. on Electrical Techniques in Med. & Bio., ISA, AIEE, IRE; Edgewater Beach Hotel, Chicago, Ill.

Oct. 30-Nov. 1: Radio Fall Mtg., EIA, IRE (PGED, BTR, RQC); Hotel Syracuse, Syracuse, N. Y.

INTERNATIONAL

Oct. 2-4: Canadian Electronic Conf., IRE; Automotive Bldg., Exhibition Park, Toronto, Ont., Canada.

Oct. 3-12: British Electronic Computer Exhibition; Olympia, London, England.

Oct. 23-24: Joint Mtg., Canadian Aeronautical Institute & Institute of Aerospace Sciences; Quebec, Que., Canada.

Oct. 26-27: Semiannual Conf., American Soc. of Tool and Mfg'g. Engineers; Royal York Hotel, Toronto, Ont., Canada.

NOVEMBER

Nov. 1-3: Internat'l. Conf. on High Magnetic Fields, MIT, AFOSR/Solid State Sciences Div.; MIT, Cambridge, Mass.

Nov. 1-3: Industrial Engineering Managing Clinic, Industrial Management Soc.; Pick-Congress Hotel, Chicago, Ill.

Nov. 1-3: Mtg. Soc. for Experimental Stress Analysis; Hotel New Yorker, New York, N. Y.

Nov. 1-3: Plastics in Packaging and Engineering Exhibition, North Texas Sec. SPE, SPE Southwestern Div. Chapter; Sheraton-Dallas Hotel, Dallas, Tex.

Nov. 2-3: Annual Mtg. American Inst. of Mining, Metallurgical and Petroleum Engineers; Los Angeles, Calif.

Nov. 2-3: 10th Annual Instrumentation Conf., Louisiana Polytechnic Institute, Dept. of Mech. Eng'g.; Rushton, La.

Nov. 5-8: Annual Conv., American Documentation Institute, ADI; Somerset Hotel & Kresege Auditorium, MIT, Boston, Mass.

Nov. 6-8: Special Tech. Conf. on Non-linear Magnetics, AIEE, IRE (PGEC, PGIE); Statler-Hilton Hotel, Los Angeles, Calif.

Nov. 6-9: 1961 Nuclear Conf., Atomic Industrial Forum & AtomFair, ANS; Conrad Hilton Hotel, Chicago, Ill.

Nov. 7-9: 7th Conf. on Radio Interference Reduction and Electronic Compatibility, IRE (PGRFI), Armour Research Foundation; Illinois Institute of Tech., Technology Center, Chicago, Ill.

Nov. 7-9: 8th Industrial Electric Exposition, Electric League of Western Penna., Penn-Sheraton Hotel, Pittsburgh, Penna.

(*Continued on page 12*)

Coming Events

(Continued from page 11)

"CALL FOR PAPERS"

1962 IRE Internat'l. Conv., Mar. 26-29, 1962, Waldorf Astoria and Coliseum, New York, N. Y. Only original papers not published or presented prior to the 1962 IRE Conv. will be considered. Papers may be on any field associated with or in Electronics. **Deadline for 100 word abstracts (3) and 500 word summary (3): Oct. 20, 1961.** Forward to: Dr. Donald B. Sinclair, Chairman, 1962 Technical Program Committee, The Institute of Radio Engineers, Inc., 1 E. 79th St., New York 21, N. Y.

1962 Spring Joint Computer Conf., May 1-3, 1962, San Francisco, Calif. Post card notice of intent to submit paper is requested as soon as possible. No advance summary or abstract is required. **Complete preliminary draft** (3 copies with legible drawings) should be forwarded. **Deadline—Nov. 10, 1961,** to: Mr. R. F. Tanaka, Chairman, Technical Program Committee, 1962 SJCC, Lockheed Missiles & Space Co., 3251 Hanover St., Palo Alto, Calif.

1962 Internat'l. Solid-State Circuits Conf., Feb. 14-16, Phila., Pa. Papers to deal with circuit properties, circuit philosophy, and design techniques related to solid-state devices. **Deadline** for 300 to 500 word abstracts is **Nov. 1, 1961.** Forward to: Mr. Richard H. Baker, Room C-237, MIT Lincoln Laboratory, Lexington, Mass.

Symp. on Electromagnetic Theory and Antennas, June 25-30, 1962, The Technical Univ. of Denmark, Copenhagen, Denmark. Papers will deal with: Electromagnetic fields in anisotropic media; Diffraction theory; Antenna pattern synthesis; and Quasi-static electromagnetic problems. **Deadline for** 800-1200 word 3 page summary is **December 1, 1961.** Forward to: Technical Program Committee, The Technical Univ. of Denmark, Oster Voldgade 10 G, Copenhagen K Denmark.

1962 PGMTT Nat'l. Symp., May 22-24, 1962, Boulder Labs., Boulder, Colo. Papers to deal with research, development and applications in all areas of the microwave field. **Deadline: Dec. 18, 1961** for both 50-100 word abstracts and 500-1000 word summaries with up to 6 illustrations. Forward to: R. W. Beatty, Chairman, Technical Program Committee, 1962 PGMTT Nat'l. Symp., National Bureau of Standards, Boulder, Colo.

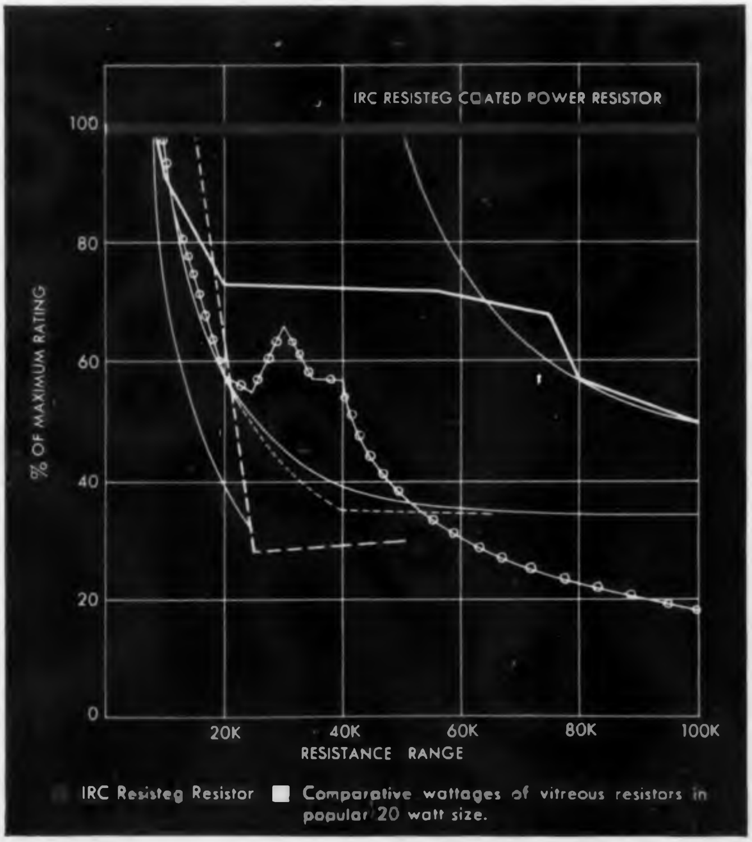
in POWER RESISTORS : if it's news, expect it first from IRC

NO DERATING with IRC Resisteg Coated Power Resistors

Exclusive RESISTEG COATING accounts directly for the ability of IRC Power Resistors to operate at full rated power—even at high resistance values. Resisteg Coating is cured at less than 205°F. This is more than 1000° lower than is required for other power resistor coatings.

With Resisteg low-temperature curing there is no tendency for wire turns to shift, no necessity for tight windings, no hot spots from arcing-over, no appreciable change in temperature coefficient or resistance.

Resisteg Coating permits the use of close spacing, large wire diameter, and maximum number of turns. This increases the transfer of heat from the interior of the IRC resistor to the terminals—providing a safety margin for surges and minimizing any need to derate at high ambient temperatures. Request Bulletin C-IC. International Resistance Co., 401 N. Broad St., Phila. 8, Pa.



COMPLETE LINE OF POWER RESISTORS • STOCKED BY IRC MAJOR INDUSTRIAL DISTRIBUTORS

IRC

Leading supplier to manufacturers of electronic equipment

As We Go To Press . . .

"Wingless Wonder" Developed by W. O.

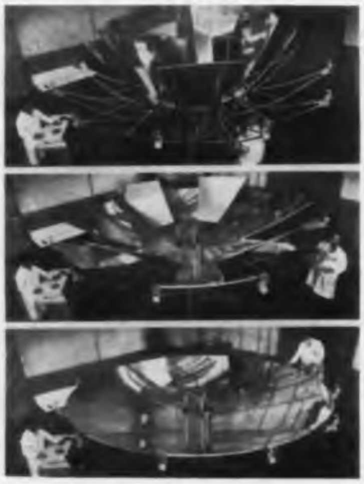
Warrant Officer James M. Schneider, Assistant Shop Avionics for the Seaplane Branch, Norfolk Naval Air Station, has developed a proficiency trainer for Anti-Submarine Warfare crews. Known as the "Wingless Wonder," it was constructed with the aid of Frank Angelo and the Air Station crew of the Avionics Branch.

Need for a device to train entire ASW crews, including tactical coordination as a crew, was pressing. Loral Electronics Corp. of New York provided NAS Norfolk with aircraft mockup suitable for conversion to operational trainer, along with certain electronic equipment needed and Frank Angelo, a top engineering assistant.

The trainer contains electronic equipment comparable to that which was installed in the P5M aircraft backfit program earlier this year. Basic idea of the trainer is to promote proficiency training on the ground for the entire ASW crew. Any problems that may arise while the aircraft is in the air are simulated and solved by the entire crew. The unit, with the extensive research and expensive equipment, was constructed without cost to the government and is comparable to a $2,000,000 trainer.

SPACE "FLOWER"

Parabolic mirror for G.E.'s new Solar Test Facility at Phoenix, Ariz. is part of an experimental solar thermionic electrical power system being developed for the Air Force's Aeronautical Systems Division.



PRECISION MACHINE

Gaging of a transparent part demonstrates the new Bendix Dynapoint controlled precision measuring machine developed by The Sheffield Corp., a Bendix subsidiary. System is capable of detecting part deviations in the order of ten millionths.

Ultrasonic Treatment Improves Soft Drinks

Ultrasonic equipment that sends silent sound waves through a carbonated beverage, creating a controlled foaming condition which drives most of the entrapped air from the bottle, has been perfected by the Electronic Assistance Corp. of Red Bank, N. J.

Coca-Cola Co. has agreed to assist EAC in promoting the adoption and use of this equipment by all authorized bottlers of Coca-Cola. Operation of the equipment consists of electronically generating the foam in the head space of a bottle during the filling process to displace unwanted air and then introducing carbon dioxide gas into the small remaining space just prior to sealing. By removing the excess air, shelf life of the beverage is improved.

Patents Granted

Two patents on improvements in thermistor infrared detectors have been granted to Eric M. Wormser and assigned to Barnes Engineering Co., Stamford, Conn. One patent covers new bolometers in which the sensitivity may be increased nearly 16 times by optically immersing the thermistor flake in an extremely fast germanium lens. The other patent covers optically flat thermistor flakes which are used in all of the best modern bolometers, including the immersed type.

Low Cost Sonic Gun Developed

A Sonic Gun developed by Ultrasonic Industries, Inc., Engineers Hill, Plainview, L. I., N. Y., makes possible instantaneous ultrasonic defoaming, degassing, mixing, and dispersing in pipe lines or tanks. The device can also be used as a high level noise source for signaling or environmental testing but, unlike conventional sirens or whistles used for the purpose, the Sonic Gun has no moving parts. It is essentially a series of vibrant antennae composed of acoustically resonant elements which are excited at their natural resonant frequency by a free-floating air-driven piston.

The Sonic Gun can be used to suit specifications for any work requiring a specific frequency from 10 kc to 100 kc. The output frequency can be varied by altering the dimensions of the resonant elements.

BANK COMPUTER

Dause L. Bibby, president, Remington Rand (l), and Earl B. Schwulst, president, The Bowery Savings Bank, discuss the $2 million Univac 490 Real-Time computer system purchased by the bank. Computer system is capable of handling up to 800,000 accounts at a rate of 50,000 customer transactions an hour.

VHF-FM Portables To Be Marketed

A new portable two-way radio described as the smallest, lightest, most compact VHF-FM communications unit to be marketed to date (with the transmitter and receiver in a single case), has been announced by the General Electric Co. The new personal communication units will be manufactured for high band frequencies (132-174 mc) with one watt transmitter RF power output.

Called the "Voice Commander," the new equipment weighs slightly more than four pounds and is only 9.5 inches high, 5.3 inches wide and 1.7 inches deep. It is self-contained with a built-in microphone and speaker.

FILMISTOR® 'C'

METAL FILM RESISTORS OFFER 5 DISTINCT TEMPERATURE COEFFICIENTS TO MEET ALL CIRCUIT REQUIREMENTS

RUGGED END-CAP CONSTRUCTION FOR LONG TERM STABILITY

• • •

EXCEPTIONAL RESISTANCE TO MOISTURE AND MECHANICAL DAMAGE

• • •

SURPASS MIL-R-10509 PERFORMANCE REQUIREMENTS

Providing close accuracy, reliability and stability with low controlled temperature coefficients, these molded case metal-film resistors outperform precision wirewound and carbon film resistors. Prime characteristics include minimum inherent noise level, negligible voltage coefficient of resistance and excellent long-time stability under rated load as well as under severe conditions of humidity.

Close tracking of resistance values of 2 or more resistors over a wide temperature range is another key performance characteristic of molded-case Filmistor "C" Resistors. This is especially important where they are used to make highly accurate ratio dividers.

Filmistor "C" Resistors are automatically spiralled to desired resistance values by exclusive Sprague equipment. The metallic resistive film, deposited by high vacuum evaporation, bonds firmly to special ceramic cores. Noble metal terminals insure low contact resistance.

The resistance elements, complete with end caps and leads attached are molded in dense, high temperature thermosetting material to form a tough molded shell for maximum protection against mechanical damage, moisture penetration and repeated temperature cycling.

Filmistor "C" Resistors, in 1/8, 1/4, 1/2 and 1 watt ratings, surpass stringent performance requirements of MIL-R-10509C, Characteristic C. Write for Engineering Bulletin No. 7025 to: Technical Literature Section, Sprague Electric Co., 233 Marshall Street, North Adams, Mass.

For application engineering assistance write: Resistor Division, Sprague Electric Co. Nashua, New Hampshire

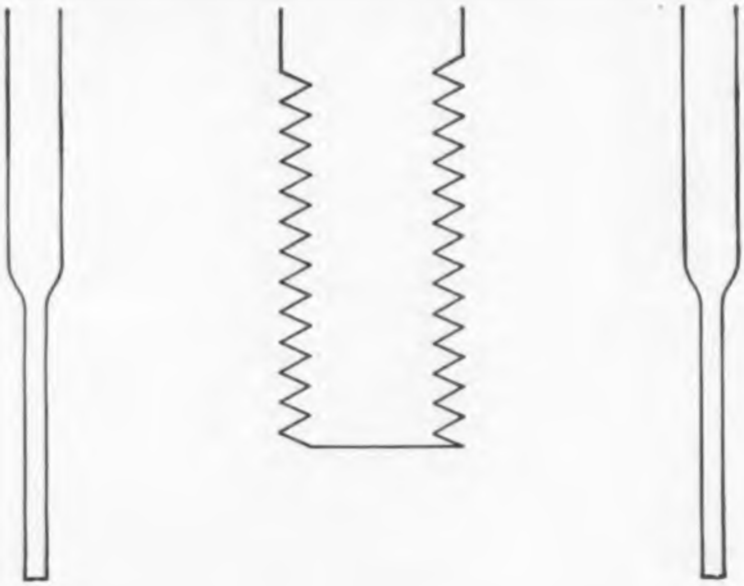
SPRAGUE COMPONENTS

RESISTORS	INTERFERENCE FILTERS	HIGH TEMPERATURE MAGNET WIRE
CAPACITORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
MAGNETIC COMPONENTS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
TRANSISTORS	PULSE-FORMING NETWORKS	FUNCTIONAL DIGITAL CIRCUITS

SPRAGUE

THE MARK OF RELIABILITY

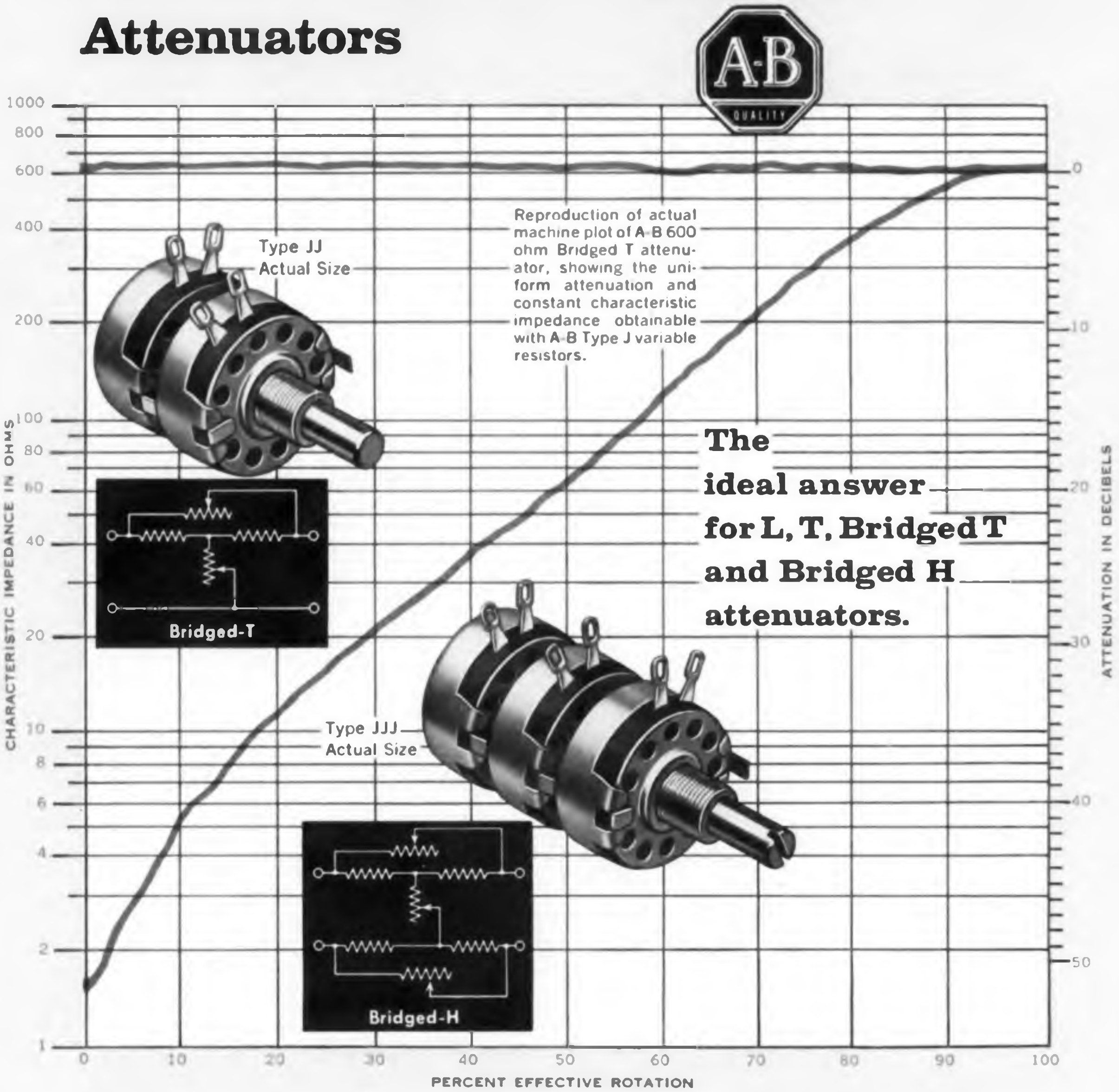
Circle 7 on Inquiry Card



Circle 8 on Inquiry Card

Circle 9 on Inquiry Card →

Use Low Cost Allen-Bradley Type J Pots for Constant Impedance Attenuators



Allen-Bradley dual and triple Type J variable resistors are widely used in attenuators in electronic circuitry because they provide dependably smooth and uniform attenuation plus constant characteristic impedance.

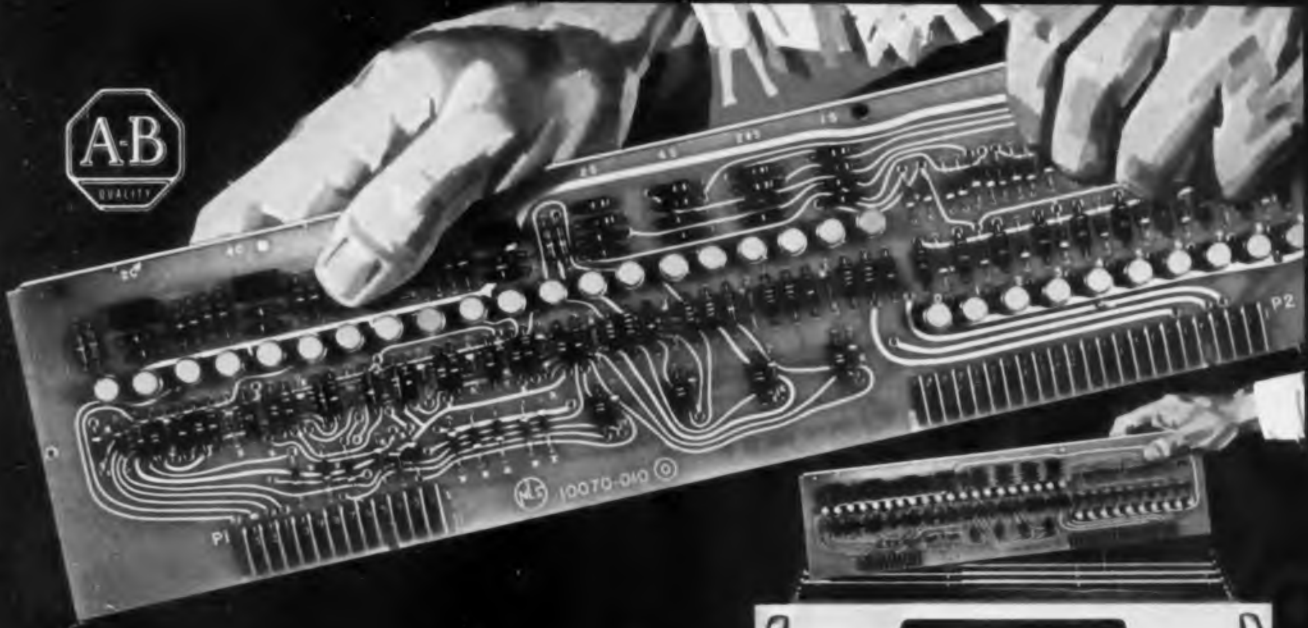
Stability, high wattage, long life, ideal uniformity, plus remarkable compact structure are combined in the Type J to assure top performance. The solid resistance element—made by A-B's exclusive hot molding process—provides smooth control at all times.

With this precise control over the resistance-rotation characteristics during production, A-B attenuators have a consistently uniform attenuation that approaches calibration accuracy . . . and the characteristic impedance can be held to ±10% over *entire* rotation—*end* to *end*. The virtually infinite resolution eliminates the definite incremental steps of wire-wound units, while freedom from inductance insures excellent high frequency response. For full details on Type J variable resistors, send for Publication 6024.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS



Non-Linear Systems, Inc. designs first digital voltmeter to satisfy critical standards for missile work

Digital voltmeters — originated by NLS — permit rapid and accurate voltage measurements. New Series 20 unit — with one plug-in decade board removed — shows the use of Allen-Bradley fixed resistors.

Resistor Failures UNHEARD OF

...naturally, NLS uses ALLEN-BRADLEY hot molded resistors

To satisfy the high standards of consistent accuracy and reliability demanded for missile and weapons checkout, Non-Linear Systems, Inc., developed this digital voltmeter. It uses scores of Allen-Bradley fixed resistors. (For example, the latest Series 20 unit, shown above, contains about 1,000 in each instrument.) "In the selection of A-B resistors," says NLS, "quality and availability have never been a problem."

A-B resistors have such consistently uniform electrical characteristics that their performance can be accurately predicted over long periods of time under various operating conditions . . . with *complete freedom* from catastrophic failure while in service! The hot molding process used exclusively by A-B is the reason for this uniformity and reliability.

To obtain this same measure of superior performance for your equipment, always insist on Allen-Bradley quality fixed resistors available in various types. For full details, send today for your copy of Technical Bulletin 5000 or Publication 6024. Write to: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

ALLEN-BRADLEY Hot Molded Resistors ACTUAL SIZE

Hot molded composition resistors are available in all standard EIA and MIL-R-11 resistance values and tolerances.

**Pending MIL Spec Assignment*

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

SILICON PLANAR 2N709

6 NSEC τ_s MAX.

MADE POSSIBLE BY FAIRCHILD PLANAR PROCESS

2N709 VERY HIGH SPEED NPN SILICON PLANAR TRANSISTOR
ULTRA-FAST SWITCHING APPLICATIONS

JEDEC TO-18 PACKAGE
300 mW POWER DISSIPATION AT 25°C. FREE AIR TEMPERATURE

2N709 CHARACTERISTICS

	Min.	Typ.	Max.	Condition	
C_{ob}	----	----	3.0 pf	(V_{CB} = 5.0 V; I	= 0 mA)
C_{TE}	----	----	2.0 pf	(V_B = 0.5 V; I_C	= 0 mA)
f_T	----	800 mc	----	(V_C = 4.0 V; I_C	= 5.0 mA)
τ_s	----	3.0 ns	6.0 ns	(I_B = I_B = I_C	= 5.0 mA)
h_{FE}	20	----	120	(I_C = 10 mA; V_{CE}	= 0.5 V)
BV_{CBO}	12 V	----	----	(I_C = 10 μA; I	= 0)
I_{CBO}	----	----	100 mμA	(V_{CB} = 5.0 V; I	= 0)

ULTRA-FAST SPEED

100-200 mc saturated switching circuits are now made possible and practical because of: typical f_T of 800 mc, average DC propagation delay time of 3 nsec. (6 nsec. max.), 3 pf C_{ob} (max.) and 2 pf C_{TE} (max.).

LOW LEAKAGE

With the 2N709 you can design micropower high speed satellite circuits with minimum allowances for leakage. Provides the parameter stability and uniformity characteristic of Fairchild's silicon Planar devices.

LOW COST

2N709 is on distributor shelves, ready for immediate delivery. You can have this ultra-fast, guaranteed, high-performance device at prices practical for the "breadboard" budget as well as quantity production.

Contact your Fairchild Distributor or Field Office. Or write for complete specifications and pricing information.

FAIRCHILD SEMICONDUCTOR

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. • YORKSHIRE 8-8161 • TWX: MN VW CAL 853
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

NOW

THERMOFIT CRN

HIGH-STRENGTH • SEMI-RIGID SLEEVING

Flex point extended to insulation

CRN is a new irradiated Thermofit insulation sleeving designed for maximum mechanical strength at stress or connection points. As with other Thermofit products, the sleeving diameter may be reduced 50% upon the application of heat in excess of 275°F for a few seconds. It does not cold flow or melt and retains form stability at any temperature. It is available in eight standard color-coded sizes.

CRN

A NEW PLASTIC MEMORY PRODUCT OF

A SUBSIDIARY OF RAYCHEM CORPORATION

RAYCLAD TUBES INCORPORATED

OAKSIDE AT NORTHSIDE • REDWOOD CITY, CALIFORNIA • EMERSON 9-3376

News Briefs

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

EAST

LABORATORY FOR ELECTRONICS, INC., has opened a new Washington Regional Office in Suite 313, Riddell Building, 1730 K St., N.W., Washington, D. C.

CONTINENTAL CONNECTOR CORP., has licensed **AMP, Inc.**, to manufacture, use and sell separable assembly mechanisms for internal connectors used in missiles, rockets, business machines and other electronic units. The arrangement was concluded on a royalty basis.

Definitization of a $15,381,250 contract has been completed covering development of the missile guidance computer for Skybolt. The contract was awarded by Nortronics, div. of Northrop Corp., to **GE's LIGHT MILITARY ELECTRONICS DEPT.**, Utica, N. Y.

GYROTRONICS, INC., Asbury Park, N. J., a subsidiary, has been formed by United Telecontrol Electronics, Inc., to manufacture hermetic enclosures and precision metal parts used in military transformers, delay lines and wave filters.

CLAROSTAT MFG. CO., INC., Dover, N. H., has renovated and converted approx. 100,000 sq. ft. of their Dover, N. H., plant for precision potentiometer manufacturing space. This area is in addition to previous space devoted to precision component manufacturing.

RCA's Burlington plant is having an additional 175,000 sq. ft. of floor space added to it. The enlarged plant will be occupied by **RCA's AEROSPACE COMMUNICATIONS AND CONTROLS DIV.** now operating on the site. Completion is scheduled for early 1962.

GULTON INDUSTRIES, INC., Metuchen, N. J., has received contracts, totalling $427,000 to supply power storage and conversion systems for the Orbiting Astronomical Observatory satellite program from Grumman Aircraft Engineering Corp., Bethpage, N. Y.

The Bureau of Ships, U. S. Navy Dept., has awarded **POLARAD ELECTRONICS CORP.**, Long Island City, N. Y., a contract in excess of $4 million for an undisclosed quantity of AN/URC-32 Single Sideband Ship-to-Shore Transceivers and auxiliary equipment.

MICROWAVE ASSOCIATES, INC., Burlington, Mass., has received a $1 million contract from the Navy Dept., Bureau of Naval Weapons for magnetron tubes.

To provide a more selective distribution base, **WESTINGHOUSE ELECTRIC CORP., ELECTRONIC TUBE DIV.**, Elmira, N. Y., has announced the cancellation of 215 distributor franchises from coast to coast. Along with the cancellation, Westinghouse plans to offer several different franchises based on distributor needs and product scope.

TIMES WIRE & CABLE CO., INC., Wallingford, Conn., announces a new technique for producing coaxial cable with a phase shift of only 20 ppm/°C, within the range of 10 to 32°C.

The U. S. Army has announced award of two contracts totalling approximately $70,685,283 to the **MARTIN COMPANY**, Orlando, Fla., for continued work on the Pershing missile system. One contract provides for completion of the test program now in the advanced phase. The other covers subsequent production of missiles for delivery to combat units.

SPRAGUE ELECTRIC CO., North Adams, Mass., has opened a new branch manufacturing plant in Hillsville, Va. The plant on long-term lease from the Carroll Knitting Co. contains approximately 30,000 sq. ft. of manufacturing and office space.

DAYSTROM, INC., Murray Hill, N. J., has transferred its Weston recorder controller and industrial gauge operations from the Poughkeepsie, N. Y., plant to its facilities in Archbald, Pa.

ADLER ELECTRONICS, INC., New Rochelle, N. Y., has been awarded a contract approximating $1,200,000 by the U. S. Army Signal Corps for the production of 3 AN/TSC-18 air-transportable communications systems.

MELPAR, INC., Falls Church, Va., has been awarded a $957,940 contract by the U. S. Air Force, for production of 7 GAM (Guided Air Missile) 83A/B missile trainers. Primary purpose of the trainer is to instruct aircraft pilots in pre-launch, launch and guidance techniques.

Electro-Science Investors, Inc., Dallas, Tex., has announced affiliation of a new partner firm, **ULTRASONIC INDUSTRIES, INC.**, Plainview, L. I., N. Y. The initial investment is to be $240,000 in the form of stock, convertible debentures and senior notes. This will give ESI an ownership interest in Ultrasonic in excess of 38%.

THE LIONEL CORP., Hillside, N. J., has acquired the government products division of M. Steinthal & Co., Inc., New York City and Roxboro, N. C.

MIDWEST

AMERICAN SEMICONDUCTOR CORP., Chicago, Ill., has moved its entire plant and operation to new and larger quarters at 3940 N. Kilpatrick Ave., Chicago 41, Ill.

BENDIX SYSTEMS DIV., BENDIX CORP., Ann Arbor, Mich., has been awarded a U. S. Air Force contract for $8 million for work on a rocket-borne communications system.

OFFNER ELECTRONICS, INC., Schiller Park, Ill., has been acquired by **BECKMAN INSTRUMENTS, INC.**, Fullerton, Calif., for 58,823 shares of Beckman common stock.

ELGIN NATIONAL WATCH CO., Elgin, Ill., has received orders totalling $547,984 from the government for production of safety and arming devices for use in the Sidewinder, Sparrow and Hawk missiles.

DELCO RADIO DIV. General Motors Corp., Kokomo, Ind., has broken ground for a new semiconductor manufacturing building. The 150,000 sq. ft. building will be erected near Delco's new research and engineering building. Completion is expected in early 1962.

CLEVITE ELECTRONIC COMPONENTS, DIV., CLEVITE CORP., Cleveland, Ohio, has announced the signing of an agreement granting rights to produce piezoelectric barium titanate to **CHANNEL INDUSTRIES, INC.**, Santa Barbara, Calif.

JAMES ELECTRONICS, INC., has moved its Magnetic Div. to a new 12,000 sq. ft. building near the main plant on Chicago's northwest side.

SYNTHANE CORP., Oaks, Pa., has opened a sales office for the St. Louis area at 2360 Humming Bird Drive, Florissant, Mo.

WEST

CONSOLIDATED ELECTRODYNAMICS CORP., TRANSDUCER DIV., Pasadena, Calif., has received a contract in excess of $1,900,000 from the Bureau of Naval Weapons for the manufacture of pressure detectors, hydrophones, and depth compensators. $319,000 will be subcontracted to Miller Research Laboratories, Baltimore, Md., and the Dukane Corp., St. Charles, Ill., for the hydrophones and depth compensators.

The **RF PRODUCTS DIV., AMPHENOL-BORG ELECTRONICS CORP.**, Broadview, Ill., is establishing a western marketing region with headquarters at Chatsworth, Calif.

HEWLETT-PACKARD CO., Palo Alto, Calif., and the **SANBORN CO.**, Waltham, Mass., have combined operations with the approval of their stockholders, effective August 31st. Under terms of the combination, Sanborn stockholders will receive for each share of Sanborn stock, 1.4 shares of common stock and 1 share of cumulative convertible preferred stock of Hewlett-Packard.

SEMICONDUCTOR DISTRIBUTOR SPECIALTIES, INC., Chicago, Ill., has opened a new Southwest branch at 2215 N. Olive St., Dallas 1, Tex.

FAIRCHILD SEMICONDUCTOR CORP., Mountain View, Calif., has been awarded a subcontract by the Boeing Co., Seattle, Wash., valued in excess of $500,000 for the production of transistors of high reliability, for use in the Air Force Minuteman weapon system.

AMPEX CORP., Redwood City, Calif., has announced the sale of its majority interest in Invar Electronics Corp., to **BEHLMAN ENGINEERING CO.**, Burbank, Calif.

NASA has awarded **SPACE TECHNOLOGY LABORATORIES, INC.**, Los Angeles, Calif., a contract to conduct a study of the payload capabilities of current U. S. medium class space vehicles, with respect to future requirements of space missions and satellites. The study is to be completed in 6 months.

SIGMUND COHN CORP., Mt. Vernon, N. Y., has organized the Sigmund Cohn Corp. of California with offices at 151 C. North Maple St., Burbank, Calif.

RCA's West Coast **MISSILE AND SURFACE RADAR DIV.**, has received 2 contracts totaling $1,917,000 from General Dynamics/Astronautics for Atlas Missile launch control and checkout equipment. The equipment will be used at the Pacific Missile Range, and for accelerated activation of the "F" series Atlas Missile sites.

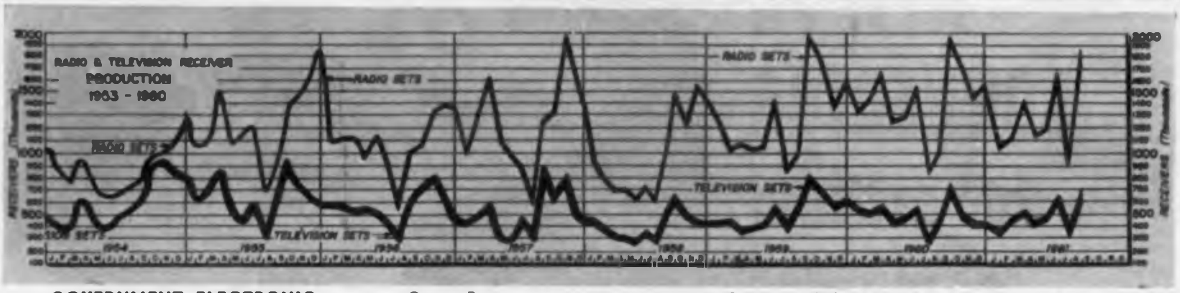
HUGHES AIRCRAFT CO., Culver City, Calif., is including a new infrared device which operates at 452° below zero Fahrenheit into equipment being developed under a $1.8 million contract from the Navy Bureau of Weapons.

COLLINS RADIO CO., Dallas, Tex., has announced the integration of all microwave activities into one organization within its new systems division, the Alpha Corp. **ALPHA CORP.**, formerly a subsidiary, has now become a division of Collins.

CONTINENTAL ELECTRONICS MFG. CO., SUB. LING-TEMCO-VOUGHT, INC., has received a $767,000 addition to its contract for BMEWS radar transmitter equipment. The original contract was signed with the RCA prime contractor for the Air Force's BMEWS.

Facts and Figures Round-Up
October 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 August, 1961.

Amplifiers	702,756
Antennas	158,941
Attenuator	55,968
Batteries	2,421,644
Cable Assembly	1,621,667
Cable, Telephone	124,462
Calibrator	49,700
Comparator, Frequency	105,956
Computers	212,288
Controls	556,375
Decoder	42,370
Detector, VHF	26,976
Gyros, Rate	63,642
Indicators	1,226,267
Intercom Equipment	234,500
Interference Blanker	188,907
Inverters	299,884
Jammer, Transportable	600,000
Meters	87,644
Monitor, Error Voltage	33,370
Multicouplers	33,000
Oscillators	509,924
Oscilloscopes	203,077
Preamplifier	33,786
Preproduction Equipment	4,075,363
Radar	1,074,874
Radiac Set	50,676
Receivers	1,320,632
Recorder/Reproducer	137,641
Recorders	173,690
Recording system	105,670
Relay Armature	332,518
Relays	239,842
Reproducer, Signal Data	168,580
Resistors	166,411
Semiconductors	189,628
Signal Generators	546,314
Simulators	739,667
Solenoid	95,827
Switch	326,485
Systems	524,295
Test Equipment	590,141
Tower, Radar	235,000
Transceivers	688,331
Transducers	32,812
Transformer Rectifier Assy	179,410
Transmitters	426,685
Transponders	175,529
Tube, Electron	8,963,903
Tube, Klystron	385,550

Estimated Shipments of Electron Tubes during 1960

CATEGORY	QUANTITY (in thousands of units) Total	Military	Nonmilitary	VALUE (in thousands of dollars) Total	Military	Nonmilitary
POWER AND SPECIAL PURPOSE TUBES	11,063	2,763	8,300	252,324	164,835	87,489
High vacuum tubes	3,478	1,383	2,095	57,948	29,339	28,609
Diodes	451	221	230	5,374	3,129	2,245
External anode, except diodes, 100 w or less	839	460	379	14,300	7,601	6,699
External anode, except diodes, over 100 w	304	215	89	24,170	13,519	10,651
Internal anode, except diodes	1,884	487	1,397	14,104	5,090	9,014
Gas and vapor tubes	2,306	824	1,482	26,825	13,815	13,010
Diodes	643	269	374	3,731	1,632	2,099
Thyratrons, Ignitrons	1,441	366	1,075	13,999	4,079	9,920
Gas switching device [2]	222	189	33	9,095	8,104	991
Klystrons	157	101	56	50,111	41,697	8,414
Reflex klystrons (1 w and under)	144	94	50	18,442	13,251	5,191
Other, CW and pulsed (over 1 w)	13	7	6	31,669	28,446	3,223
Magnetrons	78	68	10	43,516	41,036	2,480
Forward wave devices	8	7	1	17,967	16,229	1,738
Backward wave devices	4	3	1	4,281	3,402	879
Light sensing tubes	1,054	56	998	15,123	3,026	12,097
Light emitting tubes	324	159	165	10,475	6,366	4,109
Storage tubes	6	4	2	6,314	4,253	2,061
Other [3]	3,648	158	3,490	19,764	5,672	14,092
RECEIVING TUBES	398,327	22,715	375,612	347,941	48,872	299,069
Subminiature	6,871	5,402	1,469	23,729	19,970	3,759
Miniature	291,899	14,610	277,289	226,493	22,475	204,018
Military reliable	15,024	8,901	6,123	26,144	16,801	9,343
All other types	276,875	5,709	271,166	200,349	5,674	194,675
Standard Glass (G and GT)	88,834	1,920	86,914	84,948	3,848	81,100
Military reliable	1,259	549	710	4,562	1,987	2,575
All other types	87,575	1,371	86,204	80,386	1,861	78,525
Other (metal, ceramic, lock-in, etc.)	10,723	783	9,940	12,771	2,579	10,192
TELEVISION PICTURE TUBES	13,035	([4])	13,035	259,109	([4])	259,109

[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 gas 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 nonmilitary shipments to avoid disclosure of proprietary information.

Source: 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 PC CONNECTOR for critical computer applications

Now—*from Continental*—a printed circuit connector that combines all the advanced design features for rugged service in missile, ground support and other critical applications. Expressly designed for high speed automatic wire-wrap connection techniques which combine better reliability with maximum wiring density in minimum space. Type 600-83-10 meets all applicable specifications of Buships MIL-C-21097.

3/4 ACTUAL SIZE

Designed specifically for automatic wire-wrap connections. Solid square, sharp-edged brass terminations, gold plate over silver plate. Three #20 AWG wire-wrap connections can be made on each terminal.

- 64 contacts, bifurcated beryllium copper. Patented "Bellowform" construction accepts .054" to .075" printed circuit boards. Up to 192 connections in less than 7½" length.
- Special molding geometry assures superior ruggedness under severe shock and vibration. Compound is glass filled Diallyl Phthalate per MIL-M-19833, Type GDI-30.
- Polarizing slots in molding permit any required polarization by customer while retaining use of all 64 contacts.

DESIGNERS' DATA FILE

If you're designing around printed circuits you'll want to have Continental's Con-Dex File PC, compiled to help you select and specify the PC connectors best suited to your needs. For your copy, please write to: **Electronic Sales Division, DeJur-Amsco Corporation, Northern Boulevard at 45th St., Long Island City 1, New York (Exclusive Sales Agent) RAvenswood 1-8000.**

MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK

Circle 14 on Inquiry Card

RUBY MASER

Dr. P. P. Kisliuk of Bell Telephone Laboratories, New York, adjusts collimator which directs the beam from a ruby maser oscillator (right) through the ruby maser amplifier (center) to the photomultiplier tube (far left). Amplification of the light by a factor of two was observed. It was reported in a paper by Drs. P. P. Kisliuk and W. S. Boyle at the 1961 Western Electronic Conference and Show at San Francisco, California.

WYOMING PATROL BOAT

A Raytheon Model 1700 marine radar extends the effectiveness of this National Park Service boat on Yellowstone Lake where it is used to patrol the lake, search for lost boatmen, and provide emergency assistance.

Snapshots . . . of the Electronic Industries

SOLAR-THERMOELECTRIC POWER

Sunlight concentrated by the reflector of this Westinghouse Corp. solar-thermoelectric power plant is hot enough to ignite a thick piece of wood almost instantly. The heat is converted directly into electricity.

HARNESS ASSEMBLY

Making the harnesses has been put on a production-line basis at Pleasantville Instrument Corp., Pleasantville, N. Y. Framework holding Harness Boards can be adjusted to handle boards of varying sizes, from 4 x 8 feet to 10 x 12 inches.

BUILT-IN DICTATION SYSTEM

New Chase Manhattan Bank Building has a built-in dictation system. It utilizes Dictaphone Time-Master dictating machines, transcribers and a Telecord "telephone dictation" system (above) with multiple recorders.

FUEL CELL DISPLAY

Model monorail system powered by converting chemicals directly into electrical energy in fuel cell is part of a display demonstrating various fuel-cell electrical power sources under development at Exide Industrial Div. of The Electric Storage Battery Co., Phila., Pa. Exide officials viewing model are (l to r) H. Casterlin, advertising dept. supervisor; H. Riggs, engineering dept. staff asst.; and A. Hedges, supervisor of publicity.

WHEELS HELP MAKE TUBES

Two employees of the RCA Electron Tube Division at Harrison, N. J., are framed within giant wheels of an automatic lead wire loading device which speeds production of tiny nuvistor tubes. High efficiency tubes are small enough to fit into an ordinary thimble.

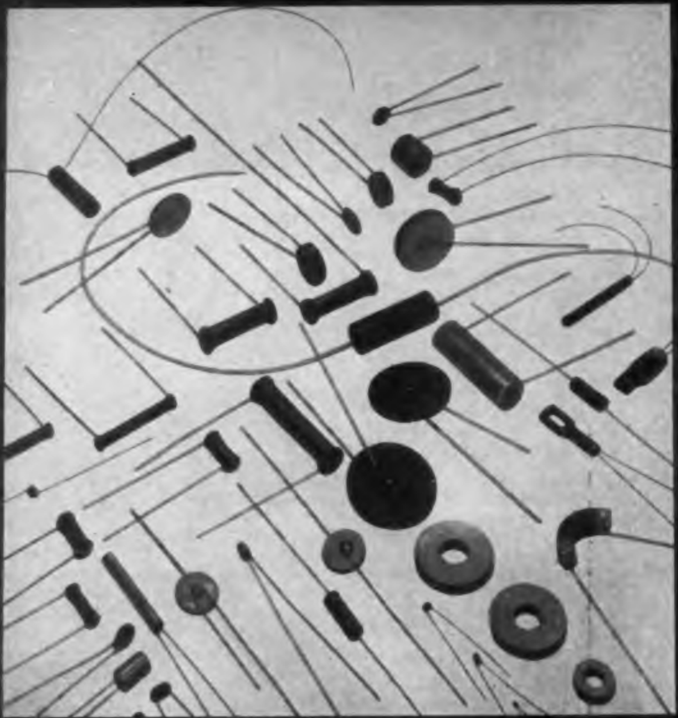
AS ONE ENGINEER TO ANOTHER

Miss Universe of 1961, Marlene Schmidt, who is a practicing engineer representing North American Electronics, Inc., West Lynn, Mass., chats with Mrs. Ampex (Mrs. B. Warren) at the Wescon show. Mrs. Warren is an Engineer with Ampex Corp., Redwood City, California.

IN THERMISTORS

...whether you need 10 or 10,000,000 pieces—

STANDARD PARTS



Versatility Plus . . .

A partial list of small discs and rods, all with identical characteristics

Temperature Coefficient (25°C) –3.8% / °C
Beta Value (37.8°C / 104.4°C) 3500°K
Ratio (37.8°C / 104.4°C) 7.3

Resistance 25° C	Keystone Type Number	Diameter (Inches)	Thickness (Inches)
500	L0503-312-73	0.050	0.030
160	L0903-100-73	0.100	0.030
500	L0903-312-73	0.100	0.030
1000	L0909-623-73	0.100	0.100
100	L2003-62-73	0.200	0.030
180	L2006-112-73	0.200	0.060
200	L2006-125-73	0.200	0.060
230	L2006-143-73	0.200	0.060
270	L2008-168-73	0.200	0.080
300	L2008-187-73	0.200	0.080
100	L3006-62-73	0.300	0.060
200	L3008-125-73	0.300	0.080
250	L3008-156-73	0.300	0.080
300	L3018-187-73	0.300	0.180
270	L060637-168-73*	*Rod, 0.060" square, ⅜" Length.	
5000	L060637-3120-73*		
10000	L060437-6234-73*		

Special Mounting Requirements

Thermistor applications often dictate special mounting requirements. As a result, Keystone units are supplied with many types of special lead assemblies, mounting tabs, heat dissipating fins. Units are mounted in probes and transistor type cans, attached to plates and metal parts of wide variety.

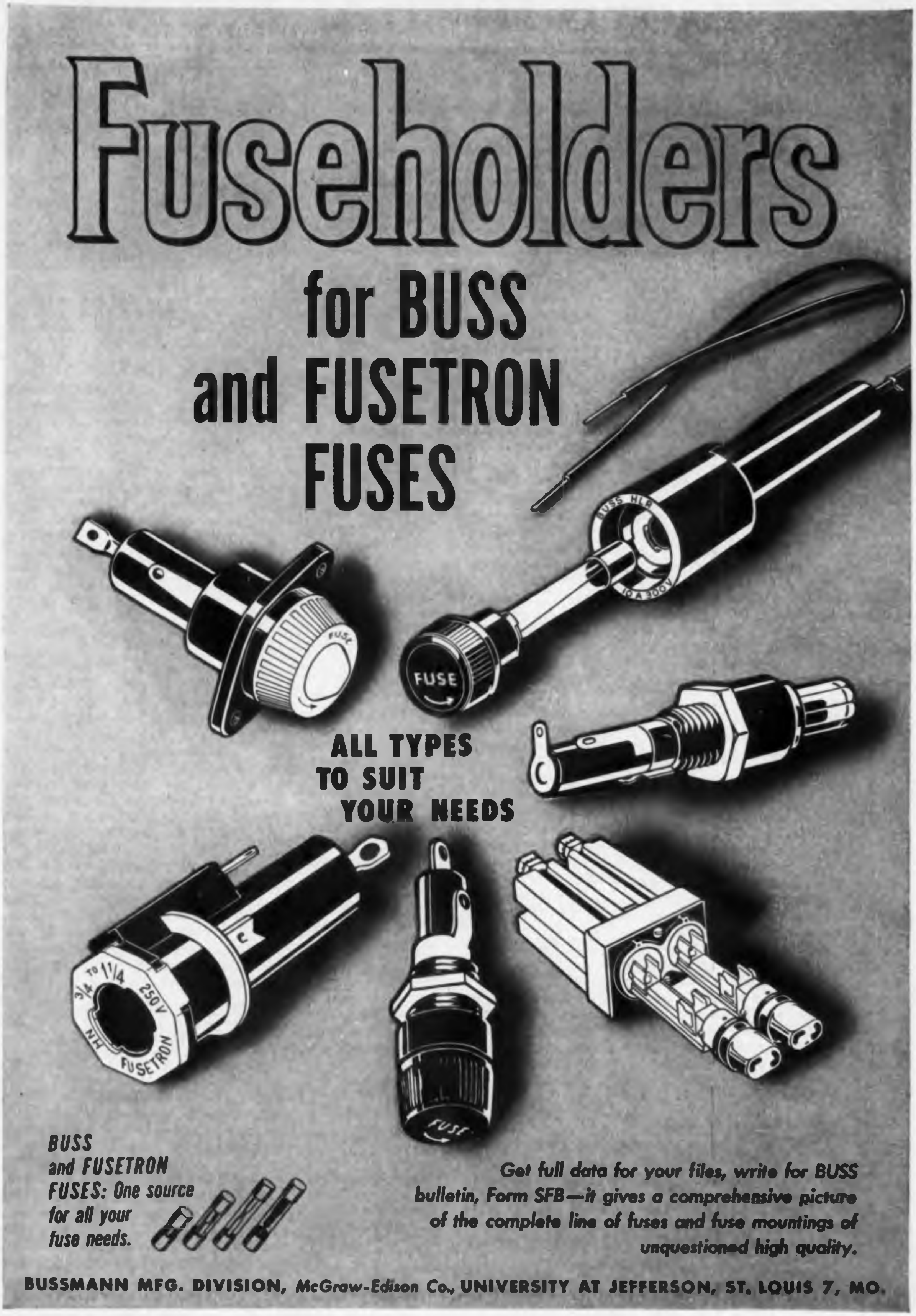
Keystone has the experience (over almost a quarter of a century), the knowledge and production capability to handle your thermistor requirements in any quantity—of any type and size.

Because of unsurpassed quality control, your tolerance specifications are acceptable to ± 2% on resistance value and Beta value (in fact, we maintain a ± 2% production tolerance on the material constant of *all* Keystone thermistors regardless of resistance tolerance). All parts can be supplied in pairs or sets matched closely in resistance-temperature or voltage drop characteristics.

We can supply discs, washers, rods, beads and special shapes including washer segments, square rods, rectangular wafers, square wafers, etc. Our experienced sales staff and engineering and research and development organizations are available for consultation. Write us or call today.

Keystone
CARBON COMPANY
RESISTOR DIVISION • St. Marys, Pa.
Telephone: Terminal 4-1591

Circle 17 on Inquiry Card



Circle 18 on Inquiry Card

EI's International News

JAPAN

Asia's Largest Research Center

What will be the Far East's largest research center is scheduled for completion by the end of November, it has been announced by Taro Kuraishi, vice president of the Tokyo Shibaura Electric Company.

Mr. Kuraishi, newly appointed director of Toshiba's Central Research Laboratory, said that the laboratory buildings which are being built at a cost of $15,277,000, are expected to be completed by the end of August and the remainder of the facilities by the end of November.

The plant will occupy 452,000 square feet in Kawasaki, near Tokyo.

Toshiba, Japan's largest manufacturer of electronics and electrical equipment, is planning to invest over $333,000 for research purposes, representing an investment of more than $11,000 for each of 300 research specialists and scientists who initially will form the research staff cadre. Other workers will bring the total staff to about 950 initially.

Tsuneo Harada, who has been appointed deputy director of the Toshiba laboratory, said that the new laboratory will be used by Toshiba for research in both light and heavy electrical fields, which thus far have been conducted at the company's Hatsuda and Tsurumi laboratories.

CZECHOSLOVAKIA

New Landing System by Pye

Pye Telecommunications Limited of Cambridge, England, announce that a Pye Instrument Landing System has been ordered by the Czechoslovakian Government for installation at Bratislava International Airport.

The Instrument Landing System will be the third supplied by Pye to Czechoslovakia, the previous two installations being at Prague International Airport.

The Pye contract brings the value of I. L. S. and ancillary equipment supplied by the Company to Czechoslovakia to over $300,000.

The latest contract covers additionally the supply of transistorized radiotelephones for use on Czechoslovak airfields.

BERMUDA

Electronic Finance Bank

Electronics International Capital Limited is the first international capital banking institution concentrating its investments in free world electronics companies. Electronics International, a Bermuda Corporation, was created through a Special Act of the Parliament of Bermuda.

Through its second major investment commitment, Electronics International will acquire 83% equity in AREL, a leading European electronics manufacturer based in Scoten (Antwerp), Belgium. Mr. Charles E. Salik, President of Electronics International, said, "The total commitment involves $2,900,000."

Organized in 1952, AREL engages in a continent-wide business, with operating subsidiaries in Amsterdam, Luxembourg, Copenhagen and Innsbruck and an associated company in Italy.

In addition to television and radio receivers, AREL has been very active in the design and manufacture of mobile communication equipment for military and industrial use, electronic organs, automatic test equipment, and research and development in the field of specialized industrial computers. The company also operates a factory producing high-unit-cost, reinforced plastic tanks and containers.

AREL's facilities are among the most modern and efficient on the Continent. It manufactures many of its own components, such as transformers, coils, and tuners. Depending on tariff, cartel, and other local conditions, AREL is in a position either to manufacture basic subassemblies in Belgium and do final subassembly in the ultimate country of sale, or merely to manufacture certain components and complete both subassembly and final assembly in the subsidiary plants.

SWITZERLAND

New Raytheon Subsidiary

Raytheon Company has formed a new subsidiary to market electronic components in Europe. The new firm, Raytheon-Elsi AG, will have its headquarters at 1 Alpenstrasse, Zug, Switzerland. They will promote and sell

The new plant built by Burndy Corporation, Norwalk, Conn., for its wholly-owned Belgium subsidiary Burndy Electra S.A. will supply and service electrical connector requirements throughout Europe.

components manufactured by Raytheon and Elettronica Sicula, Palermo (Elsi). Products to be marketed by the new firm include microwave, receiving and industrial tubes; transistors, diodes and other semiconductor devices; rectifiers; and magnetic and electro-mechanical components.

Raytheon-Europe AG holds a 51% interest in the new corporation with the remaining interest owned by La Centrale Finanziaria Generale S.P.A. Fred H. Brooke has been named General Manager of Raytheon-Elsi AG.

ENGLAND

Built-In TV System

When residents move into 88 bungalows and flats on Bognor Regis, England, they will find that a wired television system has been installed with the gas, water and electricity. This is believed to be the first estate where a television system has been built in at the same time as other essential services and where the owners have undertaken not to erect individual TV aerials on their properties. This will preserve the amenities of the estate against the disfigurement of unsightly aerial arrays.

To preserve the estate's amenities in every possible way, cabling from the aerial tower to all dwellings will be buried underground and amplifier cabinets along the route will be camouflaged.

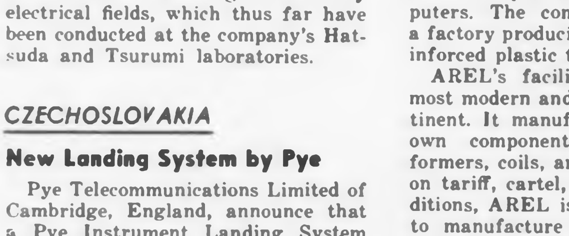
BRAZIL

Computer Markets in S.A.

Computer Control Co. announces the recent addition of two new representatives to supplement its foreign sales force in the marketing of high-speed digital computers, core memory systems, logic modules, and related products. Ambriex in Rio De Janeiro, Brazil and Coasin, S.R.L. in Buenos Aires, Argentina will cover South American territories. Other overseas representatives include Kyokuto, Boeki, Kaisha, Ltd., Tokyo, Japan, and Andrew Thom, Ltd., Sydney, Australia.

(Continued on page 34)

View of Tokyo's Giant Research Center



See story on Tokyo above describing Asia's biggest research center for electronic research. *(See story on Tokyo.)*

"Really demanding specifications call for DALE Type RS Resistors"

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

A subsidiary of **HATHAWAY INSTRUMENTS, INC.**

DALE TYPE RS RESISTORS

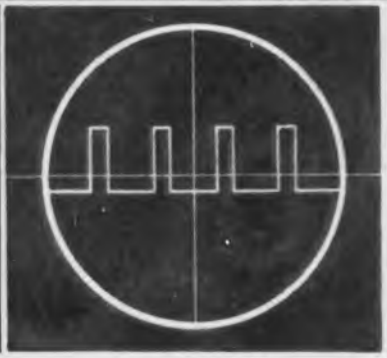
WIRE WOUND • PRECISION • POWER

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

ALL-NEW... TRUE RMS VOLTMETER

now . . . measure true RMS value of virtually all waveforms



FLUKE

ACCURACY 1%

BAND WIDTH: (10 cps–7 mc)

Accurate measurement of complex waves is now possible over a wide range of frequency with the NEW jf MODEL 910A.

MODEL 910A

For the *first time* one instrument provides 1% midband accuracy, 10 cps to 7mc bandwidth, plus 100 u v sensitivity. For added versatility an amplifier output is provided for simultaneous oscilloscope or recorder monitoring.

Model 910A employs a thermocouple located in the feedback loop of a sensitive DC amplifier to measure the actual heating effect of the input waveform. This circuit arrangement is the key to the rapid response and high calibration accuracy of the Model 910A and also prevents any error in reading due to ambient temperature variation. Isolation of the thermocouple from the input terminals by a high gain, ultra stable AC amplifier provides high input impedance and completely protects the thermocouple from burnout under any condition of overload.

Model 910A is ideal for measuring AC currents in non linear devices, total harmonic content of distorted waveforms, noise, average power of pulse trains, and other measurements that involve waveforms which are not necessarily pure sinusoids.

Partial Specifications—jf MODEL 910A

Voltage Range:	1 MV to 300V (full scale readings)
Decibel Range:	−72 to +52 dbm
Frequency Response:	10 cps to 7Mc
Accuracy:	± 1% of full scale 50 cps to 800 KC ± 2% of full scale 20 cps to 2Mc ± 3% of full scale 20 cps to 3.5 Mc ± 5% of full scale 10 cps to 7 Mc
Input Impedance:	10 megohms shunted by 30 pf for 0.3 volt range and below. 10 megohms shunted by 15 pf for 1.0 volt range and above.
Crest Factor:	3 at full scale, proportionately higher for readings less than full scale.
Price:	Cabinet Model—$545.00 Rack Model—$565.00 Prices f.o.b. factory.

Prices and data subject to change without notice.

A more complete description will be sent to you upon request.

FLUKE

JOHN FLUKE MFG. CO., INC.
P. O. Box 7428 Seattle 33, Washington

International News

(Continued from page 30)

W. GERMANY

New U.S. Plant in Germany

The Hewlett-Packard Company has started a major expansion of its European operations, and is building a new plant in West Germany.

The company's decision to expand its operations in Europe, according to Mr. Packard, is based on that area's rapidly growing market for electronic products.

Hewlett-Packard's new plant in Germany will be located on an eight-acre site in Boeblingen, which is near Stuttgart. Construction will begin immediately on the first of four projected buildings of 25,800 square feet each. The initial building, a single-story structure costing approximately $300,000 is expected to be completed early in 1962.

The plant will be operated by Hewlett-Packard G.m.b.H., the company's manufacturing subsidiary in Germany. The plant's initial unit is expected to employ over 150 persons, many of whom are already employed at the company's leased facility in Boeblingen.

HONG KONG

Hong Kong Challenges Japanese Markets

The current production rate for transistor radios in Hong Kong is 20,000 to 25,000 units a month, mostly 6-transistor models. None of the plants were operating at capacity in the spring. Additional facilities being established will expand capacity by about 20,000 units.

The principal market is the United States, although some items are sold locally, some are exported to the United Kingdom, and some to Latin America.

A low wage scale prevails in the Hong Kong radio industry. The usual payment to production workers is 75 cents a day for a 9- to 10-hour day. No fringe benefits are given. The f.o.b. quotations on a 6-transistor radio range from $7.50 to $8.50.

Components are generally of Japanese origin, although one firm was about to switch to a U. S. brand of transistor as a result of a quotation approximating the amount paid for a Japanese brand. The radio manufacturer felt that the quality of the U. S. product was better than that of the Japanese transistor he was using.

If U. S. importers do a good job in marketing Hong Kong radios, competition could become keener than that from Japanese producers.

CENTRALAB'S 20 VOLT ULTRA-KAPS®

Ceramic Capacitors for Semi-Conductor Circuits

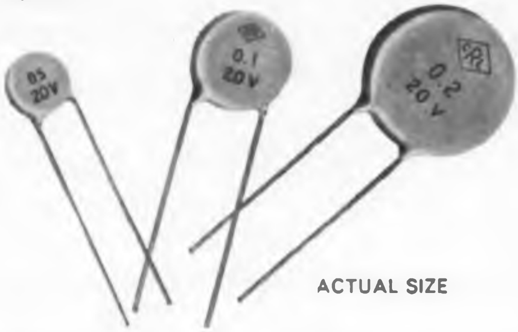
BEAT PAPER CAPACITORS 3 WAYS!

1. 20V Ultra-Kaps® are smaller than paper units of equivalent capacity.

CAPACITY MFD.	ULTRA-KAPS® (diameter x thickness)	PAPERS (diameter x length)
.05	.408" x .156"	.468" x 1.0"
.1	.590" x .156"	.625" x 1.125"
.2	.890" x .156"	.625" x 1.688"

2. Ultra-Kaps® provide the utmost in reliability. They have excellent stability from —55°C to 85°C . . . and electrical failure is virtually unknown among the millions of them now in the field.

3. Ultra-Kaps® are easier to work with than paper capacitors. No axial leads! This construction feature greatly simplifies insertion into printed circuit boards.



ACTUAL SIZE

Ultra-Kaps® also out-perform other ceramic capacitors, because of their more stable temperature coefficient and higher capacity for their size. For every low voltage application requiring high capacities, high reliability and small size—use Centralab's 20V Ultra-Kaps®.

For additional technical information on these new units, write for Engineering Bulletin EP-1245.

Centralab.

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
938J EAST KEEFE AVENUE—MILWAUKEE 1, WISCONSIN
In Canada: Centralab Canada Ltd., P. O. Box 400, Ajax, Ontario

ELECTRONIC SWITCHES • VARIABLE RESISTORS
PACKAGED ELECTRONIC CIRCUITS
CERAMIC CAPACITORS • ENGINEERED CERAMICS

D-6144

Circle 25 on Inquiry Card

Aid For Small Business Owner

A wall chart of "Do It Yourself" cost reduction program is available to company owners on letterhead request. There is a charge of $0.35 to cover mailing charges. The chart tells of the Cost Reduction Program and gives steps necessary to the installation of the program. It also concerns itself with the recognition of two theories pertinent to small business. Orders should be sent to Small Business Service, 65 Linden St., Malverne, L. I., N. Y.

Moon Room

The first settlers on the moon will live in quarters similar to the one pictured. The bed and chair are of lightweight metals, vinyl lacing and poly-urethane foam. They are designed to support 30 lbs. This is equivalent to 180 lbs. on earth. The top of the table-desk, cabinets and other surfaces are of rigid urethane foam and lightweight metal frames.

The room contains a table-top television and microfilm unit. Reading material will be on tapes. There is also a television camera and an ultra-violet lamp. The latter for suntans. Exercise equipment, inter-com. system and recessed ceiling lights complete the room's accouterments. The room is a 10 ft. di. by 7 ft. high section of a space ship. The rocket that carried the men to the moon will be sliced up to provide the rooms.

Fig. 1: "Moon Room" donated by the Decker Corp. to the Fels Planetarium, Phila., Pa.

It was designed by Harper Landell Assoc. of Phila. under the direction of Dr. I. M. Levitt, Dir. of the Fels Planetarium, Franklin Institute, Phila., Pa. The room was R&D'd by the Decker Corp. of Bala-Cynwyd, Pa., and constructed by Accent Graphic Industries, Inc., of Camden, N. J.

This room has been donated by The Decker Corp. to the Fels Planetarium. Others will start touring the U. S., South America, Europe and Japan in the next 6 months.

hp 456A AC CURRENT PROBE

Converts ac current to ac voltage directly (1 amp = 1 volt) for reading on your scope or voltmeter

Just clamp around and read:

Tube circuits . . . . view current on your scope or measure it with a VTVM

Transistor circuits . . . . . measure small signals dynamically, without clipping leads or circuit loading; study diodes at breakdown

Logic circuits . . . . measure ac current in presence of dc current

Impedance measuring . . with a dual-channel scope, measure current, voltage magnitude; phase angle

Power measuring . . . . . with dual-channel scope read current, voltage directly, calculate power

Frequency counting . . . . use 456A with counter for clip-on frequency access

And, how about these? . . phase comparisons of ac carrier waveforms; instrument fuse current ratings; cable identification, response of magnetic cores; magnetic field sensing; silicon rectifier peak currents

SPECIFICATIONS

Sensitivity: 1 mv/ma ±1% at 1 KC
Frequency Response: ±2%, 100 cps to 3 MC
±5%, 60 cps to 4 MC
— 3 db at 25 cps and above 20 MC
Maximum Input: 1 amp rms; 1.5 amp peak. 100 ma rms above 5 MC
Maximum dc current: Dc up to 0.5 amp has no appreciable effect
Input Impedance: Probe adds to test circuit only approx. 0.05 ohms in series with 0.05 μh
Equivalent Input Noise: Less than 50 μa rms (100 μa ac powered)
Power: 10 radio mercury cells; approx. 400 hours service normally supplied. Ac supply available
Size: 5" wide, 1½" high, 6" deep, weight 3 lbs.
Price: $190.00; for ac operation $210.00.
hp 456-95A ac supply for field installation $32.00

Data subject to change without notice
Prices F.O.B. Factory

Just clamp the hp 456A probe around a wire under test and view or read ac current directly on an indicating device. Model 456A's 1 mv to 1 ma unity conversion permits direct readings up to 1 ampere rms. The instrument's wide bandwidth permits use with oscilloscopes to view complex current waveforms with rise times to 0.017 μsec. No direct circuit connection is required; there is no loading, no appreciable impedance change in the circuit under test, and the impedance of the test circuit is immaterial.

HEWLETT-PACKARD COMPANY
1028B Page Mill Road, Palo Alto, California, U. S. A.
Cable "HEWPACK" • DAvenport

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

hp offers almost 400 precision test instruments

Shallcross precision circuit news

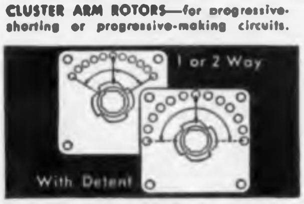
Standard 'Specials' in Shallcross Miniature Switches

PRE-WIRED & HARNESSED SWITCHES — Decks pre-wired before ganging to reduce your production costs and time.

