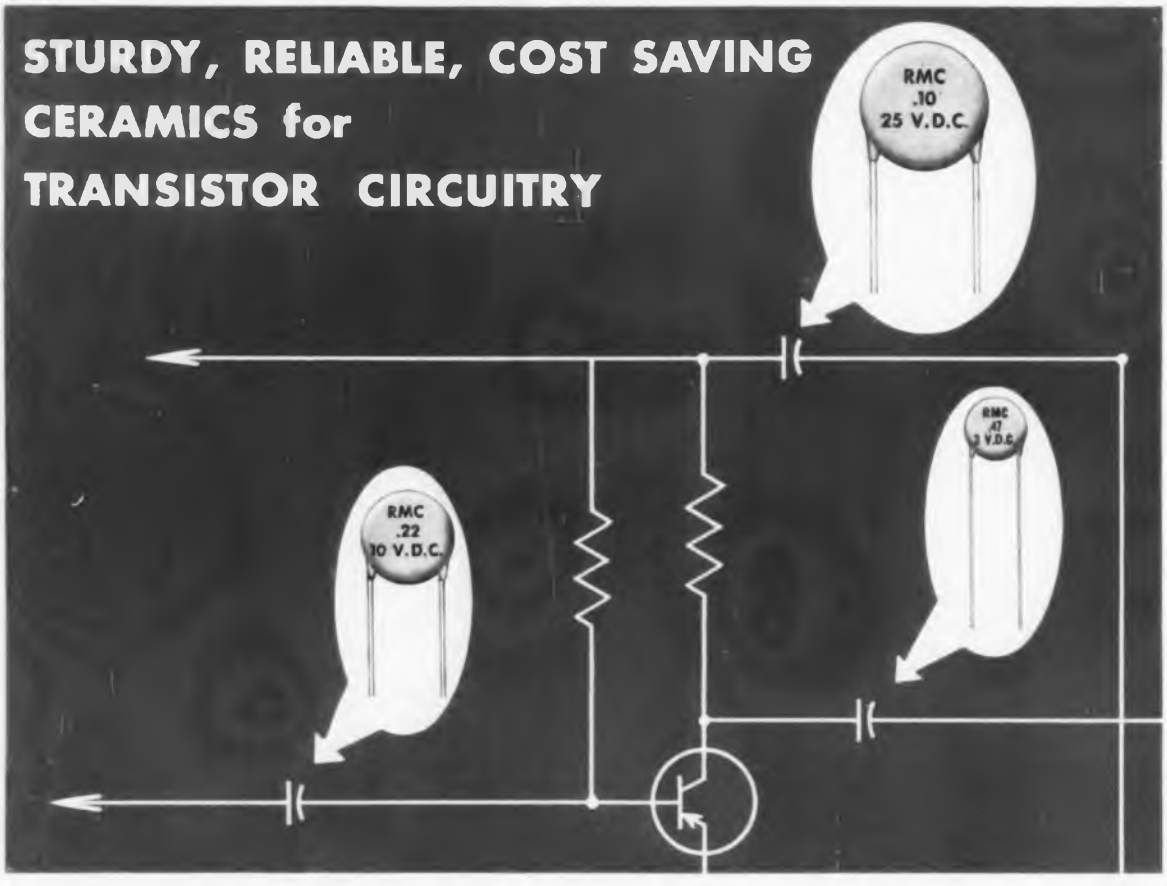
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

Hall Effect Isolators

May 1961

STURDY, RELIABLE, COST SAVING CERAMICS for TRANSISTOR CIRCUITRY



RMC Magnacaps®

3 VOLTS D. C.

μF.	Diameter
.05	.265
.10	.265
.22	.265
.47	.345
1.0	.565
2.2	.710

10 VOLTS D. C.

μF.	Diameter
.05	.265
.10	.350
.22	.555
.47	.725
1.0	.835
2.2	1.00

25 VOLTS D. C.

μF.	Diameter
.02	.410
.05	.600
.10	.785

RMC's Ceramic Research Laboratories have designed these new Magnacaps for application in low voltage circuits requiring capacitors with ultra high values and low power factors. RMC Magnacaps combine these desirable features with the miniature size, reliability and lower costs associated with ceramic capacitors.

Magnacaps exhibit a minimum capacity change between −55°C to +85°C and feature the mechanical construction necessary to effect additional production line economies.

If you have applications where space is critical and performance and economy are prime considerations, it will pay to investigate all the advantages offered by RMC Magnacaps.

U.S. Patent No. 2,529,719

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY

A DIVISION OF P. R. MALLORY & CO., INC.

GENERAL OFFICE: 4242 W. Bryn Mawr Ave., Chicago 46, Ill.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card

ELECTRONIC INDUSTRIES

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

"Defogging" RFI

FOR more than a year now ELECTRONIC INDUSTRIES has been publishing a series of articles dealing with the problems of radio frequency interference (RFI). Reader response to this series has far surpassed our greatest expectations. There is a constant request for reprints and hardly a day goes by now without some new development or announcement being made on this subject by the military, government or industry. In presenting this series, our aim was to provide tutorial information. Since we are now out of print on many of these reprints, and in low supply on others, we believe that a recap of article titles in this series, names of authors and dates of issue will be of benefit. It will enable readers to preserve the actual copies of the magazine containing this information.

Consider Interference in System Design; Rocco F. Fiecki; March 1960

Controlling RFI Susceptibility in Receivers; H. M. Sachs & J. J. Krstansky; September 1960

Guide to RFI Filters; Mervin H. First; June 1960

Instrumentation for RFI Measurements; F. Haber & R. Showers; March 1961

Making Transmitters RFI-Free; C. E. Blakely & R. N. Bailey; March 1960

Predicting the Antenna's Role in RFI; Ernest Jacobs; May 1960

Propagation Considerations in RFI; L. Valelik & R. B. Schulz; December 1960

RFI in Satellite Communications; O. M. Salati; April 1960

The FCC Controls Man-Made Noise; E. W. Allen & H. Garland; October 1960

Articles not in the series that appeared as "extras" are:

Detecting Interference to Missiles; H. Killberg; April 1960

New System Defeats Multipath Effect; George A. Scheer; May 1960

Designing RFI-Free Communication Systems; L. Mazzlotti & M. Engelson; May 1961

On June 12-13, the 3rd National Symposium of Radio Frequency Interference will take place at the Sheraton Park Hotel in Washington, D. C. An unusual integrated selection of papers together with panel discussions on controversial topics will be presented. Three sessions will develop the theme on identification and requirements of communication-electronic characteristics data for interference control. Recognizing, again, the great need for tutorial information on this subject, a special series of papers will be presented that will run concurrently with the main program. These will cover selected subjects in the fields of interference prevention and fixes, instrumentation advances, and systems problems involving prediction and control.

We wish to congratulate the symposium fathers for recognizing the need to make tutorial information available to interested attendees. RFI studies are sophisticated and complex. Tutorial information will materially aid those with limited exposures. Also, while symposium attendees get a great deal more out of such a program combination the symposium, in turn, will attract greater numbers of attendees. This other approach, therefore, might well be considered by the fathers of other symposia in other equally complex fields.

Systems Wanted . . . Technical Filing

THE constant expansion of the Electronic Industries over the past decade has also given rise to a vastly increased flow of technical data and information in the forms of articles, manuscripts, and catalog sheets. The problem of an adequate filing and retrieval system for the control of this information is acute with us all.

Most of us have definite spheres of technological interest and hence do not require or desire to work with a system as comprehensive as the Dewey Decimal Classification System. Many of us have created filing systems of our own and many of these work out very well. Yet, if you discuss this subject with engineers as we have . . . in their plants and at shows and conventions . . . it always seems that each man's system leaves a little something to be desired.

In last year's May issue we published an article entitled "A Filing System for Technical Articles" by Klaus H. Jaensch. Many of you wrote in and requested reprints of this material. The thought now occurs that if we could collect a number of these suggestions for filing technical information we might assist our readers in locating that missing element in their system. We therefore now entreat and invite you to write or jot down your thoughts on this subject, even in the briefest way. Please send in your thoughts at your earliest opportunity, and we, in turn, will be happy to pass the ideas along to the entire industry with equal dispatch.

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ELECTRONIC INDUSTRIES

Vol. 20, No. 5 May, 1961

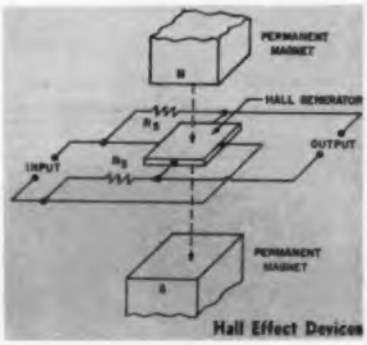
MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

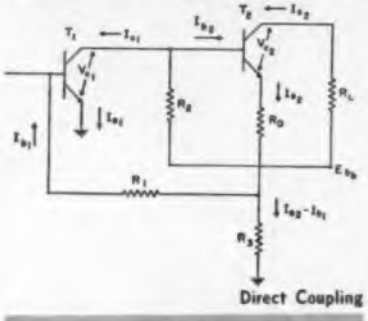
DEPARTMENTS

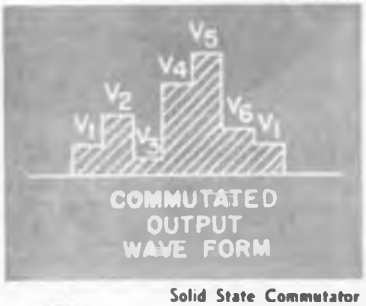
BPA NBP

Highlights of this issue

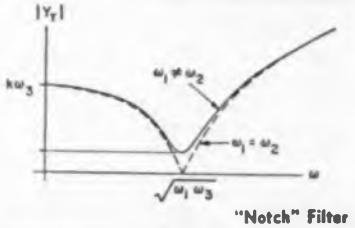


Hall Effect Devices


Direct Coupling



Solid State Commutator


"Notch" Filter

RADARSCOPE

NEW THERMOELECTRIC MATERIAL

In this specially designed vacuum induction furnace at Westinghouse's materials laboratories a new thermoelectric material—samarium sulfide—is being prepared. The new material is one of a family of ceramic-type, rare earth compounds which can convert heat directly into electricity at temperatures in the neighborhood of 2,000 degrees F.

EXPERIMENTAL FUEL CELLS, designed to produce auxiliary power in orbiting satellites are being developed for ARDC's Wright Air Development Div. The cells have power output of 50 w. The ion exchange membrane fuel cell will replace the present satellite batteries which run down in only a few weeks. GE's Missile and Space Vehicle Dept., Phila., Pa., is now working on these fuel cells under a contract with WADD.

EXPENDITURES FOR R&D in the nation equals about 2.6% of the gross national product. This ratio has remained relatively constant over the past year.

PROTECTION FOR SMALL MANUFACTURERS supplying the missile and rocket industries has been requested by EIA's Small Business Committee. As the law presently stands, small contractors could be held liable for "fantastic" losses if a test rocket falls by accident into a heavily populated area. Component manufacturers would be open to suit, together with Government and prime contractors. Research and development contractors are now protected by law against such losses but authority is lacking for similarly indemnifying production contractors.

THE PROPOSED BOYCOTT by a Chicago Labor Union against the use of foreign electronic components—principally Japanese—has been postponed for 90 days. The announcement was made following a meeting between Secretary of Commerce Luther H. Hodges and M. F. Darling, President of Chicago Local 1031, IBEW. The delay will give both the union and Government officials time to study the problem.

THE SOVIET UNION lags behind the U. S. in most areas of basic and applied heat transfer for research and development, but is on a par in a few specific areas and may soon be ahead in some cases. This conclusion was reached by the Office of Technical Services, after reviewing the available translated Russian chemical engineering literature.

MORE STRINGENT military requirements for reliability of electronic parts will increase the cost to producers, but the rise may be offset by increased yield and greater reliability of equipment. This opinion was voiced by Paul S. Darnell, Chairman of the EIA Military Industry Study Group.

NEW OPTICAL MASER developed by IBM, from uranium, gives the first continuous generation of coherent light waves in the infrared portion of the spectrum. Important applications are expected from optical masers in communicating in space, projecting TV pictures, and diagnosing by X-rays or fluoroscopy.

MOVING IMAGES

The half-inch thick panel combines piezo-electricity and electro-luminescence to produce a moving, lighted image. Developed by General Telephone and Electronics Labs, its earliest potential is seen in military and lab devices where the production of lighted lines and dots is needed to meet today's system requirements.

EMPLOYMENT IN THE COMPUTER INDUSTRY has increased by more than 50% over the past 5 years, from 64,700 in 1956 to 103,000 in September 1960. Reporting these statistics, the Labor Dept.'s Bureau of Employment Security pointed out that while computers have been largely applied to mechanizing clerical and bookkeeping functions and for scientific and engineering calculations, the greatest growth potential lies in their application to control production processes.

PUERTO RICO'S ELECTRONIC INDUSTRY has been assigned higher minimum wage rates under the Fair Labor Standards Act by the U. S. Labor Dept. Manufacturers of capacitors, transistors, coil forms, hermetic seals, crystal units, etc., now must pay a minimum wage of $1.00 an hour instead of the former hourly rates of 90 and 95 cents. In the classification which includes the manufacture of transformers and wire wound transistors, a minimum wage of 95¢ an hour replaces the current minimums of 90 and 95¢.

THE MARITIME ADMINISTRATION has invited qualified companies to submit proposals for design and construction of an integrated ship's bridge control system. The system would permit a better integration of the watch officer's functions by providing electronic assistance to his decision-making. Any of the routine functions presently requiring the deck watch officer's attention can be performed by control systems, the administration feels.

JAPANESE EXPORTS of electronic products to the U. S. were up 24% in 1960 over the preceding year. The dollar figures were $94 million for 1960, against $75.6 for 1959. Radio receivers, which account for 74% of total shipments, registered a gain of 11% over 1959. Other products showing substantial gain were tape recorders, radio-phonos, speakers, and receiving tubes.

FIRST COURSE offering a Master's degree in reliability engineering will begin this June at Case Institute of Technology, as part of the Air Force program to establish higher reliability standards.

WASHINGTON IS CONCERNED over reports that American scientists do not have access to the top military officers who plan the country's defense. Chairman Overton Brooks of the House Committee on Science and Astronautics said that the development of military weapons systems is possibly being delayed 10 to 15 years due to this lack of communication. Spur to the investigation came from a statement by Dr. Richard J. Russell of Louisiana State University that said that industry scientists have to deal with military subordinates on the "captain or colonel level—sometimes even a lower level." Russell added that, "the people through whom the information is filtered are incapable of transmitting the ideas across to the top brass."

EXPORTS OF ELECTRONIC PRODUCTS from the United Kingdom to the U. S. in the first nine months of 1960 totaled approximately $13.7 million, a 3% drop from the corresponding period of 1959. The data provided on a quarterly basis by the British Radio Equipment Manufacturers Assoc., shows total sales to the United States were reasonably well maintained, although shipments of record players, the leading items in this trade declined about 27% from the 1959 level. There was also a sharp drop in sales of phono parts and accessories and moderate declines for electron tubes and radio receivers.

IS SMALL BUSINESS to increase its share of defense contracts through administrative cooperation or legislative action? That was the question raised by C. J. Harrison, Chairman of the EIA Small Business Committee, commenting on the bill offered by Senator Proxmire (D.-Wis.). The Proxmire measure would empower the Small Business Administration to set up a subcontract program in which small firms would be considered "fairly" as subcontractors and suppliers to prime Government contractors, require prime and subcontractors to cope with and consult with the SBA on request, and permit SBA to obtain information and records relating to the subcontracting by Government prime contractors. Harrison said as the bill stands, the SBA becomes an additional statutory contracting party and this arrangement could only result in delays in awarding prime contracts in the selection of contractors.

FOR SPACE SIMULATION

The world's largest, most advanced general purpose analog computer, designed and built for NASA, is shown undergoing final inspection at Electronic Associates Inc., West Long Branch, N. J. The $1,510,000 computer will be installed at NASA's Langley Field, Va., research center.

Surpassing MIL-C-25A, CP-70, requirements by a wide margin—

New Difilm® Vitamin Q Capacitors

for −55 to +125 C operation without derating

Sprague's new series of small, drawn-rectangular case capacitors are far and away the best of their type that can be produced in the present state of the art. Surpassing MIL-C-25A TypeCP-70 requirements for performance, reliability, minimum size, and temperature range without derating, DIFILM Vitamin Q® Capacitors are made to withstand the most severe operating conditions encountered in military and industrial electronic equipment.

Type 271P Capacitors are designed to operate over the temperature range of −55 C to +85 C, while Type 272P Capacitors will withstand operation at temperatures up to 125 C without voltage derating. Because of the superior electrical characteristics of both Type 271P and 272P Capacitors, their physical size is smaller than mineral oil capacitors customarily used where wide ambient temperature ranges are encountered.

The new dual dielectric used in these capacitors consists of both synthetic polyester film and the highest grade capacitor tissue . . . a combination which offers the *best* properties of *both* materials!

The impregnant is Vitamin Q, a synthetic polymer which has been used by Sprague with outstanding success in paper capacitors for many years.

Capacitor cases are of drawn-terneplate seamless construction with double-roll sealed and soldered covers. The result is a virtually leakproof container with increased reliability over MIL units using fabricated cases.

For complete engineering data on Drawn-Rectangular Case DIFILM Vitamin Q Capacitors, write for Engineering Bulletin 2340 to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:

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

As We Go To Press...

Sergeant Missile System Is Accepted by the Army

The U. S. Army has accepted delivery of the first complete "Sergeant" tactical missile industrial production system from Sperry Utah Co., division of Sperry Rand Corp.

The solid-fueled "Sergeant" extends range and vastly increases the lethal power of conventional artillery. It can be transported by land, sea or air for immediate use in rapidly changing tactical situations. It was developed for use in all weather, climates or environments. It has an 85-mile range, can be emplaced, assembled and fired within minutes by a six-man crew and replaces the currently operational liquid-fueled "Corporal."

The production system will be used at the Army Ordnance Guided Missile School, Redstone Arsenal, Ala., in training Army missile men. Previous deliveries of the surface-to-surface missile have been for research and development testing.

GE Awarded Airborne Transponder Contract

General Electric has been awarded a $2.2 million contract for a new airborne transponder for use in the Air Force's MISTRAM missile trajectory measurement system. When operational in 1962, MISTRAM will monitor with extreme accuracy the guidance performance of missiles launched at the Atlantic Missile Range, Cape Canaveral, Fla.

The function of the transponder will be to receive and re-transmit signals for processing by ground stations, to determine position, velocity, and trajectory of a ballistic missile or space vehicle with greater accuracy than any trajectory measurement system presently available. The system will also provide accurate real time data for range safety purposes.

Optical Fingerprinting

Approximately 900 pupils in Texas are being fingerprinted by a new optical device developed by the Electronics Div. of Chance Vought Corp. Called PROOF, the system uses no ink or chemicals but makes an instant photographic record as the fingertip is touched against a glass surface.

CLOSED-CIRCUIT TV

Engineer holds telephone which is part of a completely-integrated closed-circuit TV system designed by John F. McCarthy, Inc., Philadelphia. The system is used primarily by financial institutions to insure proper signatures on checks.

Space "Life Jackets"

GE engineers have under simulated space conditions made scale models of foamed plastic "space life jackets" to demonstrate how an astronaut could actually build his own nose cone for a quick emergency return to Earth.

The plastic foam fills an envelope pre-cut to a re-entry vehicle shape at the same time encasing the man. The resulting vehicle would protect him from the severe heat and shock of re-entry and landing on Earth.

"New Proposals Threaten U. S. Patent System"

Sen. Clair Engle says that the traditional American patent system is endangered by proposals currently before Congress which would require the government to take title to patents resulting from government-financed research. The proposals call for the government to take title to patents developed in research and development performed by private industries under government contracts.

Sen. Engle said that the proposals might well lead to eventual government ownership of all patents and subsequent elimination of the patent incentive to inventors. Congress should allow the Federal agencies to follow a flexible patent policy which leaves the question of patent rights to the discretion of officials concerned.

World Communications

System designed to meet the rising demands for world-wide communications has been announced by RCA Communications, Inc. Employing data-processing techniques in international commercial communications for the first time, it is scheduled for use late in 1962. The system will be able to handle traffic transmitted by wire lines, microwave, coaxial cable, h-f radio, tropospheric scatter propagation or satellite communications systems.

More on Page 8

"MITE" TELEPRINTER

A U.S. Marine carries two teleprinter MITES to a helicopter for installation in the aircraft. Compact and lightweight, the entire unit including case weighs approximately 32 lbs. It operates at speeds up to 100 wpm. The Marine Corps has placed a $2 million order for "MITES" with the Mite Corp., New Haven, Conn.

Electronic SHORTS

Bell Telephone Laboratories is conducting a test program on new cathode materials. Cathodes of very pure nickel with tungsten and magnesium additives may result in high performance electron tubes that will last many years in undersea service.

The United Air Lines passenger terminal at the Los Angeles International Airport now uses closed-circuit television to display flight arrival and departure information. Eight 27-inch screens are placed in prominent positions throughout the lobby, concourse and baggage-claim area.

A miniature infrared radiometer suitable for rocket exploration of the upper atmosphere is under development at RCA's Missile Electronics and Control Division. The overall package, including the sensor head, the complete electronic and mechanical components, is less than 3 in. in diameter and 4 in. long.

Aerojet-General is constructing a $1¼ million facility at its Azusa, Calif., plant to test and manufacture infrared subsystems for the Air Force MIDAS satellite. The testing, and manufacturing and assembly areas are enclosed in a dust-free atmosphere. Impurities are filtered down to one micron size.

The Federal Aviation Agency and the Air Force have announced the transfer of military flight service functions from the Air Force to the FAA for all military aircraft operating within the continental United States and in oceanic areas.

NASA has negotiated a contract with the G. T. Schjeldahl Company of Northfield, Minn. for the design, development, fabrication, and testing of rigidized inflatable spheres for its passive communication satellite program, Project Echo.

Infrared Industries, Inc. announced that their infrared traffic detector has been approved for use on federally-sponsored roads. The unit emits a "coded" beam of infrared radiation which is bounced from passing vehicles and its reflection caught by a sensitive detector.

Pentron Electronics Corp. has developed and is currently testing a Transmissometer fog alerting system for toll road and highway application. The system will reportedly eliminate multiple pile-up type fog accidents.

With one of Information Products Corporation's Interrogators, an individual will be able to communicate directly with centralized data processing equipment by means of a simple keyboard and viewing screen. All the information required to satisfy an inquiry can be obtained in a few seconds.

RCA has announced unique advancements in the design and development of a transistorized ultrasonic height sensor which ensures the success of autopilot-controlled hydrofoil craft. The new device provides instantaneous and constant measurement of the changing height of waves, enabling the craft to proceed smoothly and without loss through automatic adjustment as dictated by the sensor.

According to the Bureau of Mines, Department of the Interior, synthetic borite and bornite-type minerals of the highest purity now obtainable possess no advantages over the natural crystalline compound of copper, iron and sulfur for thermoelectric and semiconductor applications.

Hughes Aircraft Co.'s Ground Systems Group, Fullerton, Calif., is investigating the feasibility of building an advanced space tracking antenna 200 to 250 ft. in dia. The antenna would increase DSIF communications capability 10 to 30 times. Caltech's Jet Propulsion Lab. let the contract.

A research station for experiments in the preservation of food by atomic radiation will be built for the U. S. Army. The station will house the largest cobalt-60 radiation source in the U. S. It will also be equipped with a large linear accelerator to irradiate foods with high-velocity electrons. Associated Nucleonics, Inc. is designing the $1.8 million station.

As We Go To Press (cont.)

Radar Navigation System

Bendix Doppler Radar Navigation Systems have been adopted by Scandinavian Airlines (SAS) and Swissair for their DC-8 and CV-990 jet aircraft. Both airlines plan fleetwide installations and are making provision for dual installation on all aircraft.

The recently developed and highly accurate radar navigation aid, continuously determines the aircraft's true ground speed and wind drift angle. An electronic computer combines this information with heading data to tell the pilot how many miles he has to go to his destination and how close he is to his planned course. The system is already standard equipment aboard jet aircraft of a number of U. S. airlines, and is also used on the Fiat G.91 light-strike NATO fighter aircraft.

Remote Control System

RCA has announced an electronic system that keeps a constant vigil over widely separated petroleum wells or cross-country pipelines, reporting breakdowns, relaying instructions from a central control point and logging vital production data. The Automatic Logging Electronic Reporting and Telemetering system (ALERT) is "virtually foolproof."

ALERT enables the operator of a computer to keep in constant touch with all the wellheads under control, making production changes instantaneously or according to a desired program to maintain the daily output required. It provides up-to-the-second reports on pressures, pumping station failures or power breakdowns for the pipeline operator.

"Bullpup" Missile

Maxson Electronics Corp. has been selected as the second source for guidance and control components and for assembly of the Bullpup air-to-surface missile. The Martin Co. has produced the weapon since 1958.

The Bullpup answers a need for a tactical attack weapon which will provide the launch aircraft with a high kill probability, while minimizing the exposure of the pilot and plane to the hazards of close enemy ground fire.

More News on Page 11

FABRICATING MICROMODULES TO MOBILE ROOMS

Magnetic Shields Custom Fabricated to Any Size or Shape

The industry's widest range of production facilities . . . in 3 factories:
PRESS FORMING AND DRAWING • HYDROFORMING • SPINNING • HAND FABRICATION OF PROTOTYPES

Already Tooled for Samples or Production

- Simple designs to elaborate complexes.
- Single or multiple laminae constructions.
- Micromodule size to a completely prefabricated mobile shielded room weighing 5 tons which can be transported anywhere — an achievement unique with Magnetic Shield Division.*

ALSO AVAILABLE
- Processed stock for fabrication in your own plant.
- Co-operative design facilities.

Use this SINGLE CONVENIENT SOURCE for all magnetic shielding requirements. Saves you countless design hours . . . helps speed your project . . . lowers your costs.

We recommend NETIC and CO-NETIC magnetic shielding materials because they are non-shock sensitive, non-retentive, do not require periodic annealing and provide completely effective shielding for optimum results.

NETIC and CO-NETIC are widely specified for satellite, missile, protecting recording tapes, data processing and for innumerable other military, scientific and laboratory applications as well as for commercial applications.

*

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Perfection Mica Company

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ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING

Micro miniature shield and cover, punch press operation.

Sequence of shield cans, punch press or spinning.

Complex configuration multi-lamina shield, hydroformed.

CRT shield illustrating combination of hand fabrication, spinning and sizing.

Backward wave tube shield assembly design, involving hand fabrication and hydroform or spinning.

Special purpose shield, hand fabrication (levitated gyro).

Tape preserver can be spun, hydroformed or punch press fabricated.

Data storage tube shield, hydroform or spinning, plus hand fabrication.

Large fabricated special structure (shaker table shield), approx. 60" dia. and 57" high.

Composite photo demonstrating that magnetic shielding qualities of NETIC alloy material are not affected by vibration, shock, (including dropping), etc.

3 new additions to the SPRAGUE MADT* transistor line!

TYPE 2N768

- Micro-energy switch—designed for low current, low voltage, high speed applications
- 10 mc pulse rates, collector currents as low as 1 ma, collector supply voltages as low as 1 volt
- No reduction in switching speed, as with ordinary low current, low voltage devices. Permits higher density packaging
- Typical DC beta of 40 @ $V_{CE} = -0.20$ v, $I_C = -2$ ma

TYPE 2N769

- World's fastest switch—will operate reliably at speeds in excess of 100 mc
- Gain bandwidth product (f_T) typically 900 mc
- Low capacitance, low saturation voltage, high beta—ideal for low-level, high-frequency logic circuits
- Extremely low hole storage factor (K'_s) typically 18 nsec

TYPE 2N779A

- Manufactured with tighter parameter control than any other transistor in the industry
- Designed to meet rigid specifications of 16 electrical characteristics—ideal for NOR logic and other super-critical applications
- Low saturation voltage—typically 0.09 volts
- Higher in performance, lower in price than mesa transistors with lesser specifications

High-speed switching transistors in TO-18 cases are now being mass-produced by Sprague. These hermetically-sealed germanium Micro-Alloy Diffused-base Transistors are made by a controlled-etch process to insure extreme uniformity. Maximum frequency capabilities have been improved by graded-base construction. Automated manufacturing techniques have brought about increased production efficiency, permitting favorable reductions in prices. This is why Sprague MADT Transistors can offer you greater performance per dollar than other high-speed devices in low-current switching circuits.

Other Sprague Micro-Alloy Diffused-Base Transistors

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

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

*Trademark of Philco Corporation

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TRANSISTORS	INTERFERENCE FILTERS	HIGH TEMPERATURE MAGNET WIRE
CAPACITORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
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MAGNETIC COMPONENTS	PULSE-FORMING NETWORKS	FUNCTIONAL DIGITAL CIRCUITS

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As We Go To Press . . .

Hi-Fi Goes Afloat

New developments in record playing equipment make them suitable for the music-loving small boat skipper, reports the Inst. of High Fidelity Manufacturers.

Previously, the rolling motion of the boat would send tone arms skidding across the record. This problem has now been solved. A new type of tone arm has the ability to play records at a slant. No matter which way the turntable tilts, these arms keep on tracking without skipping a beat or groove. They will even play upside down. An ingenious interplay of spring tension and counterweight keeps the needle pressure on the record constant regardless of the angle of the gravitational pull.

WEATHER INFORMATION

Burroughs S203 electrostatic teleprinter prints-out live weather information at 857 words per min. Meteorological information comes

from more than 600 observation points throughout U. S. and Canada. Info goes to some 2,400 subscribers within minutes. Engineer is R. N. Westley of Burroughs Corp.

Microwave System

A seven-station microwave system is being installed by RCA for the Indiana & Michigan Electric Co's. new Breed generating plant near Fairbanks, Ind. The 2,000 MC system will cover approximately 200 miles. The link will carry six channels of RCA multiplex equipment, providing circuits for telemetering, telephone, and VHF radio control.

Data Processing System Delivered to Air Force

One of the largest data processing systems ever built has been delivered to the Air Force by Melpar, Inc. FINDER can store up to 31.5

million bits of information, correlate and analyze military data, prepare printed reports, charts and graphs, and display on large TV type screens, visual material in five colors. Its four individual subsystems can operate simultaneously and independently of one another.

FINDER contains a modified Burroughs 220 General Purpose Computer, and 89 racks and consoles of special purpose data processing equipment designed by Melpar. With the exception of the 220 computer, the system is completely transistorized.

The total complement of approximately 17,000 printed circuit boards contains 45 circuit types and 80,000 transistors. Overall power requirements are some 275 kva.

New Sale-Leaseback Plan

Electrical and electronic companies can now sell their existing plant and equipment and immediately lease it back for terms of from three to 12 years. The plan by Nationwide Leasing Co., 11 South La Salle St., Chicago 3, Ill, is designed specifically for firms which have an over-large investment in fixed assets and whose growth, as a result, is being hampered by tight working capital.

It will be possible for selected electrical and electronic firms to sell, for cash, fully or partially depreciated equipment at greater-than-book-value and lease it back. Custom-built equipment is included, and no security deposit is required. The minimum amount which will be considered under the plan is $25,000. There is no maximum.

Bus Communications

General Electric Co. will install four base stations and supply 584 mobile units to the Niagara Frontier Transit System, Inc., at Buffalo, N. Y. The equipment will operate on four low-band frequencies assigned by the FCC. Dispatchers will be able to reach the operator of every bus on the streets, and to give immediate instructions in the event of traffic delays, unexpected accumulations of passengers, or mechanical difficulties. Also, bus operators can now report difficulties to the dispatcher, without leaving the bus.

Psychology in Industry

Some corporations are now using psychology to protect expensive electronic equipment. Pressure-sensitive labels created by Paramount Paper Products Co. are now in use in many plants throughout the country. The labels read, "The replacement cost of this machine is $——. Use it with care." Observers say the result of placing the label on the item is invariably the same—it is treated with heightened respect by its operator. Repair and maintenance costs fall, and time lost by breakdowns is cut drastically.

TRACKING ANTENNA

Portable microwave tracking antenna has handwheels for manual tracking in Azimuth and Elevation. Model shown has parabolic

antenna for operation at 1680 MC ± 50 MC with gain of 22db over half wavelength dipole and 10° beamwidth. Automation Dynamics is maker.

PRODUCTION QUANTITY TI SIL

MAXIMUM 12 nsec t_{on}

MAXIMUM 40 nsec t_{off}

$V_{CE(sat)}$ PRACTICALLY INSENSITIVE TO TEMPERATURE... CONSTANT 1 VOLT FROM −55 to +170°C

The fastest silicon switcher in the industry! Design today with Texas Instruments new 2N743 and 2N744 silicon epitaxial transistors and get *two-times faster switching than possible from any other commercially available silicon transistor!* This outstanding new epitaxial series gives you an optimum combination of ultra-fast switching times, temperature-stable R_{CS}, very low collector capacitance, and high f_T, to make the 2N743 and 2N744 *ideal for application in current ranges from 1 to 100 ma.*

Utilize the low R_{CS}/high current characteristics of these new epitaxial units to *replace large size medium-power transistors* and cut your overall switching times as much as two-thirds. Cut cost and reduce the complexity of your NOR logic designs with the new TI 2N743 series — these new epitaxial units give you a guaranteed I_{CEX} of 30 μa at a V_{CE} of 10 volts and V_{BE} of 0.35 volts to eliminate additional circuits previously required for an I_{B2} turn-off source in your computing systems.

Apply the new 2N743 and 2N744 to your designs today and get *guaranteed d-c betas at three current levels.* The 2N744 gives you a guaranteed h_{FE} of 20 at 1 and 100 ma and a 10-ma beta spread of 40 to 120, while the 2N743 features a minimum h_{FE} of 10 at 1 and 100 ma, and 60 maximum at 100 ma.

New TI 2N743 and 2N744 silicon epitaxial transistors are immediately available from distributor stocks or in mass production quantities at prices competitive with conventional silicon mesa and micro-alloy transistors.

Compare the 2N743 and 2N744 with conventional transistors!

Parameter	Approx. Test Conditions	TI 2N743	TI 2N744	2N834	2N706B	2N708
T_s(nsec)	$I_{B(1)} = -I_{B(2)} = I_C = 10$ ma	14	18	25	25	25
t_{on}(nsec)	$I_{B(1)} = 3$ ma, $I_{B(2)} = -1$ ma, $I_C = 10$ ma	11 (TYP)	10 (TYP)	35	40	35
t_{off}(nsec)		22 (TYP)	25 (TYP)	75	75	75
t_{on}(nsec)	$I_{B(1)} = 40$ ma, $I_{B(2)} = -20$ ma, $I_C = 100$ ma	12 6 (TYP)	12 6 (TYP)	NO SPEC	NO SPEC	NO SPEC
t_{off}(nsec)		40 18 (TYP)	45 23 (TYP)	NO SPEC	NO SPEC	NO SPEC
$V_{CE(sat)}$	$I_B = 1$ ma, $I_C = 10$ ma, $T_A = +170$°C	0.35 v	0.35 v	No High Temp. Guarantee (0.19 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)
I_{CEX}	$V_{CE} = 10$ v, $V_{BE} = +0.35$ v, $T_A = 100$°C	30 μa	30 μa	No Guarantee	No Guarantee	10μa (MAX.) @$V_{BE} = +0.25$, $V_{CE} = 20$ v, $T_A = +125$°C

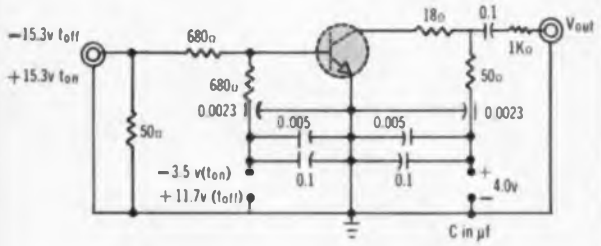
NOTE: All limits are max. unless otherwise noted.

ICON EPITAXIAL TRANSISTORS

@100 ma

MAKE YOUR OWN COMPARISON FROM THESE TYPICAL CIRCUITS

50-ma SWITCHING CIRCUIT



USE THE TI 2N743 TO SWITCH IN 1/3 THE TIME!

2N706

t_{on} = 10 nsecs
t_{off} = 50 nsecs
60

2N743

t_{on} = 7 nsecs
t_{off} = 15 nsecs
22

USE THE TI 2N743 TO DOUBLE POWER OUTPUT AND EFFICIENCY!

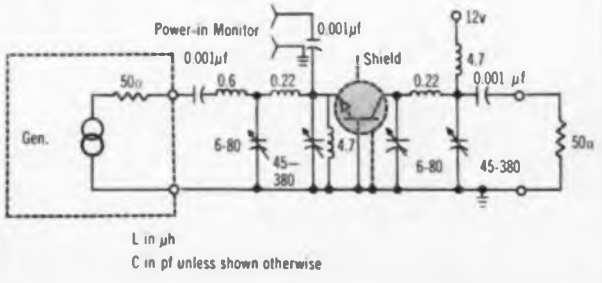
2N706

Pout = 225 mw
Eff = 32%
P.G. = 6 db

2N743

Pout = 500 mw
Eff = 65%
P.G. = 6 db

70-mc POWER AMPLIFIER



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other *Certified* disc types available

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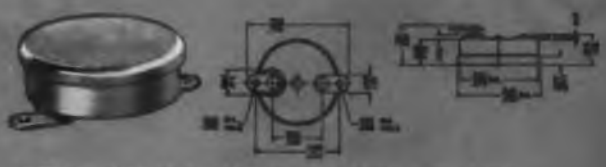
1° to 4°F Differential Special
**Maximum spread of 6°F including differential and tolerance*



***6°F is difference between maximum open and minimum close**

Coming Events in the electronic industry

May 1-3: 12th Annual Appliance Tech. Conf., Domestic Appliance Comm., AIEE; Kentucky Hotel, Louisville, Ky.

May 1-4: 7th Annual Aero-Space Instrumentation Symp. North Texas Section, ISA; Dallas, Texas.

May 2-3: 33rd Annual Mtg. of Lead Industries Assoc., LIA; Drake Hotel, Chicago, Ill.

May 2-4: Industrial Waste Conf., Purdue Univ., West Lafayette, Ind.

May 2-4: 6th Biennial Midwest Electrical Industry and Lighting Exp., Electric Assoc. of Chicago, Electrical Maintenance Eng. of Chicago; McCormick Pl., Chicago, Ill.

May 2-4: Electronic Components Conf., IRE(PGCP), AIEE, EIA, WEMA; Jack Tar Hotel, San Francisco, Calif.

May 4: Engineering Applications of Medium sized Digital Computer, Univ. of Vermont, AIEE; Univ. of Vermont, Burlington, Vt.

May 4-5: 2nd Natl. Symp. on Human Factors in Electronics, IRE-(PGHFE); Marriott-Twin Bridges Hotel, Arlington, Va.

May 4-5: Spring Textile Conf., AIEE; Heart of Atlanta Motel, Atlanta, Ga.

May 4-7: Convention of the American Women in Radio & Television, Inc.; Statler Hilton Hotel, Washington, D. C.

May 5: Midwestern Regional Mtg., SAME; Detroit, Mich.

May 6-9: 5th Midwest Symp. on Circuit Theory, IRE; Univ. of Ill., Urbana, Ill.

May 6-10: Mtg. of the Electrochemical Society, Inc.; Statler Hotel, Los Angeles, Calif.

May 7-11: 42nd International Conf. & Office Exp., NOMA; Sheraton-Jefferson Hotel & Kiel Auditorium, St. Louis, Mo.

May 7-11: 39th Annual Conv. & Broadcast Eng'g. Conf., NAB; Shoreham & Sheraton Park Hotels, Washington, D. C.

May 7-12: 89th Conv. of the Society of Motion Picture & TV Engrs., SMPTE; King Edward Sheraton Hotel, Toronto, Canada.

May 8-10: 13th Annual Natl. Aero-Space Electronics Conf. (NAECON), PGANE & Dayton Section of the IRE; Biltmore & Miami Hotels, Dayton, Ohio.

May 8-10: 4th Natl. ISA Power Instrumentation Symp.; LaSalle Hotel, Chicago, Ill.

May 9-11: Power Sources Symp., U. S. Army (Signal Corps R & D Labs.); Shelburne Hotel, Atlantic City, N. J.

May 9-11: Eastern States Show, Material Handling Institute: Convention Hall, Phila. Penna.

May 9-11: Western Joint Computer Conf., IRE(PGEC), AIEE, ACM; Ambassador Hotel, Los Angeles, Calif.

May 9-11: Electronic Components Conf., IRE; San Francisco, Calif.

May 10-12: Mtg. of the Society for Experimental Stress Analysis; Benjamin Franklin Hotel, Phila., Pa.

May 10-12: Production Engineering Conf. & Show, ASME; Royal York Hotel, Toronto, Canada.

May 10-12: Pulp and Paper Instrumentation Symp., ISA; Northland Hotel, Green Bay, Wisconsin.

May 11-12: Annual Mtg. American Institute of Chemists; Statler Hotel, Washington, D. C.

May 11-13: Mtg. American Radium Society: Colorado Springs, Colo.

May 11-13: Spring Mtg. of the Acoustical Society of America; Bellevue-Stratford Hotel, Phila., Penna.

May 12: Mtg. of the Electronic Representatives Assoc. Exec. Comm. & Natl. Board of Governors; Conrad Hilton Hotel, Chicago, Ill.

May 12-13: Ill. Section Mtg. of the MAA; Univ. of Illinois, Urbana, Ill.

May 15-16: Packaging Industry Conf., AIEE; New Ocean House, Swampscott, Mass.

May 15-16: Annual Mtg. of the Society of American Military Engineers; Mayflower Hotel, Washington, D. C.

May 15-17: Natl. Symp. on Microwave Theory & Techniques, IRE (PGMTT); Sheraton Park Hotel, Washington, D. C.

May 17-19: North-eastern District Mtg. of the AIEE; Statler Hotel, Hartford, Conn.

May 17-21: Intl. TV Symp. as part of the 1st International Festival of TV Arts and Sciences, International Telecommunication Union; Montreux, Switzerland.

May 18: Tour of Environmental Facilities, IES (N. Y. Metropolitan Chapter); Brooklyn Navy Yard, N. Y.

May 18-20: Annual Board Mtg. of the Penna. Society of Prof. Engineers, Pittsburgh Hilton Hotel, Pittsburgh, Penna.

May 19-20: Design and Drafting Seminar, American Institute for Design and Drafting; Oklahoma State Univ., Stillwater, Okla.

May 19-June 4: British Trade Fair; Sokolniki Park, Moscow, USSR.

May 22-24: Annual Conv. and Exp. of the American Society for Quality Control; Sheraton Hotel, Phila., Pa.

May 22-24: Natl. Telemetering Conf., IAS, IRE, AIEE, ARS, ISA; Sheraton-Towers Hotel, Chicago, Ill.

May 22-24: 5th Natl. Global Communications Symp. (GLOBECOM V), IRE(PGCS), AIEE; Sherman Hotel, Chicago, Ill.

May 22-24: Electronic Parts Distributors Show; Conrad Hilton Hotel, Chicago, Ill.

May 22-25: Design Engineering Show & Conf., ASME; Cobo Hall, Detroit, Mich.

(Continued on page 16)

"CALL FOR PAPERS"

The East Lansing Symposium on Engineering Writing and Speech, Oct. 16-17, Kellogg Center for Continuing Education, Michigan State University, East Lansing, Mich. Papers to deal with the theme "Communicating Ideas—The Modern Engineer's Function." Deadline date for papers: 500 word summary—July 15, 1961. Forward papers to: J. D. Chaplin, Program Chairman, Philco Corp., 3900 Welsh Rd., Willow Grove, Penna.

International Symposium on Aerospace Nuclear Propulsion, Las Vegas, Nev., Oct. 23-26, 1961. Deadline date for papers: rough draft and 500 word abstract by July 1, 1961. Forward to: P. M. Uthe, University of California, Lawrence Radiation Laboratory, Box 808, Livermore, Calif.

1962 Winter General Mtg., New York City, January 28-Feb. 2, 1962, American Institute of Electrical Engineers, Computing Devices Comm., Computer Systems Subcomm. Subject: "Kilomegacycle Computing Systems." Deadline for papers: 100 word abstract and 500 word informal summary, July 1, 1961. Forward papers to: J. H. Wright (Papers Chairman) Division 12, U. S. National Bureau of Standards, Washington 25, D. C.

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Position_____

Company_____

Address_____

City_____ State_____

Coming Events

(Continued from page 15)

May 22-26: Engineering Conf. & Exhibit, ASTME; New York Coliseum & Statler Hotel, New York, N. Y.

May 22-26: Natl. Conf. of the Society of Photographic Scientists & Engineers, SPSE; Arlington Hotel, Binghamton, N. Y.

May 23: Fractional Horsepower Motors Conf., AIEE; Biltmore Hotel Dayton, Ohio.

May 23-25: Symp. on Large Capacity Memory Techniques for Computing Systems, ONR (Information Systems Branch); Dept. of Interior Auditorium, Washington, D. C.

May 24-26: 37th Annual Conf., Electronic Industries Assoc.; Pick-Congress Hotel, Chicago, Ill.

May 25-26: Mtg. Operations Research Society of America; Sheraton-Blackstone Hotel, Chicago, Ill.

May 26-29: Southwestern Div. Conv. of the American Radio Relay League, ARRL; Westward Ho Hotel, Phoenix, Arizona.

May 30-June 2: Electronic Components Show; Grand Hall, Olympia, London, W. 14, England.

May 31-June 2: 7th Annual Radar Symp., Institute of Science and Technology; Univ. of Mich., Ann Arbor, Mich.

May 31-June 2: Frequency Control Symp., U. S. Army (Signal Corps R & D Labs.); Shelburne Hotel, Atlantic City, N. J.

Abbreviations

ACM—Association for Computing Machinery
AIEE—American Institute of Electrical Engineers
ARRL—American Radio Relay League
ARS—American Rocket Society
ASME—American Society for Mechanical Engineers
ASTME—American Society of Tool and Manufacturing Engineers
EIA—Electronic Industries Association (formerly RETMA)
IAS—Institute of Aerospace Sciences
IES—Institute of Environmental Sciences
IRE—Institute of Radio Engineers
ISA—Instrument Society of America
LIA—Lead Industries Association
MAA—Mathematical Association of America
NAB—National Association of Broadcasters
NOMA—National Office Management Association
ONR—Office of Naval Research
PGANE—Professional Group on Aeronautical & Navigational Electronics
PGCP—Professional Group on Component Parts
PGCS—Professional Group on Communications Systems
PGEC—Professional Group on Electronic Computers
PGHF—Professional Group on Human Factors in Electronics
PGMTT—Professional Group on Microwave Theory & Techniques
SAME—Society of American Military Engineers
SMPTE—Society of Motion Picture & TV Engineers
SPSE—Society of Photographic Scientists & Engineers
WEMA—Western Electronic Manufacturers Association

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saturated logic switching

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MEDIUM h_{FE}

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HIGH h_{FE}

• Low V_{CE} (sat) • Low T_s • High Power • High Current

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TECHNICAL DATA								
TYPE	V_{CBO}	V_{CER}	V_{CEO}	V_{EBO}	h_{FE}*	V_{CE}(sat)*	T_s max.*	Pkg.
2N919	25	20	15	5	20-60	.2	25 ns	TO-18
2N920	25	20	15	5	40-120	.2	25 ns	TO-18

NOTE: GUARANTEED 15 ns Max. T_s available in both types. Specify "A" versions.
*See data sheet for exact test conditions.

Phone, wire or write a nearby PSI field office for full details, delivery schedules and quantity prices.

Off-the-shelf delivery from PSI distributors everywhere.

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• Low V_{CE} (sat) • High Current • Fast Switching • Controlled h_{FE}

TRIPLE DIFFUSED MESA CONSTRUCTION

TECHNICAL DATA

TYPE	V_{CBO}	V_{CER}	V_{EBO}	h_{FE}*	$V_{CE(sat)}$* max	t_{on} typ.*	P_C 25°C	Pkg.
PT600	60	45	4	15-45	1.0	40 ns	13w	TO-8
PT601	60	45	4	30-90	1.0	30 ns	13w	TO-8

*Measured at 1 Amp collector current. See data sheet for exact conditions.

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NEW ONE-WATT
Vitreous-Enameled Resistor
With Axial Leads

Lots of people thought this tiny "1-watter" was impossible. But here it is. And for the first time in this power rating, circuit designers can get all the advantages of a wire-wound, vitreous-enameled resistor with axial leads—high temperature operation, up to 350°C; ±5% tolerance; low temperature coefficient; low "noise" level; stability; and sfrong, welded construction.

Construction is the same as Ohmite's 3, 5, and 10-watt sizes—including ceramic core, uniform winding, tough Ohmite vitreous enamel coating, and traditional Ohmite reliability.

Resistance values range from 1 to 6000 ohms. But you can find out all about this *exclusive* Ohmite development by writing for *Bulletin 147F. Do it now!*

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Tantalum Capacitors Tap Switches
Relays R.F. Chokes
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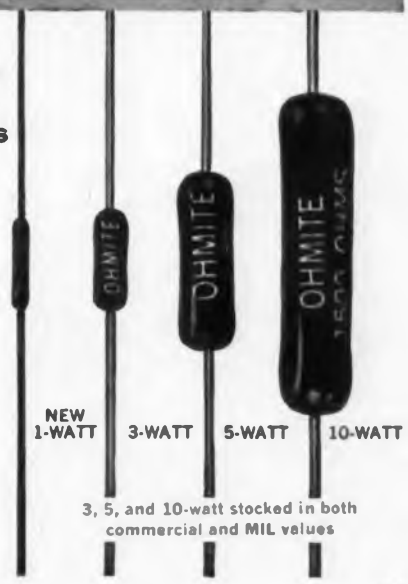
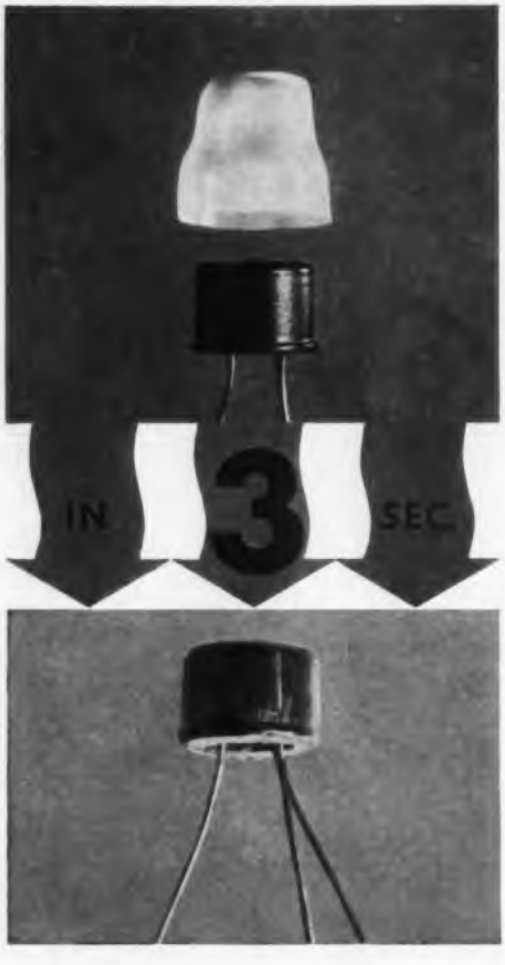


3, 5, and 10-watt stocked in both commercial and MIL values



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News Briefs

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

EAST

RADIO CORP. OF AMERICA will add a 3-story wing to their David Sarnoff Research Center in Princeton, N. J. It will accommodate additional laboratories needed for an expanding program of research in electronically active materials.

BURNELL & CO., Inc., Pelham, N. Y., has acquired a fixed assets, inventory and name of Gray & Kuhn, Inc., Westbury, N. Y., manufacturer of delay lines, from IMC Magnetics Corp.

DOUGLAS MICROWAVE CO., INC., Mt. Vernon, N. Y., has purchased the Eli-Ron Electronics Co., Brooklyn, N. Y. Eli-Ron will be known as the Turotron Corp., a division of Douglas. Turotron will design and manufacture an expanded line of toroidal components, magnetic amplifiers and related components, as well as wave filters, static inverters and high precision decade inductors.

MELPAR, INC., has been awarded a $1.7 million Navy contract to product two operational flight trainers for the A4D-2N weapon system. This will make a total of 6 such systems built by Melpar for the Navy.

McLEAN ENGINEERING LABS., Princeton, N. J., has just completed a new wing to their present building. The wing will permit expansion of the company's research and development departments.

PHILCO CORP.'s new suburban Research Center in Blue Bell, Pa., is now complete. Formal dedication ceremonies are planned for late Spring.

GENERAL ELECTRIC's MSVD's new Valley Forge Space Technology Center planned investment has been increased to about $30 million. Construction has been speeded up and the size of the facilities expanded.

ITT FEDERAL LABS has received an additional USAF contract for radio transmitting equipment to guide aircraft and missiles linked to the nation's SAGE warning network. This brings the Nutley firm's total commitments to the SAGE program to $13 million.

KEYSTONE ELECTRONICS CO., Newark, N. J., has announced that they have recently been awarded several contracts for an undisclosed sum by Raytheon Mfg. Co. Contracts are for the development of filters on the Mauler Missile Program.

MILGO ELECTRONIC CORP., Miami, Fla., will be delivering highly flexible instrumentation for NASA's Wallops Island launching facility this Spring. The material will be delivered under a $705,000 prime contract with NASA.

LABORATORY FOR ELECTRONICS, INC., has taken the first step in a planned, 8-year facilities expansion program with the acquisition of a 115-acre site on Route 128 in Danvers, Mass. Immediate plans call for construction of a 60,000 sq. ft. R&D facility on this land.

NAVIGATION COMPUTER CORP., Norristown, Pa., has formed a new Special Products Div. so that their experience with etched-circuit packaging can be made available to industry.

ELECTRO-TEC CORP., So. Hackensack, N. J., has been awarded $280,000 contract for platter-type slip ring assemblies to be used in radar antennas (AN/SP26) being built for the Air Force by the AVCO Mfg. Corp.

GENERAL PRECISION, INC., Link Div., has been awarded two new contracts, totaling more than $6 million from the Air Force. One contract from the Air Material Command calls for the delivery of flight simulators for pilot training for the C-130 Cargo Transport. The second contract provides for development and manufacture of a new visual simulation system to be attached to Air Force simulators for modern types of aircrafts.

THE MAGNAVOX CO. enters the electronic organ field in July. The organs will be fully transistorized and in the popular price range. The company says that the sale of organs has increased 20% per year since 1955 and has now reached an annual retail sales mark of $185 million.

THE RAYTHEON CO. has been awarded a Navy contract for $28,177,129 for added production of the Sparrow III air-to-air supersonic missile system. Work on the contract will be performed at the firm's Aero/Weapons Div. plants in Lowell, Mass., and Bristol, Tenn.

WESTINGHOUSE ELECTRIC CORP., Pittsburgh, Pa., has received a contract for $7.3 million for the development and production of the weapon direction equipment for the Navy's Typhon weapon system. The contract is said to be unique, in that it covers the first integrated shipboard radar and armament control system to be produced for the Navy by a single company.

MIDWEST

THE VICTOREEN INSTRUMENT CO., Jordan Electronics Div., has received $434,389 contract from Sperry Rand Corp. for additional guidance power supplies for the U. S. Army's Sergeant guided missile system.

REMINGTON RAND, Univac Military Dept., St. Paul, Minn., has received a letter contract for $5,534,526 for the production of additional computer systems for the recently announced Naval Tactical Data System (NTDS).

CLEVITE CORP., Cleveland, has announced an agreement with Centralab, the Electronics Div. of Globe-Union Inc., Milwaukee, granting rights under Clevite patents in lead zirconate-lead titanate, piezoelectric elements.

AMPHENOL-BORG ELECTRONICS CORP., Broadview, Ill., and **FXR, INC.,** Woodside, N. Y., announced an agreement "in principle" for the merger of FXR, Inc., into Amphenol-Borg. The proposal will be submitted to stockholders of both companies this month.

OAK MFG. CO., Crystal Lake, Ill., has acquired McCoy Electronics Co. of Mt. Holly Springs, Pa., producers of quartz crystals and filters. Acquisition of McCoy is being made through cash purchase, although the price was not disclosed.

COLLINS RADIO CO., Cedar Rapids, Ia., has received a $524,000 letter contract award to supply the U. S. Air Force with HF-101 airborne communication transceivers and accessories.

TELEX, INC., St. Paul, Minn., has received initial orders from three major computer customers for their Telex I Mass Memory Module. Schedule calls for delivery this year. Amount of the orders was not disclosed.

THE EMERSON ELECTRIC MFG. CO., has established a new Industrial Electronics Div. to design and manufacture a broad range of precision electronic control devices and systems for industry.

WEST

LITTON INDUSTRIES has acquired Hopkins Engineering Co. of San Fernando, Calif. Hopkins manufactures microminiature capacitors and radio interference filters. The purchase is being made with an undisclosed amount of Litton stock.

TEXAS INSTRUMENTS INCORPORATED has been awarded two contracts totalling more than $600,000 by Minneapolis-Honeywell for the development and production, by the Apparatus Div., of electronic flight controls for use in Martin Co.'s TITAN intercontinental ballistics missile and Chance Vought Corp.'s SCOUT research vehicle.

VARO MFG. CO., INC., Garland, Tex., and **D&R LTD.,** Santa Barbara, Calif., have announced the agreement between management of their companies for the sale of all assets of D&R Ltd. to Varo, Inc., for an undisclosed amount of Varo stock.

THE BENDIX CORP., N. Hollywood, Calif., has received a $1.3 million follow-on production order from Convair-Pomona Div. for electronic portions of Terrier missile guidance system.

HUGHES AIRCRAFT CO., Culver City, Calif., has made available to private industry their complete instrument calibration laboratory. The company was encouraged to take the step because of the increasingly stringent standards of accuracy being imposed on manufacturers by the demands of the space age.

HOFFMAN ELECTRONICS CORP., Los Angeles, has received a new contract valued at approximately $1.25 million. Contract is for the delivery of an additional quantity of submarine radio transmitters. This new order increases the value of the total orders received to date on this program to approximately $7.75 million.

PACIFIC SEMICONDUCTORS, INC., received a report made by the American Bosch Arma Corp. indicating that only one of their diodes failed in 150 million hours of diode operation.

MIDWESTERN INSTRUMENTS, Tulsa, Okla., has received an order for $750,000 worth of oscillographs to be used in Lockheed's "MADREC" program.

AERONUTRONIC DIV., FORD MOTOR CO., Newport Beach, Calif., has received a $5,361,619 contract from the U. S. Army for the continuation of the development of the still-secret Shillelagh missile. This new award brings the current contract total on this missile program to $20,099,739.

AMERICAN SYSTEMS INC., an affiliate of Schlumberger Well Surveying Corp. of Houston, Tex., has completed the acquisition of the Instrument Div. of Micro-Path Inc.

EITEL-McCULLOUGH, INC., has received a $432,000 order from the Aerospace Div. of Ryan Aeronautical Co. for traveling-wave tubes. The tubes will be used for the Q-2C Firebee target drone. The tube will make it possible for the Firebee, a pilotless radio-controlled drone, to appear as large as a B-52 on the radar screen of the nation's defense team. It will simulate a large enemy bomber and serve as a target.

CANNON ELECTRIC CO., Los Angeles, has announced that a license agreement between their company and New Twist Connector Corp. of Santa Monica, Calif., has been signed. Under the agreement Cannon is authorized to manufacture and use a new form of twisted-wire pin contact developed by New Twist.

FOR MILITARY REQUIREMENTS

BE SURE OF MAXIMUM RELIABILITY...SPECIFY PHILCO TRANSISTORS

Look to the pioneer producer of ***many millions of Military transistors*** for your critical applications. Philco has been the symbol of reliability from one of the industry's first JAN types (2N128) to the present broad Military line.

The enviable record of ultra-reliable performance has resulted in the use of Philco transistors in many Military programs. The following types are available to existing Military specifications:

TYPE NO.	APPLICATION	MILITARY SPEC. NO.
2N128	High frequency amplifier	MIL-T-19500/9A
2N240	High speed switch	MIL-S-19500/25A
2N393	High speed switch	MIL-S-19500/77A (Sig C)
2N495	Medium frequency amplifier (Silicon)	MIL-T-19500/54A (Sig C)
2N496	Medium speed switch (Silicon)	MIL-S-19500/85 (Sig C)
2N499	VHF amplifier	MIL-S-19500/72A (Sig C)
2N501A	Very high speed switch	MIL-T-19500/62 (Sig C)
2N502A	VHF amplifier	MIL-S-19500/112 (Sig C)
2N599	Medium speed switch	MIL-S-19500/166 (Navy)
2N1118	Medium frequency amplifier (Silicon)	MIL-S-19500/138 (Sig C)
2N1119	Medium speed switch (Silicon)	MIL-S-19500/139 (Sig C)
2N1158A	VHF oscillator	MIL-S-19500/113 (Sig C)
2N1199A	High speed switch	MIL-S-19500/131 (Sig C)
2N1200	HF amplifier (Silicon)	MIL-S-19500/105 (Sig C)
2N1201	HF amplifier (Silicon)	MIL-S-19500/101 (Sig C)
2N1411	High speed switch	MIL-S-19500/133 (Sig C)
2N1499A	High speed switch	MIL-S-19500/170 (Sig C)
2N1500	Very high speed switch	MIL-S-19500/125 (Sig C)

For information on any of the above types, write Dept. EI561.

PHILCO®

Famous for Quality the World Over

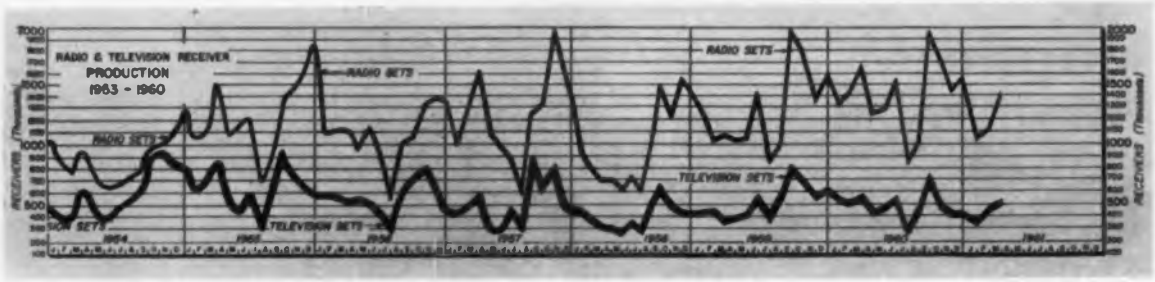
LANSDALE DIVISION • LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

Circle 12 on Inquiry Card

Facts and Figures Round-up
May 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 January, 1961.

Amplifiers	411,751
Antenna Multicouplers	394,600
Antennas	96,752
Antenna Systems	84,459
Attenuator	39,000
Batteries	1,645,288
Beacons	386,503
Cable	250,606
Calibrator, Instrument	25,551
Capacitors	587,188
Coil Assembly	26,568
Communication Equipment	583,601
Computer, Digital Artillery	210,491
Connectors	29,000
Control Set	524,858
Converters	594,000
Coordinate Data Set	565,200
Discriminator System	58,345
Echo Box	83,655
Echo Sounder, Special Purpose	102,850
Filters	46,610
FM/FM System	40,520
Gyroscope	1,019,031
Handset	115,735
Hydrophones	46,875
Meters	490,426
Microphone	400,826
Oscillators	71,404
Phase Shifter	26,936
Power Supplies	262,560
Radio Direction Finder	1,359,925
Radio	9,466,767
Radiosonde Set	38,165
Radio Transmitting Set	3,040,476
Radar Set	5,232,339
Receiver	232,521
Receiver-Transmitter	160,000
Recorders	303,648
RF Patching System	89,631
Relay Armature	131,571
Relay Assembly	35,063
Resistors	520,217
Semiconductors	122,540
Servos	102,447
Signal Generators	124,405
Spectrum Analyzer	57,492
Switches	185,275
Switching Units, Antenna	78,501
System Analyzer, R.F.	130,000
Tape, Magnetic	273,981
Telemetry Equipment	196,677
Telephone Set	379,500
Terminal, Telegraph	2,506,717
Test and Calibration System	129,889
Test Sets	1,366,894
Tracking System, Infra-red	42,787
Transducers	1,202,250
Transformer	36,000
Transformer Assembly	104,700
Transmitter	273,932
Tube, Electron	4,288,767
Tube, Magnetron	230,985

U. S. DOMESTIC EXPORTS OF SELECTED ELECTRONIC PRODUCTS, ANNUAL 1960 AND 1959

(Value in thousands of dollars)

Commodity Description	1960 p	1959
Radio broadcast transmitting equipment, parts	2,354	3,621
TV broadcast transmitting equipment, parts	3,223	3,441
Radio and TV broadcast audio equipment, parts	1,495	1,463
Television broadcast studio equipment, parts	13,768	9,931
Radio beacon (beam) transmitters, parts	910	1,493
Automobile radio receivers	1,395	1,782
Radio-phono. combinations, without TV	515	916
Radios, home-type, without TV	2,861	4,086
Radio receiver chassis, home-type, without TV	876	935
Television receivers	14,713	17,631
Television receiver chassis	3,968	2,901
Electron tubes, receiving	14,382	14,671
Television camera tubes	1,468	1,682
Television picture tubes	21,304	13,757
CRT's, not elsewhere classified	2,086	889
Parts, accessories for electron tubes	6,796	4,987
Crystal diodes and transistors	15,973	9,148
Capacitors (condensers)	7,570	6,102
Resistors	5,379	4,175
Inductors (also transformers, coils)	4,092	3,970
Loudspeakers	1,646	2,137
Carrier current equipment, parts	1,197	2,628
Audio amplifiers, amplifier systems	2,798	3,317
Amplifiers (except audio frequency), parts	1,695	1,172
Recorders (disc, tape, wire), parts	12,971	10,986
Electronic equipment and parts, not elsewhere classified	44,001	38,613
Coin-operated phonos, new	10,545	11,020
Coin-operated phonos, used, rebuilt	2,025	2,144
Phonos, except coin-operated	2,346	3,108
Phono parts	5,687	6,864
Phono records and blanks	10,682	10,704
Signal generators	6,041	4,651
Test instruments	11,613	7,623
Test instrument parts	18,408	16,955
Electronic computers	38,730	17,055
Parts and accessories for computers	9,019	5,820
Subtotal	304,530	252,378
Special category items:		
Radio communications equipment	94,262	90,691
Electron tubes not elsewhere classified	18,055	13,340
Electronic detection and navigation apparatus not elsewhere classified	49,639	44,316
Total	466,486	400,725

p—Preliminary.

Source: U. S. Department of Commerce, Bureau of the Census.

Acoustical noise: 85 db. at 6 inch distance

For noise at microwave frequencies, too, there's an ideal device in a small package. It's the Litton L-2000 series of miniature gas discharge noise sources. Use them for automatic monitoring of the performance and sensitivity of modern radar systems. They're available to cover the most-used frequency bands and come in a variety of mount configurations.

The series features a shielded cathode, low modulator drain, and field-replaceable tube insert. Rugged. Insensitive to a wide range of ambient temperatures. Compactly engineered for demanding air and ground environments. Economical because of replaceability, plus added advantages of logistic simplicity and ease of maintenance.

BIG NOISE FROM A SMALL SOURCE

The tube pictured here is the single-ended L-2000 with the LR-2000 insert, specified for a recent generation of FAA airport surveillance radars and for a variety of well-known "S-band" military systems.

For more data on these or other precision gas tube products, write Litton Industries, Electron Tube Division, 960 Industrial Road, San Carlos, California. Or telephone LYtell 1-8411.

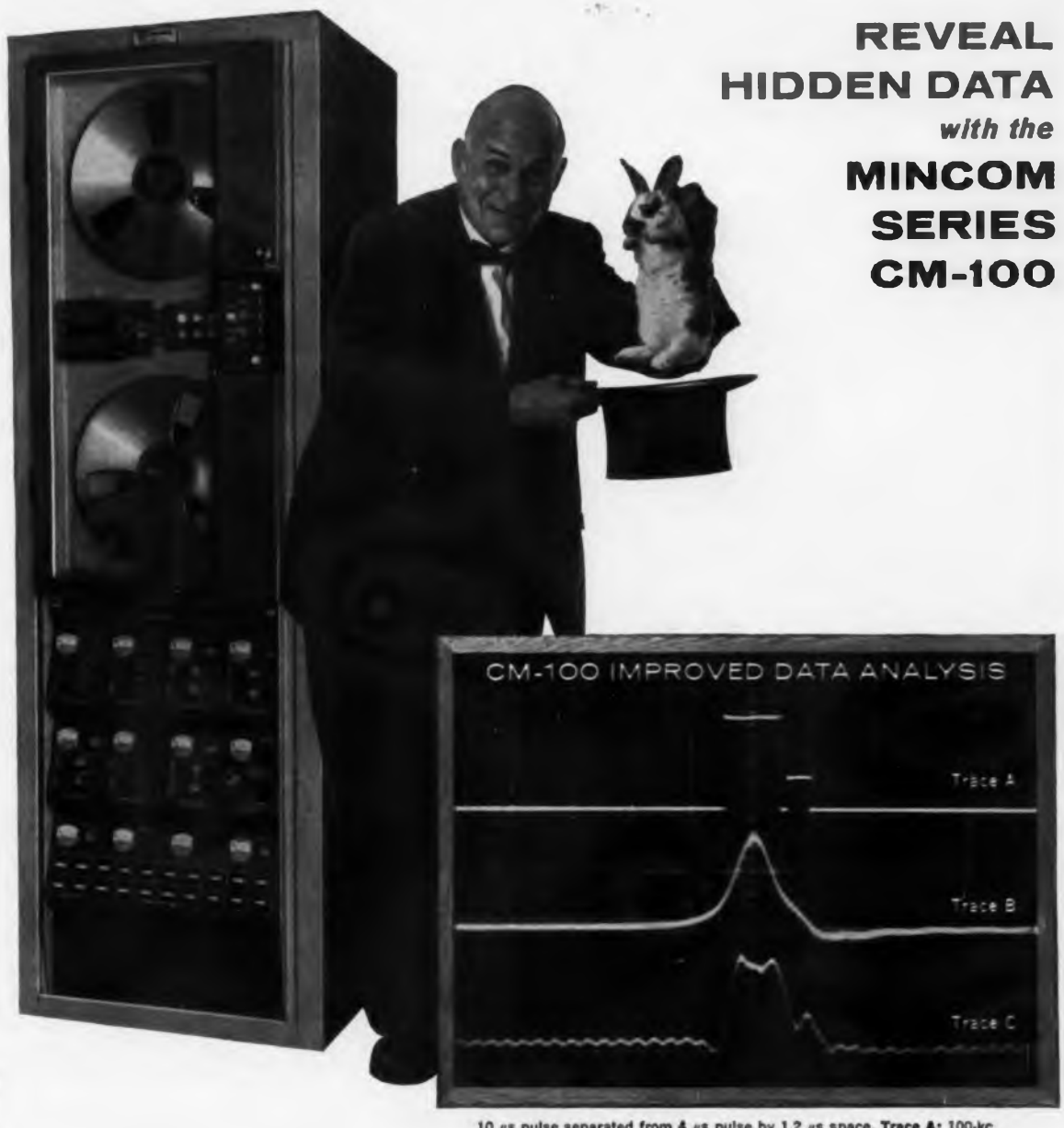
GAS NOISE TUBES

Type Number	Frequency Range (megacycles)	Excess Noise Ratio (db)	Nominal Operating Current (ma)	Nominal Operating Voltage (volts)	RF Coupling
L-2008	200-250	18.5 ± 0.5	25	200	¾" coax*
L-2013	570-630	18.5 ± 0.5	25	200	¾" coax*
L-2006	1200-1400	18.5 ± 0.5	50	175	¾" coax**
L-2000(R)	2700-2900	18.5 ± 0.2	75	30	RG-48/U WG*
L-2018(R)	2700-2900	15.5 ± 0.2	75	35	RG-48/U WG*
L-2011(R)	3300-3700	18.4 ± 0.2	150	30	RG-48/U WG*
L-2009(R)	3400-3700	15.5 ± 0.5	125	20	RG-48/U WG*
L-2007	2000-4000	18.5 ± 0.5	85	135	¾" coax**
L-2010	2000-4000	15.0 ± 0.5	40	60	¾" coax**
L-2001(R)	5400-5900	13.0 ± 0.5	100	55	RG-49/U WG**
L-2002(R)	7500-8600	14.5 ± 0.5	100	40	RG-51/U WG**
L-2003(R)	8500-9600	14.5 ± 0.5	100	45	RG-52/U WG**
L-2004(R)	8500-9600	18.5 ± 0.5	100	45	RG-52/U WG*
L-2017(R)	8970-9190	18.5 ± 0.5	100	45	RG-52/U WG*
L-2005	16000-17000	18.5 ± 0.5	55	55	RG-91/U WG*

(R) denotes replaceable gas tube insert
*single ended mount
**double ended mount

LITTON INDUSTRIES
Electron Tube Division
MICROWAVE TUBES AND DISPLAY DEVICES

REVEAL HIDDEN DATA *with the* MINCOM SERIES CM-100



10 μs pulse separated from 4 μs pulse by 1.2 μs space. **Trace A:** 100-kc system input. **Trace B:** 100-kc output. **Trace C:** CM-100 output. Sweep Rate: 10 μs/cm. Vertical Deflection: .5v/cm.

Pulses recorded on any standard 100-kc system reveal previously undisclosed data when played back on the Mincom Series CM-100 Video Instrumentation Recorder/Reproducer. At 60 ips, a prerecorded tape from a standard 100-kc recorder will present on the CM-100 an improved frequency response of 200-220 kc ± 4 db with a practical limit of 250 kc. CM-100's superior playback heads and phase-compensating electronics produce better rise time, correcting for phase shift and overshoot. This recovery of hidden data is only one of the advantages of the CM-100, a 7 or 14-track 1-megacycle system which is now performing predetection recording/reproducing on an operational basis—in FM, FM/FM modulation, PCM and PCM/FM. Write for specifications.

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

MINCOM DIVISION MINNESOTA MINING AND MANUFACTURING COMPANY

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Snapshots . . . of the Electronic

COMPUTER LOGIC CIRCUIT

Raytheon Company's electronic "Spider" is actually a logic circuit for computers. Three diodes, a coupling network, a transistor and two resistors have been squeezed into an ordinary transistor case.

SPACE-AGE BARGE "PALAEMON"

The Palaemon is shown on its first "shakedown cruise" on the Tennessee River. It will transport the first two stages of the Saturn space vehicle from the Space Flight Center, Huntsville, Alabama to Cape Canaveral, Fla. for its initial flight test later this year.

DOLLAR BILL CHANGER

Machine converts dollar bills into a dollar's worth of nickels, dimes and quarters. Manufactured by the A.B.T. Division of Automatic Canteen Co. of America it accepts only U.S. one dollar bills and rejects all others.

BRIGHTER TV PICTURE TUBE

A rainbow of color is produced on RCA's new color TV picture tube during tests. The 21 inch color tube provides up to 50 per cent brighter pictures with greater sharpness and contrast. It also enhances B&W images.

DIGITAL VOLTMETER

This digital voltmeter by the Cubic Corp. will operate when totally submerged. Developed for use aboard Polaris-firing submarines, it can withstand 50G shock, and will operate in highly volatile atmospheres.

EPITAXIAL CRYSTAL GROWTH

High purity silicon for rapid switching transistors and diodes is grown epitaxially in a special furnace at Sylvania's Semiconductor Device Development Lab, Woburn, Mass.

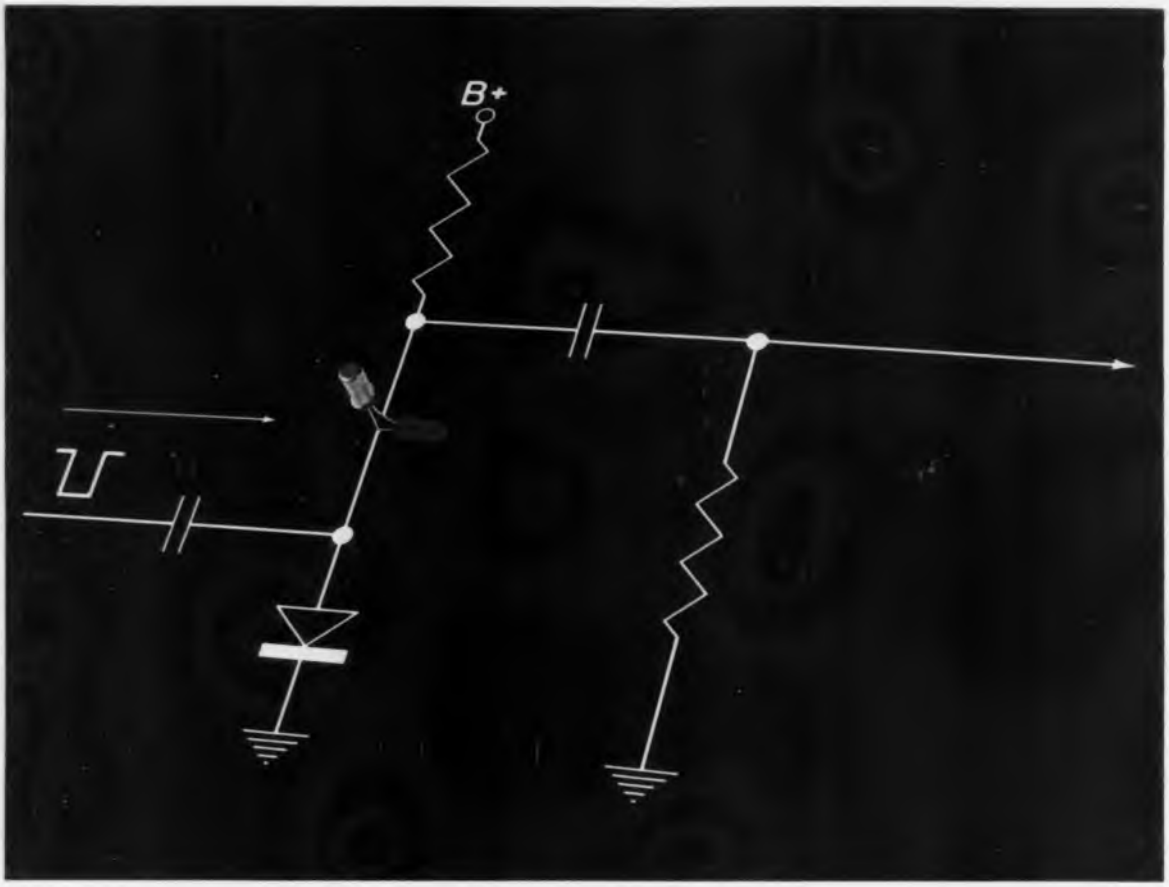
RHENIUM-MOLYBDENUM

A tungsten arc furnace is used to melt Rhenium - Molybdenum alloy compacts into bars. Chase Brass & Copper Co. has announced the first commercial production of the metal.