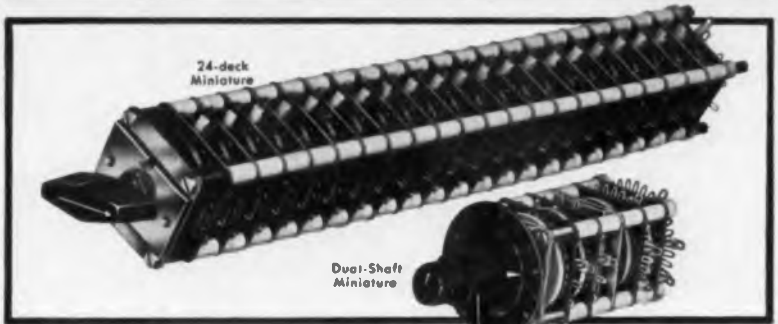
GOLD PLATED CONTACTS & TERMINALS—for the ultimate in maintaining low, stable contact resistance under corrosive conditions.

PRINTED CIRCUIT TERMINALS—available on single-deck or last deck of multi-deck switches.

CLUSTER ARM ROTORS—for progressive-shorting or progressive-making circuits.



SPRING RETURN ROTORS—on either or both directions of rotor travel.



MAXIMUM CIRCUIT SWITCHING IN MINIMUM SPACE

Here's a positive approach to miniaturization—a way to handle more circuits per cubic inch! Conservatively estimated, over 650 circuits may be switched in only 38 cubic inches by a Shallcross Miniature Series switch . . . and with the quality and reliability only a button-contact, multi-leaf wiper arm switch can provide. In one recent application, the single 24-deck Shallcross Miniature switch shown above replaced four "subminiature" units.

Equally impressive space advantages are possible with dual concentric shaft versions of the Shallcross Miniature Series. Either shaft may operate up to five of a total of ten decks. The inner shaft may also control a rheostat, variable capacitor, or other device.

If, in addition to size, switch quality is also your concern, the following highlights substantiate why Shallcross Miniature Switch users repeatedly specify these switches, and no others, for critical airborne, missile control, and computer applications.

Low initial contact resistance—less than 0.002 ohm.

Stable contact resistance—0.5 milliohm for 10,000 operations.

Highly immune to vibration damage—exceeds MIL-S-3786 requirements.

Uncompromised material quality—silver button contacts; silver alloy, multi-leaf, self-cleaning wipers; diallyl phthalate rotors; epoxy-laminate decks (filament woven with glass fiber).

Designed to applicable MIL-S-3786 Specifications.

Minimum thermocouple effects—similar materials for all current-carrying parts.

Excellent RF characteristics.

Minimum depth—1" first deck. 5/8" each additional deck.

Maximum Versatility—up to 32 positions, 1 to 4 poles, shorting or non-shorting in the same switch. 1 to 24 decks, ball detents, many special modifications.

For complete details, write for Shallcross Switch Bulletin

Solenoid-Operated Switches

For indirect switching of complex circuits, or to avoid "over stepping" positions in critical circuits, most Shallcross Miniature Switches can be furnished with solenoid operation. Outline your circuit requirements for a prompt recommendation by Shallcross engineers.

Shallcross Manufacturing Co. Selma, North Carolina

Precision wirewound resistors, Switches, Instruments, Delay lines, Resistance networks, Audio attenuators.

WERFUL TRANSMITTER..2,000,000 WATTS VLF

Huge Helix coil 20 feet in diameter and 40 feet tall is wound with 3½ inch Litz Wire . . . just one of the scores of huge components that combine to give this new communication station maximum power . . . range . . . reliability . . . and the special penetration possibilities VLF possesses that no normal high frequency radio provides.

Control console and portion of the unique CEMC Type-125 2,000,000 watt VLF Transmitter that propagates along the curvature of the earth instead of bouncing off the IONOSPHERE: thus eliminating dead communication areas or skip distances to give this Naval voice of command greater range and improved reliability.

In one instant 2,000,000 watts will blast the U. S. Navy's voice of command around the world. At the control console, during operation, push-button simplicity provides a new and highly reliable major element of command to the U. S. Navy . . . another element of that might by which the nation promotes the keeping of the peace.

Circle 32 on Inquiry Card

WORLD'S MIGHTIEST VOICE
OF COMMAND TO HELP KEEP
THE PEACE. OFFERING NEW
RELIABILITY
DEPENDABILITY
MAINTAINABILITY
ONE FULL YEAR AHEAD OF SCHEDULE!

Electronics
COMPANY
EVergreen 1-7161 ■ SUBSIDIARY OF LING-TEMCO-VOUGHT, INC.
MOST POWERFUL RADIO TRANSMITTERS

Tele-Tips

THE EIGHT-HOUR DAY is not necessarily the most efficient means of accomplishing certain specialized tasks involving around-the-clock operations. The Air Force selected 16 male college students and tested them for 96 continuous hours under varying conditions. Four different work-rest cycles were used: two hours on and two hours off, four on and four off, six on and six off and eight on and eight off. Tests showed that subjects in the two hour and four hour cycles "achieved a much more favorable adjustment" than the other groups.

"HAM" WEEK. A bill before Congress would designate the third week in June of each year as National Amateur Radio Week. Americans would be encouraged to observe the week with appropriate exercises to stimulate interest in amateur radio in the United States.

AIR FORCE RESEARCHERS have discovered a world-wide aerosol layer consisting mainly of sulphur particles which completely envelopes the earth. The layer forms a three-mile thick shell about 11 miles out in space.

ELECTRONIC ENGINEERS with teenage youngsters are being subjected to an exquisite form of torture these days, listening to their offspring refer to portable radios as "transistors."

A MISSILE IN FLIGHT is not where the radio fix says it is, because radio waves bend in air. At sunrise, when you see the sun, you don't, because it's still three minutes below the horizon. Scientists at NBS say these phenomena are caused by the passage of electromagnetic energy through a medium of variable refractive index. The amount of bending of radio waves is further affected by the amount of moisture in the air—the relative humidity These phenomena are being investigated by the Radio Refractive-Index Center at the Boulder Laboratories of NBS in Boulder, Colorado.

Tele-Tips

NEW MOVIE TECHNIQUE developed in Europe uses a technique in which live actors play their role side-by-side with their own or other actors' filmed images. For example, a living ballet dancer might dance with a film partner. The actor's action is then "inseparably combined with the motion picture," giving the impression that both are live performers.

AUTOMATIC JOB KEEPER. U.S.I. Robodyne, a division of U.S. Industries, Inc., has developed a machine that trains people to keep their jobs when they are threatened with automation. The Post Office is the first organization to use it. Men who are now sorting mail by hand are being trained to handle new electronic letter sorters. The machine uses the principle of the conditioned reflex. Students see sample address flashed on the film screen. Simultaneously, the correct combination of keys rises on the keyboards and the students automatically push the keys back. Their reflexes are thus conditioned to operate the machine quickly and correctly.

"GUST ALLEVIATORS," to provide smooth air travel, rely on a computer to instantly measure the force of random air currents and automatically adjust the plane's control to compensate for them.

BERYLLIUM is expensive, hard to work, hard to handle, and has a number of other drawbacks, but it may yet find favor with engineers building space vehicles. It is extremely lightweight and very stiff (as long as the temperature doesn't get too hot).

EXOTIC METALS like columbium, molybdenum, zirconium and beryllium, are difficult to join. Among the new techniques for joining these metals are welding them together with an invisible beam of high speed electrons, welding them in a vacuum chamber by remote control, and ultrasonic welding.

SILICONE NEWS from Dow Corning

For protection of value

New casting resin - Sylgard® 182 - is tough, flexible and repairable

Visual inspection . . . environmental protection . . . ease of processing . . . simplicity of repairs — these and other features make Sylgard 182 an important new tool when engineering for value.

Tough yet flexible, this solventless silicone casting resin cushions against shock and vibration from −70 to 225 C . . . assures constant dielectric strength in any environment . . . resists the effects of ozone, voltage stress, heat aging and thermal cycling.

Processing is simplified since Sylgard 182 and its curing agent are not toxic to the skin . . . nor do they give off toxic fumes or heat during blending or curing. Curing time can be controlled by the external heat applied — from as little as 15 minutes at 225 C to 72 hours at 25 C.

Deep sections cure thoroughly. There are no solvent fumes to be trapped . . . and visibility is excellent. Applied as a fluid, Sylgard 182 resin flows readily around intricate shapes . . . cures even in deep sections without damage from internal stresses or exothermic heating.

Repairability is assured when circuits are embedded in Sylgard 182. Defective components can be removed and replaced after cutting away the cured resin with a sharp knife. New resin, poured over the repaired area, adheres to the existing encapsulant restoring the entire unit to its original condition.

Circle 21 on Inquiry Card

Dow Corning is your best source for a broad line of silicone fluids, gels, elastomers and rigid forms for potting, filling, embedding and encapsulating.

first in silicones

Dow Corning

-- specify these silicones

Visually inspect . . . instrument check and replace faulty parts with ease

Dielectric Gel permits both visual and instrument inspection of potted circuits and components. Poured as a liquid, Dielectric Gel fills all voids, then sets up as a transparent, heat-stable, resilient mass. No significant stresses or exothermic heating develops during cure. Even the most delicate electronic components are safe. Instrument probes can be inserted and withdrawn repeatedly without damaging the outstanding dielectric properties of this Dow Corning silicone potting material.

Circuit Repair is easy to accomplish. Simply cut away the gel surrounding a defective component with knife or scissors. After the circuit is repaired, simply pour new gel into the repaired area to restore original high quality protection.

Circle 22 on Inquiry Card

Deep section . . . rugged protection with repairable Silastic® RTV

Silastic RTV, Dow Corning's fluid silicone rubber that vulcanizes at room temperature, is available in several variations. Select the best one suited for your application or processing requirements. All have excellent dielectric properties, low water absorption, stability under extreme temperatures, resistance to thermal cycling and aging. The newest Silastic RTV cures in thick sections in 24 hours at 77 F. Variations in thickness have no significant effect on curing rate or material uniformity.

Vulcanized Patch. Defective parts embedded or encapsulated in Silastic RTV . . . even where thick sections are used . . . can be replaced. The cured Silastic RTV is cut away with a knife, the component replaced, and new Silastic RTV applied to the repair area. The fresh material bonds to the original, restoring the encapsulant's integrity.

Circle 23 on Inquiry Card

Free 12-page manual, "Silicones for the Electronic Engineer". Write Dept. 4122, Dow Corning Corporation, Midland, Michigan.

An unusual combination of advantages found only in mercury-wetted relays has led many design engineers to specify them for tough switching jobs. Here are but 3 typical characteristics of our JM series:

RELIABILITY. Sealed-in-glass mercury contacts are renewed with every operation. Won't pit or weld. Make or break is positive . . . every time. No bounce, no chatter. Signals ranging from a few micro amps to 5 amps are switched with singular consistency.

LONG LIFE. Think in terms of *billions* of operations when considering JM series relays. Proper application, of course, is a requisite.

SPEED. Operate time is just less than 3 milliseconds using 2 watts of power. Release time is about 3.2 milliseconds. Thus, relays can be driven 100 times per second.

If your project calls for exceptional relay performance, perhaps the answer lies in our JM Mercury-Wetted contact relay.

JM SERIES ENGINEERING DATA

Contact Rating:
5 amperes maximum
500 volt maximum
250 volt-amp max. with required contact protection.

Contact Configuration:
Each capsule SPDT. Combination of capsules in one enclosure can form DPDT, 3PDT, 4PDT. (All Form D.)

Terminals:
Plug-in or hook solder; 8, 11, 14, or 20-pin headers.

Coil Resistance:
2 to 58,000 ohms.

More information?
Write today for free catalogue.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD

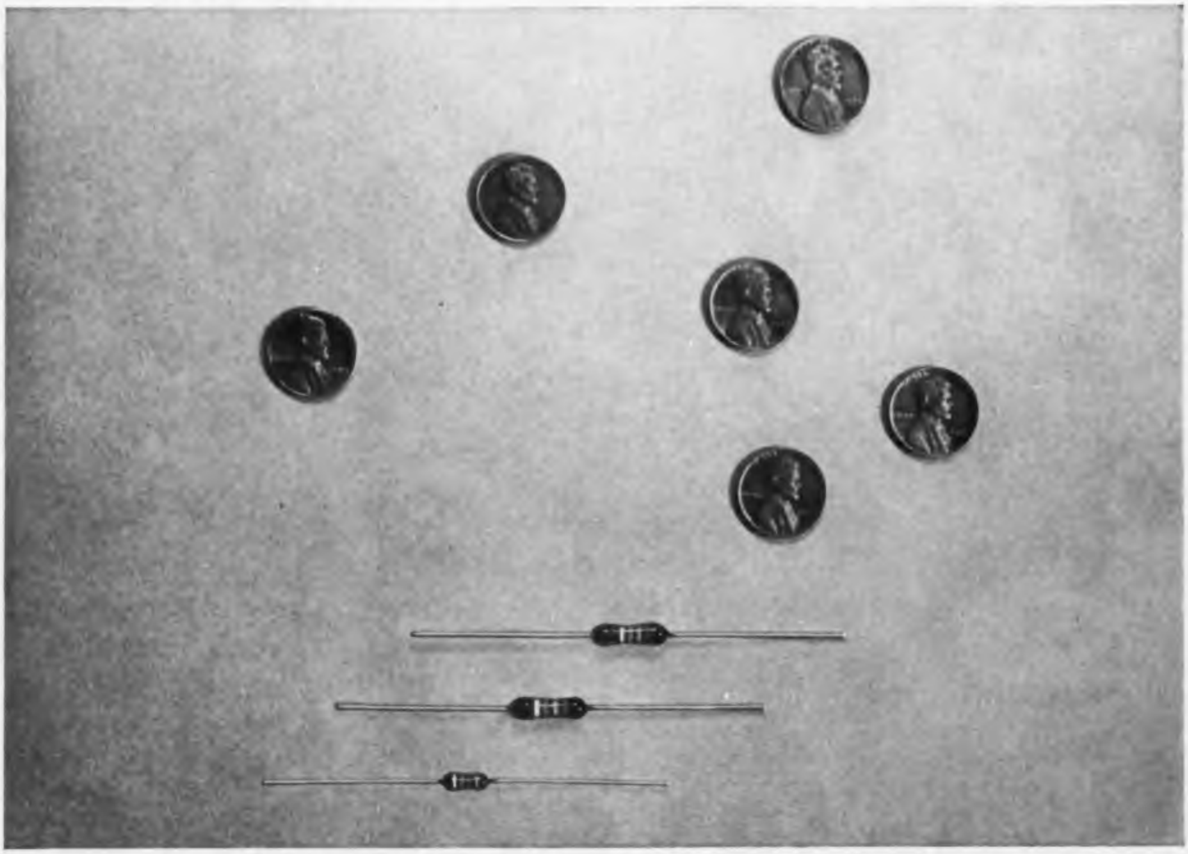
DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA
IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

Circle 35 on Inquiry Card

GET 5% DESIGN TOLERANCE IN CORNING C RESISTORS FOR 6¢

You can design better circuits for less money when you *know* your resistance values won't budge more than 5% . . . ever. Corning C resistors give you this assurance of stability, the kind that lets you drop an entire amplifier stage or use broader tolerance, cheaper tubes or transistors. We build stability into ½, 1 and 2 watt C resistors with a tin-oxide conductor fired into a glass substrate. The helix is cut under precise electronic control. Then we add a special solvent-resistant insulation. These resistors meet MIL-R-22684 (Navy) all the way . . . and cost as little as 6¢. Use C resistors in place of composition types to boost product performance at virtually the same cost *or* to maintain the high performance of precision-type resistors at much less cost.

New, free booklet Get full details on C resistors and the remarkable design tolerances they give you. Write for "The Story Behind the Corning C Resistor" and for Data Sheet CE-2.12 to Corning Glass Works, 546 High Street, Bradford, Pa.



CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.

Electronic Giants no bigger than your thumbnail... now through electron-beam welding

High-energy density electron-beam welding techniques, recently developed by the Zeiss Foundation of West Germany and the Hamilton-Standard Division of United Aircraft, markedly improved packaging density and production methods in the field of microelectronics.

In microcircuitry, for example, packaged circuits no bigger than a thumbnail can now be reliably produced. Electron-beam equipment now welds microelectronic components into circuits with pinpoint precision, making intra- and inter-circuit connection, and hermetically encapsulating the completed micromodule.

Only electron-beam welding, performed in a high vacuum, can offer these significant advantages for the field of microelectronics: virtual elimination of contamination; a close control of penetration; low thermal distortion; and close dimensional control. The upper illustration shows weldments of 0.002" thick copper leads to 0.002" thick nickel-plated ceramic substrate. In the field of thin films difficult welds are possible with this revolutionary new equipment such as 0.002" gold tabs to chromium-gold films 3000-A° thick.

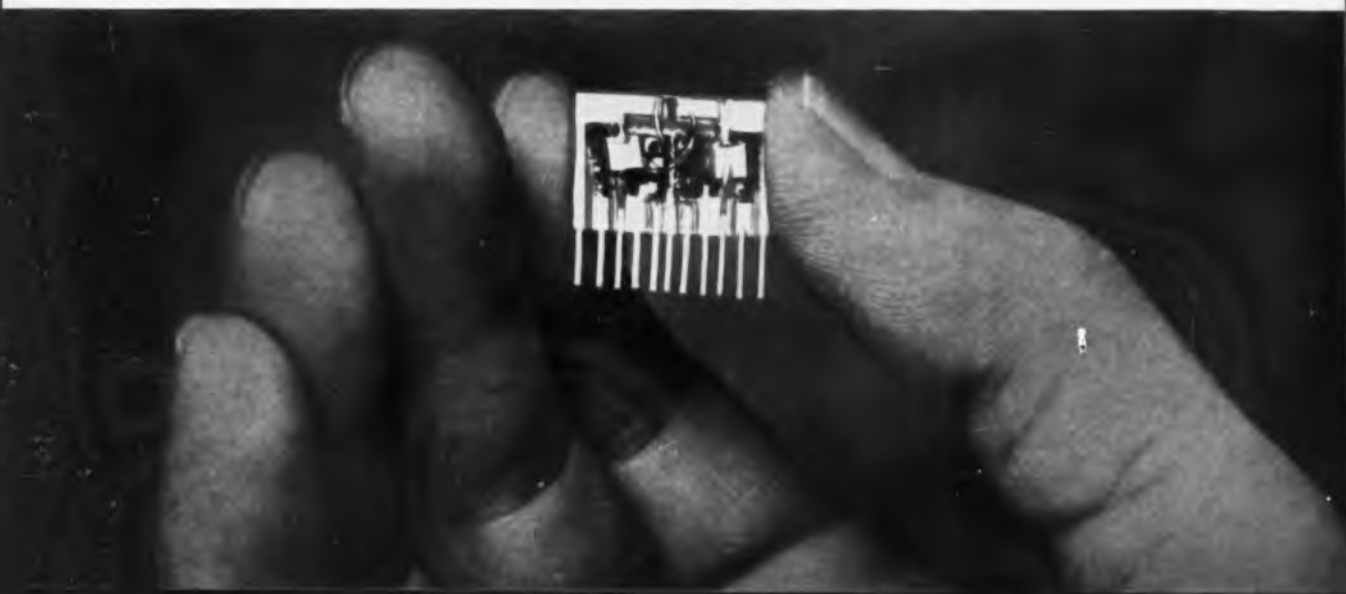
Another important use of electron-beam equipment is the welding of ceramics used in vacuum tubes which require extremely high temperature performance. For these procedures, tight ceramic-to-ceramic bonds are necessary — bonds available only through high-energy density electron-beam welding. The lower illustration is a 12 X magnification of two aluminum oxide ceramic wafers ½" x ¾" x .010" thick edge-welded by deflecting the high energy density beam of a Hamilton-Zeiss electron beam welder across the edge surface.

Hamilton-Standard, with over twenty years of metallurgical experience and meeting rigid government specifications, has exhaustively tested the welds produced with Hamilton-Zeiss equipment. The data, which are available for your inspection, demonstrate conclusively that the Hamilton-Zeiss method produces welds in miniature workpieces that are as strong as the original materials themselves. Such results are possible only by the use of high energy density and precision focusing by the Zeiss magnetic lens system which are exclusive features of the Hamilton-Zeiss equipment. Find out what this revolutionary equipment can mean in your business. For full information call Hamilton-Electrona, Inc., exclusive marketing agent for Hamilton-Zeiss equipment in the United States and Canada.

HAMILTON-ELECTRONA, INC.

TIME-LIFE BUILDING, ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Circle 37 on Inquiry Card



Letters to the Editor

Editor, ELECTRONIC INDUSTRIES:

I shall feel very grateful if you would kindly send me one copy of each of the following articles from back issues of E.I.:
(Sender lists 8 articles on microwave.)

S. S. S. Agarwala
Senior Scientific Officer
Vacuum Tubes Division
Central Electronics Engineering
Research Institute
Pilani Rajasthan, India

As Teaching Aids

Editor, ELECTRONIC INDUSTRIES:

In your monthly publication, *Electronic Industries,* it is mentioned that reprints of articles may be obtained by writing to your office. The May 1961 issue contains three articles that are of major interest to me.

Would you please send me a reprint of each of the following articles:

1. "Develop Practical Hall Devices."
2. "Direct Coupling and DC Stability."
3. "Suppressing a Single Interference Frequency."

These three topics will be very useful as references in teaching transistor and network theory.

George A. McKean
Instructor
University of Idaho
College of Engineering
Electrical Engineering
Moscow, Idaho

Low-Noise Amplifiers

Editor, ELECTRONIC INDUSTRIES:

Please forward to this company, in care of the undersigned, a copy of the article "How to Design Low-Noise Amplifiers" which appeared in the August 1961 issue of ELECTRONIC INDUSTRIES.

In order that equation (1) be consistent with the stated definition of noise factor, F and the use of this definition in the deviation of equation (10), equation (1) should read:

$$F = \frac{SiNo}{SoNi}$$

R. A. Fraser
Lead Engineer
Systems Development Division
Orlando
Radiation Incorporated
5800 McCoy Road
P. O. Box 13010
Orlando, Fla.

Circle 39 on Inquiry Card →

Letters to the Editor

(*Continued from page 53*)

"Low-Noise Amplifiers"

Editor, ELECTRONIC INDUSTRIES:

I would like to call to the attention of your readers two mistakes in Francis Opp's article "How to Design Low-Noise Amplifiers."

The IRE definition of noise figure is "The ratio of 1) the total noise power per unit bandwidth at a corresponding output frequency available at the output part when the noise temperature of the input termination is standard (290k°) to 2) that portion of 1) engendered at the input frequency by the input termination." Thus the noise figure of an amplifier is equal to the ratio of signal-to-noise ratios if and only if the input and output frequencies are the same. This is not true if the output frequency is different from the input frequency as in a parametric up-converter amplifier or frequency multiplier or mixer or other devices for which noise figure measurements are applicable.

John Banzhaf
Engineer
Olympic Radio & Telvision
Division of the Siegler Corp.
34-01 38th Avenue
Long Island City 1, New York

Mr. Opp replies:

Reference your letter on the mistakes in my ELECTRONIC INDUSTRIES article. The noise factor definition is of course incomplete if applied to all types of networks. I considered only the simple amplifier and therefore, felt justified in using the abbreviated definition.

Francis Opp

Microwave Consultant

Editor, ELECTRONIC INDUSTRIES:

I am taking this opportunity to inform you and your publication of the fact that I am now in the private consulting business and have very recently established an office at the above address. It is my hope that you will consider this information of sufficient interest to your many readers to publish a short note in my behalf in the Industry News column of a forthcoming edition of ELECTRONIC INDUSTRIES.

To brief you a bit more about myself, I left my position as Project Engineer in the Microwave Tube Division of Hughes Aircraft Co. last February to enter private consulting practice. My fourteen years of experience in the design, development, test-

(*Continued on page 60*)

New! from — E-I

CLEAR GLASS WINDOWS

THE COMPLETE LINE OF CUSTOM AND STANDARD

Hermetically Sealed Visual Windows

— FOR OBSERVING INTERNAL CONDITIONS IN HERMETICALLY SEALED ELECTRONIC, ELECTRICAL AND MECHANICAL EQUIPMENT

E-I clear glass windows are manufactured to the same high quality standards that have made ELECTRICAL INDUSTRIES the industry-preferred name in glass-to-metal seals. E-I sealed windows are available in both kovar and compression types. Compression sealed windows are extremely rugged . . . meet the test of the most gruelling "space age" environments! For complete information and recommendations on specific applications, just call or write today; detailed data will be supplied to you promptly on request, without obligation.

For All Applications

- INDICATOR LIGHT OBSERVANCE
- METER READING
- FLOW AND FLUID LEVEL
- PRESSURE INDICATION
- GAS-MOISTURE CONTROL VALVES
- TRANSISTOR PHOTO CAPS
- PHOTO SENSITIVE DEVICES
- REFRIGERATION EQUIPMENT
- AIR CONDITIONERS
- ENVIRONMENTAL CHAMBERS
- SPECIAL LABORATORY UNITS, ETC.

ELECTRICAL INDUSTRIES

MURRAY HILL, NEW JERSEY

A Division of Philips Electronics & Pharmaceutical Industries Corporation

Patented in Canada, No. 523,390; in United Kingdom, No. 734,583; licensed in U. S. under No. 2561520

SPECIFICATIONS FOR STANDARD CLEAR GLASS, SEALED WINDOWS

	MATCHED SEALS (KOVAR)	COMPRESSION SEALS (STEEL)
THICKNESS	.040" to .200"	.090" to .500"
GLASS O.D.	.150" to .300"	From .150" up

Mechanical strength up to 10,000 P.S.I. depending on design and application, various finishes available, as well as special shapes and sizes

Circle 41 on Inquiry Card

For Long Life and Power Economy

Specify *the* ***NEW***

CLARE ***LATCHING***

SUBMINIATURE

crystal can

RELAY

The new CLARE Type LF, magnetic latching subminiature relay offers designers simplified circuitry in small space by providing latching effect without transistors. Magnetic latching results in power economy.

The Type LF is available with either 2-coil or 1-coil configuration. The 2-coil relay allows complete control of the latching operation within the relay and provides an extremely compact operating unit. The 1-coil relay is somewhat more sensitive; it is adaptable to existing circuits where outside control is provided. (See opposite page for specifications and circuit diagrams.) The Type LF provides the same wide range of mounting arrangements and terminals as the CLARE Type F relay.

FOR NON-LATCHING OPERATION

CLARE Type F Subminiature Crystal Can Relay

The CLARE Type F relay is extremely fast and more than moderately sensitive. It is built to withstand temperature extremes, heavy shock and extreme vibration. Contacts, rated at 3 amperes, are excellent for low-level circuit operations. Send for Design Manual 203.

TYPE LF
relay shown (cover removed) is the 2-coil design which controls the entire latching operation within the relay. Shown twice actual size.

2-Coil Circuit Diagram

1-Coil Circuit Diagram

PHYSICAL FEATURES

Life Expectancy
Wet Circuit:
3.0 amperes, 28VDC resistive—100,000 operations
2.0 amperes, 28VDC resistive—250,000 operations
1.0 ampere, 28VDC resistive—1,000,000 operations
1.0 ampere, 28VDC inductive (100 millihenry)—100,000 operations
1.0 ampere, 115 VAC resistive—100,000 operations
Dry Circuit:
1,000,000 miss free operations when subject to conventional dry circuit requirements.

Temperature— +125° C to −65° C

Shock—100g's for 1/2 sine wave 11 ± 1 MS pulse

Linear Acceleration—100g's minimum

Vibration—.250" DA or 30 g's, 5-2000 cps.

Humidity & Salt Spray—MIL-R-5757D

Enclosures: Tinned brass cover with fungus-resistant finish. Hermetically sealed and filled with dry nitrogen at atmospheric pressure.

Contact Arrangement—2PDT latching

Terminals—Plug-in (3/16" straight), solder hook, 3" straight

Wiring—Two coils (as shown on drawing above)
One coil (as shown on drawing above)

Weights—.54 oz, for plug-in
.62 oz. for 2 studs, 3" leads

ELECTRICAL FEATURES

Operate Time—Two coil: When applying—for a minimum of 5 milliseconds—a voltage of at least two times the must operate voltage, the operate time including bounce will not exceed 5 milliseconds. One Coil: operate time will not exceed 8 milliseconds.

Sensitivity—Two coil, approximately 150 milliwatts
One coil, approximately 75 milliwatts

Dielectric Strength
Sea level: 1000 volts rms—all terminals to case
1000 volts rms—between contact sets
500 volts rms—between open contacts of a set
70,000 ft: 350 volts rms—all terminals to case

Insulation Resistance—1000 megohms minimum at +125° C between any two terminals and between all terminals and case.

Maximum Interelectrode Capacitance—

Closed contacts to case	3.7 picofarads
Open contacts to case	2.0 picofarads
Between contacts of a set	2.0 picofarads
Between adjacent contact sets	3.5 picofarads

Maximum Coil Dissipation
Two Coil: .50 watts at +125° C
.75 watts at +25° C
One Coil: 1.25 watts at +125° C
2.0 watts at +25° C

Standard Adjustment—Relay will operate and hold when the must operate voltage is applied

Contact Resistance:
Maximum: 50 milliohms at 6 volts, 100 milliamperes.
Typical: 25 milliohms at 6 volts, 100 milliamperes.

For coil and mounting data on CLARE Type LF relay send for CPC-12. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. Cable Address: CLARELAY.

C. P. CLARE & CO. *Relays and related control components*

Circle 42 on Inquiry Card

"I been workin' on the railroad for two years, ten months... 6,800,000 revolutions!"

Model 901S Micropot— Serial #15458 — 50 ohm

"I am a Borg 900 Series Micropot®. Streeter-Amet, Grayslake, Illinois, manufacturer of heavy-duty electronic scales, put me on the job weighing railroad cars two years and ten months ago. I lasted longer than any other make potentiometer used — 34 times longer to be exact, in an application where pot life had formerly been measured in terms of *weeks!* I rolled up 6,800,000 revolutions and withstood four quick random reverses for each railroad car."

"Then Streeter-Amet sent me back to Borg with a note saying I was the first Borg Micropot to fail out of more than 500 they now have in the same service (secretly, they had been wondering just how much longer I could continue). They meant well, but it just wasn't so.* Fact is I only had a broken lead wire. Borg also found that I was Micropot Serial No. 15458 which had been lab-tested at Streeter-Amet for 1,566,000 revolutions before I was reconditioned and put to work."

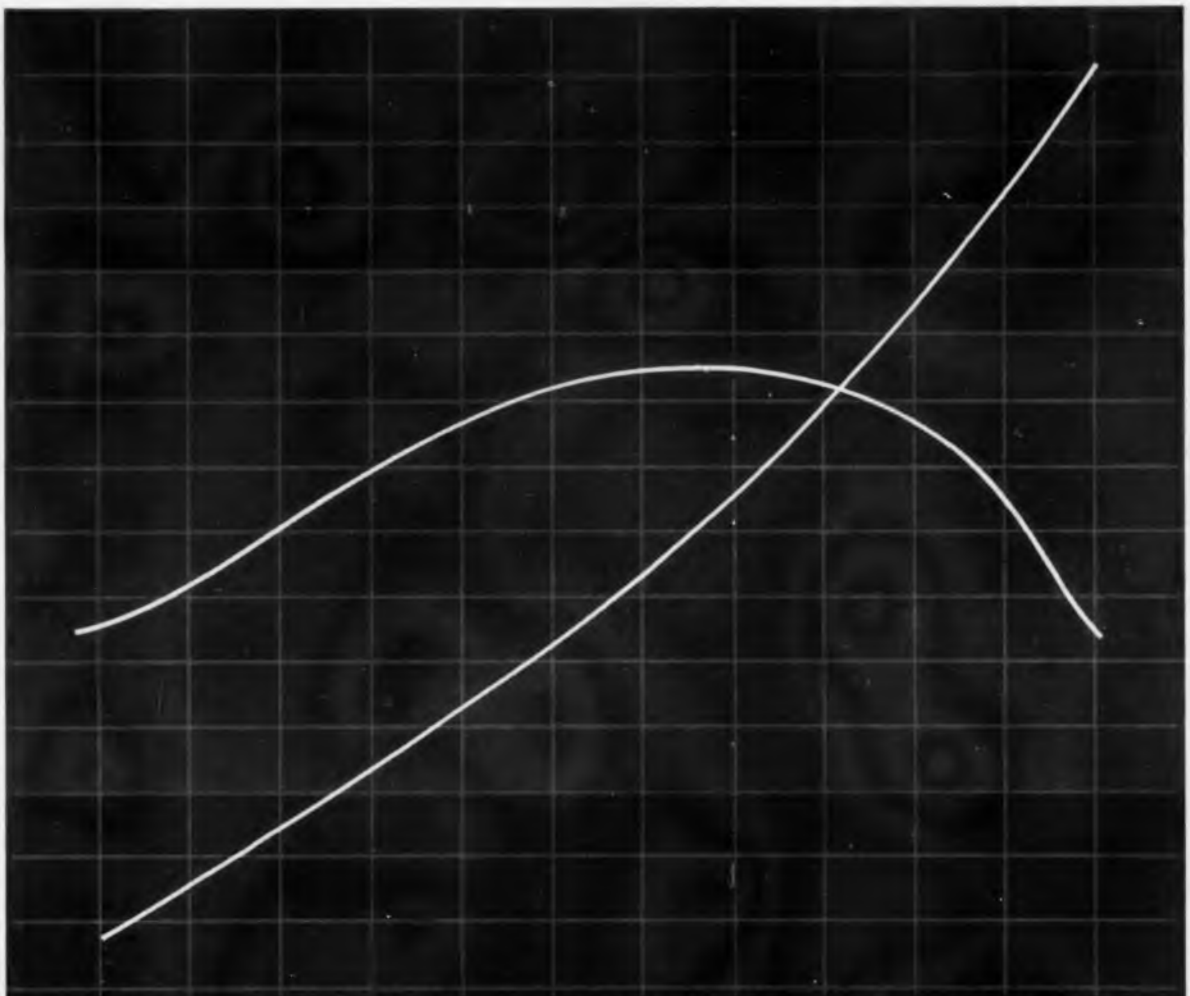
"Even now my linearity is within .05% and total resistance tolerance within 1%. For a 50-ohm model that is better than good. Best of all, I now have the satisfaction that Streeter-Amet uses only Borg Micropot Potentiometers!"

"If my story touches you, contact your nearest Borg Technical Representative about the 900 Series Micropot or write Borg direct."

BORG EQUIPMENT DIVISION

Amphenol-Borg Electronics Corporation
Janesville, Wisconsin • Phone Pleasant 4-6616

Micropot® Potentiometers • Microdial® Turns-Counting Dials • Sub-Fractional Horsepower Motors • Frequency and Time Standards



HUGHES' BWO'S — SMOOTH AND CLEAN!

Hughes' BWO's are smooth and clean!

Smooth–because fine grain power output variations are less than 1 db. Extremely smooth tuning curves make AFC easy. ■ Clean–because signal outputs with spectrum widths as narrow as .05 mc are typical, with commercially available power supplies. In phase-locked loops, signals of width well under 1 kc have been obtained. Noise 30 mc off carrier in two 1 mc bands was -96 dbm in a typical case. ■ Also–Hughes' tubes feature non-intercepting grids, low pushing and pulling factors, stability in phase-locked operation, and very high signal-to-noise ratios. ■ Pictured below are four popular models, available for immediate delivery, which cover the frequency range from 7 to 20 kMc. Further information on these or any special requirements for BWO's may be obtained from Hughes MTD.

NORTHEASTERN 4 Federal Street, Woburn, Mass. WElls 3-4824 **EASTERN** 2000 "K" Street, N.W., Washington 6, D. C. FEderal 7-6760; 13 Lloyd Avenue, West Long Branch, N. J. CApital 2-1111 **WESTERN** 11105 South La Cienega Blvd., Los Angeles 45, Calif. SPring 6-1515

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HUGHES AIRCRAFT COMPANY

MICROWAVE TUBE DIVISION

346H	**356H**	**326H**	**366H**
7.0—12.4 kMc	10.0—15.0 kMc	12.4—18.0 kMc	15.0—20.0 kMc
30 mw min P_o	10 mw min P_o	10—65 mw P_o	10 mw min P_o

Letters to the Editor

(*Continued from page 54*)

ing and production of microwave systems, subsystems, components and tubes should, I believe, stand me in good stead for this practice. My services are available to anyone having problems concerned with the specific fields of my specialization or other areas relating to microwaves.

Alvin R. Margolin

Alvin R. Margolin
Microwave Consultant
16218 Ventura Boulevard
Encino, California

Cathode Follower

Editor, ELECTRONIC INDUSTRIES:

Would you please send me a reprint of the article entitled "Analyzing a Realistic Cathode Follower" from the May 1961 issue of your magazine.

The circuit for Figure 5 does not have a value for the grid resistor, as is shown in Figure 4. Information on this resistor value would also be appreciated as this makes the graph more meaningful.

Lee Whitman
Electronic Engineer
Pickard & Burns, Inc.
240 Highland Avenue
Needham Heights 94, Massachusetts

Magnetic Fields To Aid Research

A continuous magnetic field of over 126,000 gauss has been generated at Mass. Inst. of Technology. Believed to be the most powerful ever produced, it was achieved in the core of a special solenoid magnet invented by Dr. Henry H. Kolm, staff member of the M. I. T. National Magnet Laboratory. The magnet, about the size of a grapefruit, was built by High Voltage Engineering Corp., Burlington, Mass., under contract to Lincoln Laboratory.

Higher magnetic fields have been achieved in pulses of only a few millionths of a second duration, but the field produced by the new solenoid was continuous. The 126,000 gauss field may be compared with the earth's magnetic field which is only ½ gauss. It is expected that such high magnetic fields will make possible research in many scientific and engineering areas including those related to fusion power, superconductivity and solid state physics.

PLATINUM POINTS THE WAY TO LOWER COSTS

The low cost of platinum is real, because of its long life, high recovery rate and scrap value (once you have purchased platinum, you have it almost forever).

LONG LIFE—it is almost indestructible, even in the most difficult environment.

EXCELLENT RECOVERY—most of the original metal is easily recovered, even after years of use.

HIGH SCRAP VALUE—the dollar value of recovered scrap is almost as great as the original metal cost.

When you need Platinum, take advantage of BISHOP'S long experience (. . . since 1842), ample supply . . . broad capabilities:

- FORMS—foil, gauze, plate, sheet, strip, tubing
- WIRE—pure, commercial, composite, thermocouple
- LABORATORY APPARATUS
- CLADS AND BIMETALLICS
- CHEMICALS
- CATALYST RECOVERY
- SCRAP CONVERSION

For the full story, write for Bulletin P-6.

BISHOP

J. BISHOP & CO. *platinum works* / MALVERN, PENNSYLVANIA

A JOHNSON MATTHEY ASSOCIATE "METALS FOR PRECISION AND PERFORMANCE"

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How to find laminations when you need them fast!

High permeability lamination stock list goes out to purchasing agents and engineers semimonthly

A stock list, mailed every other week, pinpoints the quantities and sizes of our high permeability laminations that are immediately available from stock. It's sent to purchasing agents and interested engineers throughout the country. To get *your* regular copy, just address a request to Magnetics Inc., Department EI-94, Butler, Pa.

What makes the stock list important? Depleted inventories or stepped-up production means that when laminations are needed, they're needed fast—and in perfect condition. Magnetics Inc. stock list shows what types are available for immediate shipment. In addition, the stock list contains information on the new higher permeability "E" grade laminations. What's more, stocks listed reinforce those maintained at regional outlets on the east and west coast (all connected by teletype to assure fast delivery).

What makes Magnetics Inc. high permeability laminations special is the fact that they are the heart of high performance audio transformers, chokes and countless other fast response magnetic devices. They're burr-free, precision-sized and flat (thanks in part to a standardized 9" long carton that keeps the laminations undistorted during shipment and stocking). For more information, write to Magnetics Inc., EI-94, Butler, Pa.

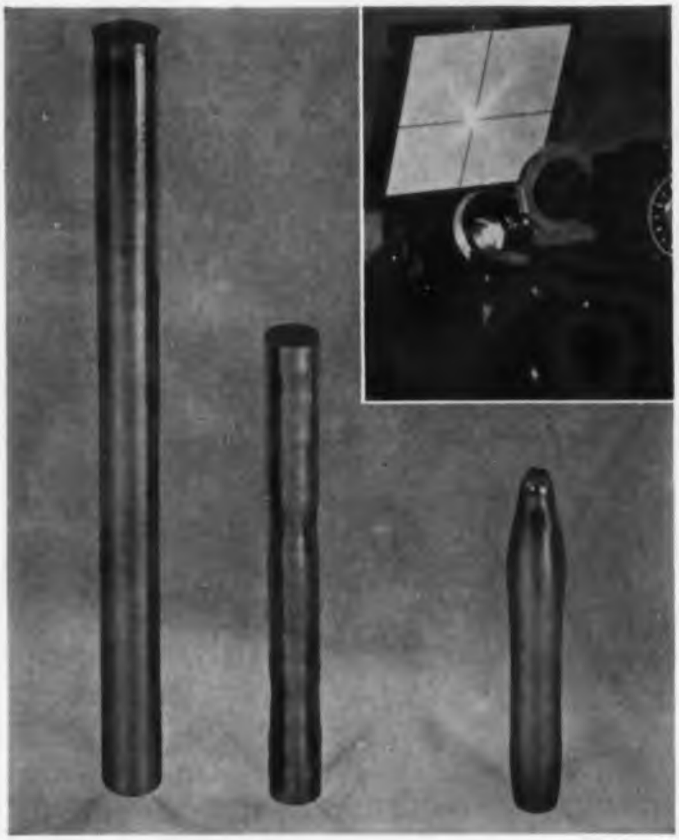
Magnetics Inc. also publishes a bi-weekly stock list on tape wound cores and permalloy powder cores. It's available to you along with the laminations stock list. Ask for it.

MAGNETICS inc. ®

SILICON NEWS from Dow Corning

Need 1-0-0 Silicon?

Specify float zoned crystals for these three reasons...



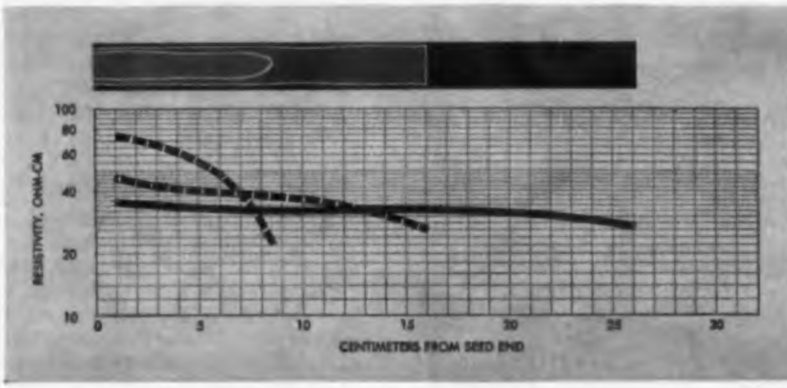
You will find Dow Corning Hyper-Pure (1 0 0) crystals provide a number of definite advantages over Czochralski pulled crystals with (1 0 0) orientation.

More Uniform Dimensions. With Dow Corning vacuum float-zoned (1 0 0) crystals, you get more than twice the useable length of the usual Czochralski crystal . . . better than 50% more than the best premium Czochralski crystal. Physical profile is far more uniform, so wafers have more consistent physical dimensions. Result: crystals that are easier to process . . . less waste.

More Uniform Parameters. Lateral and radial parameters are more uniform throughout the entire length of Dow Corning vacuum float-zoned (1 0 0) crystals. Typical resistivity curves show float-zoned crystals vary less from end to end—and the ends are up to three times further apart. This consistent quality — plus uniformity from rod to rod — means fewer rejects . . . increased device yield.

Ease of Handling. For the clean cleavage and nearly waste-free handling of (1 0 0) oriented silicon crystals, plus the advantages of uniform dimensions and uniform parameters, specify Dow Corning crystals. Greater length means less chance for contamination, less waste and easier handling in scribing and scoring wafers.

Whatever your need — float-zoned crystals of (1 0 0) orientation; crystals of (1 1 1) orientation; doped to specification or high resistivity rod; polycrystalline rod or prepackaged one-piece crucible charges — Dow Corning should lead your list of sources.



Length:	50 mm to 250 mm (approx. 2" to 12")
Diameter:	12 mm to 20 mm (.5" to .79")
Diameter Variation:	less than 1 mm (.040")
Type:	P or N
Resistivity:	1 to greater than 1000

For free brochure — "Hyper-Pure Silicon for Semiconductor Devices" write Dept. 4122a.

Dow Corning CORPORATION

HYPER-PURE SILICON DIVISION • HEMLOCK, MICHIGAN

Communications Centrals Are Air-transportable

Three air-transportable centrals which provide the U. S. Army with unlimited communications in limited war situations have been developed by Adler Electronics, Inc., New Rochelle, N. Y. These compact stations can be transported to any world trouble spot and quickly erected for reliable telephone and teletypewriter contact with the Pentagon. Known as the AN/TSC-18, AN/TSC-19 and AN/TSC-20, they are compatible with STARCOM, the Army's global communications network. A TSC central operating in any potential trouble spot in Asia or Africa is within range of the STARCOM network.

The TSC-18 and 19 each provide three voice and 16 teletype channels, while the TSC-20 has one voice and three teletype channels. Where needed, one facsimile channel can replace one voice channel in each of the systems. The TSC-18 has a range of 7,000 miles. Ranges of the TSC-19 and 20 are 5,000 and 2,500 miles respectively.

A Signal Corpsman uses teletype equipment in the shelter of one of the systems in the Army's family of long-range, air-transportable communications systems.

Radio Controlled Signs

Radio controlled roadside warning signs will soon be in operation on the New Jersey Turnpike. The signs, part of a $290,000 system to be supplied by Motorola Communications and Electronics, Inc., Chicago, Ill., will show motorists six basic messages. They will be turned on and off by radio from a central location. The system will also provide linked and extended two-way communications coverage for fixed and mobile maintenance units along the 131 mile roadway.

DORSETT'S 3 NEW SILICON SOLID STATE SUBCARRIER OSCILLATORS FOR FM TELEMETRY

To meet increased demand for a wide range of subcarrier oscillator configurations Dorsett Electronics now offers its extremely reliable solid state subcarrier oscillator in three new package forms.

Dorsett's three new configurations provide the systems engineers with unmatched mechanical flexibility in telemetry system design, without sacrificing component reliability and stability.

These new subcarrier oscillators are only a few of the many state of the art telemetry components currently in production at Dorsett Electronics. Put Dorsett's experience to work for you on your next telemetry requirement. Your inquiries and specifications will receive a prompt reply.

SPECIFICATIONS

Input:	0 to 5 volts, or −2.5 volts to +2.5 volts.
Output:	Adjustable from 0 to .5 volts RMS into 8K load impedance. Fixed output at least 3 volts RMS into 100K or higher load impedance.
Power Requirements:	28 volts DC at 10 milliamperes.
Linearity:	Deviation from the best straight line less than .25%.
Distortion:	Less than .75% harmonic distortion.
Amplitude Modulation:	Less than 1db across the band.
Input Impedance:	500K for Channels 1 through 18. 250K for Channels A through E.
Electrical Stability:	No more than ±.5% FBW change in center frequency or deviation sensitivity for a supply voltage change of ±10%.
Temperature Stability:	Less than 2% FBW change in center frequency or band-width for a 50°C change within the range of −55°C to +100°C.
Acceleration:	100G Linear
Vibration:	20G, 55 to 100 cps
Shock:	100G for 11 milliseconds
Altitude:	Unlimited
Size:	0-18 1.75 in. x 1.36 in. x .76 in. 0-20 2.25 in. x 1.88 in. x .88 in. 0-28 1.27 in. x 1.25 in. x 1.25 in.
Connector:	Cannon DE-9P.
Controls:	Output, Centering, Deviation Sensitivity

D

DORSETT ELECTRONICS, INC.

P.O. BOX 862 • NORMAN, OKLAHOMA • JEFFERSON 4-3750

Circle 50 on Inquiry Card

Personals

Dr. R. E. Henning — named Chief Engineer, Sperry Microwave Div., Clearwater, Fla.

Rudolph Furrer — named Special Assistant, Reliability to the President, Lockheed Missiles & Space Co., Div. Lockheed Aircraft Corp., Sunnyvale, Calif.

Joe S. Kirk—named Manager, Commercial Engineering, National Electronics, Inc., Geneva, Ill.

Robert W. Carr—appointed Manager of Product Development, Shure Bros., Inc., Evanston, Ill.

Walter W. Kunde, Jr.—promoted to Vice President, Engineering, HST Div., Dresser Electronics, Garland, Tex.

Dr. D. E. Newell—named to the Staff of the Pioneer-Central Div., The Bendix Corp., Davenport, Ia.

Elmer W. Torok—named Development Manager, Microcircuitry, International Rectifier Corp., El Segundo, Calif.

Roswell P. Barnes — appointed Head, Applied Science Div., Physics Laboratory, Melpar, Inc., Watertown, Mass.

Malcolm H. Burdett—named Chief Engineer, Dage Electric Co., Inc., Beech Grove, Ind.

Dr. Lester C. Van Atta—appointed Technical Director, Research Laboratories, Hughes Aircraft Co., Malibu, Calif.

W. W. Kunde, Jr.

Dr. W. J. Perry

Dr. L. C. Van Atta

B. Rosen

Dr. William J. Perry — appointed Director, Electronic Defense Laboratories, Sylvania Electric Products Inc., Mountain View, Calif.

Fred W. Hannula—named Product Planning Manager, Computer Products Div., Laboratory for Electronics Inc., Boston, Mass.

Robert A. Morgan—appointed Manufacturing Manager, Clevite Electronic Components, Div. of Clevite Corp., Cleveland, Ohio.

Alfred C. Evans—named Director of Research and Development, Weston Instruments Div., Daystrom, Inc., Newark, N. J.

Dr. M. John Rice, Jr.—appointed Director of Engineering, CBS Electronics Semiconductor Operations, Danvers, Mass.

Gary Himler—named Director of Engineering, Computer Measurements Co., San Fernando, Calif.

Richard S. Tveter—named Principal Mechanical Engineer, S. Himmelstein and Co., Chicago, Ill.

Robert J. Shafranek—named Chief Engineer, Electrical Power Equipment Section, and **Fred H. Guth** — named Chief Engineer, Control Equipment Section, Electrical Product Development, Tapco, Div. of Thompson Ramo Wooldridge Inc., Cleveland, Ohio.

Bernard Rosen—appointed General Manager, Equipment Engineering Dept., Defense Products Div. Polarad Electronics Corp., Long Island City, N. Y.

Russell T. Dean—appointed Chief Engineer, Resistor Engineering Dept., Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.

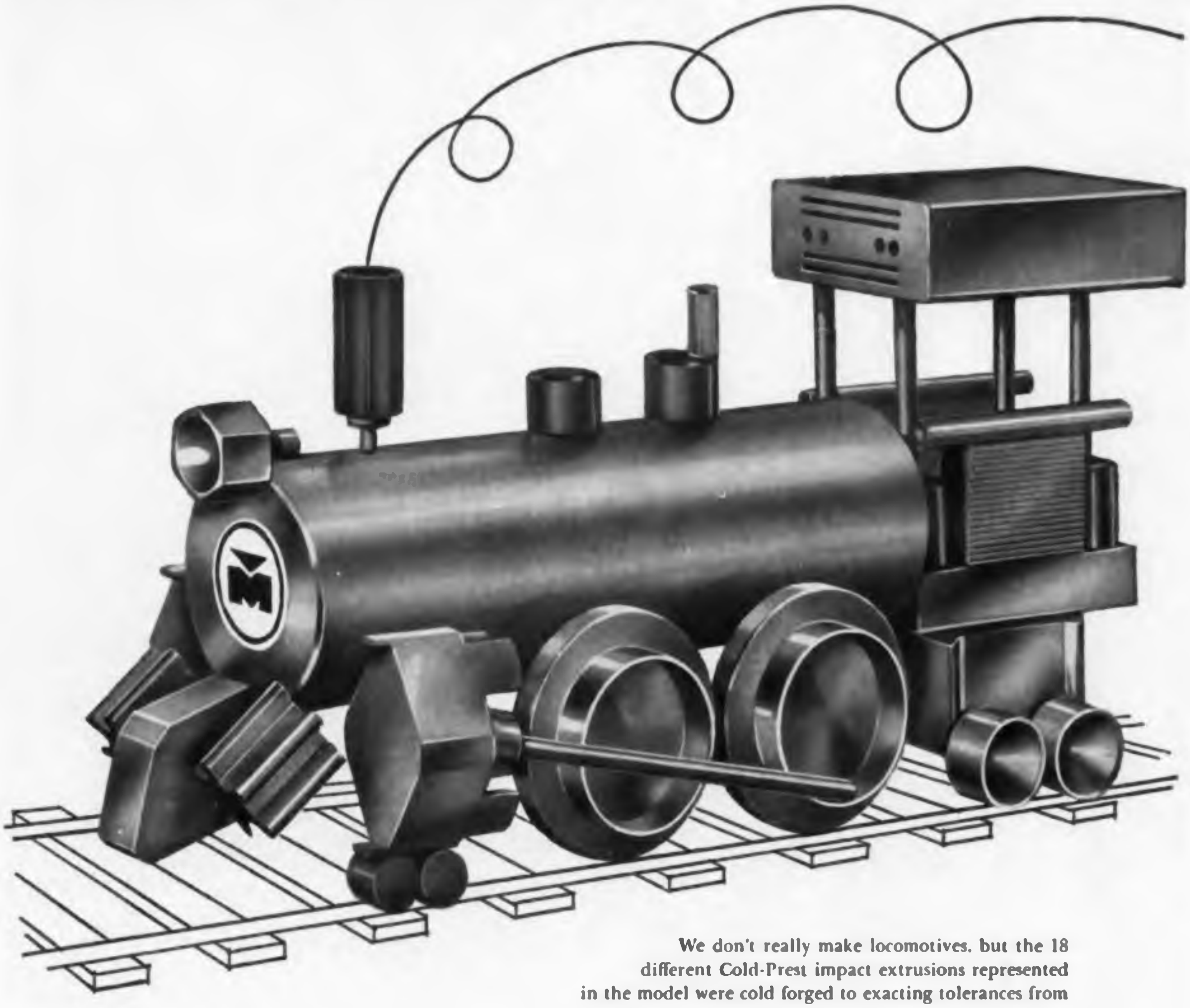
Frederick Walzer—appointed Manager, Quality Control and Reliability, Allen B. Du Mont Laboratories, Div. of Fairchild Camera and Instrument Corp., Clifton, N. J.

Dr. Gabriel Novick—has joined Tucor, Inc., sub. Trak Electronics Co., Wilton, Conn.

Allied Chemical Corp., General Chemical Div., Morris Township, N. J., announces the following appointments: **Charles B. Miller** and **Dr. Curtis B. Hayworth**—named Assistant Technical Directors.

Amperex Electronic Corp., Hicksville, L. I., N. Y., announces the following appointments: **Dr. James McKenzie**—Manager, Gas Tube and Semiconductor Depts.; **Kenneth Spitzer**—Manager, Microwave Tube Development Dept.; **Selig Gertzis**—Manager, Tube & Semiconductor Applications Laboratory; and **Walter Bosse**—Manager, Quality Control Dept.

MUELLER CAN MAKE MOST ANYTHING IN IMPACT EXTRUSIONS...



We don't really make locomotives, but the 18 different Cold-Prest impact extrusions represented in the model were cold forged to exacting tolerances from a number of aluminum, copper, brass, and steel alloys.

These parts are employed in products ranging from door closers to missiles. Mueller has also made important advances in the production of copper impact extrusions that are especially adaptable to electronic applications. Cold forgings are precision produced to exacting tolerances and offer the additional advantage of a better finish and appreciable metal savings.

Mueller's flexible facilities for the production of Cold-Prest Impact extrusions make practical long or short runs of simple or relatively complex shapes on an economical basis. In addition, the entire Mueller engineering staff, excellent machining, finishing and assembly facilities are readily available to you when you . . .

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344

. . . that's a job for Tele-Dynamics

The design, development, and production of solid-state telemetry components and complete systems for aerospace projects are important capabilities at Tele-Dynamics. Today, Tele-Dynamics equipment is recognized for top performance and reliability in a majority of missile and space programs.

In addition to aerospace telemetry, Tele-Dynamics offers basic knowledge and experience in analog and digital data handling systems, electrostatic recording equipment, instrumentation and systems for underwater and meteorological applications, and electronic support equipment. Tele-Dynamics new capabilities bulletin is now available, write for a copy today. Tele-Dynamics, 5000 Parkside Avenue, Philadelphia 31, Pa.

TELE-DYNAMICS ***DIVISION***

AMERICAN BOSCH ARMA CORPORATION

Low cost silicon voltage regulators

Help Yourself!

Help yourself to improved circuit performance at a new low cost with these Tarzian 1-watt units. Epoxy-enclosed, they combine:

1. sharp and instantaneous breakdown (avalanche) and instantaneous recovery
2. small size, inherent ruggedness, and physical simplicity that are distinct improvements over other types of regulators
3. low cost—less than a dollar in production quantities at the standard 20% tolerance. All standard tolerances available on request.

At these low prices, their regulating, clipping, limiting, and protecting functions and advantages can be used to improve the performance of more circuits than ever before.

Write for price and ordering information. Application assistance is available. For even faster service, contact the Tarzian Industrial Distributor near you.

Other Tarzian silicon voltage regulators are available in ¼-, 1-, and 10-watt series, 31 units in each series, 5.6 to 100 Zener volts in 10% increments; standard tolerance 10%.

Specifications at 25° C

Tarzian Type	Zener Voltage (V)	Test Current (MA)	Dyn. Imp.(MAX) (Ohms)
VR6	6	25	4.0
VR7	7	25	5.0
VR8.5	8.5	25	6.0
VR10	10	12	8.0
VR12	12	12	10
VR14	14	12	11
VR18	18	12	17
VR20	20	4	20
VR24	24	4	28
VR28	28	4	42
VR33	33	4	50
VR39	39	4	70
VR47	47	4	98
VR56	56	4	140
VR67	67	2	200
VR80	80	2	280
VR90	90	1	340
VR105	105	1	400

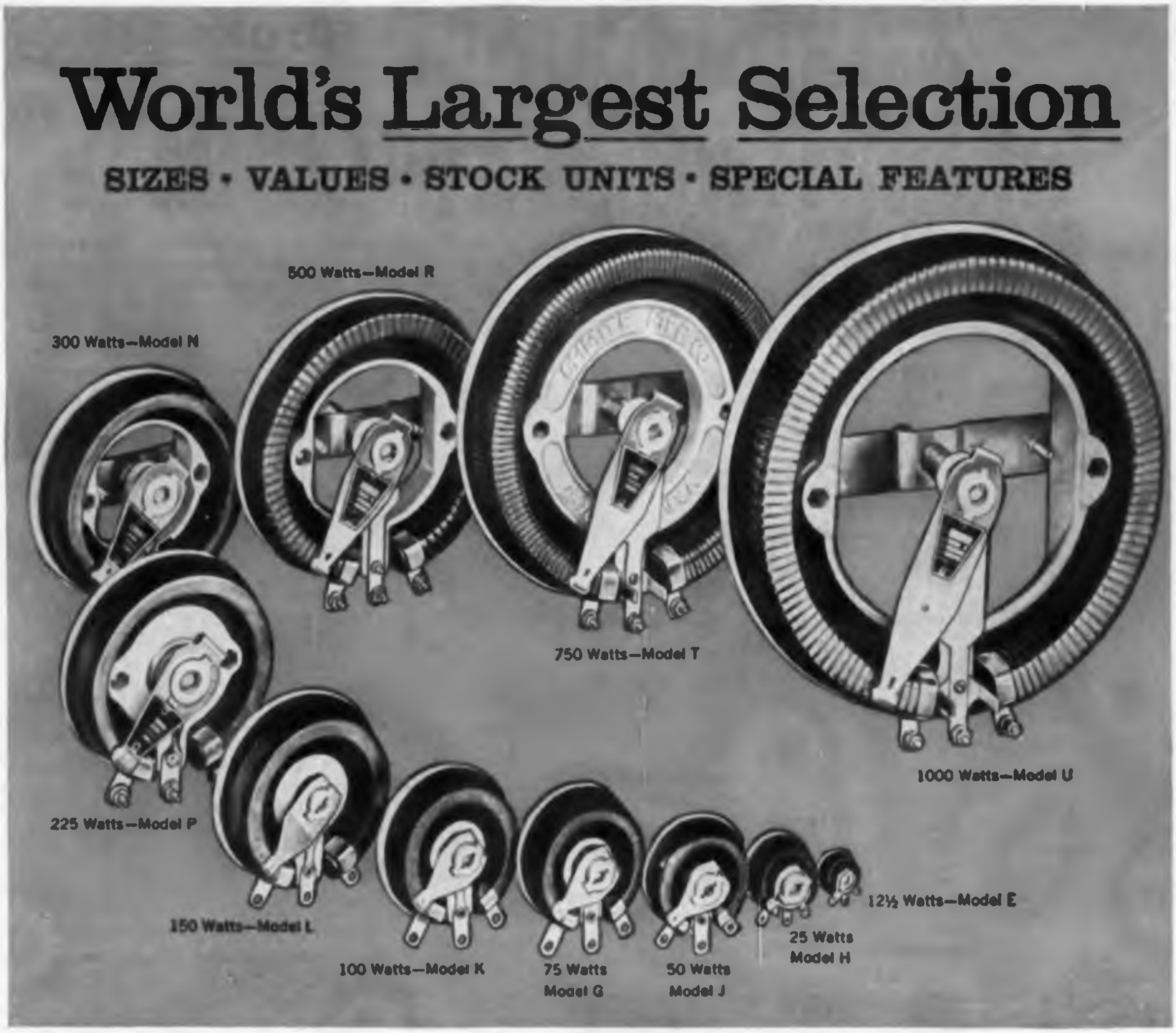
Send for free SVR Catalog: includes data on all four Tarzian series of silicon voltage regulators, plus design and test information.

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



OHMITE offers the largest and most varied assortment of power rheostats ever developed.

You can choose from 413 *stock* commercial sizes and types ranging from 12½ to 1000 watts . . . or from over 400 *stock* MIL-R-22A sizes and values, with "special fast delivery" on *all* other MIL units. You can find, for example, scores of different shaft styles, sizes, configurations—already engineered and waiting. Literally, hundreds of other special features take care of any rheostat application envisioned today.

But Ohmite rheostats give you more than just "largest selection." Ohmite wire-wound units of *all ceramic and metal construction* represent the highest degree of operational reliability ever attained in rheostats. They bring you the backup of industry's greatest reservoir of engineering talent in rheostat design and application.

Because of this, you find more Ohmite units in use than all other makes combined. On your next project calling for rheostats, make your selection from the smooth, close control units preferred throughout industry.

Stocked by the Factory and Electronic Distributors Everywhere

OHMITE RHEOSTATS

OHMITE MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois

OHMITE

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

Circle 55 on Inquiry Card

Books

Conversion Factors and Tables, Third Edition

By O. T. Zimmerman and I. Lavine. Published 1961 by Industrial Research Service, Inc., Masonic Building, Dover, New Hampshire. 710 pages. Price $7.50.

This is a pocket-size, time-saving handbook for workers in all technical and scientific fields. It contains over 15,000 conversion factors and 122 pages of conversion tables based on the latest and most accurate fundamental data. It contains information on weights, measures, velocities, densities, energies, viscosities, pressures—mechanical, electrical, thermal, nautical, astronomical units—refrigeration, air conditioning, hydraulic power, heat transfer, surveyors', photometric, apothecary units — and numerous others.

The Design of Small Direct-Current Motors

By A. F. Puchstein. Published 1961 by John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y. 407 pages. Price $12.00.

Emphasis throughout the book is on electromagnetic aspects of design problems and orderly procedure. The book is eminently suited for use either as a reference or as a textbook. Problems calling attention to significant theoretical and practical points are included for the use of both the general reader and the student.

Advances in X-Ray Analysis, Vol. 4

Edited by W. M. Mueller. Published 1961 by the University of Denver and available from Plenum Press, Inc., 227 West 17th St., New York 11, N.Y. 576 pages. Price $15.00.

Contains the complete texts of 38 reports presented at the Ninth Annual Conference on Applications of X-Ray Analysis held August 10-12, 1960 in Denver, Colorado.

Operational Electricity

By Charles I. Hubert. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave., South, New York 16, N. Y. 530 pages. Price $8.50.

After careful analysis of the traditional methods of teaching this subject and critical examination of the demands the subject places on teacher and student alike, the author concludes that an integrated study of ac and dc circuits and machines offers much more than the usual separate treatment.

The text is arranged for two levels of instruction. This is realized by blocking off the more complex derivations of formulas not essential to a basic understanding of electrical theory. The blocked off derivations provide additional interest for the faster students without confusing and slowing students less well grounded in the requisite physics and mathematics.

(*Continued on page 76*)

2 NANOSECOND MICROWAVE SWITCHING with SOLID STATE RELIABILITY

Microwave Associates' new coaxial switches provide:

- Efficient switching across the microwave spectrum
- Solid-state reliability for military applications
- Lightweight (approx. 5 oz.) ruggedized construction
- Low driving power — from 10 to 100 milliwatts
- Power handling capability: 4 watts CW (S.P.S.T. unit); 150 watts peak at 0.001 duty cycle
- Low insertion loss — as low as 0.2 db

Solid-state switches are as good as the semiconductors they incorporate. All units described use the most advanced microwave silicon diodes available, specifically developed for this function by Microwave Associates Semiconductor Division.

LOW POWER LEVEL COAXIAL SWITCHES

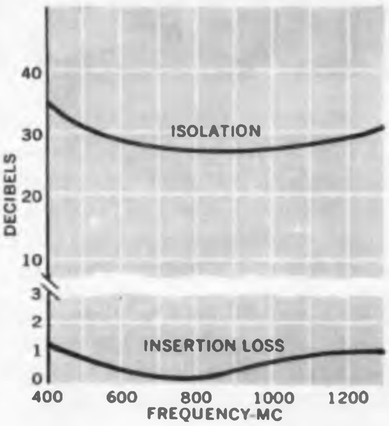
Frequency (Mc)	Insertion Loss (Max)	Isolation (Min)	Switching Power
210-240	0.2 db	20 db	10 mw
260-340	0.2 db	18 db	10 mw
400-500	0.3 db	20 db	10 mw
570-630	0.3 db	20 db	10 mw
900-1000	0.3 db	20 db	10 mw
1250-1350	0.5 db	20 db	10 mw
MEDIUM POWER LEVEL COAXIAL SWITCHES			
200-1000	1.5 db	22 db	70 mw
1000-2000	1.5 db	20 db	70 mw
2000-4000	2.0 db	16 db	70 mw

LOW POWER LEVEL VOLTAGE VARIABLE ATTENUATORS

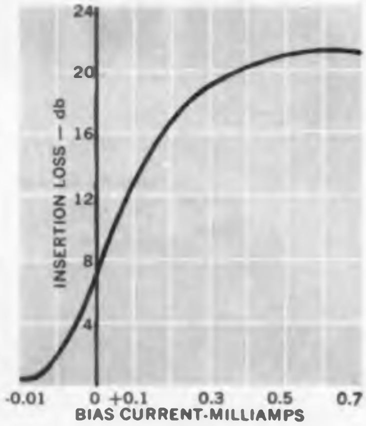
Frequency (Mc)	Attenuation Range
260-340	0.2 db-18 db
400-450	0.3 db-20 db
570-630	0.3 db-20 db
1250-1350	0.5 db-20 db

Narrow-band higher frequency units are available with lower loss and increased isolation.

TYPICAL PERFORMANCE BROADBAND MICROWAVE SWITCH SPST



TYPICAL PERFORMANCE VOLTAGE VARIABLE ATTENUATOR (425 Mc±25)



Units for handling higher powers are now in development. Microwave Associates has capabilities for meeting your requirements for single-pole multiple-throw and waveguide switching devices. Our switches invite comparison. We invite your inquiries. A quotation/data sheet will be sent on request.