MILLION DOLLAR CLASSROOM

This trainer (right) serves as an all-weather, non-flying classroom for training CIC crews in the operation of the APS-82 Radar. Made by Huyck Systems Co., it is also used to indicate limitations of the operational equipment under normal combat conditions.

Industries



MORE MEGAWATT CYCLES PER DOLLAR*

The Shockley 4-layer diode offers you a fast, simple method for generating voltages up to 200 volts and pulse currents from 2 amps to 100 amps. Turn on time–just 0.1 μs.

This reliable, solid state device gives you simplicity along with small size, light weight, drastically reduced power consumption and high speed.

These unique advantages make the Shockley 4-layer diode an ideal device for pulse generators, pulse amplifiers, pulse modulators, squib firing detonator circuits, for triggering thyratrons, magnetrons, traveling wave tubes...

Shockley 4-layer diodes have been proved in many, many industrial and critical military applications. If you have a circuit problem involving the fast switching of high power, the advantages and capabilities of the Shockley 4-layer diode could help you solve it. Call your Shockley representative or write for application information.

*Even the smallest Shockley 4-layer diode will handle 2 ampere pulses. (The unit price for 500 Type D diodes is $4.)

Shockley TRANSISTOR

UNIT OF CLEVITE TRANSISTOR

STANFORD INDUSTRIAL PARK PALO ALTO, CALIFORNIA

CLEVITE CORPORATION

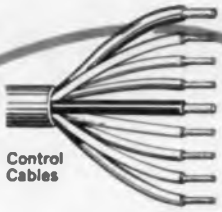

Shielded Power Supply Cables—Rubber


Duplex Connector Extension Cords


Cathode Ray Tube Lead


Miniaturized Cables


Grid Wires


Control Cables


Magnet Wire


Plastic Microphone Cables

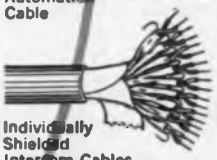

Automation Cable

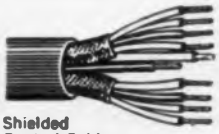

Shielded Interconnecting Cables


Low Impedance Lines


Unpaired Intercom Cables


Audio Cables


Individually Shielded Intercom Cables


Shielded Control Cables


RG/U Transmission Line Cables


Coiled Test Prod Wire


3-Conductor Power Cords


RC/U Cables

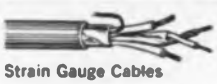

Control Cables


Rubber Microphone Cables


Miniature Audio Cables


Hook-Up Wires


Duplex Primary Wires


Strain Gauge Cables


Call System Cables


Test Prod Wires


2-Conductor Power Cords

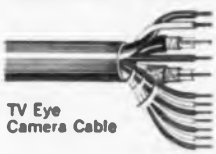

Multiple Pair Cables


Broadcast Audio Cables


PA System Cables


2 & 3 Conductor Extension Cords


Miniature Microphone Cables


TV Eye Camera Cable


Sound & Alarm System Cables


Mil-Spec Wires

Color, Studio, Closed Circuit Camera Cables


75-Ohm Video Cable


Industrial Intercom Wires

Portable Cordage

Coiled Cords

Lamp Cordage

Teflon® Wires
®Du Pont trademark

Shielding & Bonding Cable

Special Sound 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.

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 — CHICAGO

One Wire Source for Everything Electronic and Electrical

• electronic wire • magnet wire • lead wire • power supply cords
• cord sets • portable cordage

8-61

EI's International News

EUROPE

German Airfields Improve Air Safety

Leipzig, Germany — The German Democratic Republic has awarded Pye Telecommunications Ltd., Cambridge, England, a $112,000 contract for electronic equipment. It includes an Instrument Landing System (I.L.S.) for Dresden International Airport and the latest vhf ground-to-air communications equipment for Schoenefeldt airfield and the East German area.

R.S.A.F. Bolsters Air Defense

Stockholm, Sweden—The Royal Swedish Air Force, in an effort to more effectively deploy its fighter aircraft and surface-to-air missiles, is bolstering the electronic equipment in its air defense system. More than $4,760,000 is being spent in the effort.

Marconi Wireless Telegraph Co., Ltd., England, is contractor for a high speed computer system which solves a larger number of interception problems simultaneously, enabling defense weapons to be deployed to best advantage.

ENGLAND

B.O.A.C. Comets Get Marconi Doppler

Chelmsford, Essex—The British Overseas Airways Corp. has elected to equip its fleet of 19 Comets with the Marconi Doppler Navigator, type AD2300A.

Comet captains will now have instrumentation to provide them with instantaneous and continuous information on ground speed, angle of drift and distance flown. This equipment is completely self-contained in the aircraft, and requires no ground stations for operation.

Exhibition of Nuclear Electronics

The Scientific Exhibition on Nuclear Electronics will be held at the Belgrade Fair Grounds, Belgrade, Yugoslavia, from 13 to 21 May 1961 in connection with the Conference on Nuclear Electronics. The purpose of the Exhibition will be to illustrate papers presented at the Conference by means of exhibits and to show advanced nuclear electronic equipment and instruments.

USSR

Automation and Process Control Get Big Push

Los Angeles, Calif.—"The Soviets attach almost as much importance to progress in the iron and steel industry as they do to their missile program," W. E. Miller, Manager of GE's steel mill engineering, told the Association of Iron and Steel Engineers, at its Western meeting.

After an 11 day trip in Russia last summer, and talks with top steel industry engineering management and development engineers, Mr. Miller states, "we had learned with considerable shock the rapid progress Russia has achieved through automation and extreme concentration of effort in this important industry." He went on further, "all indications are, that the USSR has placed its economic future in the hands of the automation and systems engineers."

Posters and signs picture a continually growing Soviet economy and the eventual death of capitalism. "In one instance," he added, "the application and wholehearted acceptance of automation by Soviet workers is pictured as the key to eventual Soviet superiority in the economic race."

BROADCASTING IN ECUADOR

Continental Electronics Sales Manager T. Moseley, left, explains one of the new features of a 10 kw radio transmitter to A. Horvath, Radio Engineer for the Ecuadorian Government, which has purchased two transmitters from the Ling-Temco subsidiary. One transmitter will operate in the standard broadcast band, the other on shortwave.

U.S. Firms Aided in Establishing European Sales Beachhead

Paris, France—Daniel J. Verge, Managing Director of Didot-Bottin, reports U. S. firms are now sending catalogue sheets and pricing data to their newly established Trade Information Bureau. This Bureau is designed to serve European buyers who want to make contact with American suppliers. "This program was established as a result of the survey trip I took to the United States last month," stated Mr. Verge. "We are most gratified at the response and hope that more firms will take advantage of this free offer to register their companies and their products with our headquarters in Paris."

ELECTRONIC CONVERTERS FOR USE IN JAPAN

Japanese engineers being trained to service the 2 electronic converters made by Digitronics Corp. for use in Japan by the Tokyo Electric Power Co. Shown in the photo are — Digitronics Engineer W. Buynak, and Engineers T. Endo and K. Fujita of Nippon Remington Univac, Kaisha, Ltd. The two electronic converters are designed to accommodate both Japanese and English languages.

FAR EAST

Red China Modernizes Radio Manufacturing Industry

Washington — The modernization of Communist China's radio manufacturing industry, including the use of automation and semi-automation in production, is progressing "with great vigor," according to a report containing six articles on radio production in Communist China. The report, which forecasts resultant savings in manpower and sharp increase in production, is one of four translations of foreign technical literature by the Office of Technical Services, Dept. of Commerce, Washington, D. C.

(*Continued on page* 34)

if it's news, expect it first from IRC

now...
a METAL FILM resistor for commercial as well as military applications

You and others in the industry have made increasing performance demands on deposited carbon and other film resistors because metal film has been too costly for many applications.

To continue our leadership as suppliers of precision film resistors, we set an objective—to produce a metal film resistor at a price comparable to deposited carbon resistor. *We have met our objective!*

IRC has invested nearly $2,000,000 in plant, automated equipment and engineering to achieve this new dimension in Metal Film Resistors.

A new technical production breakthrough makes it economically feasible to specify premium performance Metal Film Resistors for commercial as well as military applications.

T-O Metal Film Resistors are available . . . now! Write for Bulletin B-3. International Resistance Company, 401 North Broad Street, Philadelphia 8, Pennsylvania.

MIL-R-10509:

CHARACTERISTIC B—exceeds all requirements.
CHARACTERISTIC C—Meets or exceeds all requirements except for ±50 ppm. T.C.
CHARACTERISTIC D—meets or exceeds all requirements.
CHARACTERISTIC G—meets or exceeds all performance requirements without hermetic sealing.

TEMPERATURE COEFFICIENT: within ±150 ppm.

DESIGN TOLERANCE: approximately 5 times tighter than deposited carbon (MIL-R-10509, Characteristic B) resistors and 20 times tighter than carbon composition (MIL-R-11) resistors.

RESISTANCE TOLERANCE: 0.5% and 1%.

COST: Same as molded deposited carbon resistors.

IRC

Leading supplier to manufacturers of electronic equipment

NEW FROM WESTINGHOUSE AT YOUNGWOOD

New Westinghouse High Gain Transistor simplifies circuitry, increases reliability, eliminates driver stage components, reduces cost of assembly.

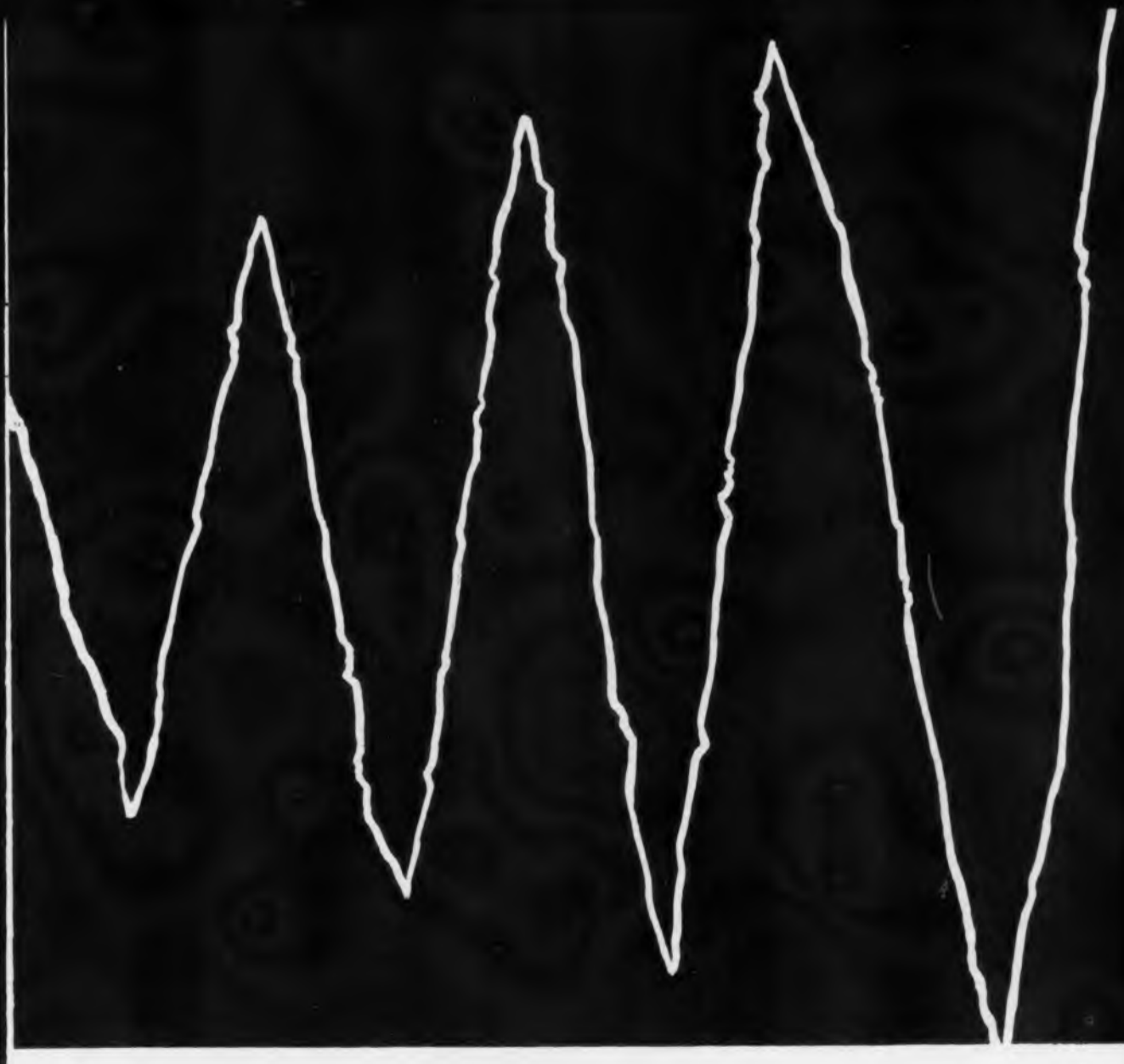
NEW WESTINGHOUSE SILICON POWER TRANSISTOR PROVIDES GAIN OF

Westinghouse introduces a complete new family of High Gain Silicon Power Transistors providing a gain of 1000 or more at 2 amps . . . with guaranteed minimum gain of 400 at 10 amps (WX118X series) . . . a guaranteed minimum gain of 100 at 10 amps (WX118U series). These devices can substantially reduce circuit components, increase reliability, save space and weight.

They're ideal for application in high power, high efficiency regulators, amplifiers and switching circuits. For example, 1500 watts of power can be easily controlled with a 50 milliwatt signal! For full information call your nearest Westinghouse representative or write to Semiconductor Dept., Youngwood, Penna. You can be sure . . . if it's Westinghouse. SC-1025

OTHER FEATURES INCLUDE

- **True Voltage Ratings to 150 volts**
- **Power dissipation of 150 watts**
- **Operating temperature to +150°C.**
- **Low thermal impedance: .5°C/watt**
- **Collector current—10 amperes**



1000 AT 2 amps!

Circle 17 on Inquiry Card

Prototype quantities now available. Order from these Westinghouse Distributors.

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Birmingham 5, Ala./FA 2-0588

CAMERADIO Pittsburgh, Pa./EX 1-4000

CRAMER ELECTRONICS, INC.
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ELECTRONIC WHOLESALERS, INC.
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INTER-STATE RADIO & SUPPLY CO.
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SEMICONDUCTOR SPECIALISTS, INC.
Chicago, Ill./NA 2-8860

S. STERLING CO.
Detroit, Mich./BR 3-2900

UNITED RADIO, INC.
Cincinnati, Ohio/MA 1-6530

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HAMILTON ELECTRO SALES
Los Angeles, Calif./DR 2-9154

NEWARK ELECTRONICS CO.
Inglewood, Calif./OR 4-8440

Westinghouse

Seagoing recorder helps tame the tempest

To poet and pilot alike, the sea is unpredictable. But a long step toward fathoming its mysteries has recently been taken, in the form of an idea which will provide data on the effects of turbulent seas on ship motion. Among the benefits will be the design of hulls and ships better able to meet the challenges of wind and wove.

To help the U.S. Maritime Administration and the David Taylor Model Basin collect data for performing statistical analysis of ship motion, a "Seakeeping Instrumentation System" was designed by Sierra Research Corp. of Buffalo, N.Y. Operating completely unattended for periods of several weeks at a time, the system automatically goes into operation at 4-hour intervals, recording a short run if the weather is calm or a longer run if the weather is rough.

Heart of the system is a 14-channel P.I. instrumentation magnetic tape recorder, capturing such data as wind velocity and direction, ship's heading, roll and pitch, wave height, vertical acceleration, time pulses, and propeller shaft RPM and horsepower. The P.I. recorder was chosen for the system because of its superior reliability — no attention was required during its entire first cruise of four months — and because its compact design involves far less weight, space, and power than conventional recorders.

For details on other P.I. recorders used above and below the sea, check with your local Precision engineering representative or write direct.

S. S. MORMACPRIDE, which gathers data at sea through the automatic, unattended operation of the "Seakeeping Instrumentation System."

Clock, control unit, and recorder mounted in the Gyro Room of the Mormacpride's Bridge Deck.

P.I. Invites inquiries from senior engineers seeking a challenging future.

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1011 Commercial Street • San Carlos • California
Phone LYtell 1-4441 • TWX: SCAR BEL 30

REPRESENTATIVES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

International News

(*Continued from page* 30)

Agreements

The Itek Electro-Products Co.'s line of Hermes crystal filters will be manufactured and marketed internationally by Toyo Communication Equipment Co., Ltd., Kawasaki, Japan, under an agreement that will run for 7 years.

Micro Balancing, Inc., New York, has completed negotiations with Shoshin Shoji Kaisha, Ltd., to market Micro's line of Dynamic Balancers in Japan.

CANADA

Most Powerful Low-band TV Will Be Built in Canada

Montreal, Canada—The most powerful low-band television transmitter in North America will be built at CBC's CBXT-TV in Edmonton. The station will be capable of broadcasting with an effective radiated power of 318 kw, double of any low-band station (covering Channels 2 to 6) in Canada, and three times as powerful as any in the U. S. The location of CBXT-TV is such that it is outside the 250 mile limit, for low-band power of 100 kw, of the U. S.-Canadian border. The new station is scheduled to go on the air Sept. 1st.

CENTRAL AMERICA

Mexican Business Climate Improving

Berkeley, Calif.—The business climate in Mexico may be in for a marked improvement chiefly because of changing attitudes among some top governmental officials. That's the view of Forrest Englehart, northern California businessman and President of Automatic Plastic Molding Co., Berkeley, Calif., who just returned from an extended business trip south of the border.

Despite a "Mexicanization" policy which insists that all business be at least 51% owned by Mexican nationals, President Adolfo Lopez Mateos is known to be favorable to joint U. S.-Mexican ventures, particularly in light manufacturing. One inducement is, basic companies not operating before in Mexico are there now, and turning out a broad range of raw materials. Availability of these materials in Mexico at low cost is a big plus because of the avoidment of tariffs. Another inducement is the ever increasing availability of technically trained workers at a lower cost than in the U. S.

Because Government officials are much easier to get to than before, and red tape is cut to a minimum, the "climate" seems to be changing in Mexico.

THE

Blue Chip

OF THE MINIATURE

GYRO FIELD

Reeves proudly presents its latest achievement in precision gyro miniaturization . . . an extremely compact and rugged unit designed and produced to meet the most exacting requirements of service in advanced inertial reference packages and stable platforms.

Reeves 12IG Gyros are 1.25 inches in diameter, 2.5 inches in length overall, and weigh only 6 ounces. Trimmed drift rate is very low . . . 0.1° hr.— Mass unbalance, 1.0°/hr/g. Angular momentum, 30,000 c.g.s. units. Gyros can be supplied with or without case heaters. For more complete information, write for data file 303.

Reeves

THE ULTIMATE

IN MINIATURE

FLOATED

INTEGRATING GYROS

Qualified engineers who are seeking rewarding opportunities for their talents in this and related fields are invited to get in touch with us.

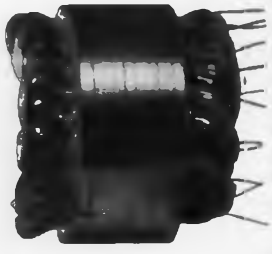
REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America

Roosevelt Field, Garden City, New York

3RV61

NEW COATED GLASS INSULATION SURVIVES CLASS F PUNISHMENT



Here's an exceptional insulation for motors, transformers, coils, and other electrical equipment that operates continuously at high temperatures. New "Irvington" Brand Epoxy Coated Glass No. 2525 retains its electric strength and flexibility even after sustained aging at rugged Class F temperatures. It is particularly suited for use in epoxy impregnated or cast units.

Extremely flexible and snug conforming, No. 2525 offers excellent compatibility with epoxy systems. It helps eliminate voids, hot spots, delaminations and moisture access points; will not contaminate or degrade transformer oils.

Use "Irvington" Epoxy Coated Glass No. 2525 for phase insulation, coil separator and interlayer insulation, or as an outer wrap on coils of all types. Available in tape, sheet or roll form in thicknesses of .003", .007" or .010". For further information write: 3M Company, 900 Bush Ave., St. Paul 6, Minnesota. Dept. ECB-51.

Irvington Division

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M

"IRVINGTON" IS A REGISTERED TRADEMARK OF 3M CO., ST. PAUL 6, MINN.

As We Go To Press (cont.)

Washington Award to Illinois Bell's Kahler

William V. Kahler, Pres., Illinois Bell Telephone Co., will receive the 1961 Washington Award. The award is for "distinguished leadership in business and civic affairs and for exceptional service to education and humanity."

The Washington Award is conferred upon "an engineer whose professional attainments have preeminently advanced the welfare of mankind." The Award Commission represents the American Society of Civil Engineers, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, and the Western Society of Engineers. Western Society administers the award.

Computer-Human Study

M.I.T. is making a study aiming to optimize man-computer operation. The four-year research program, funded by the Office of Naval Research and the National Science Foundation, aims to merge man and machine in a system that would closely couple human powers of reasoning and intuition and the ability of computers to process vast quantities of information at great speed.

Now, when a scientist wants an answer to a problem, he must submit it to a computer staff and then wait—from an hour to a week—before the computer can solve the problem and get the answer to him. The new program at M.I.T. will try to make it easier for the scientist to work with the machine. The scientist will be able to ask the machine a question and get the answer quickly without having to relinquish his place at the machine.

Optical Radar

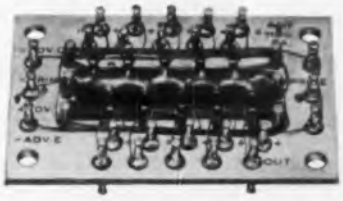
Scientists at the Univ. of Michigan have successfully completed an experiment demonstrating the feasibility of an optical radar. Members of the University's Institute of Science and Technology have sent a beam of very intense red light from a laser across Willow Run Airport. They were able to measure the light that was reflected from a target three miles away.

COUNTS LIKE MAD!

Miniaturization . . . extreme reliability . . . almost negligible power consumption . . . low bit cost—these merely provide the base for a whole stack of advantages when you choose AMP-MAD© Counters over other types.

AMP-MAD Counters are made with special multiaperture magnetic cores and wire **only.** Cores and wiring can be totally encapsulated. AMP-MAD devices provide either static count indication, or, in the case of higher count rates, a dynamic output as the count changes.

Identical counter/driver units are triggered by pulses to be counted. As shown (below), in cascaded decade applications, units and tens "carry" kicks over following decade counter/driver and advances the count . . . with no limit to the number of decades!

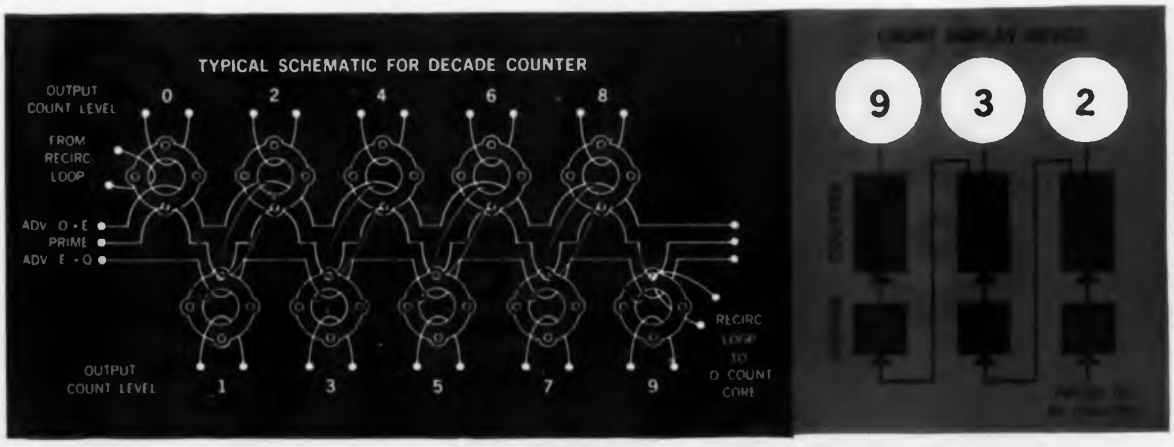


(Actual length 1 27/32" max.)

Check these additional AMP-MAD features:

- −55°C to +75°C temperature operating range (standard)
- small size—fits miniaturization requirements
- ultimate in reliability
- requires no sustaining power
- one to zero discrimination of 8 to 1 (20 to 1 on request)
- non-volatile count storage
- minor aperture output level up to 80 mw for incandescent light display of count (alternate output wiring scheme for that illustrated).

You'll want to know more about AMP-MAD Counters . . . Shift Registers, too! And there's more to tell. Write for complete information today.



AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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

Select here the VOLTMETERS, AMMETERS, Many are

AC

hp 403A Transistor ac Voltmeter—1 cps to 1 MC

Battery-operated, weighing less than 5 pounds and small enough to hold in your hand — this new transistor ac voltmeter measures 100 μv to 300 v (max. full scale sensitivity 1 mv) over frequencies 1 cps to 1 MC! Twelve voltage ranges; also reads direct in db from —72 to +52 db. 400 hour battery life equals 6 months of average use; battery voltage may be checked by front panel switch. Noise less than 30 μv on all but lowest range. Completely isolated from power line or ground interference. Average reading meter minimizes turnover and waveform errors. Accuracy ±3% to 500 KC, ±5% to 1 MC. Input impedance 2 megohms; generous 600 v overload capacity on higher ranges, 25 v maximum on lower ranges. $275.00.

All of these widely useful -hp- instruments are available in rack-mounted -hp- voltmeter accessories—voltage dividers, coaxial connectors, voltage

DC

hp 405 Digital Voltmeter
Automatic range, polarity

Here's true "touch-and-read" measuring simplicity. Automatic range, polarity selection; covers 0.001 v to 1,000 v. (Accuracy ±0.2% of reading ± 1 count). New, unique circuitry provides a stability of readings virtually eliminating fatiguing jitter in the last digit. Floating input, multi-electronic code output for use with digital recorders. Uses electronic computing circuits to insure low maintenance, trouble-free operation. Just 7" high! $850.00, $925.00.

Complete array of ac and dc measuring equipment

versatile, precision OHMMETERS you need. multi-purpose!

400D
10 cps to 4 MC

Regarded by many as finest ac VTVM ever built. Covers all frequencies 10 cps to 4 MC, extremely sensitive, wide range, accurate within 2% to 1 MC. Measures 0.1 mv to 300 v (max. full scale sensitivity 1 mv), 12 ranges. Direct reading in v, db. 10 megohm input impedance with 15 $\mu\mu$f shunt insures negligible loading to circuits under test. $250.00.

400L
Log VTVM—10 cps to 4 MC

Covering 10 cps to 4 MC, this new hp VTVM features a true logarithmic scale 5" long plus a 12 db linear scale. The log voltage scale plus long scale length provides a voltmeter of maximum readability, with accuracy a constant percentage of the reading. Accuracy is ±2% of reading or ±1% of full scale, whichever is more accurate, to 500 KC, ±5% full range. Range 0.3 mv to 300 v, 12 steps, (max. full scale sensitivity 1 mv). $325.00.

400H
1% accuracy VTVM

Here's extreme accuracy of 1% in a precision VTVM covering 10 cps to 4 MC. Big 5" meter has exact-reading mirror-scale, measures voltages 0.1 mv to 300 v (max. full scale sensitivity 1 mv). 10 megohm resistance with 15 $\mu\mu$f shunt minimizes circuit loading. Amplifier with 56 db feedback insures lasting stability. $325.00.

410B
ac to 700 MC, also dc

Time-tested standard all-purpose voltmeter. Covers 20 cps to 700 MC, full scale readings 1 to 300 v. Input capacity 1.5 $\mu\mu$f, input resistance 10 megohms. Also serves as dc VTVM with 122 megohms input impedance, or ohmmeter for measurements 0.2 ohms to 500 megohms. $245.00.

models! Also, inquire about multipliers and shunt resistors.

HEWLETT-PACKARD COMPANY
1004B Page Mill Road • Palo Alto, California, U.S.A.
Cable "HEWPACK" • DAvenport 6-7000
Field representatives in all principal areas

412A Precision
Volt-Ohm-Ammeter

At last a true, precision multi-purpose instrument. Measures dc voltage 100 μv to 1,000 v (max. full scale sensitivity 1 mv), 1% accuracy full scale. Measure currents 1 μa to 1 amp with ±2% accuracy full scale. 13 ranges. As ohmmeter measures 0.02 ohms to 5,000 megohms. Extremely low noise, drift. Recorder output provides 1 v full scale. $400.00.

425A Microvolt-
Micromicroammeter

New, high sensitivity, high stability instrument reading end scale voltages of 10 μv to 1 v in 11 ranges, or currents of 10 $\mu\mu$a to 3 ma in 18 step, 1-3-10 sequence. Accuracy ±3% on all ranges. Drift less than 4 μv per day. Input impedance 1 megohm ±3% on all ranges. Also usable as 100 db amplifier with up to 1 v output from signals as small as 10 μv. $500.00.

428A/B
Clip-On Milliammeter

Employs radical new approach to current measurement which eliminates breaking leads, soldering connections or loading of circuit under test. Revolutionary "current sensing" probe clips around wire under test, measures the magnetic field around the lead. Easily measures dc current in presence of strong ac. Covers 0.3 ma to 1 amp in 6 steps; full scale sensitivity 3 ma. Accuracy ±3%, probe inductance less than 0.5 μh. $600, $550.

—unique value, traditional -*hp*- dependability

DIRECTIONAL COUPLERS • RF LOAD RESISTORS
COAXIAL TUNERS • RF WATTMETERS • VSWR METERS

MicroMatch® RF Power and VSWR measuring instruments are rugged and accurate in both field and laboratory use. The patented circuit produces an output essentially *independent of frequency*. Over 3800 models of coupler units available. MICRO-MATCH instruments meet highest government and commercial standards, combine highest quality with low cost.

Model No.	Frequency Range (mcs.)	Power Range Incident & Reflected (watts)	RF Connectors and Impedance
263	0.5 - 225	0 - 10; 100; 1000	Type N° 52 ohms
706N	28 - 2000	0 - 400	Type N° 52 ohms
711N	25 - 1000	0 - 30; 75; 300	N plus 83-1R Adapters
712N	25 - 1000	0 - 2.5; 5; 10	N plus 83-1R Adapters
722N	1000 - 3000	0 - 4	Type N 52 ohms
723N	1000 - 3000	0 - 12	Type N 52 ohms
405B8	28 - 2000	0 - 4000	1⅝" Flange 51.5 ohms
445A10	20 - 2000	0 - 40,000	3⅛" Flange 50.0 ohms

Model No.	Frequency Range (mcs.)	Power Range Incident & Reflected (watts)	RF Connectors and Impedance
576N1	42 - 2000	1.2	Type N° 52 ohms
576N6	28 - 2000	0 - 400	Type N° 52 ohms
596N2	1000 - 3000	0 - 4	Type N 52 ohms
596N3	1000 - 3000	0 - 12	Type N 52 ohms
402B8	28 - 2000	0 - 4000	1⅝" Flange 51.5 ohms
442A9	28 - 2000	0 - 12,000	3⅛" Flange 50.0 ohms

Model No.	Frequency Range (mcs.)	Coupling Attenuation	RF Connectors and Impedance
313N3	300 - 2000	30 db	Type N° 52 ohms
313N5	60 - 2000	50 db	Type N° 52 ohms
442A40	200 - 1000	40 db	3⅛" Flange 50.0 ohms

Model No.	Frequency Range (mcs.)	Power Range (watts)	RF Connectors and Impedance
621N	1 to over 1000	0 - 120 milliwatts	Type N° 52 ohms
625C5	50 - 1000	0 - 120	Type C 50 ohms
651N	25 - 1000	0 - 25; 100; 500	Type N 52 ohms
611A7	50 - 1000	0 - 1200	3⅛" Flange 50 ohms
612A	44 - 1000	0 - 6000	3⅛" Flange 50 ohms

Model No.	Frequency Range (mcs.)	RF Power Dissipation (watts)	RF Connectors and Impedance
603N	3000	20 (air cooled)	Type N 52 ohms
633N	3000	50 (air cooled)	Type N° 52 ohms
636N	3000	600 (air cooled)	Type N° 52 ohms
638A	2000	6000 (water cooled)	3⅛" Flange 50.0 ohms

Model No.	Frequency Range (mcs.)	Power Range	RF Connectors and Impedance
641N	0 - 3000	0 - 3; 10; 30; 100; 300	Type N 52 ohms

Model No.	Frequency Range (mcs.)	Range of Correction	RF Connectors and Impedance
151N	200 - 1000	Tunes a load with a VSWR of 2.00 max. down to a VSWR of 1.00	Type N 50 ohms
152N	500 - 4000		Type N 50 ohms

For more information, write:

M. C. JONES ELECTRONICS CO., INC.

185 N. MAIN STREET, BRISTOL, CONN.

SUBSIDIARY OF The Bendix Corporation

Tele-Tips

RFI ODDITIES: The Denver field Office of the FCC and a local power company were both deluged with telephone calls from a particular section of that city complaining of TV interference. An FCC engineer located the place where the disturbance was strongest. With the help of a lineman of the utility company, power line connections to various buildings were opened one at a time until the interference stopped. The culprit proved to be an unused neon sign at a gasoline service station. Bare output wires from the transformer were touching a brick wall which served as a conductor because it was covered with aluminum paint.

WHEN A GOVERNMENT satellite tracking station in Alabama, complained of difficulty to radio reception from a space object, the FCC monitoring net pinned the blame on spurious signals from a point-to-point station in the Netherlands. Contact with the latter brought elimination of the intruder, also a letter of thanks from the tracking station.

LONG-DISTANCE trace was made for a West German station. It asked that the origin of a certain call be located. FCC bearings showed it came from the vicinity of Ceylon, which helped to further determine that it emanated from the nearby Maldive Islands.

INTERFERENCE to transmission from California to Japan was found due to a faulty transmitter of a station in Hawaii.

AN AM STATION in Tennessee sent the FCC Atlanta field office a handbill announcing the opening of a "new broadcast station" in the same town. The latter did not appear on the Commission's records so an FCC engineer visited the scene. He found a 14-year-old boy who had advertised a low-power device to communicate with playmates in the immediate neighborhood during certain hours.

(Continued on page 44)

Circle 25 on Inquiry Card

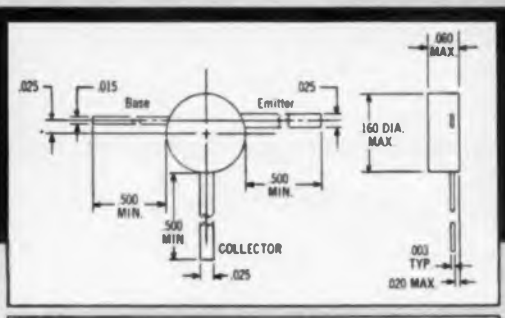
Circle 26 on Inquiry Card →

NEW FROM

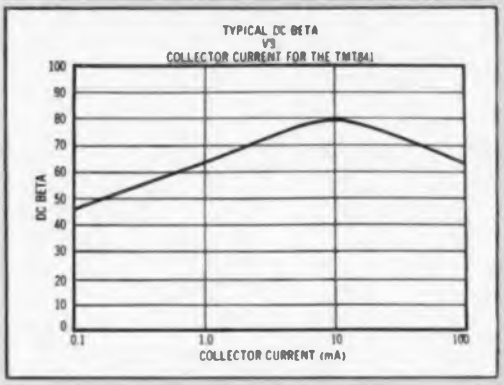
Transitron

micro-T

(A MESA MICRO-TRANSISTOR)



- SILICON DIFFUSED
- HERMETICALLY-SEALED
- ALL-GLASS PACKAGE



AMPLIFIER TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum AC Beta (h_{fe})	Typical Gain-Bandwidth Product (Mc)	Maximum Collector Leakage Current at 25°C (μA)	Maximum Power Dissipation at 25°C Ambient (mW)
TMT 839	45	20	45	1	150
TMT 840	45	40	45	1	150
TMT 841	45	80	65	1	150
SWITCHING TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum DC Beta (h_{FE})	Typical Gain-Bandwidth Product (Mc)	Maximum Saturation Resistance (Ohms)	Maximum Power Dissipation at 25°C Ambient (mW)
TMT 842	45	20	45	120	150
TMT 843	45	45	65	120	150

INTRODUCING THE FIRST SERIES IN A COMPLETE LINE OF MICRO-TRANSISTORS

Development of the **MICRO-T** — first silicon diffused mesa micro-transistor in an hermetically sealed all-glass package — represents a major step forward in microminiaturization. As compared with conventional "metal can" configurations, the **MICRO-T's** hard glass packaging embodies a significant improvement in the hermetic seal between leads and package. Reliability is substantially increased; possibility of leakage is sharply reduced.

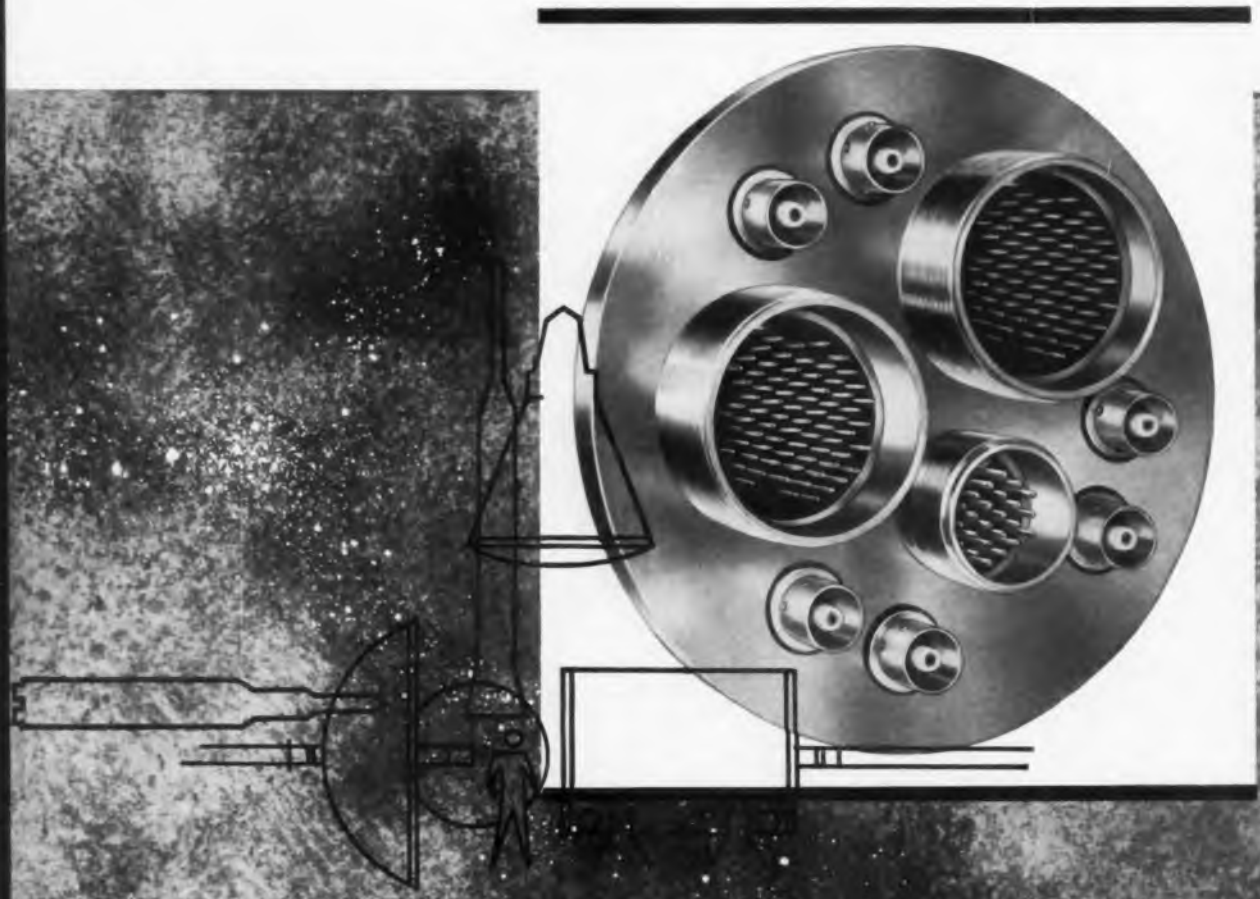
This new series of 45-volt micro-transistors is the first designed for small-signal low-level applications, with current operating range from 50 microamps to 20 milliamps. Other electrical characteristics include an Rcs of 100 to 200 ohms; minimum Betas from 20 to 80; cut-off frequencies of over 50 megacycles. Perfectly compatible with present circuitry, **MICRO-T's** will facilitate microminiaturizing in such critical areas as airborne, space vehicle and missile application. They are 1/20th the size of the TO-5, and 1/5th that of the TO-18.

The first five types of **MICRO-T's** are available now. For full information, write for Bulletins No. PB-78, (Amplifier types) and PB-79, (Switching types).

Transitron electronic corporation
wakefield, melrose, boston, mass.
SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO

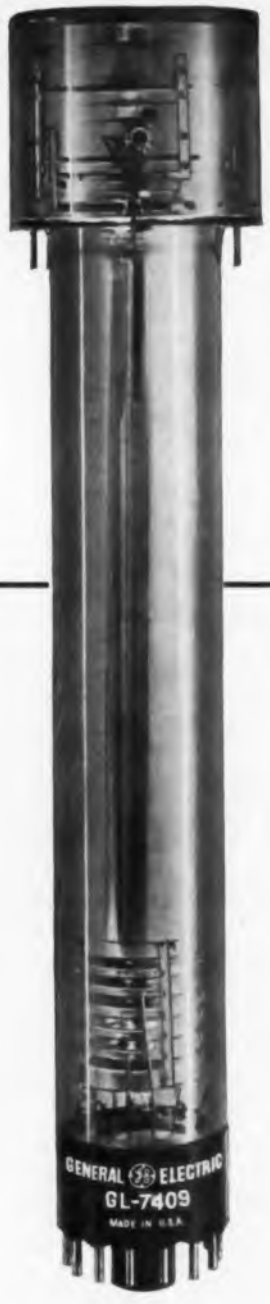
hermetic seal · leakage rate · 1 x 10^{-9} cc/sec

AMPHENOL can do it. Sealed electrical penetrators for space simulator chambers are currently being produced with a leakage rate lower than 1x10^{-9} cc/sec. AMPHENOL Interstage and other missile connector types are also being provided for every major missile program. Connectors up to a foot in diameter with 175 individually sealed contacts have been manufactured for ultra-reliable systems. AMPHENOL For less exotic applications, AMPHENOL supplies every type of hermetically sealed electrical connectors: MS-type receptacles with AMPHENOL-developed "Identoseal" contact identification, 3/8" square Micro Mod receptacles with 12 contacts on .075" centers, and a wide variety of special and general purpose connectors. Maximum permissible leakage rate in standard connectors is 1x10^{-6} cc/sec. Write for full information on AMPHENOL'S capabilities in this highly important field.



AMPHENOL CONNECTOR DIVISION

1830 S. 54TH AVE. • CHICAGO 50, ILLINOIS • An Amphenol-Borg Electronics Corporation



NEW FROM GENERAL ELECTRIC:

ADVANCED-DESIGN CAMERA TUBES FOR MILITARY APPLICATIONS

Diversified line now available from stock

General Electric now offers a wide and diversified line of camera tubes which incorporate significant breakthroughs in the state of the art: *sensitivity* improved 50:1 . . . *resolution* improved by as much as 50% . . . *life* extended 3-5 times . . . radical new *design and construction* features (e.g., supersensitive, long-life magnesium oxide target introduced by General Electric).

Image Orthicon Type	Typical Applications	Features	Spectral Response (Angstroms)	SENSITIVITY (photocathode illum. in f/c; 100% Contrast Chart; 1/30 Sec.)
GL-7409 (Z-5358)	Missile- and Satellite-borne Systems Fire Control Drone Guidance	Ruggedized High Sensitivity Magnesium Oxide Target Non-burn-in Storage Capabilities	3200-6950 4500-Peak (S-10)	500 TV Lines at 10^{-5} f/c
GL-7538 (Z-5294)	Low-light-level Surveillance Space Navigation Electro-optical Telescope Systems	High Sensitivity Magnesium Oxide Target Non-burn-in Storage Capabilities	3200-6950 4500-Peak (S-10)	500 TV Lines at 10^{-5} f/c
ZL-5395*	Aerial Mapping Passive Detection Systems Spectrographic Detectors	Near-Infrared High Sensitivity Magnesium Oxide Target Storage Capabilities	3200-10,800 8000-Peak (S-1)	200 TV Lines at 10^{-5} f/c (No filter)
GL-7967* (Z-5396)	Extreme Low-light-level Surveillance Orthicon Intensifier Applications Underwater Observation	Supersensitive Magnesium Oxide Target Storage Capabilities	3200-7400 4250-Peak (S-20)	300 TV Lines at 10^{-4} f/c
GL-7969* (Z-5453)	Missile Detection Spectrographic Detectors Underwater Observation	Ultraviolet High Sensitivity Magnesium Oxide Target	2500-7000 3800-Peak	500 TV Lines at 10^{-5} f/c
GL-5820	Educational TV Video Taping Standard Monochrome Broadcast	High Sensitivity Stable Performance	3200-6950 4500-Peak (S-10)	Scene Illumination: 100 f/c
GL-7293 (field-mesh)	Educational TV Video Taping Standard High-quality Monochrome Broadcast	Improved Landing and Shading Improved Corner Focus Sharp Black-to-white Transition	3200-6950 4500-Peak (S-10)	Scene Illumination: 100 f/c
GL-7629	Closed Circuit Training Applications Special Monochrome and Color Broadcast	Supersensitive at Low Light Levels Magnesium Oxide Target Non-burn-in Storage Capabilities	3200-6950 4500-Peak (S-10)	Scene Illumination: Color—as low as 5 f/c Monochrome—as low as 1 f/c

*Ruggedized versions available (ZL-7805, ZL-7806, and ZL-7807, respectively). Will withstand frequency in excess of MIL requirements, and DC acceleration in excess of 90 G's.

General Electric continually offers technical camera tube seminars in customer plants. A limited number of open dates are still available. Ask now to have a meeting scheduled for your group.

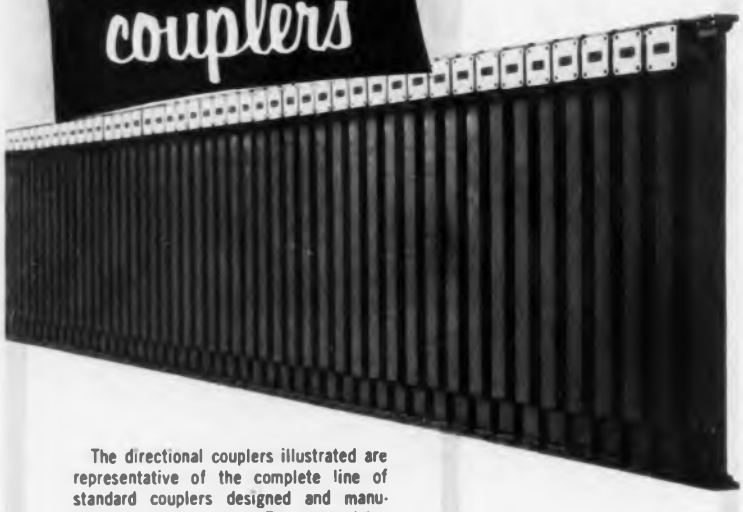
FOR INFORMATION on the above tubes, or for any specialized requirements—including Government-classified projects, contact the camera tube representative in the nearest Power Tube Department Regional Office. General Electric Company, Camera Tube Section, Building 267, Schenectady 5, New York.

265-08-9545-8481-35

CATHODE RAY TUBE DEPARTMENT

GENERAL ELECTRIC

Waveguide directional couplers



The directional couplers illustrated are representative of the complete line of standard couplers designed and manufactured by Waveline. These precision microwave instruments cover the frequency range of 2.60 to 40.0 KMC in a number of basic design configurations, such as: cross-guide, narrow-wall, and precision broad-wall couplers. All models are available with standard values of coupling and are manufactured of rugged brass construction with silver plating and baked enamel finish.

Your attention is invited to the many special couplers designed and manufactured by Waveline for system applications. These devices have been produced in a variety of complex configurations utilizing Waveline's engineering skills and advanced technique of aluminum flux dip brazing. Our modern facilities are capable of generating basic designs in the form of prototypes for evaluation, as well as, quantity production of established designs.

We welcome your inquiry concerning standard couplers or your special coupler requirements covering design of prototype and manufacture of production quantity.

A six page illustrated brochure of Waveguide Directional Couplers is available on request.

WAVELINE INC.

CALDWELL, NEW JERSEY

Phone: CApital 6-9100 TWX Caldwell, N. J. 703

Tele-Tips

(*Continued from page* 40)

CRYSTAL-CONTROLLED Transmitter was operated by two Wisconsin youths in the middle of the broadcast band to transmit "boogie", "bop" and "roll" recorded music to teenagers within a radius of 20 miles. The youngsters proudly told the FCC engineer that they had spent eight months planning and constructing their equipment, and had even built the control console and installed a modulation monitor. They used call letters not on regular broadcast station lists.

SOME INTERFERENCE complaints boomerang:

Interference to high-flying jet planes was traced to a receiver used at the complaining airfield. Somebody had forgotten to replace the protective cover shield.

A Tucson airport interference complaint was determined to be caused by the strips of neon lights which outline its control tower.

INTERFERENCE involving manual radiotelegraph is now rare. However, one concerned complaint by an Army camp of undecipherable telegraph signals on a military frequency. Though the keying was poor, FCC monitors were able to fix them as coming from another Army post, presumably from a class studying telegraphy.

FAILURE to comply with small boat radio regulations resulted in the loss of both a fishing boat and money. Fortunately, no lives were lost. It concerned the sinking of the vessel off Florida which resulted in nine persons spending a very uncomfortable 22 hours clinging to a life-raft in shark-infested waters. Inquiry showed that the vessel had not been equipped with proper radio apparatus for safety purposes. In consequence, forfeiture of $500 was levied against the boat's owner, $500 against the lessee, and $100 against the master.

the Counter with a Memory

Continuous Readout to 10 Megacycles

The "memory" in this Counter constitutes an important new operating aid. Four of the instrument's eight decades are used for storage and continuous display, while the remaining four decades count continuously. At the end of each counting interval, the total accumulated by the counting decades is transferred automatically and quickly (only 100 μsec) to the storage and display decades. Continuous counting offers many advantages – information is sampled more often, frequency adjustments become easy; analog recording is greatly simplified; and operator eye fatigue induced by the dancing lights of intermittent displays is eliminated.

The Type 1130-A Digital Time and Frequency Meter is not just another counter. It embodies a number of new engineering contributions that are of fundamental importance.

This instrument is designed like a digital computer — to achieve a uniform level of high reliability throughout. "Down time", the bugaboo that robs the user of his full investment, is at a minimum.

Unsurpassed reliability is achieved by:

1. New decade codes and high-speed counting circuits, *unlike those in other counters*, that make this instrument inherently reliable.
2. Circuits designed to operate properly under the worst combination of *cumulative* tolerances imposed by tubes, component values, and voltage levels. Counter *performs properly even with tubes approaching the half-dead state.*
3. Use of proven "hard-bottoming" multivibrator dividers that make for exceptional stability — eliminate need for periodic adjustments of time-base circuits.
4. Elimination of critical voltages. Neither plate nor filament supplies are, or need be, regulated.

RANGES:
Frequency: dc to 10 Mc
Period: 10 μsec to 10^7 sec
Time Interval: 1 μsec to 10^7 sec
Also measures 10 periods, frequency ratios, phase shifts, pulse characteristics, and counts random events.

SENSITIVITY:
0.25v rms

DISPLAY
4 digits continuous; 8 digits for sequential counting and display, with display-time variable from 0.1 to 10 sec.

ACCURACY:
±1 count ± time-base oscillator stability

AVAILABLE WITH SEVERAL PLUG-IN TIME-BASE OSCILLATORS

Buy the Time-Base Stability You Need

	Complete Instrument Type – Price	Short-Term Stability Better Than	Long-Term Stability Better Than
Completely Self-Contained	1130-A4, $2,950.	1 part in 10^9 per min.	5 parts in 10^9 per week
	1130-A3, $2,670.	1 part in 10^8 per min.	2 parts in 10^7 per week
For Use from External Standards	1130-A2, $2,750.	---- Same as 1130-A3 ---- Also operates from external 100-kc, 1-Mc, and 5-Mc inputs.	
	1130-A1, $2,585.	Requires 5-Mc driving signal; G-R 1113-A 5-Mc Standard Frequency Oscillator provides stability of 1 part in 10^{10} per min, 2 parts in 10^9 per week.	

For Digital Recording

1132-A Data Printer . . . $1450.

Records 8 digits from counter plus 4 digits from clock or other source, at speeds to 3 prints per sec . . . no modification of counter is required

For Graphic Recording

1134-A Digital-to-Analog Converter . . . $595

Makes possible low-cost, ALL-ELECTRONIC graphic strip-chart recording (no data printer needed) . . . high accuracy of 0.1%

For Measurements to 500 Mc

Frequency conversion units are under development

Write for Complete Information

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

All G-R Products are covered by a *2-Year Warranty*

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

Circle 105 on Inquiry Card

2 NEW SOLID STATE

TRUE FM TELEMETRY TRANSMITTERS

Actual Size

from
Dorsett Electronics

Power Consumption is less than 17 Watts for 2 Watts Output.

SPECIFICATIONS

	TR-20	TR-21
Frequency	225-260 mc.	136-137 mc.
Output	2.0 Watts minimum	2.0 Watts minimum
Modulation Range	100 cycles to 100 KC	DC to 50 KC
Deviation	±125 KC	± 75 KC
Frequency Stability	.01% (−20° C. to+90° C.)	.01% (−20° C. to+90° C.)
Spurious Radiation & RF Interference	Per MIL-I-26600	Per MIL-I-26600
Distortion	Less than 1%	Less than 1%
Output Impedance	50 ohms	50 ohms
Input Impedance	500,000 ohms	500,000 ohms
Power Requirements:	28 v. at less than 600 ma.	28 v. at less than 450 ma.
Connector	Cannon: DA-11C1P	Cannon: DA-11C1P
Mounting	Two 6-32 captive Screws	Two 6-32 captive Screws
Size	1.875" wide; 2.25" high; 3.50" long	1.875" wide; 2.25" high; 3.50" long
Environmental: (Identical on both TR-20 & TR-21)	Altitude:	Unlimited
	Acceleration:	50-G in any plane
	Temperature.	−40° C to + 90° C
	Vibration.	15 G, 55 to 2000 cps.
	Shock.	100 G for 11 milliseconds in any plane.

Model TR-20–225-260 mc.
Model TR-21–136-137 mc.

SILICON SEMI-CONDUCTORS are used throughout the circuits to provide high reliability performance over a wide range of environmental conditions.

A FULL 2 WATTS OF RF OUTPUT is achieved through use of a unique circuit design.

CRYSTAL CONTROLLED FREQUENCY STABILITY is .01% or better over a wide temperature range.

MODULAR PACKAGE DESIGN affords versatility for customer-designed systems . . . and conformity with the complete Dorsett-built line of "Twenty" series telemetering components and systems.

For your telemetry requirements, contact Dorsett. Your inquiries or specifications will receive a prompt reply.

DORSETT ELECTRONICS, INC.

P. O. BOX 862 · NORMAN, OKLAHOMA PHONE JE 4-3750

Centralab Model 7 Linear Motion Variable Resistors

11 different types

0 contact bounce

No contact bounce when vibration tested, 20-20,000 cps at 30 g's, loaded at 80% rated load, at 80% wiper travel, 3 planes, 10 minutes each. Induced noise less than 10 millivolts.

DESCRIPTION	MODEL	TERMINAL LEADS	RESISTANCE RANGE	POWER RATING (Watts)	MAXIMUM OPERATING TEMP.	ENCAP-SULATED
Gen. Purpose (Composition)	BA-701	Nylon or Teflon	10K to 2.5 Meg	0.25@50°C	+125°C	No
Gen. Purpose (Wirewound)	BA-702	Nylon or Teflon	10Ω to 20K	0.25@50°C	+125°C	No
Gen. Purpose (Composition)	BA-703	Printed Circuit	10K to 2.5 Meg	0.25@50°C	+125°C	Yes
Gen. Purpose (Wirewound)	BA-704	Printed Circuit	10Ω to 20K	0.25@50°C	+125°C	Yes
Gen. Purpose (Composition)	BA-705	Nylon or Teflon	10K to 2.5 Meg	0.25@50°C	+125°C	Yes
Gen. Purpose (Wirewound)	BA-706	Nylon or Teflon	10Ω to 20K	0.25@50°C	+125°C	Yes
Gen. Purpose (Composition)	BA-707	Printed Circuit	10K to 2.5 Meg	0.25@50°C	+125°C	No
Gen. Purpose (Wirewound)	BA-708	Printed Circuit	10Ω to 20K	0.25@50°C	+125°C	No
High Temp. (Wirewound)	BA-712	Teflon	10Ω to 20K	1.0 @ 70°C	+175°C	No
High Temp. (Wirewound)	BA-714	Teflon	10Ω to 20K	1.0 @ 70°C	+175°C	Yes
High Temp. (Wirewound)	BA-716	Printed Circuit	10Ω to 20K	1.0 @ 70°C	+175°C	Yes

Maximum end resistance: < 1% of total.

Size:
encapsulated 23/64" x 19/64" x 1-11/32", without encapsulation 5/16" x 1/4" x 1-1/4".

Resistances: Wirewound: 10-20-50-100-200-500-1K-2K-5K-10K-20K ohms. Composition: 10K-20K-50K-100K-500K, 1 Meg, 2.5 Meg.

Standard Tolerances: ±5% Wirewound, ±20% Composition. Closer tolerances available upon request.

Shock: Less than 1% change in resistance with JAN-S-44 apparatus at 100 g, 5 shocks in each of 3 planes, Method 202A.

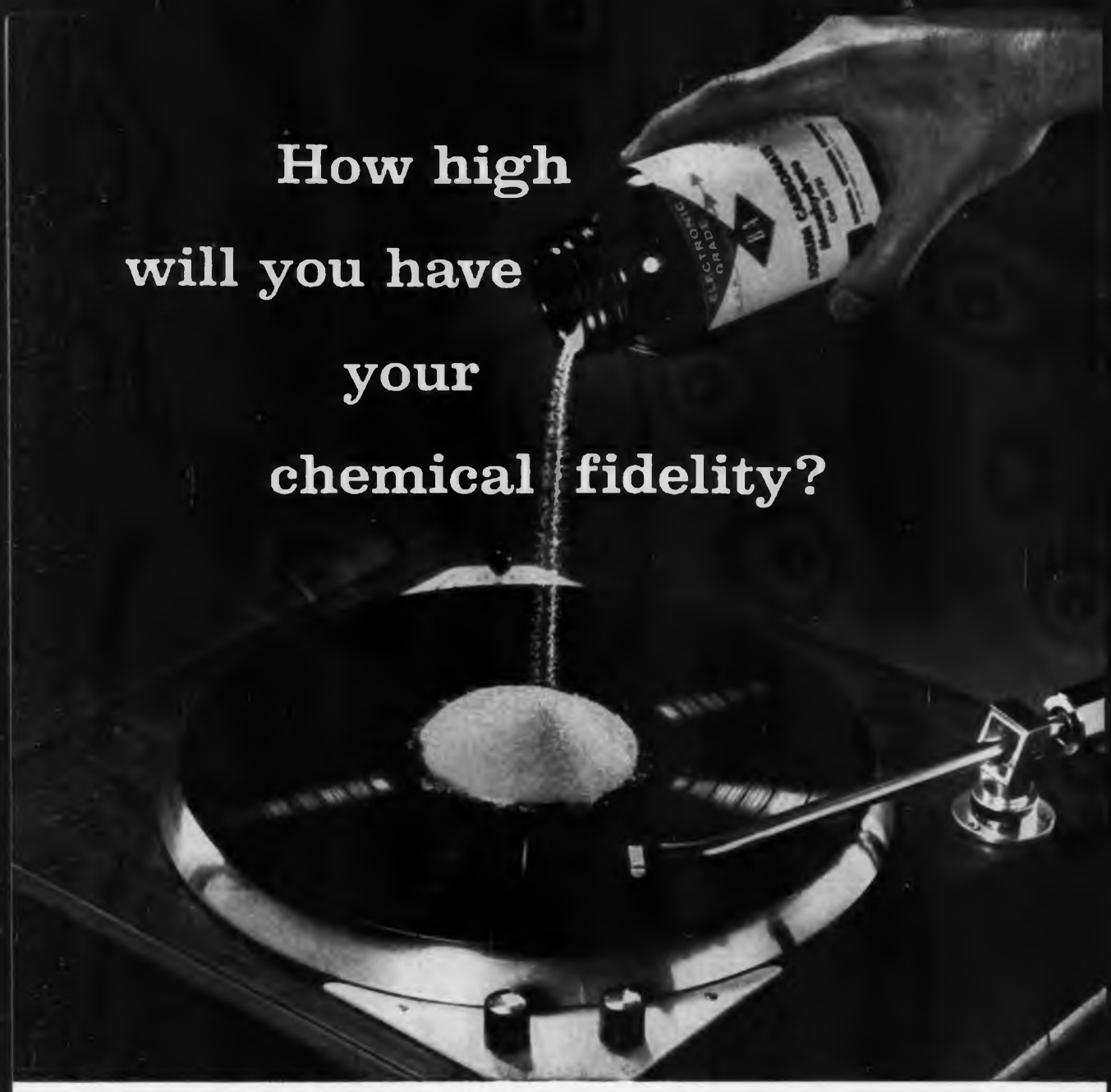
Meet or exceed all specifications of applicable MIL-STD 202-A, MIL-R-19A and MIL-R-94B tests.

Industrial quantities of the Model 7 are available for immediate delivery at factory prices from your CENTRALAB industrial distributor.

Centralab CRL ®
B-6039

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

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



To be considered truly hi-fi, an amplifier's distortion at rated output should not exceed 1% at 20 CPS and 20,000 CPS. B&A® "Electronic-Grade" Chemicals meet standards far higher than these. Their maximum allowable impurities are limited to ten thousandths, even millionths of a *percent*.

These standards of purity are *pre-determined*—established by B&A quality control and development scientists to meet the electronic industry's rigid chemical requirements. In achieving these electronic-grade standards, Baker & Adamson consistently holds impurities at the lowest limits ever attained.

B&A has led the way in chemical purity since 1882. Today it is the largest supplier of high purity chemicals to the electronic industry. Our nation-wide network of shipping points provides same or next day delivery to most electronic centers. When specifying chemicals, rely on B&A to supply the finest . . . fastest.

BAKER & ADAMSON®
"Electronic-Grade" Chemicals

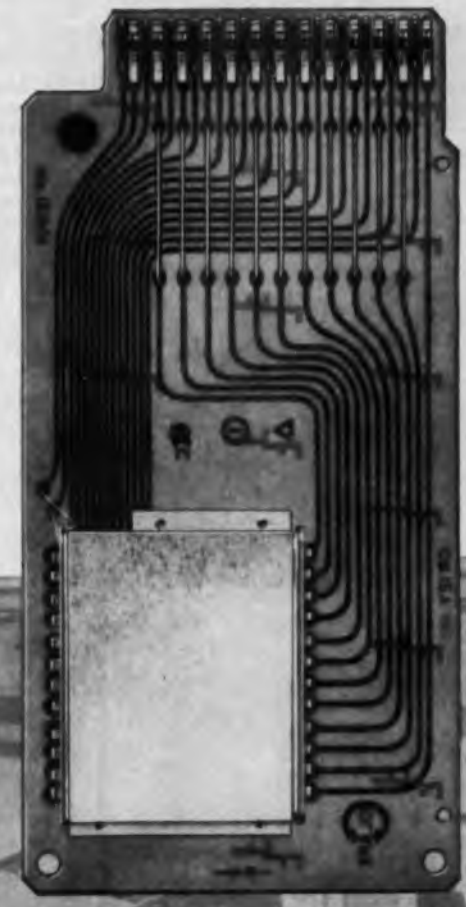
Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.
Circle 30 on Inquiry Card

RCA uses 252 CLARE Printed Circuit Relays in the 501 electronic data processing system

RCA's 501 incorporates many advanced features which significantly increase reliability as well as economy. It takes up less space, weighs less and operates on less electrical power than previous models.

252 relays (each consisting of 12 Clareed sealed contact reed switches—3,024 switches in all) make up this "matrix relay," used in the model 547-6 switching unit of the RCA 501.



CLAREED switch capsule consists of a pair of magnetically operated contacts, hermetically sealed in an atmosphere of inert gas.

CLAREED Sealed Contact Relays provide fast, sure switching

Contributing to the efficiency, speed and compact structure of the RCA 501 are 252 CLAREED sealed contact reed relays. Mounted on printed circuit boards, these relays, their contacts hermetically sealed in contaminant-free inert gas, assure millions of perfect operations...hundreds of millions when operated at up to ½ rated load.

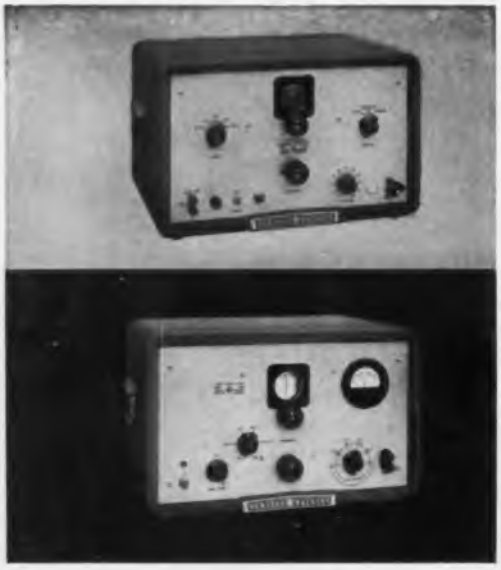
CLAREED relays are ideal components for transistor-drive applications such as the RCA 501. Their low inductance, and the low inductance change in the operating coil at each operation, limit the transients produced.

These relays may be mounted to meet the requirements of almost any application or environment. Consult your nearby CLARE sales engineer...or write: 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. Ask for Bulletin CPC-10.

C. P. CLARE & CO.

Relays and Related Control Components

Circle 33 on Inquiry Card



202A FUNCTION GENERATOR—Down to 0.008 cps; transient-free!

Uses: Electrical simulation of mechanical phenomena, vibration studies, servo research and testing, medical research, geophysical problems, subsonic and audio testing.

Advantages: No switching transients, continuously variable 0.008 to 1,200 cps range, 30 v output peak-to-peak constant, hum less than 0.05%, square, triangular or electronically synthesized sine waves, 1% stability, 0.2 db response, less than 1% distortion (sine waves) on all but x 100 range.

Price: $550.00 (cabinet model), $535.00 (rack mount).

650A TEST OSCILLATOR—Flat within 1 db, 10 cps to 10 MC!

Uses: Testing TV amplifiers or wide-band systems, measuring filter transmission characteristics and tuned circuit response, determining receiver alignment, making telephone carrier and bridge measurements.

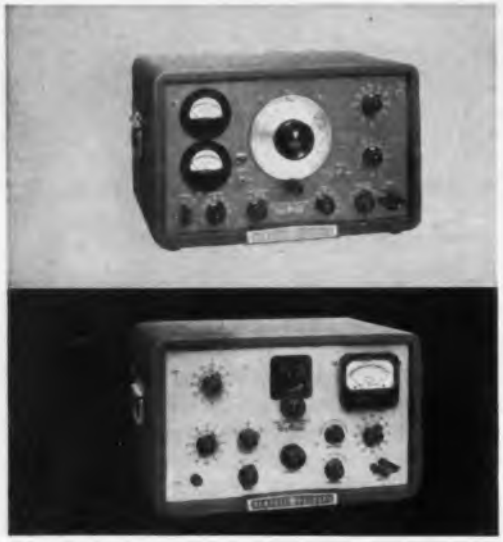
Advantages: No zero set, no adjustments during operation, output voltage range 30 μv to 3 v, less than 1% distortion, 20 cps to 100 KC; less than 2%, 100 KC to 1 MC; approx. 5% at 10 MC. Hum less than 0.5%, output voltage attenuator, self-contained voltmeter, 2% to 3% stability.

Price: $550.00 (cabinet model), $535.00 (rack mount).

Easy to operate, highly stable, wide range

PRECISION OSCILLATORS

hp precision oscillators perform a wide variety of audio, video, and low frequency tests. They offer the outstanding advantages of flexibility and broad usefulness at moderate cost. Employing the hp pioneered RC resistance capacity circuit, the units combine accuracy and reliability with ease of operation and minimum adjustment.



205AG AUDIO SIGNAL GENERATOR—Six instruments in one; 20 cps to 20 KC!

Uses: Measure amplifier gain and network frequency response, measure broadcast transmitter audio and loudspeaker response, drive bridges, use in production testing or as precision source for voltages. Monitors oscillator output, measures output of device under test.

Advantages: Self-contained instrument, no auxiliary equipment needed. 5 watts output, ± 1 db response, less than 1% distortion, hum more than 60 db down, no zero setting, output and input meters read v and dbm; four output impedances.

Price: $600.00 (cabinet model), $585.00 (rack mount).

206A AUDIO SIGNAL GENERATOR—Less than 0.1% distortion; 20 cps to 20 KC!

Uses: Convenient, precision audio voltage source; checks FM transmitter response, makes high quality, high fidelity amplifier tests, transmission measurements.

Advantages: Continuously variable audio frequency voltage, (output 15 dbm) 0.2 db response, hum 75 db down, 2% frequency accuracy, less than 0.1% distortion. 111 db attenuator with 0.1 db steps.

Price: $800.00 (cabinet model), $785.00 (rack mount).

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

hp pioneered the world-famous resistance-capacity oscillator circuit

HEWLETT-PACKARD COMPANY
1031B Page Mill Road, Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000
HEWLETT-PACKARD S.A.
Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36
Field representatives in all principal areas

ELECTRON TUBE NEWS
...from SYLVANIA

Design
BIG TUBE
performance
into your
printed circuit
boards...

NEW SYLVANIA 9-T9 TYPES!

Improve tube performance! Increase chassis efficiency! Extend tube life! Reduce equipment costs! Sylvania-originated 9-T9 type tubes can help you achieve all four vital design requirements. Here's how: 9-T9 enables the use of large tube structures capable of high plate dissipation in printed circuit designs. Sylvania 9-T9 eliminates the octal base, uses conventional T-6½ sockets – improves volumetric efficiency and reduces socket costs.

9-T9 Types for Vertical Deflection Oscillator-Amplifier Service

6/10EW7, dissimilar double-triode . . . triode #1: mu of 17.5; triode #2: 10 watts plate dissipation.

6/17HC8, triode-pentodes . . . triode section: mu of 68; high perveance beam power pentode: 11 watts plate dissipation.

6/10/13FD7, dissimilar double-triodes...triode #1: mu of 68; triode #2: 10 watts plate dissipation.

9-T9 Beam Power Pentodes for Audio Amplifier Applications

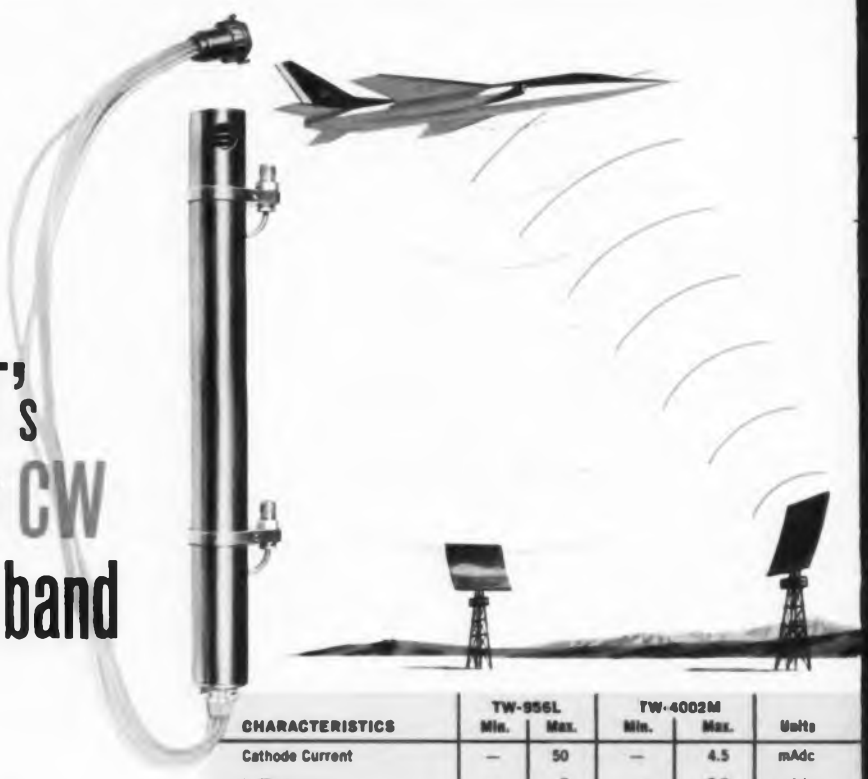
6GC5 . . . for quantity-produced hi-fi equipment; features high power sensitivity. In Class A1 it delivers 2.1W output with a B+ voltage of 110V. Electrically similar to octal-based 6DG6GT.

6GM5 . . . delivers 43W output in Class AB_1 push-pull service, with total distortion of only 1.5%. In ultra-linear circuits it delivers 32W with a B+ supply of 400V. Similar to octal-based 7591.

7695 . . . features exceptionally high power sensitivity. Offers 4.5W output with a B+ supply of only 140V. Utilizes 50V heater. Plate dissipation is 16W. 7754 is 6.3V version of 7695.

Examine the design advantages of 9-T9 types with your Sylvania Sales Engineer. Or, for data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. E, 1100 Main Street, Buffalo 9, New York.

MICROWAVE DEVICE NEWS from SYLVANIA



NEW!
GRIDDED TWT's for PULSED or CW operation in S band frequencies

CHARACTERISTICS	TW-956L Min.	TW-956L Max.	TW-4002M Min.	TW-4002M Max.	Units
Cathode Current	—	50	—	4.5	mAdc
Helix Current	—	7	—	3.2	mAdc
Grid Current	—	7	—	1.0	mAdc
CW RF Power Output (sat)	2W	—	10mW	—	
Small Signal Gain					
(– 30dbm input)	37	—			db
(– 40dbm input)			35	—	db

Designed for Airborne ECM . . .

Sylvania TW-956L, TW-4002M are PPM-focused, magnetically shielded, weigh only 4 lbs., are just 15" long, 1.4" in diameter, temperature compensated for −65° to +72° C.

Utilizing a unique TWT design incorporating grids, both types exhibit sharp cutoff characteristics. They feature relatively flat frequency response over the full 2.0−4.0 kMc frequency range.

TW-956L is capable of 2W CW saturated power output. TW-4002M features CW saturated power output of 10mW. Both types can be provided with virtually any mounting.

For full data on these types contact your Sylvania Sales Engineer, or write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. MDO-E, 1100 Main St., Buffalo 9, New York.

FIRST DC BLOCK COVERING 2.5 TO 10,000 MC

Sylvania SB-100, wideband coaxial device providing dc and low frequency isolation, features low VSWR of 1.3 : 1 or less over its rated frequency range and maximum insertion loss of 0.2db. CW power rating is 100W, peak power is 2KW, voltage isolation of 2KV dc. SB-100 offers excellent stability over a temperature range of −50° to +100° C. It is available with type N connectors. Soon to be available are the SB-101 having BNC connectors and the SB-102 featuring TNC connectors.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

P-129-3

Letters to the Editor

"Measuring Return Loss"

Editor, ELECTRONIC INDUSTRIES:

In the October issue of Electronic Industries there appeared an interesting and well-written article by Raymond E. Lafferty entitled, "Measuring Return Loss Accurately."

I should like to call your attention to the fact that there is a prior publication which describes a similar circuit used for the same purpose. The paper I am referring to was written by Chester B. Watts, Jr. and Andrew Alford. It was presented to the National Convention of the IRE in 1957, and it was published in the 1957 IRE National Convention Record, Part 5, Pages 146-150. For your convenience, a preprint of this paper is enclosed. Figures 2, 3 and 4 and equation 4 are particularly relevant.

Construction of my "Hybridge" is described in U. S. Patent 2,950,449 which was issued on August 23, 1960.

It might also be added that for several years the Alford Manufacturing Company has been selling "Hybridges" separately for measuring small reflections and as parts of automatic impedance plotters.

Andrew Alford
Alford Manufacturing Company, Inc.
299 Atlantic Ave.
Boston 10, Mass.

(*Mr. Lafferty answers*)

Editor, ELECTRONIC INDUSTRIES:

I wish to thank Mr. Alford for directing my attention to his paper which details a novel method for measuring VSWR. I cannot completely agree with Mr. Alford when he compares our respective methods and states that the two circuits are similar, and I believe he does an injustice to his system to so describe it. The systems may be related, but Mr. Alford has combined the features of the directional coupler or hybrid and the bridge and used it in a system which provides an automatic plot of the impedance vs. frequency and the method has much to offer where continuous investigations are required and the additional complexity is justified.