MICROWAVE ASSOCIATES, INC.
ELECTRON TUBE AND DEVICE DIVISION, Burlington, Mass.
Western Union FAX • TWX: Burlington, Mass., 942 • BRowning 2-3000

Circle 57 on Inquiry Card


Shielded Power Supply Cables—Rubber
Duplex Connector Extension Cords
Cathode Ray Tube Lead
Miniaturized Cables
Grid Wires
Control Cables
Magnet Wire
Plastic Microphone Cables
Shielded Interconnecting Cables
Low Impedance Lines
Unpaired Intercom Cables
Audio Cables
Automation Cable
Individually Shielded Intercom Cables
Shielded Control Cables
Mr. Design Engineer...
BELDEN Has It
Every electronic and electrical wire you need—from the finest drawn magnet wire to the most complex multi-conductor cable.
There is a Belden wire or cable in every insulation and shielding to meet your design and application requirements. Here is just part of this complete line. Available from stock.
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SINCE 1902 — CHICAGO
One Wire Source for Everything Electronic and Electrical
• electronic wire • magnet wire • lead wire • power supply cords
• cord sets • portable cordage
8-4-1
RG/U Transmission Line Cables
Coiled Test Prod Wire
RC/U Cables
3-Conductor Power Cords
Control Cables
Rubber Microphone Cables
Hook-Up Wires
Miniature Audio Cables
Duplex Primary Wires
Strain Gauge Cables
Call System Cables
Test Prod Wires
2-Conductor Power Cords
Broadcast Audio Cables
PA System Cables
Multiple Pair Cables
TV Eye Camera Cable
Sound & Alarm System Cables
2 & 3 Conductor Extension Cords
Miniature Microphone Cables
Mil-Spec Wires
Belden
WIRES · CABLES · CORDS
ELECTRONIC WIRES
Color, Studio, Closed Circuit Camera Cables
Industrial Intercom Wires
75-Ohm Video Cable
Lamp Cordage
Portable Cordage
Coiled Cords
Teflon* Wires
*DuPont trademark
Shielding & Bonding Cable
Special Sound Cables

Books

(Continued from page 72)

Management Models & Industrial Applications of Linear Programming, Vol. I

By A. Charnes and W. W. Cooper. Published 1961 by John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y. 471 pages. Price $11.75.

These volumes illustrate all aspects of the underlying theory of linear programming with concrete numerical examples accompanied by explanations which 1) carefully explain the theories and examples, and 2) suggest further possible applications. Accompanying geometric representations are included whenever possible as a further aid to intuition and understanding. Volume I provides a thorough preparation for Volume II and serves as an introductory text.

Magnetic Control of Industrial Motors

Part I: A-C Control Devices and Assemblies. By Gerhart W. Heumann. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave., South, New York 16, N. Y. 273 pages. Price $9.00.
Part II: A-C Motor Controllers. By Gerhart W. Heumann. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 334 pages. Price $9.00.

In what are primarily application books, controllers for industrial type A-C and D-C motors are carefully analyzed and each type of motor is granted full treatment in conjunction with its associated controllers. Motor performance data for the A-C squirrel-cage, wound-rotor, and synchronous motors are presented as well as data on D-C series and shunt motors; this is accompanied by formulas useful for calculating motor performance when motors are used with different types of controllers. Principal circuits, selection of controller sizes and components, economic factors affecting controller selection, motor protection, and existing safety codes and standards are all given the most complete coverage possible.

Plasmas and Controlled Fusion

By David J. Rose and Melville Clark, Jr. Published 1961 by The Technology Press, Mass. Inst. of Technology and John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 493 pages. Price $10.75.

This book is a graduate-level textbook on the principles underlying plasma physics and controlled fusion. The authors are M.I.T. professors experienced in teaching, research, and engineering applications of plasma physics.

The first twelve chapters cover plasma physics, hydromagnetics, and elementary gaseous electronics in association with transport and electromagnetic theories. The last four chapters dwell more specifically upon the controlled fusion problem, including experimental and theoretical approaches, and methods of eventual energy recovery.

(Continued on page 82)

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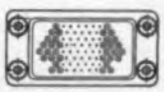

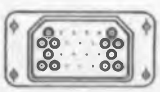

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Input Voltage: 5 to 120 v rms; usable to 240 v rms.

Input Impedance: Approx. 1 megohm, 80 pf shunt

Price: $750.00

8 other widely used hp Electronic Counters

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hp 523D/DR Electronic Counter

Offers electronic features identical with those of hp 523CR but has six-place neon columnar readout. hp 523DR (rack mount) $1,285.00; hp 523D (cabinet) $1,310.00.

hp 522B/BR Electronic Counter

Popular hp 522B/BR measures frequency 10 cps to 120 KC, period 0.00001 cps to 10 KC, time interval 10 μsec to 10^8 sec. Reads direct in cps, KC, seconds, milliseconds. Time base stability 1/10^8 per week; counts automatically, resets, action repetitive. Applications include measurement of production line quantities, nuclear radiation, power line frequencies, very low frequencies, and, with transducers, a wide array of physical quantities and phenomena. hp 522B (cabinet) $915.00; hp 522BR (rack mount) $900.00.

hp 521 Series Industrial Counter

hp offers five Model 521 counters, all useful in measuring frequency, random events per unit of time, and, with transducers, speed, rps, rpm, weight, pressure, temperature, etc. Direct readings, display time variable or "hold"; four instruments cover frequency range 1 cps to 120 KC; the fifth measures to 1.2 MC. Two models with big, bright, in-line numeric readout, three with columnar neon display. Prices $475.00 to $955.00. Cabinet and rack mounts available.

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Books

(*Continued from page 76*)

Automatic Control and Computer Engineering, Vol. I

Edited by V. V. Solodovnikov. Published 1961 by Pergamon Press, Ltd., Headington Hill Hall, Oxford, England. 502 pages. Price $15.00.

These volumes contain papers presented at a recent U.S.S.R. conference on Automatic Control and Computer Engineering organized by the Scientific Technical Society of the Instrument Making Industry. Volume I is devoted to the problems of developing and applying the resources of up-to-date computer engineering in the automatic control of manufacturing processes. Attention is given to both analogue and digital computing techniques.

Statistical Processes and Reliability Engineering

By Dimitris N. Chorafas. Published 1960 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 438 pages. Price $12.75.

This book is designed primarily as a tool for engineers, and particularly for reliability engineers. It presents to the reader an integrated approach to stochastic processes and to their use as a means for prediction and control. The author views statistics as a fundamental tool for scientific investigation and he first presents and explains statistical laws, and then explores their relationships with engineering disciplines and practices.

Modern Mathematics for the Engineer, Second Series

Edited by Edwin F. Beckenbach. Published 1961 by the McGraw Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 456 pages. Price $9.50.

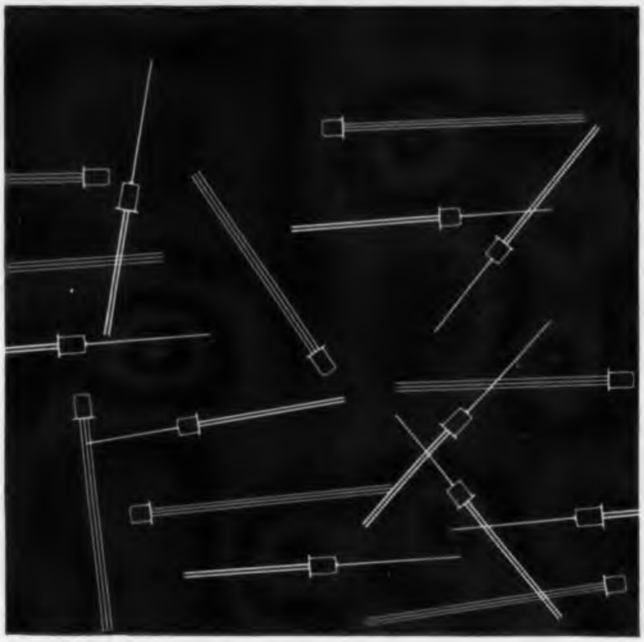
Book is intended for engineers, scientists, mathematicians, students, teachers, and others who wish to keep abreast with current applied mathematical developments, resulting largely from the demands of modern engineering programming and design. Material is divided into three parts: Mathematical Methods, Statistical and Scheduling Studies and Physical Phenomena.

Sensory Communication

Edited by Walter A. Rosenblith. Published 1961 by The M.I.T. Press, Mass. Inst. of Technology, Cambridge 39, Mass., and John Wiley & Sons, Inc., 440 Park Ave., South, New York 16, N. Y. 844 pages. Price $16.00.

Chapters in this book represent the contributions by forty-two participants in the International Symposium held at M.I.T.'s Endicott House in July 1959. The chapters present experimental results and theoretical considerations from a variety of approaches. The authors, who are well known for their research contributions, have tried to present evidence that should prove useful to formulation of principles of sensory communication.

SUBMIN TRANSISTORS



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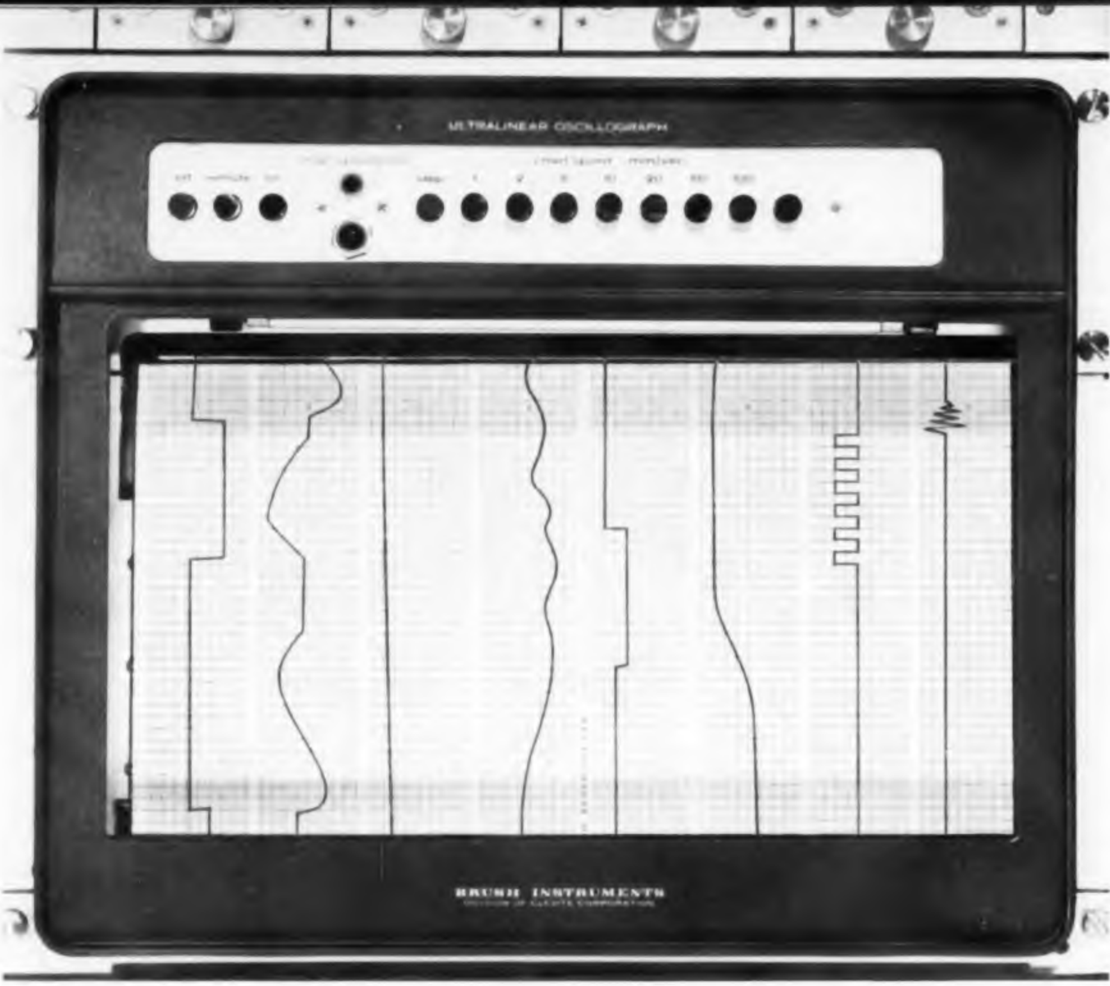

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Next month

MICROWAVE ROUND-UP STORY

A round-up story which gives a very brief history of the art, highlights recent developments in the field, and dwells at length on masers and lasers.

DESIGNING A POWER METER FOR THE MICROWAVE REGION

A double bridge principle is used to compensate for temperature variations in this extremely accurate new instrument.

TWT FOCUSING GOES MODERN

The cumbersome solenoids used with the early TWT's are now passe, except for very low noise tubes. Today's small, lightweight integrally packaged tubes contain the focus structure within the tube capsule. This article describes the three modern focusing techniques: uniform-magnetic-field by miniature solenoids, electrostatic, and periodic-permanent-magnet.

HIGH POWER TWT'S WITH WAVEGUIDE BANDWIDTHS

Present TWT's which exhibit bandwidths, comparable to waveguide or other passive microwave components are limited in power to only a few watts of average power and to about a KW of peak power. A loaded waveguide inter-action circuit is described which has just had its frequency capabilities extended to equal that of waveguide.

MEASUREMENT OF VSWR IN COAXIAL SYSTEMS

This article provides a simplified explanation of the definition and measurement of coaxial VSWR. It lists the accuracy obtainable with presently available equipment and brings to light the lack of standardization still present in the measurement and specification of coaxial VSWR.

Plus all 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—

ELECTRONIC MATERIALS—NOW AND IN THE FUTURE!

Within the last two years there has been a new comprehension of the inherent electrical properties of materials. Stemming from the science of solid-state techniques a deeper appreciation of the behavior of the electron and its reactions to its environments is taking place. This article reviews the various areas of materials of particular current interest to electronic engineers, and points out the direction of future advancements.

Watch for these coming issues:

***NOVEMBER**
9th Annual Microwave Issue

***JANUARY**
Statistical and Annual Industry Review

***MARCH**
Annual IRE Issue

Thin films are in the research "limelight."
Micro-miniature units are in production.
What will be the interim category?
Here's one suggestion—using discrete components.

Applying Dot Components to Electronic Packaging

THE Dot packaging system uses discrete, individual components. By keeping components as basic circuit elements, adequate design flexibility is retained. Thus, design progress in new systems is not stifled by lack of suitable, standard circuits or modules.

Small size is attained by using very small components with a single, standard dimension. The Dot system standardizes on a disc-shaped component 0.030 in. thick, Fig. 1. The disc diameter may vary. The ends of the disc form the component terminals.

Dot component availability is basic to the system's success. At the start of 1960, there were few Dot components—only some experimental diodes. By the end of that year a number of Dot component sources were available, Fig. 2. More components have been added and their preliminary evaluation completed. Availability is constantly improving as more firms become aware of the advantages and potential of the Dot system. Once units are available, the next step is to assemble them. Here is where one of the system's main advantages becomes apparent—the designer is free to do as he chooses.

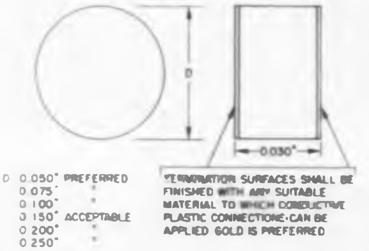

Fig. 1 (left): Disc-shaped component with a thickness of 0.030 in. is standard of the Dot System.

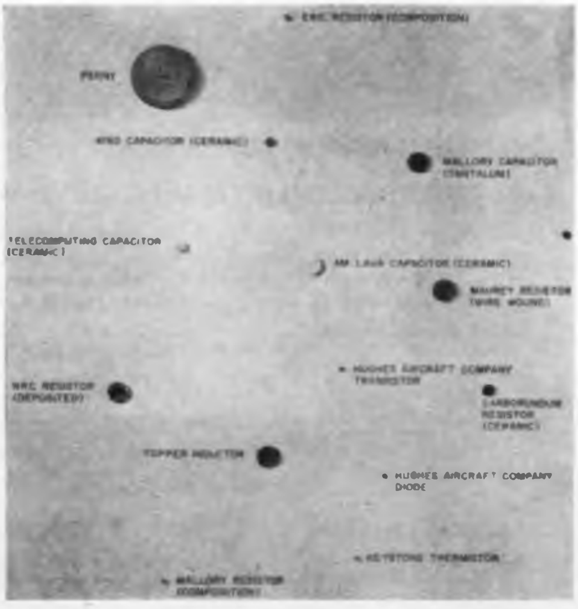

Fig. 2 (right): Available Dot components with manufacturer's name.

Assembly

For many uses, the following assembly method is satisfactory. First, select a sub-strate material. Substrate problems are slight. Ordinary materials, e.g., epoxy/glass, which have long been used in printed circuits, can be used here; but, for some uses, the more exotic materials, e.g., ceramics, beryllia, and insulated metals may be preferable.

Next, we bond the components in the holes. This can be done with a thick epoxy adhesive, applied to the assembly with a "squeegee" action. This forms all the bonds in a single, simple operation.

Finally, a conductor pattern is applied to each side of the sub-strate, or card. Perhaps the easiest way of doing this is to apply conductive adhesives, e.g., silver-filled epoxy, by silk screening. Of course, other methods of connection may be used.

If desired, the completed cards may be spray- or dip-coated for moisture protection. Some circuits which have been made this way are shown in Figs. 3 and 4.

This audio amplifier has a parts density of 630 parts/in³, containing 2 transistors, 6 resistors, and 2 tantalum capacitors. The power gain is 48 db.

By J. R. GOODYKOONTZ

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Reliability Considerations

The basic feasibility of the Dot packaging system has been shown. But how good is the system? What is its reliability?

Answer. The *objective* is to produce equipment by this method which is far more reliable than present equipment. It will take time, of course, to develop data which will yield a meaningful reliability picture. Reliability data accumulation is still in the early stages; the results to date have been encouraging.

Basically, the program is divided into two parts:

(1) Component Evaluation or Qualification Testing. This effort's scope is quite normal. We simply apply the same test methods used for other components. This evaluation is proceeding independently of any particular system considerations.

(2) Evaluation of the Fabricating Process. Here we are concerned with connection reliability, resistivity, insulation resistance, etc.

Figs. 5 and 6 show something of the general nature of these evaluations. Using many of these boards we are able to obtain statistical data on connection reliability, as well as on resistivities.

Since evaluation is still in the early stages, it would be premature to quote figures. However, the results so far are most encouraging; and, we are confident that both components and processes will combine to produce equipment of superior reliability.

Unit Assemblies

In Figs. 3 and 4 three wafer-like circuits, roughly the size of postage stamps, were shown. These units were built for feasibility demonstration only. We would not seriously propose building up complex systems from these units because of the prohibitive interconnection problem.

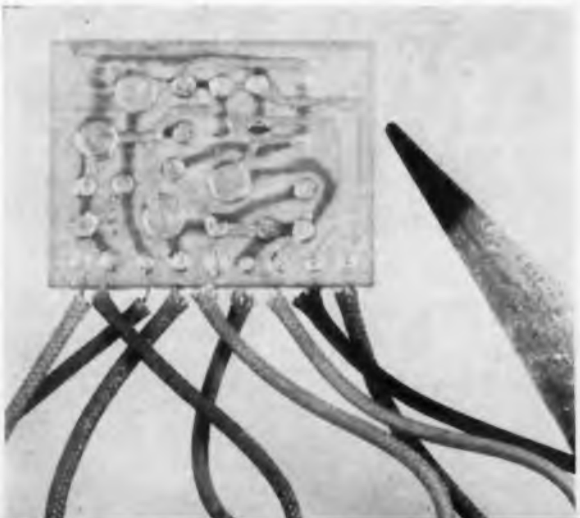
A better approach we feel is to put more functions on a single board or card. This is a layout of a subunit (the digital delay line of the AN/URC-15 airborne converter) using Dot components.

Originally, the subunit had 300 components packaged in 17 plug-in modules—three double flip-flop cordwood modules and 14 diode gating modules. It required some 219 plug-in connections and a greater number of wire-wrapped connections. The subunit occupied a 32 in.³ and had a parts density of 16,000 parts/ft.³

The same subunit, redesigned with Dot components,

This article was prepared while both men were employed by Communications Division, Hughes Aircraft Co., Los Angeles 45, Calif.

Fig. 3: This 18 component flip-flop contains 2 transistors, 4 diodes, eight resistors, and 4 capacitors; gross parts density, 1100 parts/in³ 8.



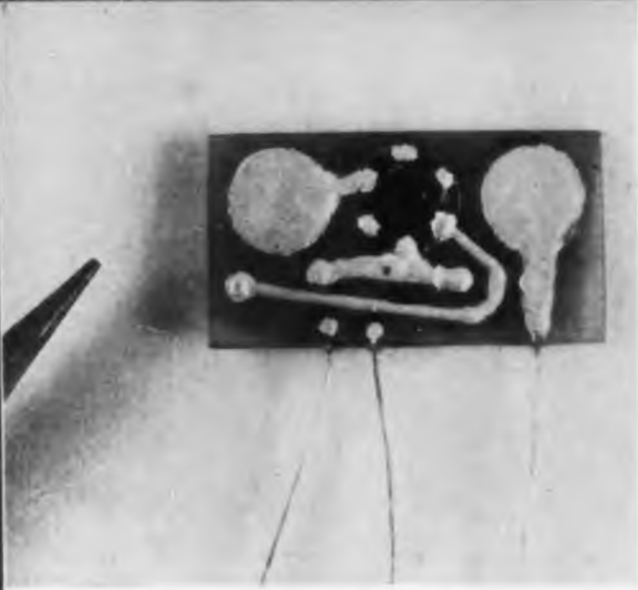


Fig. 4: This blocking oscillator has a relatively modest parts density of 500 parts /in³/ with 1 transistor, 1 diode, 2 capacitors, 2 resistors, and 1 transformer. The latter was made at the Hughes lab.

Dot Components *(Continued)*

occupies ⅓ in.³ Allowing an equal volume for clearance on each side of the card results in a total volume of ⅔ in.³ and a net parts density near 780,000 parts/ft.³

In addition to the excellent size reduction, the number of external connections is reduced to 11. This is a decrease of the external connections by a factor of 20. Such a decrease is the battle half won. A number of such sub-units, or cards, would be stacked together to form a whole unit or system.

This many-layered sandwich consists of functional cards alternating with sheets of aluminum which act as heat conductors. Thin sheets of mylar or other insulating material lie between the aluminum and the cards. The assembly is compressed by screws or other members so that it becomes a brick-like structure—virtually immune to the effects of vibration. Yet, it can be disassembled completely and repaired—down to the component level. Components may be punched or drilled from the cards and replaced. Connection repair is then made by hand. A small brush, or pen, can be used to apply new conductive adhesive connections.

Although it is possible to reduce the number of interconnections by placing numerous related functions on a single card, it is still necessary to have some. Wire-wrap terminals can be brought out from the card edge and the interconnections made by the standard wire-wrapping technique. Of course, to take such a unit apart, it would be necessary to unwrap; however, this is possible, although not easy.

A fully disconnectable connector is also desired. The main problem is to conserve connector width. Considerable effort has been exerted to achieve a card only 0.030-in. thick. We cannot permit the connector to cancel out this gain; in short, a 0.030-in. thick connector is needed also.

To achieve this, two spring contacts are provided; one flat, one curved. These are fastened permanently to the card edge. The spring connector, however, does not grasp its mating part in the usual fashion. Instead, the mating part is inserted and then the connector is compressed. The compressing action is natural since the cards are going to be stacked and compressed anyway.

Thermal Aspects

In microelectronics, attention must be given to the thermal problem. Certainly as parts densities go up, power densities go up also. But there is a bright side to the picture in that the geometry of a Dot assembly is so simple that accurate calculations can be made of the temperature that will exist within the assembly.

Thus, the thermal analysis will be right the first time and it will not be necessary to design thermal mockups to gather empirical data; nor, will it be necessary to overdesign thermally to avoid unpredictable hot spots. Examining the structure in cross section, Fig. 7, we see that convection and radiation are ruled out as heat transfer means. Only conduction through the aluminum spacers needs to be considered and this conduction is limited essentially to two dimensions. Note that spacer technique is only one of the methods of heat removal. Others might be to use metal or beryllia substrate materials.

Using the spacers, there are 3 main thermal drops to consider: (1) Δt_1 across the interface, (2) Δt_2 along the length of the aluminum conductor. The amount of drop is dependent upon the length of the path and the thickness. Knowing these two things, and the dissipation densities involved, the drop can be calculated. For power dissipation densities anticipated (say, 1 watt/in.²), paths only 2 or 3 in. long, and aluminum spacers 0.020-in. or 0.030-in. thick, this drop is negligible. (3) The third drop, Δt_3, is at the junction of the aluminum conductors and the heat exchange or sink; and, this will be a function of the particular design. Of course, this junction will be

designed with low drop as its major objective. In any event, prior to building any equipment for test, it should be possible, knowing the sink temperature, to establish the temperature inside the substrate within a degree or so.

Δt_1 was measured by an experiment conducted to insure that the calculations of this value were correct. To do this 16 resistors were imbedded in epoxy glass in a one-inch-square area. Calibrated thermistors were also imbedded in this area so that the substrate temperature could be monitored. Eight layers of ¼-mil mylar were then placed over each side of this test piece and thick metal plates, or heat sinks, were pressed against each side of that. Thermocouples were imbedded in the metal plates near the surface of the interface. By dissipating power in the resistors we were able to produce a Δt across the mylar. At 1- or 2-watts dissipation, this drop was not measurable. At 10 watts, curves indicate that even at this high wattage, Δt_1 could only be a few degrees; the curve indicates from 4.5° to 1.5° C.

Thus, we do not feel that getting the heat out of the package is a particularly difficult problem. However, some sophistication will be needed in the design of the compact heat exchangers needed for these assemblies.

Manufacturability

Another problem is that of identifying and handling these small components. Is automation possible? Or practical?

The advantage afforded by the small size of the Dot component is realized only after it has been installed in a circuit. Preceding that time, its small size is a disadvantage.

Identification is a major problem since even color coding is impractical. The small size also makes handling by the user, if not by the supplier as well, quite difficult. The component simply cannot be handled readily by "hands" or even by what could be considered normal-size machinery. This problem is not merely a matter of installing the component at the production line, but includes the whole gamut of handling from the time the component is made—inspection, packing, shipping, receiving, unpacking, testing, transfer into stores, transfer out of stores, etc.

Dot components must be packed so that identification and handling will be facilitated. Further, a standard packing method must be used for all Dot units. This technique must be compatible with both manual and automatic methods of testing, storing, inspecting, and installing.

The method suggested is that the components be mounted individually in cards, Fig. 8. By use of such a card the component identity, as well as record of test and inspection when this is desired, can be maintained up to the instant of insertion onto a substrate.

Moreover, the card is large enough to be handled easily by people as well as machines. Actual installation is also simplified; the card is merely positioned so that the component rests directly over the proper hole in the substrate and the component is then "punched" from the card to the substrate.

Besides providing a simplified means of identification and handling, the card provides a high degree of protection for the component. Spare parts handling in military establishments would also be facilitated by use of this mounting means.

Finally, the arrival of the automatic factory would be hastened since these cards can be handled easily by simple, standard machinery. Of course, the simpler the automation machinery is, the cheaper it is; the cheaper it is, the sooner it becomes justified economically, and put into use.

A magazine or dispenser, solenoid operated, can dispense one component at a time. It can be used for all Dot units regardless of their diameter. Such a magazine could be used as a basic component of a fully or partially automated assembly system.

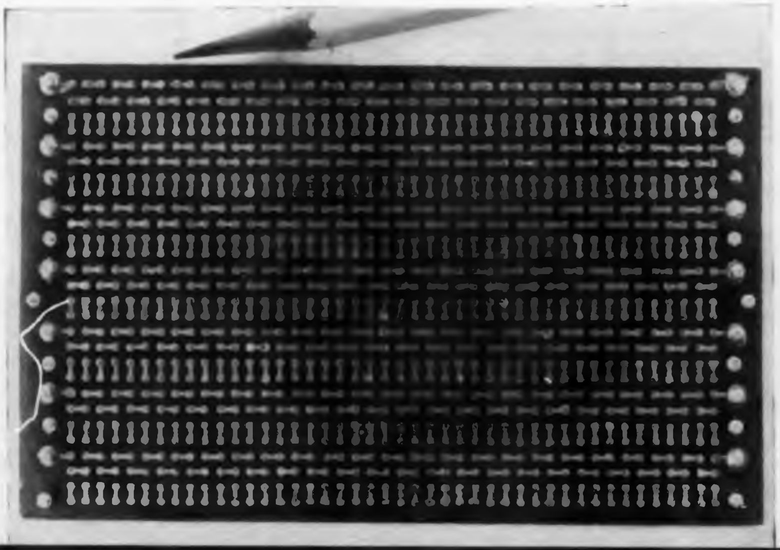
Considering the assembly operation, the elimination of errors is a major objective of an assembly device, be it automatic or manual. Our auto-manual station achieves error elimination by eliminating the necessity of the operator to make a decision of any kind. In addition, the station makes the assembly task easier and more rapid.

The station is programmed by means of a plastic impregnated paper or fabric roll, which is divided into frames, one per component. Each frame has one indexing hole at the side and a row of magazine program holes. In addition, there will be a component mounting card outline drawn on each frame with a hole at the component position.

The cycle of operations to install one component is as follows:

Fig. 5 (left): Photograph of the comb pattern used to investigate insulation resistance, and also silver migration effects.

Fig. 6 (right): This is the connection test board which contains some 1200 brass slugs, or feedthroughs, connected in series.



Dot Components *(Concluded)*

(1) The operator presses an advance button,

(2) A motor drives the roll to the next frame, automatically stopping at the correct position by sensing the indexing hole,

(3) The magazine program reader reads the magazine program holes in the top of the frame and so generates a signal which actuates one of the solenoid operated magazines.

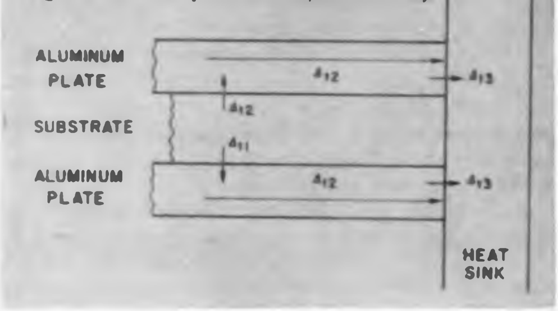


Fig. 7: Thermal drops in a Dot system assembly.

Fig. 8: For ease of handling and identification, each component is mounted on a card. This also is advantageous for systems using automation.

(4) The selected component falls into a constantly moving belt and is delivered to the operator,

(5) The operator places the component mounting card within the component mounting card outline and, by means of a small tool, pushes the component from its mounting card into the substrate,

(6) The empty component mounting card is discarded, and

(7) The operator presses the advance button, causing the program roll to advance to the next frame.

When all components are installed, the substrate and tray are passed on to the next station for component bonding and conductor application. These will be batch processes.

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.

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Design is Speeded By...

Using the

IN an earlier article we showed how some simple graphical techniques can aid the analysis and design of single-tuned band-pass filters. Now we'll treat double-tuned band-pass filters, i. e., filters with a transfer function containing a pair of closely spaced, isolated, complex poles. Let's examine a commonly occurring circuit: the transformer-coupled, double-tuned band-pass filter, Fig. 1.

The transformer is described by 3 measured parameters: L_1, the self-inductance of the primary side; L_2, the self-inductance of the secondary side; and, $(N_2/N_1)_{eff}$, the effective turns ratio of the transformer. Additionally, we known that the primary actually contains N_1 turns and the secondary, N_2 turns. For convenience, we replace the transformer with the equivalent circuit model,[2] Fig. 2a, where L_{m1} is the magnetizing inductance (that part of L_1 which is coupled by common flux with L_2) measured on the primary side, and L_{l1} and L_{l2} are the leakage inductances of the primary and secondary, respectively. The ideal transformer in the model has a turns ratio N_2/N_1 for all frequencies including dc, infinite magnetizing inductance, and zero leakage inductances. All of these various parameters of the transformer may be tied together by Eqs. (1), (2), and (3).

$$L_1 = L_{l1} + L_{m1} \tag{1}$$

$$L_2 = L_{l2} + L_{m1}\left(\frac{N_2}{N_1}\right)^2 \tag{2}$$

$$\left(\frac{N_2}{N_1}\right)_{eff} = \frac{L_{m1}}{L_1}\left(\frac{N_2}{N_1}\right) \tag{3}$$

The T of inductances in Fig. 2a are characterized by the inductance matrix[3]

$$[L] = \begin{bmatrix} L_1 & L_{m1} \\ L_{m1} & L_2\left(\frac{N_1}{N_2}\right)^2 \end{bmatrix} \tag{4}$$

An earlier article dealt with single-tuned filters; here, we treat the double-tuned band pass type. For such a circuit, transformer coupled, we show how a simple pencil compass is enough to make not only the locus of the hump frequencies, but also, the 3 and 6 db bandwidth frequencies.

S-Plane for Filters

the determinant of which is

$$|L| = L_1 L_2 \left(\frac{N_1}{N_2}\right)^2 - L^2_{m1} \cdot \qquad (5)$$

Transformer Circuit Function

Thus, the circuit function of the transformer is in the form of Fig. 2b, where the inductances of the π section are given by[3] (6), (7), and (8)

$$L = \frac{|L|}{L_2}\left(\frac{N_2}{N_1}\right)^2 = \frac{L_1}{L_2}\left[L_2 - L_1\left(\frac{N_2}{N_1}\right)^2_{eff}\right] \qquad (6)$$

$$aL = \frac{|L|}{L_{m1}} = \left(\frac{N_2}{N_1}\right)^{-1}\left(\frac{N_2}{N_1}\right)^{-1}_{eff} \left[L_2 - L_1\left(\frac{N_2}{N_1}\right)^2_{eff}\right] \qquad (7)$$

$$bL = \frac{|L|}{L_1} = \left(\frac{N_2}{N_1}\right)^{-2}\left[L_2 - L_1\left(\frac{N_2}{N_1}\right)^2_{eff}\right] \qquad (8)$$

and the factors a and b are

$$a = \frac{L_2}{L_1}\left(\frac{N_1}{N_2}\right)\left(\frac{N_1}{N_2}\right)_{eff} \qquad (9)$$

$$b = \frac{L_2}{L_1}\left(\frac{N_1}{N_2}\right)^2. \qquad (10)$$

Since both the primary and the secondary are to be tuned to the same center frequency, we must choose C_2 and R_2 of Fig. 1 such that

$$C_2 = \frac{L_1}{L_2} C \qquad (11)$$

$$R_2 = \frac{L_2}{L_1} R \qquad (12)$$

resulting in the convenient equivalent circuit of Fig. 3. This circuit is two single-tuned filters tuned to the same center frequency, but differing in impedance level by a factor b. The filters are coupled by the inductance aL; the ideal transformer accounts for the transformer action.

The transfer impedance $Z_{21}(s)$ is characterized apart from a constant multiplying factor by the ratio of its zeros to its poles.[4] The poles are the open-circuit natural or characteristic resonant frequencies of the circuit. One pair of complex poles is seen to be the

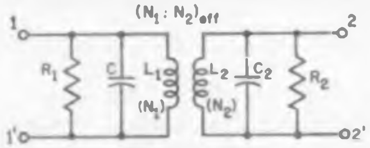


Fig. 1: This transformer-coupled, double-tuned, band-pass filter is the circuit which is dealt with.

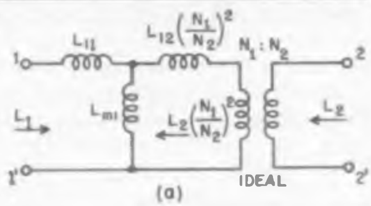


Fig. 2a: Transformer of Fig. 1 is replaced with this equivalent circuit model.

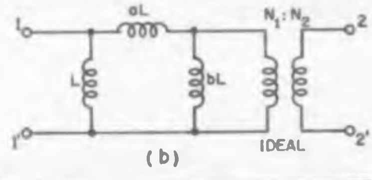
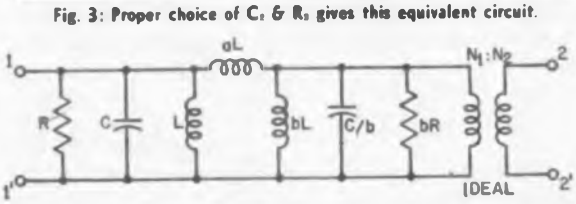


Fig. 2b: Here the inductive T has been transformed into a π.

Fig. 3: Proper choice of C_2 & R_2 gives this equivalent circuit.



S-Plane *(Continued)*

common natural frequency of the single-tuned filters and is given[1] by

$$s^2 + \frac{1}{RC}s + \frac{1}{LC} = 0. \tag{13}$$

The other pair of poles is a little harder to envision but may be computed from Fig. 4 where the two single-tuned filters are thought of as a series connection of two similar impedances (see Eq. 25, Ref. 1) in parallel with the coupling inductance. The LC-product of the equivalent circuit in Fig. 4 is

$$(LC)_{eq} = \frac{a\,(b+1)\,L^2}{aL + (b+1)\,L} \cdot \frac{C}{b+1} = \frac{aLC}{a+b+1} \tag{14}$$

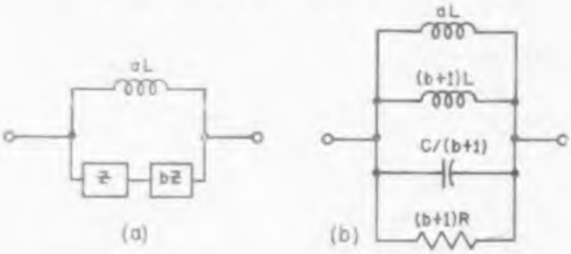


Fig. 4: The two single tuned filters may be thought of as a series circuit of two similar impedances paralleling the coupling inductance

and the remaining poles are given by

$$s^2 + \frac{1}{RC}s + \frac{a+b+1}{aLC} = 0. \tag{15}$$

The zeros of $Z_{21}(s)$ are those frequencies for which there is no transmission through the network. There is one zero at zero frequency due to the π of inductances, and there are 3 zeros at infinite frequency because of the two shunt capacitances separated by the coupling inductance. $Z_{21}(s)$ is now characterized except for the constant multiplier which may be calculated by assuming a limiting frequency (infinity) and a convenient output voltage. Thus we find

$$Z_{21}\,(s \to \infty) \to \frac{\left(\frac{N_2}{N_1}\right) b}{aLC^2\, s^3} \tag{16}$$

and

$$Z_{21}\,(s) = \frac{\left(\frac{N_2}{N_1}\right) \frac{b}{aLC^2}\, s}{\left(s^2 + \frac{1}{RC}s + \frac{1}{LC}\right)\left(s^2 + \frac{1}{RC}s + \frac{a+b+1}{a\,LC}\right)} \tag{17}$$

$Z_{21}(s)$ is seen to contain two closely spaced, isolated (high Q case) poles, equidistant from, but close to, the j-axis typical of the type of circuit we are analyzing. The general character of the amplitude response of this filter is a double-humped or peaked band-pass shape.

Impedance Vectors

We may show an impedance by vectors drawn in the S-plane from its poles and zeros to the point (frequency) at which we wish to evaluate its response.[1] Also in the vicinity of interest near the isolated poles, all vectors are essentially constant in length and angle, except those drawn from the two nearby poles. For this condition, $|Z_{21}(j\omega)|$ behaves as

$$|Z_{21}\,(j\omega)| = \frac{k}{s_1\, s_2} \tag{18}$$

where s_1 and s_2 are the magnitudes of the vectors from the two poles, and k is an appropriate constant. Fig. 5 is a magnified view of the S-plane in the vicinity of the two poles and shows the two-pole vectors and the angle θ between them. The area of the triangle[5] formed by the two vectors and the line of length

$2\,s_o = \left(\frac{a+b+1}{aLC}\right)^{1/2} - \left(\frac{1}{LC}\right)^{1/2}$ joining the two poles is

$$\text{area of } \triangle = s_o\,\alpha = \frac{1}{2}\, s_1\, s_2 \sin\theta; \tag{19}$$

therefore,

$$|Z_{21}\,(j\omega)| = k^* \sin\theta \tag{20}$$

where k^* is a constant. In the vicinity of the two poles $|Z_{21}(j\omega)|$ is dependent only on $\sin\theta$. The center or trough frequency of the filter is determined by the minimum value of $\sin\theta$ between the humps and from Fig. 5 is seen to be

$$\omega_C = \left(\frac{1}{LC}\right)^{1/2} + s_o \quad \text{Radians/sec} \tag{21}$$

Recall from geometry that the 3 points of a triangle describe a circumscribed circle of radius r given by the ratio of the length of a side to twice the sine of the interior angle opposite this side. Choosing from our triangle, the side $2s_o$ and the angle θ we have

$$r = \frac{2\,s_o}{2\sin\theta} = \frac{s_o}{\sin\theta} \tag{22}$$

for the radius of a circle circumscribing the triangle of Fig. 5. The condition for the hump frequencies

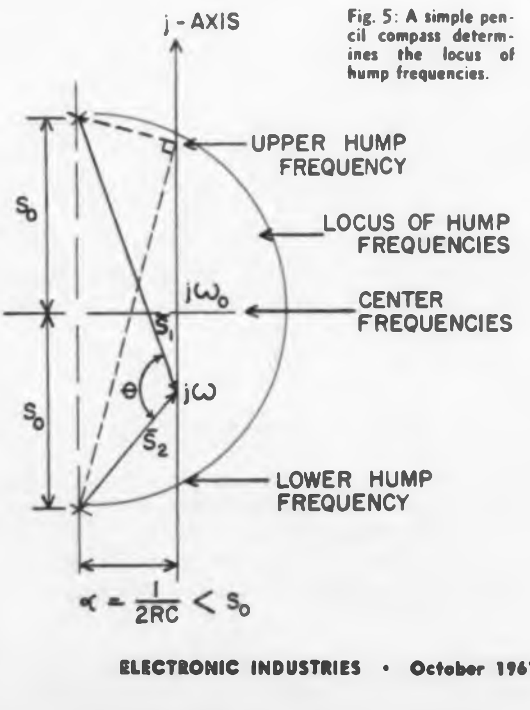


Fig. 5: A simple pencil compass determines the locus of hump frequencies.

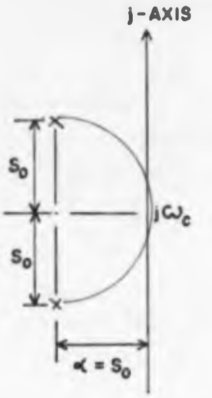


Fig. 6: This is the condition for maximally flat response—circle and j tangent meeting.

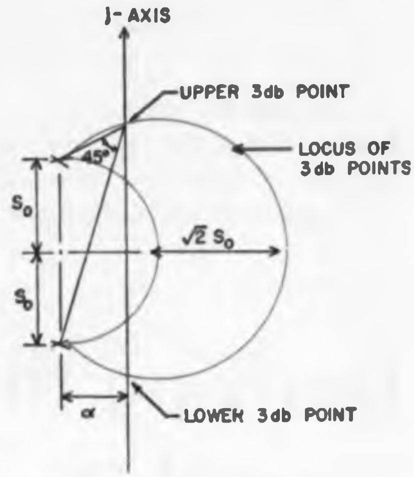


Fig. 7: Here's how to determine the 3 db down points from the peaks.

may be found by setting $\sin\theta$ equal to its maximum value unity and solving for the corresponding radius $r_h = s_o$. The hump frequencies are then as shown in Fig. 5 given by the intersections of the j-axis with a circle drawn through the two poles with its center midway between them. As the loss factor α is allowed to increase, the hump frequencies are seen to move closer together until at the critically coupled or maximally flat condition, the humps merge into a single flat peak at the center frequency. This condition results as shown in Fig. 6 when the circle lies tangent to the j-axis and $\alpha = s_o$ so that the center frequency is

$$\omega_{max.\ flat} = \left(\frac{1}{LC}\right)^{1/2} + \frac{1}{2\,RC} \cdot \quad \text{Radians/sec} \qquad (23)$$

Bandwidths

The 3 db points down from the peaks are determined by setting $\theta = 45°$ for which the radius of the circumscribed circle is $r_{3db} = \sqrt{2}\,s_o$. As in Fig. 7, the center of this circle is at the intersection of a line through the center frequency with the circle that determines the hump frequencies. The intersections of the j-axis with this new circle determine the 3 db bandwith. For the critically coupled case, the 3 db bandwidth is

$$3\ db\ BW|_{max.\ flat} = \frac{(2)^{1/2}}{RC} \cdot \quad \text{Radians/sec} \qquad (24)$$

Similarly, if the assumptions leading to Eqs. (18) and (20) hold over a slightly wider range of frequencies, the 6 db bandwidth may be found by setting $\theta = 30°$ for which the radius is $r_{6db} = 2s_o$. The center of this circle lies on a line through the center frequency and $\sqrt{3}s_o$ to the right of the center of the locus of hump frequencies circle. Fig. 8 shows the 6 db points as determined by the intersections of the j-axis with this circle. For the critically coupled case, the 6 db bandwidth is

$$6\ db\ BW|_{max.\ flat} = \frac{(12)^{1/4}}{RC} \cdot \quad \text{Radians/sec} \qquad (25)$$

One other parameter of the double-tuned filter may be of interest, and that is the trough depth relative to the hump height. At a hump frequency, the magnitude of the impedance is $k(\theta = 90°)$ and at the center frequency, it is $k \sin\theta_C$, where θ_C is the corresponding angle between s_1 and s_2. The relative trough depth is then

$$\text{Depth} = \frac{k - k\sin\theta_C}{k} \qquad (26)$$

From reference to Fig. 5, we see that

$$\sin\theta_C = \frac{2\,\alpha\,s_o}{s_o^2 + \alpha^2} \qquad (27)$$

and thus the relative trough depth is

$$\text{Depth} = \frac{\left(1 - \frac{\alpha}{s_o}\right)^2}{1 + \left(\frac{\alpha}{s_o}\right)^2} \cdot \qquad (28)$$

1. J. J. Jones, "S-Plane Aids Filter Design," *Electronic Industries*, Feb. 1961.

2. Reintjes and Coate, *Principles of Radar*, McGraw-Hill, pp. 124-130.

3. E. A. Guillemin, *Introductory Circuit Theory*, John Wiley and Sons, pp. 158, 159, 371.

4. E. A. Guillemin, "An Introduction to Modern Filter Theory," *Proc. National Electronic Conference*, Vol. 9, February, 1954.

5. R. J. McLaughlin, "Design and Adjustment of Bandpass Amplifiers," M.I.T., Research Lab. of Electronics, Prog. Report 47, October, 1947.

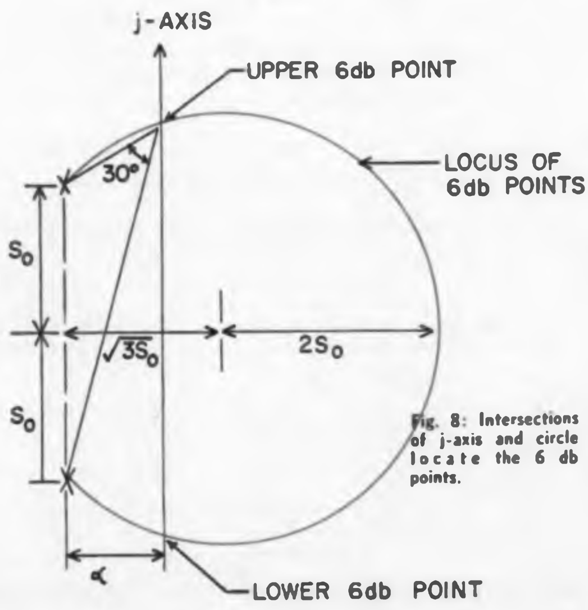


Fig. 8: Intersections of j-axis and circle locate the 6 db points.

F. H. Mitchell, Jr.

Through quantum mechanics, Esaki predicted the I-V characteristic curve for a tunnel diode. This article shows how to evaluate that integral and produce a useful, algebraic equation for the curve

Deriving the Tunnel Diode Curve

By FERDINAND H. MITCHELL, JR.

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FOR a slightly forward-biased tunnel diode, quantum mechanics predicts the following *I-V* characteristic curve:

$$I = C \int_{E_c}^{E_v} [f_c(E) - f_v(E)] \sqrt{E - E_c}\sqrt{E_v - E}\, dE \quad (1)^*$$

$$V = \mu_c - \mu_v/q$$

where, $f_c(E)$ and $f_v(E)$ are Fermi-Dirac distribution functions, μ_c and μ_v are the Fermi levels, and E_c and E_v are band edges, in the conduction and valance bands, respectively, in each case, Fig. 1. The integral, Eq. 1, may be evaluated in an approximate manner to give a useful algebraic equation for the tunnel diode curve.

The factor $f_c(E) - f_v(E)$ has the general form shown in Fig. 2. The factor has its peak value

$$y_p = \frac{1 - e^{-\frac{1}{2}qV/KT}}{1 + e^{-\frac{1}{2}qV/KT}} \text{ at energy } E_p = \frac{1}{2}(\mu_c + \mu_v)$$

The second factor under the integral, $\sqrt{E - E_c}\sqrt{E_v - E}$, is the product of two parabolas, Fig. 3, symmetrical about $E = \frac{E_c + E_v}{2}$.

Since $E_v + E_c - (\mu_v + \mu_c) = (\zeta_v - \zeta_c)$ with ζ_v and ζ_c constants, Fig. 1, the two sets of curves, Figs. 2 and 3 may be superimposed on the same axis $E_c + E_v =$ const., $\mu_c + \mu_v =$ const., with axes of symmetry displaced by a distance $\epsilon = \zeta_v - \zeta_c$.

To perform the integration, approximate the integrand as follows:**

$$f_c(E) - f_v(E) = [V^n\alpha_1 - |E - E_p| + \alpha_2]\alpha_3 \qquad n > 0$$

$$\sqrt{E - E_c}\sqrt{E_v - E} = [(\alpha_4 - V^m)\alpha_5 - |E - E_p + \epsilon| + \alpha_6]\alpha_7 \qquad m > 0$$

* L. Esaki, Phys. Rev. 109, 603(1958).

** In the following development, the alphas represent constants.

Fig. 1: The energy band diagram indicates the various constants used in derivation.

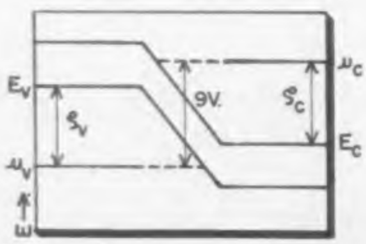


Fig. 2: The Fermi-Dirac distribution function has the general form shown below.

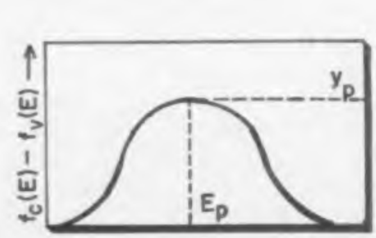
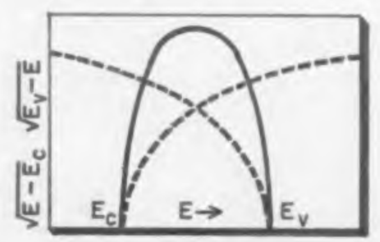


Fig. 3: The parabolic product forms the second factor under the integral of Eq. 1.



If $\epsilon = \theta$, the curves are symmetrical about E_p, and Eq. (1) now becomes:

$$I = \alpha_e \int_{E_p}^{E_e} \left[V^n \alpha_1 - (E - E_p) + \alpha_2\right] \left[(\alpha_4 - V^m) \alpha_5 - (E - E_p) + \alpha_6\right] dE \quad (2)$$

Letting $X = E - E_p$

$$I = \alpha_e \int_0^{\frac{1}{2}(\zeta_e + \zeta_e - qV)} \left[V^n \alpha_1 + \alpha_2 - x\right] \left[(\alpha_4 - V^m)\alpha_5 + \alpha_6 - x\right] dx$$

If n and m are integers, the integrated expression is a power series of order $m + n + 1$:

$$I = \sum_{i=0}^{n+m+1} a_i V^i \qquad 3 \leq n + m + 1$$

Therefore, the above integration predicts a cubic is the lowest order equation that will approximate the tunneling current curve. Since $I = 0$ for $V = 0$, a_o can be set equal to zero.

$$I = a_1 V + a_2 V^2 + a_3 V^3$$

Shifting the origin, this can be written

$$I = A\,(\alpha - V)^3 + B\,(\alpha - V)^2 \qquad (3)$$

The three constants of Eq. (3) may be evaluated by demanding:

$$\left.\frac{dI}{dV}\right|_{V = V_p} = 0$$

$$I = I_p,\ V = V_p$$

$$I = 0,\ V = 0$$

The resulting equation is:

$$I = I_p \left[\frac{19}{4}\left(\frac{V}{V_p}\right) - \frac{3}{2}\left(\frac{V}{V_p}\right)^2 + \frac{1}{4}\left(\frac{V}{V_p}\right)^3\right]$$

$$= \frac{I_p}{4V_p^3}\, V\,(3V_p - V)^2 \qquad (4)$$

This is the lowest-order approximation to the actual curve, and generally agrees with the theoretical curve, for small V, Fig. 4. To obtain a more exact fit, a higher order solution can be found by noting that the tunneling current curve should approach the $i = 0$ axis tangentially as V/V_p becomes large. The final equation should also be exponential, since the original integral was of this form. Applying these conditions, the equation can be rewritten

$$\frac{I}{I_p} = f\,(V) \exp - \beta V/V_p$$

where $f(V)$ is arbitrary. Expanding $\exp -\beta V/V_p$ in an infinite series:

$$\frac{I}{I_p} = f\,(V)\left[1 - \frac{\beta V}{V_p} + \frac{\beta^2}{2}\left(\frac{V}{V_p}\right)^2 - \cdots\cdots\right] \qquad (5)$$

For Eq. 5 to conform with Eq. 4, $f(V)$ must be evaluated as:

$$f\,(V) = K\left(\frac{V}{V_p}\right) \qquad (6)$$

Where K is a constant. Substituting:

$$\frac{I}{I_p} = K\,\frac{V}{V_p} - K\beta\left(\frac{V}{V_p}\right)^2 + K\,\frac{\beta^2}{2}\left(\frac{V}{V_p}\right)^3 - \cdots\cdots$$

The characteristic equation has now become:

$$\frac{I}{I_p} = K\,\frac{V}{V_p} \exp - \beta V/V_p$$

Inserting boundary conditions as given above

$$K = e \quad \beta = 1$$

The equation for the tunneling current becomes:

$$\frac{I}{I_p} = \frac{V}{V_p} \exp\left(1 - \frac{V}{V_p}\right) \qquad (7)$$

The usual diode equation can be added to Eq. (7) to form a semi-empirical tunnel diode characteristic curve that includes the excess current, Fig. 5.

$$I = I_p\,\frac{V}{V_p} \exp\left(1 - \frac{V}{V_p}\right) + I_o\left[\left(\exp \frac{qV}{KT}\right) - 1\right]$$

Fig. 4: The lowest order approximation to the actual agrees with the theoretical curve.

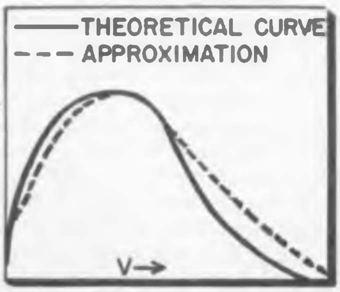
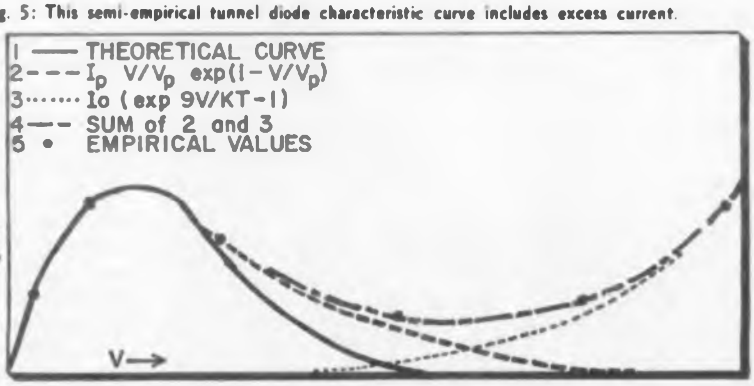


Fig. 5: This semi-empirical tunnel diode characteristic curve includes excess current.



By FINN JORGENSEN
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Mincom Division
Minnesota Mining & Mfg. Co.
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In Magnetic Instrumentation Recording...

Phase Equalization Is Important

In audio work, only a musician's ear can detect phase-distorted transients. But in instrumentation recording, phase distortion has far more importance—it can be highly detrimental. Here's how to provide proper phase equalization without sacrificing frequency response.

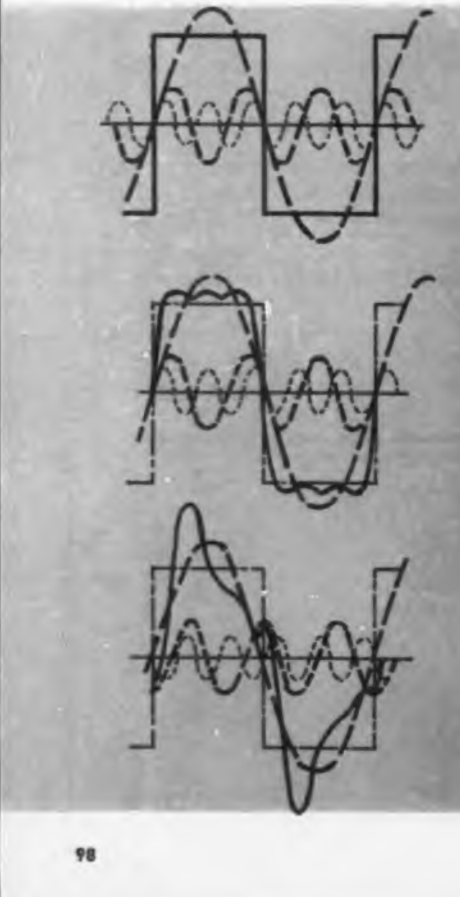


Fig. 1: Reproduction of square waves: (top) square wave input to recorder/reproducer; (center) output waveform with 1st, 3rd, & 5th harmonic in proper amplitude and phase relationship; and, (bottom) the same waveforms in proper amplitude relationship but with phase distortion.

INSTRUMENTATION recording systems are an important factor in modern science and research; and, the demands for accurate data preservation are increasing. The word *accurate* is thoroughly emphasized by MIL-specs and IRIG Telemetry Standards. Tremendous progress has been achieved in the recording field over the last decade, and the state of the art is constantly improving.

One important specification in recording is frequency response. Until recently, this has been considered to be of paramount importance, along with signal-to-noise ratio and high standards of performance in the mechanical transport of the tape. Frequency response, however, is closely allied with phase response; and when complex waveforms must be reproduced faithfully, the latter appears to be more important, even at the expense of a flat frequency response. Improper phase equalization can cause serious impairment of pulse waveforms and misinterpretation, or even loss, of vital data.

In audio work, where magnetic recording first became accepted, only a musician's ear can detect the phase-distorted transients. But in instrumentation recording, phase distortion becomes highly detrimental. Fig. 1 shows what happens to a recorded and reproduced square wave with and without phase distortion. When amplitude and phase of a waveform are correctly equalized, the reproduction is as faithful as the frequency response permits, but any phase distortion shows up very strongly. Not only is the original waveform obscured, but as the frequency of the square wave changes, the reproduced waveform also changes and the correlation with the original data may be entirely lost.

It is possible, however, to provide proper phase equalization in an instrumentation recorder without sacrifice of frequency response. For a complete understanding, we will review the magnetic record-playback process.

Record-Playback Analog

For a first approximation of the analog circuit for the record-playback process, we will consider only the inevitable ***thickness losses*** during recording and the playback equalizer to correct these losses. The thickness losses are due primarily to self-demagnetization when the recorded wavelength is in the order of, or less than, the thickness of the magnetic coating, and can be expressed mathematically:

$$\text{Thickness loss } A_t = \frac{\lambda}{2\pi c}\left(1 - \exp\frac{-2c}{\lambda}\right)$$

where,

λ = the wavelength, and

c = coating thickness.

The remanence in the coating is determined by the trailing edge of the recording field, which has both a longitudinal and a perpendicular component. For long wavelengths, the demagnetization factor N is nil for the longitudinal remanence but almost unity for the perpendicular colponent. For decreasing wavelengths, N increases for the longitudinal component and when λ equals 2π times the thickness c, it is approximately 0.5, causing a 3 db loss in the outer flux. The perpendicular component becomes more effective and will be the dominating remanence for shorter wavelengths associated with a +90° phase shift. The remanence will further concentrate in the surface of the coating and the outer flux will decrease 6 db per octave.

During playback, the flux is differentiated and a flat frequency response is finally restored through an integrator with a shelf for frequencies above f_o, Fig. 2.

Therefore, the analog circuit is as shown in Fig. 2, where the amplitude *versus* frequency curves for the flux and voltages also are shown. The net response for the record current i to the output voltage V_o is flat with no phase shift.

Other losses also play an important role in the magnetic recording, and at frequencies above f_o the first losses encountered are those caused by the finite *length of the gap* in the playback head and the *spacing* between the tape and the head interface. Mathematically these losses can be expressed:

$$\text{Gap loss:} \quad 20 \log \frac{\sin\frac{\pi l}{\lambda}}{\frac{\pi l}{\lambda}} \; db$$

$$\text{Spacing loss:} \quad 54.6 \frac{d}{\lambda} \; db$$

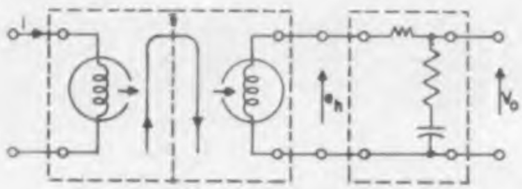
where,

l = effective gap length,

λ = recorded wavelength, and

d = distance between tape and playback head.

In the analog circuit, these losses are represented by



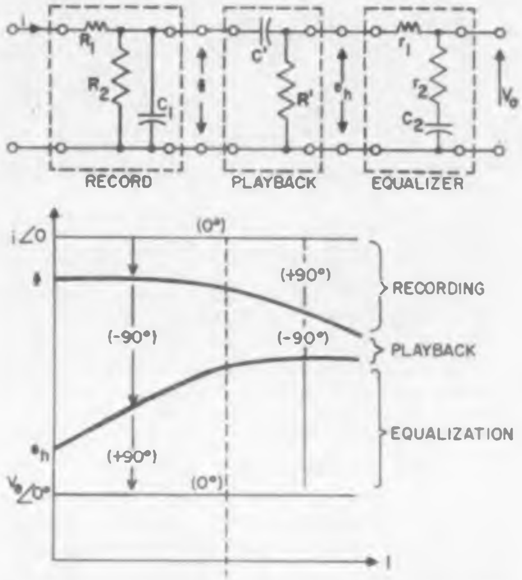


Fig. 2: This is the magnetic record-playback analog; there is no loss encountered except the tape thickness loss.

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.

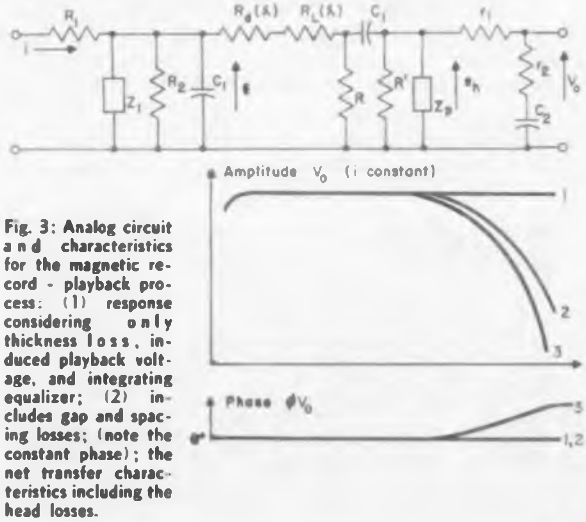


Fig. 3: Analog circuit and characteristics for the magnetic record - playback process: (1) response considering only thickness loss, induced playback voltage, and integrating equalizer; (2) includes gap and spacing losses; (note the constant phase); the net transfer characteristics including the head losses.

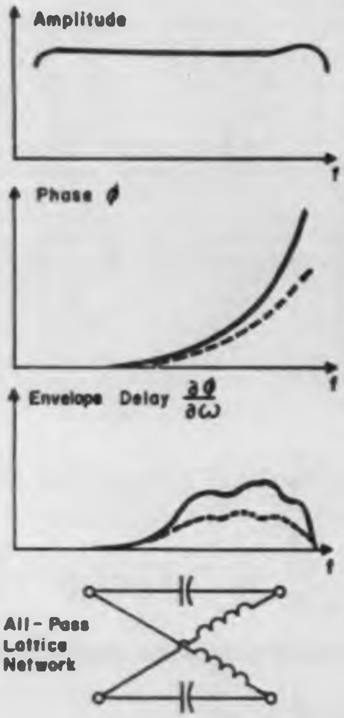


Fig. 4: The effect of standard RCL equalization upon amplitude, phase, and envelope delay of a magnetic recorder/reproducer. Insertion of an all-pass lattice network affords some improvement in the envelope delay curve (shown dotted).

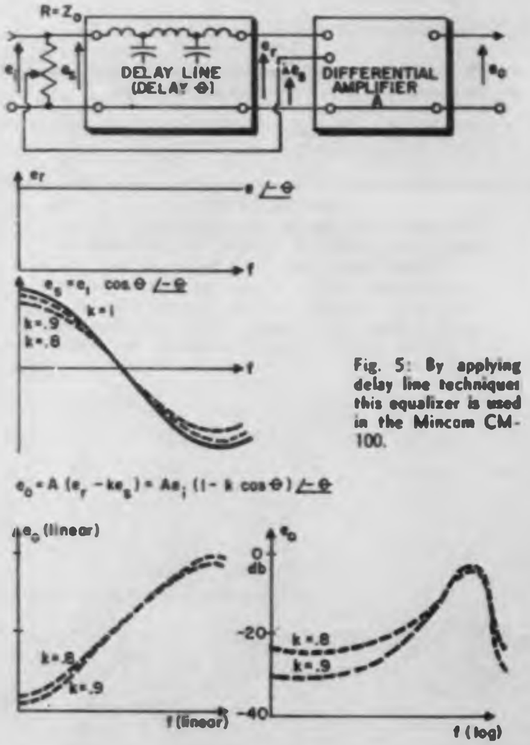


Fig. 5: By applying delay line techniques this equalizer is used in the Mincom CM-100.

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The Editor

ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

Phase Equalization *(Continued)*

R_t (λ) and R_e (λ), and the losses they introduce are *not* accompanied by phase shifts.

At very high frequencies, eddy currents in the head introduce further losses (skin-effect, complex permeability) accompanied by positive phase shifts; they are represented by Z_r and Z_p to indicate their complex nature.

Equalization

Fig. 3 shows the complete analog circuit together with the over-all amplitude and phase characteristic. Note that the magnetic record-playback process violates this almost universal rule for electrical networks: *"If the frequency response is flat within a certain frequency range, there is no phase shift within the same range."* Without discrimination, this rule has been applied to magnetic tape recorder/reproducers, and the amplitude characteristic simply equalized with common RC and/or RLC networks.

Before we discuss how this distortion can be partly corrected or, by proper equalization, eliminated, we will introduce the concept of *envelope delay.*

Consider a four-terminal network with a certain phase characteristic:

$$\phi = f(\omega)$$

where, $\omega = 2\pi f$ the envelope delay is defined as:

$$T = \frac{d\phi}{d\omega}.$$

It is simply the slope of the phase characteristic, and its magnitude is equal to the transmission time for the corresponding frequency. If the phase characteristic for a given network varies linearly with the frequency, the envelope delay T is a constant and all frequencies arrive at the output simultaneously, so a complex waveform is correctly reproduced. But if the slope varies, different frequencies will arrive at the output with different time delays, and destructive interference will result.

Now let us return to the problem of correct equalization. RC and/or RLC networks can easily produce the necessary equalization which results in a flat frequency response, Fig. 4. But the phase characteristic will be nonlinear and result in a considerable envelope delay for the higher frequencies. If an all-pass lattice network is inserted after the equalizer, we can obtain a more linear phase characteristic and consequently reduce the envelope delay.

Natural Solution

From the analog circuit we recall that there were certain losses during recording as well as during playback; and, since the tape, to be properly used, should leave the record head with a constant flux (less, of course, the thickness losses), both pre- and post-equalization are used in most recorders. Therefore, a natural solution is to apply constant phase equalizers rather than add phase-correcting networks to a standard recorder where the pre-equalizer already has recorded considerable high frequency phase distortion

Fig. 6: Overall envelope delay curve for the Mincom CM-100; the tape speed is 120 cps.

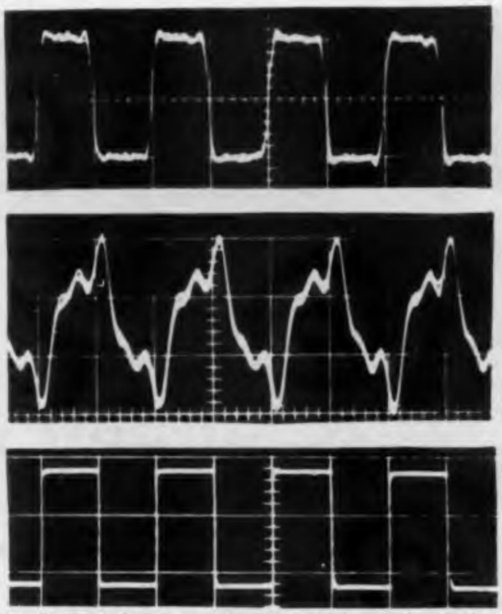


Fig. 7: (Top) Square wave input; (center) reproduction from a recorder with no phase equalization; and (bottom) the reproduction from a recorder with proper phase equalization.

onto the tape. Furthermore, it removes the problem of phase matching.

Such equalizers are sometimes used by applying delay line technique. The equalizer is shown in Fig. 5. The input voltage e_i is transmitted along the delay line and received without attenuation at the receiving end. Since the termination here is open circuited, the signal is reflected and combines with e_i at the transmitting end to the voltage e_s. The termination here is equal to the characteristic impedance Z_o of the delay line, and there is no further reflection. The voltage e_s at the sending end, therefore, will vary cosinusoidally with frequency because of the reflected signal.

When the voltages e_r and a slightly attenuated portion ke_s are applied to a differential amplifier, the output voltage e_o will vary with frequency as shown.

In practice, the value of k is in the order of 0.99, resulting in a 40 db attenuation of the low frequencies and a rise toward 0 db at f_o'. When k equals unity, the slope approaches 12 db/octave with no phase shift from input to output of the equalizer.

We use one delay line equalizer in the record circuitry to overcome the record losses, and one in the playback circuitry where a low-pass filter with a Gaussian roll-off also is incorporated. This eliminates noise and unwanted frequencies above the upper frequency limit of the recorder, and the Gaussian characteristic assures a smooth attenuation with excellent phase response.

Fig. 6 shows the over-all envelope delay curve to be well within $\pm 1/10$ µsec which assures exceptionally good pulse reproduction. This is shown in Fig. 7 for 10 µsec pulses separated by 10 µsec. The input to the recorder is a well-defined square wave and the photographs below it show the reproduction from a standard recorder (b) and from the Mincom CM-100 with constant phase and better frequency response (c). In (b) the phase distortion is heavy with the high frequencies arriving too soon, but in (c) the reproduction is faithful, clearly underlining the most important role of proper phase equalization.

Shifted Raster Reads Variable Font

ALTHOUGH many firms are interested from the inventory control aspect, the Post Office has been the driving force behind activity in the automatic reading machine field.

Since the Post Office has no control of the printed material to be read by the machine — the addresses—it requires a device that can automatically read not one, not several, but various styles of typewriter print and a large range of print sizes obtainable from the printing press.

One of the latest entries into the race for an acceptable machine and a very promising one, is that of the Philco Data Recognition Dept., Blue Bell, Pa.

This data recognition system reads about 60,000 written characters a minute—the average person reads 1500. The device being developed for the Post Office will read addresses on envelopes by separate recognition of individual letters and numbers. Combined with a mail sorting machine supplied by the Post Office Dept., it will read 36,000 letter-sized envelopes per hour.

If we stop to think for a minute about the various fonts of type available, and don't forget *italics* in the same font, we can begin to appreciate how tough a job this can be. Philco's solution is the use of a flying spot scanner with a raster which shifts automatically until it recognizes the type face, spacing, and the possibility of *italics*.

The flying spot beam from the CRT at the left is focused through the lens in the center to scan the letter. The unit is capable of reading machine printed alpha-numeric symbols but not handwritten ones.

From the knowledge gained through solid state electronics, and the study of transistors and epitaxial growths, the art of thin-film technique developed. The building of crystalline structures by vaporizing and other methods introduced new processes to grow metallic structures for electronic applications. The technology has made extraordinary progress in the creation of electronic components, and is leading to many revolutionary concepts.

A Survey of Thin-Film Technology

BY JOHN WATKINS
Assistant Editor
Electronic Industries

Part Two of Two Parts

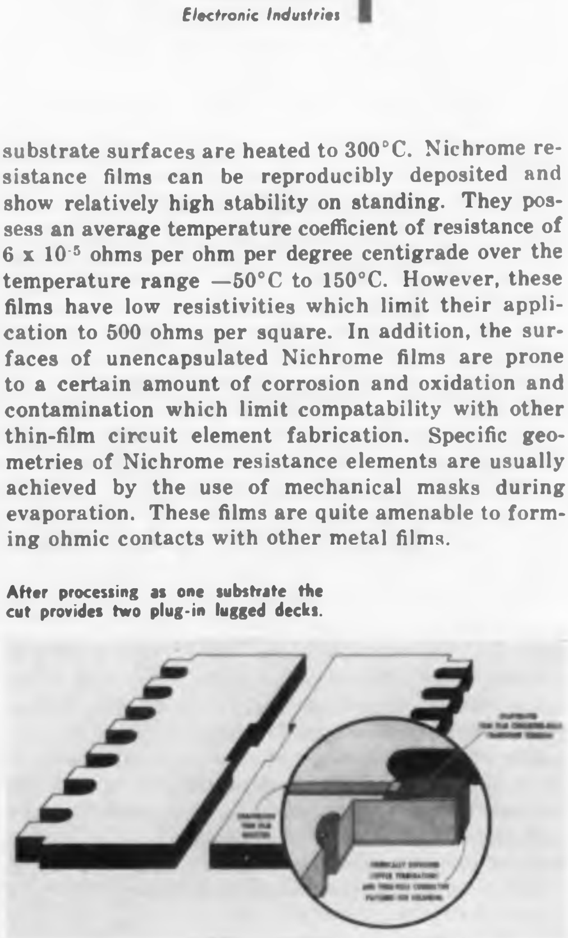
RESISTANCE may be provided in integrated circuits in at least four ways. The three intrinsic ways are by bulk resistivity, by transverse conduction in thin diffused back-biased regions within a semiconductor substrate, or by an epitaxial layer of opposite impurity back-biased with respect to the parent substrate. The extrinsic way is by deposited thin-film resistors on top of the substrate. Each method has particular advantages for certain applications and a complete integrated circuit capability requires mastery and evaluation of each. Both methods may be sensitive to their ambients.

Tin oxide films have reached sheet resistance values of over 5000 ohms per square. With conventional resistance patterns, values of up to 1.0 megohm can be achieved. The films are produced by hydrolysis in a technique that has been brought to a high degree of development.

Indium oxide films have been produced by a two-step metallizing-oxidizing process involving a vacuum deposition of pure indium in a low pressure pure O_2 atmosphere followed by a low temperature (below 200°C) thermal oxidation for several hours. This low temperature technique has application in instances where higher temperature resistance fabrication would damage other temperature sensitive thin film functions.

Nichrome films can be evaporated directly on clean substrates by volatilizing the alloy from a tungsten heater. These films show excellent adhesion when substrate surfaces are heated to 300°C. Nichrome resistance films can be reproducibly deposited and show relatively high stability on standing. They possess an average temperature coefficient of resistance of 6 x 10^{-5} ohms per ohm per degree centigrade over the temperature range —50°C to 150°C. However, these films have low resistivities which limit their application to 500 ohms per square. In addition, the surfaces of unencapsulated Nichrome films are prone to a certain amount of corrosion and oxidation and contamination which limit compatability with other thin-film circuit element fabrication. Specific geometries of Nichrome resistance elements are usually achieved by the use of mechanical masks during evaporation. These films are quite amenable to forming ohmic contacts with other metal films.

After processing as one substrate the cut provides two plug-in lugged decks.



Back-Bias Types

Diffused back-biased regions cover the class of resistors formed by transverse conduction within a thin diffused back-biased layer of semiconductor. They cover a much wider range of values and have additional advantages in their possible range of temperature coefficients. By control of the diffusion profile it is possible to achieve positive, negative, or substantially zero temperature coefficient at room temperature. The difficulty in using diffused resistors in practical circuits lies in their great sensitivity to the back-biasing voltage including the self-generated component of back bias caused by the voltage drop in the resistor. Where very high resistance of non-critical value is required, diffused resistors may have great value. Their other attractive application is in circuits needing an electrically alterable resistance.

Epitaxially grown resistive layers can form resistive regions with useful characteristics. The method is similar to the diffused back-biased resistance described above but the epitaxial process promises better control of the junction characteristics. The epitaxial resistor requires a compatible masking technique during layer growth if mesa techniques and wet chemistry are to be avoided.

Resistor Construction

As an alternative to the carbon resistor, attention has been centered on the use of metal alloy films deposited chemically, or physically onto a ceramic, or glass substrate. Applications such as deposits on ceramic rods, by evaporation of nickel chrome films in a high vacuum, have shown much success.

The evaporated metal film resistor has the great advantage that it can be made with a substantially zero temperature coefficient of resistance by deposition of the correct alloy composition on a substrate.

Through the use of masks, patterns can be produced to make multiple resistors in one evaporation. In some instances, conductors, resistors and insulators can be deposited to form laminar circuits. Satisfactory resistors can be made from semiconductors such as oxides of tin, and antimony deposited onto a substrate.

Looking to the future, the use of monocrystalline elements such as silicon suitably doped into the correct resistivity range, is more attractive as it presents the possibility of making resistors together within the same block of material. If the resistance and temperature problems can be overcome, the advantages will be considerable.

A recent application by RCA, at the micro-electronics Department, produced a vacuum deposition resistor directly on a substrate in the form of a ceramic rod resistor, 0.020 inch diameter by 0.1 inch long. Each end of the resistor was metallized for soldering to the circuit pad. The resistive was vacuum deposited on a 0.060 inch of the body and covered with a deposited inorganic film and a silicone resin to avoid damage during handling.

Design of Thin-Film Resistors

The geometrical design of Thin-Film resistors is discussed in detail in the following description based on CBS Electronics research data.

A Univac engineer is shown taking thin Film substrate measurements of individual spot parameters.

Thin-film resistors to be produced in multiple on microcircuit substrate can be calculated if the following information is available;

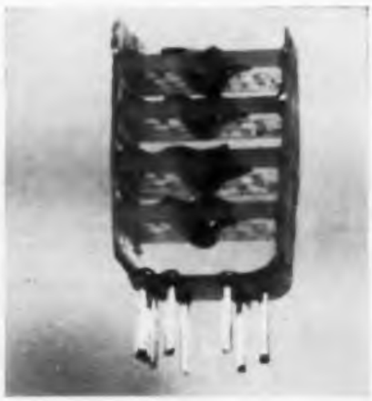
1) The value required for each resistor.
2) The watts to be dissipated in each resistor.
3) The ambient temperature of the substrate.
4) The approximate area available for each resistor.

Three charts have been designed to assist in the design of these resistor arrays.

Chart 1 presents the unit resistance values, using lin. as the unit of length for various line widths, and several practical thicknesses of chromium films given in ohms per square.

Chart 2 is a graph relating film thickness in ohms per square to the loading, in watts per square in. allowable on a glass or Fotoceram substrate to maintain a reasonable stability for normal life under a load at 25°C ambient.

Experimental data is being validated to stabilize it at less than a 3 per cent change in resistance during a 1000 hour load life. At present it serves as a reasonable design basis.



A four layer unit of computer logic circuits by I.R.C. Philadelphia.

Thin Film *(Continued)*

Another chart shows the derating curve for ambient temperatures up to 150°C which must be applied to the loading in watts per square in. determined by Chart 2 where a resistor is to operate above 70°C. This derating curve is consistent with characteristic B of MIL-R-10509C for fixed film resistors.

The desired value of a resistor (R) is related to the unit resistance from Chart 1 (R_1) and length in inches by the formula;

$$L = \frac{R}{R_1}$$

The evaporation of a single thickness of film for all resistors on a substrate is a practical requirement. A choice of this film thickness must be made, considering both permissible loading and available area for all the resistors.

Generally a choice of resistor parameters is possible. The practical approach is to work toward the heaviest film (lowest ohms per square) without losing sight of the physical dimensions of the resistor. The total area for placing a high value resistor may restrict the thickness of a film that can be chosen. Extremely short lengths require high accuracy in the conductor registration to obtain accurate resistance values in production.

A consideration of the several possible geometries can be obtained from Chart 1 and a tentative film thickness chosen.

For this chosen thickness a maximum permissible loading is obtained from Chart 2 and modified for the ambient temperature at which the substrate is to operate from another prepared chart.

Having this permissible watts per square in. and the desired watts to be dissipated, the minimum allowable square ins. can be calculated from;

$$\text{minimum area} = \frac{\text{watts dissipation of resistor}}{\text{watts per square in.}}$$

(Chart 2)

An actual area for the required resistance value (R) is then;

$$\text{Actual area of } R = \text{width} \times \text{length, where length} = \frac{R}{\text{unit resistance from Chart 1 } (R_1)}$$

When the length of the resistor is greater than the length of the allocated areas, a simple folding of the resistor line for maximum surface utilization can be resorted to. The insulating area between folds should be held to at least .002 in.

Example;

Find the minimum practical area required for three 0.1 watt resistors of 2K, 5K, 10K value operating at 110°C ambient.

Solution;

Space is a controlling factor for the 10K resistor as seen from a study of Chart 1. Allowable loading may be a determining factor for the 2K resistor if too thin a film is chosen. Supposing a 500 ohms per square had been chosen. The new minimum area for adequate dissipation would be $\frac{.1}{2.5} = .04$ sq. in.

Now examine the 2K resistor;

The 500 ohms per square column (Chart 1) shows a .100 in. width which gives a 5000 ohms/ one in. line and a length of $\frac{2000}{5000} = .04$ in. The area then will be 0.04 sq. in., which is adequate for the dissipation requirement, but it is not a desirable resistor configuration because of its excessive width.

With experience the circuit translator learns to select for his starting point a film thickness which pro-

GLOSSARY OF TERMS

To avoid ambiguity the following terms are defined

Active . . . The condition when a device is acting as an amplifier, or an active device capable of any form of amplification. The transfer of a quantity of energy to an atomic system to raise it to an excited state, in which it can participate in a process not possible when the system is in its ground state.

A; Angstrom, the Angstrom unit equals 10^{-8} centimeters. Visible light has a wavelength of a few thousand (4000-7500) Angstroms.

Anodise . . . A process used to impart corrosion resistant or decorative colored films to metal surfaces. The protection afforded by the oxide film ordinarily present on the surface of aluminum articles is considerably increased by building up this film by anodic oxidation. The process is useful for identification by coloring components, and for creating dielectric surfaces as the anodization provides an insulating film.

Back-wall Photovoltaic Cell, a cell in which the light must pass through the front electrode and a semi-conductor layer before reaching the barrier layer.

Barrier layer. An electrical double layer formed at the surface of contact between a metal and a semi-conductor, or between two metals, in order that the fermi levels in each material should be the same.

Epitaxy. The oriented intergrowth between two solid phases. The surface of one crystal provides, through its lattice structure, preferred positions for the depositions of the second crystal.

Fermi level, the point of an energy level diagram corresponding to the top of the fermi distribution; or the energy level (in a semiconductor) for which the Fermi-Dirac distribution function has a value of ½.

Magnetostriction. The term literally implies magnetic contraction, but it is understood to include a number of closely allied phenomena relating to ferromagnetic substances under magnetic influence.

Junction p-n type, a region between p and n type semi-conducting material.

Photon, a quantum of electromagnetic energy.

Permeability, the capacity of a membrane or other material to allow another substance to penetrate or pass through it. Absolute permeability, B/H, or magnetic induction divided by magnetizing force.

Photovoltaic Effect, the production of an electromotive force by incidence of radiant energy, commonly light, upon the junction of two dissimilar materials, such as p-n junction or metal semi-conductor junction.

Piezo-electric Effect. The interaction of mechanical or electrical stress-strain variables in a medium. Piezo-electricity is only possible in crystals classes which do not possess a center of symmetry. The directions in which tension or compression develop polarization parallel to the strain are called the piezo-electric axis of the crystal.

Q . . . A figure of merit equal to wL/R for an inductor, where R is the equivalent series resistance. For a capacitor, Q is 1/wCR, again the ratio of reactance to effective resistance. For a medium Q is the ratio of displacement current density to conduction current density. The basic equation may also be expanded to include series and parallel resonant circuits, for which cases appropriate approximations of equations may be developed. Q value is also used as a synonym for nuclear disintegration energy.

duces a satisfactory geometry for production of all resistors.

Conduction

Evaporation of conductors covers the vaporization of metals at high temperatures in vacuums at 10^{-4}mm Hg or better. The metallic vapor moves in substantially straight lines onto a substrate which may be mechanically masked to limit the deposition to desired regions. The substrate must be very clean and must generally be raised to an elevated temperature in order to assure intimate contact of the particles with the substrates after impact before solidifying. Alternative means of producing conductive material by one of a number of techniques. Evaporation may be of a single metal or of an alloy. In the latter case the deposition may be made simultaneously from a common source or sequentially from separate sources, after which the substrate may be heated to produce an alloy on the surface of the substrate. If the alloy penetrates the substrate, as in the case of a semiconducting substrate, the result is classed as intrinsic.

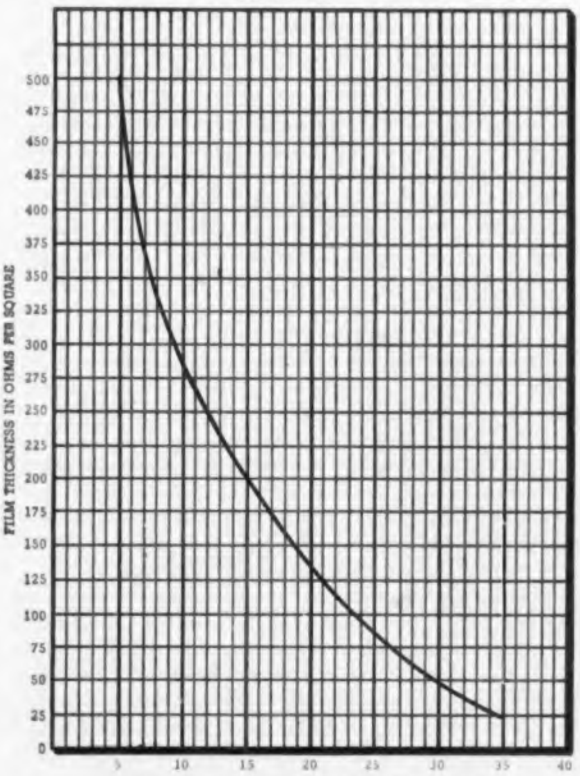
In the study of conductors by deposited techniques, resistivities below one order of magnitude higher than metal conduction have been achieved. Where mechanical or thermal considerations made adhesion more important than achieving the lowest ohmic resistance the introduction of a chrome-gold alloy has been useful.

Sputtering differs from the evaporation process discussed above in the conditions under which the conductive material reaches the substrate. Sputtering is the result of a glow discharge between an inert anode and a bombarded cathode of the desired conducting material. Because the presence of gas at 10^{-2} to 10^{-4}mm Hg is necessary for the generation of the ionized bambarding molecules, the sputtering process is inherently harder to keep clean. Even so the process has certain advantages over vacuum evaporation in the relatively low temperatures needed or generated in the system, and thus the lower chance of contamination from the evaporative source. It finds one of its most important applications in the production of thin films of tantalum for resistors or capacitors.

Pyrolysis as used for deposition of conducting films is the same process discussed previously for insulators. It has the advantage of flexibility of materials and conditions of deposition but the disadvantage that the deposited material cannot be masked by mechanical shields as satisfactorily as the vacuum evaporated materials. Pyrolysis finds application where an entire surface can be coated as for electrostatic or magnetic shielding, or where the unwanted material can be removed selectively after deposition. Pyrolysis may also be carried out on selective regions under certain circumstances by employing a catalyst.

Plating of conductors includes electroplating, chemical or electroless plating, and vapor plating. Electroless plating tends to cover everything as does vapor plating. Selective removal of unwanted material can be combined with electroplating to build up conduct-

Chart One



Resistance charts by permission of CBS Electronics.

Chart Two

UNIT FILM RESISTANCE CHART

Line Width in Inches	Resistance of 25 ohm/sq. film 1" long	Resistance of 50 ohm/sq. film 1" long	Resistance of 100 ohm/sq. film 1" long	Resistance of 150 ohm/sq. film 1" long	Resistance of 200 ohm/sq. film 1" long	Resistance of 300 ohm/sq. film 1" long	Resistance of 400 ohm/sq. film 1" long	Resistance of 500 ohm/sq. film 1" long
.006	4166	8333	16,666	25,000	33,332	50,000	66,664	83,333
.007	3560	7120	14,240	21,360	28,480	42,720	56,960	71,200
.008	3140	6280	12,560	18,840	25,120	37,680	50,240	62,800
.009	2790	5580	11,160	16,740	22,320	34,480	44,640	55,800
.010	2500	5000	10,000	15,000	20,000	30,000	40,000	50,000
.011	2275	4550	9100	13,650	18,200	27,300	36,400	45,[illegible]00
.012	2080	4160	8320	12,480	16,640	24,960	33,280	41,600
.013	1920	3840	7680	11,420	15,360	22,840	30,720	3[illegible],400
.014	1780	3560	7120	10,680	14,240	21,460	28,480	33,600
.015	1665	3330	6660	10,000	13,320	20,000	26,640	33,300
.016	1565	3130	6260	9390	12,520	18,780	25,040	31,300
.017	1470	2940	5880	8820	11,760	17,640	23,520	29,400
.018	1385	2770	5540	8310	11,080	16,620	22,160	27,700
.019	1315	2630	5260	7890	10,520	15,780	21,040	26,300
.020	1250	2500	5000	7500	10,000	15,000	20,000	25,000
.021	1170	2340	4680	7020	9360	14,040	18,720	23,400
.022	1135	2270	4540	6810	9080	13,620	18,160	2[illegible],700
.023	1085	2170	4340	6510	[illegible]	13,020	17,360	21,700
.024	1040	2080	4160	6240	8320	12,480	16,640	20,800
.025	1000	2000	4000	6000	8000	12,000	16,000	20,000
.050	500	1000	2000	3000	4000	6,000	8,000	10,000
.100	250	500	1000	1500	2000	3,000	4,000	5,000

Thin Film *(Continued)*

ing paths. Both electroplating and electroless plating suffer from danger of contamination from the wet chemistry involved. Vapor plating is capable of achieving high-purity deposition.

Mechanical Coating includes conducting glass pastes which can be painted onto gross terminal pads to bridge irregularities that vapor deposition cannot manage. It also includes various solders that may find temporary use in making conductive paths to external terminals. The conductive glasses have the advantages of bonding well to many substrate materials and of reasonable match in thermal expansion coefficient.

Inductance

Deposited nickel-iron films are among the extrinsic means available for storing energy resulting from the flow of current. Deposited nickel-iron films of 82%-18% composition and 1000A to 4000A thickness have been used for storing energy for logical matrices and as small-valued low-frequency inductors. A requirement is the presence of a magnetic field during the deposition process to orient the magnetic anisotrophy. Unfortunately this limits the magnetic film configuration to simple forms. If the driving magnetic field is applied in the direction of the "easy" magnetization of the domains, a square-loop B-H curve results which is useful for memory and for magnetic logic applications. When the magnetic field intensity is applied normally to the direction of "easy" magnetization, a more linear B-H curve results which is useful for linear systems and impedance transformation.

Deposited ferrites have possibilities as a second extrinsic technique for obtaining inductance. Glass, which is a mixture of metal oxides, is currently deposited by the pyrolytic decomposition of suitable metallic-organic esters. The reaction temperature required to form the ferrite material from mixed oxides is in the order of 300°C. Since ferrites do not have the same magnetic anisotrophy as thin nickel-iron films, no magnetic field is needed upon deposition and the form factor is not limited as it is with metallic films. Magnesium-manganese ferrite material provides a square-loop B-H curve and is, therefore, suitable for magnetic logic elements. Manganese-zinc ferrite provides a high Q linear material usable to about 500 kc. Nickel-zinc ferrite provides a high μQ linear material suitable for the frequency range 0.5 to 100 mc. By proper masking methods it is possible to form thin-film solenoids which surround such deposited ferrite materials and provide a means for coupling energy into and out of the material. Finally ferrite materials possess variable permeability which is a function of the applied dc magnetic field, and this can provide a control element for ac magnetic flux. Such variable inductors can serve as electronic tuning elements or other control elements.

Air core geometries are suitable for r-f coils and other high-frequency small-valued inductors. It is possible to deposit "air core" pancake-type windings of thin-film conductors. When associated with thin-film insulators of low dielectric constant the pancake-type winding can be formed in multilayers to increase the total inductance of the element.

Ferrite substrates provide the possibility of using a single or multi-aperture ferrite material both as an inductive core and as a substrate for other integrated circuit elements. The coupling to the ferrite can be achieved by thin-film conductors. These elements, because of dependence of their permeability on the applied field, can also serve as a means for controlling magnetic flux.

Photovoltaic Cells

Photovoltaic cells are self-contained current and voltage generators, which produce a potential difference between their terminals when exposed to light or ionizing radiation. Recent research by RCA laboratories, has investigated the use of Thin-Film in the application of polycrystalline photovoltaic cells.

The essential properties that a Thin-Film of a polycrystalline semi-conductor must possess to be applicable to this type of cell is described.

In the case of a p-n junction cell, the thickness of the film must be great enough to absorb an appreciable amount of the protons having an energy greater than the band gap of the film material. In addition the carrier diffusion lengths must be equal or exceed the film thickness. A polycrystalline layer must have minimum grain size at least equal to the film thickness. This ensures that a carrier diffusing towards the junction will not be intercepted by a grain boundary and thus have the opportunity to recombine. In the case of a metal semi-conductor junction these requirements for a thin layer may not have to be as astringent as for a p-n junction device.

The silicon p-n junction electronvoltaic cell unveiled in 1954, converted radioactive radiation into electrical energy with practical efficiencies. At the same period a silicon p-n junction photovoltaic cell was developed to give a solar conversion efficiency of 6 per cent. Recent production line units have obtained 10-14 per cent, and laboratory units have reached 15 per cent. The advent of this cell made it possible to convert useful amounts of solar energy directly and efficiently into electricity. The present cost of silicon cells is about 200 dollars per watt for high efficiency cells, and 100 dollars for low efficiency cells.

Cadmium sulfide photovoltaic cells have been investigated by RCA Laboratories to find the feasibility of large-area Thin-Film cells. A brief description of this technique follows:

Thin-Film cadmium sulfide layers were deposited on a transparent conducting (tin oxide Pyrex* substrates). The pressure during evaporation was slightly lower than 10^{-5}mm Hg. These layers were about 1-2 microns thick and were hard and adherent.

Microscopic observation revealed the layers to be microstalline and free of pin holes. Their optical properties appeared to be very similar to cadmium sulfide single crystals and were transparent to wavelengths greater than 5200A. There was no visible evidence of layer deterioration even after standing for several months in the atmosphere. Indications show the resistivities of the layers to be about 100 ohm-cm.

The photovoltaic cell was completed by applying an

* Registered Trade Mark

opaque layer of copper to the exposed surface of the cadmium sulfide layer. Electrical contacts to the cell were made on the copper layer and on the tin oxide. The transparent tin oxide coating appears to make an ohmic contact to the evaporated cadmium sulfide film.

Thin-Film Superconductors

A discovery made by Ivar Giaver of General Electric Research Laboratories is contributing to tunneling and superconductivity technology, using Thin-Film applications. In 1960 it was announced that tunneling had been observed in devices consisting of two metal thin films, which were separated by a thin insulating layer, with one or both of the films in the superconducting state.

From the phenomena of these functions it may be possible to new forms of diodes, switches, triodes, resistors or capacitors.

In this device the tunneling occurs through the simple barrier of an insulating film, rather than through the charge depletion region of a semiconductor p-n junction.

If the tunneling of electrons is regarded as waves rather than particles of energy, the transmission through the thin layer can be better understood. When the charge-carrying waves strike a barrier, such as an insulator, almost all of them will be reflected back from the barrier. Possibly a portion of the waves will pass through the barrier if it is thin enough. On the other side the presence of these tunneling waves can be detected as current. A substantial current may flow through the barrier film due to the large number of waves generated.

To produce a capacitor it was found necessary to make the insulating film infinitesimally thin, in the region of 10 to 100 atoms thick. In using ultra thin insulating films it was found that when one of the conducting films was a superconductor, instead of a straight line graph showing the current increased proportionately with voltage, a convex curve was produced. This indicated that a tunnel diode effect might be involved.

This led to the revelation that a region of "negative resistance" in which the current decreases with voltage, when both metal films were superconducting.

It was apparent that certain energy levels in a superconductor are "forbidden" to electrons, and that where energies are equal in the metal film the electron cannot tunnel through.

The negative resistance effect is unique in that it is independent of the direction in which the current flows. Which is not the case in a tunnel diode. In addition the negative resistance may be changed by subjecting the device to a magnetic field or by changing the temperature.

These experiments have been conducted using thin-films of aluminum, lead, indium, and tin, all of which are superconductive near liquid helium temperatures.

In almost all the experiments, aluminum oxide was the insulating layer. It was found also possible to obtain tunneling with tantalum oxide, niobium oxide, and nickel oxide as well.

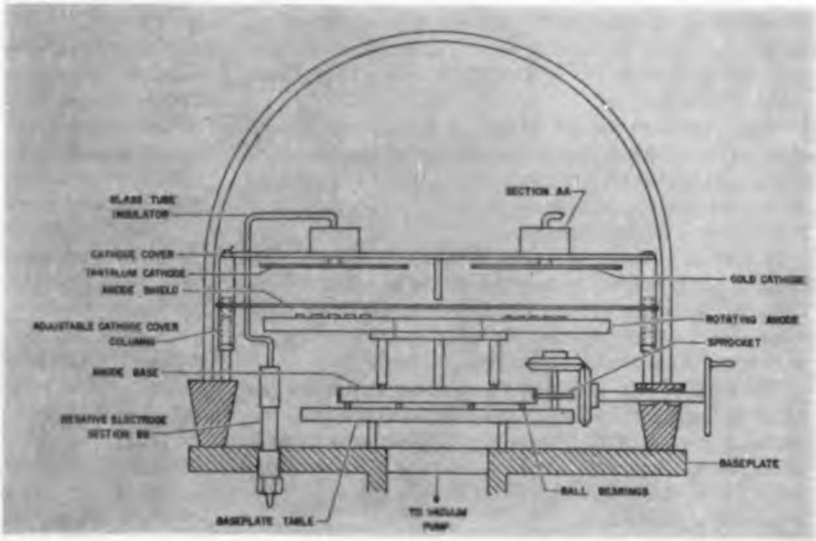
Thin-Film Amplifiers

New means for achieving electronic amplification based on thin films has been demonstrated recently.

The term "Metal Interface Amplifier" (MIA) designates a new Thin Film device developed by Philco Research Division. Experimental devices are described and the central role played in them by thin metal films.

The amplifier in its present form consists of a thin film sandwich of metal, metal oxide, and metal deposited on a germanium substrate. Under the control of signal voltages applied across the two metal films, "energetic" electrons are transferred through the intermediate oxide layer by the process known as quantum-mechanical tunnelling. The inner metal layer is so thin that these injected electrons pass completely through to the succeeding layer where they undergo an energy boost. At the same time, electrons normally residing in this thin metal film at low energy remain confined by natural electrical barriers at the metal interfaces and do not contaminate the process of controlled conduction of injected electrons.

The two metal layers and the germanium substrate serve as injector, control film, and collector respectively corresponding to the emitter, base, and collector



A diagram of a multiple cathode sputtering system.

Thin Film *(Concluded)*

of the transistor. The MIA cannot be classed as a transistor, however, since electron current through the metal base is actually the flow of "majority carriers." This is distinct from transistors where base current is always effected by the flow of "minority carriers" in a semiconducting material. The MIA likewise differs from tunnel diodes, either as semiconductors or as cryogenic metal films, which depend on a negative resistance characteristic between two terminals. Moreover, the three-terminal arrangement permits isolation of the circuits which couple energy in and out of the device.

The power gain characteristics of the MIA have been demonstrated in several fashions. Initially, power gain was computed from detailed measurements of the electrical characteristics of the device, thereby confirming theoretical predictions. The MIA has since been combined with suitable passive elements to form an oscillator.

Significance of the MIA lies in low cost, reliable circuitry, microminiaturization techniques. Indications show higher operating frequencies, bandwidths, gain, and power handling capabilities are possible. The use of films of polycrystalline metals and their oxides may lead to devices to operate over a wider temperature range, and which withstand greater radiation fluxes, without sustaining permanent damage in all respects—undoubtedly the electronic theories. It is anticipated the MIA will supercede the transistor and successful prototypes indicate this potential.

Sputtering

Philco Research Division have had considerable success in the development of sputtering techniques, and a brief description of the technique is given. An arrangement for sputtering tantalum is shown in the diagram. A plain tantalum cathode, 6 in. sq. and ¼ in. thick, is suspended from the grounded cathode cover. The glow discharge from the upper surface of the plate is avoided by making the gap "D" less than the crookes dark space between the cathode and anode, thereby confining the discharge to that region, which results in much higher sputtering current densities. It also prevents the metal being deposited on the upper surfaces of the bell jar.

The substrates are preheated by a nichrome heater element attached to the underside of the anode which is also connected to a thermocouple. The anode can be raised or lowered in respect to the cathode to obtain optimum sputtering conditions.

A gold cathode is suspended from the grounded aluminum cover which serves the same purpose as the tantalum cathode cover. The cover is attached to a rotary arm which enables the gold cathode to swing between the anode and cathode.

The cathode acts also as a shield to prevent tantalum oxide being deposited onto the substrates during the cleaning period of the tantalum cathode, which takes about ten minutes. The gold cathode is cleaned by allowing it to sputter for several minutes well out of the way of the substrates.

The positive side of the high tension supply is grounded, and taken into the chamber via the baseplate. The negative side of the supply enters the system via a high voltage terminal. The lead wire from this terminal plugs into the tantalum cathode suspension stud, otherwise the bare end of the negative terminal would discharge to ground unless closely encased by the grounded covers; the function of which is exactly the same as the cathode covers.

The thickness of the tantalum film on the substrate is measured by the resistance of the tantalum deposited on a small monitor alongside the substrate on the anode.

The sputtering was performed in an argon atmosphere of 50-100 microns Hg. The cathode potential was approximately 2500 volts, and the current density approximately $2ma/cm^2$. The cathode to anode distance was 1 in.

With a six in. sq. cathode, only a central area, three ins. sq. can be used if the same value of sheet resistivity is to be obtained for all circuit plates, as thirty-six ½ in. wide substrates can fit into this area with adequate zone safety.

It was discovered that if the cathode is not utterly clean before operation the sheet resistivity distribution will be inconsistent.

An interesting effect was shown in the sheet resistivity of the monitoring resistor which was always about 10 per cent higher than the substrates around it. The effect was attributed to the passage of current through the tantalum film as it was deposited. Investigations into the cause of this effect have so far enabled no conclusions to be drawn.

Acknowledgments

This survey is made from the studies of many engineers and companies who provided most valuable assistance, and are acknowledged with appreciation.

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Texas Instruments Incorporated, Dallas, Texas.

Dr. John Bohrer, International Resistance Co., Phila., Pa.

David Moore, Lear Inc., Solid State Physics.

Contributions were helpfully given by British Communications & Electronics.

Mr. A. C. Lynch, Post Office Research Station, England.

Mr. G. C. Gaut, Plessey Co., England.

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Interpreting Transistor Noise Performance

Equivalent Noise Voltage can prove a useful, and simple concept as a noise factor. With relatively inexpensive equipment the ENV can be measured, and a noise figure can be obtained from a single algebraic calculation.

WITH the advent of the production of silicon double-diffused mesa transistors in large quantities, the circuit designer now has available transistors which combine many desirable features. Not the least of these is a high degree of uniformity in many parameters, including that of excellent low-noise characteristics. This article evaluates "Equivalent Noise Voltage" referred to the input, as a useful measure of transistor low-noise performance, compared with the commonly used parameter Noise Figure. The effects of source impedance variation are illustrated.

Theoretical Background

Transistor noise is due to several phenomena intrinsic to the device. This noise is termed fluctuation noise, and its important sources can be summarized:[1]

(A) Semiconductor or "excess" noise, which is believed to be a consequence of surface phenomena, such as collector leakage, and which has been empirically determined to have a frequency dependent characteristic

$$\overline{v^2} = \frac{K_1 V_c}{f^n} \qquad (1)$$

where $0.9 < n < 1.2$.

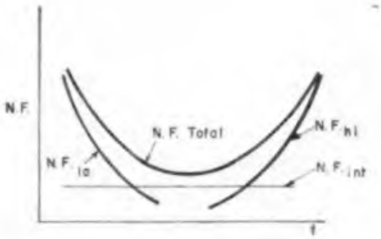
(B) Shot noise associated with the flow of carriers across the emitter-base junction

$$\overline{v_2} = K_2 I_e r_e^2 B_{eff} \qquad (2)$$

(C) Shot noise associated with the flow of carriers across the collector-base junction

$$\overline{v^2} = K_3 I_c r_c^2 B_{eff} \qquad (3)$$

Fig. 1. Frequency dependent Noise Factor Components.



(D) Shot noise associated with the partition of emitter current between collector and base

$$\overline{v^2} = K_4 I_e B_{eff} \qquad (4)$$

(E) Thermal noise generated by the base resistance r_b, which according to Nyquist's theorem is

$$\overline{v^2} = 4\,kT\,r_b\,B_{eff} \qquad (5)$$

where, in the above equations,

V_c is collector voltage
r_e is emitter resistance
r_c is collector resistance
r_b is base resistance
I_c is collector current
I_e is emitter current
k is Boltzmann's constant
T is temperature in degrees Kelvin
B_{eff} is Effective Noise Bandwidth
K_1, K_2, K_3, K_4 are empirically determined constants

These several sources can be lumped into three terms: 1/f noise, shot noise, and thermal noise.

The above equations contain a term B_{eff} for Effective Noise Bandwidth. This is the bandwidth of the idealized power passband, i.e., a rectangle with the same height and total area as the true passband. For a 6 db per octave rolloff of the passband, the B_{eff} equals 1.57 times the 3 db passband.[2]

A common figure of merit for an amplifier is Noise Factor, commonly stated in decibels. Several definitions exist, all equivalent, each expressing Noise Factor from a slightly different viewpoint. The simplest is

$$\text{Noise Factor} = \frac{\text{Signal to Noise ratio at input}}{\text{Signal to Noise ratio at output}} \tag{6}$$

Since an amplifier is always driven from some source impedance, which generates some thermal noise, another common definition is

$$\text{Noise Factor} = \frac{\text{Total Output Noise Power}}{\text{Output Noise Power due to thermal Noise of the Source Impedance}} \tag{7}$$

This latter definition is useful because it indicates a relatively simple method of measuring Noise Factor. Total Output Noise Power is the sum of that due to the thermal noise of the source resistance plus that noise power generated within the amplifier. Therefore, if a signal is injected sufficient to double the observed output power, that signal is then equal to the RMS value of thermal noise plus the noise, referred to the input, generated within the amplifier. Then:

$$NF = \frac{\overline{v_g^2}}{4\,kT\,R_g\,B_{eff}} \tag{8}$$

where

v_g is the injected signal that doubles output power.

R_g is the source resistance.

Note that the thermal noise voltage, v_T, generated in a resistor R_g is described by the equation.

$$v_T^2 = 4\,kT\,R_g\,B_{eff}$$

or at room temperature by

$$v_T^2 = 1.6 \times 10^{-20}\,R_g\,B_{eff}$$

The noise sources indicated may be included in the equivalent circuit of the transistor. Noise Factor may then be calculated according to the most convenient of the several definitions. This is well covered in the literature.[3] It is shown that for all practical purposes, the Noise Factor equation is identical for all three transistor connections. It is further shown that the Noise Factor equation consists of three terms,

$$NF = NF_{LO} + NF_{INT} + NF_{HI} \tag{9}$$

where

REFERENCE PAGES

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

SOMETHING NEW HAS BEEN ADDED

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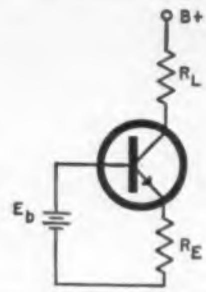


Fig. 2. Test Circuit: Input a-c short-circuited.

$$NF_{LO} = \frac{(R_g + r_b)^2}{4\,kT\,R_g\,f}\,(K_1\,I_c + K_2) \tag{10}$$

$$NF_{INT} = 1 + \frac{r_b}{R_g} + \left(\frac{q}{2\,kT\,R_g}\right)(R_g + r_b)^2 \left\{ \left[(1 - \alpha_0) + \left(\frac{r_e}{R_g + r_b}\right)^2\right] I_C + I_{CO} \right\} \tag{11}$$

$$NF_{HI} = \left[\frac{q}{2\,kT\,R_g}\right](R_g + r_b)^2\,I_C\left(\frac{f}{f_c}\right)^2 \tag{12}$$

Examination of equations (10), (11), and (12) yields that the Noise Factor curve will have the shape indicated in Fig. 1. The high frequency portion of the curve is of academic interest only, since that portion is significant only beyond the useful frequency range of the transistor.

Calculation of Noise Factor from the above equations is at best difficult. For this reason, it is more convenient to measure Noise Factor.

Equivalent Noise Voltage

A useful measure of the noise characteristics of a transistor may be defined as input "Equivalent Noise Voltage." Consider the circuit of Fig. 2. In this circuit E_b sets the operating point of the transistor.

The gain of the circuit is easily calculated. Since

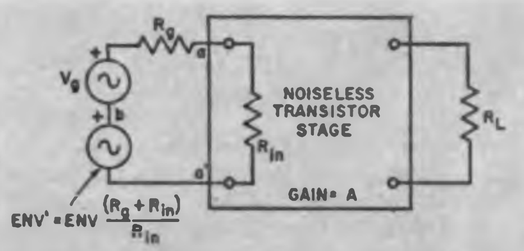


Fig. 3. Equivalent circuit for determining ENV.

the input is a-c short-circuited through E_b, any noise at the output must, therefore, be generated in the transistor or the resistors. If the resistors are made small enough, their contribution will be insignificant. For practical circuit values, even to hundreds of Kilohms, this is the case. If the measured output noise voltage is referred to the input, the Equivalent Noise Voltage (ENV) is obtained. This quantity is a function of collector current, collector voltage, circuit effective noise bandwidth, and circuit impedances.

Its usefulness lies in the fact that it gives the designer a reference value for a minimum detectable signal. For example, for a signal-to-noise ratio of unity, the rms signal voltage equals the rms ENV. For higher S/N ratios the signal must be proportionately higher than the ENV.

Noise Factor can easily be calculated from ENV. Consider the equivalent noise circuit of Fig. 3, where a signal source v_g of impedance R_g is added. The ENV generator must be modified by the factor $(R_{in} + R_g)/R_{in}$ so that the voltage across terminals a-a' with the input short-circuited (short a-b) will be ENV. Noise Factor is then derived from equation (7). For $v_g = 0$,

$$P_{out}[R_g] = \left[A\,(v_T)\,\frac{R_{in}}{R_g + R_{in}}\right]^2$$

$$= A^2\,4\,kT\,R_g\,B\left[\frac{R_{in}}{R_g + R_{in}}\right]^2 \quad (13)$$

$$P_{out}[ENV'] = \left[A\,(ENV'')\,\frac{R_{in}}{R_g + R_{in}}\right]^2 = A^2\,(ENV)^2 \quad (14)$$

Then from equation (7)

$$NF = 1 + \frac{(R_g + R_{in})^2\,ENV^2}{4\,kT\,B_{eff}\,R_g\,R_{in}^2}$$

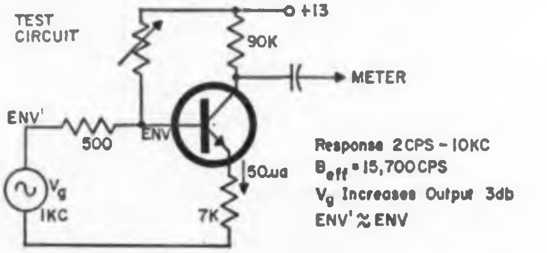
The point is that NF is a measure of the degradation of the S/N ratio of equation (6), but the highest S/N ratio is obtained at the lowest ENV where the signal voltage remains constant. However, if a transformer is used to drive the transistor, its ratio should be chosen so that the transistor sees the optimum source impedance for lowest NF.

Summary

The concept of Equivalent Noise voltage (ENV) is discussed. Its relation to Noise Factor is derived to be:

TABLE I

Sample measurements to show correlation between ENV measurement and single frequency method.



Transistor	ENV' (μv)	Calculated from ENV' Noise Factor 1	V_a(μv)	Single Frequency Noise Factor 2	Noise Figure (db) 1	Noise Figure (db) 2
1	1.64	23.4	1.70	23.1	13.7	13.6
2	1.55	21.1	1.65	21.7	13.2	13.4
3	1.55	21.1	1.65	21.7	13.2	13.4
4	1.48	19.3	1.55	19.2	12.9	12.8
5	1.55	21.7	1.55	19.2	13.4	12.8
6	1.41	17.8	1.40	15.6	12.5	11.9
7	2.21	40.7	2.70	66	16.1	18.2
8	1.78	27.2	2.00	36.5	14.3	15.6
9	1.64	23.4	1.70	26.3	13.7	14.2
10	1.70	25.0	1.85	31.2	14.0	14.9
Average		24.1		28.0	13.8	14.5

Comparison of the averages of the two methods, 13.8 db and 14.5 db, shows good agreement to two significant figures, the accuracy of measurement.

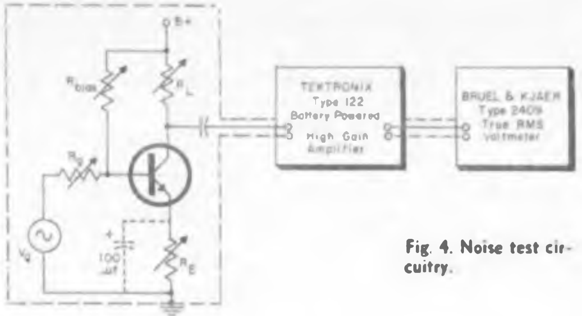


Fig. 4. Noise test circuitry.

This result is experimentally verified (see Table 1). It is shown that wide-band ENV can be measured easily with an amplifier and a true RMS voltmeter. (Fig. 4). The complete measuring technique is described in the section on "Measurements."

A study of the variation of ENV and NF shows that ENV is lowest if R_g is low, less than 500 ohms. (Fig. 5).

N.F. is low if R_g <10K except for very low values of R_g. Below $R_g \approx 500$ ohms, NF rises. This indicates a degradation in the signal to noise ratio rather than an increase in noise level. In considering noise level with respect to source impedance, when not using an impedance transformer, better results will be obtained by considering ENV rather than N.F.

Conclusion

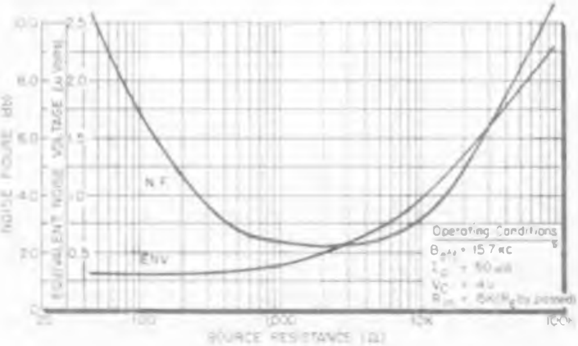
Equivalent Noise Voltage is a useful, easily understood concept. The measurement of ENV requires simple, relatively inexpensive equipment and yields noise figure from a single algebraic calculation.

$$NF = 1 + \frac{(ENV'')^2}{4\,kT\,B_{eff}\,R_g} \quad (15)$$

$$\text{or } NF = 1 + \frac{(R_g + R_{in})^2\,ENV^2}{4\,kT\,B_{eff}\,R_g\,R_{in}^2} \quad (16)$$

This relationship was experimentally verified by measuring the Noise Factor by the single-frequency method and comparing the result with that calculated

Fig. 5. Transistor Type RT5230 Noise Figure and ENV vs. Source Resistance.



Transistor Noise

(Concluded)

from the ENV measurement. Agreement was in all cases excellent as shown by the comparison in Table 1.

ENV was experimentally determined to be a function of both R_g and R_{in}. Therefore equations 15 and 16 are not by themselves sufficient to determine minimum NF.

Measurements

The test circuit of Fig. 4 was used to determine ENV as a function of R_g*. The test procedure was as follows:

1. Set the desired operating condition. (See fig. 5).
2. Determine B_{eff}.
3. Measure overall gain by inserting a signal e_g.
4. Set $e_g = 0$.
5. Measure rms volts at output.
6. Divide by measured gain to obtain $\sqrt{ENV'^2 + v_T^2}$.
7. Determine ENV' using $v_T^2 = 4\,kT\,B_{eff}\,R_g$.
8. Correct ENV' to ENV. (See fig. 3).

The measurements were made wide-band, i.e., 3 db down at 0.8 cps and 10KC.

Experimental Results

Fig. 5 shows the experimentally determined variation of ENV as a function of R_g. The Noise Figure curve was calculated from the ENV curve according to equation (16). The NF curve was then experimentally checked by the single frequency power-doubling method of equation (8). Agreement was excellent.

Fig. 5, ENV vs. source resistance R_g, indicates lowest ENV for R_g less than about 500 ohms. The NF curve shows a broad minimum for $500 < R_g < 10{,}000$ ohms. The reason for the increase in NF for $R_g < 500$ is obvious from equation (16). ENV is essentially constant as R_g decreases, therefore NF increases. Note that ENV increases rapidly above $R_g \approx 500$ ohms, doubling in value while NF remains essentially constant. Therefore, the NF curve should not be the primary criterion for choosing a source resistance.

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* The resistors in the test stage, though indicated as being variable, are not potentiometers. Fixed value resistors were substituted to obtain the required test points. Potentiometers were found to be noisy.

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For the Designer . . .

Analyzing

FROM Ohm's Law we know that for any given resistance the current will be proportional to the voltage. The volt-ampere characteristic of a resistor may be determined by "interrogating" the resistor with a voltage and determining the current that flows.

In Fig. 4, R_1 and E_1 could be in a "black box." Their volt-ampere characteristics can still be determined by interrogating the black box at points a and b. Such an interrogation results in characteristic (1) of Fig. 4b. Also, interrogration of R_2 results in characteristic (2).

If we interrogate R_1 and E_1 in parallel with R_2, we can determine the characteristic of the combination by noting that the interrogating voltage is common to R_1 and E_1 in parallel with R_2. Therefore, we may use characteristics (1) and (2) to obtain combined characteristic (3) graphically by reading the currents for (1) and (2) at each assumed common voltage e_x and adding them algebraically. The short-circuit current of the E_1, R_1 and R_2 combination is again the current that flows when a and b are shorted. It is point (4) in Fig. 4b. Thus, the short-circuit current is E_1/R_1. The open circuit voltage of the E_1, R_1 and R_2 combination may be found from curve (3) at point (5) where the current is zero, and this is $(E_1/R_1) \times R_2$.

Diodes

If the non-linear circuit element is a diode, its volt-ampere characteristic appears as curve (1), Fig. 5c. Suppose a resistor and battery are placed in series with the diode and we want to find the voltage drop across the diode and the current through it. If the circuit of Fig. 5a is redrawn so that the resistor is the load for the diode, we obtain Fig. 5b. We plot the volt-ampere characteristic of the diode as curve (1) and of the resistor and battery as curve (2). Then the mirror image of curve (2) gives us the load line for the diode. The point of intersection of curves (1) and (3) is the operating point of the diode.

By using the volt-ampere characteristics of non-linear devices, designers can get a graphical picture of the action of a component under chosen conditions. He is then better able to modify parameters by visual observation of the graphical parameters.

Non-Linear Circuits

If we want to determine the volt-ampere characteristic of the diode with the resistor and battery in parallel, we need only interrogate at a-b, Fig. 5b. By noting that the interrogating voltage e_x is common to both branches and that the currents in both branches add algebraically, sets of points for i_x and e_x for the parallel combination are obtained, curve (4).

Curve (4) then represents the volt-ampere characteristic of the combination shown in Fig. 5b. If a new combination is desired, Fig. 6a, the graphical analysis may be made again by considering each element in turn. Note that Fig. 6a shows a form of an AND circuit (an output occurs only if all inputs are present). The solution for AND circuits driving other AND or OR (an output occurs if any input is present) circuits may be found by the process just described, considering each element in turn.

The AND circuit of Fig. 6a should be analyzed for the several conditions under which it will operate. For one case the input to D1 could be at a high voltage, while the input to D2, low. This would prevent the appearance of a high voltage output at point 0 in Fig. 6a. An example of this is given in Fig. 7, which shows how curve (1) of Fig. 6c is displaced because of the presence of voltage E_2. Using the same principles discussed above, the operating point is found as shown in Fig. 7c. Note this point is not far different from that in Fig. 6c, where both diodes are at a low potential.

Fig. 8 is drawn for the case where both diodes are at a high potential. This is the case where the output of the AND circuit should be high, and it will be observed that this is so on the graph of Fig. 8c.

(Continued on following page)

Fig. 1: Volt-ampere characteristics of a resistor by interrogation.

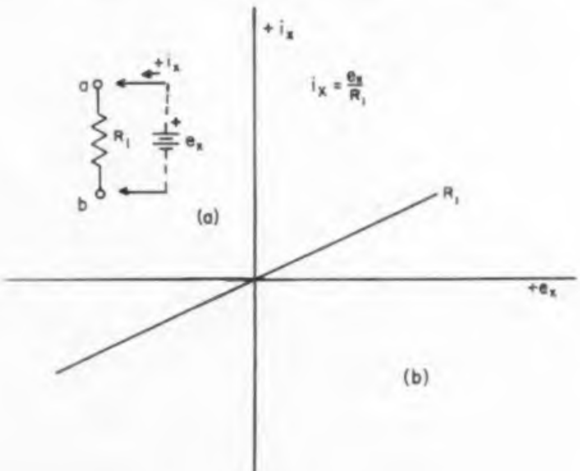
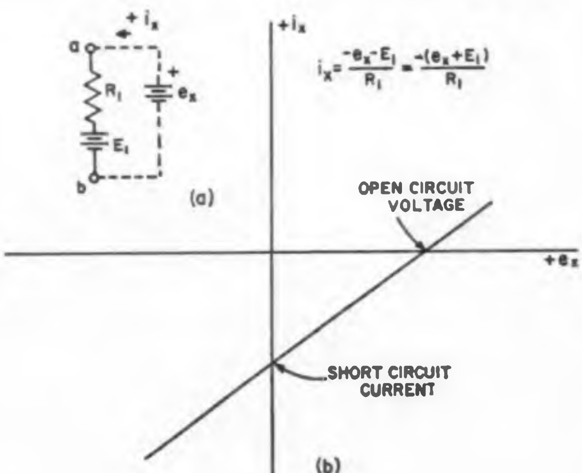


Fig. 2: The interrogation of a resistor and a battery in series.



Non-Linear Circuits *(Continued)*

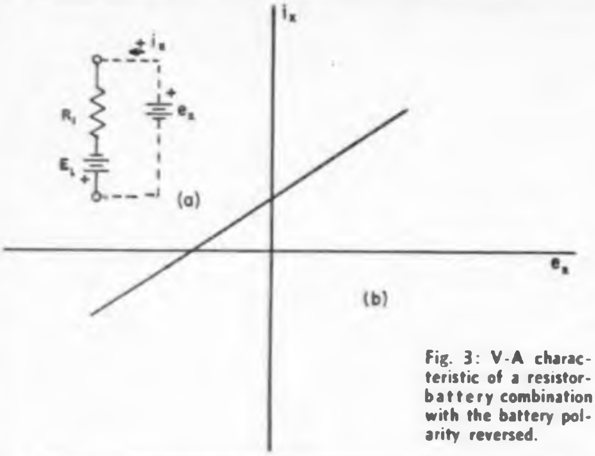


Fig. 3: V-A characteristic of a resistor-battery combination with the battery polarity reversed.

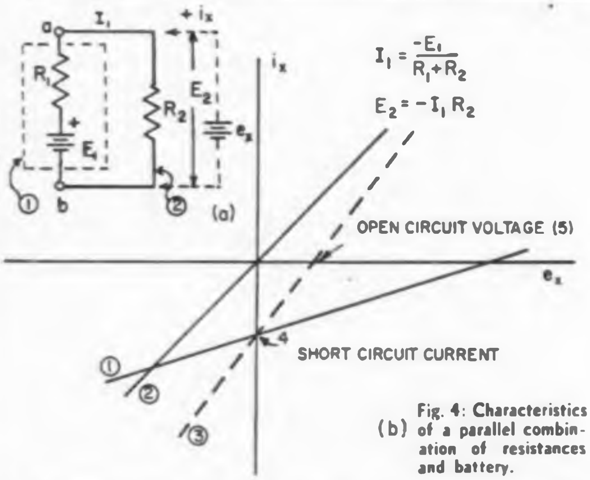


Fig. 4: Characteristics of a parallel combination of resistances and battery.

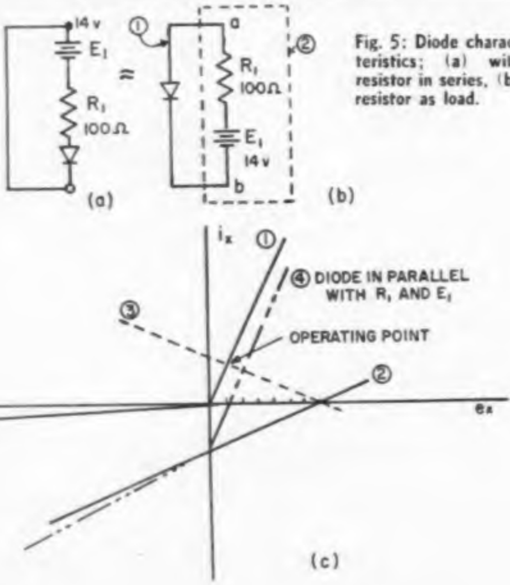


Fig. 5: Diode characteristics; (a) with resistor in series, (b) resistor as load.

Transistors

Common Base

Fig. 9 shows a family of curves of collector voltage *versus* collector current for a PNP transistor, for constant emitter voltages. Operating points may be determined as follows:

The interrogating voltage e_x may be used to obtain the volt-ampere characteristic of the load resistor and battery, curve (1) in Fig. 1. If this curve is reflected on to the transistor characteristic, we obtain curve (2), which is the proper load line for the transistor when the characteristics are plotted as shown. The load line (2) may now be used to obtain other operating points.

Assume that we want the quiescent collector operating point to be 2 milliamperes. From Fig. 9, this corresponds to $V_e = 150$ mv, at the point marked Q. It is now necessary to determine the emitter conditions for 150 mv. This can be done by referring to a second set of curves, Fig. 10, where V_e is plotted against I_e for constant V_c.

Fig. 9 shows that at point Q the collector voltage is -10 volts and the emitter voltage is 150 mv. This point may be located on Fig. 10, where it is also shown as Q. Fig. 10 tells us that the emitter current is also 2 milliamperes. We now have enough information to determine R_g.

$$E_e - I_e R_g - V_e = 0$$

If we assume $E_e = 1.5$ volts, we may solve for R_g

$$R_g = 745\ \Omega$$

The input impedance R_i is also obtained from Fig. 10 at point Q.

$$R_i = \left.\frac{\Delta V_e}{\Delta I_e}\right|_{V_c} = 41.5\ \Omega$$

This common base configuration has a low input impedance.

If we want to determine the change in output with change in input, we may proceed as follows:

Fig. 9 shows that for the load line plotted, a change in V_e from 125 to 150 mv produces a change in V_c of 13 to 10 volts, while I_c goes from 1.2 to 2 ma. Fig. 10 at the transferred load line shows that a change in V_c from 13 to 10 volts at V_e from 125 to 150 mv produces a change in I_e of from 1.5 to 2 ma.

Table 1 summarizes this data.

The transferred load line, Fig. 10, may be derived from Fig. 9, point by point from the load line (2). The transferred load line then serves to yield information concerning the output for various input values. Thus for $V_e = 200$ mv, the transferred load line tells us that $V_c = -1$ (in Fig. 10). Fig. 9 shows that with $V_c = -1$, for load line (2), $I_c \cong 3.9$ ma.

$$\text{The voltage gain is } A_v = \frac{I_{c1} R_L - I_{c2} R_L}{I_{e1} R_g - I_{e2} R_g} = 10$$

$$\text{The current gain is } A_i = \frac{I_{c1} - I_{c2}}{I_{e1} - I_{e2}} = 1$$

$$\text{The power gain is } A_p = \frac{I_{c1}^2 R_L - I_{c2}^2 R_L}{I_{e1}^2 R_g - I_{e2}^2 R_g} = 10$$

The transferred load line, Fig 10, shows that we cannot D.C. couple the circuit of Fig. 9a to another

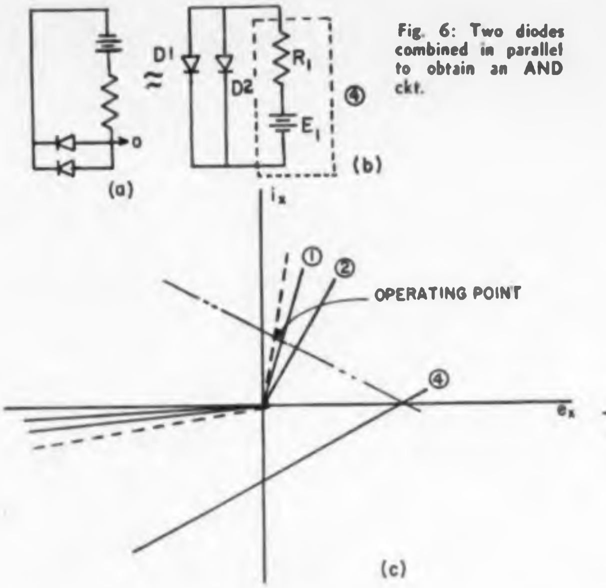


Fig. 6: Two diodes combined in parallel to obtain an AND ckt.

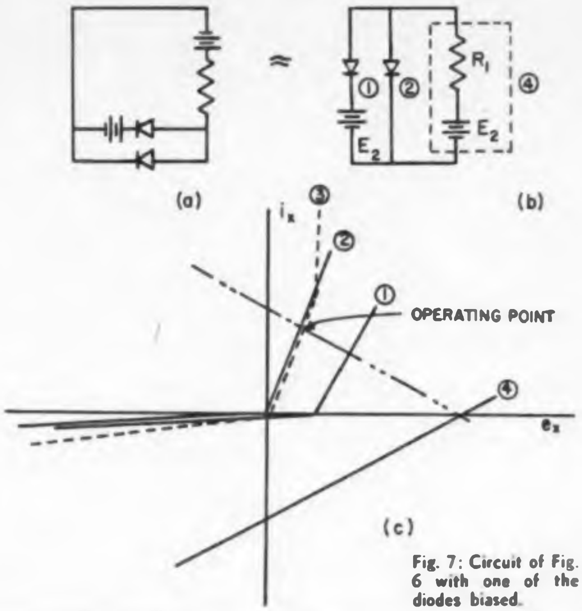


Fig. 7: Circuit of Fig. 6 with one of the diodes biased.

stage like itself, unless we use bias to effectively shift the transferred load line so that it appears in the second quadrant. Then, if in the second quadrant, it may be considered the load line for the preceding stage; and, therefore, reflected onto the third quadrant output characteristics of the preceding stage to obtain operating points.

Common Emitter

Fig. 11 shows a family of curves of collector voltage *versus* collector current for constant base voltage. Operating points may be determined as follows:

Assume a load resistance, $R_L = 8K$. By interrogation, curve (1) of Fig. 11 is obtained, and this becomes load line (2) when it is reflected onto the transistor characteristics.

As before, if we wish to operate with $I_c = 2$ ma, we see now that the base should be operated at -150 mv with respect to the emitter. (See Fig. 11.) Also the collector is at -10 volts. Referring to Fig. 12, we see that for $V_c = -10$, $V_e = -150$ mv, and I_b is -12 μa. We now have enough information to determine R_g and E_b from Fig. 12a:

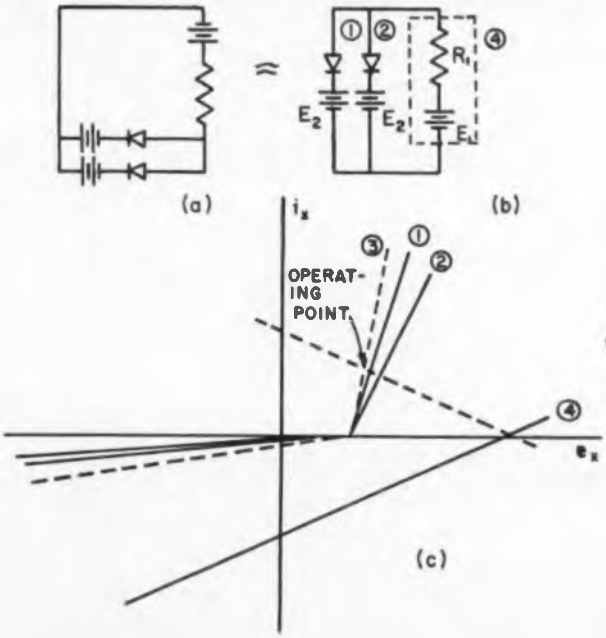


Fig. 8 (left): The AND circuit of Fig. 6 with both diodes biased.

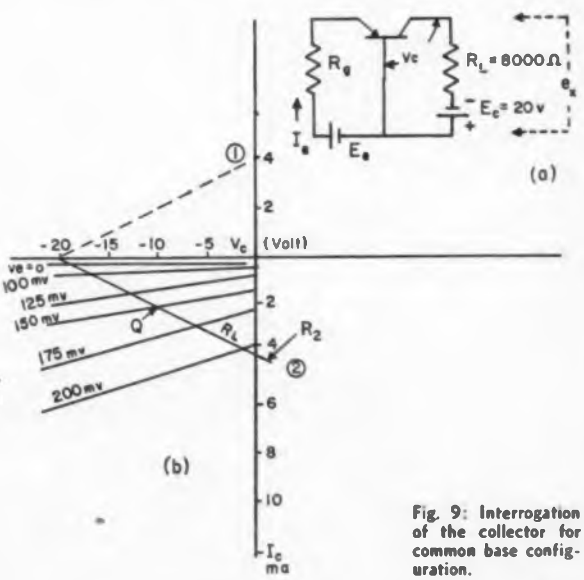


Fig. 9: Interrogation of the collector for common base configuration.

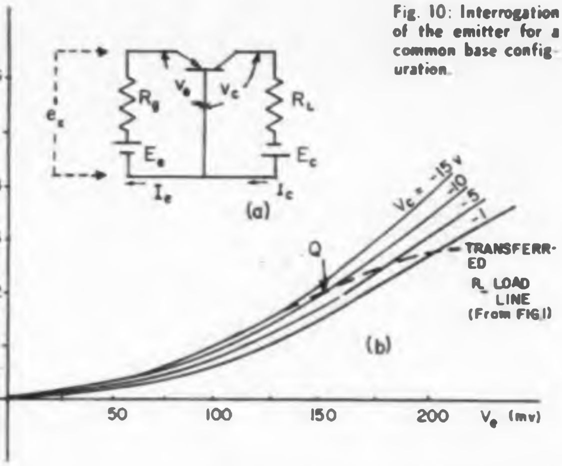


Fig. 10: Interrogation of the emitter for a common base configuration.

Non-Linear Circuits *(Continued)*

$$-I_b R_g + E_b - V_b = 0$$

Assuming $E_b = 1.5$ volts

$$\therefore R_g = 102{,}000\ \Omega$$

The input impedance from Fig. 12b, at point Q is

$$R_i = \frac{\Delta V_b}{\Delta I_b}\bigg|_{V_c} = 3000\ \Omega$$

Here's how to determine change in output with change in input.

Fig. 11 shows that for the load line plotted, a change in V_b from 125 to 150 mv produces a change in V_c of from 13 to 10 volts, while I_c goes from 1.2 to 2 ma. With this information, Fig. 12 shows that I_b goes from 4 to 12 microamps under these conditions. Summarizing this, we obtain Table 2.

$$\text{The voltage gain is } A_v = \frac{I_{c1} R_L - I_{c2} R_L}{V_{b1} - V_{b2}} = 256$$

$$\text{The current gain is } A_i = \frac{I_{c1} - I_{c2}}{I_{b1} - I_{b2}} = 100$$

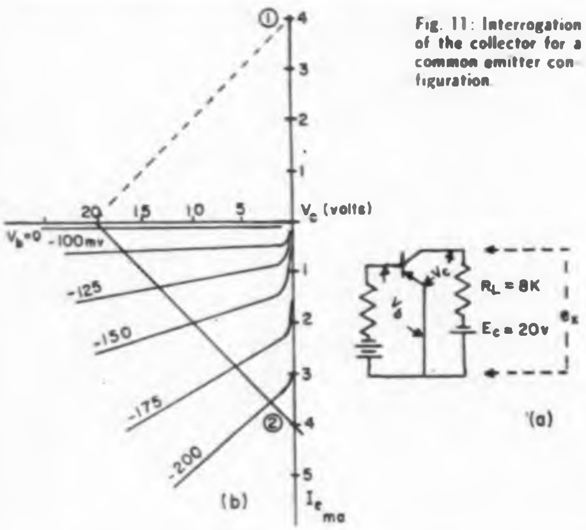


Fig. 11: Interrogation of the collector for a common emitter configuration.