In my paper, the emphasis was on the simple, but accurate, measurement of VSWR, or return loss, using either a basic bridge circuit or directional coupler. I tried to stress that the technique was possible only because of the availability of a sensitive RF voltmeter with full scale ranges from 1 millivolt to 3 volts (such as the Boonton ELECTRONICS Corporation 91CA). This method, naturally,

(*Continued on page* 56)

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*Q.E.D. = Quod erat demonstrandum (what was to be proved)

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POSITIONERS

'Anchor' Antennas at Naval Postgraduate School

On the windswept beach at Monterey, California, the U.S. Naval Postgraduate School operates an antenna facility in connection with courses designed to give advanced students a broader background in antenna engineering. Recently the school made an important addition to its facility—a rugged Scientific-Atlanta tri-axial antenna positioner. Featuring extremely small deflection with maximum bending moment, this Series PAEA Positioner precisely* orients the antenna under test in all three axes of rotation. DC drive motors permit continuous speed control, and 1:1 and 36:1 precision synchros on each axis relay nonambiguous position information to the instrument shelter 400 feet away. Antenna patterns are plotted and measured by a Scientific-Atlanta receiver and recorder.

Model PAEA-23
Heavy duty tri-axial positioner.

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Scientific-Atlanta supplies positioners with various load capacities and bending moments in a modular series of azimuth, elevation, and polarization units. Restricted axes are equipped with limit switches, continuous rotation axes can be supplied with rotary joints and/or slip rings. All axes are normally supplied with precision 1:1 and 36:1 synchros. DC, variable speed drives, or servo drive amplifiers are available.

For details, write for technical bulletin. Dept. 44

*Position Accuracy of Model PAEA Positioner at U.S. Naval Post-graduate School (degrees): Upper Azimuth, 0.04; Elevation, 0.05; Lower Azimuth, 0.03.

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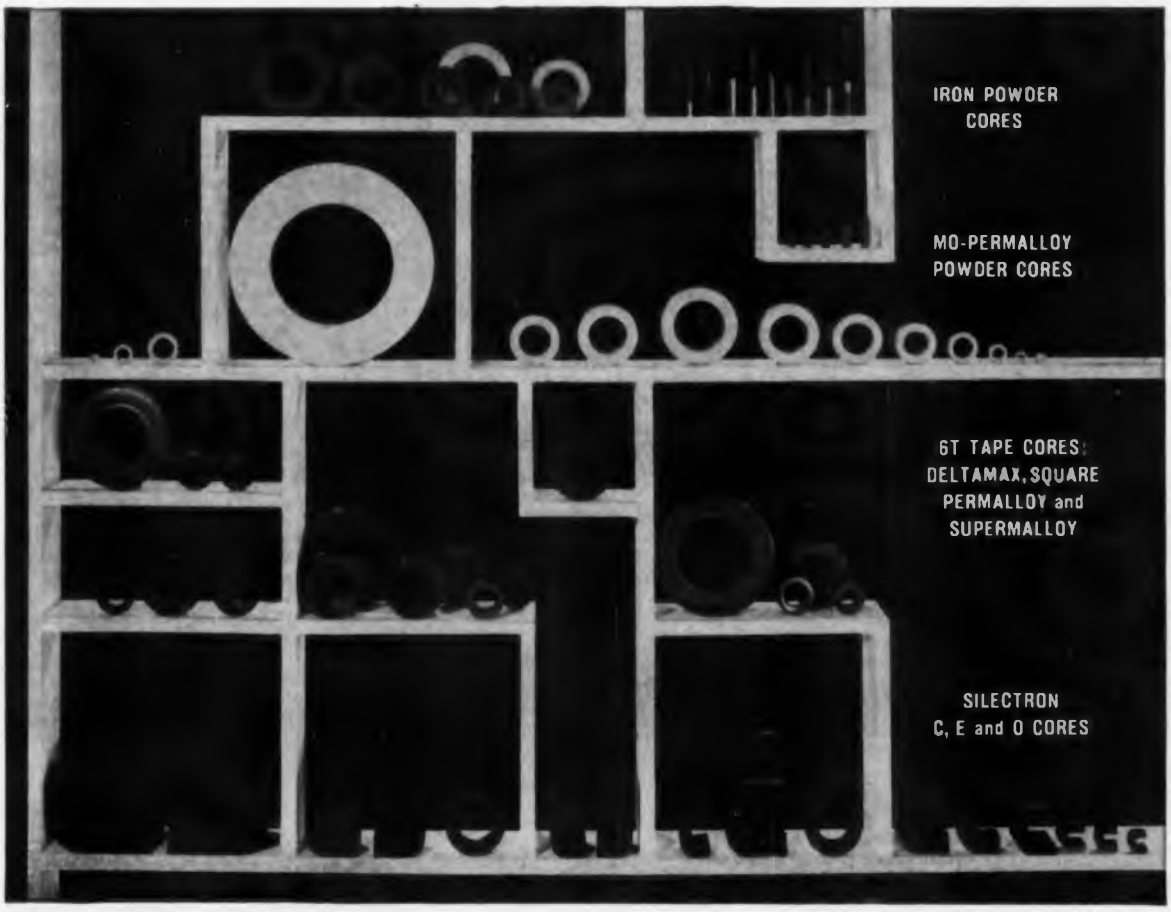

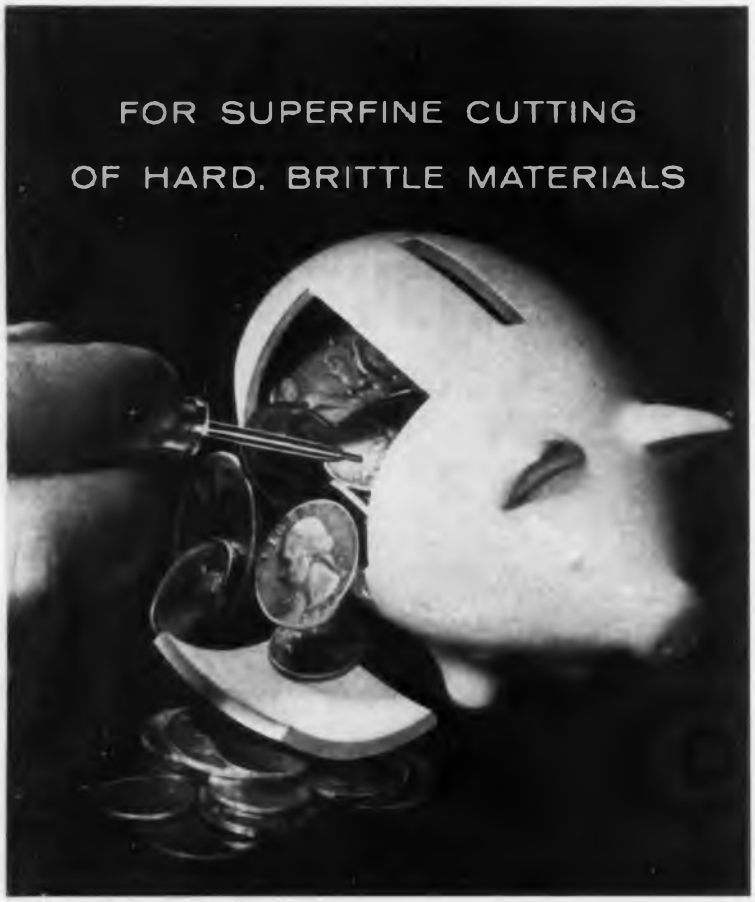

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Letters to the Editor

(*Continued from page* 53)

requires several measurements if a frequency or impedance range is to be investigated, but for laboratories which do not specialize in UHF measurements, the simpler approach as described in my paper is quite satisfactory. A combination which suggests itself is Mr. Alford's "Hybridge" and our 91CA RF voltmeter for a simple set-up for return loss measurements.

I regret that I did not know of the contribution by C. B. Watts and Andrew Alford and was therefore unable to reference it in my paper. It is interesting to note that when the wide-band measuring technique is used, the limit of measurable return loss by either method is approximately the same, i. e. 45 db. The narrow band, tuned system, described in my paper has a little more to offer in that return loss measurements up to 55 db are possible. This is equivalent to a VSWR of 1.004.

Raymond E. Lafferty
Chief Engineer
Boonton ELECTRONICS Corporation
738 Speedwell Ave.
Morris Plains, N. J.

New Markets

Editor, ELECTRONIC INDUSTRIES:

In the July 1960 issue of your excellent publication, there appeared the article "Searching for New Electronic Markets." I would like to obtain about 10 reprints to circulate to our key marketing people.

D. P. Rohrbach
Marketing Research Manager
Shure Brothers Incorporated
222 Hartrey Ave.
Evanston, Ill.

"Writing—The Key"

Editor, ELECTRONIC INDUSTRIES:

Would you be kind enough, in the next issue of "Electronic Industries" to publish a correction in relation to the author's name of "Writing—Key to your Engineering Development" (Feb. 1961). My correct name is

A. M. Morgan-Voyce

I also have received a request from the U. S. Naval Ordnance Laboratory for some reprints of the paper and presume you will be kind enough to forward them the copies.

Thank you.

A. M. Morgan-Voyce
General Electric Company
Court Street
Syracuse, N. Y.

(*Continued on page* 60)

another Sarkes Tarzian production breakthrough!

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

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6 to 105 volts, in 20% increments

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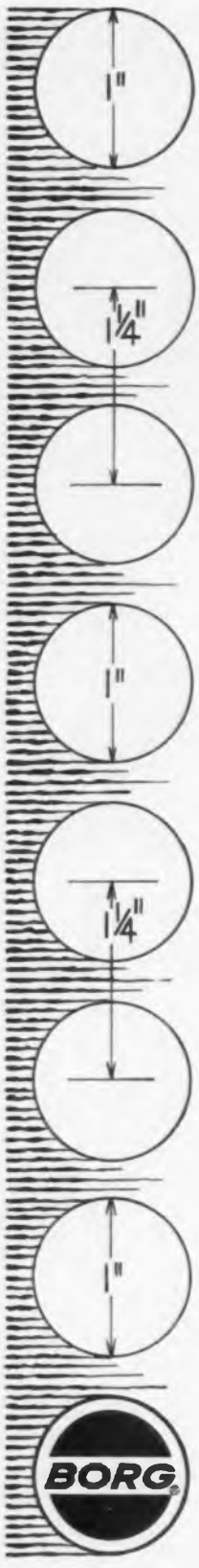

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Without Brake
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Actual Size

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Models	**Numeral Colors**
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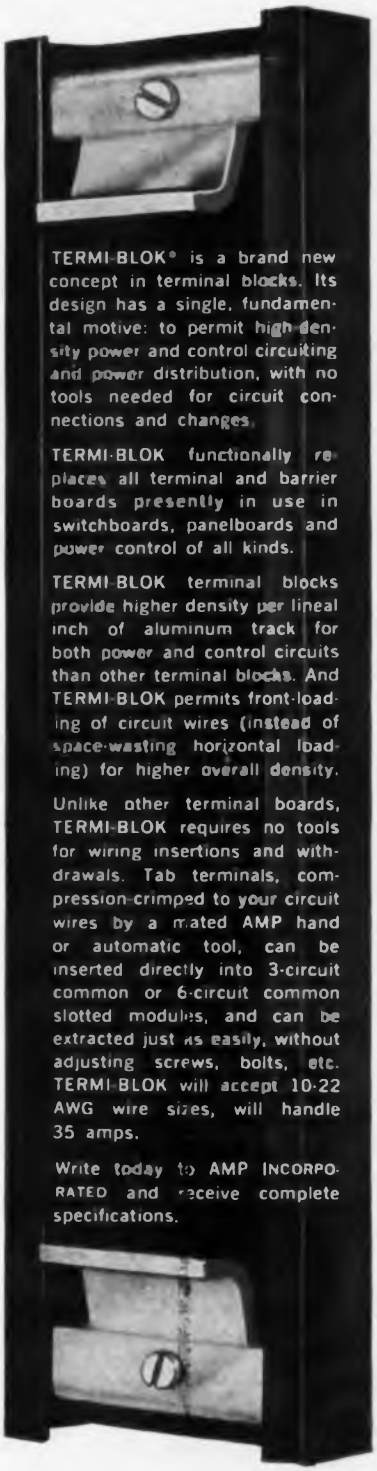

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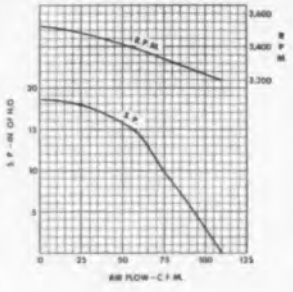

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Letters to the Editor

(*Continued from page* 56)

"RFI Series—"

Editor, ELECTRONIC INDUSTRIES:

I have followed many of your articles on R.F.I. throughout the past year, and would appreciate reprints of all these articles published in Electronics Industries throughout 1960. I would also like to receive a reprint of the article "An Introduction to Boolean Algebra" published in the June Directory and all Reference Issue.

We receive your publication here at the office and I must say it contains many interesting articles and data. Thanks for a fine selection of material.

Albert F. Collett, Engineer
New England Telephone and
Telegraph Company
50 Oliver Street
Boston 7, Mass.

Editor, ELECTRONIC INDUSTRIES:

Following Your invitation on page 90 in the "Electronic Industries" (October, 1960) I should greatly appreciate to receive a reprint of the eight articles so far published concerning Radio Frequency Interference problems.

Borge Jiesen

Kingdom of Denmark
General Directorate of
Posts and Telegraphs
Tietgengade 37
Copenhagen

Technical Dictionary

Miss Sylvia N. Berman
Group Secretary
Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge 39, Massachusetts

In the January 1961 ELECTRONIC INDUSTRIES, "Letters to the Editor," you suggested a manual of correctly spelled and abbreviated terms for technical secretaries.

The American Institute of Physics publishes a "Style Manual," which I think is about what you have in mind. This is a list of standard abbreviations which are quite commonly used by scientists and engineers, at least in the United States.

I feel sure this manual would be helpful to you and others in your organization. The address of the American Institute of Physics is 335 East 45th Street, New York 17, New York.

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Office Manager
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S311A	$150.	S312A	$270.	2.60 to 3.95	48
H311A	$140.	H312A	$210.	3.95 to 5.85	49
C311A	$135.	C312A	$180.	5.85 to 8.20	50
W311A	$130.	W312A	$150.	7.05 to 10.0	51
X311A	$125.	X312A	$130.	8.20 to 12.40	52
Y311A	$130.	Y312C	$135.	12.40 to 18.00	91
—		K312C/CF	$155.	18.00 to 26.50	53
—		U312B/BF	$170.	26.50 to 40.00	96
—		Q312B	$235.	33.00 to 50.00	97
M311A	$225.	M312C	$245.	50.00 to 75.00	98
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—		F313A	$775.	90.00 to 140.00	138
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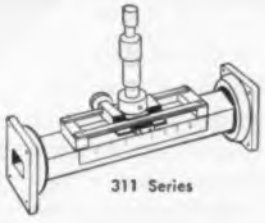

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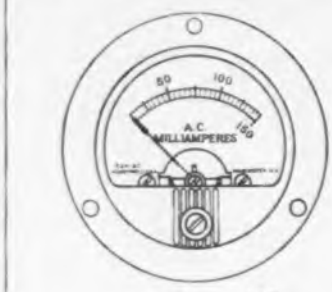

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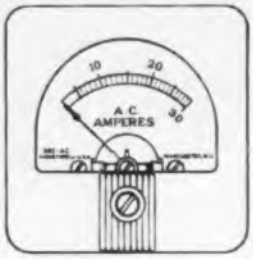

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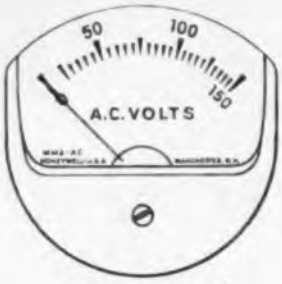

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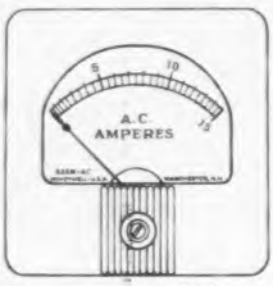
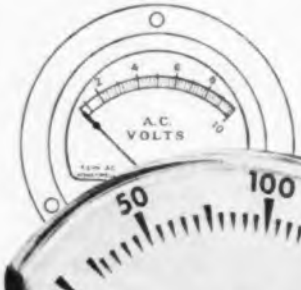
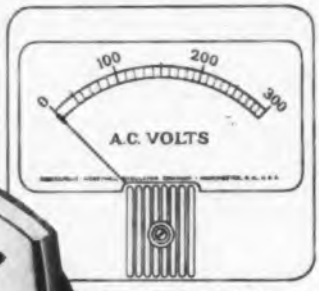


53SN-AC 3½"





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ELECTRICAL CHARACTERISTICS
(25° C except as noted)

TYPES	DESCRIPTION	JEDEC OUTLINE	f_T TYPICAL	P_C@25°C CASE TEMP.	h_{FE} MIN.	h_{FE} MAX.	V_{CER}	V_{CBO}	$V_{BE(Sat)}$ MAX.	$V_{CE(Sat)}$ MAX.	I_{CBO}@25°C MAX.
2N1985 2N1984 2N1983	Small signal types for AC and DC amplifiers	TO-5	50 mc	2 watts	15* 35* 70*	45* 100* 210*	40	50	—	—	5 μA
2N1987 2N1986	Switching types	TO-5	50 mc	2 watts	20 60	80 240	40	50	0.9	0.6	5 μA
2N1989 2N1988	High voltage types particularly suited to video amplifiers and RF oscillators	TO-5	50 mc	2 watts	20 35	60 120	60	100	1.0	2.0	5 μA
2N1991	PNP complement to the small signal and switching types	TO-5	50 mc	2 watts	15	60	—25	—30	—1.5	—1.5	5 μA
2N1990	Neon tube and Nixie® driver type	TO-5	—	2 watts	20	—	60	100	1.0	0.5	—

Nixie Registered Burroughs Corporation.

* For the small signal types, this specification is h_{fe} at 1 k_c instead of h_{FE} at DC.

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Circle 80 on Inquiry Card

model 317

NEW Ballantine VTVM measures 300 μV to 300 V

Price: $445. (With probe $495)

at Frequencies 10 cps to 11 Mc

FEATURES: ● Accuracy is % of reading anywhere on scale at any voltage ● Five inch mirror-backed voltage scales of 1 to 3 and 3 to 10, each with 10% overlap; 0 to 10 db scale ● Use as a sensitive null detector 5 cps to 30 Mc ● Use as a stable 60 db wideband amplifier, 2.5 volts max. output ● Cathode follower probe has a voltage range of 300 μV to 300 mV, and a high input impedance ● Instrument is average responding type. ● Effect of line transients nil ● Available in portable model shown or in 19 inch rack version.

SPECIFICATIONS:

VOLTAGE: 300 μV to 300 V.
FREQUENCY: 10 cps to 11 Mc (As a null detector, 5 cps to 30 Mc).

ACCURACY: % of reading anywhere on scale at any voltage. 20 cps to 2 Mc — 2%; 10 cps to 6 Mc — 4%; 10 cps to 11 Mc — 6%.

SCALES: Voltage. 1 to 3 and 3 to 10, each with 10% overlap. 0 to 10 db scale.

INPUT IMPEDANCE: With probe, 10 megohms shunted by 7 pF. Less probe, 2 megohms shunted by 11 pF to 24 pF.

AMPLIFIER: Gain of 60 db ± 1 db from 6 cps to 11 Mc; output 2.5 volts.

POWER SUPPLY: 115/230 V, 50 — 400 cps, 70 watts.

DIMENSIONS (Inches): Portable, 13 h x 7½ w x 9½ d. Rack, 8¾ h x 19 w x 8½ d.

WEIGHT: 17 pounds, portable or rack models. Approximately 34 pounds shipping weight.

Write for brochure giving many more details

— Since 1932 —

BALLANTINE LABORATORIES INC.

Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO, AC DC AND DC AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND RF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES. ASK ABOUT OUR LABORATORY VOLTAGE STANDARDS TO 1,000 MC.

Personals

William G. Wolff—named to the newly-created post of Applications Manager for Temptron, Inc., Reseda, Calif.

H. Herbert Jackson—to Manager of the Nimbus Weather Satellite Control System for General Electric's Missile and Space Vehicle Dept., Phila., Pa.

William L. Greyson—appointed Manager of Research and Development for Tensolite Insulated Wire Co., Inc.

Claire Bell—joins Varian Associates as Manager, Instrument Product Engineering, Instrument Div., Palo Alto, Calif.

Meyer Leifer to the post of chief Engineer of the Ampex Instrumentation Products Co., Redwood City, Calif.

M. Leifer

R. L. Trent

Robert L. Trent—named Technical Director for the Semiconductor Div. of Sperry Rand Corp., Norwalk, Conn.

John Cammarata—named Manager of Product Reliability for Arma Div., American Bosch Arma Corp., Garden City, N. Y.

Gerald D. Ewing has been appointed Supervisor of Application Engineering for Shockley Transistor unit of Clevite Transistor, Palo Alto, Calif.

William R. Bidermann—appointed to the newly created position of Chief Production Engineer of Telecomputing Corp.'s Whittaker Gyro Div., Van Nuys, Calif.

Ralph G. Lindstrom—to Manager, Engineering Services Dept. for the Western Development Laboratories of Philco Corp., Palo Alto, Calif.

PRD Electronics, Inc., Brooklyn, N. Y., announces the appointments of **Dr. L. J. Castriota** as Manager of Engineering; and in the Weapons Systems Div., **Ralph G. Lohmann**, Project Manager of Attack Systems and Messrs. **Erick J. Koch** and **George H. Teommey** as Project Engineers.

THE NEW 707 ASTROJET* JET AGE: STAGE II

Now offered in regular transcontinental passenger service, American Airlines' new 707 Astrojet brings you a new standard of jet performance by the airline that's *first choice of experienced travelers.*

Powered by revolutionary new Jet-Fan engines, the 707 Astrojet greatly outperforms all other airliners. It takes off more quickly, uses far less runway than the best of standard jets. Aboard it, you experience a wonderful feeling of confidence as the Astrojet climbs swiftly to cruise easily, smoothly, within the transonic range—faster than any other jetliner in the world.

In keeping with its 25-year tradition of leadership, American is proud to be first in bringing you this new dimension in jets—this historic new era in air travel.

AMERICAN AIRLINES
America's Leading Airline

*Service mark of American Airlines, Inc.

Circle 82 on Inquiry Card

NWL portable AC power supply

The portable AC power supply shown here is just the thing for hard to reach places or when the main power source is too far removed. It has numerous types of outputs and many voltages and phases offer a wide selection of power requirements. The unit can also be designed for outdoor use. Input and output are 3 ø, 60 to 400 cycles. Output voltages are 120, 240, and 460 in single, 2 or 3 ø. The portable AC power supply can also be furnished with an adjustable voltage control from 0 to full output. This unit can be built with any output to meet your requirements.

Each NWL unit is thoroughly tested and must meet all customer requirements before shipment. We shall be pleased to quote you according to your individual requirements.

NWL
ESTABLISHED 1920
NEMA

Nothelfer
SAY: NO—TEL—FER

NOTHELFER WINDING LABORATORIES, INC., P. O. Box 455, Dept. EI-5, Trenton, N. J.
(Specialists in custom-building)

Personals

Dr. Henry F. H. Wigton has been appointed to the Technical Staff of Fairchild Semiconductor Corp.'s Research and Development Laboratories, Physics Section, Mountain View, Calif.

Dr. Taffee T. Taniomoto named Head of the Pattern Recognition Laboratory at Melpar's Applied Science Div., Watertown, Mass.

John Stiles—now heads the Advanced Products Dept., Gyrodynamics Branch in Kearfott Div., General Precision, Inc., Little Falls, N. J.

Sol Wiener—named Chief Value Engineer of Polarad Electronics Corp., Long Island City, N. Y.

Thomas J. Vaughan—to the post of Manager of RF Engineering for Antenna Systems, Inc., Hingham, Mass.

T. J. Vaughn

P. F. Grad

Peter F. Grad—new Chief Chemical Engineer for Rotron Mfg. Co., Inc., Woodstock, N. Y.

Richard J. Martin—joins the Magne-Head Div. of General Instrument Corp. as Engineer in Charge of Evaluation and Tests.

Dr. Peter Wargo named Manager of Engineering for General Electric's Cathode Ray Tube Dept., Syracuse, N. Y.

Norman Rudnick—appointed Director of the new Transducers and Materials Laboratory at Gulton Industries, Inc., Metuchen, N. J.

Dr. George M. Nonnemaker named Manager of Signal Processing Products, Missile Electronics and Controls Div., Defense Electronic Products, Radio Corp. of America, Burlington, Mass.

Hughes Aircraft Co. announces the appointment of **Charles W. Curtis** as Manager of the radar laboratory, ground systems group; **Dr. Daniel Binder**, Head of the Nuclear Measurements Dept.; **Edson B. Gould III**, Manager of Reliability and Quality, Semiconductor Div.; and **Jose M. Tellez**, Associate Manager of the Computer Laboratory, Ground Systems Group.

DALE

Type MC resistors meet every environmental test

As specifications grow even more demanding . . . as environmental conditions grow even more rigorous . . . you can continue to place the utmost confidence in Dale precision resistors.

Dale resistors retain their stability because it is inherent —that is, "firmly infixed" by design and methods of manufacture. These methods have reached new levels of achievement as the result 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.

DALE ELECTRONICS, INC.

1304 28th Ave., Columbus, Nebraska, U.S.A.

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

DALE **TYPE MC** RESISTORS

CARBON FILM • MOLDED • PRECISION

Type MC carbon film resistors are completely insulated and protected by molded housings against mechanical damage and against moisture, salt spray and other severe environmental factors. They offer outstanding stability and have excellent high frequency characteristics.

- RATED AT ⅛ watt, ¼ watt, ½ watt, 1 watt, 2 watts
- RESISTANCE RANGE from 1 ohm to 50 megohms
- TOLERANCE ±1%
- TEMPERATURE COEFFICIENT 500 P.P.M. maximum
- FULL POWER to 70° C.

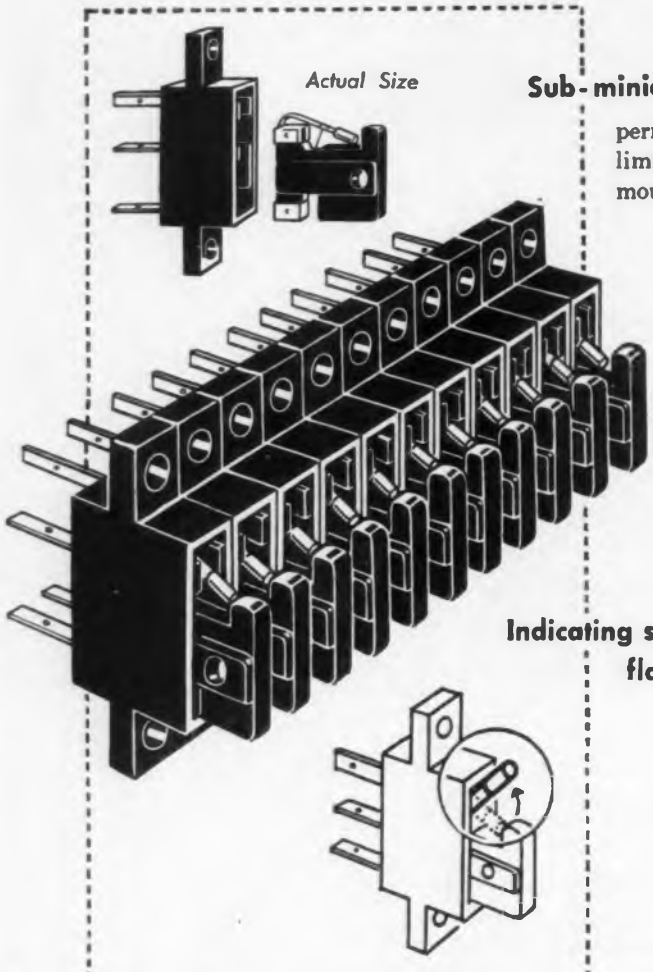
Write for Bulletin R-36 and handy cross reference file card

Circle 98 on Inquiry Card

NEW! BUSS . . .

Signal Indicating · Alarm Activating

GMT Fuse & HLT Fuseholder



Sub-miniature design

permits multiple mounting of fuses in limited space. Fuseholders can be mounted on ¼ inch horizontal centers.

Fuse and holder combination readily adaptable for use in equipment operating at 300 volts or less, such as: communication equipment, business machines, computors, control equipment or other multiple circuit apparatus where space is at a premium.

Indicating spring flashes color-coded flag when fuse opens

to give quick, positive identification of faulty circuit.

Indicator spring also makes contact with an alarm circuit so, it can be used to flash a light—or sound audible signal on fuse panel or at a remote location.

Ask for bulletin GMCS on BUSS GMT fuses and HLT holders.

561

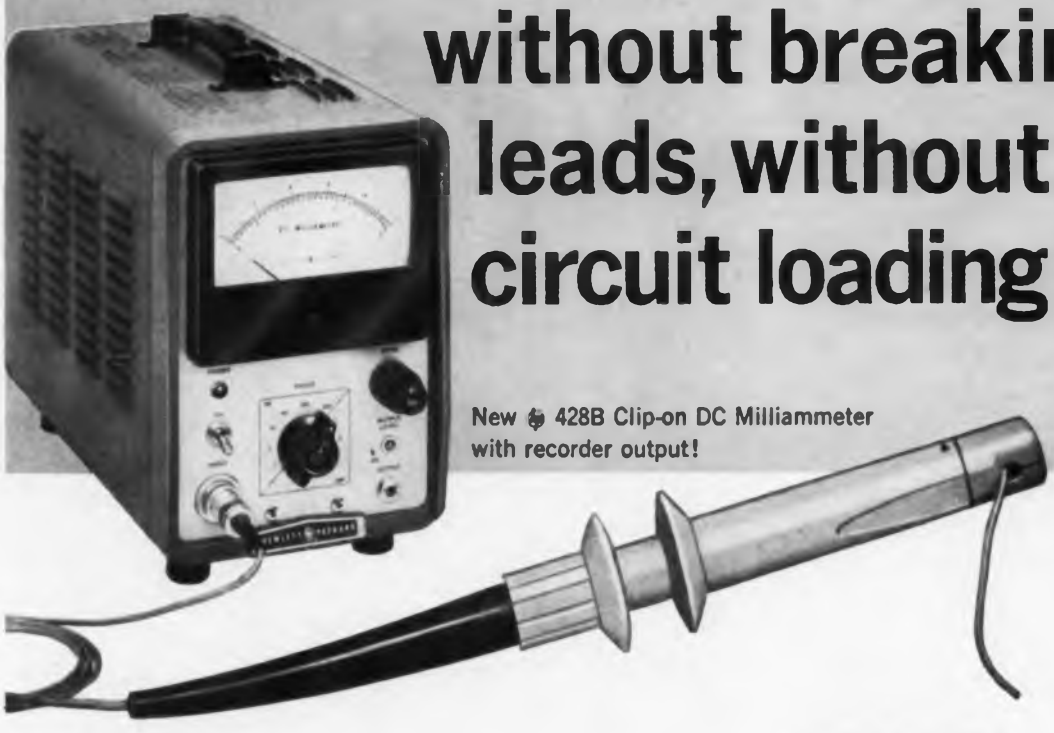
In the BUSS line,

you'll find the type and size fuse to fit your every need . . . plus a companion line of clips, blocks and holders.

FUSETRON BUSS — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — McGRAW EDISON

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.,* **UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.**

Measure and record DC current, 0.1 ma to 10 amps without breaking leads, without circuit loading!



New hp 428B Clip-on DC Milliammeter with recorder output!

Now you can measure and record dc current to 10 amps without interrupting the circuit and with no circuit loading. You simply slip the jaws of the hp 428B probe around a bare or insulated wire and read dc, even in the presence of equally strong ac on the same wire. No need to break leads. The 428B reads dc current directly in 9 ranges by sensing the magnetic flux induced by dc current in the wire.

To measure current difference between two separate wires just clip the probe around them both and read, then reverse one lead and read their sum! For even greater sensitivity you simply increase the number of lead loops through the probe, increasing sensitivity by the same factor as the number of loops.

The recorder/oscilloscope output, dc to 300 cps, makes it easy to record dc levels as well as analyze ground buss, hum and ripple currents on an oscilloscope—all without circuit loading.

hp also offers Model 428A Clip-on DC Milliammeter. This instrument is similar to hp 428B except that coverage is limited to 3 ma to 1 ampere (6 ranges), the recorder output is not included, and price is somewhat lower.

SPECIFICATIONS

Current Range: hp 428A, 3 ma to 1 a full scale in 6 ranges
hp 428B, 1 ma to 10 a full scale in 9 ranges

Accuracy: ± 3%, ± 0.1 ma

Probe Inductance: < 0.5 uh introduced into measured circuit

Probe Induced Voltage: < 15 mv peak into measured circuit

AC Rejection: AC with peak value less than full scale affects meter accuracy less than 2% at frequencies above 5 cps and different from carrier (40 KC) and its harmonics. (On 428B 10 amperes range, ac is limited to 4 amperes peak)

Recorder/Oscillator Output: hp 428B, approximately 1.4 v across 1,400 ohms full scale. Frequency response dc to 300 cps

Probe Insulation: 300 v maximum

Probe Tip: ½" x 9/32". Aperture diam. 3/16"

Size: Cabinet, 7½" x 11½" x 14¼"; rack mount, 19" x 7" x 13" behind panel

Weight: Cabinet, 19 lbs; rack mount, 24 lbs.

Price: hp 428A, $500.00 (cabinet); hp 428AR, $505.00 (rack mount)
hp 428B, $550.00 (cabinet); hp 428BR, $555.00 (rack mount)

HEWLETT-PACKARD COMPANY
1066F Page Mill Road Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000
Sales representatives in all principal areas

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

7058

DIGITAL MODULES

...building block or plug-in card

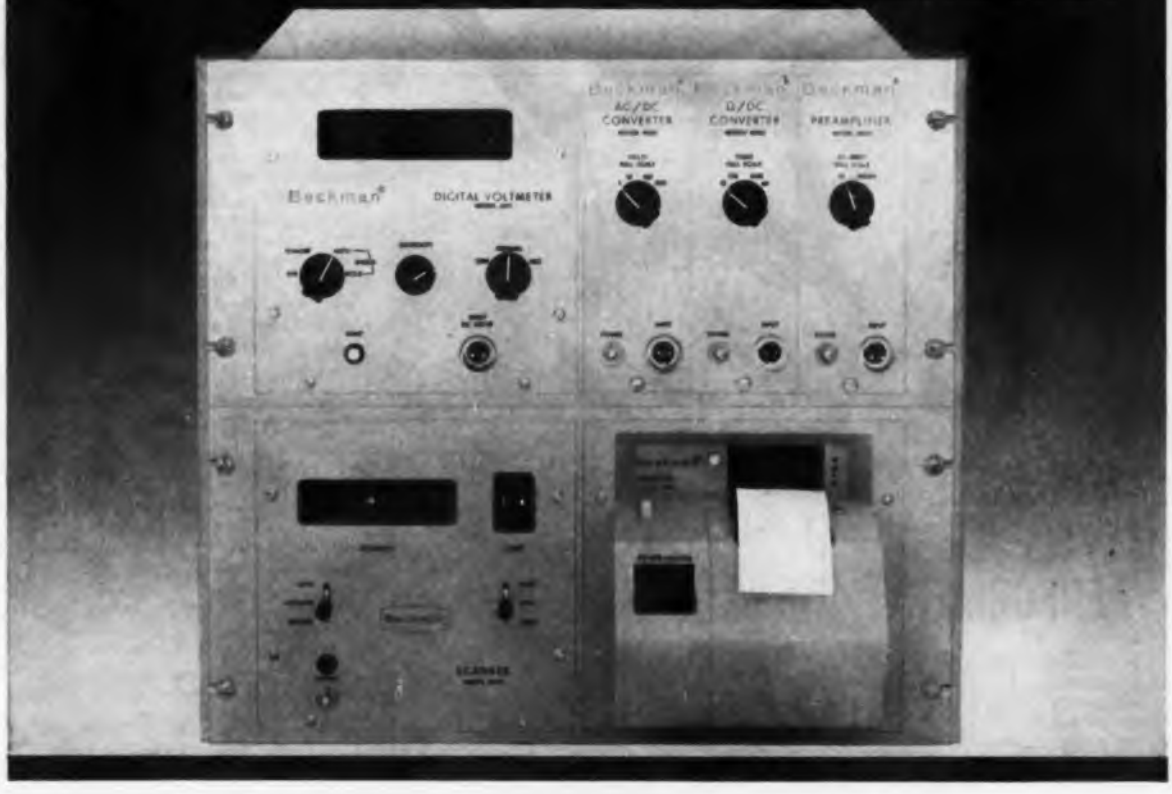
Which package fits into your design? Packaged either way, Delco Radio Digital Modules meet or exceed all MIL-E-5272D (ASG) environmental requirements. Continuing life tests on these computer circuits now exceed four and one-half million transistor hours *without a failure*. The modules perform all the standard logic functions and come in many basic types and variations. Delco modules in the transistorized building block package are ideally suited for airborne guidance and control because of their extreme ruggedness, compactness and reliability. All miniature building block modules employ three dimensional welded wiring techniques and are vacuum encapsulated in epoxy resin. Delco Radio can offer you off-the-shelf digital circuits packaged as building blocks or plug-in cards, or can supply circuits to meet your specific needs. Our Sales Department will be happy to send you complete engineering data. Just write or call. ■ *Physicists and electronics engineers: Join Delco Radio's search for new and better products through Solid State Physics.*

PIONEERING ELECTRONIC PRODUCTS THROUGH SOLID STATE PHYSICS

DELCO RADIO
DEPENDABILITY
RELIABILITY

Division of General Motors • Kokomo, Indiana

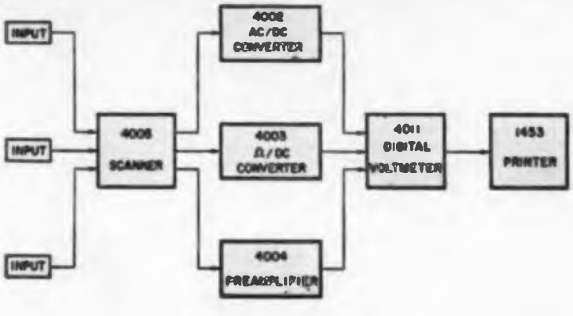
EXPANDABLE
MODULAR DIGITAL MULTIMETER



Picture this self contained, automatic system working for you—the compact Beckman 4011 .01% dvm; together with converters for measuring low millivoltage DC, AC and ohms; a scanner which allows automatic readings of 29 sources of information; and finally, the Beckman solid-state, digital printer to make a permanent, indexed record of all the readings.

Price for the complete system about $4800

For detailed specifications on all these instruments and their use together, write for Brochure A4011.



Beckman 4011 a complete portable dvm is available, as are the other modules shown above, as a portable package.

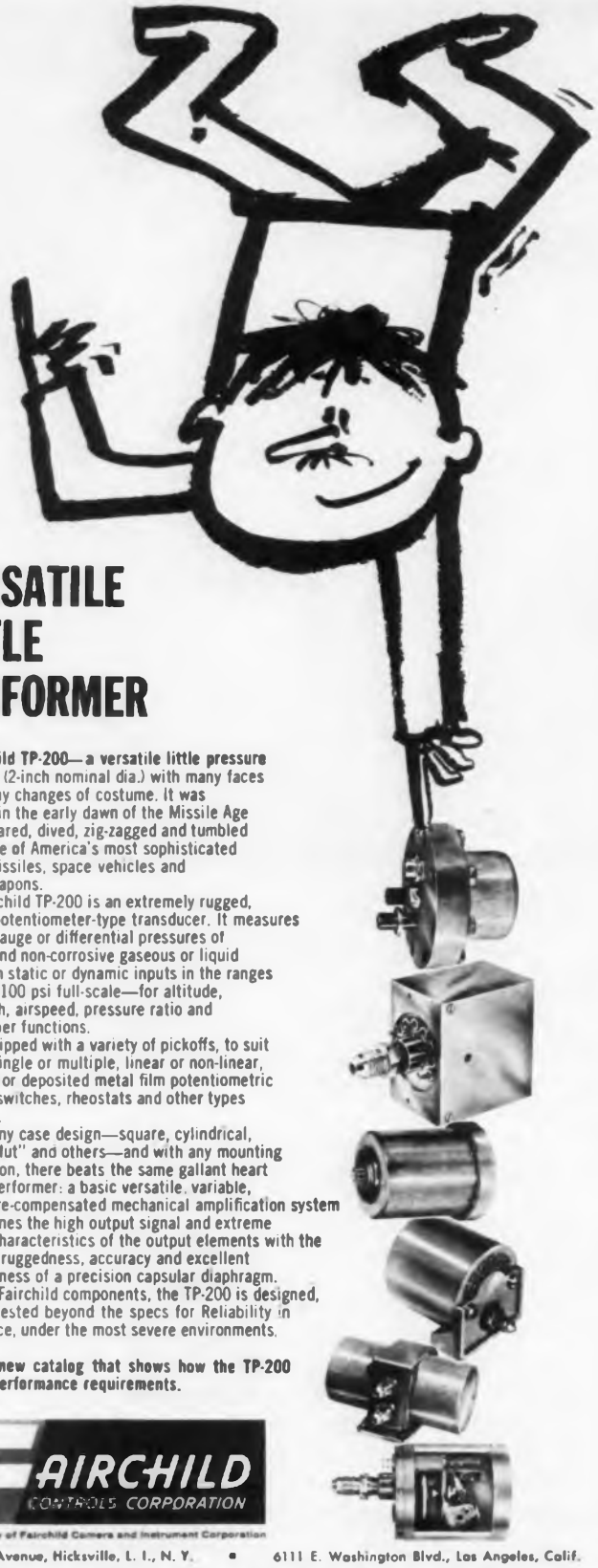
BERKELEY DIVISION
of Beckman Instruments, Inc.

INSTRUMENTAL IN YOUR FUTURE • Beckman

Richmond, California

T29

Circle 87 on Inquiry Card



A VERSATILE LITTLE PERFORMER

The Fairchild TP-200—a versatile little pressure transducer (2-inch nominal dia.) with many faces and as many changes of costume. It was conceived in the early dawn of the Missile Age and has soared, dived, zig-zagged and tumbled within some of America's most sophisticated aircraft, missiles, space vehicles and special weapons.

The Fairchild TP-200 is an extremely rugged, precision potentiometer-type transducer. It measures absolute, gauge or differential pressures of corrosive and non-corrosive gaseous or liquid media, with static or dynamic inputs in the ranges of 0-5 to 0-100 psi full-scale—for altitude, water-depth, airspeed, pressure ratio and Mach number functions.

It is equipped with a variety of pickoffs, to suit its role—single or multiple, linear or non-linear, wirewound or deposited metal film potentiometric elements, switches, rheostats and other types of pickoffs.

Within any case design—square, cylindrical, "Quonset Hut" and others—and with any mounting configuration, there beats the same gallant heart of a true performer: a basic versatile, variable, temperature-compensated mechanical amplification system that combines the high output signal and extreme accuracy characteristics of the output elements with the reliability, ruggedness, accuracy and excellent responsiveness of a precision capsular diaphragm.

Like all Fairchild components, the TP-200 is designed, built and tested beyond the specs for Reliability in Performance, under the most severe environments.

Write for new catalog that shows how the TP-200 fits your performance requirements.

FAIRCHILD CONTROLS CORPORATION

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TRANSDUCERS • RATE GYROS • POTENTIOMETERS • ACCELEROMETERS

Books

Statistical Processes and Reliability Engineering

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

This study of the theory and applicaton of mathematical statistics 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. He first presents and explains statistical laws, and then explores their relationships with engineering disciplines and practices.

Electronic Tubes and Semiconductor Elements in 2 Volumes, Volume I

Edited by P. Mikolajczyk. Published 1960 by Pergamon Press, Inc., 122 E. 55th St., New York 22. Price $20.00.

This important reference work contains an exhaustive compilation of data on electron tubes and semiconductors in seven languages: English, French, Spanish, German, Polish, Russian and Italian, relating to all tubes manufactured throughout the world used in radio receivers and transmitters (up to 500 W of dissipated power) television and television equipment, computers, etc.

Elements of Electronics, 2nd Edition

By Henry V. Hickey and William M. Villines, Jr. Published 1961 by McGraw-Hill Book Co., Inc. 330 West 42nd Street, New York 36, N. Y. 549 pages. Price $8.75.

This easy-to-understand book has been designed to cover sufficient material to prepare the reader for advanced work in any of the branches of electrical engineering. It begins with a comprehensive survey of basic physics. It then progresses through the study of a simple transmitter and receiver, with all associated and related material thoroughly explained.

Books Received

A History of Platinum

By Donald McDonald. Published 1960 by Johnson Matthey & Co., Limited, Hatton Gardon, London, EC1. 254 pages. Price $5.50.

Electron Optics in Television

By I. I. Tsukkerman. Published 1961 by Pergamon Press, Inc., 122 East 55th Street, New York 22, N. Y. Price $8.50.

Reflections on the Motive Power of Fire

By Sadi Carnot. Published 1960 by Dover Publications, Inc., 180 Varick Street, New York 14, N. Y. 152 pages, paper bound. Price $1.50.

Optics and Optical Instruments

By B. K. Johnson. Published 1960 by Dover Publications, Inc., 180 Varick Street, New York 14, N. Y. 224 pages, paper bound. Price $1.65.

(Continued on page 76)

This Baby is Bayonet-Locking

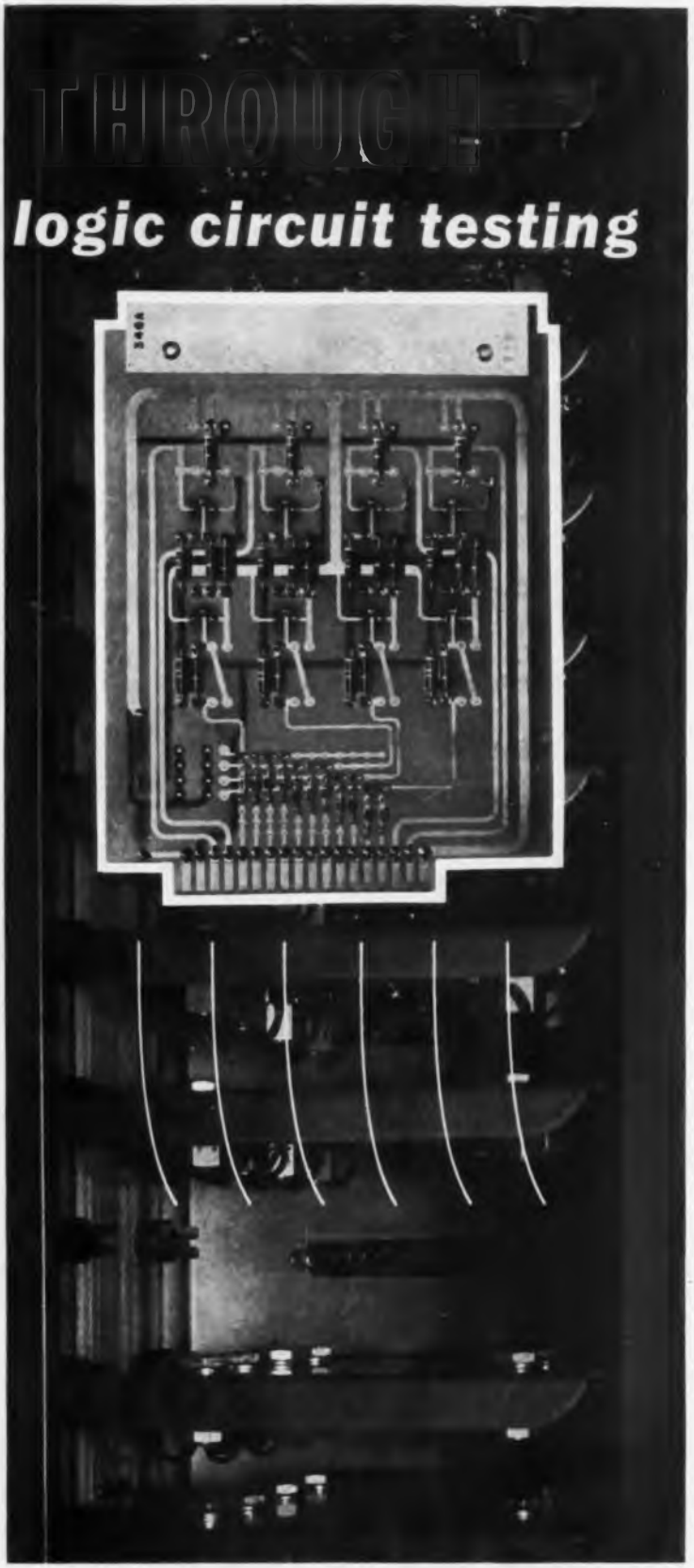
Meet DTK...the best little bayonet-locking electrical connector available today. DTK is short for Deutsch Tri-Kam and refers to the triple cam coupling design that assures fast, positive engagement and lock. As a direct descendant of MIL-C-26482, this baby is interchangeable with existing MS 3110 and 3116 series connectors. The DTK also inherits many desirable features from its Deutsch ancestors including superior silicone inserts and MIL-C-26636 crimp-type contacts that are insertable and removable with military standard tools. Color-keyed mating indexes and 7-point inspection for lock, make this latest generation connector a cinch to couple, even in remote locations. For more vital statistics on the latest addition to the Deutsch family, contact your local Deutschman today or write for Data File A-5.

DEUTSCH

Electronic Components Division • Municipal Airport • Banning, California

ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

BREAK THROUGH
in automatic logic circuit testing



Production of packaged module circuits gains new impetus with this major achievement! Now you can *automatically* test the operating characteristics of logic circuit modules, memory boards, component cards and similar units —with speed, precision and dependability.

The new Tape Programmed DIT-MCO Model 720 rapidly performs static and dynamic tests on active and passive modular circuits.

Tests that can be performed with the new Model 720 include:

- Logic circuit response to all logical combinations of DC input levels.
- Marginal tests to evaluate logic modules under conditions of lowered or raised supply levels in combination with lowered or raised signal input levels.
- Complete tests of conversion matrices for proper logic, levels.

The Tape Programmed DIT-MCO Model 720 will accurately test variables which are required to maintain ± 0.5% accuracy, and 3 digit tolerance values can be programmed. Provision is made for programming AC or DC sources and external signals through the tester.

Performance of this entirely new circuit analyzer is backed by the experience and reliability of DIT-MCO, Inc.—the nation's *leader* in automatic circuit testing.

Automatically yours

DIT MCO

DIT-MCO, INC. • 911 BROADWAY
Kansas City 5, Missouri • HArrison 1-0011

Los Angeles Area • Oregon 8-6106
New York City Area • MUrray Hill 2-5844

INLAND

first with solid state 100-watt d-c amplifier

Inland's new **Model 579.35** d-c amplifier has a high power output of 100 watts when used with low impedance loads requiring direct current. And this completely transistorized amplifier is packaged in a hermetically sealed can only **2½" x 3⅜" x 2½"**.

Designed for use with d-c torquers, in one typical application Model 579.35 provides 65 db power gain between the output of a d-c driver stage and the input terminals of a permanent magnet torque motor. This amplifier has these outstanding performance characteristics:

- The d-c output has magnitude and polarity proportional to the input signal.
- All amplifier circuits use a combination of silicon and germanium transistors (all-silicon models also available).
- Amplifier null and gain are stable and independent of temperature.

Inland also makes a complete line of rotary amplifiers for matched use with Inland's distinctive pancake shape d-c torquers.

A brochure on this new high-power amplifier is available. For your copy and complete data on Inland torquers and amplifiers, write Dept. 8-5.

TYPICAL SPECIFICATIONS

Maximum Power Output, watts (6 ohm load)	100
Power Gain	4,000,000
Current Gain	200,000
Voltage Gain	15
Frequency Response	DC to 1000 cps
Input Impedance, ohms	50,000
Dimensions, inches	2½ wide 3⅜ long 2½ high
Operating Temperature Range in °C	minus 50° to plus 50°

INLAND MOTOR

INLAND MOTOR CORPORATION OF VIRGINIA • A SUBSIDIARY OF KOLLMORGEN CORP., NORTHAMPTON, MASS.

from
Magnet Charger
HEADQUARTERS

MODEL 1500
with Dual Ranges to 10,000 Ampere-Turns

3 VERSATILE MODELS

Designed for production, research and instrument repair work, the Model 1500 will magnetize the new cobalt platinum and barium ferrite materials as well as all the Alnicos. It will saturate large switchboard meter assemblies and all panel type instruments and uses most existing adapters designed for the Model 107A. Wire-wound fixtures are plugged into front panel through a safety interlock system providing maximum operator protection. Operates from 115-volt, 60 cps line. Size 11 x 20 x 15; weight 125 lbs. Price $995.

MODEL 107A

A basic condenser discharge unit for most medium size magnets, the Model 107A provides ranges of 12,000 and 24,000 ampere-turns. It is capable of saturating most instrument magnets, including the new core type mechanisms, using adapters or wire-wound fixtures. Designed for continuous duty. Operates from 115-volt, 60-cycle line. Price $590.

MODEL 942

A high powered magnetizer (up to 200,000 ampere-turns) capable of charging large Alnico and ceramic magnets of various shapes or pole configurations. Adapters for multi-pole rotors, rod, bar, ring and other shapes are available. Designed for continuous production use. Size 30" x 33" x 38"; weight 235 lbs. with 200-uf unit. Price of basic unit is less than $2100.

Performance of all models is rigidly guaranteed. Prices are not f.o.b. Boonton, N.J. and subject to change without notice.

WE CAN HELP YOU

13 years' magnet charging experience is yours for the asking—send for illustrated data sheets.

RFL Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

Books

(Continued from page 72)

The Dynamical Theory of Sound

By Horace Lamb. Published 1960 by Dover Publications, Inc., 180 Varick Street, New York 14, N. Y. 301 pages, paper bound. Price $1.50.

Principles of Illumination

By H. Cotton. Published 1961 by John Wiley & Sons, Inc. 440 Fourth Avenue, New York 16, N. Y. 526 pages. Price $12.00.

Photoelasticity, Principles and Methods

By H. T. Jessop and F. C. Harris. Published 1960 by Dover Publications Inc., 180 Varick Street, New York 14, N. Y. 184 pages, paperbound. Price $2.00.

Weight-Strength Analysis of Aircraft Structures

By F. R. Shanley. Published 1960 by Dover Publications, Inc., 180 Varick Street, New York 14, N. Y. 404 pages, paperbound. Price $2.45.

Servicing AGC Systems, Revised

By Henry Carter and Thomas Lesh. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 6, Indiana. 128 pages, paperbound. Price $2.00.

Citizens Band Radio Handbook

By David E. Hicks. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 6, Indiana. 160 pages, paperbound. Price $2.95.

101 Key Troubleshooting Waveforms for Vertical-Sweep Circuits

By Bob Middleton. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 6, Indiana. 128 pages, paperbound. Price $2.00.

"ABC's of Radar"

By Alan Andrews. Published by Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 6, Indiana. 112 pages, paperbound. Price $1.95.

Tube & Semiconductor Selection Guide 1960-1961

By Th. J. Kroes. Published 1960 by Centrex Publishing Co., 2 Cederlaan, Eindhoven, Holland. 180 pages, paperbound. Price $1.75 U.S.

Progress in Astronautics and Rocketry Vol II, Liquid Rockets and Propellants

Edited by Martin Summerfield. Published 1960 by Academic Press, Inc., 111 Fifth Avenue, New York 3, N. Y. 682 pages. Price $6.50.

Proceedings of the Second Annual Symposium on Nondestructive Testing of Aircraft and Missile Components

Copies may be obtained from R. B. Wangler, Southwest Research Institute, P.O. Box 2296, San Antonio 6, Texas. Price $10.00.

(Continued on page 80)

Inductrol regulators provide highly accurate, highly reliable voltage control for BMEWS.

GENERAL ELECTRIC INDUCTROL REGULATORS PROVIDE . . .*

Precise, automatic voltage control for Free World's largest radar installation

Automatic ±1% accuracy . . . stepless control . . . maximum reliability. These are just some of the voltage-control requirements for the U.S. Air Force's giant Ballistic Missile Early Warning System (BMEWS). General Electric Inductrol regulators meet them *all* in providing precise voltage control for both the BMEWS high-voltage transmitter and receiver power supplies.

INDUCTROL REGULATORS offer *you* these advantages, too, for a wide variety of applications—including radar, communications equipment, rectifiers, computers, laboratory equipment and many others. You also benefit from these other important Inductrol regulator features: drift-free control; 100 percent overload capacity; 97 to over 99 percent efficiency; load, power-factor and frequency compensation; no harmful waveform distortion; and rugged, compact design.

RELIABILITY is inherent in the simple induction principle of General Electric's Inductrol regulator design. There are no tubes to replace, no sliding brushes or contacts to wear out, and no separate d-c power supply. Thus, operation is essentially maintenance-free.

FOR MORE INFORMATION, contact your nearby G-E Sales Office, or write General Electric Company, Section 457-04, Schenectady 5, N. Y. *Voltage Regulator Products Section, Pittsfield, Mass.*

* *Registered trade-mark of General Electric Co.*

Progress Is Our Most Important Product

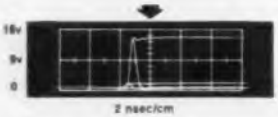
GENERAL ELECTRIC

Circle 93 on Inquiry Card

for clear display of:

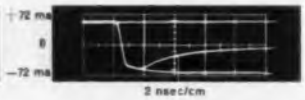
Single-Shot Nuclear Events/Transistor Switching/Fast Diode Turn-on/Radio-Frequency Waveforms/Tunnel-Diode Switching

Small pulses—with minimum slewing



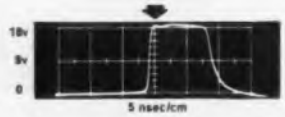
Outstanding trigger capability is illustrated by this multiple-exposure photograph which demonstrates the Type 519 triggered internally by various wave shapes—including one small amplitude signal having 0.5-nsec duration.

Fast-diode recovery time



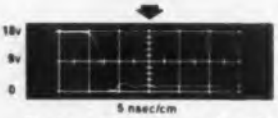
Switching and storage times in fast diodes can be measured easily by the Type 519. In this multiple-exposure, diode-recovery-time waveform, the upper trace is +50 ma reference, the middle trace shows the diode turn-off, and the lower trace shows the diode shorted.

Avalanche-transistor characteristics



A Type 2N526 transistor in avalanche generates the pulse shown. This output pulse is available from the Rate Generator on the Type 519 at 50 ohms impedance—with the repetition rate variable from 3 cycles to 30 kilocycles.

High-speed circuit analysis



The Type 519 Oscilloscope is an invaluable tool for testing active or passive wideband circuits. In this wideband amplifier waveform, little or no correction is necessary for the inherent risetime of the oscilloscope.

NEW KMC OSCILLOSCOPE TEKTRONIX TYPE 519

. . . for recording high-speed one-shot occurrences

NOW, you can see and record non-repetitive, high-speed phenomena with a standard oscilloscope—one that does not depend upon sampling techniques. On its distributed-deflection CRT, you can observe bright displays with 100-line-per-centimeter definition. You can photograph fractional-nanosecond signals with ease on its full 2 x 6 centimeter display area.

You will find the Type 519 engineered for convenience . . .

Internally—all circuit components of the complete unit fit compactly, yet are readily accessible for easy maintenance. A fixed signal-delay line plus variable sweep-delay control maintains the wide display passband and eliminates any need for adjusting delay-cable lengths.

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CHARACTERISTICS

Passband—from dc, 3 db point typically above 1 KMC. **Instrument Risetime**—less than 0.35 nanosecond (including trigger takeoff, delay line, CRT, and termination). **Synchronization**—200 mv peak-to-peak, 1 MC to 1 KMC. **Accelerating Potential**—24 kilovolts. **Sensitivity**—10 volts/centimeter, maximum, into 125 ohms. **Time Base**—linear 6-centimeter sweeps from 2 nanoseconds/centimeter to 1 microsecond/centimeter in 9 steps. **Sweep Delay**—through 35 nanoseconds. **Triggering**—jitter-free: **External**—3-microwatt (20-millivolt) pulse of 1-nanosecond duration. **Internal**—2-tracewidth pulse of 1-nanosecond duration. Signal waveform undisturbed by trigger takeoff. **Power and High-Voltage Supplies**—electronically regulated. **Calibration-Step Generator. Avalanche-Transistor Rate Generator.**

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... world's fastest PNP germanium switch!

CONDITIONS	MAX.
$V_{BE(off)} = 0.5$ V; $I_{B(1)} = -1$ mA	$t_d + t_r$ 60 nsec
$V_{CC} = -3.5$ V; $R_C = 300$ Ohms	t_r 20 nsec
$I_{B(1)} = 0.25$ mA	t_s 50 nsec

... features unusually low V_{CE} (sat)

CONDITIONS	MAX.
$I_C = -10$ mA, $I_B = -1$ mA	−0.16 V
$I_C = -100$ mA, $I_B = -10$ mA	−0.25 V

SYLVANIA 2N781 – a remarkable advance in epitaxial mesa techniques — is a superior switching device featuring speeds previously unattainable with a germanium transistor. Too, it provides exceptionally low saturation voltage at all current levels.

SYLVANIA 2N782, electrically similar to the *2N781*, is specifically designed for service where high speed switching, low saturation voltage and *economy* are prime design requirements.

SYLVANIA 2N781, 2N782, utilize the TO-18 package with the collector internally tied to the case. Both are products of highly automated Sylvania manufacturing techniques and possess exceedingly uniform electrical characteristics.

ABSOLUTE MAX. RATINGS (AT 25°C)

	2N781	2N782	UNIT
Collector to Base Voltage	−15	−12	V
Collector to Emitter Voltage	−15	−12	V
Emitter to Base Voltage	−2.5	−1.0	V
Collector Current	100	100	mA
Power Dissipation (free air)	150	150	mW
Power Dissipation (case at 25°C)	300	300	mW
Storage Temperature	−65 to +100	−65 to +100	°C
Junction Temperature	+100	+100	°C

ELECTRICAL CHARACTERISTICS (AT 25°C)

Symbol	Conditions	2N781 Min.	2N781 Max.	2N782 Min.	2N782 Max.	UNIT
BV_{CBO}	$I_E = -100$ mA, $I_B = 0$	−15	–	−12	–	V
BV_{EBO}	$I_E = -100$ mA, $I_C = 0$	−2.5	–	−1.0	–	V
BV_{CES}	$I_C = -100$ mA, $V_{BE} = 0$	−15	–	−12	–	V
h_{FE}	$I_C = -10$ mA, $V_{CE} = -0.22$ V	25	–	–	–	
h_{FE}	$I_C = -10$ mA, $V_{CE} = -0.25$ V	–	–	20	–	
V_{BE}	$I_C = -10$ mA, $I_B = 0.4$ mA	−0.34	−0.44	−0.34	−0.50	V
I_{CBO}	$V_{CB} = -5$ V, $I_E = 0$	–	−3.0	–	−3.0	nA
V_{CE} (Sat.)	$I_C = -10$ mA, $I_B = -1$ mA	–	−0.16	–	−0.20	V
	$I_C = -100$ mA, $I_B = -10$ mA	–	−0.25	–	−0.45	V
$t_d + t_r$	$V_{BE(off)} = 0.5$ V, $I_{B(1)} = -1$ mA	–	60	–	75	nsec
t_r	$V_{CC} = -3.5$ V, $R_L = 300$ ohms	–	20	–	35	nsec
t_s	$I_{B(1)} = 0.25$ mA	–	50	–	75	nsec

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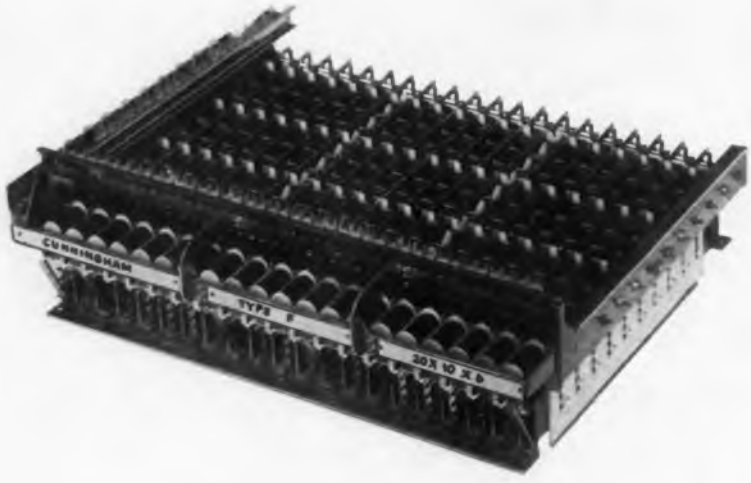

Tolerance Buildup No Bugaboo with Punched Laminated Plastics Parts

The compounding of individual tolerances on several punched holes or cutouts over the length of the piece is not the bugaboo that many designers believe. Careful die work and good working knowledge of the laminate used minimizes tolerance buildup. A good example of what can be done is the insulated pusher fabricated by Taylor for a high-performance crossbar switch manufactured by James Cunningham, Son & Co., Inc., Rochester, N.Y.

These switches are 3-dimensional conductor matrices, with from 30 to 1200 switching contacts, which bring intelligence from as many as 600 sources to one or more readout or signal points. They are basic components in computers, machine tool programming systems, high frequency scanning systems, thermocouple and strain gage monitoring, and similar equipment.

The insulated pusher, only 2.955 in. long and .031 in. thick, and fabricated from Taylor Grade GEC-500 glass epoxy laminate, is a critical part of the crossbar. It must be held flat within ±.005 in., with total over-length buildup not exceeding ±.002 in.

The materials used before to fabricate the pusher proved difficult to hold to the tolerances required. The success of the GEC-500 laminate fabricated by Taylor is evidenced by marked reduction in rejects and a 20% gain in production.

Taylor Fibre's Fabricating Division has the manpower, experience and equipment to produce parts to close tolerances from any of the company's raw materials. Send us your problem—we will recommend the best material for the job and quote on production runs. Write Taylor Fibre Co., Norristown 53, Pa.

Taylor

LAMINATED PLASTICS ■ VULCANIZED FIBRE

Books

(Continued from page 76)

Dictionary of Mechanical Engineering

By Alfred Del Vecchio. Published 1961 by Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. 346 pages. Price $6.00.

NARM Relay Symposium Papers

A compilation of papers presented at the Eighth Annual Relay Symposium at Stillwater, Oklahoma. Published 1961. Distributed by Professor Charles F. Cameron, Oklahoma State University, Stillwater, Oklahoma. 115 pages, paperbound.

General Catalog 1125N, ICS

General Catalog describing over 250 standard International Correspondence Schools home-study courses. Available from ICS, Scranton, Pa. 96 pages, paperbound. Free.

Semiconductors and Transistors

By Alexander Schure. Published 1961 by John F. Rider Publisher, Inc., 116 West 14th Street, New York 11, New York. 138 pages, paperbound. Price $2.90.

Basic Transistors

By A. Schure. Published 1961 by John F. Rider Publisher, Inc., 116 West 14th Street, New York 11, New York. 146 pages, paperbound. Price $3.95.

Governmental Publications

Orders for reports designated (OTS) should be addressed to the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Make check or money order payable to: "OTS, Dept. of Commerce." OTS reports may also be ordered through the Dept. of Commerce Field Offices. Prepayment is required. Use complete title and PB number for each report ordered. All other reports may be ordered from the Supt. of Documents, Government Printing Office, Washington 25, D. C.

Standard Frequencies and Time Signals from NBS Stations WWV and VH, National Bureau of Standards Miscellaneous Publication 236

Issued December 1, 1960. May be ordered from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 5 pages. Price $0.10.

Ultrasonics and Ceramic Coatings

By R. R. Whymark and W. E. Lawrie. 52 pages. PB171057. Price $1.50.

Supplement 4—Maintainability Handbook for Electronic Equipment Design to NAVTRADEVCEN 330-1 Design for Maintainability

I. M. McKendry and others. 386 pages. PB161029. Price $5.00.

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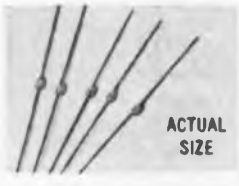
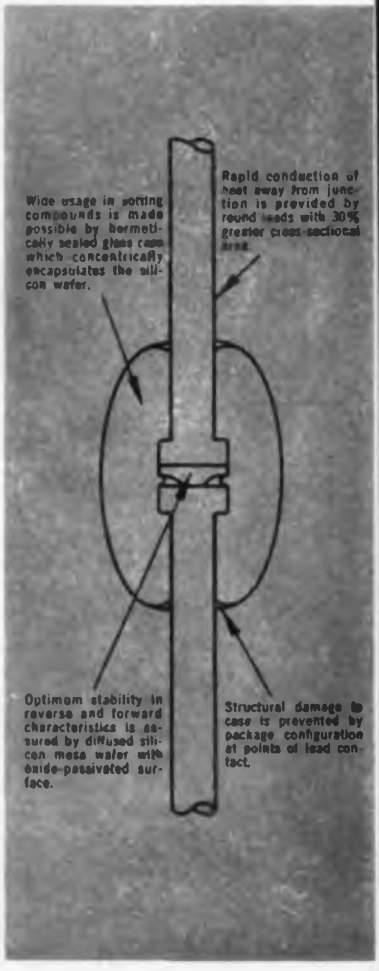


ACTUAL SIZE

MAXIMUM RATINGS	TI-2	TI-6	UNITS
V_F Fwd. voltage Drop at 25°C	1 at I_F=10 ma	1 at I_F=5 ma	v
C Capacitance at V_R=0 Vdc at 25°C	4	10	μμf
I_R Reverse Current at 10 v at 25°C	0.025	1.0	μa
t_{rr} Reverse Recovery Time (10 ma I_F, 10 ma I_R Recovery to 1 ma reverse)	10	100	nsecs
V_R Reverse Voltage	40	20	v



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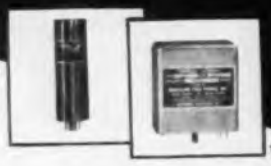
AND TUNING FORK OSCILLATORS

TYPE 10, ACTUAL SIZE

SIZE, 1-3/8" x 1-3/8" x 3/8"

This frequency standard (360 or 400 cy.) is accurate to ± 25 parts per million at 10° to 35°C. The tuning fork is made from Iso-elastic alloy and is approximately 1 inch long. Fork aging has been greatly minimized. Compensation in the circuit provides a minimum rate change throughout the useful life of the power cell (over a year). External power of 1.4 volts at approximately 6 microamperes can also power the unit. An hermetically sealed model, Type 15, is also available.



For more than 20 years, this company has made frequency standards and fork oscillators within the range of 30 to 30,000 cycles for applications where consistent accuracy and rugged dependability are demanded. A few examples are shown and described here.

Some users integrate these units into instruments of their own manufacture. Others rely on our experience and facilities to develop complete operating assemblies to meet their special needs.

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Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, —55° to + 71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave
at 115V into 4000 ohm load (approx. 4W)

TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± .02% (—50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (—65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 25 PRECISION FORK

Size, ⅝" dia. x 2⅛"
Weight: 2 ounces
Frequencies: 200 to 1000 cy. (specify)
Accuracies:
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25T and 25V ± .02% (—65° to 85°C)
For use with tubes or transistors.

TYPE 15 FREQUENCY STANDARD

Similar to Type 10 (illustrated) except with silicon transistor, hermetically sealed and vibration resistant.
Size, 1" x 2" x 2" high
Tolerance, ± .01% from —40°C to + 71°C
Output: .1V at 50,000 ohms source impedance.

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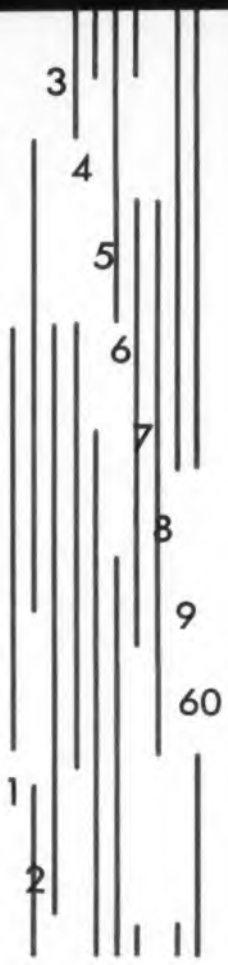
verify events permanently in milliseconds



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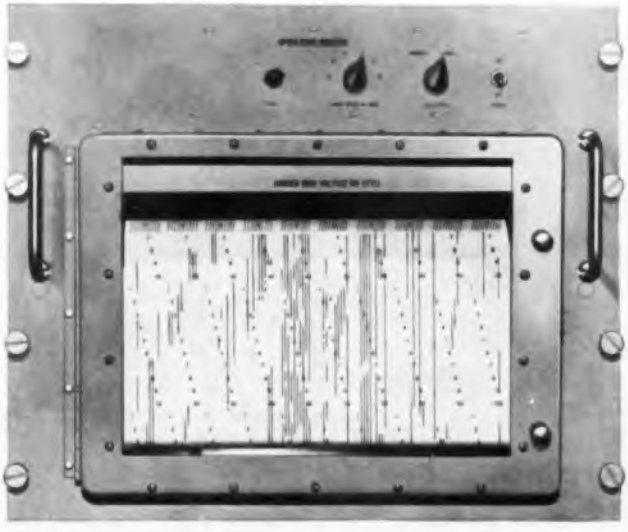
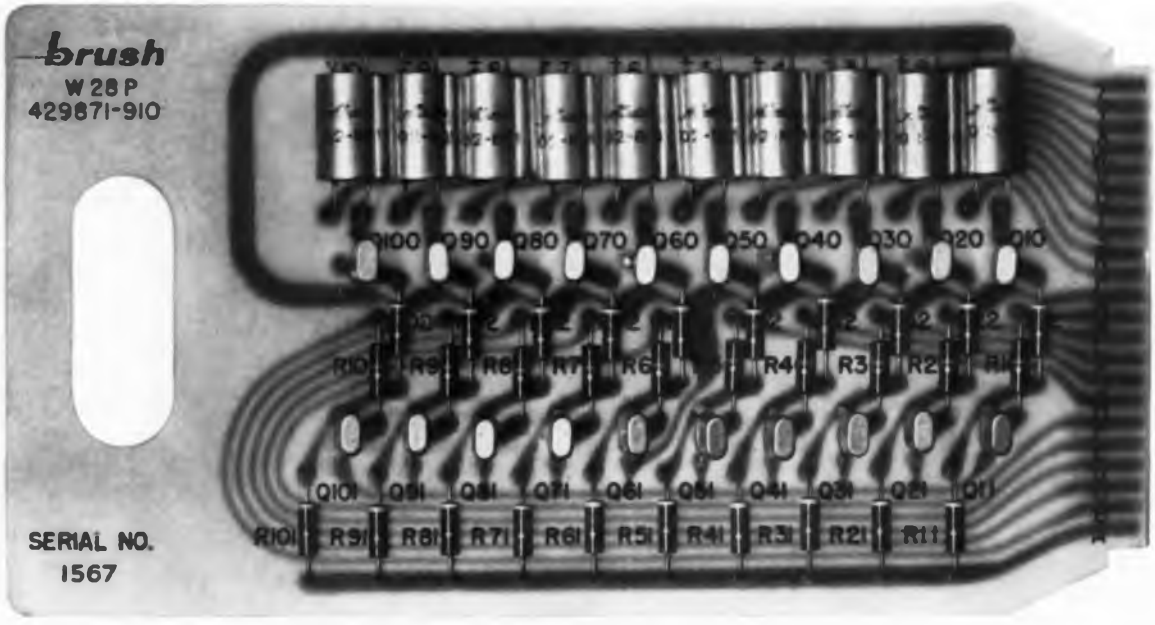


→

compact transistor switching for millisecond monitoring



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  - Printed Circuit Laminated Boards—from the wide variety of printed circuit boards that are on the market the four types of principal interest to the electronic engineer are discussed here
  - The 1961 Diode Similarity Chart

- ***And These CONTINUING FEATURES—Revised and brought Up-to-date***
  - The 1961 Transistor Interchangeability Chart
  - Survey of New Receiving Tubes and Special Purpose Tubes
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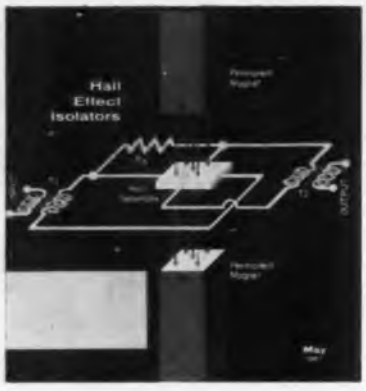

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Develop

AN "ISOLATOR" is a four-terminal, unidirectional, transmission device. Many devices fall in this class, e.g., vacuum tube and transistor amplifiers, UHF and microwave ferrite isolators, and electromechanical isolators.[1, 2]

"Gyrator" is sometimes used interchangeably with "isolator". Basically, a gyrator is a nonreciprocal device but does not necessarily have a unidirectional characteristic.

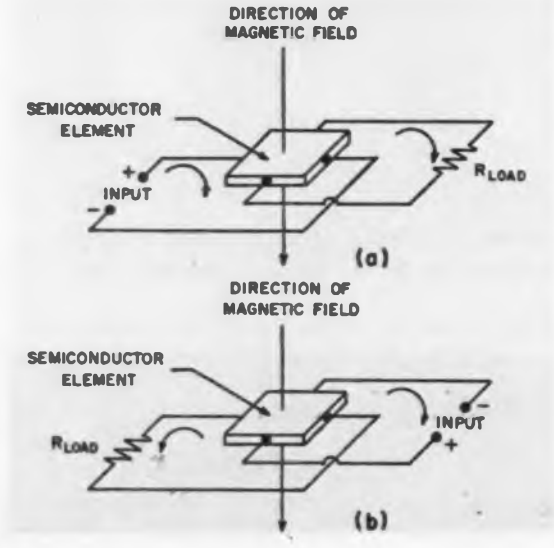
The isolators in this article use the Hall effect in semiconductors. Theoretical analyses of Hall effect gyrators and isolators have been made.[3, 4] Such gyrators use a semiconductor element and a constant magnetic field, Fig. 1.

If an input voltage causes a clockwise current flow in the input circuit, there is one direction of the magnetic field which causes a similar flow in the output circuit, Fig. 1a. With the same magnetic field orientation, a voltage, applied to the output terminals, producing a clockwise current flow in the output circuit, causes a counter-clockwise flow in the input circuit, Fig. 1b.