Common Collector

This circuit is shown in Fig. 13a. The equations that describe the static conditions are given below: (Assuming voltage drops to be positive).

$$e_x - V_b - V_{eg} = 0 \tag{1}$$

$$I_b = I_e - I_c \tag{2}$$

$$E_c - V_{ce} - V_{eg} = 0 \tag{3}$$

Fig. 13b is a plot of collector to emitter voltage V_{ce} *versus* collector current, I_c. Interrogation is accomplished from collector to emitter by e_x, Fig. 13a, yielding curve (1). The reflection of curve (1) onto the collector plane yields the load line (2). This load line gives us V_{ce}, I_c, and V_{b1}, Fig. 13b, which are uniquely determined for the 8K load. With V_b and V_{ce} determined, we may enter the base plane of Fig.

Fig. 12: Interrogation of the base for a common emitter circuit.

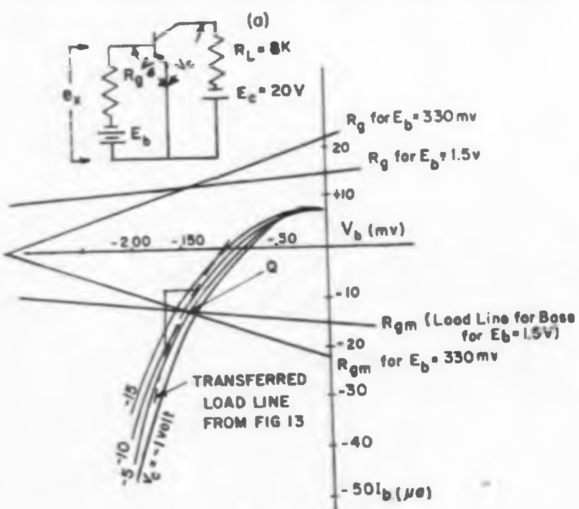
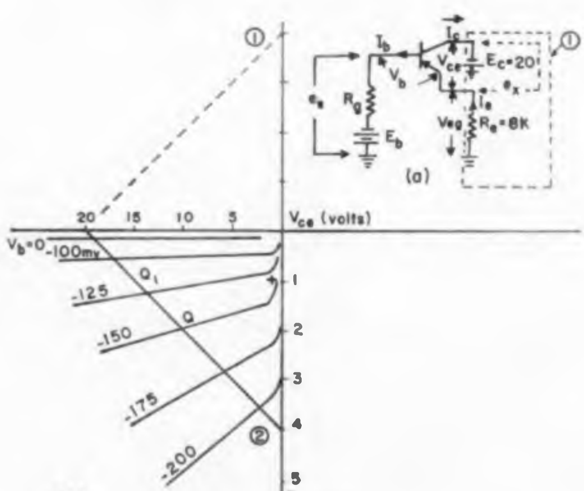


Fig. 13: Interrogation of collector for common collector circuit



12 to obtain I_b. Knowing I_b and I_c, I_e may be calculated from $I_b = I_e - I_c$. With V_b determined we may calculate V_{eg} from Eq. (1), above, for assumed values of e_s.

Using numerical values, we obtain the following: From Fig. 13b, the parameters of Table 3 are obtained for selected portions of the load line.

From Fig. 12b, I_b may be obtained for the values of V_b and V_c in Table 3. This is shown in Table 4.

Now that I_b and I_c are known, I_e may be calculated from Eq. (2), above. This is tabulated in Table 5.

Knowing V_b, we may calculate V_{eg} for assumed values of e_s.

Table 6 illustrates the emitter follower action of the common collector configuration, where V_{eg} follows closely the variations of e_s.

The base resistor and battery may be determined as follows:

Assume we wish 2 ma to flow in R_c. From Fig. 13 this corresponds to point Q, where $V_c = -10$ volts, $I_c = 2$ ma, $V_b = 150$ mv. With this data, Fig. 12 tells us that $I_b = -12$ μa. We may now express voltages in the base circuit as follows:

$$-I_b R_g + E_b - V_b = 0$$

Assuming $E_b = 1.5$ volts

$$R_g = 112{,}500\ \Omega$$

The voltage gain is expressed as $A_v = \dfrac{\Delta V_{eg}}{\Delta e_s} = 0.95$

The current gain is $A_i = \dfrac{\Delta I_e}{\Delta I_b} = 51.0$

Output Impedance

The output impedance is V_{eg}/I_e. On Fig. 12, R_g is plotted for both $E_b = 1.5$ v and $E_b = 330$ mv.

For the value of $E_b = 330$ mv, the load line in Fig. 12 intersects V_c at -1 where $V_b = -142$ mv. From Fig. 13, we find that $I_c = 0.9$ ma at the point $V_c = -1$, $V_b = -142$ mv. Since $I_c \cong I_e$, we obtain:

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$$R_o = \frac{V_{eg}}{I_e} = \frac{19}{1.1} \times 10^{-3} = 17{,}300\ \Omega$$

$$\text{since } V_{eg} = E_c - V_{ec} = 20 - 1 = 19v.$$

Also, for the value $E_b = 1.5$v, the load line in Fig. 12 intersects V_c at -1 where $V_b = 140$. From Fig. 13, $I_c - 1.0 \cong I_e$,

$$R_o = \frac{19}{1 \times 10^{-3}} = 19{,}000\ \Omega$$

For $E_b = 1.5$v and $E_b = 330$ mv, both curves cross at the same point at $V_c = -15$ in Fig. 12. This point is $V_b = 155$ mv. In Fig. 13 for $V_c = -15$, $V_b = -155$ mv this yields $I_c = 2.7$ ma $\cong I_e$.

$$\therefore R_o = \frac{5}{2.7 \times 10^{-3}} = 1850\ \Omega$$

Thus it can be seen how both the value of R_g and the operating point affects the value of the output impedance.

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TABLE 1

V_e (mv)	I_e (ma)	V_c (volts)	I_c (ma)
+125	1.5	−13	1.5
+150	2.0	−10	2.0

TABLE 2

V_b (mv)	I_b (μa)	V_c (volts)	I_c (ma)
125	4	13	1.2
150	12	10	2.0

TABLE 3
From Fig. 13b

V_b (mv)	V_{ce} (volts)	I_c (ma)
0	−19	−0.2
−100	−17	−0.5
−150	−10	−2.0
−200	−2.5	−3.5

TABLE 4
From Fig. 12b

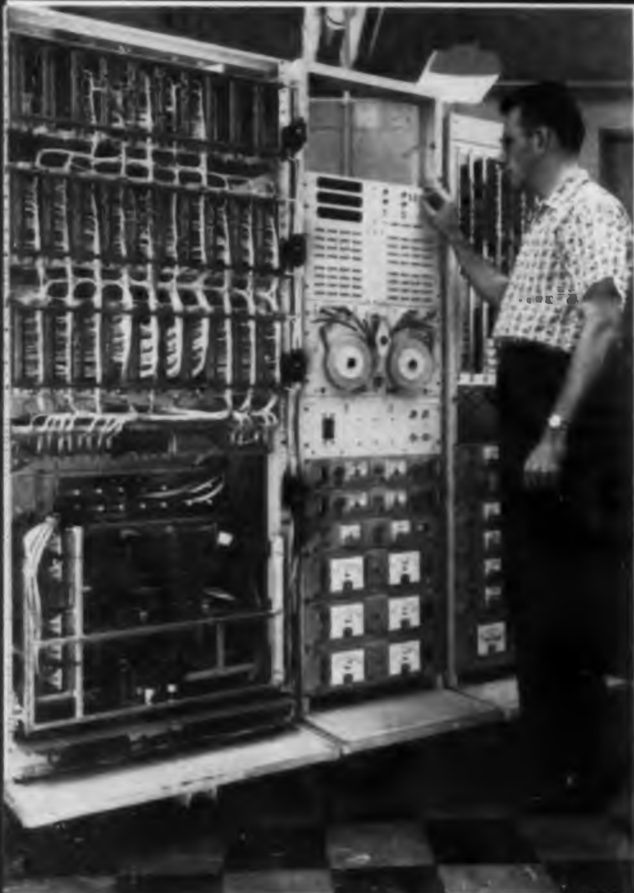
V_b (mv)	V_{ce} (volts)	I_b (μa)
0	−19	+9
−100	−17	+1
−150	−10	−13
−200	−2.5	−43

TABLE 5

I_b (ma)	I_c (ma)	I_e (ma)
+.009	−0.2	−0.191
+.001	−0.5	−0.499
−.013	−2.0	−2.013
−.043	−3.5	−3.543

TABLE 6

V_b (mv)	e_s (volts)	V_{eg} (volts)
0	0	0
−100	−1	−0.9
−150	−2	−1.85
−200	−3	−2.80



What's New . . .

Lincoln Laboratory's FX-1 Computer

Fig. 1: FX-1 computer at the M.I.T. Lincoln Laboratory. Effective clock rate of 50 megapulses/sec. Entire computer, with power supplies, occupies only 3 relay racks.

ONE of the fastest digital computers ever built is now in operation at the M.I.T. Lincoln Laboratory in Lexington, Mass. Known as the "FX-1", this computer is a working model for a new generation of machines, 10 times faster than any computers in general use today. The significance of the new machine lies in the unusually high speed, random-access storage. FX-1 is designed to be a complete, small-scale general-purpose computer, for realistic tests of fast logic circuitry and magnetic film storage in system operation.

Fig. 2: Completed 3328-bit, 0.3 μsec. magnetic-film main memory of the FX-1 computer.

The read-write cycle time for the central memory of the Lincoln FX-1 is 0.3 μsec. The initial FX-1 memory has a capacity of 256 words of 13 bits each, but provision has been made to increase the initial capacity by a factor of 4.

The memory uses printed-circuit wiring on a flexible sheet of resin-impregnated glass-fiber cloth. As shown in Fig. 3, the two halves of the flexible wiring sheet are mounted on stiff backing boards, leaving a flexible hinge between the halves. The arrays of memory elements deposited on thin glass backing plates, are positioned on the wiring so that each magnetic film element rests on the intersection of 2 perpendicular leads on the wiring sheet. When all the memory element arrays are in place on the lower half of the wiring sheet, the upper half is folded over to make the completed memory, shown in Fig. 2 with associated circuitry. This single unit contains the 256-word, 3328-bit memory of the FX-1 computer.

The logic circuits in Lincoln's FX-1 operate at an effective clock rate of 50 million pulses/sec., 10 times faster than TX-2 and other large machines currently in operation, and 4 times the rate of the fastest commercial machine disclosed to date. This increase in speed is made possible by high-

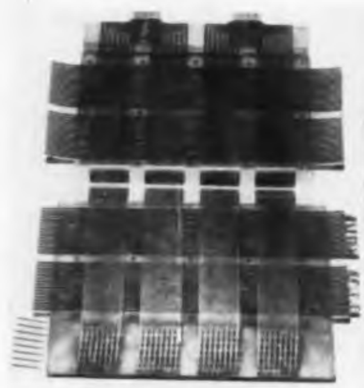


Fig. 3: Printed-circuit wiring assembly for high-speed magnetic-film main memory in the FX-1 computer at the M.I.T. Lincoln Laboratory.

speed switching transistors developed under subcontract, with the collaboration of Lincoln's Computer Components Group, and now in commercial production. Approximately 3000 transistors are used in the FX-1.

(Continued on page 196)

More
What's New
on page 177

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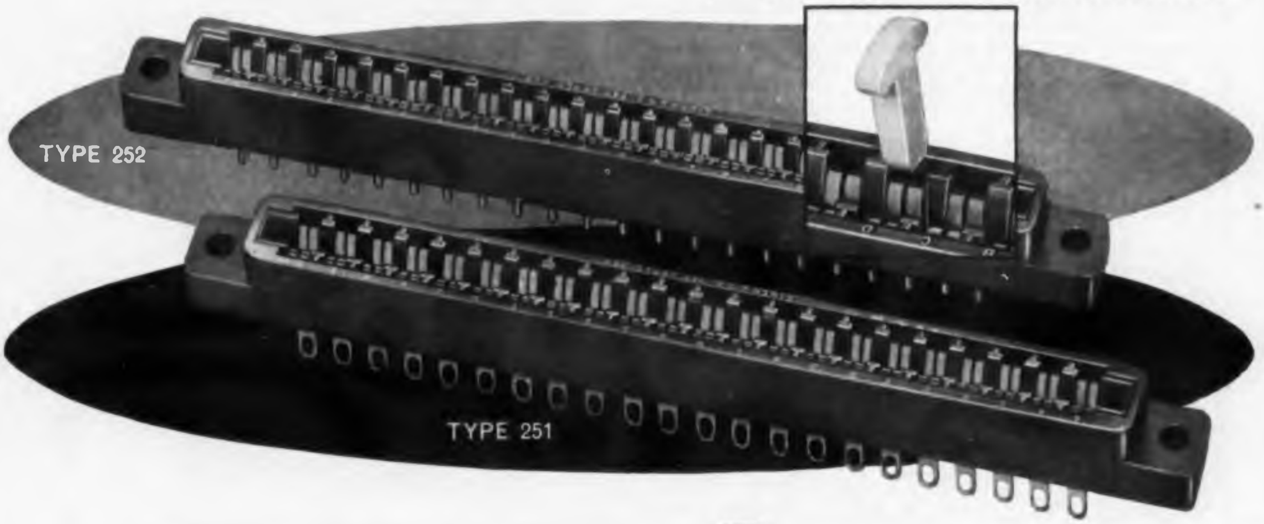

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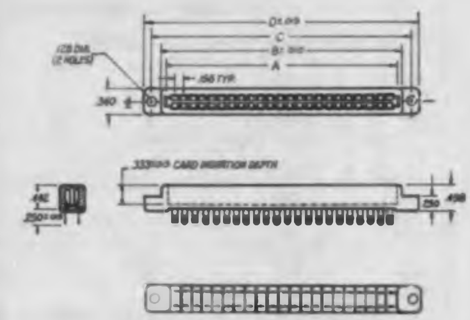

Contact* Positions	DIMENSIONS			
	A	B	C	D
6	1.098	1.239	1.531	1.785
7	1.254	1.395	1.687	1.941
8	1.411	1.552	1.844	2.098
9	1.567	1.708	2.000	2.254
10	1.723	1.864	2.156	2.410
11	1.879	2.020	2.312	2.566
12	2.036	2.177	2.469	2.723
13	2.192	2.333	2.625	2.879
14	2.348	2.489	2.781	3.035
15	2.504	2.645	2.937	3.191
16	2.661	2.802	3.094	3.348
17	2.817	2.958	3.250	3.504
18	2.973	3.114	3.406	3.660
19	3.129	3.270	3.562	3.816
20	3.286	3.427	3.719	3.973
21	3.442	3.583	3.875	4.129
22	3.598	3.739	4.031	4.285
23	3.754	3.895	4.187	4.441
24	3.911	4.052	4.344	4.598
25	4.067	4.208	4.500	4.754

*Number of contacts equals contact positions times two.

1961 Survey of Cathode Ray Oscilloscopes

This listing of cathode ray oscilloscopes and performance specifications is the result of a survey just completed by ELECTRONIC INDUSTRIES of oscilloscope manufacturers here and abroad. Twenty-nine manufacturers are represented in the chart which contains more than 150 types of oscilloscopes currently in production.

The survey covers real-time and storage CRT's. Every effort has been made to present in the space available the most significant data concerning each instrument. The frequency limits of 'scopes with dual vertical amplifiers or wideband-narrowband inputs are listed separately for each type. In some instances where price information is not given, it may be obtained by directly contacting the manufacturer.

TYPE NO.	V AMPL				H AMPL			SWEEP		CRT	DIM. (in.) WT. (lbs)	PRICE
	FREQ (cps) RESP (db) w/n bands	RISE Tµs	SENS. mv/cm	Z-IN meg/pf	FREQ cps	SENS. mv/cm	Z-IN meg/pf	FREQ (cps) SPEED (/cm)	EXP. x1			
ALLEGANY INSTRUMENT CO., 1081 Wills Mountain, Cumberland, Md.												
3001E	dc-100k;3		300/in	2-	dc-100k	300/in	2-				8¾ x 15 x 21;35	
ALLIED RADIO CORP., 100 North Western Ave., Chicago 80, Ill.												
83YU144*	5-5m;3		25/in	3.4-12	dc-1m	.6v/in		15-600k		5UP1	10⅝ x 14¼ x 15½;28	$ 69.95
83YZ945*	(see plug-ins)				dc-750k	1v		.5s-50ns	5		12⅝ x 16 x 19½;60	395.00
(plug-ins for 83YZ945):												
83YZ946*	dc-100k;3		1	1-40								54.50
83YZ947*	dc-10m;3	.04	10	1-40								64.50
83YZ948*	dc-10m;3		50	1-40	(dual trace)							79.95
**in kit form*												
ANALAB INSTRUMENT CORP., 30 Canfield St., Essex County, Cedar Grove, N.J.												
1120	dc-500k;3		40		dc-500k	40				5AQPB	9 x 15 x 22;40	525.00
	dc-500k;3		40		(electronic sw. at 40kc)							
1220	(single – dual-trace storage oscilloscope)											
1100	dc-500k;3		40		dc-500k	40				5AQPB	9 x 15 x 22;35	385.00
(dual channel plug-ins for series 1100 and 1120):												
700	dc-150k;3		.1	2-50				1µs–50s	5		8½ x 7 x 13¼;15	360.00
600*	dc-500k;3		40									310.00
200	dc-500k		1(A)					1µs-0.5s	5			170.00
100	dc-500k;3		40	2-50							8½ x 7 x 13¼;3	37.50
**channel B specs given; channel A identical to type 700*												
ALLEN B. DUMONT LABS., 750 Bloomfield Ave., Clifton, N.J.												
304A	dc-300k;3		10	2-50	dc-300k	1.2v/fs	2.2-50	2-30k	6	5ADP	8⅝ x 13½ x 19½;50	425.00
304AR	(rack-mtg 304A)										19 x 8¾ x 19½	495.00
322A	dc-300k;3		25/in	2-50	dc-300k		2-40	2-30k	6	5AFP	12½ x 15¾ x 22⅞;75	1090.00
	dc-300k;3		25/in	2-50								
401B	dc-500k		10		dc-500k	10		1µs-10s	5	K1931	8¾ x 15½ x 23½;45	430.00
401BR	(rack-mtg 401B)										19 x 7 x 23¼;45	
403	dc-300k	1	1/fs	2-60	dc-200k	3v/fs	2-50	1µs-1s	5	5AQP	8¾ x 15 x 20⅝;44	645.00
403R	(rack-mtg 403)										19 x 8¾ x 19;44	645.00
411	dc-100k	3.3	1/fs	2-60	dc-100k	3v/fs	2-50	1µs-1s		5ARP	13 x 17½ x 23¼	995.00
	dc-100k	3.3	1/fs	2-60								
411R	(rack-mtg 411)										19 x 17½ x 13½;70	995.00
425	dc-35m/[1]	.01	50		/4			.05µs-2s	5	K1736P	13½ x 16½ x 27;125	2750.00
	dc-33m/[2]	.011	50									
	dc-21m/[3]	.017	5									
430	dc-10k	35	10	1-47	dc-10k	10	1-47	50µs-2s	5	8x12cm	8¾ x 15½ x 23¾	1350.00
440	dc-5m;3	.08	50	1-47	dc-500k	10	1-47	1µs-.2s	5	K1931	8¾ x 15½ x 23¼;45	595.00
440R	(rack-mtg 440)										19 x 7 x 23⅝;45	
403B	dc-2m	.4	50	1-47	dc-500k	10	1-47	1µs-5s	5	K1931	8¾ x 15½ x 23¼;45	
403BR	(rack-mtg 403B)										19 x 7 x 22⅝;45	
412	dc-500k	.7	10	1-47	dc-500k	10	1-47	1µs-.2s	5	K1990	17¾ x 15½ x 23¼;85	
	dc-500k	.7	10	1-47	dc-500k	10	1-47					
420	dc-35m/[1]	12ns	50		/4			.05µs-2s	5		13½ x 16½ x 27;120	
	dc-33m/[2]	11ns	50									
	dc-21m/[3]	17ns	5									

1. *with 4201 Single channel plug-in*
2. *with 4202 Dual Trace plug-in*
3. *with 4205 plug-in*
4. *Plug-ins available for bandwidths of 4mc: and various sweep and trigger delays.*

1% accuracy 100 μv to 1,000 volts!

Also 2% accuracy, 1 μa to 1 amp full scale.

Measures 0.02 ohms to 5,000 megohms.

No zero adjustment. Fast warm-up.

Floating chassis. $1,000 worth of convenience for $400!

Haven't you wished for one compact, simple instrument that would make *precision* dc voltage, dc current and resistance measurements over a wide range?

The ⓗ 412A is it! In its VTVM circuit, the 412A uses an exclusive ⓗ photo-chopper instead of old-style mechanical vibrators—no drift, no 60 cps pickup. Input is floating, with resistance increasing from 10 megohms on the 1 mv range to 200 megohms on ranges above 100 mv. Current and voltage ranges have a 10 db sequence for maximum readability and overlap. The ohmmeter is a modified Kelvin bridge eliminating lead resistance error; you measure resistance accurately on hook-up wire sections as short as 6".

Model 412A also includes a 1 v or 1 ma recorder output, and 3 separate probes. Call your ⓗ rep today for a demonstration on your bench. Price, $400.

HEWLETT-PACKARD COMPANY
1001B PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAVENPORT 6-7000
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

ⓗ 400L LOGARITHMIC VOLTMETER—$325

ⓗ voltmeter covers 10 cps to 4 MC; accuracy high as ±2% of reading or 1% of full scale. Voltage range 0.3 mv to 300 v, 12 ranges, 1-3-10 sequence. Max. full scale sensitivity 1 mv. Large 5" true log voltage scale, linear 12 db scale, generous overlap. High stability, high input impedance. Also useful as amplifier for small signals, or to monitor waveforms.

ⓗ 400H PRECISION VOLTMETER—$325

Extreme accuracy as high as ±1% to 500 KC, ±2% to 1 MC, ±5% full range. Frequency coverage 10 cps to 4 MC. Large 5" meter with precision mirror scale. Voltage range 0.1 mv to 300 v; max. full scale sensitivity 1 mv. High 10 megohm input impedance minimizes circuit disturbances. Amplifier with 56 db feedback insures lasting stability. Reads direct in db or volts.

ⓗ 400D WIDE RANGE VOLTMETER—$250

Highest quality, extremely versatile. Covers 10 cps to 4 MC. Highly sensitive, accurate to within ±2% to 1 MC. Measures 0.1 mv to 300 v; max. full scale sensitivity 1 mv. Reads direct in dbm. High 10 megohm input impedance virtually eliminates circuit loading. 56 db amplifier feedback insures high stability and freedom from change due to external conditions.

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

ⓗ complete precision voltage measuring equipment

Circle 47 on Inquiry Card

CATHODE RAY OSCILLOSCOPES

TYPE NO.	V AMPL FREQ (cps) RESP (db) w/n bands	V AMPL RISE Tμs	V AMPL SENS. mv/cm	V AMPL Z-IN meg/pf	H AMPL FREQ cps	H AMPL SENS. mv/cm	H AMPL Z-IN meg/pf	SWEEP FREQ (cps) SPEED (/cm)	SWEEP EXP. x1	CRT	DIM. (in.) WT. (lbs)	PRICE
ALLEN B. DUMONT LABS.—*(Continued)*												
436	dc-10k	404s	10/div.		(17" Indicator and monitor)							
(Plug-in units for Series 420 oscilloscopes):												
4206	(Comparator Sens: 500μv/cm; rise T: 41ns; dc-7.5mc)											
4210	dc-1000m	.35	10	50 ohms				.5ns-10ns	5			
4212	dc-30m	12ns	50	1-23								
4213	dc-33m	11ns	50	1-25	(includes waveform generator)							
EDGERTON, GERMESHAUSEN & GRIER, 161 Brookline Ave., Boston 15, Mass.												
2236A	dc-2km	.1ns	27/in					25ns-5μs		KR3B		
EICO ELECTRONIC INSTRUMENT CO., 33–00 Northern Blvd., L. I. City 1, N.Y.												
460	dc-4.5m	.06	25	3-35	1-400k	.6v/in	5-35	10-100k		5UP1	13 x 8½ x 16;26	$ 129.50
425	5-500k		.05v/in	1-	5-500k	.05v/in	1-	15-75k		5"	15 x 8⅞ x 17⅞;30	79.95
ELECTRO INSTRUMENTS, INC., 8611 Balboa Ave., San Diego 11, Calif.												
260	dc-1m;3	.35	250/in	1-25	(7 plug-in scope modules)			10-10k	10	2"	2 x 3½ x 11	3250.00
260R	(rack-mtg 260)										19 x 3½ x 16	
ELECTRONIC TUBE CORP., 1200 E. Mermaid Lane, Philadelphia 18, Pa.												
K260	dc-500k		.2	1-42	dc-200k	.3v/10	2-25	1s-2μs	5	62DRP	12¾ x 15 x 22;60	895.00
	dc-500k		.2	1-42								
K11R	dc-300k		.15	1-40		150μv	1-40	1s-2μs		61DRP	19 x 7 x 16;32	
K120	dc-15m;3	.023	50	1-20	dc-1.2m	0.2v	1-30		100	51FGP	12¾ x 15½ x 22½;60	
(preamp plug-ins for K120):												
20A	dc-15m;3	.023	50	1-20	(dual trace)							
20B	dc-15m;3	.023	50	1-20								
20C	dc-12m;3		5	1-40								
K270	(dual channel – see plug-in preamps and time-base units)									62DRP	16⅝ x 15⅝ x 23;65	
K470	(four channel – see plug-in preamps and time-base units)									74DRP	16⅝ x 15⅝ x 23;65	
	(ext. P.S.):										9 x 10 x 15¼;60	
(plug-ins for K270 and K470):												
70A	dc-5m;3		50	2-25								
70B	dc-1m;3		10	2-25								
70C	dc-500k;3		2	2-25								
70D	dc-250k;3		0.5	2-25								
70E	dc-50k;3		.05	2-25								
70A	(sweep gen.)							1μs-1s				
70	(calibrator and time-mark gen.)											
K10R	dc-300k		25/in	2-40	dc-100k	300	2-40	2-30k	8	4KPL	19 x 5¼ x 11⅝;22	
H42B	dc-150k;3		2/in	2-	dc-150k	2/in	2-	0.2s-100μs		4-gun	28 x 60 x 34	
K215	dc-15m									2-gun		
HEATH CO., Benton Harbor, Mich.												
OR1	dc-200k		100	3.6-28	dc-200k	100	3.6-28	5c-50kc		5"		
OM3	4c-1.2m	.25	100		2-425k	290	10-25	20c-150kc		5"	9 x 14 x 18;18	
OP1	dc-3.6m	.1	100	3.6-28	dc-600k	200	1-37	1μs-2ms	5	5"	9 x 14 x 19;34	
HEWLETT PACKARD CO., 1501 Page Mill Road, Palo Alto, Calif.												
120	dc-200k		10	1-50	dc-200k	100	1-100	1μs-.5s	5	5AQP	9¾ x 15⅝ x 20¾;34	450.00
120AR	(rack-mtg 120)										19 x 7 x 20¹¹⁄₁₆;32	450.00
122A	dc-200k		10	1-50	dc-200k	100	1-100	5μs-.2s	5	5AQP	9¾ x 15 x 21¼;35	675.00
	dc-200k		10	1-50								
122AR	(rack-mtg 120A)										19 x 7 x 20¾;33	675.00
130B	dc-300k		1	2-25	dc-300k	1	2-25	.2μs-12s	5	5AQP	9¾ x 15 x 21¼;41	650.00
130BR	(rack-mtg 130B)			2-125			2-125				19 x 8¾ x 22;47	650.00
150A	(see plug-ins)				dc-500k	200	1-31	.1μs-5s	100	5AMP	14 x 17½ x 24½;83	1300.00
(plug-in units for 150A):												
151B	dc-10m	.035	5	1-31								200.00
152B	dc-10m	.035	50	1-30	(each channel)			sw. 100k				250.00
153A	dc-500k		1	1-35								150.00
154A	50c-8m		1ma/cm	.01Ω/1μh	(current channel)							430.00
	dc-10m		50	1-30	(voltage channel)							
160B*	dc-15m	(see plug-ins)			dc-1m	100	1-30	.1μs-5s	100	5AMP	19 x 14⅝ x 22¼;85	1850.00
160BR	(rack-mtg 160B)										19 x 12⅞ x 21;85	1850.00
170A*	dc-30m	(see plug-ins)			dc-1m	100	1-30	.1μs-5s	100	5BHP	19 x 14⅝ x 22¼;85	2150.00
170AR	(rack-mtg 170A)										19 x 12⅞ x 21;85	2150.00
(plug-in units for 160B and 170A):												
162A	dc-14m	.025	20	1-25	(each channel with 160B)							350.00
162A	dc-24m	.014	20	1-25	(each channel with 170A)							350.00
162D	dc-14m		5	1-35	(with 160B)							
162D	dc-24m		50	1-35	(with 170A)							
162F	dc-15m	.023	50	1-22	(with 160B)							145.00
162F	dc-30m	.012	50	1-22	(with 170A)							145.00
185A	(see 187B)							.1ns-.1μs	100	5AQP	19 x 14⅝ x 22¼;75	2000.00
(dual channel plug-in for 185A):												
187B	dc-800m;3	.5ns	10	.1-2								1000.00

* *accepts plug-in marker gen. and time-axis units*

CATHODE RAY OSCILLOSCOPES

TYPE NO.	V AMPL FREQ (cps) RESP (db) w/n bands	V AMPL RISE Tμs	V AMPL SENS. mv/cm	V AMPL Z-IN meg/pf	H AMPL FREQ cps	H AMPL SENS. mv/cm	H AMPL Z-IN meg/pf	SWEEP FREQ (cps) SPEED (/cm)	SWEEP EXP. x1	CRT	DIM. (in.) WT. (lbs)	PRICE
HICKOK ELECTRICAL INSTRUMENT CO., 10514 Dupont Ave., Cleveland 8, Ohio												
1810	dc-4m		10	2.2-50			2.2-50	2-30k	6	5ABP	12¾ x 14¾ x 18¾;50	$ 470.00
387R	dc-500k;3	0.7	10	1-50	dc-500k	15	1-50	1-100k	10	3RP1	19 x 5¼ x 11¼;15	385.00
385CSM	dc-4m;3	.08	75/in	2.2-25	dc-500k	75/in	2.2-25	3-50k	3	3RP1	6 x 9 x 13¼;15	430.00
	dc-2m;3	.15										
685	dc-750k	0.5	20/in	1-40	dc-750k	30/in	1-40	1-100k	10	5UP1	10 x 13 x 16;35	383.00
770	dc-5m;3	.07	35/in	2.2-50								
	dc-2.5m;3		10/in		dc-500k	75/in	2.2-50	2-30k	6	5ADP	12 x 14 x 18;50	
675A	dc-4.5m;3	.08	20/in		1-450k	250/in		10-100k	10	5UP1	10 x 13 x 16;35	
HUGHES, Vacuum Tube Products Div., 2020 Short St., Oceanside, Calif.												
105	dc-10m	.035	50/div.		dc-350k	.25v/div.	1-50	.1μs-1s	5	5"	13 x 16¾ x 23¼;58	2870.00
105R	(rack-mtg 105)										19 x 17½ x 23¼;63	2915.00
(Plug-in amplifiers for 105/R):												
05-1	dc-10m		50/div.	1-50	(general purpose)							125.00
05-2	dc-10mc		50/div.	1-50	(dual trace)							350.00
05-3	dc-400k		1/div.	1-50	(two channel amplifier)							175.00
ITI ELECTRONICS, INC., 369 Lexington Ave., Clifton, N.J.												
15869	dc-50k;3	5	25/in	2-80	dc-50k	3.5v/in	2-80			5ADP	19 x 8¾ x 19;30	460.00
ITT, Industrial Products Div., 15191 Bledsoe St., San Fernando, Calif.												
2135D	dc-200k		1/in	2-35	dc-200k	2-35	1/in	10μs-1s/in		17"		
1735D	(rack-mtg 2135D)										19 x 19 x 21	
	(ext. P.S.):										19 x 7 x 10	
2140D	dc-85k		1/in	2-35	dc-85k	2-35	1/in	10μs-1s/in		17"		
1740D	(rack-mtg 2140D)										19 x 19 x 20	
	(ext. P.S.):										19 x 7 x 10	
JACKSON ELECTRICAL INSTRUMENT CO., Dayton, Ohio												
600	10c-4.9m;1		30/in	1.5-20	10c-650k	.8v/in	1.1-12	10c-100k		5BTP	9⅛ x 15 x 13;24¼	
	10c-400k;6		20/in									
CRO-2	20c-4.5m		250/in	1.5-25	20c-200k	.4v/in	1.1	20c-50k		5UP1	10¼ x 13¾ x 15⅛;26	
	20c-300k		18/in									
KINGSTON ELECTRONIC CORP., Medfield, Mass.												
VS5*	20-300k;6		2/in					20-20k				349.50
EA1**	20-300k;6		2/in		20-70k	500/in		20-45k				425.00
LUMATRON ELECTRONICS, INC., 116-120 County Courthouse Road, New Hyde Park, L.I., N.Y.												
112*	ac-900m	0.4ns	3	50 ohms				50ns-.05ns		5BGP7	26¼ x 12¼ x 17¼;105	
	(ext. P.S.):										17 x 13 x 9	
PACKARD BELL ELECTRONICS, 12333 W. Olympic Blvd., Los Angeles 64, Calif.												
5mc-2	dc-5m;3	70ns	1	1-30	dc-200k	200		1μs-1s	10	3½"	11½ x 14 x 9½;22	495.00
	dc-5m;3	70ns	1	1-30	(dual vert. ampls., dual gun)							
PHILIPS ELECTRONIC INSTRUMENTS, 750 S. Fulton Ave., Mount Vernon, N.Y.												
GM5655	1-250;6		60	85k-35		100	0.1-45	5-30k		DG7-32	4½ x 9½ x 11¼;14	
GM5606	dc-200k;3		10	0.5-20	dc-300k	1000	1.1-5	2.5μs-1s	5	DN10-78	11¼ x 8½ x 15¾;31	
GM5666	0-60k;3		3	4.5-25	0-100kc	400	1-25	1s-3μs	10	DN10-78	9¾ x 14 x 20¾;66	
GM5659	1-1m;6		60	1-15	1-1m	90	1-15	3-250k		DG7-32	8¼ x 11¼ x 15¾;37	
GM5600	dc-5m;3	70	50	10-8	5-2m	3v		.5μs-30ms		DH7-78		
GM5601	dc-5m;3	75	100	0.5-35	dc-300k	1v	1-5	.5μs-200μs	5	DH10-78	11¼ x 8½ x 15¾;31	
GM5602	3-14m;3	25	75	5-10	dc-800k	1v		.2μs-10ms	5	DH10-78		
GM5603	dc-15m;3	25	50	1-22	dc-2m	1v	1-35	.2μs-1s	5	DN13-79	11¾ x 15¾ x 23½;77	
GM5650	0-4m;3		300	1-60	20-10k	5v	10-8	.5μs-20ms		DG7-32	4½ x 9½ x 12;16½	
	0-700k;3	45										
GM5662	dc-20m;6	.025	50	2-25	0-800k	700	10-30	.05μs-10ms	4	DH10-78	9⅞ x 14 x 20¾;66	
RCA, Electron Tube Div., Harrison, N.J.												
WO-33A	5.5c-5.5m		100	10-10				15c-75k		3"	6¼ x 8¾ x 10¼;14	
	20c-150k		3									
WO-91A	10c-4.5m;1	.1	50/in	1-40	10c-500k		2.2-30	10c-100k		5UP1	9 x 13½ x 16½;30	
	10c-.5m;1	.5										
WO-56A	dc-500k	.7	12	1-30	dc-500k	24	1-30	3c-30k	3	7VP1	9 x 14 x 17	
WO-88A	dc-500k	.5	28	1-30	dc-200k		2.2-55	15c-30k		5UP1	9 x 14 x 17	
WO-78B	3c-5m;1	.1	40	1-54	3c-1m		1-28	10c-100k	3	5ABP	9 x 13 x 18	
ROHDE & SCHWARZ, 111 Lexington Ave., Passaic, N.J.												
OMF	dc-20m;3	.018	4	1-30	dc-1m	400	1-	1s-0.1μs	10	DG1354	14½ x 21¼ x 18;110	3800.00

Kingston notes:

**Covers all VHF TV channels, plus 23-27mc, 42-46 mc, 3.58mc and 4.5mc*

***Incorporates tuned circuits for coverage 3mc-240mc; Sens.: 200-600μv/in.*

Lumatron note:

**Utilizes waveform sampling technique*

...here's a little 'scope for BIG JOBS

TYPE 310A

HINGED CHASSIS AFFORDS EASY ACCESSIBILITY TO ALL TUBES AND COMPONENTS

Measuring deviations to quantity parts-per-million in similar units under test.

Instrumentation includes a Tektronix Type 310A Oscilloscope and the new *Electro Scientific Industries* precision-measurement console—which measures resistance, capacitance, and voltage ratio over wide ranges with direct traceability of accuracy to three reference standards certifiable by the National Bureau of Standards.

Photographed at Electro Scientific Industries, Portland, Oregon.

Need a precision-measurement tool in the dc-to-4 mc range?

A small-size, light-weight, semi-ruggedized instrument that operates almost anywhere from 50-to-800 cycles line frequency?

One that combines stability in performance, simplicity of operation, accessibility for maintenance?

Then consider a Tektronix Type 310A Oscilloscope.

For size, convenience, presentation of trace display—a Type 310A ideally suits precision-measurement applications at point-of-use . . . such as quality-control checks in production testing . . . or maintenance and calibration of complex electronic equipment in the laboratory or in the field.

Call your Tektronix Field Engineer for a demonstration.

TYPE 310A CHARACTERISTICS

Frequency Response—dc to 4 mc: 100 mv/div to 125 v/div; 2 cycles to 3.5 mc: 10 mv/div to 100 mv/div. *Risetime*—less than 90 nanoseconds. *Sweep Range*—0.5 μsec/div to 0.2 sec/div in 18 calibrated steps, continuously variable between steps and to 0.6 sec/div uncalibrated. *5X Magnifier*—extends calibrated sweep range to 0.1 μsec/div. *Triggering*—amplitude-level selection with manual or preset stability control, and automatic facility. *Horizontal Input. Amplitude Calibrator. Electronically-Regulated Power Supplies.*

Type 310A Oscilloscope (F.O.B. Factory) **$625.00**

Dimensions—10" high, 6¾" wide, 17" deep. *Weight*—23½ pounds.

Tektronix, Inc. *P. O. BOX 500 · BEAVERTON, OREGON / Mitchell 4-0161 · TWX—BEAV 311 · Cable: TEKTRONIX*

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ENGINEERING REPRESENTATIVES: Kentron Hawaii Ltd., Honolulu, Hawaii. Tektronix is represented in twenty-five overseas countries by qualified engineering organizations.

European and African countries, the countries of Lebanon and Turkey, please contact TEKTRONIX INTERNATIONAL A.G., Terrassenweg 1A, Zug, Switzerland, for the name of your local engineering representative. Other Overseas areas, please write or cable directly to Tektronix, Inc., International Marketing Department, P. O. Box 500, Beaverton, Oregon, U.S.A. Cable: TEKTRONIX.

CATHODE RAY OSCILLOSCOPES

TYPE NO.	V AMPL FREQ (cps) RESP (db) w/n bands	V AMPL RISE Tμs	V AMPL SENS. mv/cm	V AMPL Z-IN meg/pf	H AMPL FREQ cps	H AMPL SENS. mv/cm	H AMPL Z-IN meg/pf	SWEEP FREQ (cps) SWEEP (/cm)	SWEEP EXP. x1	CRT	DIM. (in.) WT. (lbs)	PRICE
SCOPES CO., INC., (Telequipment, Ltd.) P.O. Box 56, Monsey, N.Y.												
S32	dc-7.5m;3	.05	10	1-30				1μs-.5s	10	3"	6⅓ x 8 x 13;16	$ 365.00
D33	(see plug-ins for D33)							1μs-.5s	10	3½"	7½ x 12½ x 16½;33	495.00
(Plug-in amplifiers for D33):												
A	dc-6m;3		10									
B	dc-200k		1									
SIERRA ELECTRONIC CORP., 3885 Bohannon Dr., Menlo Park, Calif.												
218	2c-300k;3		35/in	*1-50	4c-100k	500	2-35	15c-40k	10	3SP1	19 x 14 x 18½;80	1995.00
	(seven plug-in scopes for function monitoring)											
SIMPSON ELECTRIC CO., 5200 West Kinzie St., Chicago 44, Ill.												
458	dc-4.5m;1		30/in					200k		7"	11 x 14¼ x 16½;29	249.95
	10-300k;2		20/in									
466	15-100k;1		30/in	0.5-35	15-20k	0.7v/in		15-80k		5"		149.95
2610	dc-5m;0.5		6/in					5-5kμs				575.00
	dc-8m;1.5											
SOLARTRON, INC., 1743 South Zeyn St., Anaheim, Calif.												
513.2	dc-10m		1	1-30	dc-5.5m			.1μs-.1s	5	4EP1	10 x 16¾ x 23;70	
523S.2	(similar to 513.2 but to British Joint Services spec.)											
518	dc-5m;3			1.6-45				.75μs-.1s		90EG4	9 x 12 x 18;40	
557	dc-1m;3		3	1-60				1μs-1s	10	4EP7	10 x 16¾ x 23;70	
643S	dc-12m;3	30	100	1-40	dc-2m	25		.1μs-.1s	100	5BKP	14¾ x 20 x 27¾;140	
711S.2	dc-7m;3	.05	3	(dual channel)				.3μs-3s	10	4EP7	13½ x 18½ x 26¼;118	
814.2	.9c-9m	.04	40	1-30	1.5c-1m	500		.2μs-.01s	10	4EP1	10¾ x 14¾ x 20;42	
1014	dc-5m;3	.07	1	1-30	dc-200k	200		1μs-1s	10	3½"	8 x 9½ x 13;22	
	dc-5m;3	.07	1	1-30								
1012	dc-25m;3	14	50			200		.1μs-12s	5	5CLP		
1016	dc-5m;3	.07	1	1-30	dc-750k	150	.5-.05μf	1μs-1s	10	3½"	19 x 5¼ x 14½;25	
	dc-5m;3	.07	1	1-30								
TEKTRONIX, INC., P.O. Box 831, Portland 7, Ore.												
531A	dc-15m[1]	23ns[2]	50		dc-240k	15	1-47	0.1μs-12s	5	5"	13 x 16¾ x 24;62	995.00
RM31A	(rack-mtg. 531A)										19 x 14 x 22¼;79	1095.00
532	dc-5m;3[3]	.07[3]	100		dc-[illegible]	15	1-40	0.2μs-12s	5	5"	13 x 16¾ x 24;55	875.00
RM32	(rack-mtg 532)										14 x 19 x 22¼;72	975.00
533	dc-15m[1]	23ns[2]	50		dc-500k	100	1-45	.1μs-15s	100	5"	13 x 16¾ x 24;62	1100.00
RM33	(rack-mtg 533)										19 x 14 x 22¼;79	1200.00
535A	dc-15m[1]	23ns[2]	50		dc-240k	15	1-47	0.1μs-12s	5	5"	13 x 16¾ x 24;66	1400.00
RM35A	(rack-mtg 535A)										19 x 14 x 22¼;83	1500.00
536	dc-10m[4]	35ns[4]	50/div.		dc-10m[4]	50/div.		0.2μs-2s	5	5"	13 x 16¾ x 24;60	1050.00
541A	dc-30m;3[5]	12ns[5]	50		dc-240k	200	1-47	.1μs-12s	5	5"	13 x 16¾ x 24;62	1200.00
RM41A	(rack-mtg 541A)										19 x 14 x 22¼;79	1300.00
543	dc-30m;3[5]	12ns[5]	50		dc-500k	100	1-45	.1μs-15s	100	5"	13 x 16¾ x 24;64	1275.00
RM43	(rack-mtg 543)										19 x 14 x 22¼;81	1375.00
545A	dc-30m[5]	12ns[5]	50		dc-240k	200	1-47	.1μs-12s	5	5"	13 x 16¾ x 24;67	1550.00
RM45A	(rack-mtg 545A)										19 x 14 x 22¼;85	1650.00
551	dc-25m[5]	14ns[5]	50		dc-400k	200	.1-40	.1μs-12s	5	5"	13 x 16¾ x 24;52	1800.00
	(ext. P.S.):										13 x 10 x 17½;46	
555	dc-30m[5]	12ns[5]	50		dc-240k	200	1-47	.1μs-12s	5	5"	13 x 20 x 24;68	2600.00
	(ext. P.S.):										13 x 10 x 17½;54	
581	dc-100m;3	3.5ns	100		dc-240k	200	1-47	50ns-2s	5	5"	13 x 16¾ x 24;68	1375.00
585	dc-100m;3	3.5ns			dc-240k	200	1-47	2μs-1s	5	5"	13 x 16¾ x 24;74	1675.00
517A		7ns	50					10ns-20μs		5"	13 x 18¾ x 27;76	3500.00
	(ext. P.S.):										13 x 9¾ x 19¾;69	
507		10ns	50v					20ns-50μs		5"	13 x 16¾ x 23¾;53	3000.00
	(ext. P.S.):										13 x 10½ x 17½;41	
310A	dc-4m	90ns	10/div.	1-40		1.5v/div.		.1μs-.6s	5	3"	6¾ x 10 x 17;23½	625.00
316	dc-10m	35ns	10/div.	1-40	dc-500k	1.4v/div.		.2μs-6s	5	3"	8½ x 12 x 19½;34	750.00
RM16	(rack-mtg 316)										19 x 7 x 17¾;45	825.00
317	dc-10m	35ns	10/div.	1-40	dc-500k	1.4v/div.		.2μs-2s	5	3"	8½ x 12 x 19½;34	800.00
RM17	(rack-mtg 317)										19 x 7 x 17¾;40	875.00
321	dc-5m	.07	10/div.	1-30	dc-1m	1.5v/div.	.1-20	.5μs-5s	5	3"	5¾ x 8¾ x 16;13½	785.00
502	dc-1m		.2	1-47		100		1μs-5s	20	5"	11¼ x 15 x 23½;56	825.00
503	dc-450k		1	1-47	dc-450k	1	1-47	1μs-5s	50	5"	9¾ x 13½ x 21½;31	625.00
RM503	(rack-mtg 503)										19 x 7 x 16½;27	640.00
504	dc-450k		5	1-47				1μs-.5s		5"	9¾ x 13½ x 21½;29	525.00
RM504	(rack-mtg 504)										19 x 7 x 16½;25	535.00
515A	dc-15m	23ns	50	1-36	dc-500k	1.4v		.2μs-6s	5	5"	9¾ x 13½ x 21½;46	800.00
RM15	(rack-mtg 515A)										19 x 8¾ x 23;57	875.00
516	dc-15m;3	23ns	50	1-20	dc-500k	1.4v		.2μs-6s	5	5"	9¾ x 13½ x 21½;40	1000.00
	dc-15m;3	23ns	50	1-20				sw:150k				
524AD	dc-10m	35ns	150	1-45				.1μs-.01s	10	5"	13 x 16¾ x 25;61	1250.00
525	60c-5m;1%		15	75 ohms	(TV waveform monitor)			7.875k;30c	25	5"	19 x 8 23/32 x 22¼;54	1100.00

1. *with C-A, K, L, or N plug-ins; A, B, or G: 14m; D: 2m; E: 60k; Q: 6k; Z: 10m*
2. *with C-A, K, L or R plug-ins; A, B, G: 25ns; H: 31ns; N: 0.6ns*
3. *with wide-band plug-ins*
4. *with G plug-ins; X-Y main frame almost identical*
5. *with K or L plug-ins*

Data loss due to drop-outs is eliminated in FM predetection recording-reproducing by Mincom's new, exclusive Tracklok®

This is because, for the first time in the field of instrumentation, the **Tracklok** makes possible redundant FM data recording at the carrier level. In any desired FM or PM-type carrier system, data loss is eliminated by a 99% skew reduction; existing skew of $\pm 0.3\ \mu s$ for example, is effectively reduced to $\pm 0.003\ \mu s$, a reduction of 100 to 1.

The Tracklok

Completely Compatible: The new **Tracklok** is designed to improve the predetection performance of Mincom's 1-mc Series CM-100 Instrumentation Recorder/Reproducer (which now, on special order, performs to 1.5 mc at 120 ips). **Tracklok** can be incorporated into all existing Series CM-100 systems, since it is compatible with CM-100 or any comparable recorder-reproducer in the standard IF carrier frequencies.

TRACKLOK®

Shown here with the Mincom Series CM-100 1.5-mc Instrumentation Recorder/Reproducer, a standard auxiliary rack houses (from the top down) an oscilloscope monitor unit, the new **Tracklok**, and a demodulator.

Reliable Simplicity: The same reliability that has been typical of Mincom's instrumentation systems for years has been built into **Tracklok.**

MINCOM DIVISION **3M MINNESOTA MINING & MANUFACTURING CO.**

2049 SO. BARRINGTON AVE., LOS ANGELES 25, CALIFORNIA • 529 PENN BLDG., 425 13th ST. N.W., WASHINGTON 4, D.C.

CATHODE RAY OSCILLOSCOPES

TYPE NO.	V AMPL FREQ (cps) RESP (db) w/n bands	V AMPL RISE Tμs	V AMPL SENS. mv/cm	V AMPL Z-IN meg/pf	H AMPL FREQ cps	H AMPL SENS. mv/cm	H AMPL Z-IN meg/pf	SWEEP FREQ (cps) SPEED (/cm)	SWEEP EXP. x1	CRT	DIM. (in.) WT. (lbs)	PRICE
TEKTRONIX, INC.—*(Continued)*												
526	(color video Vectorscope)									5"	19 x 8¾ x 18½;45	$1800.00
945	dc-24m	15ns	50	(to MIL-T-945A spec.)				.1μs-5s	5	5"	13 x 18 x 25½;77	
519	dc-1m;3	35ns	10v	125 ohms				2ns-1μs		2x6cm	14¾ x 22¼ x 25¼;99	3800.00
560	(Indicator: See plug-in amplifiers and time-base units)									5"	9¾ x 13½ x 21½;27	325.00
561	(Indicator: See plug-in amplifiers and time base units)									5"	9¾ x 13½ x 21½;27	425.00
	(Plug-ins for 560, 561 Indicators):											
59	dc-400k		1v									50.00
60	dc-1m		50									100.00
63	dc-300k		1									125.00
67								1μs-5s	5			150.00
72	dc-650k		10									250.00
75	dc-4m		50									175.00
TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio												
3441A	dc-4.5m		10/in		20-60k	150/in		10-60k		5"	11 3/32 x 15 11/32 x 16	249.50
WATERMAN PRODUCTS CO., INC., 2445–63 Emerald St., Philadelphia 25, Pa.												
MARK1	dc-75k	2.6	25/in.	.5-100	20-75k	1.5v/in	.5-100	20-20k		3"	3½ x 7¼ x 10;5¾	69.95
S11A	dc-200k	2	100/in	10-10	dc-200k	100/in	10-10	3-50k		3"	5 x 7 x 11;8¾	149.50
S14A	dc-155k	2.2	10/in	1-25	dc-155k	15/in	1-35	5-50k		3"	6 x 7 x 12;12¾	249.00
S14B	dc-700k	.35	50/in	1-25	dc-200k	150/in	1-25	5-50k		3"	6 x 7 x 12;14	239.00
S14C	dc-700k	.35	7/in	1-25				20μs-2s		3"	6 x 7 x 12;16	289.00
S15A*	dc-155k	2.2	28/in	1-25	dc-140k		1-25	5-50k		1½"x3"	6 x 7 x 12;16½	399.00
S16A	dc-5m dc-500k	.07	2.5	1-40	3-180k	10	1-120	5-50k		5"	7 x 10 x 12;18½	245.00
S17A	dc-230k	2	3.6/div.	1-53	3-170k	140/div.	1-85	100μs-10s		1½"x3"	5½ x 4¾ x 10;8	295.00
P1			56v/in		dc-t	80v/in				1½"x3"	5¼ x 5 3/16 x 10;5	109.50
P100			20v/in		3-t	28v/in				1½"x3"	5¼ x 5 [illegible]/16 x 10;5	129.50
S4C	1.5-11m;6	.05	100/in	1-25			1-17	1:2-12μs		1½"x3"		
S5C	2-6m	.07	60/in	0.3-40			6.2-47	8-800k		3JP1	17 11/32 x 14 13/16 x 14¾;74	
S12C	dc-700k	.35	50/in	1-40	dc-700k	70/in	1-35	.5-50k		3RP1A	19 x 7 x 10;30	
WATERS MFG. CO., INC., Boston Post Road, Wayland, Mass.												
7000B	dc-100k		25/in	1-70	dc-100k	35/in	1-70	15-40k		3RP1A	19 x 5¼ x 11¼;17	295.00

* *twin channel; twin tube*

CALIFORNIA INSTRUMENTS CORPORATION, 3511 Midway Drive, San Diego 10, Calif., is introducing an automatic oscilloscope with all solid state circuitry and digital readout. The 10 MC oscilloscope has automatic sweep speed, automatic sensitivity, and automatic positioning. Range of vertical sensitivity and horizontal sweep are presented digitally on nixie readouts. Calibrated DC offset is also presented digitally on an in-line display.

The CIC Automatic Oscilloscope was designed for laboratory, field, production test and automatic checkout applications. Overall dimensions of the unit are 8¾ x 14 x 22 in., and the price is approximately $1,500.

SET Development Contract Awarded

NASA has awarded Electro-Optical Systems, Inc., Pasadena, Calif., a contract for the development of a Solar Energy Thermionic Conversion System (SET). The contract will be administered by the Jet Propulsion Laboratory of the California Institute of Technology.

Designed to generate 135 watts at a solar constant 40% that available on Earth, SET can be used as the prime source of spacecraft electric power on vehicles of the Mariner class. Total weight of the system will be approximately 25 pounds.

SET will consist primarily of a lightweight solar concentrator which will focus solar radiation into a cavity used to heat several cesium vapor-filled thermionic diodes. These diodes will transform the heat into electrical current. The concentrator will be approximately 5 feet in diameter. The thermionic generator will consist of an array of diodes arranged about the cavity.

Low Cost Test Equipment

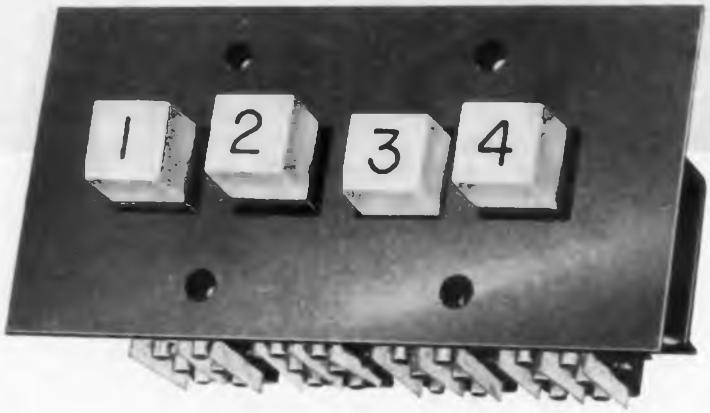
An ordinary 100-watt light bulb is used to measure capabilities of a new G. E. television tube at G. E.'s power tube department. It is used as an accurately calibrated light source inside a black, plywood box. A system of special light filters and apertures allow sensitive TV camera tubes to be precisely tested in light levels measured exactly to below one-millionth of a foot-candle. Thirty foot candles are required to read a newspaper. The highly sensitive TV tube, called a GL-7967 image orthicon, transmits the image it sees to a television screen as a bright and clear picture.

Millivolt Discriminators

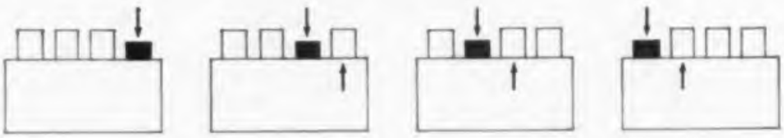
Models 710 and 711 millivolt discriminators made by Keithley Instruments, Inc., Cleveland, Ohio, are designed for use with automatic testing, process control and nuclear reactor monitoring. They are ideally suited for use in a broad range of Go, No-Go automatic control applications such as the testing of diode and capacitor leakage currents, controlling temperatures, and sorting resistors in automatic bridges. They can also be used in nuclear safety installations and numerous process control functions. Models 710 and 711 are identical except for means of adjusting the trip level.

CHEAT-PROOF

4-STATION INTERLOCK LIGHTED PUSHBUTTON SWITCH



MODEL **WC-1730**
actual size



Always One Station Committed.
Can Not Commit 2 Stations Simultaneously.
Front Panel Lamp Replacement.

This new Control Switch concept in multi-station interlocking switches features a unique "CHEAT-PROOF" design. One station is **always** committed. It is impossible to tease the system into an "all stations up" position. Actuating any of the four lighted pushbuttons causes the previously depressed button to return to normal at the exact point the system is committed to an alternate station. A lockout system makes it impossible to commit two stations simultaneously.

The Pushbuttons are individually illuminated with standard MS 25237 type lamps which are easily replaced from the front. Buttons are available in six colors and can be engraved.

The new Control Switch Interlock has been designed to permit various other station combinations. All units are engineered to withstand unusually high shock and vibration conditions.

CHARACTERISTICS

Station Circuit	D.P.D.T.
Electrical Ratings	5 amps @ 125-250 VAC
	5 amps Res. @ 30 VDC
	2.5 amps Ind. @ 30 VDC
	Switches per MS 25085-1
Lamps (not furnished)	MS 25237 Type
Weight	9 oz. max.
Size	panel surface $3\frac{3}{4}$" x 2"
	depth behind panel $1\frac{13}{16}$"

Engineers and Technicians check with Control Switch about challenging career opportunities.

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
4244 W. Lake St., Chicago 24, Ill. • Phone: Von Buren 6-3100 • TWX CG-1400

Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading electronic parts Distributors.

New Products ... for the Electronic Industries

TRANSIENT VOLTAGES

Detects and records pulses down to 1 µsec.

Indicator aids design engineers to accurately develop semiconductor circuitry without the necessity of over design or loss of costly semiconductors. Includes indicator light with memory feature for unattended operation up to 3 weeks. Selector switch has 2 voltage ranges—0-200 v. at ±5% full scale accuracy and 0-2000 v. ±2% full scale accuracy. Imput impedance is 5 pf in shunt with 1 meg. ohm, both ranges. The VAP-AIR Div., Vapor Heating Corp., 6444 W. Howard St., Chicago, Ill.

Circle 170 on Inquiry Card

X-Y RECORDER

Options include carrying case and zener diode reference supplies.

Model HR-95 X-Y Recorder includes vacuum paper holddown, continuous 10 turn precision attenuators, and an electric pen lifter as standard features. Uses standard 8½ x 11 in. graph paper or new paper divided into 100 x 150 minor divisions. Available with either 1 mv/in. 10 mv/in. amplifiers. The servo amplifiers have separate power supplies and are completely independent, isolated and interchangeable. Houston Instrument Corp., P. O. Box 22234, Houston 27, Tex.

Circle 172 on Inquiry Card

CONTROLLED-RECTIFIERS

Ratings: Current—16 a. half-wave (25 adc): voltage—to 300 v.

"Rock-Top" Transistor controlled-rectifier now available in a new high-reliability design (JEDEC 2N681 series). Features hard soldered junctions and hermetically weld-sealed cases which are intended for industrial, military and consumer use. The design of this new product is based on the 70 a. type 809 Trinistor unit. Availability of the 16 a. units extends the potential application range for static switching devices. Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Pa.

Circle 174 on Inquiry Card

MAGNETIC SENSOR

Operating temp. range −40°C to +100°C.

The transverse field "Hall-Pak," designated Model BH200, measures 0.500 x 0.130 x 0.019 in. and is furnished with 7½ in. leads of #34 ga. copper. The active area is 0.080 x 0.180 in. Model BH203, the axial field "Hall-Pak," is 0.195 in. dia. and 3/16 in. in total length and carries #34 ga. copper leads 14 in. long. The active area of this unit is 0.058 x 0.148 in. For continuous operation at 85°C. Semi-conductor Div., F. W. Bell, Inc., 1356 Norton Ave., Columbus 12, Ohio.

Circle 171 on Inquiry Card

FREQUENCY MEASUREMENTS

For accurate measurement of S, C and X-bands freqs.

Panel-mounted unit incorporates a series of tunable bandpass filters. Insertion loss of the tunable filter in each of the bands (including a low pass filter, bandpass filter adapters and interconnecting line) is less than 5 db average. Absolute accuracy of the calibrated freq. is ±0.01% Bandwith at 11 and 9 MC is 3 db down and 0.25 db down respectively. Each filter is terminated in a thermistor for spectrum power measurements. Frequency standards, P. O. Box 504, Asbury Park, N. J.

Circle 173 on Inquiry Card

COAXIAL CONNECTORS

Feature higher voltages, low VSWR and low leakage.

New versions of the Type 874 Coaxial Connectors, include locking cable and panel, and recessed locking panel types. Retaining the hermaphrodite feature of the standard 874's, the new locking connector is fully compatible with the non-locking types. The VSWR lower for locking and nonlocking versions, up to 8 GC, than N, C. BNC and UHF types. Locking adaptors available to connect the Type 874 to Types BNC, C, N, SC, TNC and UHF plugs. General Radio, Co., West Concord, Mass.

Circle 175 on Inquiry Card

New Products . . . for the Electronic Industries

PLASTIC HEADER

Maintains a tight seal under severe humidity conditions.

Molded plastic terminal header now incorporated in all Ace ½ in. precision pots. Will withstand temps. to 500°F. The plastic material is approved under spec. Mil-M-18794SDG. Header also improves heat dissipation and permits terminal identification and circuit diagrams to be molded in permanently. Terminal pins are imbedded under pressure to provide high torsional and pull strength. Ace Electronics Associated, Inc., 99 Dover St., Somerville 44, Mass.

Circle 176 on Inquiry Card

MULTI-TRACE CRT

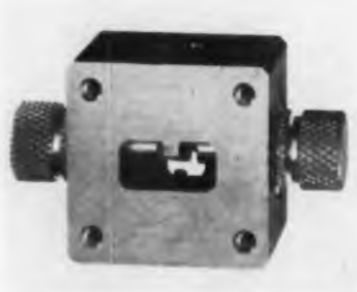
Has 3 independently controlled guns for 3 simultaneous displays.

Designated Type SC-3061, the 10 in. tube is available in a variety of phosphors, is electrostatically focused and deflected, and features an astigmatism control electode. Deflection factors, at 5 kv anode voltage, are approx. 130 v./in. horizontal and 70 v./in. vertical. The useful horizontal scan of each parallel trace is approx. 8½ in. Traces are 1⅜ in. apart on a common vertical line. Sylvania Electric Products, Inc., 730 Third Ave., New York 17, N. Y.

Circle 178 on Inquiry Card

KU-BAND MIXER

Ku-band Orthomode® Mixer covers from 13.3 to 13.7 GC.



The V-8312 is for airborne radar receiver balanced modulator applications. The mixer is 1 5/16 x 1 5/16 x ¾ in. in size and can be supplied at a weight under 2 oz. Max. noise figure is 10 db at 13.5 GC. The noise figure includes noise contribution of 1½ db 30 MC i-f strip and a 3 db allowance for image freq. The signal and local oscillator input VSWR is less than 2 to 1 over a 500 MC bandwith. Radiation Div. Varian Associates, 611 Hansen Way, Palo Alto, Calif.

Circle 180 on Inquiry Card

HIGH SPEED RELAY

"Micro-Scan" 3PDT unit features 600 μsec. switching speed.

Other features: low level (μv), low thermal noise (less than 1 μv in 100KΩ. Unit is for sampling, multiplexing, time sharing and control circuits. The 3PDT construction permits complete switching of low level 2 wire transducer data plus the associated guard shield allowing differential input isolation, low loss and high speed control. Life expectancy is in excess of 1 billion operations. James Electronics, Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Circle 177 on Inquiry Card

BAND PASS FILTERS

Series covers the freq. range from 255 to 3655 CPS.

The filters, CircuitDyne series FBH 102 use toroid coils exclusively as inductor elements. Coils adjusted to inductance tolearance of ±1% for sharp filter cutoff characteristics. Insertion loss is 6 db max. and bandwidth is approx. 10% to 30% of center freq. at the 3 db down point. Source and load impedance is 600Ω for standard versions, other impedance values available. For use in both transmitters and receivers. CircuitDyne Corp., 480 Mermaid Ave., Laguna Beach, Calif.

Circle 179 on Inquiry Card

AC RELAY

Series 5300, 50% smaller than comparable general purpose relays.

The relay is rated at 3 a. max., 115 vac resistive. The 1 Form C, cross-bar contacts are arranged for SPDT operation. Min. operating power for 1 Form C is 2.5 va. The max. ac coil voltage is 220 v. 60 CPS. Size—less than 1 cu. in.—it weighs 1.25 oz. max. It withstands 95% humidity and vibration or shock of 10 g's at 5-55 CPS operating or 50 g's non-operating. Cornell-Dubilier Electronics, div. of Federal Pacific Electric Co., Fuquay Springs, N. C.

Circle 181 on Inquiry Card

New Products . . . for the Electronic Industries

DUAL POLARIZED HORNS

Offered in standard sizes from WR-430 through WR-2300.

Are available with waveguide inputs, or 1 or 2 coax, inputs. They feature a VSWR of less than 1.2 for 30% of the freq. band. The decoupling between inputs is greater than 30 db, and the standard aperture for f/d ratio is between 0.35 and 0.50 but other aperatures are available upon request. The units are weatherized, can be pressurized and/or anti-iced, and come equipped with mounting brackets as per customer requirements. Antenna Systems, Inc., Hingham, Mass.

Circle 267 on Inquiry Card

SLIDE SWITCH

Low cost 6 a. unit designed for tight spaces.

Designated Series SS-37, the switch is 1⅝ x ⅛ x ½ in., excluding trigger. Mounting clearance is only ½ in. Lead wires do not affect clearance because leads enter the switch base from the ends and connect to recessed terminals. Rated by Underwriters' Laboratories, Inc., a 6 a., 125 vac the Series SS-37 slide switch consists of a nickle-plated steel case which is permanently attached to a molded nylon base. Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.

Circle 269 on Inquiry Card

TANTALUM CAPACITORS

Will withstand military shock and vibration requirements.

Series 125 C "cup style" sintered-anode tantalum capacitors supplement the 85 C ratings now available. Three case sizes are furnished. In the smallest case size, ratings range from 30 μf at 4 v. to 1.7 μf at 85 v.; in the middle case size, capacitances range from 140 μf at 4 v. to 9 μf at 85v.; and the largest case size capacitances range from 320 μf at 4 v. to 25 μf at 85v. All units are available in both $\pm 10\%$ and $-15+20\%$ tolerances. Sprague Electric Co., 233 Marshall St., North Adams, Mass.

Circle 271 on Inquiry Card

BAR SOLDER

Designated Alpha Vaculoy® Bar Solder.

Photomicrographs indicate that it is significantly freer from oxide-forming elements than are other commercially-made solders. As a result, Alpha Vaculoy Solder cuts dross, increases bath life, reduces inherent inclusions, improves wetting and produces brighter joints. It is available from stock in most of the common tin-lead alloys; comes in standard 1 lb. bars, or 9 lb. ingots for automatic soldering machines. Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J.

Circle 268 on Inquiry Card

SINGLE-DETECTOR SYSTEM

Senses and counts alpha and beta independently and simultaneously.

For use in any laboratory, plant or area where radioactive materials are used. The all transistorized system, PC-22 consists of a universal shield with gas flow proportional counter detector, and 2 decade scalers —1 to count and register each type of radiation. The shield features a 2 pi counting chamber shielded for low background alphas (1 count/hr.) and betas (30 counts/min.). Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.

Circle 270 on Inquiry Card

DC POWER SUPPLY

For military, commercial, and industrial computers.

The power-bloc module is a regulated dc power supply using Varo's "frozen diode" circuit principle (patent applied for) to achieve high regulation without transistors, tubes or capacitors. Completely sealed in an epoxy encapsulation with an aluminum outer housing, power-bloc modules are being manufactured in over 40 standard voltage-current-ratings from 1 v. at 10 a. to 30 v. at 0.8 a. Varo Inc., 2201 Walnut St., Garland, Tex.

Circle 272 on Inquiry Card

New Tech Data for Engineers

Time Meters

GEZ-3354 describes the latest addition to GE's line of BIG LOOK panel instruments, the Type 236 Elapsed Time Meter. Information contains applications, features, specs., standard ratings and schematics. General Electric Co., Schenectady 5, N. Y.

Circle 214 on Inquiry Card

Microfilm

Three illustrated booklets describing the use of microfilm in the Social Security Administration, the U. S. Bureau of Public Debt and the U. S. Army Finance Center, are available from Minnesota Mining and Mfg. Co., Dept. S1-417, 900 Bush Ave., St. Paul 6, Minn.

Circle 215 on Inquiry Card

Control Equipment

Boonshaft and Fuchs, Inc., Hatboro Industrial Park, Hatboro, Pa., is offering a 6-page control equipment brochure illustrating and giving brief descriptions of high-performance feedback control hardware. Included in the brochure are operational amplifiers, freq. response test equipment, pressure transmitters and receivers, actuators, and programmers.

Circle 216 on Inquiry Card

Zener Diodes

Fansteel Metallurgical Corp., Rectifier-Capacitor Div., N. Chicago, Ill., has 2 bulletins describing JEDEC Type miniaturized silicon Zener diodes for voltage regulation. The 1 w regulator requires no heat sink and dissipates max. power at amb. to +25°C. The 10 w regulator units for chassis or cooling fin mounting, dissipate max. power at case temp. to +55°C.

Circle 217 on Inquiry Card

Synchro Standards

Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif., is offering tech data on a series of synchro standards designed to simulate the output of a Master Synchro Transmitter (CX). All models feature a ratio accuracy of 10 ppm equivalent to an accuracy of better than 2 sec. of arc. Specs. on 6 models in the series are included.

Circle 218 on Inquiry Card

Telemetry Filters

PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif., is offering tech data on band pass telemetry filters designed for the replacement of conventional filters in telemetering uses. Information includes a chart displaying Typical 7½% IRIG Channel, tech. filter data and ordering specs.

Circle 219 on Inquiry Card

Resistance Standards

Julie Research Laboratories, Inc., 603 W. 130th St., New York 27, N. Y., is offering tech data describing resistance standards and techniques for establishing resistance ratio accuracy to one part in 10 million.

Circle 220 on Inquiry Card

Test Receptacles

AMP Inc., Harrisburg, Pa., has tech. data available covering complete specs. on a new line of test probe receptacles, used to test probe printed board circuitry. The bulletin gives details for both 2-lag and 3-lag AMP receptacles.

Circle 221 on Inquiry Card

Power Supply

John Fluke Mfg. Co., Inc., P.O. Box 7428, Seattle 33, Wash., has available tech data describing a new general purpose power supply. The unit is rated at 0 to 500 v., output current 0 to 500 ma.

Circle 222 on Inquiry Card

Subcarrier Oscillator

Dorsett Electronics, Inc., 119 W. Boyd St., Norman, Okla., has tech. data available on their Model 0-18 silicon-transistor, subcarrier oscillator designed for FM telemetering systems and available in all standard IRIG channels. Temp. stability from −55°C to +100°C, with high input impedance, low power consumption and compact packaging.

Circle 223 on Inquiry Card

Silicon Rectifiers

Slater Electric, Inc., Industrial Div., Semiconductors & Electronic Products, 45 Sea Cliff Ave., Glen Cove, L. I., N. Y., has tech. data available on their new series of miniature silicon rectifiers designed to replace top IN1095 and IN1096. These units are approx. half the size of the top hat, and require no heat sink for printed

Circle 224 on Inquiry Card

Space Technology

"General Electric Valley Forge Space Technology Center," an 8-page pamphlet describes the main features of this first large space center in the United States built by private industry. Designated PIB-58, the pamphlet is illustrated with facility photos and drawings. Information includes general description, a list of facilities and details of the Space Environment Simulation Laboratory. General Electric Co., Missile and Space Vehicle Dept., 3198 Chestnut St., Phila. 1. Pa.

Circle 225 on Inquiry Card

Power Supply

Lite Power Supply Data Sheet #152 from Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn., covers tech. data, features, specs., installations, outline drawings and ordering information for TEC's LPS Lite Power Supply. The unit is designed to provide supply and bias voltages for TEC-LITE

Circle 226 on Inquiry Card

4-Terminal Test Clips

Electro Scientific Industries (formerly Electro Measurements), 7524 S.W. Macadam Ave., Portland 19, Ore., has tech. data available describing their Kelvin Klips and Kelvin Klamps. Catalog Sheet C-31 describes their accessories designed for making rapid, high accuracy 4-terminal measurements even with relatively high lead and contact resistances.

Circle 227 on Inquiry Card

Cooling Equipment

McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J., is offering a 48-page catalog on their line of packaged blowers, propeller fans, centrifugal blowers, ring fans and accessory items. All mechanical and electrical characteristics of each model are included with performance curves and engineering drawings. A special section is given to basic design information for ventilating electronic equipment using forced-air cooling. Mathematical formulae and graphs are provided for problems in cooling solid state circuitry or tube assemblies.

Circle 228 on Inquiry Card

General Purpose Relays

Branson Corp., 41 S. Jefferson Rd., Whippany, N. J., has tech. data available on their transistor sized general purpose relay Type JR. Specs., characteristics, capabilities and dimensional diagrams are included. The unit is 0.04 cu. in. and weighs 5 grams.

Circle 229 on Inquiry Card

Microwave Tube Catalog

Raytheon Co., Microwave & Power Tube Div., Waltham 54, Mass., is offering a 70-page microwave tube catalog. The catalog lists 201 active, unclassified microwave tubes of all types, as well as ferrite devices, magnetic components, high power test modulators and infrared detectors. The catalog is color-tabbed, with descriptive 'specs,' for sections including magnetrons, klystrons, amplitrons and stabilotrons, BWOS, TWTS, crossed field amplifiers and associated components.

Circle 230 on Inquiry Card


ADC
TRANSFORMERS · FILTERS · REACTORS
JACKS & PLUGS · JACK PANELS
Military Standard POWER Transformers—Types MS-90016 through MS-90036.
Military Standard AUDIO Transformers Types MS-90000 through MS-90008.
Sub-Miniature, hermetically sealed, low frequency inductors and transformers.
Transformers and filters for TRANSISTOR and PRINTED CIRCUIT applications to meet MIL-T-27A Grade 5, Class R or S.
Toroids Hermetically sealed or open units for all frequency ranges.
Filters Sub-Audio to 1.5 mcs.
Telephone Coils Mechanically and electrically interchangeable with Western Electric.
Broadcast Quality Transformers Standard of the Industry.
Magnetic Amplifiers and Saturable Transformers—For servo motor control; DC-DC Power Supplies, and switching silicon controlled rectifiers.
Balanced Modulators Designs over a wide range up to 500 kcs.
Encapsulated Transformers—Using custom epoxy compounds for military and commercial applications.
Terminal Blocks Molded to your specifications. Six popular sizes in stock.
PACIFIC BRANCH
7247 Atoll Avenue
North Hollywood, Calif.
Phone: TRiangle 7-7169
Jack Panels—Several size panels in stock.
Plugs, Patch Cords and Jacks—Standard in the communication industry. Long frame telephone type jacks; wide variety; two and three conductor.
Government Approved Qualification Testing Laboratory.
Choose from over 500 stock items or let ADC design to your requirements
ADC
ADC PRODUCTS
A Division of Magnetic Controls Company
2839-13TH AVENUE SOUTH • MINNEAPOLIS 7, MINNESOTA
PACIFIC BRANCH North Hollywood, California
TRANSFORMERS • REACTORS • FILTERS • JACKS AND PLUGS • JACK PANELS

SCOTCH® BRAND MAGNETIC INSTRUMENTATION TAPES OFFER A RIGHT TAPE FOR EVERY APPLICATION

Knowledgeable tape users realize that magnetic tapes are not all alike—that it takes specific constructions to meet the needs of specific applications. And they've learned to rely on "SCOTCH" BRAND to supply the one right tape for each application. Not only does "SCOTCH" BRAND offer a complete line, it offers that something extra that makes all the difference in performance—the uniformity and reliability that result from 3M's experience, technical skill, and continuing research. Make the "SCOTCH" BRAND label your guide in buying instrumentation tapes. Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

The wide "SCOTCH" BRAND line provides many tapes, including these broad classifications:

SANDWICH TAPES 488 and 489—exclusive with "SCOTCH" BRAND, offering 30 times the wear of standard tapes, drastic reductions in head wear, elimination of oxide rub-off. In standard or extra-play lengths.

HIGH RESOLUTION TAPES 458 and 459—offering superior resolution in high frequencies, greater pulse density in digital recording. In standard and extra-play lengths.

HEAVY DUTY TAPES 498 and 499—offering exceptional life, good resolution, high resistance to temperature and humidity, reduction in the build-up of static charge. In standard and extra-play lengths.

HIGH OUTPUT TAPE 428—offering top output in low frequencies. Performs well even in temperature extremes.

STANDARD TAPES 403 and 408—offering the good all-round performance at low relative cost which has made them the standards of the instrumentation field.

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

"SCOTCH" BRAND MAGNETIC TAPES *FOR INSTRUMENTATION*

New Tech Data for Engineers

Ultrasonic Writing

Ultrasonic Industries, Inc., Ames Court, Engineers Hill, Plainview, L. I., N. Y., has tech. data available on their ultrasonic ball point writing instrument. The device capable of writing at a linear speed of 9000 ft. min. requires no writing fluids or marking compounds. It consists of a small generator which develops high freq. oscillations activating an ultrasonically transducerized pen of size and shape comparable to a conventional pen or pencil.

Circle 249 on Inquiry Card

Noise Analysis

A Tech. Report, entitled "A Practical Approach to Transistor Noise" is available from Quan-Tech Laboratories, Inc., Boonton, N. J. The report deals with the origin and nature of the various types of electrical noise generated in transistors. Specific methods for the quantitative analysis of transistor noise are treated in detail.

Circle 250 on Inquiry Card

Descent Indicator

Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J., has tech. data available on their RDI-06 Rate of Descent Indicator with a range of 0-10 ft. and an accuracy of 0.2 ft./sec. This airborne ultrasonic doppler system gives precise measurements of an aircraft's rate of descent during the last 18 in. before touchdown.

Circle 251 on Inquiry Card

R. F. Chokes

J. W. Miller Co., 5917 So. Main St., Los Angeles 3, Calif., is offering a 48-page catalog which includes specs. on molded (military type) r-f chokes, intermediate freq. transformers, adjustable coils wound on stable Ceramic and Resinite materials, exact replacement coils, and other related items. Industrial Catalog No. 62.

Circle 252 on Inquiry Card

Information Searching

American Society for Metals, Metals Park, Novelty, Ohio, has an 8-page brochure which describes a new electronic system of searching tech. articles, documents and patents on metals and related subjects for specific mention of any aspect of the subject.

Circle 253 on Inquiry Card

Power Converters

Texas Instruments Incorporated, P. O. Box 5012, Dallas 22, Tex., has an application note on DC-DC GERMANIUM POWER CONVERTERS. The application note discusses the use of medium and high power transistors in dc to dc converter circuits.

Circle 254 on Inquiry Card

Nanocircuitry

General Instrument Corp.'s Semiconductor Div., 600 W. John St., Hicksville, N. Y., is offering Bulletin NC-10, describing their facilities and capabilities in the field of nanocircuits. Some of the headings include typical nanocircuit applications, what is available today, a graph for translating a present problem into nanocircuitry, and the nanocircuit concept.

Circle 255 on Inquiry Card

Heating & Cooling

Tech. Data Bulletin 356 from Dean Products, Inc., 1042 Dean St., Brooklyn 38, N. Y., contains information on heating, cooling, heat transfer, an instantaneous LMTD chart, how to figure heating load, how to select heating surface and pressure drop short cuts, and uses of their Panelcoil®.

Circle 256 on Inquiry Card

Timing and Control Systems

Intermountain Branch, Curtiss-Wright Corp., Electronics Div., P. O. Box 10044, Albuquerque, N. Mex., has tech. data available on their programmed Timing and Control Systems. The systems are designed to provide accurate and reliable initiation and termination of various switching functions at pre-selected times.

Circle 257 on Inquiry Card

Air Bearing Turntable

Dunn Engineering Corp., 225 O'Brien Hwy., Cambridge 41, Mass., has tech. data available on their Model T900 rate turntable, which is equipped with air bearings. The T900 is designed for testing the dynamic performance of inertial systems, all types of gyroscopes, accelerometers and pendulums.

Circle 258 on Inquiry Card

Capacitors

Catalog MS61-10 from Aerovox Corp., Distributor Div., New Bedford, Mass., contains up-to-date data on their motor-run, motor-start capacitors. Information includes capacities and physical dimensions, hardware and terminal variations. Illustrated for quick reference.

Circle 259 on Inquiry Card

Microscopy

Ernest F. Fullam, Inc., P. O. Box 444, Schenectady 1, N. Y., is offering a brochure entitled, "Accessories for Microscopy." Included are accessories for evaporation, sheet screening, ordering instructions, magnification calibration, general accessories, and specimen screen for Siemens microscopes.

Circle 260 on Inquiry Card

RF Power Levels

Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md., has available a brochure on precise methods of determining r-f power levels, which discusses the sources of error of these methods. Entitled, "RF Power Bridges and Thermistor Mounts," the brochure also describes their line of precision power bridges, thermistor mounts and X-band power standards.

Circle 261 on Inquiry Card

Potentiometers

Duncan Electronics, 2865 Fairview Rd., Costa Mesta, Calif., has a tech. bulletin available covering their new 3600 Series of 5 to 600 KΩ potentiometers. Included are complete specs., dimensional drawings and performance characteristics of the 3 to 10-turn Series models.

Circle 262 on Inquiry Card

Angle Repeater

Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J., has tech. information available on their Precise Position Repeater, Model PPR-10 which provides both a visual readout and binary coded data output of the angular position with 20 sec.-of-arc accuracy and 4 sec.-of-arc resolution.

Circle 263 on Inquiry Card

Power Pentode

Application Note AN-192 from Radio Corp. of America, Electron Tube Div., Harrison, N. J., contains information on their RCA-6939 UHF twin power pentode. Uses are for Class A r-f amplifier and freq. tripler service at freqs. up to 500 MC. Under CCS conditions at 500 MC, it can deliver an average of 5 w and under ICAS conditions, 6 w.

Circle 264 on Inquiry Card

Medium Speed Printer

Soroban Engineering, Inc., Melbourne, Fla., has tech. data available on their medium speed printer which is capable of printing 100 characters or the average line of type in 1 sec. The printing platen accepts a paper width up to 11 in. and pin feed continuous forms up to 11¾ in. Loading is similar to teletype, using roll or fanfold papers.

Circle 265 on Inquiry Card

Solid State Time Delay

Shockley Transistor unit of Clevite Transistor, Stanford Industrial Park, Palo Alto, Calif., has tech. data available describing simple, variable time delay circuits, using a small number of components which can be designed with the Shockley 4-layer diode as the active element.

Circle 266 on Inquiry Card

Circle 77 on Inquiry Card →

New Tech Data for Engineers

Programmer-Comparator

Bulletin LMEJ 4643 describes second in GE's Programmer-Comparator offering simple, automatic test equipment for use at flight line, base shops, aircraft carriers, and depot facilities. Analog comparison techniques, applications, characteristics, and specs. are discussed. General Electric Co., Light Military Electronics Dept., Armament & Control Section, 600 Main St., Johnson City, N. Y.

Circle 231 on Inquiry Card

Transformer Finishes

James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill., is offering a new catalog describing standard miniature transformer finishes for military and commercial applications.

Circle 232 on Inquiry Card

Magnetic Metals

Magnetic Metals Co., Hayes Ave. at 21st St., Camden, N. J., has a 40-page booklet describing high permeability magnetic metals. Entitled "Carpenter High Permeability Alloys," the book contains information on permeability and core loss of Carpenter high permeability "49" and Carpenter HyMu "80" alloys at both 60 and 400 CPS. Also described is a new approach to core loss calculations and booklet contains a considerable amount of 60 and 400 CPS loss data.

Circle 233 on Inquiry Card

Semiconductor Packages

Corning Glass Works, Corning, N. Y., has tech. data available on a micro-miniature semiconductor package made of glass, that is opaque to visible and infrared light. The package complies with the microminiature transistor outline designation, TO-51. They have passed thermal shock tests of Mil-Std-202B, Method 107 A, Condition C, and withstand 300°C storage without damage.

Circle 234 on Inquiry Card

HV Power Supply

Mikros, Inc., 7620 S. W. Macadam Ave., Portland 19, Ore., has tech. data available on their Model HV-40 high voltage power supply, an r-f type unit providing continuously variable dc output voltages in the range from 10 to 40 KV. Catalog Sheet C-1.

Circle 235 on Inquiry Card

Wire-Wound Resistors

Bulletin 0-1 from Kelvin Electric Co., 5907 Noble Ave., Van Nuys Calif., gives electrical and mechanical specs. of very stable, encapsulated precision wire-wound resistors.

Circle 236 on Inquiry Card

Ceramic Dielectrics

Bulletin 517, an 8-page booklet, is designed to inform the O.E.M. users of ceramic dielectrics and piezoelectric ceramic transducers of the manufacturing, design, and research facilities available from Erie Technical Ceramics, Div. of Erie Resistor Corp., State College, Pa.

Circle 237 on Inquiry Card

Inductors

Vari-L Co., Inc., P. O. Box 1433, Stamford, Conn., has available Catalog 61 on their electrically-variable inductors. Information includes function of the variable inductor, principles of operation, special types, applications, explanation of tabular data, characteristic curves and dimensional drawings.

Circle 238 on Inquiry Card

Ground Stud

Jan Engineering, 2018 Pico Blvd., Santa Monica, Calif., has tech. data available on their ground stud, P/N 5008. Designed for circuits requiring up to #14 AWG wire and for establishing a true reference for single point ground to eliminate the possibility of ground loops and noise pickup. Information includes spec. sheets and outline drawings.

Circle 239 on Inquiry Card

Clean Room Uniforms

Techni-Tool, Inc., 1033 Chestnut St., Phila. 7, Pa., has tech. data available on their clean room synthetic uniforms. Information is included on their lint-free uniforms and accessories made of Dacron® polyester.

Circle 240 on Inquiry Card

Mfg.-Rep. Agreement

The Industry Relations Committee of the Association of Electronic Parts and Equipment Manufacturers, Inc., Suite 1500, 11 So. La Salle St., Chicago 3, Ill., has available a checklist of points for consideration in the preparation of n formal agreement between manufacturers and sales representatives.

Circle 241 on Inquiry Card

Digital Transceiver

Hughes Aircraft Co., P. O. Box 90-902, Los Angeles 45, Calif., has tech. data available on their digital data transceiver, which is capable of high speed serial transmission up to 4800 bits/sec. over high quality lines. The transistorized transceiver, HC-270, operates by information coded by the transmitter on a single tone in the form of 4 orthogonal phases and recognized at the receiver by element-to-element comparison.

Circle 242 on Inquiry Card

DC Power Supplies

Jordan Electronics, Div. of Victoreen Instrument Co., 121 So. Palm Ave., P. O. Box 2047, Alhambra, Calif., has a dc power supply catalog, 12 pages, which describes their line of dc power supplies.

Circle 243 on Inquiry Card

Klystron Oscillators

Sperry Electronic Tube Div., Section 101, Gainesville, Fla., has a brochure available on their family of 2-cavity Klystron oscillators. These units are developed for parametric amplifier pumping applications and FM doppler radars. One design feature is the constant output power vs beam voltage characteristic which results in a flat top power output mode.

Circle 244 on Inquiry Card

Phase Meter

Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y., is offering tech. data on their Model 200A phase meter. Information is also included on their null meter, impedance comparators, power oscillators, and electronic generators.

Circle 245 on Inquiry Card

DC Power Supplies

Electro Products Laboratories, Inc., Power Supply Div., 4500 N. Ravenswood Ave., Chicago 40, Ill., has available Bulletin PS-561 covering their line of 14 low voltage, regulated, semi-regulated and conventional dc power supplies. Information includes handy selection chart, characteristics and performance data.

Circle 246 on Inquiry Card

Fixed Resistor

Data Sheet 185 from CTS Corp., Elkhart, Ind., illustrates, describes and tabulates extensive tests of their new 0.050 in. dia. x 0.030 in. thick solid cermet high temp. high stability fixed resistor, using Mil-R-10509D, Characteristic B (RN60) as a guide to evaluation.

Circle 247 on Inquiry Card

Four Layer Semiconductor

Tung-Sol Electric Inc., 1 Summer Ave., Newark 4, N. J., has tech. data available on their Dynaquad, a low cost, germanium, alloy junction PNPN device that can be turned on and off at the base in 0.1 μsec and can switch in the megacycle range. Information includes a comparison of the circuitry of a conventional flip-flop and a Dynaquad flip-flop, illustrates a waveform of the Dynaquad's switching action and shows curves of the base turn-on and collector turn-on characteristics.

Circle 248 on Inquiry Card

NEW FROM BENDIX
42 RECTIFIERS
3-6-12 AMP SERIES

New Bendix silicon rectifiers offer lower current leakage for greater circuit stability—as low as 10 microamps at 600 volts. They're 'Dynamically Tested', an exclusive Bendix quality control process that individually tests each unit to assure uniform reliability. The result: dependable, versatile units that offer a wide range of voltage capabilities (50 to 600 volts PRV). Designs conform to JEDEC DO-4 outlines—with welded case and glass-to-metal hermetic seal between case and anode lead. Ideally suited for applications including magnetic amplifiers, DC blocking units, and power rectification. Write Bendix Semiconductor Division for information.

MAXIMUM RATINGS

Type Number	Forward Current	Peak Reverse Voltage	Reverse Current at PRV		Forward Drop at 25°C
	Adc	Vdc	@150°C	@25°C	Vdc
1N1124-1N1128	3 @ 50°C	200-600	—	10 µAdc	1.1 @ 6 Adc
1N1199-1N1206	12 @ 150°C	50-600	10.0 mAdc	—	1.25 @ 12 Adc
1N1341-1N1348	6 @ 150°C	50-600	10.0	—	1.15 @ 6 Adc
1N1581-1N1587	3 @ 150°C	50-600	0.5	—	1.5 @ 6 Adc
1N1612-1N1616	5 @ 150°C	50-600	1.0	—	1.5 @ 10 Adc
1N2491-1N2497	6 @ 150°C	50-600	2.0	—	1.1 @ 6 Adc
B-443-B-449	12 @ 150°C	50-600	2.0	—	1.2 @ 12 Adc

Bendix Semiconductor Division

HOLMDEL, N. J.

THE Bendix CORPORATION

Main Office: South Street, Holmdel, N. J.—Ph: SH 7-5400 • **New England Office:** 114 Waltham, Lexington, Mass.—Ph: VO 2-7650 • **Detroit Office:** 12950 West 8 Mile Road, Detroit 37, Mich.—Ph: JO 6-1420 • **Midwest Office:** 2N565 York Rd., Elmhurst, Ill.—Ph: BR 9-5050 • **West Coast Office:** 117 E. Providencia Ave., Burbank, Calif.—Ph: VI 9-3961 • **Canadian Affiliate:** Computing Devices of Canada, P.O. Box 508, Ottawa 4, Ont. • **Export Office:** Bendix International, 205 E. 42nd Street, New York 17, N. Y. **Stocking Distributor:** Contact nearest sales office for name of local distributor.

New Products

SILICON TRANSISTORS

Total switching time: 25 nsec; collector to emitter saturation: 0.2 v.

EIA-registered units in the new TO-51 micro package are 2 triple diffused silicon planar high speed computer switches, 2N958 and 2N959. New industry-standard TO-51 micro package is 0.165 in. dia. max. and 0.060 in. high max. Leads are flat ribbon 0.500 in. min. length. It is particularly suited to "swiss cheese" assembly as well as other advanced techniques. Pacific Semiconductors, Inc., 12955 Chadron Ave., Hawthorne, Calif.

Circle 188 on Inquiry Card

SPECTRUM TAPE RECORDER

Can be remote programmed and rack mounted.

Model TRS, Transistorized Spectrum Tape Recorder, designed to record, store, and playback the spectral information of any r-f modulated signal which can be normally displayed on the crt of a Polarad Spectrum Analyzer. A standard 3600 ft. ¼ in. magnetic tape reel permits 48 min. of recording time at 15 ips. A "RECORD" lock is provided to prevent accidental erasure. Fast forward and rewind of 60 ft./sec. is provided. Polarad Electronics Corp., 43-20 34th St., Long Island City, N. Y.

Circle 189 on Inquiry Card

New Products

TIME TOTALIZER

Features include: small size, low cost and trouble free operation.

Uses include: timing of machinery and parts for preventive maintenance; timing of devices used intermittently; and life tests. Functionally, the Time Totalizer is a mercury coulometer. Full scale range is 1000 hrs. Voltage source, ac version, 105 to 125 v., freq. range 50 to 2400 cps, dc version 24 to 32 v.; Power consumed, approx. 0.5 w.; Compensated temp. range, from −35°C to +71°C; Accuracy, ±6% over full temp., voltage and freq. range. American Machine & Foundry Co., AMF Bldg., 261 Madison Ave., New York 16, N. Y.

Circle 186 on Inquiry Card

HIGH GAIN AMPLIFIER

High common mode rejection with 5 mv/cm sensitivity.

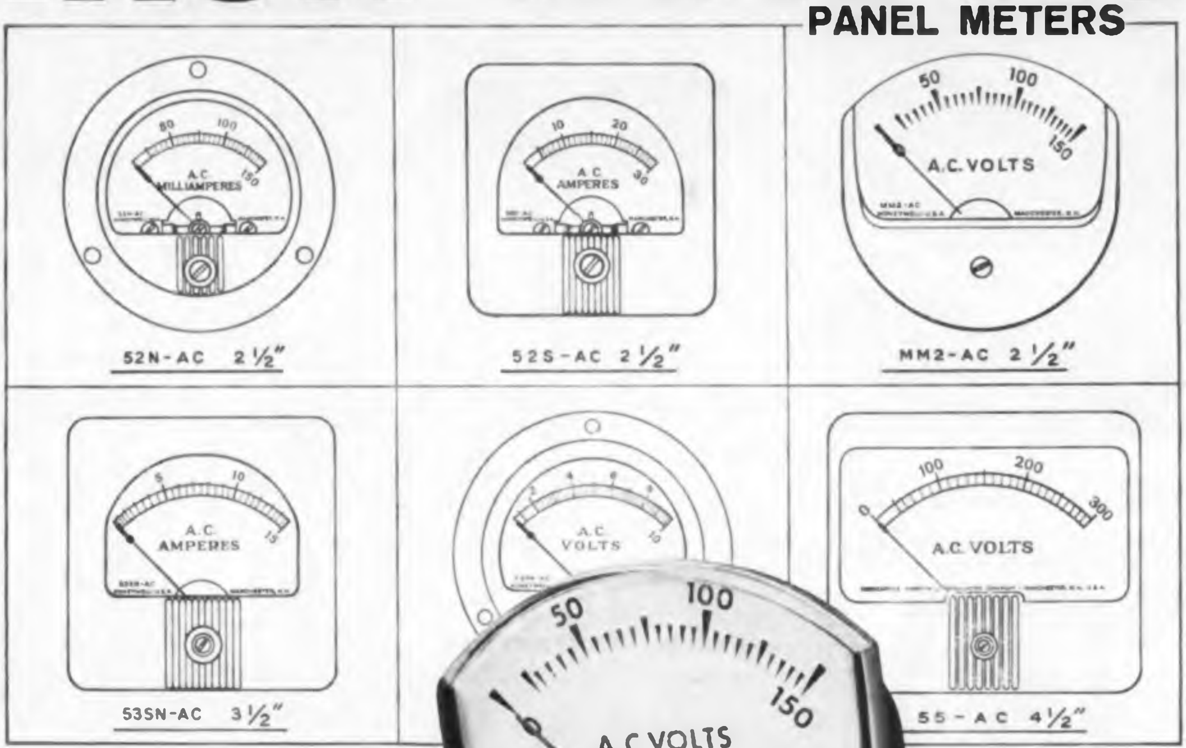
Amplifier Model 162D is a plug-in unit designed for the Hewlett-Packard Model 160B and 170A oscilloscopes. It has 12 calibrated ranges 5 mv/cm to 20 v./cm, with a vernier control extending min. sensitivity to 50 v./cm. At max. sensitivity, the 162D/170A combination has a rise time of 10 nsec.; the 162D/160B combination has a rise time of 29 nsec. It has a differential input with 40 db. common mode rejection. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif., Dept. 2114.

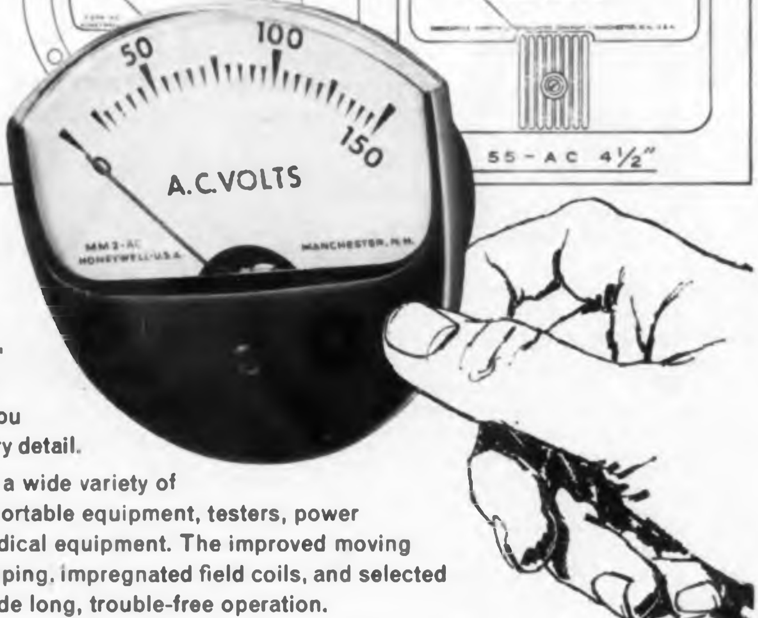
Circle 187 on Inquiry Card

ANNOUNCING THE NEW HONEYWELL

IRON VANE AC

PANEL METERS





Here are the AC counterparts of Honeywell's popular DC panel meters. Iron Vane AC Meters are perfectly matched to the DC range and are available in both the Medalist and "standard" case styles. This means a minimum of trouble and expense in mounting. And you are assured of harmonious styling in every detail.

Iron Vane AC Meters are designed for a wide variety of commercial applications — including portable equipment, testers, power supplies, generator equipment and medical equipment. The improved moving iron mechanism features magnetic damping, impregnated field coils, and selected fixed and moving iron material to provide long, trouble-free operation.

These meters are available in a wide selection of case styles and colors. Dials can be custom designed with your company name, trade-mark or other data. For full information, contact our representative in your area — he's listed in your classified telephone directory. Or us: Precision Meter Division, Minneapolis-Honeywell Regulator Co., Manchester, N.H., U.S.A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario and around the world: HONEYWELL INTERNATIONAL — Sales and service offices in all principal cities of the world.

Honeywell

Precision Meters

Circle 85 on Inquiry Card

New Products

PARABOLIC ANTENNAS

For use in the 806 to 960 MC fre. range.

Spun and mesh parabolic antennas offered in sizes from 4 to 12 ft. (10 ft. for spun). 36 newly catalogued tennas offered in sizes from 4 to 12 ft. (10 ft. for spun). 36 newly catalogued models for UHF translator, studio-transmitter link, or government use. Features ability to mount feed from front or rear and the interchangeability of different feed designs. All feeds are continuously adjustable through 360° in spun reflector models —in steps of 90° in mesh models. Technical Appliance Corp., Sherburne, N. Y.

Circle 184 on Inquiry Card

POWER TRANSISTOR TESTER

Tests transistors, power diodes and Zener diodes.

Model 1885 designed to test transistors to 50 a. of IC, power diodes to 5 a. of forward current, and Zener diodes to leakage current of 150 ma. Measures the following parometers: I_{cbo}, I_{ceo}, I_{ebo}, dc Beta, imput impedance, Zin, output impedance Hoe, GM in µmhos and mho. It will also determine Alpha and collector voltages and Vcc (SAT). This full transistorized instrument is set up from either built-in roll chart or direct from transistor manufacturers handbook specs. Hickok Electrical Instrument Co., 10606 DuPont Ave., Cleveland 8, Ohio.

Circle 185 on Inquiry Card

TRANSITRON EXPANDS ITS PACKAGED ASSEMBLY PROGRAM

WELDED CIRCUIT PACKAGES Transitron custom-assembles and encapsulates any variety of three-dimensional circuit configurations of conventional, miniature or micro-miniature components. Utilization of advanced production processes, including precision welding, assures strong, uniform joints and results in high packing density, light weight and high structural reliability. Typical custom-made packages are:

FLIP-FLOP

A general purpose flip-flop module capable of counting at speeds of 3-5Mc and operating as a logic element at bit rates in excess of 2Mc.

(Tentative Data)
Frequency in excess of 3Mc
Supply Voltage 12 Volts DC ±30%
Power Dissipation (typical) 150mW
Clock Rate in excess of 2Mc
Maximum Load 1.5KΩ

LOW LEVEL AMPLIFIER

Gives high input impedance and low noise performance with a voltage gain of approximately 20.

(Tentative Data)
Input Impedance 500KΩ
Output Impedance 3KΩ
Voltage Gain 20
Equivalent Input Noise Voltage 5μV
Voltage Supply +18 Volts
Band width DC to 100Kc

3 to 5 WATT AUDIO AMPLIFIER

Contains a stable gain push-pull amplifier circuit capable of up to 5 Watts.

(Tentative Data)
Voltage Supply 18 Volts
Maximum Input Voltage 1 Volt p.p. from 3KΩ source resistance
Maximum Linear Output (Push-Pull) 3 Watts (20 Ω load)
Band width 20-20,000 cps

First to introduce the REF-AMP, Transitron, a 5-year pioneer in the development of packaged semiconductor assemblies, is pleased to announce the broad expansion of its Special Products Service Department. In response to the increasing demand for packaged assemblies, Transitron offers the electronic industry a growing line of standard assemblies as well as a highly versatile and flexible custom design service.

VIDEO AMPLIFIER DOUBLET

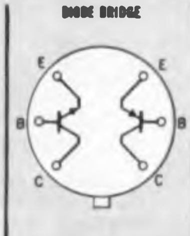
Utilizes a stable gain circuit giving a broad flat band width and relatively low noise operation.

(Tentative Data)
Band width 20 cps to 7Mc
Voltage Supply 22 Volts
Current Gain of approximately 20 per doublet
Equivalent Input Noise Current over entire band width is typically less than 0.02μA RMS

MULTIPLE SEMICONDUCTOR ASSEMBLIES

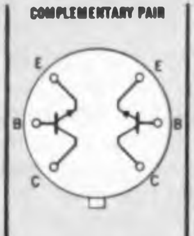
An extension of standard assembly techniques has resulted in the packaging of a number of devices in the same space normally occupied by one standard transistor package. Transitron's compact packaging features electrical isolation, close thermal proximity between junctions, matching of specific electrical specifications, and reduction of external connections. Three typical Transitron Multiple Assemblies are:

DIODE BRIDGE



BOTTOM VIEW

COMPLEMENTARY PAIR



BOTTOM VIEW

DIFFERENTIAL INPUT PAIR

BOTTOM VIEW

PACKAGED REFERENCE ASSEMBLIES

A further diversification of Transitron's packaged assembly program has produced two new additions to the firm's broad standard line of quality silicon references . . .
Selecting from among its most reliable and stable units, including devices used in the Minuteman missile, Transitron combines for the first time both temperature-compensation and close tolerances in a double anode packaged reference assembly. Further efforts have also produced a low current reference assembly which offers precision tolerance reference voltages (10 to 100 volts) in a package especially suited for high-density circuitry.
For further information, ask for Transitron's "Packaged Reference Assembly" bulletins.

Transitron
electronic corporation
wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE · CABLE ADDRESS TRELCO

Gertsch announces:

the CRB line of complex ratio bridges

Ideal for voltage and phase comparison.

Measures complex voltage ratios — both in-phase and quadrature — with high accuracy.

These Gertsch CRB instruments are designed for testing 3- or 4-terminal networks, including transformers, synchros, resolvers, gyros, and transducers. The Gertsch line includes:

SOLID STATE BRIDGE—Model CRB-4. Instrument is fully transistorized . . . highly accurate. A self-contained, phase-sensitive null indicator permits rapid measurements. $R_c + R_q$ voltage ratios are read from concentric switch dials. *Battery or line* operation . . . case or rack mounting. Operating frequency range: 380-420 cps. Weight 20 pounds.

COMPLEX RATIO BRIDGE—Models CRB-1B and CRB-2B. In these units, quadrature component reading is indicated either as rectangular coordinate, tan θ, or θ directly in degrees. Useful for measuring angles as small as .001°. Six-place resolution, with high accuracy. Cabinet or rack mounting.

CRB-1B	30-1,000 cps	2.5 f or 200 V max.
CRB-2B	50-3,000 cps	.35 f or 200 V max.

AUTOMATIC COMPLEX RATIO BRIDGE—Model CRB-3. A self-nulling AC bridge with digital readout of both in-phase and quadrature voltage ratios. Excellent for production testing.

Accuracy of bridge is .002% max. Five-place resolution, with automatic quadrant indication. Unit is self-contained, requiring no external calibration sources, and is equipped for external printer readout.

Complete literature on all units sent on request. Bulletin CRB.

Gertsch

GERTSCH PRODUCTS, INC.

3211 S. La Cienega Blvd., Los Angeles 16, Calif. • UPton 0-2761 • VErmont 9-2201

Circle 88 on Inquiry Card

New Products

SERVICE TOOL BAG

Leather tool bag for service, repair and maintenance mechanics.

Made of top grain cowhide. Upper section holds large tools, parts, meters, instruments. Lower section has 3 sliding metal trays with variety of divided compartments for smaller parts. Outside dimensions: 15 x 12½ x 15 in. Can be equipped with an outside pocket for service books and papers. Pocket measurements: 13½ in. long, 9 in. high, with 1¾ in. gusset expansion. K. Leather Products, Inc., 427 Broadway, New York 13, N. Y.

Circle 182 on Inquiry Card

ANTENNA MOUNT

Telemetry reception and tracking of missiles and satellites.

Model 28, servo controlled pedestal, features include gyro stabilization for shipboard use, a complete solid state ac servo system and automatic beam crossover switching from 3 db to 9 db. Current production model employs a 5 ft. reflector for use in the 5 GC range, but other reflectors and freqs. are available. The current system has slew rates of 36°/sec., and accelerations of 130°/sec./sec. TEMEC, Inc., 7833 Haskell Ave., Van Nuys, Calif.

Circle 183 on Inquiry Card

Circle 19 on Inquiry Card →

New Products

CAPACITOR TESTER

Automatic unit measures leakage current and gives record of failures.

Model 8515 Automatic Capacitor Tester Fixture has panel lights to indicate the unit under test. Memory light signals failure of a unit and remains on as the automatic test sequence continues. Model 8514 automatic hypot supplies a dc potential continuously adjustable from 0 to 20 kv for capacitor testing. The leakage current measurement ranges are 0-10 and 0-250 μa. Power supply gives a charging current of 20 ma. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Circle 190 on Inquiry Card

HIGH VOLUME FAN

Rugged fan, Model 1PB95W, delivers 550 CFM at low decibel rating.

They are panel mounted units for use in electronic racks, for mobile or stationary generators, military vans, or field vehicles. Powered by a continuous duty totally enclosed 115 v., 60 CPS, 1 φ, shaded pole motor, meeting Federal Specs, CC-M-636A. Ball bearings meet spec. FF-B-171 and lubrication meets Mil-G-3278 with temp. range of −68°C to +93°C. Motor is corrosive resistant and fungus protected. Motor and propeller are vibration isolated. McLean Engineering Labs., Princeton, N. J.

Circle 191 on Inquiry Card

New Products

SHORTING SWITCHES

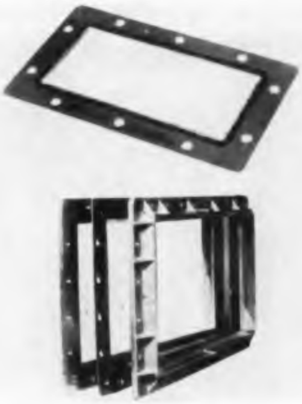
For dual waveguides and feature switching time of 10 msec.

Shorting switches mechanically short-circuit waveguide. Switches are normally closed and are available for WR90 dual sidewall waveguide covering both 8.5 to 9.6 and 9.6 to 10.0 GC. These switches are unaffected by external magnetic fields, permitting their use near ferrite and other magnetic devices. Microwave Development Labs., Inc., 15 Strathmore Rd., Natick Industrial Centre, Natick, Mass.

Circle 192 on Inquiry Card

WAVEGUIDE SEALS

Provide positive mechanical sealing; prevent r-f leakage.



Complete line of seals for WR-series and X-band waveguides eliminate burning and/or arcing. Called Electr-O-Seals,® the seals are made to fit EIA (RETMA) standard guides and, in addition to positive sealing, provide savings by making special machining of flanges unnecessary. The inside metal mating edges of the seal are knurled to assure positive electrical contact. They are also re-useable. Parker Seal Co., Div. Parker-Hannifin Corp., 10567 W. Jefferson Blvd., Culver City, Calif.

Circle 193 on Inquiry Card

New Products

NOISE FIGURE TEST SET

Provides noise figure measurement from 0 to 15 db. at 5 MC to 2 GC.

The temp. reference which serves as the noise source is essentially a temp-modulated resistor with low VSWR (less than 1.1 over the entire freq. range), negligible VSWR variation during the temp. modulating cycle (less than 2 parts in 1000) and small variations of excess noise over the freq. range (less than 0.1 db.). The Auto-Node is suited for production line test work. Unit has all necessary equipment for measurements. Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle 194 on Inquiry Card

REFLECTIVE TAPE

Pressure-sensitive tape reflects extreme heat from motors and wires.

"Scotch" brand No. Y-9050 is capable of performing continuously from 500 to 600°F, and can withstand 3000°F of radiant heat for short periods. Caliper of the tape, which is readily conformable to irregular shapes and curved pipes, is 0.006 in. Weight 0.0038 lbs/ft./in. of width, tensile strength of 75 lbs./in. of width. Available in widths of from ¼ to 36 in., and in roll lengths of 36 yds. Dept. J1-1, Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul, Minn.

Circle 195 on Inquiry Card

TIME DELAYS

Features accuracy of 0.01%, and delay from 50 msec. to infinity.

Temp. range, −54°C to +71°C. Hermetically sealed timer rated at 30G for shock, and 500 CPS at 10G for vibration. Designated 31800 Series Precision Electronic Time Delay Relay, it offers contacts from SPST to 4PDT, contact rating at 28 vdc or 115 vac and 10 a. resistive, 5 a. inductive; 5 a. resistive, 3 a. inductive; or 2 a. resistive, 1 a. inductive. Input voltage is 24-30 vdc, power required is 5.75 w. max. A. W. Haydon Co., Culver City, Calif.

Circle 196 on Inquiry Card

HIGH TEMP. DIODES

Operate in sustained ambient temps. up to 500°C.

Designed for use in a high temp. generator regulating circuit for military aircraft and missile uses. All 3 tubes are of ceramic construction and filled with an inert gas. Current ratings range from 0.15 to 10 a. The 10 a. Z-5437 is a medium size rectifier with a PIV of 200 v. The 2 a. Z-5434 is a small size rectifier with a PIV of 750 v. The 0.15 a. Z-5365, a small size rectifier has a PIV of 1000 v. Available in limited quantities for engineering samples. General Electric Co., Power Tube Dept., Schenectady, N. Y.

Circle 197 on Inquiry Card

Circle 92 on Inquiry Card

SELECTED BY RCA FOR A HIGH RELIABILITY *PROJECT

Here is MEASURED RELIABILITY!

Ten thousand El-Menco high reliability dipped mica capacitors were put on life test at 85°C with 225% of the rated DC voltage applied in accordance with an RCA high reliability specification.

*After 22,000,000 actual test unit-hours no** failures of any type occurred*

The accumulated 22 x 10^6 test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of approximately .01% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of approximately .0001% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than .00005% per 1000 hours!

Note that all the above failure rates are calculated at a 90% confidence level!

**The El-Menco high reliability dipped mica capacitors are being supplied to the Radio Corporation of America for a high reliability military ground electronics project.*

**A failure was defined as follows:

1. A short or open circuited capacitor occurring during life test.
2. A part whose capacitance changed more than ±2% and whose capacitance did not fall within the original tolerance of ±5%.
3. A part whose final dissipation factor exceeded .002.
4. A part whose final insulation resistance measured less than 100,000 megohms.

Write for a copy of our "Reliability Study of Silvered Mica Capacitors".

El-Menco
Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.
Manufacturers of El-Menco Capacitors
WILLIMANTIC CONNECTICUT

• molded mica • mica trimmer • dipped mica • silvered mica films
• tubular paper • mylar-paper dipped • ceramic feed thrus • ceramic discs

Arco Electronics, Inc., Community Drive, Great Neck, L.I., New York
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada
WEST COAST MANUFACTURERS CONTACT:
COLLINS ELECTRONIC SALES, INC., 535 MIDDLEFIELD ROAD, PALO ALTO, CALIFORNIA

New Products

POWER RESISTORS

Non-inductive precision components range from ½ through 10 w.

Available with either axial (series N) or radial (series NR) leads. Resistors have resistance range from 1 Ω to 40 GΩ, with tolerances ±0.05% to ±5.0%. Use of TEMP-COTE®, a coating material, these resistors will operate in temp. to 350°C, and are completely impervious to abrasion, salt-spray or humidity in accordance with applicable paragraphs of Mil-R-26. Omtronics Mfg., Inc., P. O. Box 1419, Peony Park Sta., Omaha 14, Nebr.

Circle 198 on Inquiry Card

COATING MACHINE

For high production plastic coating of axial lead components.

Model PR-1 Powered Resin Coating Machine for use with the C.M. Model TL-1 Tray Loader and CM Magazine Loader. The axial lead components are placed in trays, loaded in magazines and automatically fed through a radiant heat oven. They are brought up to desired heat, up to 600°F, and passed through a controlled stream of finely ground plastic powder. The thickness is controlled by the temp. of unit and the length of time, and may be varied from 5 to 15 mils. Conforming Matrix Corp., 839 New York Ave., Toledo 11, Ohio.

Circle 199 on Inquiry Card

New Products

POWER TRANSISTORS

Feature low saturation resistance and operation to 200°C.

RCA-2N2015 and 2N2016 are 150 w. Silicon npn power transistors having low saturation resistance (0.25 Ω max.), high betas (7.5 min. at I_C= 10 a., 15 to 50 at I_C=5 a.), and an operating temp. of −65 to +200°C. In JEDEC TO-36 package, they are for use as power switching for dc to dc connectors, inverters, choppers, and oscillators. Radio Corp. of America, Semiconductor and Materials Div., Somerville, N. J.

Circle 200 on Inquiry Card

FERRITE AM MODULATOR

Multi-purpose, broadband unit covers entire X-band, 8.2 to 12.4 GC.

Primary use of the X-158A is to provide a clean am microwave signal for high accuracy measurements. X-158A's modulator coil is designed so that a standard, 1 w., commercial audio oscillator will provide substantially 100% modulation at 1000 CPS. Max. input and output VSWR held to 1.20. Max. average r-f input power is 2 w., max. solenoid current requirement—300 ma. dc. FXR, Amphenol-Borg Electronics Corp., 25-26 50th St., Woodside, N. Y.

Circle 201 on Inquiry Card

New Products

FIFTY CPS SUPPLY

For use in testing components for 50 CPS countries.

Type MU motor-generator delivers 50.0 CPS from no load to full load from a standard 3 ϕ, 30 CPS line. Generator output is either 2 kva, 1 ϕ or 3 kva, 3 ϕ, at 8 pf. Voltage regulation is $\pm 2\%$. The machine is readily convertible for an input of 50 CPS and an output of 60 CPS. William I. Horlick Co., Inc., 266 Summer St., Boston 10, Mass.

Circle 202 on Inquiry Card

PHOTOELECTRIC READER

Compact single unit provides detection up to 10 ft.

Model 200 Reader, designed for automatic control systems, using electronic circuits activated by changes in reflected light. For position control, cueing, sorting, counting and inspecting by number, shade, color and size. Specs.: weight, 12 oz.; light source, G. E. No. 1619 lamp (keyed) 6.7 v. at 2 a.; photocell, Clairex Type 603A photoconductive; max. photocell power, 75 mw; photocell response time, 4 msec.; max. counting rate, 300 counts/sec. Melpar, Inc., Falls Church, Va.

Circle 203 on Inquiry Card

Circle 99 on Inquiry Card

New Products

CHOPPER TRANSISTORS

For use in high accuracy choppers, multiplexes and demodulators.

Silicon precision alloy transistors (SPAT) capable of operating at collector (V_{CBO}) and emitter (V_{EBO}) voltages of 30 v. each with leakage current of only 15 nanoamps max. at 65°C. Max. leakage current of the T2363 and matched pair T2357, at 10 v. is 1 nanoamp (25°C) which corresponds to an "open-switch" resistance of 10 GΩ. The T2357 pair is intended for "back-to-back" operation in a low level system. Philco Corp., Lansdale, Pa.

Circle 204 on Inquiry Card

CAPACITOR

Hermetically sealed flat shape for max. capacity/chassis area.

Designed for military applications, the 605 Capacitor combines the thin, flat shape of 601PE series with hermetically sealed metal case or oval cross section. Meets all Mil-Spec environmental requirements and is available in capacities from 0.01 to 0.33 in 50 v. ratings only. Temp. range is −55°C to +125°C at full rated voltage. Tolerances are ±20%, ±10% and ±5% and the dielectric is Mylar. Good-All Electric Mfg. Co., Sub. Thompson Ramo Wooldridge, Inc., Ogallala, Nebr.

Circle 205 on Inquiry Card

SOLID STATE IN *Electronics*

Men of vision thrive here. And it takes men of vision to cope with today's electronics and space problems. Space in more ways than just up. Space problems of a different nature plague the manufacturer who must expand, but hasn't the land to expand on.

Here in Florida we have the space, the climate, the work force. Florida has more to offer electronics firms than any other area on earth. Men think better where life is pleasant, where off hours can be devoted to just plain *living*—and to just plain *thinking*.

Yes, Florida is a Solid State in Electronics. Already the sun, Mother of Life, shines on over sixty thriving electronics firms in our busy state.

Cape Canaveral is here, too, with its massive, awesome missiles blasting off to make space history. Electronics makes possible every thrust into the universe. Every hope of getting to the moon depends upon electronics—and the first American to the moon will definitely soar to history from Florida.

Engineers and their families dream of living here in Florida. Give them this dream by moving your plant here. Nurture the brains that will give your business a greater and greater stature in this, the Electronics Age.

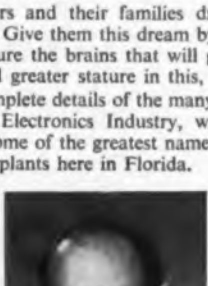
For complete details of the many advantages Florida offers the Electronics Industry, write us. Let us tell you why some of the greatest names in electronics have impressive plants here in Florida.

FLORIDA'S ASSURANCE POLICY

"You have my personal assurance of a sunny business climate here in Florida. You have positive assurance of every aid and assistance possible from our Florida Development Commission and from the overwhelming majority of our businessmen, industrialists, and financiers. We have everything to make your large or small enterprise healthy and successful. Write, wire or phone us today. The only thing better than a FLORIDA vacation is having your plant here."

Farris Bryant

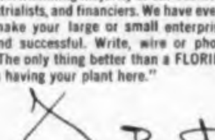
Governor, State of Florida



Investigate DEBT-FREE

Florida

...A 10 BILLION DOLLAR MARKET



Ask about free film "Profile of Progress."

Mr. Wendell Jarrard, Chairman
Florida Development Commission
Box 4121A
Tallahassee, Florida

Please send me the facts about Florida's labor, climate, schools, natural resources, taxes, etc.

Name ....
Firm Name ....
Address ....
City .... Zone ..... State ....

FLORIDA FOR CONVENTIONS—Write for free information on Florida's wonderful facilities for your group meeting.

Circle 101 on Inquiry Card

Is it a relay or coaxial switch?

Some people call this electro-magnetically actuated device a relay. We call it a coaxial switch. Do you know what the difference is?

First, the conventional relay, even when shielded and coaxially terminated isn't suited for use in circuits above 400 mc. In fact, even at this relatively low frequency, such a relay may have a VSWR of 1.5. The DK Coaxial Switch with improved impedance match will show a VSWR of only 1.1 at the same frequency.

Standard DK Coaxial Switches are designed for frequencies up to 5,000 mc. Models under development will soon extend this to the 10,000 mc range.

Improved VSWR is only one difference. DK Coaxial Switches offer *lower crosstalk, reduced insertion losses,* and great *environmental reliability*.

RF Products can supply over 1300 individual switch designs. But, since 132 of these meet 90 per cent of known applications, we have prepared a simplified catalog which makes it easy for you to find the switch you need. Write for Catalog DK61.

If you don't find the switch you want in this catalog, your local RF Products representative can supply you with information on hundreds of existing alternatives, or help you to design a new switch to solve your specific problem.

RF PRODUCTS

Division of Amphenol-Borg Electronics Corp., 33 East Franklin St., Danbury, Conn.

AMPHENOL

Circle 102 on Inquiry Card

New Products

SCOPE-CAMERA

For direct recording of oscilloscope traces.

The C-13 camera accepts Polaroid or conventionel film. It uses a sliding back (adjustable to horizontal or vertical) on which the parfocal, film-holding backs can be interchanged, can be locked securely in 5 detent positions, also rotated thru 90° increments (with the long axis of the film horizontal or vertical). It uses any of 6 easily-interchangeable lenses in varying object-to-image ratios and max. aperture to f/1.5. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 206 on Inquiry Card

VLF RECEIVER

Features dual channel reception and a built-in strip recorder.

The √RMS Model LF-18-20/A Receiver is an all transistorized receiver designed for standarizing the freq. of a 100 KC local secondary freq. standard by comparison with the Standard National Signals, 18 KC of NBA and 20 KC of WWVL. The receiver contains a strip recorder providing a permanent record of a drift or error in the local standard. The sensitivity is 2 μv. √RMS Engineering, Inc., P. O. Box 6354, Station H, Atlanta 8, Ga.

Circle 207 on Inquiry Card

New Products

SILICON RECTIFIER

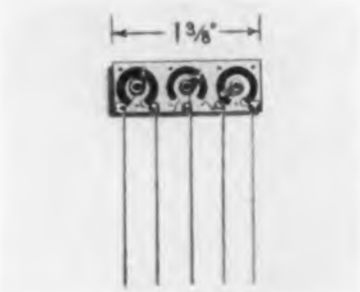
Handle 1000 to 2500 v. (PRV) with from 85 to 100 ma dc output.

Subminiature rectifiers for a wide range of low current, high voltage multiplier uses. The devices exhibit max. leakage current of 2.0 μa at PRV at 25°C, and max. forward voltage drop of 4 v. at 150°C. Designated types Q10X through Q25X, the 4 units have an operating temp. range from −20° to 130°C. Units measure 0.265 x 0.120 in. (dia.) max. not counting leads. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 164 on Inquiry Card

TRIPLE TRIMMER RESISTOR

Each resistor in the unit is rated at 0.1 w.



Resistance range is 500Ω to 5 megohms, linear taper. The complete unit measures 0.406 x 1.375 in. and is 0.1 in. thick. Through use of the PEC® packaged circuit technique, the unit can be supplied with additional fixed resistors as an integral part of the device. These can be either associated with or independent of the trimmer circuitry. Centralab, The Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Circle 165 on Inquiry Card

MICRO LAMP

Operates on 1.2 or 1.5 v. drawing 5 ma.

This lowered current drain makes Micro Lamps useful for operation on miniature batteries, or with transistors. The lamps start with an envelope dia. of 0.0139 in. with a length of 0.138 in. They give a light output of 40 to 45 millilumens, and have a lifetime of 1000 hr. min. Uses include: mounted on the tip of instrument pointers, or in photoelectric systems. Miniature Lamp Engineering Co., 350 Broadway, New York 13, N. Y.

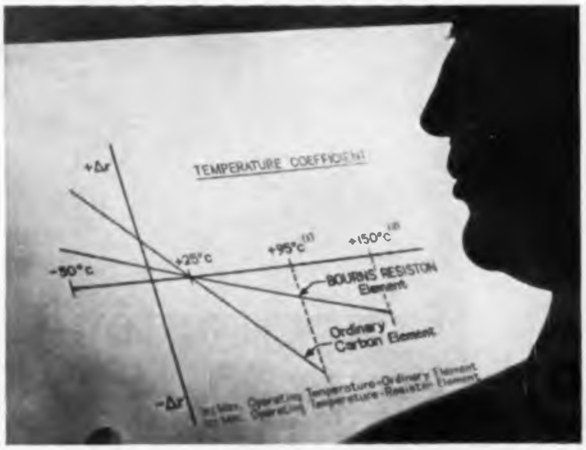
Circle 166 on Inquiry Card

Bourns Resiston® Carbon Potentiometers Now Available in Any Trimpot® Configuration

Use Them up to 150°C—They're Twice as Stable as Competitive Units!

Whatever carbon potentiometer type or configuration you need, Bourns can now fill it with Trimpot Resiston models —potentiometers incorporating the exclusive carbon-film element that virtually eliminates problems of heat and humidity. Most models operate at temperatures to 150°C and under cycling humidity conditions with only half the resistance shift of ordinary carbon potentiometers.

All units feature infinite resolution and standard resistances up to 1,000,000 ohms. Check the expanded selection below. It offers you eight ways of obtaining high resistance values and infinite resolution without sacrificing reliability. You can get the exact environmental specs you need, and you can find the right price range for your budget. Write for complete data and list of stocking distributors.



General-Purpose Resiston® Carbon Trimpot® —Model 215. Operates to 125°C / L, S, P terminals / ¼ watt / 20K to 1 Meg. Unsealed.

Humidity-Proof Resiston Carbon Trimpot—Model 235. Operates to 125°C / L, S, P terminals / ¼ watt / 20K to 1 Meg. Sealed. Meets Mil Specs for cycling humidity.

High-Quality, Low Cost Commercial Carbon Trimit®—Models 272, 274, 276. Operates to 85°C / L, S, P terminals / 0.2 watt / 20K to 1 Meg. Unsealed.

¾-Inch-Long Carbon Trimpot—Model 3001. Operates to 150°C / P terminals / 0.2 watt / 20K to 1 Meg. Sealed. Meets Mil Specs for cycling humidity.

High-Temperature Humidity-Proof Resiston Carbon Trimpot—Model 3011. Operates to 150°C / L, P terminals / ¼ watt / 20K to 1 Meg. Sealed. Meets Mil Specs for cycling humidity.

High-Temperature Humidity-Proof Resiston Carbon Trimpot—Model 3051. Only .19" wide. Operates to 150°C / L, S, P terminals / ¼ watt / 20K to 1 Meg. Sealed. Meets Mil Specs for cycling humidity.

Extra Low-Cost Commercial Resiston Carbon E-Z Trim® Potentiometer—Model 3068. Operates to 85°C / S, P terminals / 0.2 watt / 20K to 1 Meg. Meets Steady-State Humidity Specs Less than $1 in production quantities.

½" Square Resiston Carbon Trimpot—Model 3251. Operates to 150°C / L, P, W terminals / ½ watt / 20K to 1 Meg. Sealed. Meets Mil Specs for cycling humidity.

KEY TO TERMINALS
L—insulated stranded leads
W—uninsulated wires
S—solder lugs
P—printed circuit pins

Write for complete data and list of stocking distributors

BOURNS

BOURNS, INC., TRIMPOT DIVISION
6135 MAGNOLIA AVE., RIVERSIDE, CALIF.
PHONE: OVERLAND 4-1700 · TWX: RZ 9222
CABLE: BOURNSINC.

Manufacturer: Trimpot® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, Calif.; Ames, Iowa; and Toronto, Canada

SPERRY ELECTRONIC TUBE DIVISION

microwave memo

Sperry extends 30-day delivery to cover ECM and augmenter TWT's operating in L, S, and X bands

In a dramatic extension of its capability for delivering high-performance microwave tubes on short notice, Sperry Electronic Tube Division has added three system-proved traveling wave tubes to the list of those available in 30 days. Included in the move are tubes operating in L, S, and X bands. They cover a frequency range 1.1 to 11.0 kMc.

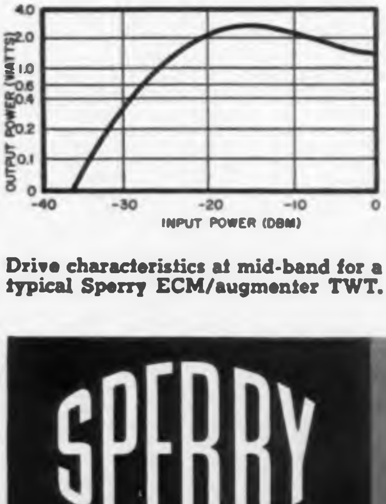
APPLICATION FLEXIBILITY

The tubes in this series are particularly suited to application in augmenters and ECM equipment. The inherent broadband characteristic and unusual ruggedness of these PPM focused tubes makes them unusually versatile in airborne applications. A full course of MIL and environment tests, as well as considerable in-system experience have verified these characteristics.

A typical saturated power versus frequency curve for an L band Sperry TWT.

INCREASED POWER POSSIBLE

Although these tubes nominally operate in the 1-2 watt power output range, optimum tuning can increase power to as much as 5 watts. A high-mu control grid adds to the versatility of these tubes by allowing remote switching, modulation control and gain adjustment.



Drive characteristics at mid-band for a typical Sperry ECM/augmenter TWT.

SYSTEM DESIGN SIMPLIFIED

Use of these Sperry tubes greatly simplifies system design problems. Low voltage and high gain reduce power supply requirements. Application is further simplified, since ambient cooling is sufficient in most applications and the tubes may be mounted in any position.

For FREE technical information on these Sperry Traveling Wave Tubes, write to Section 402, Sperry Electronic Tube Division, Gainesville, Florida.

The L-Band tube is priced at $1,900., the S-Band tube at $2,195., and the X-Band at $2,540.

For application assistance and quotation, consult your nearest Cain & Co. representative. His address and phone number appear on the opposite page.

SPERRY ELECTRONIC TUBE DIVISION
GAINESVILLE, FLA. / GREAT NECK, N. Y.
SPERRY RAND CORPORATION

New Products

POWER SOURCE

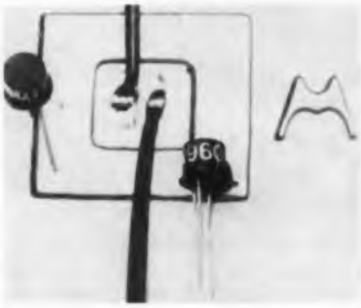
Offer accuracies of 0.25% of any output voltage dialed.

Model 120 provides 20 ma over the range of 500 to 2210 vdc; the Model 122, 20 ma from 0 to 3000 vdc, and Model 123, 20 ma from 0 to 6000 vdc. Model 120, 3½ in. high features in-line controls, regulated filament power, polarity reversal, and modular construction. Models 122 and 123, mounted on 5¼ in. panels, feature Handi-Vider® in-line controls, voltage and current metering, and reversible polarity. Smith-Florence, Inc., Seattle, Wash.

Circle 208 on Inquiry Card

TRANSISTORS

For high speed switching applications.



Six germanium expitaxial mesas combine improved switching characteristics with reduced prices. The 6 new type numbers, including 2N960 to 2N962 and 2N964 to 2N966 are housed in the TO-18 package, and are designed for high speed switching applications in both high and low current circuits. They permit greater standardization of components and smaller inventories. Motorols Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 209 on Inquiry Card

New Products

ROTARY SWITCH

Tri-Ball, Tri-Spring unit achieves a min. of 50,000 cycles.

Life tests showed a 400% increase in cycling and operating life expectancy over the 2-ball index previously used for military applications. Additional advantage of the Tri-Ball assembly is greater shaft stability, the tripod arrangement providing uniform support in all positions. Currently the new Tri-Spring, Tri-Ball mechanism can be specified for 20° throw, 18 position switches and for 15° throw, 24 position switches. Oak Mfg. Co., Crystal Lake, Ill.

Circle 210 on Inquiry Card

STANDARD BRIDGES

Permit checking synchros or resolvers to 20 parts/million accuracy.

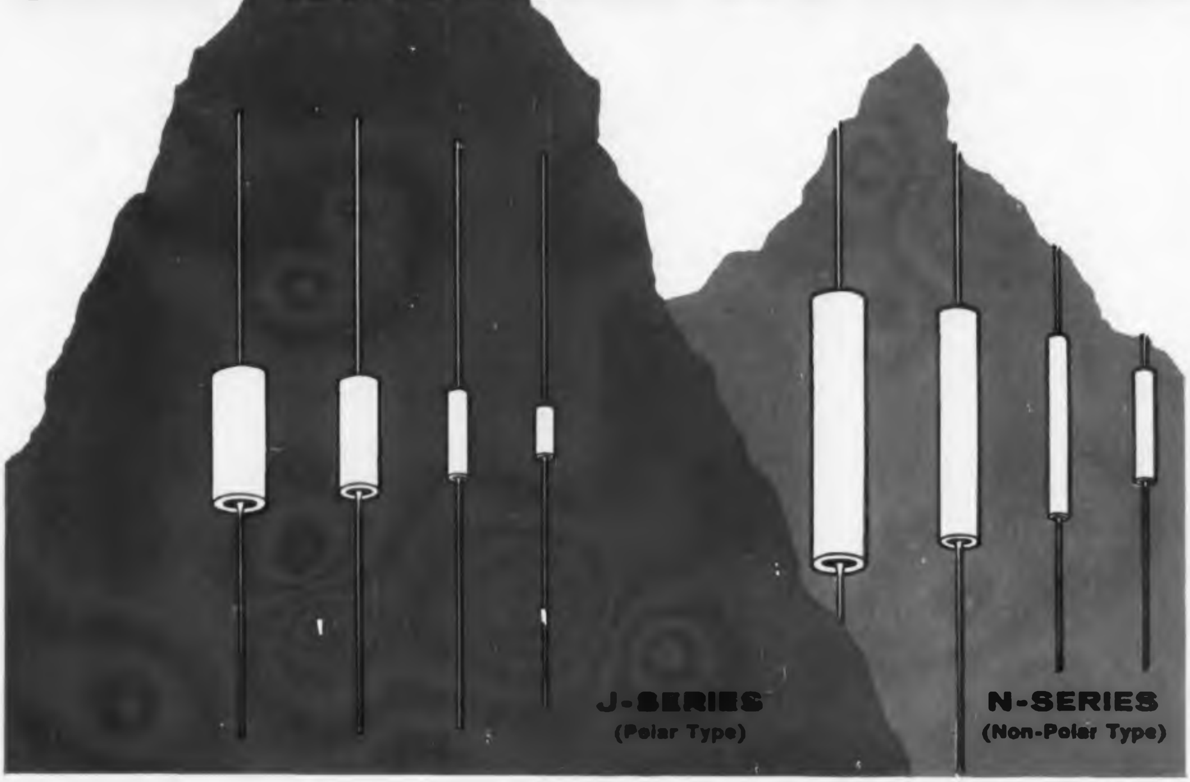
Models MSB-5 and MRB-5 provide measurements in 5° steps from 0-360°. Selector switch-contact resistance, as a result of circuit design, has no effect on the accuracy of the measurements. Absolute accuracy from 0-800 CPS is 0.002%. Freq. range extends to 10 KC at reduced accuracy. Individual arm resistance is 10 KC ±0.01%. Harmonic distortion is 0. Max. input voltage is 115 v. rms. Julie Research Laboratories, Inc., 603 W. 130 St., New York 27, N. Y.

Circle 211 on Inquiry Card

75V 60V 50V

—the "Peaks" you want in High-Voltage

SOLID TANTALUM CAPACITORS



—EXCLUSIVE WITH KEMET

TRADE-MARK

Only KEMET can offer you the *widest* selection of dependable *high-voltage* solid tantalum capacitors. Topping the list is KEMET's new 75-volt type—*the highest rated working voltage unit of its kind available today—by a margin of 50%!*

KEMET's complete J-Series and N-Series comprise voltages of 60 and 50—ranging downward through 35, 20, 15, 10, and 6 volts—providing standard E.I.A. values with ±5%, ±10%, and ±20% tolerances.

J-Series capacitance values range from .0047 to 330 microfarads; operating temperatures from −55 to +125° C. N-Series capacitance values range from .0024 to 160 microfarads; operating temperatures from −55 to +105° C.

"KEMET" solid tantalum capacitors are designed, manufactured, and *tested* to serve the most demanding industrial/military applications. All are hermetically sealed in corrosion-resistant metal cans, with solderable and weldable leads. Four J-Series case sizes meet or exceed the performance requirements of MIL-C-26655A/2.

For utmost reliability in solid tantalum capacitors—*high or low voltage*—specify "KEMET". Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

Write for technical data on the complete line of "KEMET" Solid Tantalum Capacitors

"Kemet" and "Union Carbide" are registered trade-marks for products of

KEMET COMPANY

UNION CARBIDE

Circle 110 on Inquiry Card

New Products

GLASS DIODES

Feature the 1/8 size of the standard subminiature type.