This gyrator can be used as an isolator by adding shunt resistances, Fig. 2. In one direction, the transmission through the gyrator is in phase with transmission, through the resistances; in the other, the two transmissions are 180° out of phase. Cancellation occurs. There is a value of R_s which theoretically gives complete cancellation. This value is related to the device's four terminal network resistances.

Many articles describe Hall effect isolator use.[5, 6, 7] But very few describe practical devices.

Fig. 1: Notice the change in the input circuit when the load is replaced with a voltage which causes the output circuit to flow in its original direction. In both cases the magnetic field direction must be the same.



Design Problems

Before this study, two brief ones were made in 1958. One used a laboratory-constructed InSb Hall generator; the other, a InAsP Hall generator. These studies revealed many design problems; but no effort was expended in solving them.

The main problems were:

(a) Low impedance levels of generators.
(b) Inherent forward loss of isolators.
(c) Frequency dependence of reverse characteristics.
(d) Need for common ground removal between input and output circuits.

Problem (a) has 2 answers: (1) development of higher impedance generators; or (2) use of impedance matching networks. Both solutions were investigated.

Several silicon generators with resistances between 30 and 300 ohms were made. The forward transmission loss of isolators with these elements was always higher than the losses with InAs generators. Further study revealed that forward loss depends on semiconductor material mobility. This suggests using higher mobility materials such as InAs, InSb and InAsP, rather than germanium and silicon.

Unless new semiconductor compounds yield high mobility, high resistivity materials, only one answer to the low impedance problem exists. And that is impedance matching transformers. The experimental isolators in this article use this technique. The use of transformer coupling also solves Problem (d).

Discovered decades ago, the Hall effect lay dormant for years. Now, much attention is being directed to the application of devices using the effect; but little to design of practical units. Here, we correct that situation, describing the design of a Hall effect isolator.

Practical Hall Effect Devices

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The minimum forward loss for any passive resistive isolator working into a matched load is 7.66 db, Problem (b).[3]. If the isolator works into a high impedance load, the voltage loss can be improved. In test units, 5.0 db was obtained with flux densities of 7 kilogauss; 5.7 db at 5.75 kilogauss. Recently, isolators having forward power losses as low as 2 db were obtained at 3 kilogauss. These devices used multicontact generator elements.[8] Improvement of forward loss to 1 db has been predicted.

Voltage across the gyrator and shunt resistors must be 180° out of phase to achieve complete cancellation of transmitted signal in reverse direction. As applied signal frequency increases, circuit stray reactances decrease the reverse attenuation, Problem (c). Short leads and noninductive resistors minimize inductance.

Small surface area generators and large air gap, permanent magnets minimize capacitance. An order of magnitude improvement in upper frequency limit was noted in the test models by increasing the air gap from 0.040 to 0.090 inches. This problem will probably be less critical in a resonant isolator where the stray capacitances are tuned out.

When both shunt resistors were not the same value, a null in the reverse characteristic could still be achieved. Therefore, we concluded that possibly one shunt resistor would be sufficient. Experiments proved this to be correct.

A. R. Hilbinger W. A. Scanga C. M. Barrack

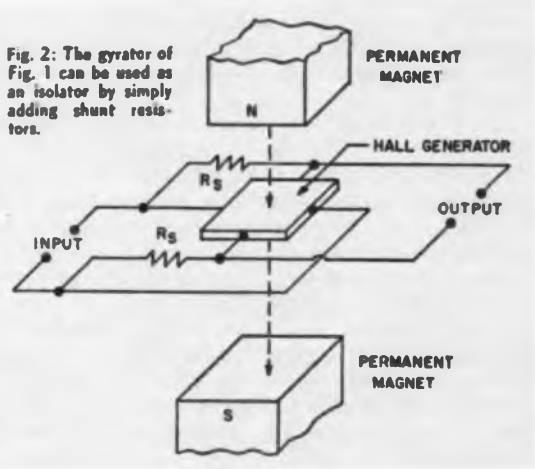


Fig. 2: The gyrator of Fig. 1 can be used as an isolator by simply adding shunt resistors.

Experimental Results

We made and tested 2 basic form isolators, Fig. 3.

The first unit, Fig. 4a, was designed for low audio frequencies. T1 and T2 are commercial transformers. The isolator input impedance is approx. 50 ohms. The Hall generator is an InAs unit; the permanent magnet, Alnico V, designed for use as a microwave ferrite isolator magnet; and R_s, a length of Cupron wire shunted by a potentiometer. Fig. 5 shows the forward response of this isolator under 2 load conditions:

Curve A: Input, 1 v RMS; load resistance, 6.8 Kohms.

Curve B: Input, 1 v RMS; load resistance, 10 megohms.

Although an overall gain is shown, Fig. 5, this gain is due to the voltage step-up in the output transformer. The generator was not working into a matched load for any case plotted. The measured generator loss was 5.0 db at 500 cps.

Fig. 5 also shows the reverse characteristic of the

isolator with R_s adjusted so that the null occurs when the input signal is 20 cps, 5 KC, and 10 KC. Although the reverse attenuation can be improved at the null frequency, the best overall reverse characteristic is obtained when the null is adjusted at the lower frequencies. Wider frequency response is possible with reactive tuning.

Using the same basic form, Fig. 3, and the same magnet, and same generator, we made an isolator to cover a wider frequency range, Fig. 4b. T1 and T2 are commercial transformers with higher frequency response. The shunt resistor R_s is a length of Cupron wire. No shunt potentiometer is used. Fig. 6 shows the forward response of this isolator under 2 load conditions:

Curve A: Input, 1 v RMS; load resistance, 6.8 Kohms.

Curve B: Input, 1 v RMS; load resistance, 10 megohms.

This isolator's low frequency response is limited primarily by the T2 primary dc resistance. It is less than one ohm and loads the generator at low frequencies.

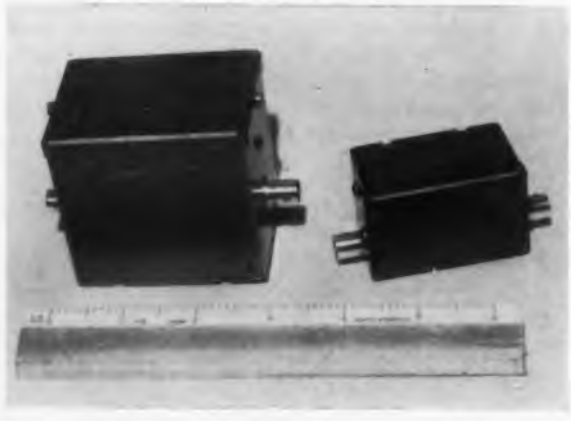
Fig. 6 also shows this isolator's reverse characteristic. The reason for the wider frequency range of the reverse characteristic as compared to Fig. 5 is the permanent magnet air gap increase from 0.040 to 0.090 inches. This decreases the stray capacitance between the generator and the magnet pole faces.

The forward frequency response in both test isolators is limited by the transformers used.

A third isolator uses a tunnel diode amplifier to partially offset the generator loss,[9] Fig. 7. The stable gain of the tunnel diode amplifier was limited to approx. 6 db. A gain of approx. 14 db was achieved with the same diode and an 82 ohm load resistor (no transformer).

The forward gain of the overall circuit is shown in Fig. 8. The transformer limits frequency response. The circuit has a dynamic range of 60 db (15 microvolts to 15 millivolts). The tunnel diode requires 2.3 milliwatts of dc power.

Fig. 4: These are the two isolators. On the left is the one designed for low audio frequencies; right, a wide range.



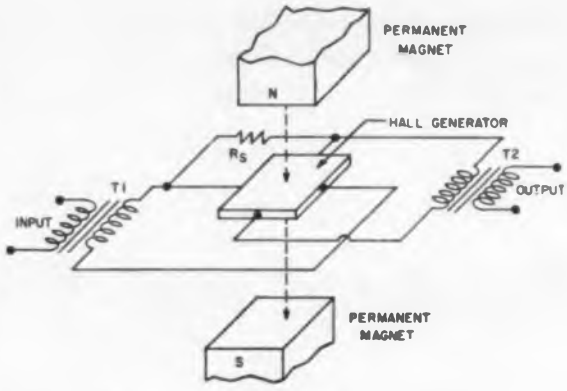


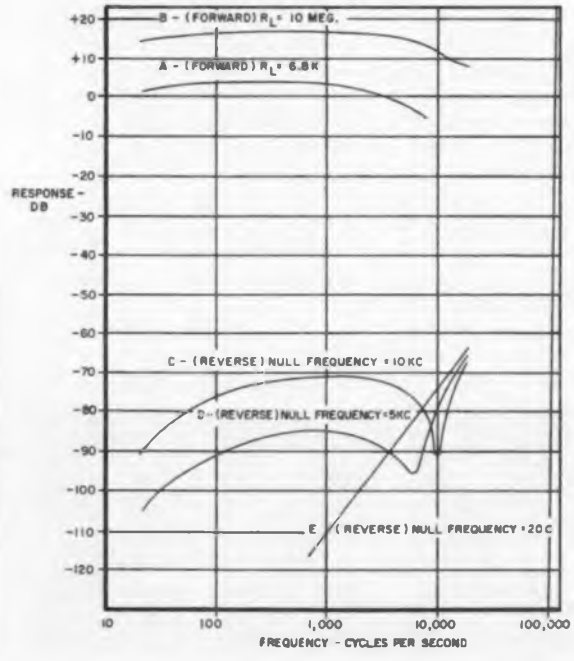
Fig. 3: The Hall Effect isolator which was tested had this basic form. Note that there is only one resistor.

The reverse characteristic is also shown in Fig. 8. To measure the output voltage in this direction, the tunnel diode was removed from the circuit. This was necessary to protect the tunnel diode from the relatively high voltages applied. To correct for the diode gain, the recorded attenuation has been changed by 6 db at all points. We assumed the tunnel diode amplifier gain to be constant over the frequency range.

Conclusions

One disadvantage of tunnel diode amplifiers is that they are two-terminal devices and are bi-directional, having common input and output terminals. Therefore, it is difficult to cascade amplifier stages. Hall effect isolators between stages will remove this disadvantage. The 6 db gain of the untuned tunnel diode amplifier cannot be considered a limiting figure for

Fig. 5: Characteristics of the low audio frequency isolator.



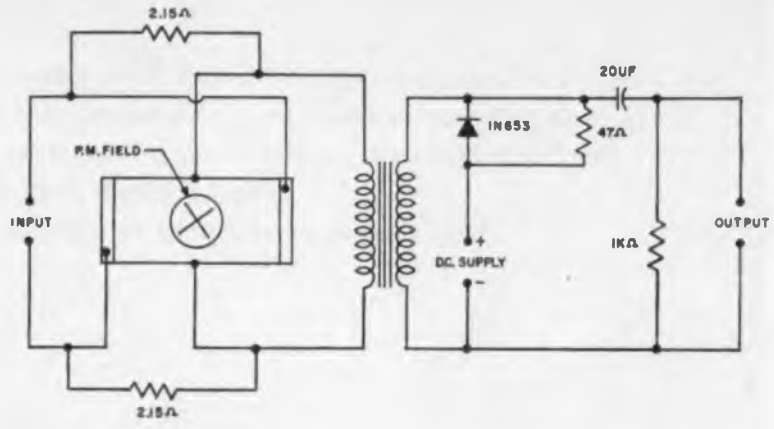


Fig. 7: This isolator, the third one to be tested, uses a tunnel diode amplifier to partially offset the generator loss.

tuned amplifiers. Gains of 20 db and higher are possible at 30 MC. A tunnel diode amplifier, plus a Hall effect isolator, should have an overall gain of approx. 14 db or greater.

Using ferrite isolators and circulators in conjunction with tunnel diode amplifiers at UHF and low microwave frequencies has been discussed in several articles.[10, 11, 12] It is too early to guess just how high into these frequency regions the Hall effect isolator can be applied. Hall generators appear to be suited for use in UHF strip-lines. Ferrite isolators in the UHF region do not at present have a particularly high reverse attenuation, about 10 db. Comparative evaluation of the two types of isolators must be withheld until more information is available on the Hall effect type.

In any Hall effect device, a large number of factors contribute to the total noise of the device. No noise measurements were made on the isolators described in this article. However, the Group III-Group V semiconductor compounds (InSb, InAs, GaAs, etc.) exhibit lower noise characteristics than the Group IV semiconductors (Ge and Si). Generally, an InAs Hall effect isolator can be a relatively low noise device.

Fig. 6: Characteristics of the second isolator tested.

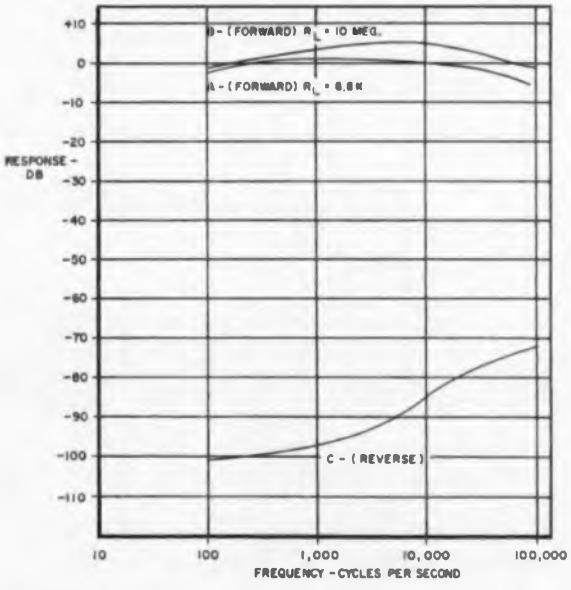


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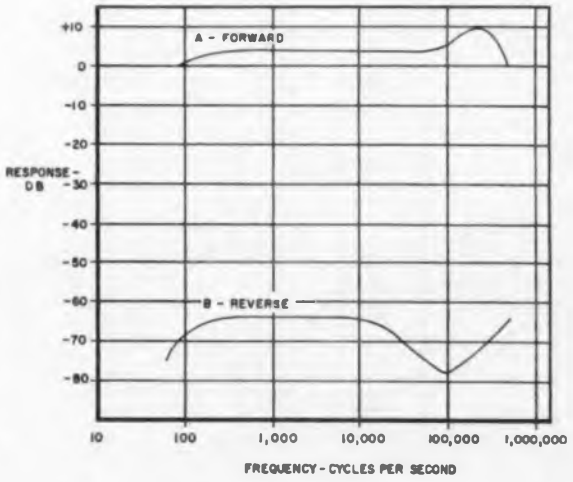
Fig. 8: Frequency response of the third isolator tested.



Commutators and distributors serve many useful purposes. The solid state versions appear more advantageous than the mechanical. This article presents a practical design procedure for such devices—including circuitry and logic equations. Minor changes adapt circuits to individual requirements.

Designing Solid State

SOLID state commutators differ from the motor-driven, mechanical type in many ways. They have no moving parts; they synchronize easily with external clocks; and, they operate at very high speeds.

Commutators, Fig. 1, collect from many voltage sources, in turn, and present a single output. Distributors, Fig. 2, do the reverse—they allot a single voltage source, in turn, to a number of outputs.

Both devices use the same building blocks: diode switches, switch control flip-flops and associated logic elements.

Diode Switches

The balanced diode switches are associated with the flip-flops. They work like a mechanical switch. Switch position depends on control lead input. These leads are M and B. The signal for our example is 0 to +15 volts to ground. However, by changing voltage levels, positive, negative, or ac signals can operate the switch. Diode forward voltage drops are assumed to be 1 volt.

Fig. 3a shows an open switch. The signal at S does not affect the signal at S′. Q is low, −2 volts on M; $\overline{Q}$ is high, +30 volts on B. Fig. 3b shows the voltages and currents in the circuit.

Fig. 4a shows a closed switch. The signal at S′ is the same as that at S. Q is high, +30 volts on M, $\overline{Q}$ is low, −2 volts on B. Fig. 4b shows circuit voltages and currents for an assumed signal voltage and load. The signal source and switch output can either supply or accept current. In Fig. 4b, the source and load are both receiving current, and power, from the switch.

In the distributor, holding capacitors at each switch output store the voltages between sampling intervals.

Fig. 1: Commutators collect from many sources and present one output.

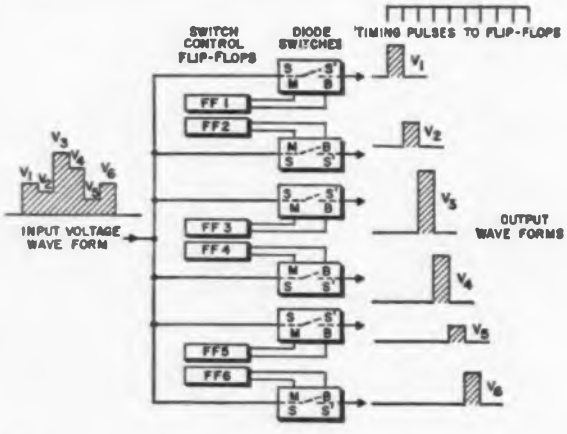
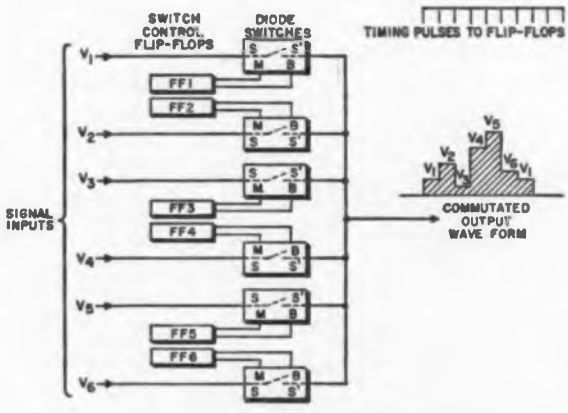


Fig. 2: Distributors allot a single source to a number of outputs.



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Commutators

In this manner, a sampled waveform can be reproduced, approximately, from its successive samples.

Switch Control Flip-Flops

The bistable flip-flop, Fig. 5, uses transistor saturation and clamping diodes to maintain accurate voltage levels. The flip-flop has inputs J and K; outputs, Q and $\overline{Q}$. It uses clock pulse triggering. The circuit must be able to supply, or accept, enough current to hold a diode switch turned "off." For top reliability, the input condition $J = K = 1$ is avoided.

Logical Equations

The input equations can be mechanized using ordinary "diode" logic. No attempt is made to discuss diode gate design.[1]

Assume that a simple six-position switch is desired. Commutators and distributors use the same equations. They are:

$$J_1 = K_4 = \overline{Q}_1\overline{Q}_2\overline{Q}_3\overline{Q}_4\overline{Q}_5 \quad (1)$$
$$J_2 = K_1 = Q_1 \quad (2)$$
$$J_3 = K_2 = Q_2 \quad (3)$$
$$J_4 = K_3 = Q_3 \quad (4)$$
$$J_5 = K_4 = Q_4 \quad (5)$$
$$J_6 = K_5 = Q_5 \quad (6)$$

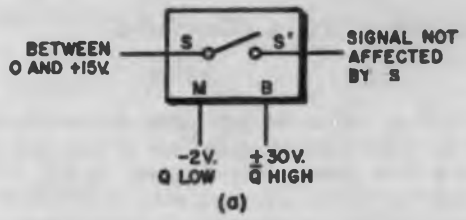
These equations provide that the flip-flops will be turned on sequentially, like a ring counter. The equation for J_1 protects against 2 undesirable situations which occur when a system is first operated. These are:

(1) All flip-flops might go to their "off" states.

(2) Several flip-flops will probably go to their "on" states.

To prevent malfunction, J_1 is written as follows:

$$J_1 = \overline{Q}_1\overline{Q}_2\overline{Q}_3\overline{Q}_4\overline{Q}_5\overline{Q}_6 + \overline{Q}_1\overline{Q}_2\overline{Q}_3\overline{Q}_4\overline{Q}_5Q_6 \quad (7)$$



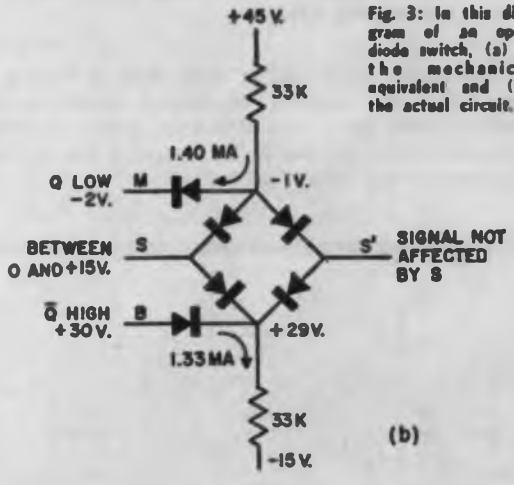


Fig. 3: In this diagram of an open diode switch, (a) is the mechanical equivalent and (b) the actual circuit.

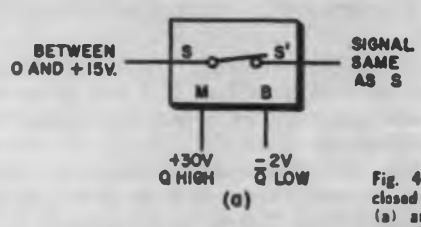
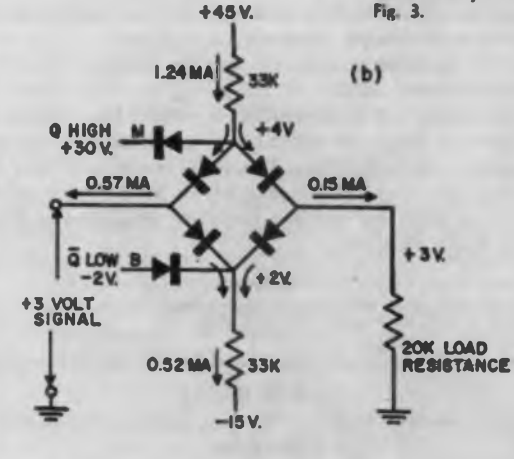


Fig. 4: Here is the closed diode switch: (a) and (b) represent the same conditions as they did in Fig. 3.



Commutators *(Concluded)*

The first term on the right provides a starting pulse for the first flip-flop in case all are initially "off." The second term insures that the first flip-flop will be turned "on" at the next clock pluse, if the sixth flip-flop is "on", and the others are all "off." This prevents more than one pulse from travelling around the ring. Eq. (7) equals Eq. (1).

Variations

One major advantage of solid state switching is versatility. By adapting the logical equations, and adding more gates and flips-flops, many desirable features can be included in the design. A few of these "optional extras" are listed below:

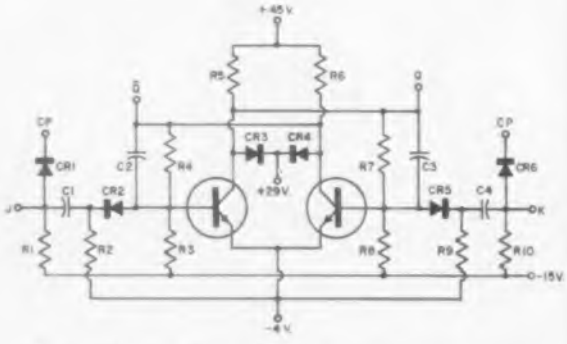


Fig. 5: This conventional switch control flip-flop uses transistor saturation and clamping diodes to maintain accurate voltage levels.

(1) The sampling sequence can be started or stopped instantly at any time. Therefore, it is easy to achieve "frame synchronization;" or, to stop and sample one channel indefinitely.

(2) In some uses it may be necessary to sample one or more channels oftener than the others, or for longer periods of time. This is readily done.

(3) The sampling need not be sequential. It is practical to have random switching to one of a large number of analog channels.

(4) Individual channels can be dropped or reinserted at any time.

Sometimes it is economical to reduce the number of flip-flops. Thus, an eight-position switch actually requires only 3 flip-flops. However, the saving may be offset by other components which have to be added, such as inverting and non-inverting amplifiers to drive the diode switches.

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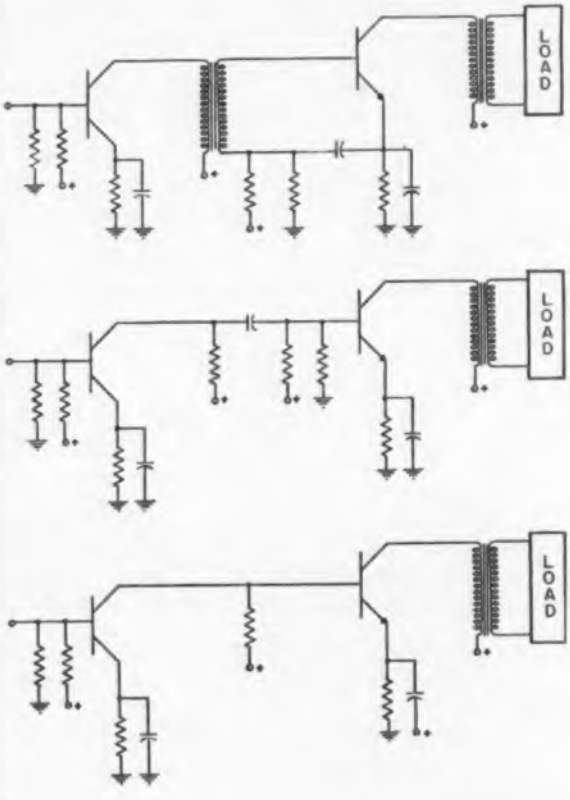
In Transistor Amplifiers . . .

Direct

ANY change in the dc conditions of one stage of a direct-coupled amplifier, Fig. 1, creates appreciable interaction with the other stage. Considerable dc degeneration in the emitter circuit can somewhat remedy this effect. This is done by making the emitter circuit dc resistance large compared to the collector

Fig. 1: The three types of coupling usually considered for control amplifer design: (top) transformer, (middle) RC, (bottom) direct.



In control amplifier design, we usually consider 3 types of coupling: transformer, RC, and direct. Though direct coupling has definite merit—miniaturization and cost savings—the transistor interchangeability problems that result have limited its application. This article dispels reluctance and shows how to achieve dc stability.

Coupling . . . and DC Stability

circuit resistance. Thus, collector current, increasing with temperature, will appear more effectively as an increase in voltage potential at the emitter. With the base voltage fixed, an increase in potential on the emitter will reduce the emitter-to-base voltage; and, thus reduce collector current. The result is a form of temperature compensation that performs fairly well.

However, the interchangeability problem still exists. If all transistors had the same characteristics, they could be freely interchanged. Since this is not the case, to achieve ac gain and dc bias stability with interchanging transistors would require careful selection of transistors, additional stabilizing networks, etc., which, in many applications, is just not practical.

Tantalum bypass capacitors also impose limits. Capacitor temperature traits are the reason. At low temperatures, ac series resistance of tantalum increases exponentially and presents a very significant degenerative effect.

Simplified Direct Coupled Circuit

One circuit, emphasizing the small size, simplicity and economy of direct coupling, still achieves excellent ac stability, Fig. 2. It uses a form of dc feedback to achieve dc stability.

This simple design uses no tantalum capacitors and fewer components. Yet it is dc stable with interchanging transistors; and, provides stable gain with silicon transistors to temperatures in excess of 125° C.

The theory of stabilization and bias is straightforward. The Zener diode, D_1, uses reverse diode characteristics to provide second stage constant emitter voltage, T_2. This diode also determines first stage dc collector voltage, T_1. The dc voltage drop across R_1 provides bias current for T_1. The voltage drop across R_2 fixes the base bias voltage for T_2. When interchanging transistors with slightly different dc characteristics, or when collector currents increase with higher temperature, the circuit should automatically stabilize itself.

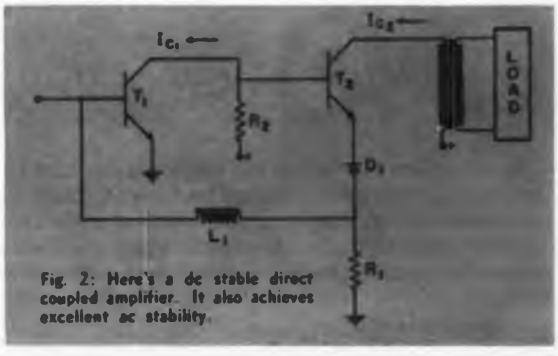


Fig. 2: Here's a dc stable direct coupled amplifier. It also achieves excellent ac stability.

If I_{c1} increases with temperature, the voltage drop across R_2 will rise. This means the base voltage of T_2 will decrease with respect to ground. Since emitter voltage of T_2 is constant (due to the Zener diode), decrease in base voltage will tend to decrease T_2 collector current. Thus, the drop across R_1 will decrease, tending to reduce the base bias current for T_1 and thus reduce I_{c1}. The same logic applies for increase in I_{c2}.

A tight dc feedback loop around the two stages gives dc stability. L_1 provides low dc resistance but high ac impedance. Thus, there is tight dc coupling, but practically no ac feedback.

General Design Relationships

Analysis of Fig. 3 can provide general design equations which relate component values to power source amplitude and dc operating points.[2] Knowing V_{c1}, I_{c1}, V_{c2}, I_{c2}, E_{bb}, a_1, a_2, and R_L (dc load resistance), we can calculate component values for either PNP or NPN two-stage direct-coupled amplifiers. Use absolute values for current and voltage.

$$E_D = V_{c1} - 2E_{b1} \tag{1}$$

$$R_2 = \frac{E_{bb} - E_D - V_{c2} - I_{c2}R_L}{I_{c2} + \frac{I_{c2}}{\beta_2} - \frac{I_{c1}}{\beta_1}} \tag{2}$$

Direct Coupling
(Continued)

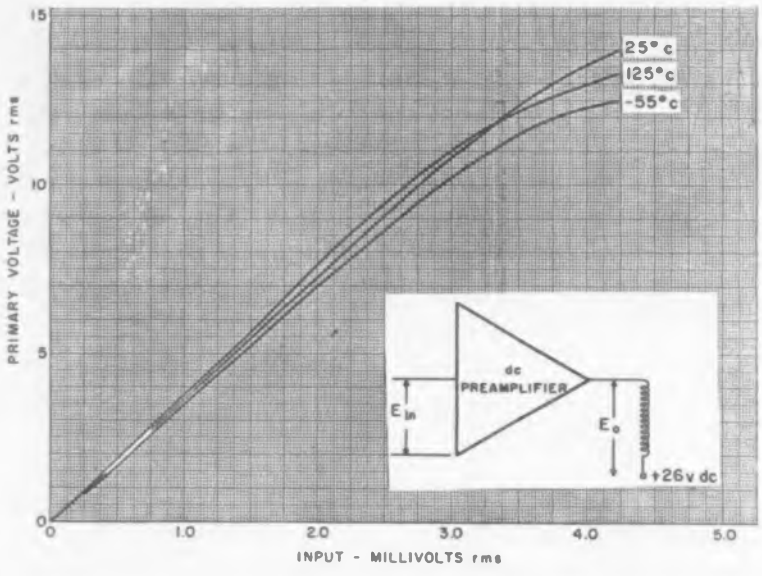


Fig. 4: Amplifier response at three different temperatures with typical transistors. Note the performance stability.

$$R_1 = \frac{R_2\left(I_{c2} + \frac{I_{c2}}{\beta_2} - \frac{I_{c1}}{\beta_1}\right) - E_{b1}}{\frac{I_{c1}}{\beta_1}} \quad (3)$$

$$R_2 = \frac{E_{bb} - V_{c1}}{I_{c1} + \frac{I_{c2}}{\beta_2}} \quad (4)$$

In ac performance terms, two-stage relationships for analysis can be made in combined terms from an equivalent circuit. However, the results are too complex for practical usage. A stage by stage study with the usual amplifier stage relationships is more convenient.

Through use of

$$A_v = \frac{\alpha\, r_e\, r_L}{r_e\left[r_e + r_b(1-\alpha)\right] + r_L(r_e + r_b)} \quad (5)$$

and

$$A_i = \frac{\alpha}{1 - \alpha + \frac{r_L}{r_e}} \quad (6)$$

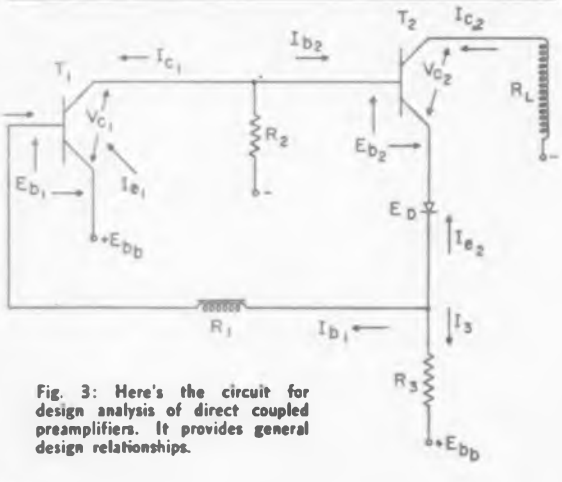


Fig. 3: Here's the circuit for design analysis of direct coupled preamplifiers. It provides general design relationships.

for a known ac load impedance, r_L, and using average small signal parameters of the selected operating points, the voltage and current gain of T_2 is calculated. Then r_{in2} is calculated from

$$r_{in2} = (r_{b2} + r_{e2} + r_{ED} + R_3)\left[\frac{r_{e2} + r_L}{r_{e2}(1-\alpha_2) + r_L}\right] \quad (7)$$

The second stage input impedance, r_{in2}, in parallel with R_2 provides the first stage load impedance, r_{L1}. With r_{L1} known, Eqs. (5) and (6) can again be used with small signal parameters of T_1. The amplifier input impedance, r_{in1}, would be obtained from

$$r_{in1} = r_{b1} + \frac{r_{e1}}{1 - \alpha_1} \quad (8)$$

Typical performance figures for this amplifier would be

$A_v \cong 20{,}000$
$A_i \cong 500$
Power gain $\cong$ 70 db
Input impedance $\cong$ 2500 ohms

Temperature Performance

The graph of Fig. 4 presents amplifier response at 25° C, 125° C, and − 55° C with typical transistors. Performance is stable over the temperature range.

Table I presents comparative dc collector current values as observed for the temperature extremes. There is less than 15% change in direct current from room temperature to temperature extremes.

Some DC Stability Considerations

Direct-coupled circuit dc stability is especially important where wide temperature range and interchangeability requirements exist. Study of the dc biasing network provides a means for measuring circuit stability. Since the greatest contributor to dc operating point change with temperature is the change due to inverse saturation current, I_{co}, temperature characteristics, it is appropriate to connect the stability of I_{c1} and I_{c2} in Fig. 5 with the I_{co} change in both T_1 and T_2.

The following 3 assumptions are made:

1. V_c, collector to emitter voltage, has a negligible effect on collector current.
2. Alpha is constant over the operating range.
3. E_{be}, the base-emitter voltage, is negligible. For germanium, it is approx. 0.1 volt; for silicon, about 0.6 volt.

Fig. 5 gives the following differential relationships

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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.

$$\frac{\partial I_{c1}}{\partial I_{co1}} = -\frac{1}{\dfrac{\alpha_1 R_3 R_2}{R_3^2 - (R_1 + R_3)(R_2 - R_2\alpha_2 + R_D + R_3)} - (1 - \alpha_1)} \tag{9}$$

$$\frac{\partial I_{c1}}{\partial I_{co2}} = \frac{R_2}{R_2 - R_3\left(\dfrac{1-\alpha_1}{\alpha_1}\right) + \dfrac{(R_1 + R_3)(1-\alpha_1)(R_2 - R_2\alpha_2 + R_D + R_3)}{\alpha_1 R_3}} \tag{10}$$

$$\frac{\partial I_{c2}}{\partial I_{co2}} = \frac{\left(\dfrac{\alpha_1}{1-\alpha_1}\right)\left(\dfrac{R_3 R_2}{R_1 + R_3}\right) - \dfrac{R_3^2}{R_1 + R_3} + (R_2 + R_D + R_3)}{\left(\dfrac{\alpha_1}{1-\alpha_1}\right)\left(\dfrac{R_3 R_2}{R_1 + R_3}\right) - \dfrac{R_3^2}{R_1 + R_3} + R_2(1 - \alpha_2) + R_D + R_3} \tag{11}$$

$$\frac{\partial I_{c2}}{\partial I_{co1}} = \frac{R_c}{\dfrac{1-\alpha_1}{\alpha_2}\left[\left(\dfrac{\alpha_1}{1-\alpha_1}\right)\left(\dfrac{R_3 R_2}{R_1 + R_3}\right) - \dfrac{R_3^2}{R_1 + R_3} + R_2(1 - \alpha_2) + R_D + R_3\right]} \tag{12}$$

of I_{c1} and I_{c2} to the respective collector inverse saturation currents.

From the 4 differential expressions, the change in I_{c1} can be expressed as a function of I_{co} change,

$$d\,I_{c1} = \frac{\partial I_{c1}}{\partial I_{co1}}\,d\,I_{co1} + \frac{\partial I_{c1}}{\partial I_{co2}}\,d\,I_{co2} \tag{13}$$

and the change in I_{c2} can be expressed in a similar fashion,

$$d\,I_{c2} = \frac{\partial I_{c2}}{\partial I_{co1}}\,d\,I_{co1} + \frac{\partial I_{c2}}{\partial I_{co2}}\,d\,I_{co2} \tag{14}$$

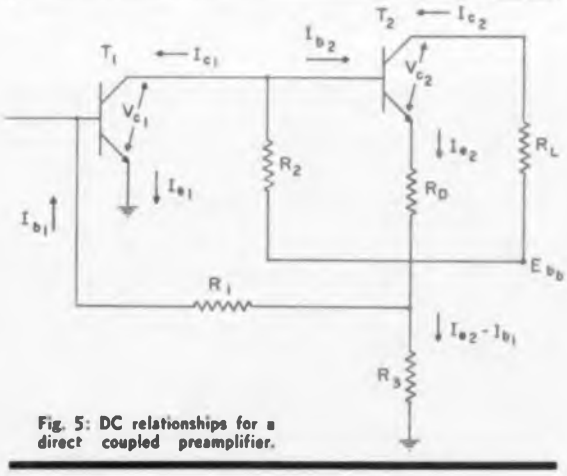


Fig. 5: DC relationships for a direct coupled preamplifier.

If the I_{co} temperature characteristic is the same for both transistors, then $d\,I_{co1} = d\,I_{co2}$. The partial expressions of Eqs. (13) and (14) may, therefore, be combined to produce stability factors relating the change in I_{c1} and I_{c2} to I_{co} change:

$$\frac{d\,I_{c1}}{d\,I_{co}} = S_1 = \frac{\partial I_{c1}}{\partial I_{co1}} + \frac{\partial I_{c1}}{\partial I_{co2}} \tag{15}$$

$$\frac{d\,I_{c2}}{d\,I_{co}} = S_1 = \frac{\partial I_{c2}}{\partial I_{co1}} + \frac{\partial I_{c2}}{\partial I_{co2}} \tag{16}$$

Ideally, S_1 and S_2 should approach zero. That is, the change in I_o due to one I_{co} will be cancelled by an opposing change in I_o due to the other I_{co}. Practically, in this article's amplifier, S_1 is about one and S_2 is about 10.