Uses glass encapsulated package, proven effective in sealing against moisture, contamination, and in withstanding high mechanical stress. Specs for the "milliminiature" line include: Max. dc inverse operating voltage—from 15 to 100 v.; max. dc forward current—25 ma; max. forward voltage drop @ 10 ma—0.5 v.; max. inverse current—from 10 μa @ 5 v. to 50 μa @ 80 v.; and max. reverse recovery time—0.0008 to 0.5 μsec. Clevite Transistor, Waltham, Mass.

Circle 167 on Inquiry Card

RACK & PANEL CONNECTORS

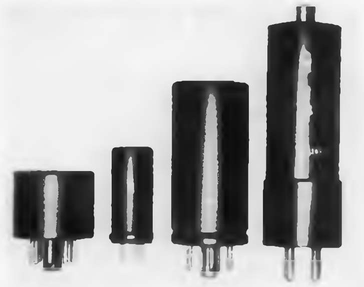
For Multi-circuit switching or rerouting applications.

The 2P-SD-600 series receptacle and the 2P-MD-600 series plug have the glass filled "Diall" insulator providing high dimensional stability and high resistance at elevated temps. Female contacts provide low mv drop after repeated insertions and assure positive contact under extreme vibration. Contacts are of spring tempered, gold-plated phosphor bronze. Mounting plates are cadmium plated steel. Methode Electronics, Inc, 7447 W. Wilson Ave., Chicago 31, Ill.

Circle 168 on Inquiry Card

SILICON RECTIFIERS

Replacement types from 1500 to 10,400 PIV available.



Line of high voltage silicon rectifier units include 1N1237 series, 1N2630 series, 1N570, 1N1150, 1N2389, and 1N2490. Designed with standard tube bases (Octal, 4-pin, 5-pin, and 7-pin) for the direct replacement of mercury and vacuum tubes. Offer the advantages of silicon and also savings in space and weight. Are highly resistant to extreme moisture, shock, vibration and acceleration. General Instrument Corp., Semiconductor Div., 65 Gouverneur St., Newark 4, N. J.

Circle 169 on Inquiry Card

Circle 111 on Inquiry Card

Circle 113 on Inquiry Card →


Choice of engineers everywhere!
JOHNSON
Air Variables
NEW! Type "U" and "UB" Sub-miniatures . . . available in Single-Section or Butterfly Types.
• 3 Mounting Methods
• Unique machined design for exceptional uniformity and outstanding mechanical stability!
• High "Q"—greater than 1500 at 1 mc.! High torque to mass ratio—2 to 7 inch ounces! Exceptionally low temperature coefficient—approximately 35 PPM C positive!
LOCTAB MOUNTING
PRINTED CIRCUIT MOUNTING
2 HOLE MOUNTING
TYPE "M" AND "S" CAPACITORS
Excellent for use in compact equipment. DC-200 treated steatite insulators. Soldered plate construction and heavily anchored stator supports provide extreme rigidity. Plates are nickel-plated brass. Single section, butterfly and differential types with straight, locking, and screwdriver shafts.
TYPE "M"—Requires only ⅝" x ¾" panel area. Peak voltage rating 1250 volts on .017" spaced units; 850 volts on 160-130, spaced .013". Mounting bushing, ¼"-32.
TYPE "S"—Slightly larger than the Type "M". Peak voltage rating 850 volts—plate spacing .013", other spacings available on special order. Mounting studs tapped 4-40 on 17/32" centers.
TYPE "J" AND "K" CAPACITORS
TYPE "J"—This heavy duty miniature has wider spacing (.025") than most small air variables, yet occupies little more space. Ideal for small space tank circuits in low power stages. DC-200 treated insulator—soldered plate construction. Peak voltage rating 1200 volts. Mounting brackets and 6-32 screws provided.
TYPE "K"—Widely used for military and commercial applications. DC-200 treated insulator—slotted stator contacts—extra-rigid soldered plate construction. Peak voltage rating 1000 volts. Plate spacing .015". Available in production quantities to meet MIL-C092A specifications—other capacities and variations available.
TYPE "R" CAPACITORS
This popular variable has extra-heavy steatite stator support insulators and soldered .023" thick brass plates. Metal parts heavily nickel-plated. Sturdy brass end frames—double bearing construction—silver-plated beryllium copper wiping contacts—peak voltage rating 1200 volts. Available in a number of plate spacings as well as special platings, shaft lengths and without mounting feet for panel mounting applications. Bearing threaded ⅜"-32.
Ceramic-soldered for greater strength!
TYPE "L" CAPACITORS
Ideal for applications requiring extreme stability and strength. Rotor bearings and stator support rods soldered directly to heavy 3/16" thick steatite. Split-sleeve bearing and silver-plated beryllium copper contact provide constant torque and smooth capacity variation. Plate spacing .030". Peak voltage rating 1500 volts. Available in a number of plate spacings, as well as special platings, shaft lengths and stator terminal locations. Bearings threaded ⅜"-32. Single section, dual, butterfly and differential types.
Free Catalog
Johnson also manufactures a line of heavy duty and special purpose capacitors in addition to the types described above.
For complete specifications and current prices on all Johnson electronic components, write for our newest components catalog.
Tube Sockets
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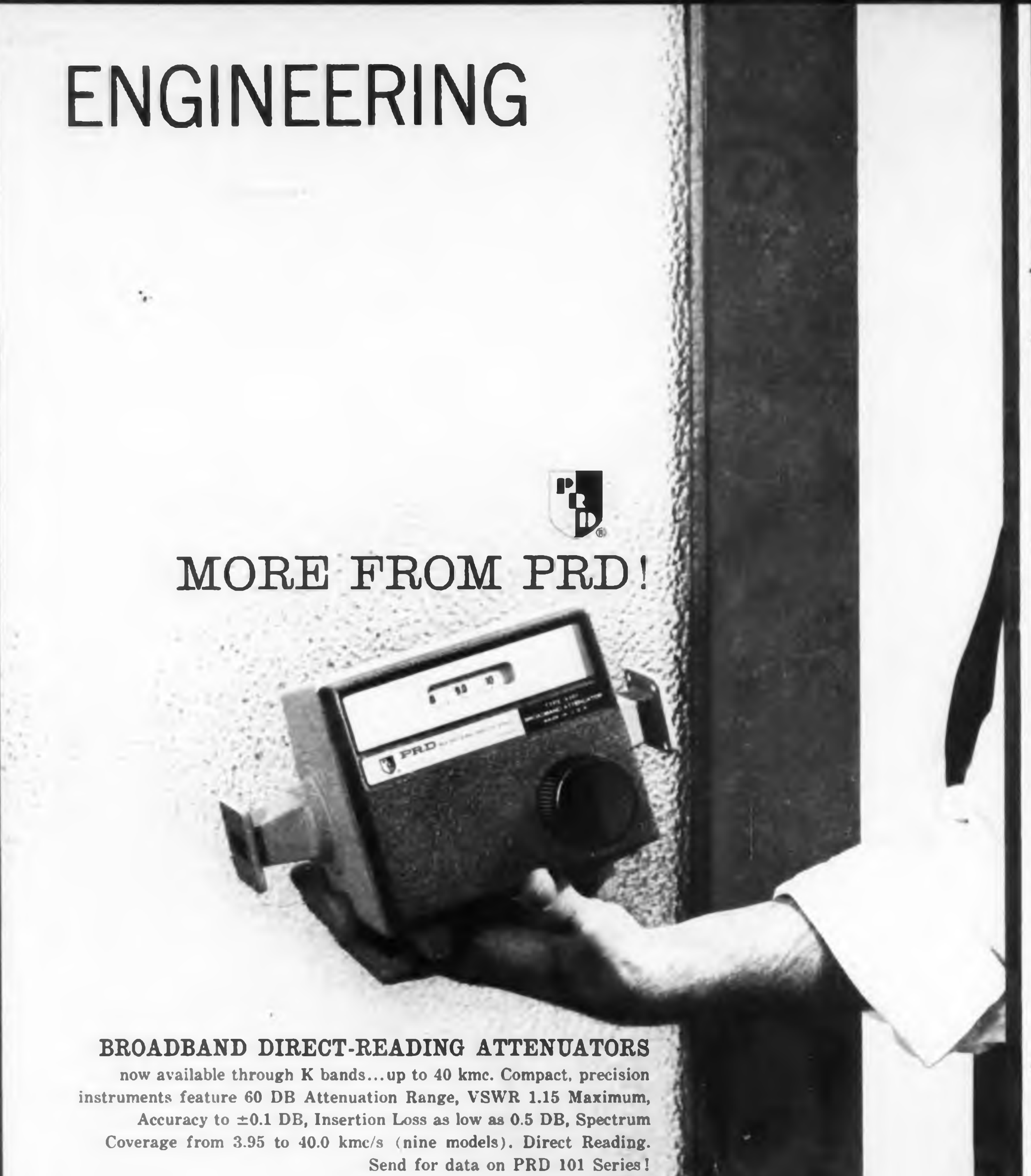
Knobs Dials
Pilot Lights
Inductors
E. F. JOHNSON COMPANY
WASECA, MINNESOTA



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85 Honeywell Precision Meters—AC panel meters
44 Hughes Aircraft Company, Microwave Tube Division—Backward wave oscillators
67 Hughes Aircraft Company, Vacuum Tube Division—Cathode storage tube

I

155 Ideal Industries, Inc.—Wire stripper
145 Industrial Electronic Engineers, Inc.—Data read-out display

PROFESSIONAL ENGINEERING OPPORTUNITIES

Circle number of company on card at right from whom you desire further information.

801 AC Spark Plug, Electronics Division of General Motors
802 National Cash Register Company, The

40 International Electronic Research Corporation—Electronic tube shields
30 International Rectifier Corporation—Silicon rectifiers
6 International Resistance Co.—Power resistors
82 ITT Capacitor Department Components Division—Tantalum capacitor

J

33 Jennings Radio Mfg. Corp.—Vacuum capacitors
114 JFD Electronics Corporation—Trimmer capacitors
113 Johnson Company, E. F.—Air variable capacitors
121 Jones Division, Howard B.—Plugs and sockets

K

110 Kemet Company Division Union Carbide—Tantalum capacitors
17 Keystone Carbon Company—Thermistors
34 Knights Company, James—Frequency standards
127 Kulka Electric Corp.—Terminal boards

L

108 Lenz Electric Manufacturing Company—Audio cable

M

24 McCoy Electronics Company—Glass enclosed quartz crystals
69 Magnetics Inc.—Laminations
124 Mepco, Inc.—Carbon film resistors
63 Methode Manufacturing Corp.—Thru-connected printed wiring boards
57 Microwave Associates, Inc.—Coaxial switches
72 Minnesota Mining & Manufacturing Company Mincom Division—Magnetic tape circuit
163 Minnesota Mining & Manufacturing Company, Magnetic Tape—Magnetic instrumentation tapes
180 Motorola Semiconductor Products Inc.—3-AMP power transistor series
51 Mueller Brass Company—Cold-prest impact extrusions

N

83 National Ultrasonic Corporation—Ultrasonic cleaner
34 North American Electronics, Inc.—Silicon devices
149 North Atlantic Industries—Ratio box

O

65 Ohmite Manufacturing Company—Rheostats

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 203 of this issue.

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PROFESSIONAL ENGINEERING OPPORTUNITIES EI-09

Please send me further information on the engineering position I have circled below.

801	806	811	816	821
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803	808	813	818	823
804	809	814	819	824
805	810	815	820	825

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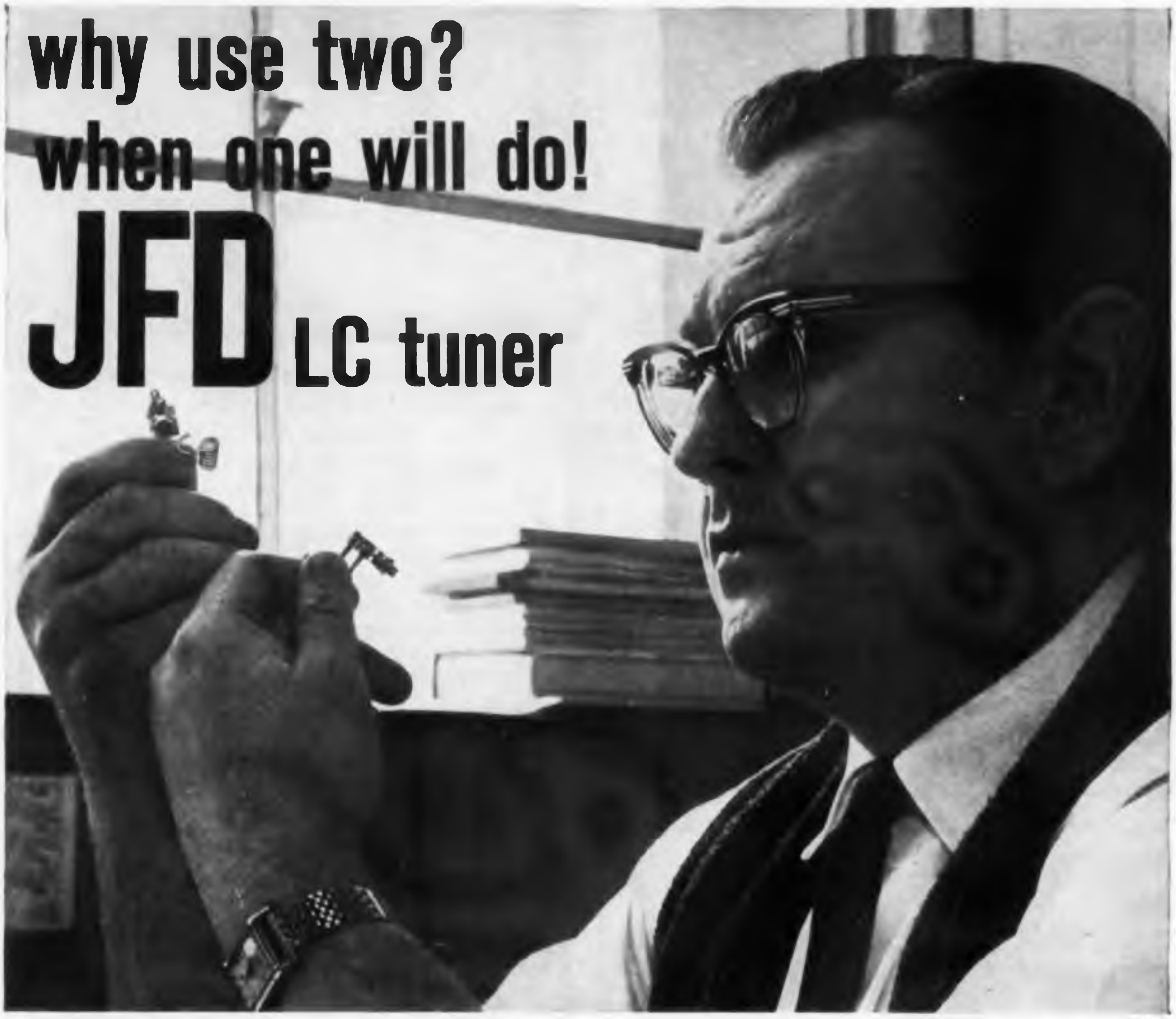

WHY USE TWO...?

a trimmer capacitor and inductor

when one JFD LC Tuner will do!

When your tuned circuit "package" calls for higher stability, greater economy, finer tuning – it's time for the versatile JFD LC Tuner.

This unique package combines the characteristics of a precision variable capacitor and a metalized inductor in one compact tuneable LC circuit. It improves performance, simplifies specifying, speeds assembly, and enhances high frequency capability.

JFD LC Tuners are available in 16 different standard panel and printed circuit types. The inductance, capacitance range, Q and other parameters can be designed to suit individual circuit requirements. Performance characteristics can also be varied by using other core materials or other lead configurations, by having the piston grounded or ungrounded, and by various types of loading.

For complete information, contact your local JFD Field office or your local JFD franchised Industrial Distributor, or write direct for Bulletins 216 and 216-1.

FEATURES: Rugged shock-proof, vibration-proof electromechanical construction. • Glass or quartz dielectric and invar assures low temperature coefficient • No derating at high temperature. • Precisely repeatable tuning–no reversals. • Single resonating frequency for each adjust screw setting.

(shown actual size) Model	Self-Resonating Freq. Range, Mc. Min.	Max.	Nominal Q of Inductor Over Tuning Range	Nominal Inductance uh. Min.	Max.
LC 303	400	725	170-200	.025	.028

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VARIABLE TRIMMER PISTON CAPACITORS • FIXED METALIZED INDUCTORS • LC TUNERS • DIPLEXERS
FIXED AND VARIABLE, DISTRIBUTED AND LUMPED CONSTANT DELAY LINES • PULSE FORMING NETWORKS

Alloy Junction, Four Layer Device

Fig. 1: DYNAQUAD —an alloy junction, 4-layer device with positive turn-off control at the base.

The Dynaquad, an alloyed junction, four layer device, has been introduced by Tung-Sol Electric, Inc. The device, made possible by a new manufacturing technique, has 4 outstanding features. It is a natural switch; it has both turn-on and turn-off control at the base; it uses an established and reliable design, and is lower in cost than comparable components.

The Dynaquad is a germanium, 3-terminal, pnpn structure packaged in a standard TO-5 case. Basically, it is a 2-position switch whose capacities and speeds are those usually associated with digital computers. It switches in the megacycles range, with rise times of the order of 0.1 µsec, and is capable of providing an output voltage swing of 35 v. Because of its bistable nature, a single Dynaquad can replace a number of transistors and associated components in many applications, and in simple on-off switching it behaves as a pulse operated latching relay with no bounce, chatter or sticking contacts.

In normal operation, the Dynaquad is turned on by applying a small negative pulse to the base, and it will remain on after the signal is removed. Turn-off is accomplished by applying a positive pulse to the base, or by dropping the collector current below the sustaining point.

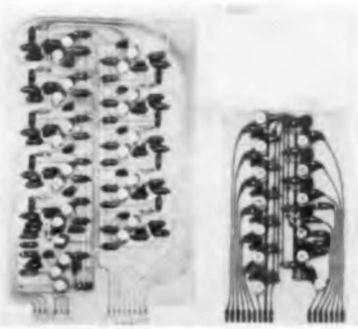


Fig. 2: The two printed circuit boards perform identical functions. The large board is an all transistor decade counter. The small board is the Dynaquad equivalent.

With the Dynaquad, Tung-Sol has developed a technique for forming multiple junctions with the same simplicity and reproductibility as single alloy junctions.

The binary nature of the Dynaquad makes it an efficient component in computer applications or wher-

(*Continued on page* 179)

New Products

TIME DELAY CONTROL

For use in magnetic amplifier circuits.

Thermo-Electric Control is also for use with flip-flop gating circuits in electronic computers and analyzers, missile controls and in other uses subject to wide and varying changes in temp. In effect, the control develops pure dc voltage from signals of any wave length applied to it. It features operation independent of amb. temp. up to 350°F. Typical control, pictured, is 2 in. long and 5/16 in. in dia. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 212 on Inquiry Card

HARMONIC GENERATOR

Available with various crystal freqs. from 0.1 to 100 MC.

Designated the CDH-0.1 Harmonic Marker, it uses 3 tubes and 2 crystal diodes for operation, and is supplied as a plug-in unit. The accuracy of the crystal used is ±0.005% and the use of the 2 diodes provides highly efficient harmonic generation. In operation, the CDH unit is plugged into the sweep generator and produces harmonics of the sweep sample via freq. multiplication. The resulting harmonics are mixed with a portion of the swept signal to create audio beats which are then superimposed upon the display across the sweep range. Telonic Industries, Inc., Beech Grove, Ind.

Circle 213 on Inquiry Card

ever digital techniques are employed. Flip-flops, counters, shift-registers and various forms of logic can be accomplished with a saving of one-third to one-half in components, labor and space.

The high gain and sharp rise time of the Dynaquad give the device great utility as a driver. It can accept small or smeared signals and convert them into sizeable current pulses sufficient to drive magnetic cores, relays and thyratrons. A single Dynaquad can be operated in the 3 basic multivibrator modes—monostable, bistable, and astable.

U. S. Army's Field X-Ray Unit

THE Army Medical Service has unveiled its latest experimental model of a compact, portable field x-ray unit.

Research on this x-ray device now being developed for field use, was initiated under a civilian research contract supported by U. S. Army Medical Research and Development Command. Feature also shown was a field developer which permits processing an x-ray film within seconds after the unit has "snapped" a picture. The 85-lb. unit, which can also be carried in a medium sized suitcase, is designed to perform most of the more important functions of a unit weighing approximately 1,000 lbs.

This self-powered device can operate on rechargeable batteries, or on any standard military vehicle battery—a particularly important feature during combat or disaster conditions.

If tests of this experimental model result in its acceptance by the military, field medical units will find the device of value in locating metal or other foreign bodies in wounds, in diagnosing fractures, and in examining certain internal organs.

The x-ray device operates at such speeds that films are not blurred by movement during chest radiography while the patient is breathing normally. This feature is particularly important when patient is dazed or unconscious and is not able to "hold his breath."

Circle 120 on Inquiry Card

NEC TECHNICAL PROGRAM

Monday Morning, October 9

COMMUNICATION SYSTEMS

Chairman: D. Campbell, Kellogg ITT.

"High Speed Teleprinting System." H. C. Waterman and W. Borman, Motorola, Inc.

"Air Traffic Control Radar Beacon System: A Digital Data Transmission and Processing System." K. Wise, Federal Aviation Agency.

"Communication Central System AN/MRC-66." J. W. Hart, Motorola, Inc.

MICROELECTRONICS

Chairman: R. A. Greiner, Univ. of Wisconsin

"Nonlinear Resistance of Microelectronics." H. C. Lin, Westinghouse Electric Co.

"Titanium Thin Film Circuits." W. D. Fuller, Lockheed Aircraft Corp.

"Design Procedure For Film Type Distributed Parameter Circuits." W. W. Hopp and W. D. Fuller, Lockheed Aircraft Corp.

"Distributed Parameter Circuit Design Techniques." W. W. Happ and P. Castro, Lockheed Aircraft Corp.

NETWORK THEORY

Chairman: L. P. Huelsman, University of Arizona

"Linear Systems With Time-Varying Components." J. B. Cruz, Jr., University of Illinois

"The Analysis of Networks Containing Periodically Variable Piecewise Constant Elements." I. W. Sandburg, Bell Telephone Labs.

"A Method For the Estimation and Precorrection of Losses in Terminated LC Networks." G. C. Temes, Northern Electric Co.

"Synthesis of Signal Generators and Matched Filters." N. D. Claris and H. S. McGaughan, Cornell University

COMPUTER LECTURE SERIES

Chairman: T. F. Jones, Jr., Purdue University

"The Digital Computer." (a) Structure of a Digital Computer (b) A Simple Approach to Programming a Digital Computer.

SYNNOETICS

"Synnoetics: The New Computer Science." (Panel Discussion)

NOON LUNCHEON

Speaker: Dr. L. V. Berkner, President IRE

Monday Afternoon, October 9

ENGINEERING MANAGEMENT I

Sponsored by IRE Professional Group on Engineering Management.

Chairman: E. White, Warwick Manufacturing Co.

"Evaluation of Technical Proposals in the Defense Products Industry." B. J. Goldfarb, Westinghouse Electric Corp.

"Enabling: Management's First Function." H. N. Boris, Science Research Assoc., Inc.

"Developing Creative-Inventive Ability." R. Renck and R. K. Burns, University of Chicago

"Relative Activity of Research in the Midwest." W. Kent, Armour Research Foundation

"On the Application of PERT to Massive Engineering." E. Codier, General Electric Co.

INSTRUMENTATION

Chairman: H. Weed, Ohio State University

"Dynamic Three-Dimensional Display Systems." C. K. Auvil and C. W. Gattos, Chrysler Corp.

"Incremental Spectrum Analyzer." J. Bartels, E. J. McGowan, Jr. and C. Montalto, Hallicrafters Co.

"Magnetoresistive Magnetic-Field Sensor." M. Epstein, J. N. Van Scoyoc, L. J. Greenstein, Illinois Institute of Technology

"A Pulsed Electromagnetic Flowmeter Transducer." F. R. Johnson, Jaeger Labs.

COMPUTER LECTURE SERIES

Chairman: T. F. Jones, Jr., Purdue University

Repeat of morning Digital Computer Lecture

OPTICAL COMMUNICATIONS

Chairman: G. K. Wessel, General Electric Electronics Lab.

"Optical Masers." R. J. Collins, Bell Telephone Labs.

"A CW Optical Frequency Oscillator Using Gaseous Discharge." A. Javan, Bell Telephone Labs.

"Optical Range Finder Application of the Laser." L. Goldmuntz, Technical Research Group, Inc.

"Optical Communications." G. Jacobs, General Electric Co.

SOLID STATE DEVICES AND CIRCUITS I

Chairman: A. P. Stern, The Martin Co.

"A Study of Tunnel Diodes for Digital Electronics Circuits." A. Hemel, Motorola, Inc.

"Graphical Analysis of Tunnel Diode Pulse Circuits." J. J. Hill, Radio Corp. of America

"An Analysis and Tolerance Study of a New Pumped Tunnel Diode-Transistor Logic Gate." Y. C. Hwang and H. Raillard, General Electric Co.

"A Fundamental Lower Bound for Junction Transistor Fall Time." R. P. Nanavati, Syracuse University

Monday Evening, October 9: 8 P. M.

ENGINEERING MANAGEMENT II

Sponsored by IRE Professional Group on Engineering Management

"New Products and Diversification." (Panel Discussion. Moderator, W. Cozzens, Cozzens & Cudahy, Inc.

Tuesday Morning, October 10

AIR TRAFFIC CONTROL

"Electronics Systems For Air Traffic Control." (Panel Discussion.)

COMPUTER LECTURE SERIES

Chairman: V. Rideout, University of Wisconsin

"The Analog Computer."

ANTENNAS I

Chairman: C. T. Tai, Ohio State University

"Plane Waves on a Periodic Structure of Circular Disks and Their Application to Surface Wave Antennas." J. Shefer, Harvard University

"Vertically Polarized Log-periodic Zig-Zag Antennas." J. W. Greiser and P. E. Mays, University of Illinois

"Uni-Directional Log Periodic Antenna of Selectable Polarization." E. Hudock and W. A. Kennedy, Collins Radio Co.

"Multi-Mode Equiangular Spiral Antennas." J. D. Dyson, University of Illinois

DIGITAL CONTROL SYSTEMS

Chairman: S. Hori, Armour Research Foundation

"A Simple But Exact Model for Sampled-Data Feedback Systems With Non-Negligible Pulse Width." G. J. Murphy, Northwestern University

"Modern Synthesis of Digital Control Systems." P. D. Joseph and J. T. Tou, Purdue University

"Simulation of Digitally Controlled Systems." E. Noges, University of Washington

"The Application of a Digital Computer to the Study of Discrete Control Systems." H. C. Tong, Cornell University

SOLID-STATE DEVICES AND CIRCUITS II

Chairman: L. L. Ogborn, Purdue University

"The Electro-Chemical Diffused-Collector Transistor." J. G. Bouchard, Sprague Electric Co.

"Two Nuclear Magnetic Resonance Devices Which Automatically Follow Time Varying Magnetic Fields—Possible Applications." M. Larson et al, Minneapolis-Honeywell Regulator Co.

"An Audio Amplifier Without Tubes or Transistors." M. J. Cudahy, Cozzens & Cudahy, Inc.

"Magneto-Optical Readout of Information in Ferromagetic Thin Films." P. Smaller, Ampex Corp.

NOON LUNCHEON

Speaker: Brig. General D. P. Gibbs, NORAD Communications and Electronics

Tuesday Afternoon, October 10

ANTENNAS II

Chairman: E. C. Jordan, University of Illinois

"Some New Results in Linear Array Theory." S. S. Sandler, R. W. P. King, Cruft Lab., Harvard University

"Mutual Impedance of Thin Linear Antennas in any Configuration." H. C. Baker, A. H. LaGrone, Southern Methodist University

"Scanning Antenna for Satellite Application." K. S. Kelleher and H. P. Coleman, Aero Geo Astro Corp.

"On the Problem of Antenna Beam Broadening." C. M. Angulo and J. Farber, Brown University

BIONICS (ARTIFICIAL NEURONS)

Chairman: R. W. Jones, Northwestern University

"Improved Transistor Neuron Models." E. P. McGrogan, RCA

"Speech Recognition by Analog Neutral Networks." F. Putbrath and T. B. Martin, RCA

"Signal Processing by Analog Neural Networks." T. B. Martin, RCA

"An Optoelectronic-Magnetic Neuron Component." T. E. Bray, General Electric Co.

LOGIC AND SWITCHING THEORY

Chairman: M. G. Keeney, Michigan State University

"Nonlinear Resistor Matrices for Logic Operations." M. S. Waserman, General Telephone & Electronics Labs, Inc.

"Statistical Theory of Dispersion in High-Speed Synchronous Combination Switching Networks." B. Biezer, Philco Corp.

"Improvement of Electronic Computer Reliability Through the Use of Majority Gate Logic Redundancy." W. G. Brown, Cook Research Labs, J. Tierney, MIT, R. Wasserman, Hermes Electronics Co.

"A Signal Processing Photoconductive Switching Device." R. D. Stewart, General Electric Co.

COMPUTER LECTURE SERIES

Chairman: V. Rideout, University of Wisconsin

Repeat of morning Analog Computer Lecture.

MICROWAVE THEORY AND TECHNIQUES

Chairman: W. A. Edson, Electro-Magnetic Corp.

"Understanding Plane Wave Propagation in Plasma Media." G. T. Flesher, Bendix Systems Div., M. Subramanian, Purdue University

"New Techniques for Microwave Diagnostics of Solids." M. E. Brodwin, Northwestern University

"The Utility of Scattering Matrix Orthogonality Conditions." R. S. Potter, U. S. Naval Research Labs.

"A New Microwave Filter Design Technique." E. Tahan, Sylvania Electric Prod., Inc.

Wednesday Morning, October 11

DIGITAL COMPUTER APPLICATIONS

Chairman: J. Van Ness, Northwestern University

"Simulating Transfer Functions by Digital Means." R. C. Radnik and W. C. Schultz, Cornell University

"Techniques for the Digital Computer Analysis of Chain-Encoded Arbitrary Plane Curves." H. Freeman, New York University

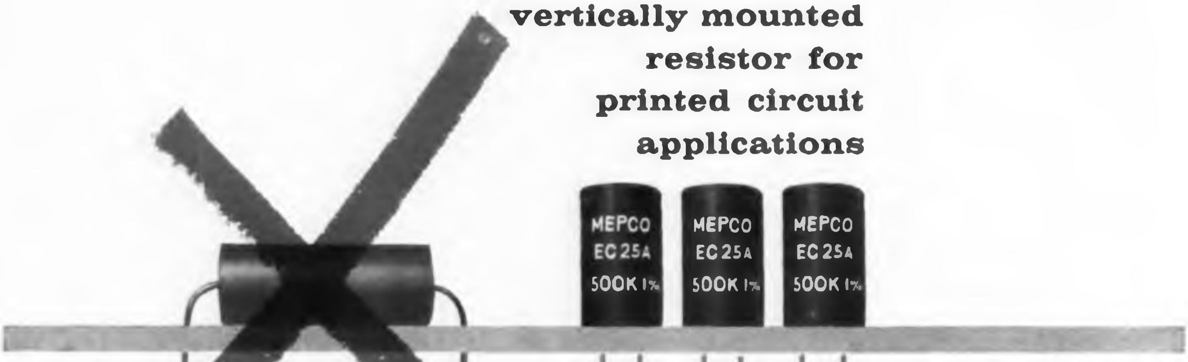
"Digital Data Recording System for Traffic Flow Analysis." N. Brainard, et al, General Motors Research Labs.

"An Information Retrieval System Tailored to the Needs of an Electronic Engg. Organization." L. Gilman and C. M. Jennings, Westinghouse Electric Corp.

(Continued on page 183)

NEW CARBON FILM RESISTORS

the first economical, space saving, vertically mounted resistor for printed circuit applications



Low cost — smaller space . . . two items high on the list of vital importance in solving today's tough design problems. MEPCO's new miniature ¼ W Carbon Film resistors were specifically designed to break the cost and space barrier in printed circuit applications.

Having both leads extending from one end and available in three different lead spacing arrangements, these Carbon Film Resistors for vertical mounting offer advantages never before available.

Write or call today for samples and literature.

SPECIFICATIONS

Power Rating	¼ W at 70°C derated to 0 at 150°C	**Length**	1 3/64 ± 1/64
		Diameter	¼ ± 1/64
Max. Voltage	300 volts	**Leads**	1" ± ⅛"
Resistance Range	5 to 500 K	**Lead Spacing**	A .125 ±005
Tolerance	±1%		B .156 ±005
Temp. Coeff.	—200 PPM to 500 PPM		C .200 ±005
Environmental Char.	MIL-R-10509C Char. B		

MEPCO

Manufacturers of Precision Resistors

MEPCO, INC.
Morristown, New Jersey

LOW-FREQUENCY SOLID-STATE AMPLIFICATION I

Tutorial Session sponsored by AIEE Electronic Circuits and Systems Committee.

Chairman: K. Enslein, Brooks Research, Inc.

"Limitations in the Design of Instrument Amplifiers." G. H. Cohen, University of Rochester.
"Noise Aspects of Low Frequency Solid-State Circuits." A. van der Ziel, University of Minnesota
"Effects of Signal Source Characteristics on Amplifier Design." W. McAdam et al, Leeds & Northrup Co.

COMPUTER LECTURE SERIES

Chairmen: T. F. Jones, Jr., Purdue University, and V. Rideout, University of Wisconsin

Detailed examples of Problem Solving on Digital and Analog Computers

PARAMETRIC DEVICES AND TECHNIQUES

Chairman: A. Kamal, Purdue University

"Synthesis of Negative Resistance Amplifiers." N. L. Weinberg, Westinghouse Electric Corp.
"Analytic Design of Varactor Diode Circuits." B. J. Leon, Hughes Research Labs.
"The Electron Beam Parametric Amplifier as a System Component." W. S. Van Slyck, Zenith Radio Corp.
"A C-Band Superregenerative Detector for Radar Beacon Applications." R. D. Standley, Armour Research Foundation

SPACE COMMUNICATIONS

Chairman: S. Lutz, Hughes Research Labs.

"On the Response of a High Gain Antenna to Complex Radio Waves." H. C. Ko, Ohio State University.
"Radiation Characteristics of Slot Antennas in Lossy Anisotropic Plasma." H. Hodara, Hallicrafters Co., and G. I. Cohn, Illinois Institute of Technology
"Effective Bandwidth Measurements Using the Moon and the Echo I Satellite." R. E. Anderson, General Electric Co.

NOON LUNCHEON

Speaker: R. W. Galvin, Motorola, Inc.

Wednesday Afternoon, October 11

APPLICATIONS OF CERAMICS

Chairman: K. E. Rollefson, Muter Co.

"A High Stability SiO_2 Capacitor." J. Minaham, et al, Sprague Electric Co.
"Miniature Ceramic Band Pass Filters." D. R. Curran and D. J. Koneval, Clevite Corp.
"Passive Electromechanical Gyrators and Isolators." J. H. Silverman, et al, Clevite Corp.

COMPUTER LECTURE SERIES

Chairmen: T. F. Jones, Jr., Purdue University, V. Rideout, University of Wisconsin

Repeat of Morning Lecture.

DIGITAL DATA TRANSMISSION

Chairman: R. Gibby, Bell Telephone Labs.

"An Analysis of Frequency Shift Keying Systems." J. R. Feldman and J. N. Farone, Armour Research Foundation
"A Highly Versatile Corrector of Distortion and Impulse Noise." E. D. Gibson, AFC Industries, Inc.
"Experiments in Signaling Through Non-Gaussian Noise." R. M. Lerner, et al, Lincoln Labs., MIT

LOW-FREQUENCY SOLID-STATE AMPLIFICATION II

Tutorial session sponsored by AIEE Electronic Circuits and Systems Committee

Chairman: G. H. Cohen, University of Rochester

"Feedback, Stability and Transients in Solid-State Low Frequency Amplifiers." V. R. Saari, Bell Telephone Labs.
"D. C. Amplifiers Using Semi-Conductor Modulators." N. F. Moody, University of Saskatchewan
"Low-Level Magnetic Amplifiers." W. A. Geyger, U. S. Naval Ordnance Lab.

Panel Discussion: The Future of Chicago Area Electronics
Sponsored by NEC and IRE PGEM

Moderator: A. MacDonald, Chairman

Presentation of a survey report by Dr. A. Rubenstein
Panel: Dr. E. Terman, Stanford University, et al

(See page 204 for N.E.C. Story)

From An Established Source...TELERAD

Antennas, Waveguide & Coaxial Components

Designed to meet the critical demands of modern R-F systems, Telerad parabolic antennas and waveguide components offer the utmost in engineering, materials, and craftsmanship. Telerad's test range facilities are in constant use measuring antenna patterns and power gain levels, supplying the most efficient equipment possible...whether it be for established designs, or for highly specialized new radar systems applications. Telerad antennas such as this incorporate a one-piece, spun aluminum reflector, which provides excellent dimensional accuracy while minimizing weight and installation problems.

Other features:

- Unique backup structure provides a clean, undistorted reflective area.
- Furnished with a 7° adjustment for both azimuth and elevation.
- Comply with FCC specifications and EIA recommendations.
- Standard antennas cover frequency ranges from 5.9 to 16 KMC.
- Diameters range from 4 to 10 feet.

This is but one type installation; Telerad's capabilities include design and manufacture of many types and sizes for special requirements, such as helical, slotted arrays, dipole and horn antennas.

Telerad waveguide is available in four types: • Rigid • Flexible • Twistable • Pre-formed.

Rigid waveguide (Tele-Guide) is supplied in straight sections to 20-foot lengths, meeting all requirements of MIL-W-85C, and constructed of aluminum, brass, silver or magnesium. Choke and cover flanges are fabricated with strict adherence to MIL Specs. Tees, elbows, adapters, pressurized units, directional couplers, cavities, mixers and duplexers, rotary joints and special devices are catalog items. Each Telerad waveguide assembly is thoroughly inspected for end fitting alignment, pressure tightness, and VSWR before shipment.

These components are only a portion of the stock equipment which Telerad offers. In addition, our engineering and production facilities are highly capable of designing or custom-building specialized coaxial equipment for individual installations...

From components to complete microwave or radar systems: Tee Assemblies • Sweep Elbows • Rotary Joints • Flexible Sections • Elbows • Adapters • Reducers • Special Devices • *Plus*—High Power, Lightweight Aluminum Sections for Airborne Application.

We welcome the opportunity to discuss your special antenna, coaxial, and waveguide requirements...from individual components through complete front end assemblies.

♦ Write Dept. 310-Y for new Telerad catalog covering expanded product line.

TELERAD Division of The Lionel Corporation

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Tele-Tech's
ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • OCTOBER 1961

SYSTEMS—WISE . . .

UTILITY NERVE CENTER

Nerve Center of Philadelphia Electric Co.'s digital computer-directed automatic economic dispatch system is this control console. Here power directors operate and supervise loading of generating units at minimum incremental cost. Control system was developed jointly by Minneapolis-Honeywell Regulator Co. and the utility. Array of knobs, dials and push-buttons are for allocating generation and its rate to 34 controlled units.

▶ New technique for high speed data transmission, DEFT (for Dynamic Error-Free Transmission) can send data at rates up to 15,000 words/min. over telephone lines. Present high speed transmission systems generally require either a coaxial cable or a broadband, very high frequency radio channel. The speed is equivalent to sending up to 150 conventional teletypewriter messages simultaneously over the same telephone line. In fact, it could be used in exactly that way—to carry 150 different teletypewriter messages at once, sort them automatically at the receiving end, and feed them into 150 separate teletypewriters. The system employs a radically new phase modulation technique. General Dynamics/Electronics is the designer-developer.

▶ The FAA has awarded Servo Corp. of America a large contract for 100 VHF/UHF advanced Doppler direction finders. The new equipment provides accurate bearings to pilots within ±1°. These direction finders will be installed in stations throughout the U. S., Alaska, and Hawaii, operated by FAA, to help insure the safety of lost aircraft. They operate on a frequency range of 100 to 400 MC and are completely compatible with all existing navigation systems.

▶ An installation for ground-based explorations of upper atmosphere and outer space is being constructed by the National Bureau of Standards, Boulder (Colo.) Labs and the Instituto Geofisico de Huancayo (Peru). It will be a site 17 miles east of Lima, Peru. The Jicamarca Observatory—named for a nearby village—will have, when completed, 6-million watt pulse transmitter and a 22-acre antenna with 9216 crossed dipoles mounted 6 ft. above a reflecting ground screen. The antenna will be used to transmit a very high frequency wave lasting from 50 to 1500 microsec., and when switched to the receiving state, to detect the faint re-radiation of the pulsed radio wave by free electrons in the upper atmosphere.

▶ RCA has developed electronic equipment for transmitting data to a computer thousands of miles away at a speed 3,000 times faster than teletypewriter. Magnetic tape terminal (MTT) units have been installed at San Francisco and Kansas City to speed social security data. In use, the equipment works with the Bell System's Data-set 201A at each end of the private line circuit. Data is relayed through the MTT's magnetic core memory to standard telephone, leased line, or microwave hookups. At the receiving end, the information once more passes through magnetic core memory and on to a magnetic tape unit for recording and computer processing. The use of core memory provides the highest rate of line efficiency by blanking out tape gap time.

▶ The McDonnell Automation Center, which supplies data processing services to more than 30 industries in the East, Midwest and Southwest, is the first firm in the nation to install an IBM 7080 Computer. Addition of the huge solid-state machine brings to some $10 million the value of the analog and digital equipment in use by the Automation Center and its staff of more than 400.

▶ Ryan Electronics is developing a radar system capable of recording altitude measurements up to 250 miles for NASA. Although radar altimeters are being used in current rockets, none meet the long-range requirements of the Saturn space vehicle program. The radar altimeter will measure the travel time of a single radar impulse transmitted from the vehicle to the ocean (in this application) and reflected back to the vehicle. Weighing only some 16 lbs., the compact unit will be employed in later multi-stage firing of the 1.5 million pound thrust Saturn.

PUNCHED CARD ELECTRONIC COMPUTER

Burroughs Corp. has entered into the punched card electronic computer business, putting the company squarely into competition for the largest single bloc of the billion-dollar-a-year market for automatic business data processing equipment. The basic punched card system in the B200 series, the B260, is described as the "workhorse computer." The series was designed for increasing productivity in medium and large-scale punched card applications. Photo shows a unit receiving a comprehensive system check-out before equipment is released.

Too many switches or controls can cause odd effects and create added burdens to the operators. Here is information about modifying your units to a one-knob control for easier operation.

Broadcasters . . .

Simplify Your Turntable

WITH the majority of announcer - operators spinning their own records, it is imperative to make the operation as simplified and reliable as possible for them. At the same time it will improve program continuity. The following are to be kept in mind when building or improving a turntable system.

(1) Quality and number of turntables and pickups.

(2) Methods of switching.

The engineer should listen to his station on a good high fidelity tuner - amplifier - speaker combination. He may be surprised at what he hears. If there is rumble or hum in any of his turntables, it certainly becomes evident, especially on bass boost. A small radio will not indicate these defects nearly as well.

Also listen intently for any signs of wow, flutter, clicks, noise, operator errors, too many pauses, and distortion of any kind. It pays to be critical.

Turntables & Pickups

Most engineers and announcer-operators will agree that there should be more than two turntables in the control room. With all of the commercials, themes, and various speed records, etc., there is a definite need for at least 3 and preferably 4 for smooth operation. Here we use 4 turntables in each control room; two Robinson's and two Garrod T MK II's as shown in Figs. 1 and 2. The Robinsons have 33 and 78 speeds. We use the Garrods exclusively for 45's and only rarely for 33's. These give our combo men plenty of flexibility. All turntables are within easy reach, which is an important factor.

Fig. 1: The control room set-up which is used by the combo man in small stations.

There are many good small turntables on the market that meet NAB specifications. The Garrod is one of them. Don't always put too much confidence in manufacturer's data. Putting them to the test with a standard test record will tell the story better.

As far as the big Robinsons are concerned, they easily exceed NAB specs. The mercury switches are the only items that we have replaced on them. Belt driven turntables, such as the Robinsons, are always good for low rumble content. When planning to broadcast stereo, beware of rim driven turntables, some broadcast types too, as their rumble content may be rather high.

Automatic 45 turntables are a great help to combo men, but they will probably never take the place of the regular turntables in the control room.

I would say that 6 pickups are best for 4 turntables, two pickups for each large one and one pickup for each small one. This eliminates turnover type cartridges, plug-in heads, weight changing, etc. These always add work for the combo man, and the resultant mistakes that go with it. I believe that LP's should be played with one arm of correct stylus and weight, and the 78s and ETs with another arm of correct stylus and weight. Mistakes

Fig. 2: The Robinson turntable is shown with the 1245L switch installed.

By NORMAN F. ROUND

Chief Engineer
Lawrence Broadcasting Co.
Lawrence, Mass.

Operation

are rare using this arrangement and the added arm will pay for itself.

There are many good cartridges on the market and the following should be considered when choosing a pickup: Frequency response, output voltage, load impedance, compliance, harmonic and intermodulation distortion, tracking force, channel separation, accurate tracking, arm resonance, and dynamic mass. Always follow manufacturers specs. to the letter when installing pickups. Much more could be said about specifications and exact data on various equipment, etc., but this is readily obtainable information.

Methods of Switching

The fewer the switches, levers, or pushbuttons the operator has to bother with, the fewer the mistakes. The following should be kept in mind for good switching:

1. Noiseless as possible both mechanically and electrically.
2. Able to perform as many functions mechanically and electrically as possible, such as, change speeds, select any one of the pickups, put all pickups on cue, put turntables on and off, change equalization when using different cartridges, and operate indicators, etc.
3. Must not introduce hum in low-level circuits.
4. Be as reliable as possible.
5. Must be able to perform with stereo recordings.
6. Must be in an easily reached location.
7. If possible, *one switch* should do all of the above.

The above has been done with remarkable success, the combo men are happy and errors are practically nonexistent.

One type Mallory 1245L, shorting, 4-section, 8-pole, 5-position switch does all of the above with ease. This switch was chosen because of its ruggedness. The schematic of the switch and wiring is given in Fig. 3.

The 1245L took the place of 6 switches that the station used to have on each side of the console. They were: two mercury switches for the motors, cue switch, 33 or 45 pickup switch, 78 or LP switch in the Gray equalizer, and the Robinson transmission speed lever. The switch is so wired that when it is in the middle position, all 3 pickups are in parallel ready for cuing. The cue amplifier is always on except when the mike key is on. This prevents any cuing going over the air. The operator can still cue a record by an earphone switch on the console if he so desires.

I installed an 8PDT telephone type relay in the console to take care of cue speaker cut-off and several other speaker cut-off's, as well as Conelrad, intercom, mobile, etc.

Having the cue amplifier on at all other times is not annoying as no sound is heard except when cuing a record. Cue volume is good and loud, and adjustable. In the "Q" position of the 1245L the turntable motors are off.

I modernized the Western Electric potentiometers so that they now have a cue position at the infinity end. It is quite easy to take these old pots apart and add a cue position. The 1245L could be wired to perform this function if the console didn't have cue pots. Cue pots have one advantage when using the 1245L. They allow the operator to listen to his records over the cue amplifier when the switch isn't in the "Q" position.

Rim Driven Turntables

One other feature that our combo men, at times, have found desirable is a small pushbutton close to the front of each Garrod. With this they can start the turntable spinning for cuing their records. Some rim driven turntables want to keep going backwards when the operator back tracks for cuing. This occurs even when the turntable is held for a second or so. To prevent this, he just makes a quick tap on the pushbutton and the turntable stays put.

In the 45 position, the Garrod pickup is the only one feeding the console and the motor goes on at the same time. This is the only position where an indicator would be desired when using idler wheel disengagement on rim driven turntables. It's easy to fix the turntable so that when the pickup is on its

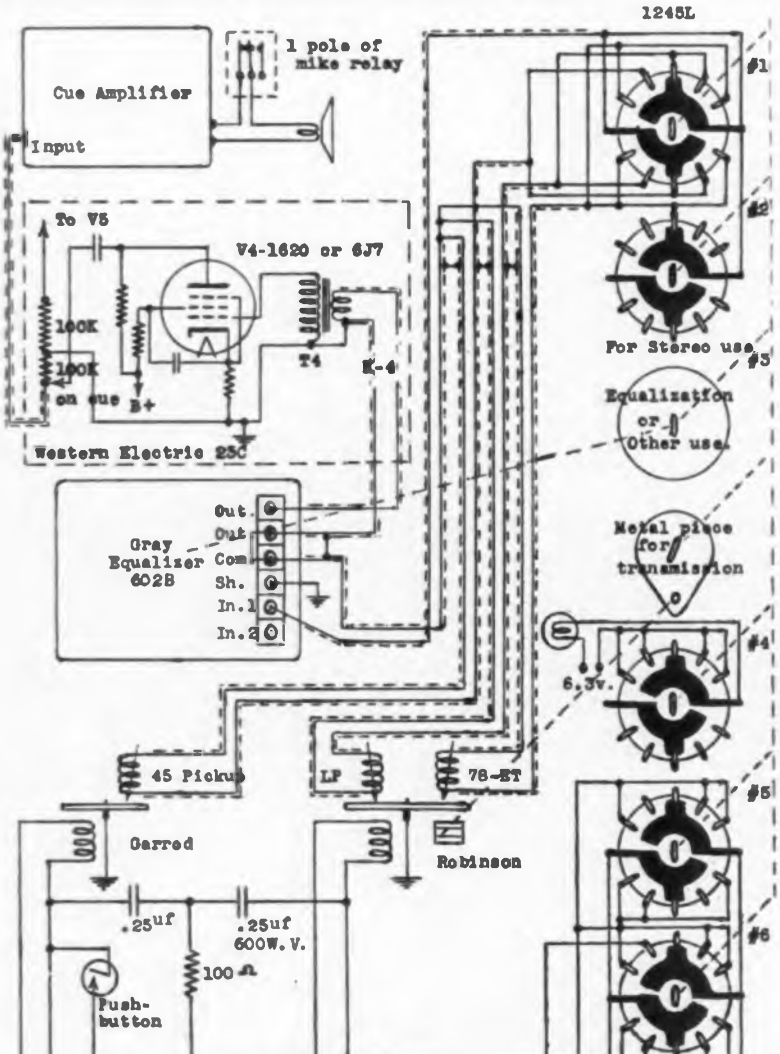
Turntables
(Continued)

rest, the idler wheel is pulled away from the motor pulley. This prevents the disturbing flat spots. Just add a one inch length of metal to the bottom end of the pickup arm near the shaft. Attach a length of dial cord between this and the idler wheel holder. When the pickup is on the record the dial cord just hangs loose and has no tension on the idler wheel. At the end of the broadcast day the operator could leave the 1245L in the 45 position, as he doesn't see the turntable running. An eye-catching indicator will prevent this.

In the 78 position the 15 gram pickup is the only one feeding the console, and the Robinson transmission is changed to 78 by a lever and the motor is also turned on. Equalization can also be done on one of the 1245L sections if desired. This is necessary when using a cartridge not exactly designed for the equalizer.

On the LP position, the LP pickup is the only one feeding the console. The transmission is now placed at 33 RPM by the lever and the motor is turned on. Another section of the 1245L can be used for stereo cartridges. If stereo is used during various periods throughout the day or evening you will want to install stereo cartridges. This would require a small switch near the LP pickup. Switch connects the cartridge's output wires together to play regular monaural LP's. Even this switch could be eliminated if a station does not use 78 records, or uses very few. The 78 position could then be used for stereo LP's. The few 78's that are used could be played on the Garrod with a plug-in head.

Fig. 3: Wiring diagram of the right hand 1245L switch is shown. Connections and switch sections are shown viewed from the bottom side of the switch.



The small turntable should not be used for only 78's and the big turntable for 45's and 33's as this lessens the operator's convenience and flexibility of operation. Having 3 turntables on a side, one for each speed, is going to the other extreme and is not necessary. The 78 position is good here as we use quite a few 78's for request shows, etc. Without the need for transmission changing at some stations, the engineer could use a 1256L switch to give him 6 available positions if he needed that many. The sixth position could be for stereo 45's. Six positions cannot be used with transmission changing as the metal piece would touch the side of the switch before it arrived at the sixth position.

On the ET position, the 15 gram pickup is the only one feeding the console, and the transmission is on 33 RPM.

Using the 1245L to mechanically change speeds on idler wheel turntables would be quite difficult if not impossible. It might be done electrically by using magnetic coils to pull-in the idler wheels on turntables that use 3 idler wheels. Wire it so that all the idlers are touching the motor shaft at same time on "Q" position. When turning to a particular speed the two unused idlers are pulled off, thereby preserving smooth starting of the turntable. Engineers shouldn't consider this a lot of work as it certainly will give him a sense of accomplishment, decrease maintenance, improve the station's sound, and keep everybody happy.

A floor switch could be used to turn on the turntables. However, this is just an added switching function that our operators would just as soon be without. The 1245L would have to be set beforehand and this might cause mistakes. Mechanical noise would also be another problem with a floor switch.

Turntables
(Continued)

Another idea is to have micro-switches® on the turntable pots, or if these make too much mechanical noise, then add a small cam shaft to the back of the pots to operate a lever switch. There are several ways to do it. It is also a good idea to have silent switches on the tape pots. These switches could operate dc relays, which in turn would put on the turntables or tape machines. With shielded ac wire and good placement of this wire in the console, the relays, possibly could be eliminated. As the engineer can see, the use of various relays, multiple pushbuttons, key switches, and what have you, could not possibly compete with the 1245L for simplicity of operation. These might simplify it to a certain extent but why settle for something less than the best? Before building or renovating your turntable system, plan it out as much as possible beforehand.

Switch Installation

Now for the actual construction of the system. The cabinets as shown in Figs. 1 and 2 were designed and constructed. Anyone that may desire the measurements, etc., just write to me, the author.

Set the Robinsons on top of the cabinets and drill a hole $1\frac{1}{8}$ in. from the front at the middle of the Robinson. This is the only place that the 1245L can be placed and it's also easy to operate here.

Before installing the 1245L, take it apart and round off the 12 humps with a grindstone, being careful not to go too far. This makes it much quieter in operation. Also solder the center section shaft to the bottom of the knob shaft for added strength. Put grease on the rollers. Now align the stop washer so that the "off" position is not used. Mount the switch in the Robinson with large lock washers so that it will not move out of position.

Now wire up sections 1 and 2 as shown in Fig. 3. Doubling up on contacts makes the switch more reliable. Before sliding the sections on the shaft, cut up the tie rod metal spacers so that the sections are very close to each other and yet not enough to touch. This enables at least 6 sections to be placed on the switch and more if desired. Now put the unwired section 3 up close to section 2. This can be wired up later while it's in position for possible equalization or other use. Next, remove the Robinson's mercury and transmission levers, leaving the spring on the transmission shaft. This spring must be soldered on so that it will not come off.

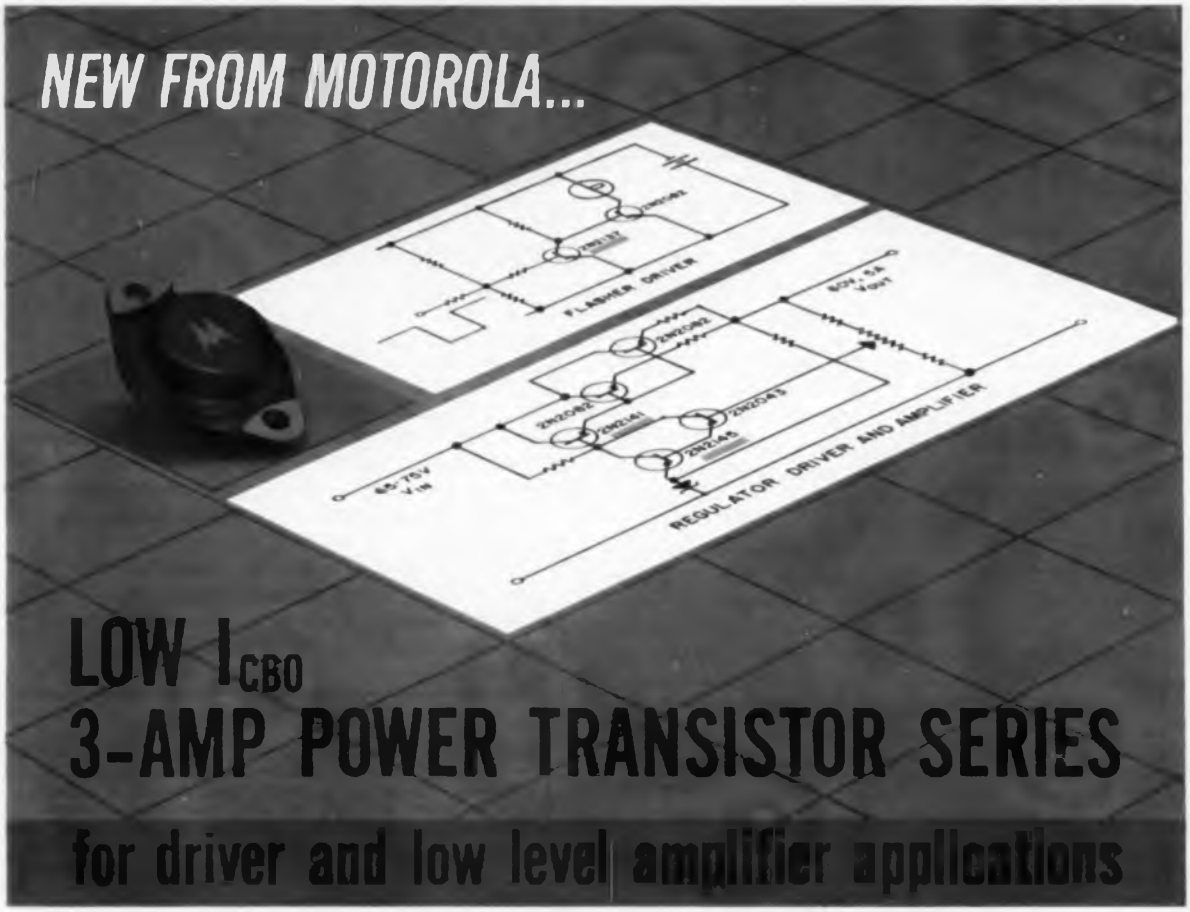
Fig. 4: Drawing may be used as the pattern for the metal gear change piece on switch.

Make the metal piece as shown in Fig. 4. Make certain that the metal isn't too thin and that it can be soldered. This metal piece is drawn to the exact size needed. The center slot is exactly at the correct angle and can be punched with a chisel. Make the hole at the end the same as shown. If you're working on the right hand Robinson first, then slide this metal piece up on the shaft with the small hole pointing toward you. Place the metal piece close to section 3 and solder it on the shaft. Be sure to use plenty of heat and solder.

For linkage to the transmission, use a metal rod about 6 in. long with small hooks at both ends. Do not just drop one end into the top of the spring but through a spacing nearest the top. This keeps it from coming out and stops noise. Make absolutely certain that the spring is in a straight up and down position and that the 1245L is in the "Q" position when the rod is installed. The rod length may be slightly less or more than 6 in. Put grease on these hooks.

Now wire section 4. One pole of sect. 4 can be connected to an indicator to show that the motor is running. It could operate on filament voltage from the console or cue amplifier. Slide section 4 on

(*Continued on page* 193)



Motorola's new 3-amp power transistor series, the 2N2137-46, offers I_{CBO} (at 2 volts) of only 50 μA instead of the usual 200 μA. Also the thermal resistance of the new small junction devices has been reduced to 1.2°C/W instead of the usual values of 1.5 to 2.5°C/W previously associated with such units. This results in a power dissipation rating of 62.5 watts at 25°C instead of the 35 watts you may be getting out of your present devices.

These new Motorola units are ideal as drivers for such types as the 2N2082 as illustrated in the accompanying circuit diagram. They are also superior in such applications as the direct-coupled amplifier circuit shown above.

The new devices are more completely specified . . . are available in "A" versions with complete life test data under Motorola's exclusive Meg-A-Life program . . . and they are available now at lower prices than comparable old-type units.

For complete specifications on the standard 2N2137-46 series, or the "A" versions available under the Meg-A-Life program, contact your Motorola district office, or call or write: Motorola Semiconductor Products Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 8, Arizona.

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Pick the device for your application from this new 2N2137-46 Series Box Selection Chart.

	h_{FE} @ 2V and I_C of 0.5A/2.0A	
	30-60/15 min	50-100/25 min
BV_{CES} 90V BV_{CBO} 90V BV_{CEO} 65V BV_{EBO} 45V	2N2141	2N2146
BV_{CES} 75V BV_{CBO} 75V BV_{CEO} 60V BV_{EBO} 40V	2N2140	2N2145
BV_{CES} 60V BV_{CBO} 60V BV_{CEO} 45V BV_{EBO} 30V	2N2139	2N2144
BV_{CES} 45V BV_{CBO} 45V BV_{CEO} 30V BV_{EBO} 25V	2N2138	2N2143
BV_{CES} 30V BV_{CBO} 30V BV_{CEO} 20V BV_{EBO} 15V	2N2137	2N2142

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Circle 130 on Inquiry Card

CUES for Broadcasters

Dynamic Frequency Monitor Test

ELMO DARRAH, Ch. of Operations
KOB, Albuquerque, N. M.

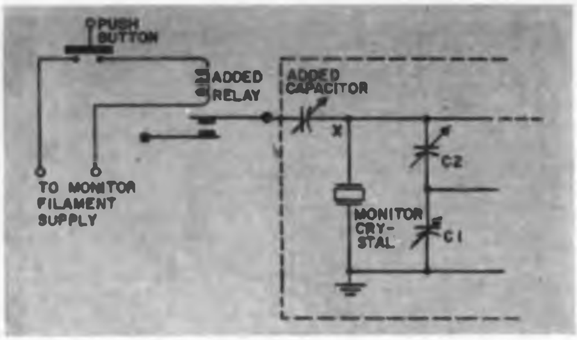
Monitoring equipment that is trustworthy is of great concern to broadcasters. "Will it monitor?" Here I describe simple means of making a routine dynamic test of the broadcast station frequency monitor's ability to show frequency deviation.

In our test circuit a small variable, or fixed, capacitor of between 5 and 30 pf is momentarily shunted across the frequency monitor crystal. The shunt capacity lowers the crystal frequency by a certain number of cycles per second. This is indicated on the frequency meter dial as a change between the transmitter and monitor oscillator frequencies.

At KOB, the capacitor used to detune the monitor oscillator is a tiny mica compression unit. It is connected through a small ceramic insulated 6 vac relay, which is controlled by a push button on the front panel of the monitor. Monitor filament voltage energizes the relay. In our monitor, the test button causes the monitor to read "4 cycles high." If pushing the button causes no deviation, or something more or less than 4 cycles, we know the monitor is out of order.

In mounting the capacitor and relay, care should be taken to keep the capacitor completely in the oscillator shield box, and the relay should be mounted outside, as close to the capacitor as possible. The main consideration is to not upset or change the basic circuit of the monitor, and not to destroy the effectiveness of the shielding by running outside wiring into the oscillator compartment.

In some monitors it may be possible to do without a relay by using a low capacity switch. Do not attempt this job casually, study it out carefully, and do not leave your station unprotected.



With the addition of a few components, a test circuit for your station's frequency monitor can be simply built.

$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double spaced text is requested. Our usual rate wil be paid for material used.

Turntables
(Concluded)

the shaft. For sections 5 and 6 you will need to buy another 1245L or buy the sections separately, if possible. On sections 5 and 6 put solder in the tiny contact cups. The Robinsons draw a heavy starting current and soldering these contacts makes them last longer. Using two sections and 4 poles for turning the Robinson motor on will give the contacts a long life expectancy.

The spark that is produced by turning on these motors will gradually wear down these contacts. Using non-shorting type contacts would render a shorter life. Another way to start the Robinson would be to use a 115 vac relay between the 1245L switch and the motor. Only one section of the 1245L would now be necessary to run the Robinson.

Another important consideration is that the 1245L on the left side will be wired differently than the right 1245L. This can be seen since the 78 position will be nearest the console on both sides. The metal piece will point toward the operator on the right side and away from the operator on the left side.

Switching the turntable motors on may produce noticeable clicks in the output. To reduce this use a resistor and capacitor in series and wire in parallel with the motors. A one watt resistor of 100 ohms and a capacitor of .25 mfd will take care of electrical noise very well.

Electric Shock

Operators of some Robinson turntables have probably found, to their astonishment, that they can get a good healthy shock from touching the center pin of the turntable if their other hand is grounded on the console, etc. The reason for this is that the platen is insulated from the rest of the turntable by large rubber washers. The friction of the belt builds up a considerable charge between the platen and the rest of the turntable. A simple remedy is to strap both together with a flexible wire, such as the outer shield of audio wire.

It is important to use a large knob on the switch. It gives the operator a good grip and reduces mechanical noise. The Gee-Lar J-312 is an excellent size with skirt or the cheaper 650SS. It is also important to use large letter designations such as Walsco No. 2115 white alphabet decals. Always spray these letters with several coats of clear coating. Be certain to file a flat spot on the shaft for the knob screw.

Now clean the top of the Robinson thoroughly and fill in holes with Lab-metal or similar material. Put tape beneath the holes to hold the Lab-metal until it dries. Spray the top with paint.

It's a good idea to remove the "LP or Other" switch in the Gray equalizer as it is not needed. While working on this equalizer you should change the 1-section switch to a Centralab 1020 3-section switch. Wire the first section the same as the original, the second section for a stereo cartridge, and the third for an indicator light that will light on any position that isn't the NAB position. This way the operator will be alerted to change the switch after using.

Fig. 5: Designations for the 1245L switch.

I'm a firm believer in having plenty of indicators for the benefit of the operators. Other indicators can be for: Conelrad, telephone, overmodulation, intercom, someone at front or back door after business hours, remote call-in, mobile call-in, etc. The engineer can use impulse or latching relays for some of these and also Amperite 6F60 flashers for making the indicators go on and off.

The equalizer can be wired either balanced or unbalanced into the console. The engineer must remember to avoid ground loops when wiring. Have the shield grounded at the console only and the turntables and equalizer grounded with separate wires. Ganged pots are necessary in the console for stereo. A balance control or two output controls are also necessary.

Now a low cost completely transistorized Scan Conversion unit is available which is capable of:
- TRANSLATION of video information from one scanning mode to another;
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- Expansion or reduction of bandwidth through TIME—COORDINATE TRANSFORMATION.

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WASHINGTON

News Letter

FCC POSITION—FCC Chairman Newton N. Minow and Commissioner T. A. M. Craven in one of the multi-faceted Congressional committee hearings—the Senate Small Business Monopoly Subcommittee—vigorously defended the FCC's development of the satellite communications program and emphasized that they and the FCC have no intention of permitting single company domination of a satellite joint venture. NASA Administrator Webb reported to the Senate body that NASA is negotiating with Hughes Aircraft Co. for a 24-hour synchronous altitude satellite, together with the AT&T and RCA contracts.

NUCLEAR SATELLITE—The Congressional Joint Committee on Atomic Energy heard about a plan for a nuclear-powered television satellite which could transmit directly to TV viewers around the world. Atomic Energy Commissioner Wilson stressed that such a nuclear space transmitter would mean much more in national prestige than a man landing on the moon. He felt that a nuclear space satellite is "possible in this decade." The nuclear system, he outlined would relay TV signals with 1 kw to ground networks and could be developed in 2-3 years. For world TV coverage a satellite would require about 150 kw of nuclear-developed power.

DEFER OWNERSHIP—In a letter to President Kennedy, made public by Rep. Emanuel Celler of New York, three Senators and 33 Representatives, all Democrats, urged that, while the United States should strive to be first to put into active operation a satellite communications system, this should be accomplished "through government research and development contracts and that consideration of the question of ultimate ownership of such a system be deferred until the system is fully operational." The letter charged that the American Telephone & Telegraph Co. would have a dominant and "very probably" a monopoly position in the ownership of the space communications system. The Congressional group urged that there should be the widest participation by all interested communications and aerospace manufacturers.

MILITARY - COMMERCIAL PROGRAMS — The Army's ADVENT project and the government's program to have private enterprise, like AT&T, RCA and Hughes, develop a plan for operation of a satellite communications system to meet international commercial requirements do not constitute a duplication of effort. This view was given to the House Science & Astronautics Committee by the commander of the ADVENT agency, NASA Administrator Webb and the executive secretary of the National Aeronautics & Space Council. The NASA Administrator lauded the AT&T on its "very forward looking view" regarding patent rights and cooperative relationships between government and industry.

National Press Building *ROLAND C. DAVIES*
Washington 4

FX-1 Computer

(*Continued from page* 118)

Some of the trays in the FX-1 are fabricated by a developmental technique called "plated-circuit" wiring, as contrasted with "printed-circuit" wiring for the plug-in units and conventional point-to-point soldered wiring for most of the trays. The plated-circuit trays use 2 layers of etched wiring sandwiched on either side of a central copper ground plane. Wiring of this type behaves like strip transmission line, with uniform impedance characteristics that should simplify and improve circuit performance at high freqs. Interconnections from 1 layer of wiring to another are made by plated-through holes rather than by soldering.

Fig. 4: Development plated-circuit tray, holding up to 20 plug-in units, has two layers of wiring on either side of a central ground plane, functioning as strip transmission line with uniform impedance characteristics.

The FX-1 logic circuits are packaged in plug-in units that have been designed for compactness, as well as being particularly suited to high freq. operation. The plug-in units are mounted in trays (Fig. 4) that hold up to 20 units each and themselves plug into the computer frame. Approx. 325 plug-in units of 12 standardized basic types are used in the FX-1. They are mounted in 24 trays, of 13 different types. The entire computer, with power supplies, occupies only 3 relay racks.

FX-1 computer was designed and built by the Digital Computers Group in the Information Processing Div. of the M.I.T. Lincoln Laboratory, with assistance from Lincoln's Computer Components Group.

* * *

News of Mfrs' Representatives

Atcheson and Adams—named representatives by CTS Corp., Elkhart, Ind., to cover Georgia, Alabama, North and South Carolina, Mississippi, Tennessee and the counties of Pittsylvania and Washington in Virginia.

General Electric Co., Schenectady, N. Y., has appointed, for their line of high-voltage test sets, the following representatives: **Electro-Tech Equipment Co.**, New York, N. Y.; **Gordon Yale Associates**, Boston, Mass.; **Sunshine Scientific Instruments** Phila., Pa.; **Wadsworth Mfg. Associates**, Liverpool (Syracuse) N. Y.; **Christie Laboratories**, Cleveland, Ohio; and **Excel Electric Service Co.**, Chicago, Ill.

George Kangas Sales Co., Overland Park, Kans.—named representative by Transistor Electronics Corp., Minneapolis, Minn., to cover Kansas and Western Missouri.

The Robert R. Thomas Co., Dallas, Tex.—named representatives for CBS Electronics in Texas, Louisiana, Arkansas, Oklahoma, Kansas, New Mexico, and Kansas City, Mo.

Goddard, Inc., West Palm Beach, Fla.—named representatives by Fairchild Semiconductor Corp., Mt. View, Calif., to cover the Southeast, including Virginia, North and South Carolina, Florida, Georgia, Alabama, Mississippi and Tennessee.

D. A. Schultz Co., Minneapolis, Minn. — named representatives by Burnell & Co., Inc., Pelham, N. Y., cover Minnesota and Iowa. Schultz will also represent Burnell's Gray & Kuhn Div.

The Deutsch Co., Electronic Components Div., Banning, Calif., has named **Arco Electronics, Inc.**, Great Neck, L. I., N. Y., as representatives for the entire country excepting the 11 Western states. The **G. S. Marshall Co.**, San Marino, Calif., will cover the 11 Western states.

Bulova Research & Development Laboratories, Woodside, N. Y., announces the appointment as representatives of **Joseph Gillman Associates**, Washington, D. C., cover Washington, D. C. area and **Dayton Technical Services Co.**, Dayton, Ohio, to cover the Dayton area.

Audax Inc., Div. of Rek-O-Kut Co., Inc., Corona, N. Y., announces the appointment of **Farrow and Dobbs**, Saratoga, Calif., as representatives in the Northern California territory.

Transistor Electronics Corp., Minneapolis, Minn., has appointed **Adolph Friedman Co.**, Mt. Vernon, N. Y., as representative for Metropolitan New York and Northern New Jersey.

Louis J. Van Eperen named Customer Sales Representative in the Eastern sales area for Fairchild Controls Corp., Hicksville, L. I., N. Y.

Westinghouse Electronic Tube Div., Elmira, N. Y., announces **Townley Metal & Hardware Co.**, Kansas City, Mo., representatives in the Greater Kansas City area, Colorado, Kansas, Oklahoma, Missouri and Arkansas.

Oak Mfg. Co., Crystal Lake, Ill., announces the following representative appointments: **Product Sales Corp.**, East Lansing, Mich., to cover Michigan: **Lloyd F. Murphy & Associates, Inc.**, Minneapolis, Minn., to cover Minnesota, Northern Wisconsin, North and South Dakota; **Cartwright & Beane**, Memphis, Tenn., to cover Florida, South Carolina, Georgia, Alabama, Mississippi and Tennessee; and **Robert O. Whitesell & Associates**, Cincinnati, Ohio, to cover Ohio.

Parker Seal Co., Culver City, Calif., announces the appointment of **Seals & Engineering, Inc.**, Rockford, Ill., as representatives covering Rockford, Illinois and surrounding area.

General Resistance, Inc., New York, N. Y., has appointed **Q.E.D. Electronics Sales, Inc.**, Mt. Vernon, N. Y., as representatives in the New York Metropolitan area.

Wheatland Electric Products Co., Carnegie, Pa., has appointed **Joseph F. Devereau's** Mid-South Sales Agency as representatives in Arkansas, Western Tennessee and Northern Mississippi.

R. M. S. Associates, Inc., Mamaroneck, N. Y., has appointed as sales representatives **Brogan Associates, Inc.**, Mineola, N. Y., for New York, New England, and Northern New Jersey; **S and S Associates**, King of Prussia, Pa., for Eastern Pennsylvania, Southern New Jersey, Maryland, Virginia, Delaware and Washington, D. C., and **Lowry Dietrich Co.**, Dayton, Ohio, for Ohio, Kentucky, West Virginia and Western Pennsylvania.

Drew Associates, Boston, Mass., have been appointed representatives in the New England States for International Resistance Co.'s Control Components Div., Philadelphia, Pa.

Industry News

Lee Ballengee — appointed Vice President-Marketing, Cinch Mfg. Co., Chicago, Ill.

John J. Moran—elected Executive Vice President, Sigma Instruments, Inc., South Braintree, Mass.

Patrick J. Morrisey—appointed Vice President, Marketing, Dresser Electronics, HST Div., Garland, Tex.


P. J. Morrisey


E. Bachorik

Edward Bachorik—appointed Executive Vice President, Allied Control Co., Inc., New York, N. Y.

Arthur P. Hill—named Head, Advanced Systems Dept., Government and Industrial Group, Philco Corp., Lexington, Mass.

Miles Powell, Jr.—appointed General Sales Manager, Chemplast, Inc., E. Newark, N. J.

J. Burton Henry—named Director of Sales, International Resistance Co., Phila., Pa.

Richard K. Mosher—promoted to Vice President, Systems Div., Laboratory for Electronics Inc., Boston, Mass.

David W. L. Hickie — appointed Manager of Marketing, Lynchburg Operation, General Electric Co.'s Rectifier Components Dept., Lynchburg, Va.

Vincent DiNapoli—appointed Vice President and General Manager, Eastern Operations, Hermetic Seal Corp., No. Arlington, N. J.

Captain Sam E. Edelstein, Jr. USN —appointed Director of the Armed Services Electro-Standards Agency, Ft. Monmouth, N. J.

R. M. Duncan—named Head of the Procurement and Distribution Section, General Electric Tube Dept., Owensboro, Ky.

Joseph J. Kaleba—named Manager of Product Design and Specifications Section, Shure Brothers, Inc., Evanston, Ill.

David F. Hansen—appointed Sales Manager, Howard Industries, Inc., Racine, Wis.

Robert E. Gaffney — named Manager - Systems Marketing, General Electric Co.'s Light Military Electronics Dept., Utica, N. Y.

Lance P. Johnson—named to the post of Product Exploitation Director, Hughes Aircraft Co., Culver City, Calif.

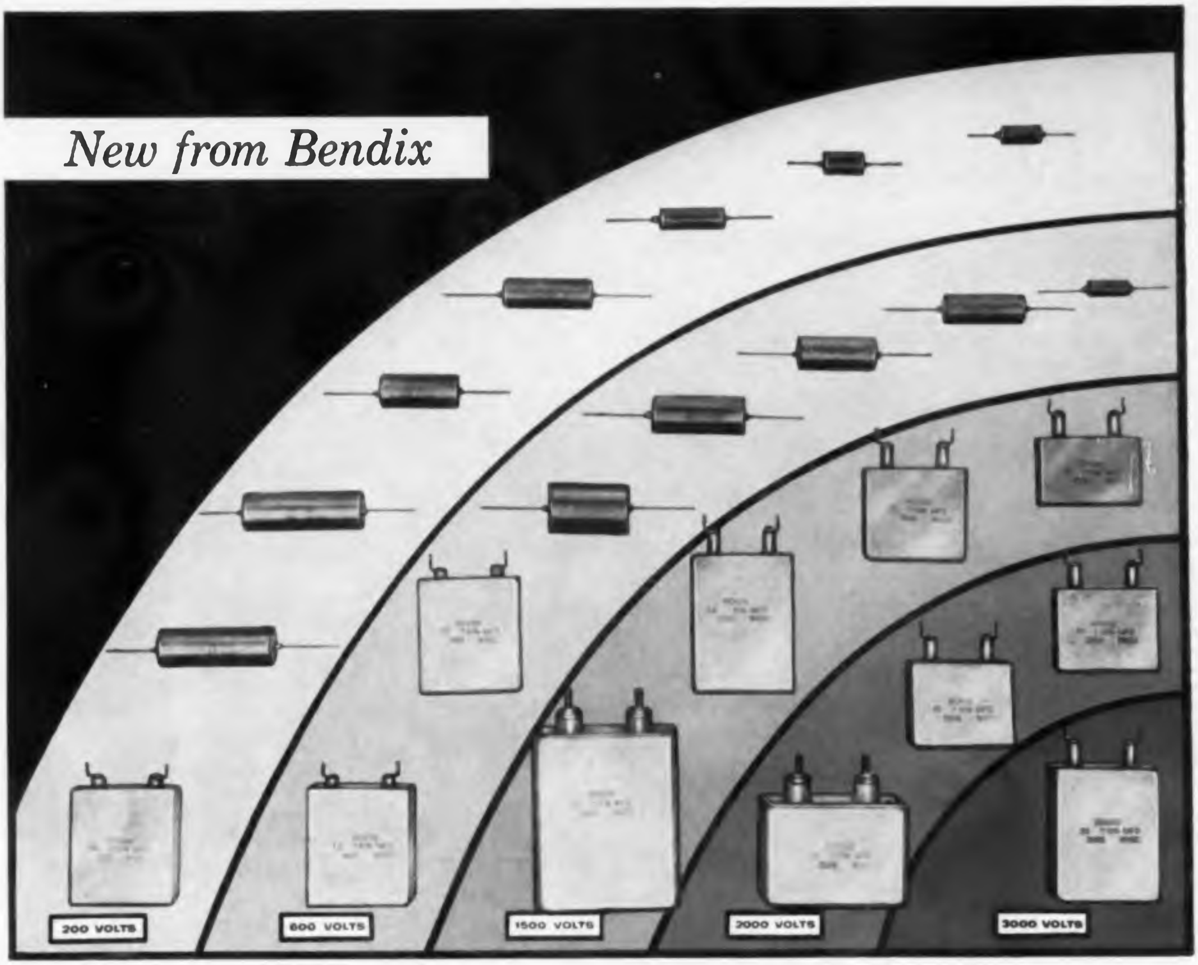

L. P. Johnson


T. H. O'Brien

Thomas H. O'Brien—promoted to Vice President-Operations, PRD Electronics, Inc., Brooklyn, N. Y.

Heinz K. Kuhlmann — appointed Product Manager, Appliance and Vending Controls, Oak Mfg. Co., Crystal Lake, Ill.

John E. Johnson—appointed Staff Vice President, Radio Corp. of America, New York, N. Y.



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Circle 138 on Inquiry Card

Industry News

Gordon I. Ness—named Instrumentation Marketing Manager, Fairchild Semiconductor Corp., Mountain View, Calif.

Asa M. Pearson—appointed Director of Electronic Marketing, National Geophysical Co., Inc., Dallas, Tex.

Robert R. Jay—named Manager of Product Marketing, Transistor Div., Sprague Electric Co., Concord, N. H.

John T. Ralph—appointed Product Planning Manager, Cinch Manufacturing Co., Chicago, Ill.

Clarence E. Watson—appointed Vice President - Business Administration, CBS Laboratories, Stamford, Conn.


C. E. Watson


S. Harman

Sidney Harman—elected President and Chief Executive Officer, Jerrold Electronics Corp., Phila., Pa.

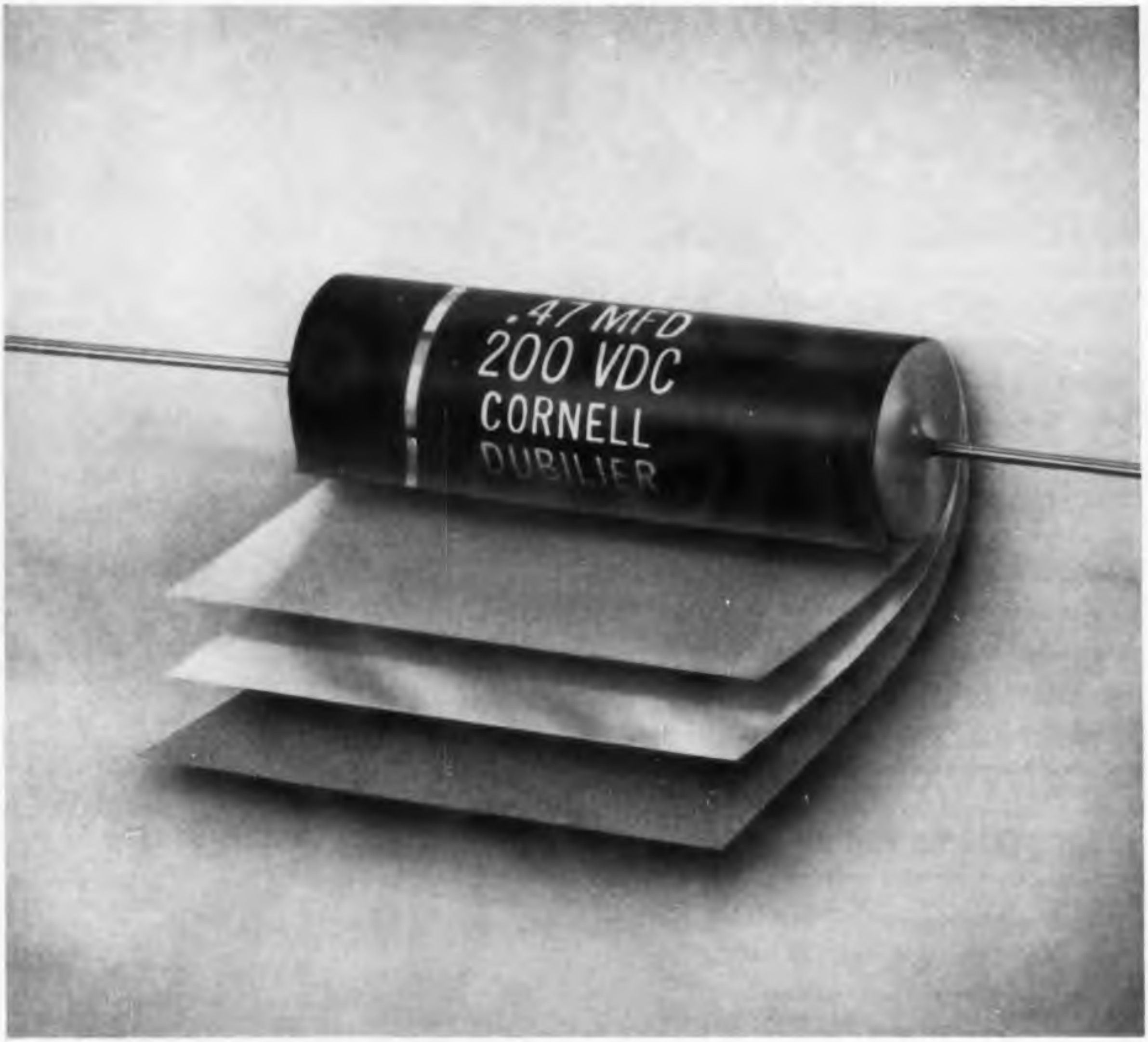
Taylor Fibre Co., Norristown, Pa., announces the following appointments: **Richard R. Hydeman**—named Vice President, Marketing and Engineering; and **Frank P. Kelly**—named Vice President, Manufacturing.

Robert Shevlot — appointed Sales Manager, Telonic Industries, Inc., Beech Grove, Ind.

Sperry Electronic Tube Div., Gainesville, Fla., announces the following appointments: **Charles E. Rich**—Assistant Manager for Special Projects; **David E. Musgrave**—Assistant Market Manager; **Oscar W. Nestor**—Production Manager; and **Warren L. Vergason**—Market Development Manager.

W. Herbert Lamb—appointed Vice President, Microwave Device Div., Sylvania Electric Products Inc., New York, N. Y.

Gordon S. Burroughs, former Vice President for Military, Industrial and Advanced Systems at CBS Laboratories—has formed Burroughs Electronics, Inc., River Rd., Cos Cob, Conn,. R&D firm with emphasis on space exploration and satellite applications.



Jaguar: Cornell-Dubilier's new dual-dielectric (polyester film and impregnated kraft paper), triclad cardboard tubulars, Type PTL. Triclad case consists of specially-impregnated glossy black kraft envelope enclosing a bonded shield of aluminum foil and moisture-resistant polyester film.

JAGUAR!™

Molded Capacitor Characteristics at a Cardboard Tubular Price

The skin of the rugged, wax-free CDE Jaguar opens a new era in cardboard tubular capacitors. Here's why:

Unbelievable moisture resistance! Withstands 95-100% relative humidity at 75°C for more than 48 hours!

Unprecedented temperature capabilities! −55°C to +125°C with no derating. It is unaffected by accidental contact with a hot soldering iron!

Remarkable insulation resistance! 5,000 megohms x mfds @ 25°C.

Solid dielectric impregnant! Eliminates the messy leakage encountered with oil-impregnated tubulars.

Wherever you need a capacitor for commercial or industrial DC, AC and pulsed DC applications—spark suppression, power supplies, RC circuits, coupling or bypassing—wherever a 200 to 1600 volt, .001 to 1.0 mfd performance band fits your requirements, you owe it to yourself to specify Jaguar.

You get molded capacitor characteristics at a cardboard tubular price! Ask your CDE representative.

CORNELL-DUBILIER ELECTRONICS, DIV. OF FEDERAL PACIFIC ELECTRIC CO., 50 PARIS ST., NEWARK 1, N. J.

CORNELL CDE DUBILIER

Circle 140 on Inquiry Card

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**

Image of Scientist Disputed by Psychologist

According to Harvard psychologist Dr. Anne Roe, the widely held public image of the scientist as cold, detached, completely objective and impersonal about his work "could hardly be further from the truth." Any creative scientist "is very deeply involved emotionally and personally in his work," and is himself his own most essential tool, she said.

Dr. Roe notes that studies relating to the personality patterns of productive scientists have shown them to be independent and open-minded, with a "strong liking for turning disorder into order." They have strong egos and strong control over their impuses. They prefer interpersonal relations of low intensity and dislike interpersonal controversy in any form. They also show "much stronger preoccupation with things and ideas than with people." They like to take calculated risks, but risks involving nature, not people, and risks not dependent on luck.

Higher Salaries For Engineers

Beginning salaries for graduating engineers at Cornell University are 4 per cent higher this year than last, according to Donald H. Moyer, director of the office of student personnel for the College of Engineering.

Reporting on salaries in the field, Mr. Moyer commented that significant changes occurred during the 60's. Previously engineers were hired at good salaries but reached a plateau midway in their careers, after which it was difficult to rise without entering some phase of administration. Increasingly, and especially in large corporations, exceptional professional engineers are being better paid than formerly without the need to resort to administrative work.

U. S. Office of Education Reports Increase In Number of Doctorates

At least 10,500 doctorates were granted during the 1960-61 academic year, according to the U. S. Office of Education. This compares with 9,800 in 1959-60 and 9,400 in 1958-59. Final figures on the number of doctorates granted during 1960-61 will be available in a few months following a survey begun at the close of the school year.

The Office of Education said that 605 colleges and universities granting advanced degrees reported that about 13,400 graduate students were scheduled to complete their last year of work necessary for a doctorate during the 1960-61 academic year. However, experience has shown that about one out of five candidates does not complete his last year of work on schedule.

Of the 13,400 students working on their doctorates 2,400 were majoring in such subjects as chemistry, metallurgy, physics, geophyhics and oceanography. Next in popularity were education with approximately 1,900 doctoral candidates; social sciences with about 1,600; engineering, with 1,500 and the biological sciences, with nearly 1,400.

Approximately 314,000 students were enrolled in 1959-60 for all levels of advanced degrees. Of these, about two-thirds had completed less than one full year of required work. Another third had completed more than a year of graduate work for either a doctor's or master's degree.

Almost 95,000 were enrolled in graduate work in education; 37,300 in social sciences; 36,600 in engineering; 25,700 in physical sciences; 25,300 in business and commerce; 14,800 in biological sciences; 13,500 in English and journalism; 11,800 in mathematics; and 6,300 in foreign language and literature.

SIGN LANGUAGE

Instructor Bill Williams directs practice in sign language training class at Lockheed Missiles and Space Div., Sunnyvale, Calif. Students are supervisory personnel who are learning how to communicate with deaf employees. Girl in foreground is Odessa Pate, deaf electronics assembler who is present to give class experience in sign communications.

Women Engineers Award

Miss Laurel van der Wal, head of bio-astronautics at Space Technology Laboratories Inc., Calif., has received the 1961 Society of Women Engineers Achievement Award, the highest honor presented by the 600-members-plus organization.

Miss van der Wal, who was named 1961 Woman Scientist of the Year by the Los Angeles Times, is best known for originating and implementing Project MIA in which white mice hitchhiked rides to outer space in the nose cones of Thor-Able rockets in 1958. Heartbeats of the mice were measured and telemetered to earth.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient Inquiry card, page 173.

The Conference is anticipating an attendance of 15,000 engineers and scientists. Over 400 electronic firms are exhibiting their products. A concentrated effort is also being made to acquaint the visitors with the techniques of computer operations and applications.

National Electronics Conference Opens

ENGINEERS attending the 17th Annual National Electronics Conference in Chicago at the International Amphitheater on October 9. 10, 11, will have the opportunity of learning how to use modern digital computer systems. A special computer workshop using actual modern digital and analog computer installations will be one of the highlights of the 1961 conference. According to Thomas F. Jones, head of Purdue University's electrical engineering department. The program will include demonstrations of basic computer concepts and techniques.

Citing the increasing utilization of electronic data processing techniques in all areas of engineering, he stated that the workshop will be directed toward those concerned with elementary engineering mathematics in design and sales. Exhibits and demonstrations of computers will run continuously through exhibit hours.

E.R.A. Becomes Sponsor

Over 400 electronic firms will exhibit their products. About 15,000 engineers and scientists are expected to attend the conference. The NEC is a non-profit organization devoted to the advancement of electronic science and education. In addition to the eleven participants, the conference is sponsored by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Illinois and Northwestern Universities.

Joseph J. Gershon, NEC President announced that the Electronic Representatives Association becomes the eleventh NEC participant. As a participant, ERA will be represented on the NEC Board of Directors and will contribute to the management of the National Electronics Conference programs and activities. NEC is recognized as the nation's leading forum on electronic research, development, application and education.

Special R and D Studies

A study of Research and Development in the Chicago-Area Electronics Industry is in its final

Dr. Lloyd V. Berkner, President of IRE who will speak on "Electronics—The Nerve System of Industry."

Robert W. Galvin, President of Motorola Inc., who will speak on "Electronics Unlimited."

Brig. Gen. David P. Gibbs, Deputy Chief of Communications and Electronics for North American Air Defense Command. He will speak on "NORAND Communications and Electronics."

Main Entrance to the Chicago Exhibition Center for 1962

October 9th

stages at Northwestern University. It is scheduled for completion in time for the results to be presented at this next conference. The study was initiated by the Professional Group on Engineering Management (PGEM) of the Institute of Radio Engineers and has been sponsored by the National Electronics Conference and supported by grants from 25 Chicago electronic companies.

The study is aimed at a better understanding of the relationships between the following factors in the Chicago-area Electronics Industry: management attitudes toward research, attitudes of the financial community, research climate in the community, resources allocated to and constraints imposed upon company research and development, R and D capabilities in the Chicago area, R and D achievements of Chicago companies, and economic results (primarily rates of growth).

One of these other studies is a long term investigation of the effects of corporate decentralization on research and development in over 100 large corporations in half a dozen industries (including electronics). Another is a survey of the time and effort required to develop new technical skills in the military electronics industry, such as infrared, computers, human factors, and inertial guidance.

No final conclusions have been reached as yet, but the general impression is that the Chicago-Area Electronics Industry has not placed enough emphasis on advanced research in the new areas of electronics such as: solid-state, computers, microwave, weapons systems, control systems, and sophisticated instrumentation.

Recruiting Problems

Chicago firms have had poor success in recruiting and holding outstanding researchers, as compared with other areas of electronic research, such as Boston, New York, and the San Francisco Bay area.

Relations with local universities in terms of company-sponsored advanced degrees, cooperative research projects, and participation in research seminars, are also lacking for a large percentage of Chicago electronics companies, and at a low rental for most.

A striking aspect of the composition of the Chicago area electronics industry is the small number of new Research-Based Enterprises, which abound in such locations as Boston, Washington, D. C., the San Francisco Bay area, and the New York Metropolitan area. Heavy concentrations of such firms in these other areas set the tone and pace of electronics research and development. So far the study has turned up less than a dozen of this kind of firm in Chicago-area electronics.

Industrial Evaluation

In addition to the NU report, results of an Armour Research Foundation study on research activity in the midwest will be reported at the National Electronics Conference. The Foundation study is being conducted by Wayne Kent of the ARF Techno-Economics Research Div.

Both studies were prompted by

(*Continued on page* 211)

COMPUTER WORKSHOP PROGRAM

Monday (morning and repeated in afternoon)

The Digital Computer, Thomas F. Jones, head of Electrical Engineering, Purdue University.

1. The Structure of a Digital Computer

2. Simple Approach to Programming a Digital Computer

At the end of the first session, attendees should be able to use a digital computer to solve simple problems.

Tuesday (morning and repeated in afternoon)

The Analog Computer, Professor Vincent Rideout, University of Wisconsin

1. Operational Components
2. Problem Set Up
3. Basic Concepts and Techniques Demonstrated

Wednesday (morning and repeated in afternoon)

Detailed Examples of Problem Solving on Digital and Analog Computers, Jones and Rideout.

(See p. 180 for Technical Papers Program)

The Representative's Role in Electronics

By ROBERT ASEN
President, RMC Associates

IN many manufacturer-representative relationships, a time occurs when the manufacturer looks quizzically at the commission checks he's paying out, and ponders whether he should begin employing his own salesmen? The merits of both methods of marketing have been debated for years—sometimes even logically!

When a $5 million sales mark is reached in the electronics business, commissions paid to a representative become significant. Naturally, the manufacturer shows increasing concern about his sales operations and procedure; it may occur to him, for instance, that he lacks complete control over the men who sell his product. But this would disregard the fact that independent rep organizations have a much stronger motivation than company-employed salesmen.

In practice, the lower the sales volume the more necessary the experienced representative becomes. Indeed, for a company just starting out in business, any other sales method would require too great an investment, too much internal supervisory personnel, and too large a fixed overhead.

In electronics, particularly, the new manufacturer would have to think of salesmen in terms of OIE—Overall Instrumentation Experience. This means Field Engineers—men whose unique combination of talents includes ability to sell, engineering education and electronic experience. Men of this calibre can only be fielded by a new manufacturer at prohibitive cost.

Considering that his reps handle several lines, the manufacturer may feel that his own line suffers from what appears to be a part-time selling effort. Here he overlooks a key fact: The representative's area salesmen usually outnumber company salesmen. Also, the rep's salesmen—especially because they handle more than one line—generate leads for all lines each time they call on a customer. This provides an automatic entree for our dubious manufacturer's products into potential sales areas his own sales force could have missed.

Eventually, the company chief will face the fact that his representatives are making quite a bit of money. And at this time he may be in a position to finance his own sales force.

At this point the representative faces the danger of losing the investment he has made in developing the manufacturer—and there is no doubt that a considerable investment has been made. Even if the early association of the manufacturer and his representative occurs under ideal business conditions, some time must elapse before the representative's commissions will begin to match his expenses. This is particularly true when the manufacturer first opens his doors—before he has earned product acceptance. In all likelihood, when a representative takes on a new manufacturer several years will pass before the representative reaps any return.

The representative's problem, then, is how to protect his investment after the manufacturer has grown, has achieved market acceptance, and is operating on a soundly profitable basis. Though formidable, this problem can be equally resolved.

The salient thought, while thinking of a solution, is that the manufacturer's marketing requirements change as he grows.

Beginning our analysis with a situation typifying the electronics industry, let us take a new manufacturer requiring engineering field representation: At the outset, one objective is of paramount importance—to guarantee a sales volume that will yield the manufacturer sufficient income to cover his expenses plus an adequate sum for expansion. In the period following the business launching, the sales volume is veritably a life and death matter. It determines whether the manufacturer will survive. In this critical time the representative's organization can supply the immediate sales power that is the marrow of survival. During this time an all-inclusive marketing program would logically be held in abeyance. This means that advertising, technical mailings and comprehensive sales promotion aids would be kept to an absolute minimum.

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

However, when the manufacturer matures and develops, when he introduces new products, gains market acceptance and attains favorable industry recognition, these sales-supporting activities become increasingly important. At this phase both the manufacturer and his representative have grown to a degree that complicates their close personal ties. Most important of all, the marketing function has changed so that the rep's original crucial importance in the pure selling aspect has now lessened. At this juncture, it is necessary for the rep to anticipate supporting activities and develop his role in them so that he remains as essential to his principal as he was initially. The evolving marketing function calls for the rep's weighty contribution which enables the manufacturer to concentrate on areas other than marketing. Local advertising and promotion programs, minimizing of paperwork, equipment servicing, future market feel and new product suggestions are a few of the rep's contributions to the manufacturer's long term growth and stability.

Representative's Role

The aforementioned functions in no way negate the manufacturers' rep's major responsibilities:

a) To promote sales of the manufacturer's products in a manner making for long-term customer relationships;

b) To aid the manufacturer in achieving his growth objectives via sufficient sales volume and information feedback.

c) To carry out both of these responsibilities with greater efficiency and at lower cost than the manufacturer.

The leader of the representative organization should cooperate closely with the manufacturer's sales manager. Plan sales meetings, contribute to the agenda and add to the broad-gauge thinking that shapes the manufacturer's sales program.

A manufacturer would think twice before trying to replace a rep whose field organization is supplying him with important specific services for the commissions he pays. Listing some of the rep's major services:

1) Territory coverage in depth and scope—enough sales specialists to keep ahead of the growth in the territory. The rep should also be cognizant of and introduce new and better marketing techniques. The manufacturer will then rely on him and look to him for leadership in this area.

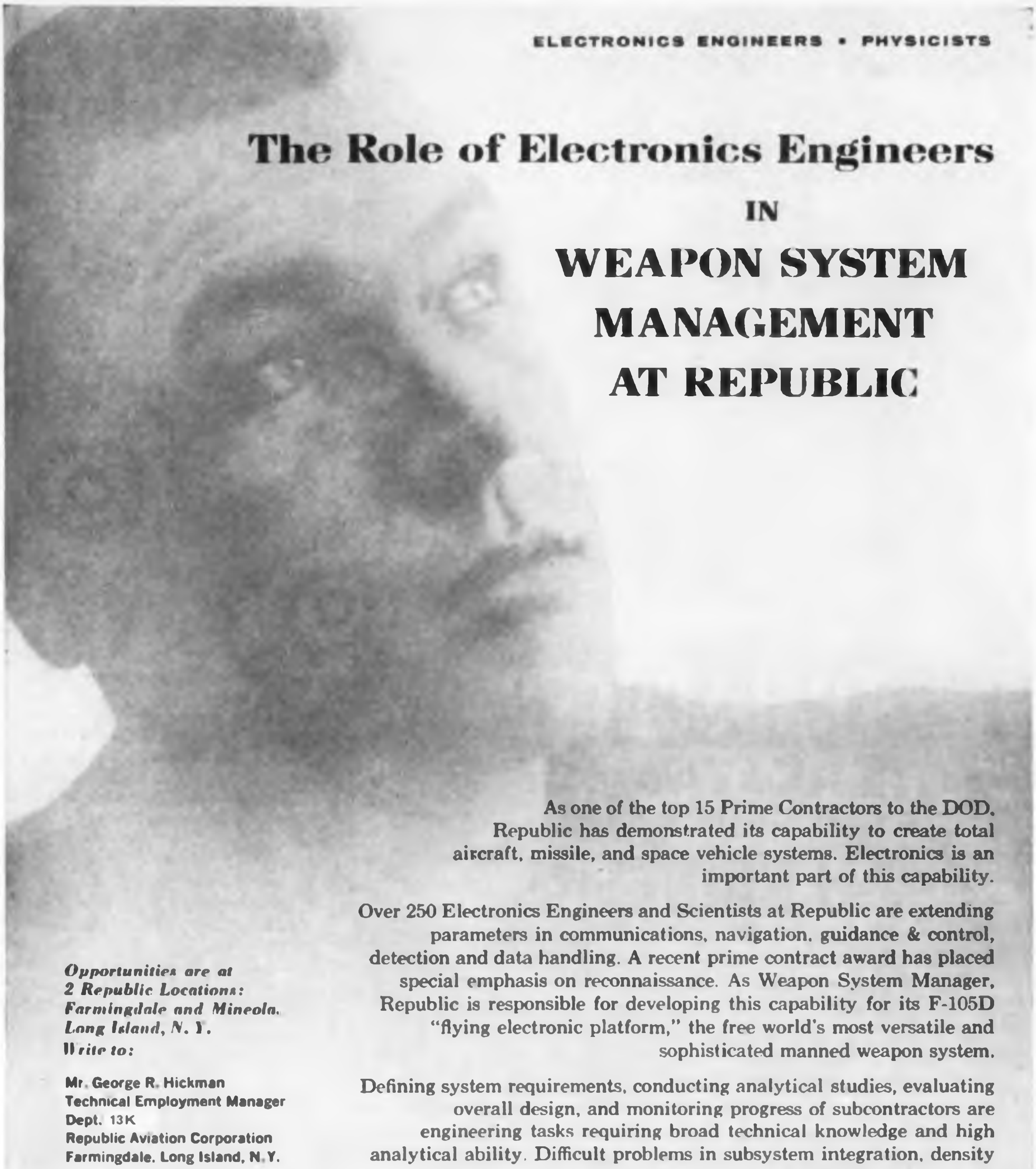
2) Local service and stocking of parts.

3) An order department which would minimize the manufacturer's paperwork. This spells out into the rep's order department correcting orders at source; processing orders; fully controlling the paperwork so that customers' questions can be cleared up by phone; expediting orders via teletype connections with principals.

4) The rep should have proper facilities which project an impressive image of his principal's company to callers at his (rep's) office.

5) The rep should carry the burden of local advertising and promotion. This includes regular direct mailings and regional space ads which supplement the manufacturer's national advertising. Sponsoring and participating in local trade shows or open houses is also within this category. Assisting his principals at national trade shows which takes place in his sales region represents another facet of promotional support the rep can render.

In conclusion, it has been suggested that stronger contracts between the rep and his principals would help the rep protect his investment. Following this logic, some have said that even the word "contract" is misnomer—that the legal binder should rather be called a "working agreement." Behind this reasoning is the fact that dissatisfaction on either side can render even the most binding contract useless. For the manufacturer, the relationship can continue and be effective only while he gives co-operation and still more cooperation.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The Role of Electronics Engineers
IN
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GE Returns to Diodes After 7-Year Absence

After a 7-year absence, the General Electric Company is back in the semiconductor diode business. Since 1954, G.E. has marketed only transistors and rectifiers in the semiconductor field.

As its first signal diode product GE announced a silicon planar, epitaxial, passivated diode designed for the very high speed computer market and for general purpose use.

James H. Sweeney, manager of the signal diode project, estimates that industry sales of signal diodes in 1961 will reach $100-million. This would be about 20% of the semiconductor industry's predicted total sales of $500-million for the year. He predicts that the industry's signal diode sales will double by 1965.

General Electric is also producing an extensive line of tunnel and back diodes in germanium and gallium arsenide.

Sweeney estimates that usage of tunnel diodes will increase "from today's million or so units to well over 100-million units by 1965."

GE's new signal diode, which has been designated the SD-150, is available with the same electrical specifications in both the conventional subminiature glass diode package and a new, hermetically sealed microminiature package.

General Electric also has the diodes available in a line of molded matched pairs and quads.

Price of the SD-150 in quantity to original equipment manufacturers is $5.50 each. In the microminiature package in quantity, also to OEM's, it is priced at $8.90 each.

Polarad Awarded $4 Million Contract

The Bureau of Ships of the U. S. Navy has awarded Polarad Electronics Corp., Long Island City, New York, a contract in excess of $4,000,000 to furnish a quantity of AN/URC-32 Single Sideband Ship-to-Shore Transceivers and auxiliary equipment.

The AN/URC-32 is a combined transmitter-receiver designed for shipboard installation. Covering the frequencies of from 2 to 29.9 mc, it features single sideband transmission of 500 watts, which is equivalent to 4,000 watts a-m, in the audio frequencies of 200 to 2,600 cycles. The unit is crystal-controlled throughout its entire transmission spectrum and is accurate to one part in a million.

N. E. C.

(Continued from page 205)

charges levelled at Chicago-area electronic firms by Dr. Frederick E. Terman of Stanford University, who appeared as a speaker during the 1960 National Electronics Conference. Terman, at that time, claimed that the Chicago-area was deficient in electronic research and development, and that, as a result, major systems contracts were being awarded to firms on the east and west coasts.

Student Program

About 600 high school students have been invited to the convention with a view to interesting them in an electronics career. It is believed that this will be the first time that such an invitation has been made for students to attend a professional meeting of this nature. The students will hear experts speak on three subjects covering the electronics industry in its vast scope, and the careers it offers.

International

Electronic Sources

Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering manuals

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 Francaise 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 Radiotechnicznego
Roz. Elek. Rozprawy Electrotechnizne

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radioteknika i Elektranika
Rad. i Elek. Radioteknika i Elektranika
Iz. Acad. Bulletin of Academy of Sciences USSR

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Philadelphia 39, Pa.

ANTENNAS, PROPAGATION

Lens-Compensated Biconical Aerial, L. Solymar. "El. Tech." June 1961. 3 pp. The dimensions of a biconical aerial can be significantly reduced by correcting the phase error in the mouth by a hyperbolic lens. The radiation pattern of this aerial is calculated with the aid of the Stratton-Chu formula. (England.)

Reduced Frequency Sensitivity of the Radiation Pattern of Wide-Band Omnidirectional Radiators, H. Meinke and H. Kraus. "Nach. Z." May 1961. 5 pp. The aim in antenna design is a radiation pattern with the lowest possible frequency sensitivity in addition to the lowest possible frequency sensitivity of the input impedance. The existing possibilities are discussed. Test arrangements with dielectric lenses are described and the results obtained are discussed. (Germany.)

AUDIO

The Evolution of the Package, J. R. Simpson. "Can. Elec. Eng." April 1961. 3 pp. The growing complexity of operating procedures in modern radio and television studios, and the need to keep operating costs at a minimum, have lead to the evolution of packaged audio control consoles. This is a discussion of the main design considerations with examples of new packaged equipment. (Canada.)

Radio Must Meet the Challenge of Listeners' Changing Needs, D. C. Trowell. "El. Elec. Eng." April 1961. 3 pp. In the past few years radio has undergone a major change. It has become a constant companion for most people and is associated with their daily activities. Radio station personnel must adapt to the new techniques to keep up with listener needs. (Canada.)

Record Playing Equipment—Design, Construction and Performance, W. T. Muscio. "Proc. AIRE." March 1961. 10 pp. The purpose of this paper is to consider some of the basic features of the design, construction and performance of disc record playing equipment, with particular reference to the types normally employed in domestic and portable systems. (Australia.)

A Summary of the Main Proposals for Stereophonic Broadcasting, K. Wilhem. "Nach. Z." March 1961. 13 pp. Since stereophonic reproduction by means of records has gained more and more in importance, the question of stereophonic broadcasting has also gained in importance. This paper discusses the possibilities for stereophonic broadcasting. (Germany.)

The Type UE 100 Universal Equalizer. "Rundfunk." April 1961. 5 pp. The paper describes an electronic filter which provides sound engineers with new possibilities of distortionless sound correction. (Germany.)

Four-Tuned I-F Filters, J. Temler and R. Orlewicz. "Prace ITE." Vol. 4, #3. 37 pp. The paper deals with four-tuned filters used in i-f amplifiers of a radio receiver AM channel. The equal circuit magnification factors and equal coupling coefficients between exterior circuits have been assumed and the expedience of this assumption is proved. (Poland.)

CIRCUITS

Energy Relationships in a Pulse Audio Power Amplifier, V. V. Malanoff, K. P. Poloff. "Radiotek" 16, No. 5, 1961. 4 pp. This is an energy analysis of the operation of a pulse audio frequency amplifier. Relationships are obtained which are useful in the design of these amplifiers. It is also shown that high losses on screens of multi-grid tubes make it necessary to use triodes in order to obtain better efficiencies. (U.S.S.R.)

Canonical Method of Synthesis of Switching Circuits, A. Sh. Blokh. "Avto. i Tel." June 1961. 9 pp. A new method of synthesis of switching circuits is described. Upper estimates for general and mean number of contacts are given. (U.S.S.R.)

A Linear Voltage-Controlled Telemetry Oscillator, D. H. Taylor. "Brit. C & E." July 1961. 3 pp. This article describes a telemetry oscillator having a frequency proportional to the magnitude of a control voltage applied to it. (England.)

Silicon Four Layer Devices as High Power Pulse Generators, R. P. F. Lauder, A. M. Brit. "Elec. Eng." July 1961. 6 pp. Several circuits are presented showing that pnpn devices in the two or three terminal configuration may be used as pulse generators delivering accurately rectangular power pulses for a variety of purposes including transmitters in the 20 kw peak input power region (England.)

Use of Glow—Discharge Thyratrons in Control Gas—Discharge Computer Tubes and Commutator Tubes, B. A. Hoffman, F. M. Yablonsky. "Radiotek" 16, No. 7, 1961. 4 pp. This article describes three relaxation oscillator circuits which operate on glow-discharge type TH5B thyratrons and are used to trigger type OG3 and OG4 decatrons and type A101 commutators. (U.S.S.R.)

Certain Aspects of Cathode Repeater Applications in a Phantastron Circuit, A. M. Tomashpolski. "Radiotek" 16, No. 7, 1961. 8 pp. The additional non-linearity which arises in phantastron circuits as a result of introducing a cathode repeater is analyzed. Examples of circuits are given where the sawtooth voltage is corrected by introducing a cathode repeater which creates additional feedback. (U.S.S.R.)

A Method to Generate Sinusoidal Frequency Modulated Oscillations, V. G. Kriksounov. "Radiotek" 16, No. 7, 1961. 5 pp. A single-pentode relaxation circuit is analyzed. Frequency modulated oscillations are produced in this circuit through relaxation action. Design fundamentals for such a circuit are given, and experimental data are included. (U.S.S.R.)

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International ELECTRONIC SOURCES

Amplifiers with Band Filter Coupling. J. Harmans. "El. Rund." May 1961. 4 pp. Feldkeller's method of describing 2-circuit band filters by the magnitudes F and D (form value and single-loss mean) is extended in its range of application by a normalization of the coupling coefficient. (Germany.)

Towards Classification of Rectifier Circuits. A. Schief. "El. Rund." May 1961. 2 pp. Starting from basic requirements presented to rectifier circuits employed for measurements of peak and mean alternating voltages, simple examples of realized circuits are described. (Germany.)

The Tristable Circuits. A. Sowinski. "Prace ITR." Vol 5, #1. 18 pp. The paper describes the simplest pulse counter operating in ternary system as well as a control system, where the tristable circuit is directly determining the maximum, minimum and zero state conditions. (Poland.)

Structural Transformations of Linear Varying-Parameter Systems. A. V. Solodov. Avto. i Tel." May 1961. 12 pp. Structural circuits of varying parameter systems are considered, the systems possessing two types of generalized units—lag network and phase-lead one. For transformations of such structural circuits, laws based on application of linear differential operators are given. (U.S.S.R.)

Controlled Rectifier Relaxation Oscillators. R. H. Morphy and P. Nambiar. "El. et Auto." July-Aug. 1961. 3 pp. This paper indicates how to design a trigger circuit for controlled rectifiers, working at frequencies ranging from 10 KCS down to a pulse every 12.5 sec. The general design principles are illustrated. A typical example of design is then worked out. (France.)

A New Wide-range Oscillator Technique. L. M. Sargent. "Brit. C.&E." Aug. 1961. 4 pp. Modifications to the well-known Wien bridge R-C oscillator enable it to be used as the signal source in an instrument which performs adequately from 10 CPS to 10 MC. (England.)

Decade Tubes Simplify Design of Preset Counter. P. G. Hodgson. "Can. I. & Comm." July 1961. 2 pp. A counter, which can be preset to give an output pulse for a range of 1 to 100 input pulses is described. (Canada.)

Stable Oscillators Operating at a Frequency Close to the Natural Frequency of the Induction Coils in the Circuit. G. T. Shitikoff. "Radiotek" 16, No. 4, 1961. 10 pp. This article deals with the analysis of a single-layer shielded induction coil on a ceramic form. According to this article, it is possible to obtain in certain circuits excellent results in the stability of the oscillator frequency, by operating it at a frequency near the natural frequency of the oscillator's induction coil. (U.S.S.R.)

COMMUNICATIONS

Ferrite Rectifiers Reduced in Weight and Overall Size. S. S. Perelmuter. "Radiotek" 16, No. 6, 1961. 4 pp. The structure of waveguide resonant rectifiers is described, which with its short length, provides good matching in the frequency band of the order of 15%. These rectifiers are used in radio relay communication lines and in measurement techniques. Electrical properties of and data for these rectifiers are given. (U.S.S.R.)

Terms and Definitions in Information Theory. P. Neidhardt. "El. Rund." July 1961. 5 pp. Various types of the information entropy in the communication channel are investigated; properties of important statistical processes as well as specific theorems of the theory of information are described. (Germany.)

Improvement of UHF Coverage in Flight Systems. C. Ancona. "Onde." May 1961. 8 pp. The problem investigated in this article is that of providing reliable air-to-ground and air-to-air UHF (225-400 mcs) communication links in every conceivable flight condition. Two solutions are given, each one employing two complementary polar diagram aerials mounted on board. (France.)

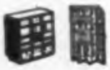
Constant Level Speech in Single Side Band (S.S.B.) Transmitters. J. Daguet and K. Gilabert. "Onde." May 1961. 12 pp. The proposed system is based on the analysis of a speech signal into two components which determine its amplitude and relative phase angle. (France.)

Signal Extremal Reception. A. A. Krasovsky. "Avto. i Tel." June 1961. 9 pp. The system is considered where a received signal is compared with a signal of an automatically adjusted inner generator. (U.S.S.R.)

VHF/FM Broadcast Receivers with PTT Test Mark. Emil Wey. "Rundfund." June 1961. 6 pp. The paper gives information concerning the creation of a Swiss PTT test mark for good VHF/FM broadcast receivers. (Germany.)

Lunar and Space Communications Studies. J. W. B. Day. "Can. Ele. Eng." June 1961. 5 pp. Studies of the use of the moon and artificial satellites as passive communications reflectors are described in the following article. (Canada.)

Control and Tracking of Satellites in Deep Space. Reginald G. Lascelles. "El. & Comm." June 1961. 7 pp. The unique characteristics of the Jodrell Bank telescope have made it possible for British and American scientists to maintain communications with, and thereby track, satellites on their journeys into deep space. (Canada.)



COMPUTERS

To Problem of Application of Digital Computing Devices To Differentiation and Smoothing of Sequences With Random Noises. A. N. Pockrovsky. "Avto. i Tel." June 1961. 4 pp. It is stressed that one has to realize a great number of arithmetic operations when using digital computing devices for solving problems of optimum smoothing and linear transformations of sequences of signals with random noises. (U.S.S.R.)

Use of an Electronic Computer to Automate Statistical Processing of Radio Signals. A. V. Prossin, I. P. Igosheff, I. P. Levshin. "Radiotek" 16, No. 5, 1961. 7 pp. This article presents a method for automated processing of experimental data on an electronic computer. (U.S.S.R.)

Automatic Control and Optimization of Primary Distillation by Means of a Digital Computer. G. Gau. "Rt." May 1961. 4 pp. The possibility of applying electronic digital computers for the automatic control of chemical processes are investigated in this article, using primary distillation as an example. (Germany.)

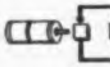
Digital Memory for Analog Computers. J. Smith. "El. et Auto." July-Aug. 1961. 2 pp. This paper describes a new type of digital memory using standard 35 mm tape and 16 tracks. Its motion is discontinuous and is produced by step-by-step motors. (France.)

Safe Programming for Digital Controls by Means of a Five-digit Code. W. Krageloh. "rt." June 1961. 3 pp. As a contribution to the discussion of suitable methods of programming for digital controls, a testable five-digit code has been suggested which contains, besides the signal codes for the teleprinter, the 10 digit, 2 signs and 14 letters. (Germany.)

Synthesis of Threshold Logic Combinatorial Networks. Luigi Dadda. "Alta Freq." March 1961. 8 pp. The problem of synthesizing arbitrarily assigned switching functions using only threshold element is considered. (Italy, in English.)

A Method for the Research of the Zeros of a Polynomial with an Analog Computer. Antonio Lepschy. "Alta Freq." March 1961. 3 pp. A method is presented to determine the zeros of a polynomial by means of an analog computer. (Italy, in English.)

On Multi-Variable Method of Automatic Search for Extremum of Cuntion. K. B. Norkin. "Avto. i Tel." May 1961. 6 pp. Sufficient conditions for extremum of n-variable function are obtained which are convenient for computer use. (U.S.S.R.)



CONTROLS

On Synthesis of Linear Automatic Control Systems. D. I. Gladkov. "Avto. i Tel." March 1961. 8 pp. The synthesis of linear dynamic systems with constant and variable parameters is considered. The structure and parameters of corrective nets are determined. (USSR)

Logic Control Servosystem. E. K. Shigin. "Avto. i Tel." March 1961. 8 pp. An electromechanic servosystem with step change of corrective network parameters which is realized by semiconductor logic unit is described. (USSR)

Transfer Function of Automatic Control System with Modulator and Half-Wave Demodulator. E. I. L'vov. "Avto. i Tel." March 1961. 12 pp. An automatic control system with modulator and half-wave demodulator is reduced to a continuous equivalent linear system. To find transfer functions the method of modulated harmonics is used. (USSR)

An Automatic Constant Level Gauge for Liquid Cooling Mediums. Hans-Werner Drawin. "Vak. Tech." March 1961. 8 pp. The article describes a device whereby the level of a liquid cooling medium (e.g. liquid nitrogen, liquid oxygen, etc.) as used in cold traps is being kept constant to an accuracy of ±0.25 mm over long operating periods. (Germany)

Precise Frequency Control for a Rotary Convertor. M. J. Tucker. "Elec. Eng." April 1961. 2 pp. The Royal Research Ship Discovery II has been provided with a 50 c/s power supply whose frequency is precise to approximately 1 part in 10^5 by locking the phase of a small rotary convertor to that of a 50 c/s reference signal derived from a quartz-crystal oscillator. (England)

Time Quantization Error in Automatic Control. S. M. Mandelshtam. "Avto. i Tel." June 1961. 7 pp. The technique of determining desirable frequency of parameter measuring in automatic discrete control is considered. (U.S.S.R.)

On Investigation of Stability of Periodic States in Nonlinear Pulse Automatic Systems. Ya. Z. Tsypkin. "Avto. i Tel." June 1961. 11 pp. Investigation of periodic states in nonlinear pulse control systems is reduced to investigation of stability of a linear pulse system with periodically varying gain. This system is shown to be equivalent to a multiple-feedback linear pulse system with constant parameters. (U.S.S.R.)

Optimization in Control Systems with Distributed Parameters. A. G. Butkowski and A. Ja. Lerner. "Rt." May 1961. 4 pp. Transmission lines with distributed parameters are described by partial differential equations. (Germany.)

Sources

A Model of a Fully Electronic Telephone Exchange for 200 Subscribers. G. Merz and R. Braun. "Nach. Z." May 1961. 8 pp. The audio wires are switched through by means of gas filled diodes. A time multiplex method is used for the control. The control circuits comprise semiconductors and ferrite core stores. A direct connection with through-dialling facilities to electromechanical exchange equipments is provided by special external link units. (Germany.)

Graphical Procedures for Solving the Approximation Problem of Electrical Filters. R. Rubini. "Alta Freq." March 1961. 18 pp. A study is made of the possibility of construcing the characteristic function of a filter as the sum and difference of functions having equal geometric shape, that is, of such type as can readily be traced with the help of a suitable outline curve. (Italy, in English.)

An Apparatus for Automatically Plotting Electron Trajectories. J. L. Verster. "Phil. Tech." No. 8. 1961. 15 pp. The electrolytic tank is a versatile tool for determining the paths of electrons in an electric field. Generally, the procedure is to use the tank to determine the equipotential surfaces, from which the electron trajectories are then construed step by step. The apparatus described here, which is based on a principle put forward by Fabor and Langmuir, traces out the trajectories automatically. (Netherlands, in English.)

A New D. C. Level Control for Adaptive Systems. R. A. Johnson & J. D. Hill. "Elec. Eng." April 1961. 3 pp. A novel electronic circuit is described and analyzed which maintains the potential drop across a load constant to within a fraction of 1% while permitting the dc level of the load to be varied through a wide range. (England)

Transductor Electrode Control for Arc Furnaces. Walter Gruber. "AEG Prog." #7. 1961. 9 pp. The article describes controllers in conjunction with induction motors, reversing clutches and amplidyne generators for the automatic control of the arc-furnace electrodes. (Germany in English)

Data Handling Equipment and its Application for the Automatic Control of Manufacturing Processes. J. J. Jardine. "Rt." March 1961. 7 pp. It is the purpose of this article to discuss generally the basic principles underlying the design of data handling equipment, to point out its advantages in comparison with the conventional measuring instruments and to describe its application as a most important member in a manufacturing process control loop. (Germany)

Digital Control of Machine Tools. P. Boese, et al. "Rt." March 1961. 6 pp. The differences are explained between point machining (e.g. drilling) and contour machining with external and internal interpolation. (Germany)

A New Type Range of Transductor-controlled DC Drives for 2.7 to 187 kW Heribert Winkler. "AEG Prog." #7, 1961. 7 pp. The method of operation and construction of power supply equipment with magnetic power amplifiers for dc drives is described. (Germany in English)

Automatic Control of Manufacturing Processes using Mathematic-Statistical Techniques. K. Brucker-Steinkuhl. "Rt." Feb. 1961. 6 pp. In control engineering it is sometimes necessary to supplement the principle of actuation by deviation with the principle of operation on the strength of statistical data or to replace the former altogether by the latter. Different statistical systems can be compared by reference to the power of test which is calculated for simple statistical operations. The author deals in particular with methods based on mean values, special groups of values and runs. The instrumentation for these methods is discussed according to their mathematic-statistical elements. (Germany.)

Absorbing Rods and Associated Actuators as Regulating Units for the Automatic Control of Nuclear Power Reactors. H. Braun. "Rt." May 1961. 7 pp. The author gives, first of all an introduction into the nature of the absorbing rod and, following this, discusses the various methods of actuation, for which electrical, hydraulic or pneumatic devices might be employed. The automatic control of the actuator is also described. (Germany.)

Distribution of Duration of Pulse Noises at Remote Control Device Output. L. B. Venchkovsky. "Avto. i Tel." June 1961. 6 pp. The effect of pulse noises with logarithmic-normal distribution of amplitudes on a remote control device is considered. There is determined distribution density of probabilities of the pulse noise durations at the device output for RC and gaussian low frequency filters. (U.S.S.R.)

Magnetic Amplifiers for Reversing Drives. Karl Heinz Bielefield and Hans Christof Heinzerling. "AEG Prog." #7, 1961. 4 pp. The method of operation and dynamic characteristics of servo-amplifiers for the reversing of universal dc and ac motors are described. (Germany in English)

The Behavior of the Controlled Plant and of the Members of the Control Loop with Automatic Frequency and Power Control of Power Distribution Networks. F. Cahen & B. Favez. "rt." April 1961. 6 pp. A general review is given of the problems encountered when designing systems for the automatic control of generators, feeding a power distribution grid system. (Germany)

Voltage-Regulation of Self-excited Generators by Means of Transductors. Eugen Renz. "AEG Prog." #7, 1961. 5 pp. The close terminal voltage regulation of self-excited generators by means of biased transformers is described. (Germany in English)

GENERAL

A Reader for Hand-Marked Documents. Cynthia M. B. Reid. "Elec. Eng." May 1961. 5 pp. A design is described for a simple machine to read hand-marked documents such as invoices. (England)

A Linear to Logarithmic Convertor Unit for use with a Linear Counting Ratemeter. J. T. Turnbull & D. N. Walder. "Elec. Eng." April 1961. 2 pp. A description is given of a convertor unit which, fed from a scale of two stage capable of generating negative going square waves (30 v. amplitude), will give an approximately logarithmic output over two decades. (England)

Wire Frequency Resonator in Telemetering. I. Pivovarov & M. Tsodikov. "Avto. i Tel." April 1961. 4 pp. The operation of a wire frequency resonator used for industrial telemetering is considered. (U.S.S.R.)

Transfer Functions and Frequency Responses of Carbon-Pile Regulators. D. A. Popov. "Avto. i Tel." April 1961. 9 pp. Frequency responses of dc and ac generator carbon-pile regulators are determined. On the basis of analysis of transient processes some expressions are obtained for regulator transfer functions and for corresponding frequency responses. (U.S.S.R.)

Gyromagnetic Resonance in Ferrites and Garnets in the Frequency Range 400 to 1200 Mc/s. J. Deutsch and H. G. Maier. "Nach. Z." March 1961. 5 pp. Measurements of the non-reciprocal attenuation at magnetic resonance have confirmed the equation which states the relationship between the lowest frequency of resonance under the condition of a saturated material and the properties of the material and its dimensions. The greatest possible ratio of the non-reciprocal attenuation can be obtained only under these conditions. (Germany.)

Sources

New Distortion Criterion—Part 2: A Criterion Based Upon that Distortion Spectrum. E. R. Wigan. "El. Tech." May 1961. 12 pp. This part of the paper is concerned with the relationship between the subjectively estimated unpleasantness and the purely objective cause—the degree of non-linearity distortion. (England.)

Pulse Response of a Delay Line. P. Poincelot. "Cab. & Trans." April 1961. 6 pp. A theoretical determination of the response of a ladder delay network to an applied pulse, assuming each line section to be derived from the basic constant-K low-pass section by the addition of a coupling between its two half-series elements. (France.)

Analogue Solution of Algebraic and Transcendental Equations by Gradient Method. M. V. Rybashov. "Avto. i Tel." January 1961. 12 pp. The method for solving systems of finite equations on electronic analogue computers is described. (U.S.S.R.)

Statistical Relay Automata and Some Methods of Their Investigation. I. I. Perelman "Avti. i Tel." June 1961. 15 pp. Automatic relay systems for statistical control of aerial production quality are considered. There is described determination of limiting laws for control parameter distribution which are obtained during operation of the considered systems under conditions of linearly time-changing regular disturbance. (U.S.S.R.)

A Probability Distribution Analyzer Utilizing Electrostatic Storage. L. K. Harvey "Elec. Eng." July 1961. 5 pp. An instrument is described which by electronic techniques, provides the one-dimensional probability distribution of any electrical variable. (England.)

To Problem of Transient Processes in Magnetic Amplifier with Feedbacks and Inductive Load Connected Through Rectifier. V. A. Sokolov. "Avto. i Tel." June 1961. 5 pp. The paper deals with the investigation of transient processes in flexible feedback magnetic amplifier with outer positive feedback and with inductive load connected through a rectifier. (U.S.S.R.)

Calculation of the Spectrum at the Output of a Non-Linear Four-Pole Network. B. V. Teloff. "Radiotek" 16, No. 5, 1961. 9 pp. The spectrum is determined by the output of a non-linear four-pole network driven by an input of two harmonic waves and noise. A method based on dividing the volt-ampere characteristic into several sections and on algebraic summation of the spectrum components corresponding to individual sections, is used to determine the spectrum. (U.S.S.R.)

Stable Oscillators Employing a Contoured Induction Coil Operating Near Its Natural Frequency. G. T. Shitikoff. "Radiotek" 16, No. 5, 1961. 5 pp. This is the continuation of the article which first appeared in the preceding issue of "Radiotek." This part deals with means of continuously changing the operating frequency. Geometrical design equations for such an inductor are presented. It is also shown that the elimination of an outside capacitor and the use of the internal capacitance of the inductor for the tank circuit greatly improves the stability of the oscillator. (U.S.S.R.)

Theory of Two-Core Magnetic Amplifier Which Even Harmonics are Rectified by Symmetrical Nonlinear Resistance. Tai Tse Hsin. "Avto. i Tel." June 1961. 9 pp. The mechanism of the magnetic amplifier at which even harmonics are used is discussed. (U.S.S.R.)

Effect of Complex Pulses on the Operation of an Inertial Detector. I. A. Fastovsky. "Radiotek" 16, No. 5, 1961. 9 pp. Expressions are derived for the calculation of the pulse characteristics of an inertial detector with known time constants when the following several forms of pulse are impressed on the detector: rectangular, cosinusoidal, sin x/x functions and triangular. (U.S.S.R.)

Sources

Experimental Studies of Spherical Electric Lenses and Reflectors. B. Chiron and Holvoet-Vermaut. "Onde." 1961. 9 pp. With R. K. Luneburg's spherical dielectric lens theories in mind, the authors indicate how a complete dielectric system can be adjusted by focussing individually and collectively the component lenses or reflectors, the latter being lenses metallized over part of their surfaces. (France.)

On Approximate Realization of Motion Along Set Trajectory. E. A. Barbashin. "Avto. i Tel." June 1961. 7 pp. Ways of selecting system parameters which secure approximate realization of the set process are proposed. (U.S.S.R.)

Introduction to Electro-Encephalography. H. Lecain. "El et Auto." June 1961. 2 pp. Nervous function is accompanied by an electrical discharge, the exact mechanism being not well known. (France.)

Extrapolating-Gradient Method of Search of Square Function Minimum. R. E. Vinograd, Yu V. Geronimus. "Avto. i Tel." June 1961. 15 pp. The method of extrapolation by three values in equally remote points is suggested for minimization of a square function. (U.S.S.R.)

Simple Holders for Crystal Detectors Feature Low VSWR, High Sensitivity. A. Staniforth & J. K. Pulfer. "Can. Elec. Eng." July 1961. 4 pp. Broadband microwave measurements often require low level crystal detectors with high sensitivity and low, uniform VSWR. This paper describes two coaxial holders for cartridge type crystals similar to the 1N23B. (Canada.)

Regulator Circuit Improves Operation of CdS Sun-Switch. S. A. Gardiner. "Can. Elec. Eng." July 1961. 2 pp. The term sun switch is used to describe a device which will switch a circuit when sunlight or daylight activates it. (Canada.)

The Required Channel Capacity in Links for Vocoder Signals and Pre-emphasized Speech. K. O. Schmidt. "Nach. Z." June 1961. 7 pp. The channel capacity requirements in links for "synthetic" speech (Vocoder signals) and "pre-emphasized" speech (with the high speech frequencies emphasized and the amplitudes in the speech signal compressed) are compared with each other. (Germany.)

Reversible Decimal Counters. J. L. Goldberg. "El Tech." July 1961. 12 pp. Counters which reverse their direction of counting in response to external control signals are described. These devices are required in the application of optical interferometry to the precise measurement of length. (England.)

MEASURE & TESTING

Pulse Contactless Telemetering System. "Prace ITR." Vol. 5, #1. 6 pp. The paper describes a telemetering system intended for measurements of electrical and non-electrical quantities. (Poland.)

Digital Volt-Ohmmeter, "DV 41," E. Schurig. "El. Rund." May 1961. 3 pp. This set is equipped with a novel single-row display facilitating quick and accurate readings of direct voltages and resistances. (Germany.)

The Detection of Cable Faults by Means of Radio-Isotopes. G. Lemm and W. Reusse. "Nach. Z." May 1961. 2 pp. An application of radio-isotopes permits X-ray film photographs to be made of the position of the center conductor in coaxial cables and thus displacements of the center conductor in bends can be detected. (Germany.)

Sources

Secondary Flare in Lenses. "BBC Mono." April 1961. 10 pp. The image formed by a lens is often reduced in contrast by extraneous light spread extensively over the image plane as a result of specular interfacial reflections within the lens and scattering by surface irregularities. A method of measuring the magnitude of the flare light is described. (England.)

Bootstrap Sawtooth Generators with Increased Sawtooth Linearity, K. Thiele. "El. Rund." May 1961. 4 pp. The second part of this paper considers the limiting case of an amplification factor 1 where the sawtooth generator supplies an ideal sawtooth voltage. (Germany.)

Acoustic Testing of Electronic Organs for Churches, W. Lottermoser and J. Meyer. "El. Rund." May 1961. 4 pp. Description of construction and operation of some large electronic organs for churches, including examples of tone specta and transients. (Germany.)

A Unit for Measuring Amplitude and Phase Distortions of the Chromenance Carrier as a Function of Modulation Depth, F. Coenning. "Nach. Z." May 1961. 6 pp. A new unit for measuring chromenance carrier distortions as a function of modulation depth is described. (Germany.)

To Calculation of Thermal Regimes in Transistors, A. N. Afanasev. "Avto. i Tel." May 1961. 7 pp. Calculation of steady thermal regimes in transistors is described. Properties of cooling plate are found out. Practical recommendations on the way of using power transistors are given. (U.S.S.R.)

Rectangular Pulse Generator for Testing Magnetic Function and Memory Circuits. "Prace ITR." Vol. 5, No. 1. 8 pp. The paper describes a generator which provides an output of a pair of rectangular current pulses, especially designed for testing magnetic function and memory circuits. (Poland.)

Moisture Measurement in Jute, D. F. Leach. "Brit. C. & E." July 1961. 4 pp. This probe moisture meter uses a single needle-like capacitor which can be plunged into a package. The relative merits of capacitance and resistance type moisture meters are discussed, and the probe, calibration, circuit methods and accuracy of the instrument are described. (England.)

A Method to Determine Antenna Losses, Y. V. Pavlov. "Radiotek" 16, No. 7, 1961. 8 pp. One possible method to determine antenna losses caused by scattering and by heat losses is offered. Formulae are derived for the use of determining heat losses in scattering and a method to measure these losses is offered. (U.S.S.R.)

The Use of the Omegatron for Quantitative Partial Pressure Analysis in High Vacuum, S. Dummler. "Vak. Tech." June 1961. 8 pp. An omegatron (cyclotron resonance mass spectrometer) is described. By using a magnetic field of 6180 Gauss, the resolving power of the instrument has been increased up to 100, so that the peaks corresponding to mass numbers 100 and 101 can be separated. (Germany.)

Measuring Methods in Nuclear Physics III, F. H. Rinn. "El. Rund." July 1961. 8 pp. This third part contains a discussion of pulse amplifiers and discriminators processing the radiation-detector output pulses in accordance with the problem in hand. This discussion is introduced by remarks on the high-voltage generator for power supply. (Germany.)

Water Determination in Spray Mixture for Oxide Coated Cathodes, K. Ettre and P. F. Varadi. "Vide." May-June 1961. 6 pp. The Karl Fischer method is applied for determination of the water content in the spray mixture which is commonly used for the preparation of the electron emissive layer of electron tubes. (France in English.)

ELECTRONIC INDUSTRIES Advertisers—October 1961

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Data Processing System Installed

An IBM RAMAC 305 Electronic Data Processing Machine has been installed at the Akron, N. Y. plant of Wales STRIPPIT, Inc. The new system will speed the processing of customer orders, shipping and billing information and make available a continually up-to-date record for production control and inventory.

VA-126 TWT

3 MW Peak

5 KW Average

5.4 to 5.9 kMc

BANDWIDTH WITH HIGH EFFICIENCY

HIGHEST POWER TWT

3 MEGAWATTS AT C-BAND

Varian Associates' new VA-126 pulse power amplifier traveling wave tube is particularly well-suited for advanced coherent radar systems employing frequency agility. With high gain and high efficiency over the full bandwidth, the tube offers a new standard in transmitter performance.

The VA-126 produces 3 MW peak and 5 KW average power, from 5.4 to 5.9 kMc. Gain, 35db; efficiency, 30%. Self-centering in electromagnet. Liquid cooled.

The VA-126 has 500 Mc bandwidth and excellent phase stability. These are desirable characteristics for pulse-to-pulse frequency changes, phase coding, chirping (frequency changes within the pulse), and electronically-steerable antenna arrays.

Varian's unrivaled capability in the development of advanced microwave tubes is at your service. For further data on the VA-126, write Tube Div.

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