References

1. DeSautels, A. N., "A Comparison of Three Common Emitter Transistor Servo Preamplifiers," *AIEE Communication and Electronics*, No. 23, March, 1956, pp. 17-25. (Paper No. 56-37)

2. DeSautels, A. N., "A Stable, Direct Coupled, Transistor Servo Preamplifier," 1958 AIEE Fall General Meeting, Tech. Paper No. 58-1238.

Table 1.

Collector Current Temperature Characteristics

Temperature	25°C	125°C	− 55°C
I_{o1} (ma)	0.63	0.75	0.57
I_{o2} (ma)	1.5	1.68	1.38

The cathode follower most commonly used is not the circuit of the textbook. It is this one—that permits operation at normal bias. Here, by deriving equations for the input and output impedance, we will offset the literature's lack of information on this circuit.

Analyzing a

IT IS well known that of the two cathode followers shown in Fig. 1, the circuit of Fig. 1b offers the greater flexibility of design and operation. It is also generally known that the output impedance of this circuit is dependent to some degree upon the source impedance, R_G (Z_o rises as R_G increases). Also, the input impedance, as seen by the source, may be many times the value of the grid resistor, R_g.

In view of the widespread use of the circuit of Fig. 1b, and the interesting interrelations of its circuit parameters, it is surprising that it has received so little attention in the literature. We will try to correct that here.

(For the equation to Fig. 1a, we recommend any of a score of engineering texts and technical journals.)

Output Impedance

We used two different methods to derive the equation for the output impedance of the cathode follower in question. They yielded identical results.

One method applies a voltage E to the cathode. We can then write the expression for the resultant current, I. Taking the ratio E/I yields the output impedance, Z_o. This method is suitable if only the output impedance is required.

A second approach produces an equation which permits the construction of an equivalent circuit. Using this method, the equation evolves as follows:

From the equivalent plate circuit theorem,

$$i_p = \frac{\mu e_g}{R_p + R + R_k} \qquad (1)$$

From Fig. 3, e_g can be found.

$$e_g = e_s + i_p (R + R_k) \frac{R_k}{R + R_k} \cdot \frac{R_G}{R_g + R_G} - i_p (R + R_k)$$

Substituting this expression in Eq. (1),

$$i_p = \frac{\mu e_s}{R_p + R + R_k + \mu (R + R_k) - \mu (R + R_k) \dfrac{R_k}{R + R_k} \cdot \dfrac{R_G}{R_g + R_G}}$$

Which may be rewritten in the form,

$$i_p = \frac{\dfrac{\mu e_s}{1 + \mu k}}{\dfrac{R_p}{1 + \mu k} + R + R_k} \qquad (2)$$

Fig. 1: Two cathode follower circuits: (a) the standard text variety; (b) a more practical version offering flexibility of operation.

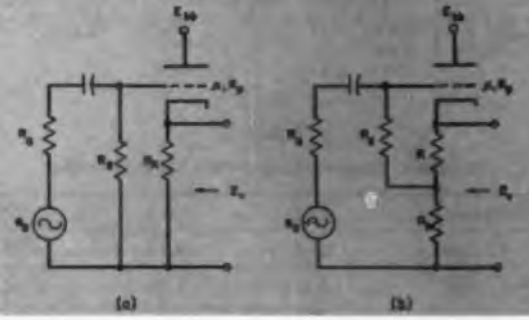
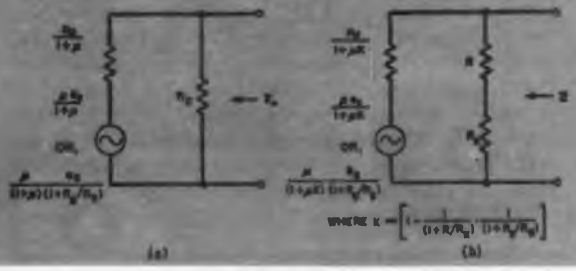


Fig. 2: Equivalent circuits for the designs shown in Fig. 1.



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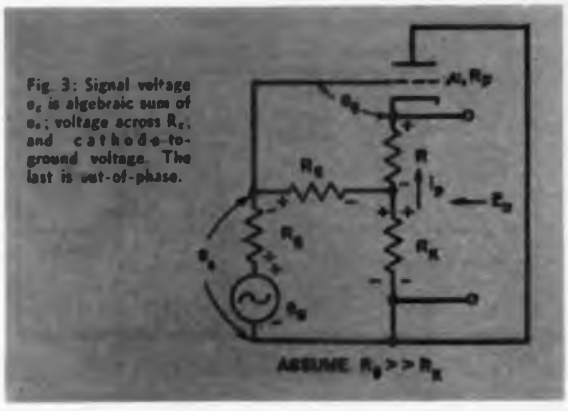


Fig. 3: Signal voltage e_s is algebraic sum of e_a; voltage across R_k, and cathode-to-ground voltage. The last is out-of-phase.

Realistic Cathode Follower

where, $$k = \left[1 - \frac{1}{1 + R/R_k} \cdot \frac{1}{1 + R_g/R_G}\right]$$

By Thevenin's theorem, Eq. (2) is manifested in the equivalent circuit of Fig. 2b, which shows this cathode follower may be considered as a generator of $\mu e_s/(1 + \mu k)$ volts, having an internal resistance of $R_p/(1 + \mu k)$ ohms. The output impedance of the cathode follower is the equivalent generator resistance, $R_p/(1 + \mu k)$, in parallel with the total cathode resistance, $(R + R_k)$.

The equivalent generator voltage just given is in terms of the terminated source voltage, e_s. We can also express the equivalent generator in terms of the open-circuited source voltage, e_G. From Fig. 3 we can write,

$$e_s = e_G \frac{R_g}{R_G + R_g}$$

Substituting in Eq. (2), the equivalent generator becomes,

$$\frac{\mu}{1 + \mu k} \cdot \frac{e_G}{1 + R_G/R_g}$$

The calculated output impedance of a 12AT7 with paralleled sections is shown by the curve in Fig. 4. The measured output impedance for different source impedances is shown by the circled points. A further example of the effect of source impedance on output impedance is shown in Fig. 5.

Input Impedance

The input resistance for Fig. 2b can be found by writing the gain equation for $R_G = 0$ and comparing it to the gain expression, after R_G is allowed to increase until the gain is one half that for $R_G = 0$. Under this condition, the input resistance, R_{in}, equals the generator resistance, R_G.

Let $R_G = 0$, $(k = 1)$. From Fig. 2b, the output voltage, e_o, equals

$$e_o = \frac{\mu}{1 + \mu} e_g \frac{R + R_k}{\frac{R_p}{1 + \mu} + R + R_k}$$

or,

$$e_o = \frac{\mu e_G (R + R_k)}{(1 + \mu)(R + R_k) + R_p}$$

Let R_G increase until the output voltage equals $e_o/2$. Call this voltage e_o'. For this condition,

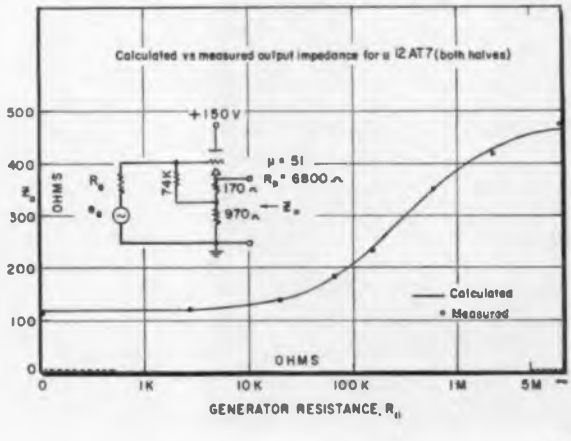
$$e'_o = \frac{\mu}{1 + \mu k} e_G \frac{R_g}{R_G + R_g} \cdot \frac{R + R_k}{\frac{R_p}{1 + \mu k} + R + R_k}$$

or,

$$e'_o = \frac{\mu e_G (R + R_k)}{(1 + \mu k)(R + R_k) + R_p} \cdot \frac{R_g}{R_G + R_g}$$

But,

Fig. 4: The calculated output impedance of a 12AT7, both halves.



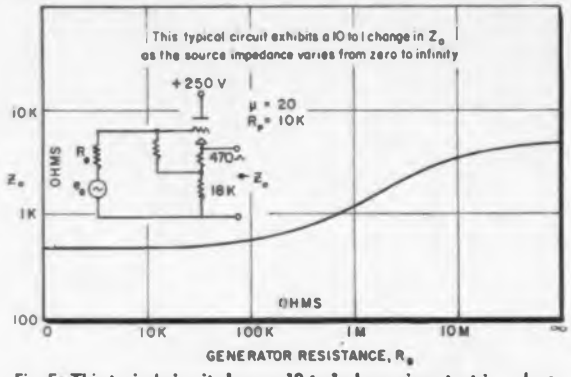


Fig. 5: This typical circuit shows a 10 to 1 change in output impedance as the source impedance varies from zero to infinity.

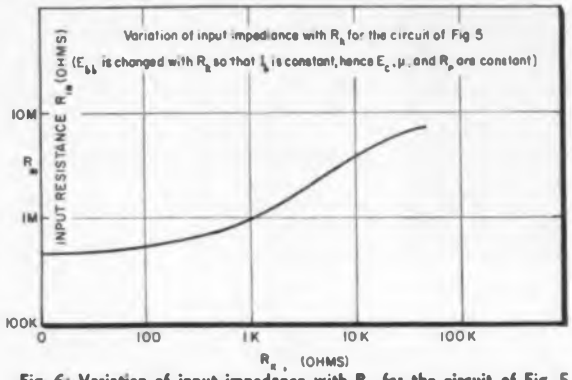


Fig. 6: Variation of input impedance with R_k for the circuit of Fig. 5 (E_{bb} is changed with R_k so that I_b is constant, hence E_c, μ and R_p are constant).

$$\frac{e_g}{e'_g} = 2 = \frac{\left[1 + \mu\left(1 - \frac{R_k}{R + R_k} \cdot \frac{R_g}{R_g + R_G}\right)\left(R + R_k\right) + R_p\right]\left(R_g + R_G\right)}{\left[(1 + \mu)\left(R + R_k\right) + R_p\right] R_g}$$

Rearranging, and knowing that under the conditions specified, $R_{in} = R_G$.

$$R_{in} = \frac{R_g}{1 - \frac{\mu R_k}{(1 + \mu)(R_k + R) + R_p}}$$

If R_k is much greater than R and R_p, Eq. (3) simplifies to $R_{in} = (1 + \mu) R_g$

It must be stressed that the analysis presented here holds only for small signal, low frequency operation. Large signal excursions which approach either grid current flow or plate current cut-off, or both, cause the tube parameters to suffer a cyclic change which negates the analysis. Tube and stray capacitance will alter the equivalent circuit at high frequencies.

The author wishes to thank his former colleague, J. O. Schroeder, for his interest in this problem.

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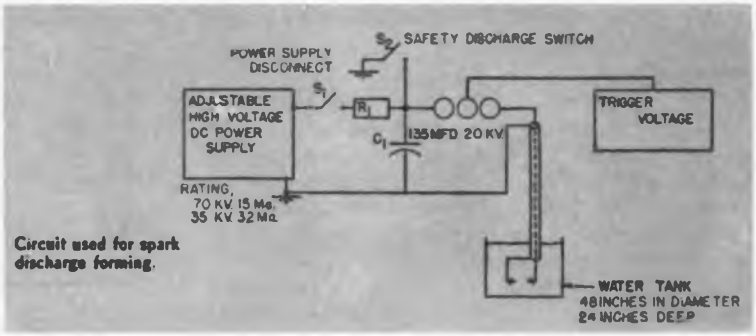
Explosive Forming

The explosions occur under water. High-intensity shock waves are directed against the metal pieces to be formed.

ELECTRICAL explosion techniques are being developed by GE for low-cost shaping of hard-to-form metals like titanium, stainless steel, and tungsten. The controlled explosions create shock waves of such force that intricate contours can be blown into the metals in millionths of a second.

The process is described as "capacitor discharge electro-spark forming." "No explosives are used. The blasts occur under water. They create high-intensity shock waves which are directed against the metal pieces to be formed. Upon impact of the shock wave, the metal instantly takes the shape of the die into which it is blown. The die is evacuated to remove air pockets that could cause the piece to have surface irregularities.

The forming is done at room temperatures and no pre-heating of the metals is needed. The pieces require minimum finish machining after they have been formed. Pieces up to 10 inches in dia. and 3/32 inches thick have been formed by the process.



Circuit used for spark discharge forming.

The design of several proven Resistance Capacitance Transistor Logic circuits are given. A basic inverter circuit is discussed in detail. From it the NOR circuit and flip-flop are evolved. A Schmitt trigger using the basic circuit is also described.

For Computers . . .

Basic RCTL Circuits

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A PRIME requisite in good computer design is high-speed capability in its components. The mesa transistor qualifies as an ultra-high-speed switch and has therefore found wide application in the computer field. The 2N705 and 2N695 transistors are good examples.

Because these transistors have a gain-bandwidth product, f_t, in excess of 300 MC, and also a low stored charge, they are well suited to computer circuitry. Here we describe some standard Resistance Capacitance Transistor Logic (RCTL) circuits. While the RCTL circuits employ proven techniques, they have been optimized to exploit the characteristics of the 2N705 and 2N695.

The inverter circuit is basic and will be discussed in detail. From it the NOR circuit and flip-flop may be evolved. A Schmitt trigger, which is useful for pulse restoration or as a wave shaper for counter stages, will also be described.

1. Roehr, William D., "Total Stored Charge, Types 2N695 and 2N705 Motorola Mesa Transistors," Application Note. Motorola Inc., Semiconductor Products Division, Phoenix, Arizona.

Inverter Circuit

Fig. 1 shows the basic inverter circuit. R_1 and R_2 form a voltage divider which adjusts the steady state base current which may be found from the relation:

$$I_B = \frac{V_{in} - V_{EB}}{R_1} + \frac{V_{BB} - V_{EB}}{R_2}.$$

C_1 supplies excess base current during switching intervals. Its chief use is in minimizing storage time. Therefore, its proper value may be found from total charge data. D_1 limits reverse voltage applied to Q_1 and establishes a low reverse bias which reduces delay time. Q_2 is used to reduce capacitive loading of Q_1 and present a low output impedance during the interval when Q_1 is being cut-off and Q_2 is driven into conduction.

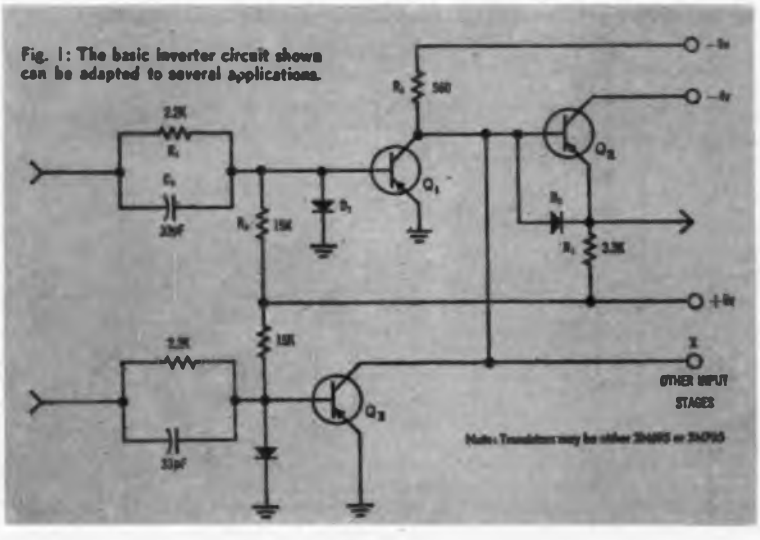


Fig. 1: The basic inverter circuit shown can be adapted to several applications.

Basic Circuits

(Continued)

Table 1

General Characteristics of All Units

Temperature Range	Input PRF	Output Levels "0" "1"
0 – 60°C	10 mc	0 ± 0.2V, 3.5 ± 0.5V

Typical Characteristics at 25°C of Each Unit

Unit	Resistive Load Switching Times (nsec) t_{D1}	t_r	t_{D2}	t_f	Minimum Load Resistance (ohms)	Maximum Load Capacitance (pF)	Capacitive Load Switching Times (nsec) t_{D1}	t_r	t_{D2}	t_f
Inverter	20	16	20	10	50	400	30	30	28	28
Flip-Flop	28	20	34	26	50	400	30	40	44	34
Schmitt	—	18	—	20	100	250	—	40	—	24

However, in the alternate interval when Q_1 is driven ON and Q_2 is driven OFF, the emitter follower can no longer present a low output impedance. Diode D_2 now serves to connect Q_1 to the output. Since C_1 provides heavy overdrive during switching, Q_1 can deliver a large amount of current to the load. Thus Q_1 effectively has a low output impedance.

Design Considerations

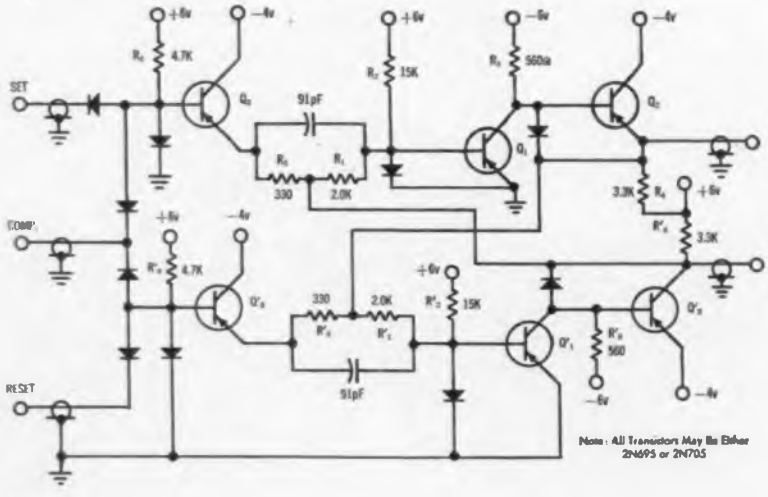
To minimize storage time, it is important not to use excessive base drive current to hold a transistor ON. The ratio of collector current to base current was determined by observing that h_{fe} at 10 ma has decreased to 80% of its 25°C value at 0°C. No temperature change is experienced in the region of 50 ma. The value of h_{fe} for the 2N705 and 2N695 is guaranteed to be greater than 25 under conditions of I_C = 10 ma and V_{CE} = 0.3 v. Since this test is performed in saturation, no additional base current is required to ensure saturation. Furthermore, h_{fe} at 50 ma is very close to the 10 ma value. Life-test data show virtually no degradation at 5000 hours. However, a 20% safety factor was employed to take care of changes of other components. The stage current gains used in the design are then determined to be 16 at 10 ma and 20 at 50 ma of collector current.

Thus the values of the resistors were determined. The value of the coupling capacitor was determined from total stored charge data.[1] At the lowest drive current of 0.75 ma, the base charge, Q_B, is 75 picocoulombs, which yields 30 pF for C_K. Contrary to what might be expected, the lowest drive condition represents the worst case because of the relationship between Q_B and I_B. The additional turn-off current through R_2 offers some safety factor. Temperature testing with a large number of sample transistors has verified this design.

The basic NOR circuit is formed by the addition of other identical input stages whose collectors are connected at point X. The addition of other input stages will lower their respective collector currents, but it will be observed that storage time remains about constant. This is in contrast to alloy-type transistors, in which an increase of storage time would be experienced. In mesa transistors most of the carrier storage occurs in the collector region. Thus diode recovery, and hence collector current, play an important part in storage time. The decrease of collector current results in an increase of excess base charge, making the net effect insignificant.

The flip-flop is essentially two inverters cross-connected as shown in Fig. 2. Transistors Q_3 and Q'_3 provide a high-impedance input and trigger steering. Resistors R_5 and R'_5 are necessary to isolate Q_3 and Q'_3 from Q_2 and Q'_2 to prevent unduly loading of the trigger signal. Therefore, the coupling capacitors are increased over the value used in the inverter to compensate for this additional resistive loss.

Fig. 2: The flip-flop is essentially two inverters cross connected as shown below.



Schmitt Trigger

The inverter also appears in a slightly modified form in the Schmitt trigger. This circuit was developed primarily because a source of 10 MC square waves was needed to test the system. However, it is also useful for pulse restoration or as a general purpose square-wave generator.

The basic circuit shown in Fig. 3 is used to explain the operation of the Schmitt trigger circuit. The dc conditions are adjusted so that Q_1 is conducting heavily and Q_2 is cut OFF. A workable set of voltages is shown. A positive-going input signal starts to cut-off Q_1, causing its collector voltage to rise toward V_{CC}, thereby turning on Q_2. The resulting increase in current

through the common-emitter resistor produces a voltage which serves to speed the cut-off of Q_1. Return to the original state occurs when the input signal again allows Q_1 to conduct. The circuit must obviously be unsymmetrical, because the "ON" current through Q_2 must be greater than the "ON" current of Q_1 to hold Q_1 in the cut-off condition. The greater the loop gain of the system, the better will be the "snap" action of the circuit. That is, the region of input voltage where erratic operation occurs will be minimized. Therefore, a speed-up capacitor, C_2, is generally needed to increase loop gain during the switching interval. The circuit could also operate with Q_1 normally off and Q_2 normally conducting.

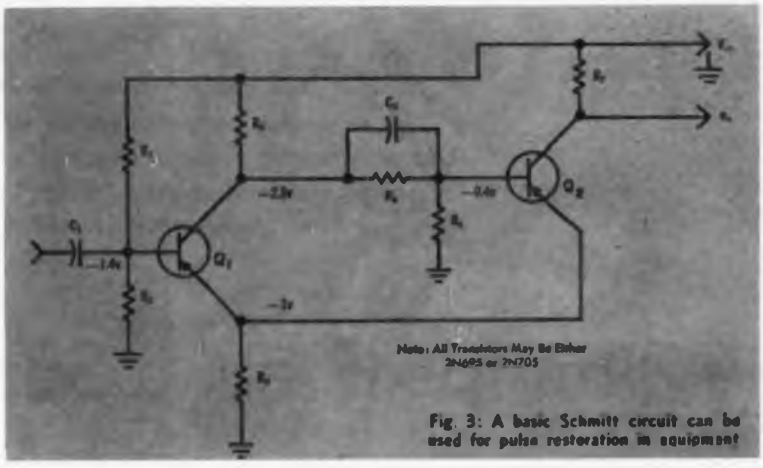


Fig. 3: A basic Schmitt circuit can be used for pulse restoration in equipment

A Practical Example

The basic circuit of Fig. 1 was modified to produce a Schmitt trigger which would operate from 100 CPS to 10 MC with mesa 2N695/-2N705 transistors. The final circuit is shown in Fig. 4.

The basic limitation of the circuit speed is the speed-up network. The capacitor should be large for fast rise times, but the time constant must be small compared with the repetition frequency. The emitter follower, Q_3, is therefore employed to lower the impedance of the speed-up network. The emitter follower also provides a low-capacitance load to the collector of Q_1. The second emitter follower, Q_4, provides a low-impedance output. The silicon diode serves merely as a voltage-dropping device so that the output voltage may be brought to zero. It offsets the voltage drop in R_6. The peaking coils were adjusted with the circuit operated as a linear amplifier. This was accomplished by removing the common-emitter feedback loop and placing a 100 ohm resistor from each emitter to ground. The bias was then adjusted by varying R_1 until maximum voltage output was obtained. This was approximately 4 volts peak-to-peak. Under these conditions, the 3 db (0.707 voltage point) bandwidth is 20 MC. Shunt peaking, though not generally used in transistor circuits, is useful in this case because emitter feedback causes the transistor input impedance to be high.

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A 0.5 volt peak-to-peak input signal will produce a stable pulse output. The input impedance is 450 ohms at low frequencies, decreasing to approximately 400 ohms at 1 MC, and 300 ohms at 10 MC.

Performance of Units

The units described will operate at 10 MC and below. Choice of clock frequency depends of course upon how many stages signals must pass through during a clock pulse. Characteristics of the units are shown in Table 1. The tolerance in output voltage is necessary because of changes in saturation voltage due to temperature, loading, and individual transistor variations. Variations of ±10% in power supply voltages will not cause malfunction; however, the 4 v. line should be closely regulated because its voltage changes are reflected directly in the output.

Note that the output emitter followers must be used with a heat sink if a 2N695 is used. Since the can is electrically floating, this may be easily accomplished. No heat sink is necessary with the 2N705 because of its higher dissipation.

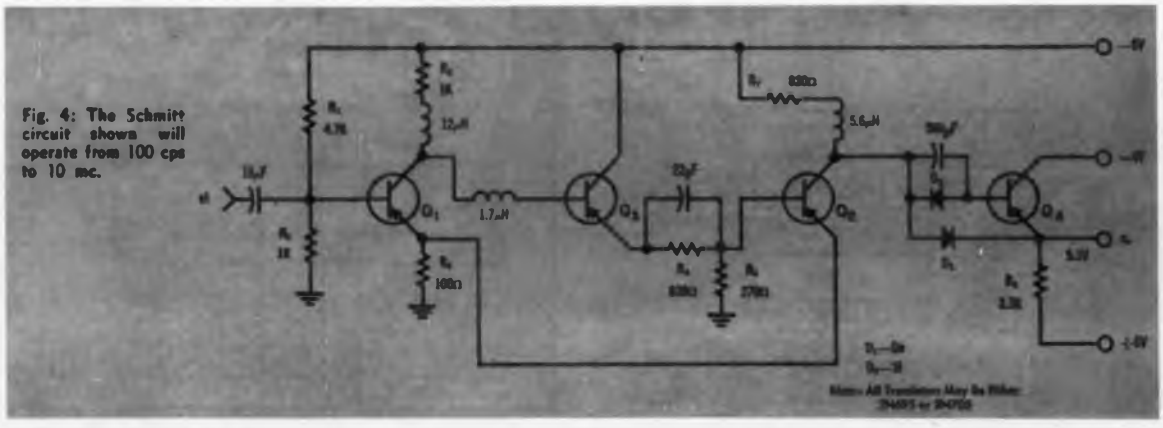


Fig. 4: The Schmitt circuit shown will operate from 100 cps to 10 mc.

How can interference in critical points in an analog computer system be eliminated? Out of a specific problem encountered in a system came one solution—the "Notch" filter circuit. Two such filter circuits are discussed in this article.

Suppressing a

THE problem of suppressing a single frequency interference signal often occurs. An example is a 60 cps signal which is usually unwanted but unavoidable. An ideal solution to this problem would be to have a filter with a unity gain, except at the frequency of the undesired signal. It should have a zero gain at this frequency. This filter must have a linear phase characteristic to prevent phase distortion. A filter of this description would suppress the undesired signal and also any desired signal at the same frequency.

A filter having this ideal characteristic is shown in Fig. 1. Two circuits which approximate this will be described. Both will depend on the characteristic of the transfer admittance of two parallel Tee networks.

Parallel Tee Network

The parallel Tee network, Fig. 2, will determine the basic nature of the frequency characteristic of the filter. The transfer admittance, Y_T [$Y_T = a\ (i/e)$], is given by Eq. 1.

$$Y_T = k\left[\frac{\omega_1\,\omega_2}{s+\omega_1} + \frac{s^2}{s+\omega_2}\right] \qquad (1)$$

The parameters are defined as follows:

$$k = \frac{C_2}{2} \quad \omega_2 = \frac{1}{2\,R_2\,C_2}$$
$$\omega_1 = \frac{2}{R_1\,C_1} \quad \omega_3 = \frac{1}{R_1\,C_2}. \qquad (2)$$

If $\omega_1 = \omega_2$ the transfer admittance may be written as:

$$Y_T = k\left[\frac{s^2+\omega_1\,\omega_2}{s+\omega_1}\right]. \qquad (3)$$

This is the admittance characteristic which will be used to describe filter characteristics. To examine detailed characteristics of the filter as it may be realized in practice, it will be assumed that $\omega_1 - \omega_2 = \delta$, where $|\delta|$ is much less than ω_1 and ω_2. The transfer admittance may be approximated by:

$$Y_T = k\left[\frac{s^2+\delta\,s+\omega_1\,\omega_2}{s+\omega_1}\right]. \qquad (4)$$

The pole-zero configurations for Eqs. 3 and 4 are shown in Fig. 3.

One effect of ω_1 not being equal to ω_2 is to prevent

Fig. 1. Shows a filter having the ideal characteristics desired.

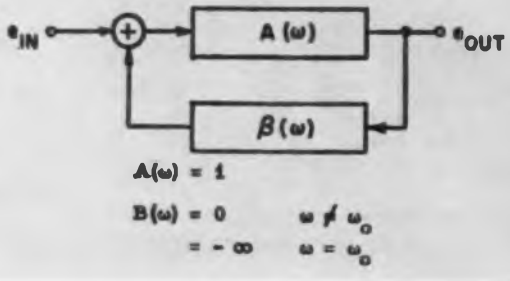
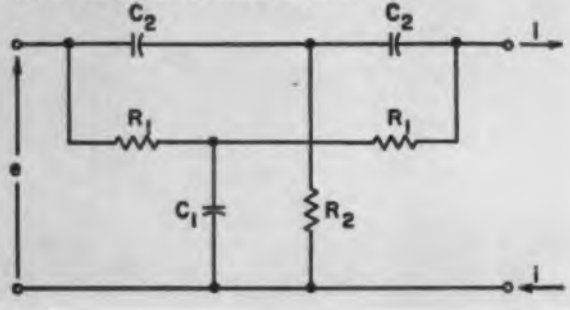


Fig. 2. The parallel Tee network is shown.



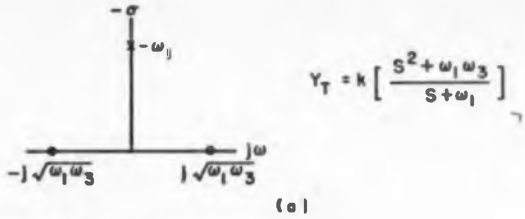


Fig. 3a. Pole-zero configuration for Eq. 3.

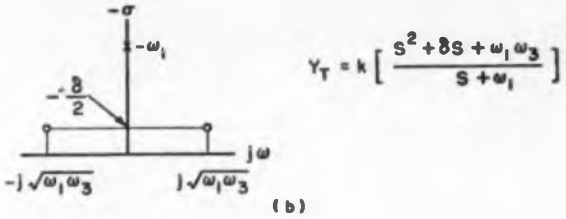


Fig. 3b. Pole-zero configuration for Eq. 4.

Single Interference Frequency

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$|Y_T|$ from being equal to zero at $\omega = \sqrt{\omega_1\omega_3}$. This is illustrated by the sketches of $|Y_T|$ in Fig. 4. Another effect of ω_1 not being equal to ω_2 is to introduce zeros of Y_T into the right-hand half of the s-plane *(Re $s > 0$)* when $\omega_1 < \omega_2$. This will be a key point in specifying conditions for stability of filters using this network.

Beta Networks

If the transfer admittance is used as the feedback admittance in an operational amplifier circuit, such as in Fig. 5, the gain of the circuit, B ($B = e_o/e_i$), may be written as:

$$B(s) = -\frac{Y_i(s)}{Y_T(s)}. \tag{5}$$

To get a general idea of the functional form of $B(s)$, the expression for $Y_T(s)$ given by Eq. 3 may be used to give:

$$B(s) = -k\,Y_i(s)\left[\frac{s+\omega_1}{s^2+\omega_1\omega_3}\right]. \tag{6}$$

If the input admittance Y_i is a resistor having a conductance of $1/R_i$, then $B(s)$ is given as:

$$B(s) = -\frac{k}{R_i}\left[\frac{s+\omega_1}{s^2+\omega_1\omega_3}\right]. \tag{7}$$

If the input admittance is that which is due to a resistor and capacitor in series having an admittance of

$$\frac{1}{R_i}\left[\frac{s}{s+\omega_i}\right]\left(\omega_i = \frac{1}{R_iC_i}\right),$$

then $B(s)$ is given as:

$$B(s) = -\frac{k}{R_i}\left[\frac{s}{s+\omega_i}\right]\left[\frac{s+\omega_1}{s^2+\omega_1\omega_3}\right]. \tag{8}$$

If $\omega_i = \omega_1$, then $B(s)$ takes on the following form:

$$B(s) = -\frac{k}{R_i}\left[\frac{s}{s^2+\omega_1\omega_3}\right]. \tag{9}$$

The two filters to be examined will employ operational amplifier circuits with gain expressions of the form given by Eqs. 7 or 9. These two expressions approach the characteristics required of the β network in the ideal filter (Fig. 1). The second of the two

Fig. 4. Is a sketch of $|Y_T|$.

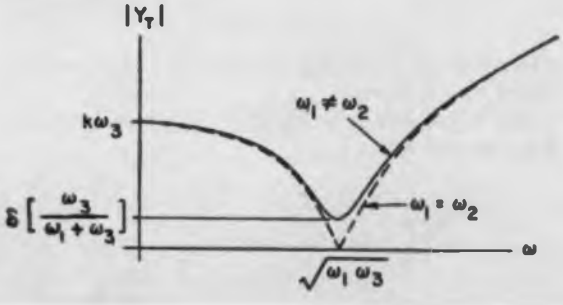
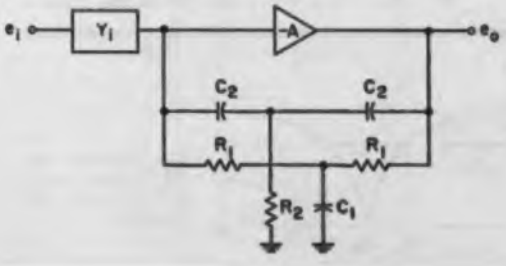


Fig. 5. Operational amplifier circuit using transfer admittance as feedback admittance.



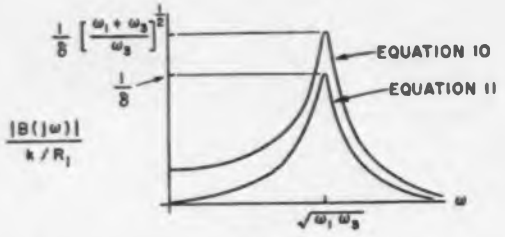


Fig. 6. Is a sketch of the magnitude of B(s) as given by equations 10 and 11.

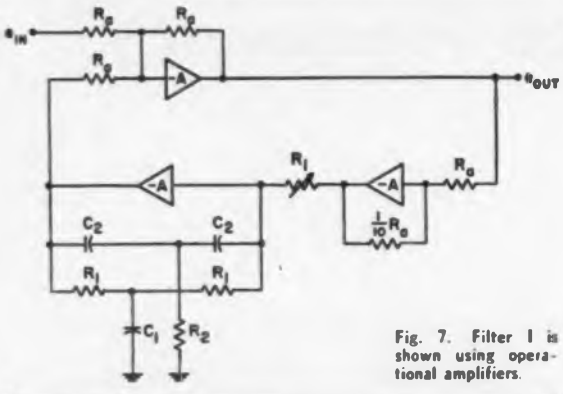


Fig. 7. Filter I is shown using operational amplifiers.

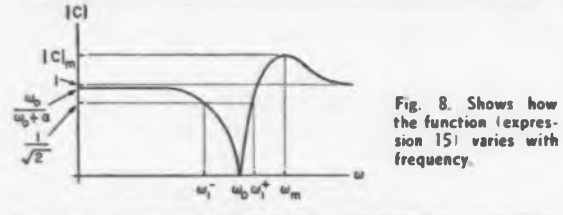


Fig. 8. Shows how the function (expression 15) varies with frequency.

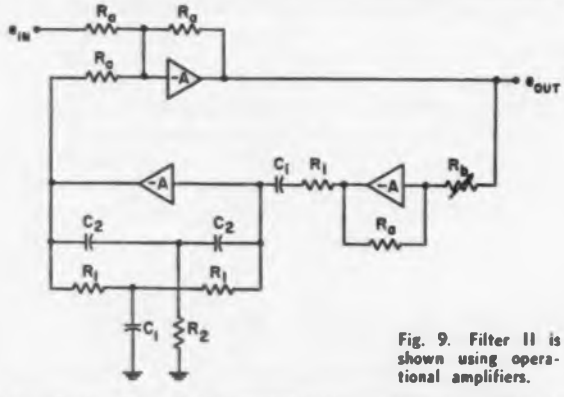


Fig. 9. Filter II is shown using operational amplifiers.

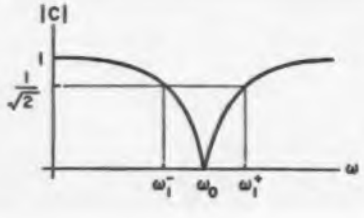


Fig. 10. Shows how the function (expression 30) varies with frequency.

Interference Frequency
(Continued)

expressions is better because it goes to zero as the frequency goes to zero.

To prevent giving the impression that the gain is infinite at the radian frequency $\omega = \sqrt{\omega_1 \omega_2}$ the more realistic form for $Y_T(s)$ (Eq. 4) should be used in the calculation of $B(s)$. The equations corresponding to Eqs. 7 and 9 are:

$$B(s) = -\frac{k}{R_i}\left[\frac{s+\omega_1}{s^2+\delta s+\omega_1\omega_2}\right] \qquad (10)$$

$$B(s) = -\frac{k}{R_i}\left[\frac{s}{s^2+\delta s+\omega_1\omega_2}\right]. \qquad (11)$$

The magnitude of $B(s)$ for $s = j\omega$ as given by Eqs. 10 and 11, is sketched in Fig. 6 to indicate the functional form of $|B(j\omega)|$ in these two cases.

If δ is negative ($\omega_1 < \omega_2$), $B(s)$ has two poles in the right-hand half s-plane ($Re\ s > 0$), and the system is unstable as described by Eqs. 10 or 11.

Filter I

The filters that are to be set down will differ from an approximation to the ideal filter by a minus sign. They will approximate a negative unity gain except at the frequency of the undesired signal where they will approximate zero gain. This is being done to simplify the circuits.

The circuit realization of this first filter, using operational amplifiers, is shown in Fig. 7.

The gain of the circuit, C [$C = a\ (e_{out}/e_{in})$], is given in general by Eq. 12.

$$C = -\frac{1}{1-\frac{1}{10}B}. \qquad (12)$$

Using Eq. 7 for B we get the following expression for C:

$$C = -\frac{(s^2+\omega_1\omega_2)}{(s^2+\omega_1\omega_2)+\frac{k}{10R_i}(s+\omega_1)}. \qquad (13)$$

To simplify matters let $\omega_o = \omega_1 = \omega_2$ and $a = \frac{k}{10R_i}$, then:

$$C = -\frac{s^2+\omega_o^2}{s^2+as+\omega_o(\omega_o+a)}. \qquad (14)$$

The magnitude of C for $s = j\omega$ may be written as:

$$|C| = \left[\frac{\left[\omega_o^2-\omega^2\right]^2}{\left[\omega_o(\omega_o+a)-\omega^2\right]^2+a^2\omega^2}\right]^{1/2}. \qquad (15)$$

The sketch of $|C|$ in Fig. 8 shows how this function varies with frequency.

The frequencies at which $|C| = 1/\sqrt{2}$ are given by Eqs. 16a and 16b.

$$\omega_1^+ = \left\{-\left[\omega_o(\omega_o+a)-2\omega_o^2-\frac{a^2}{2}\right] + \left\{\left[\omega_o(\omega_o+a)-2\omega_o^2-\frac{a^2}{2}\right]^2 - \left[2\omega_o^4-\omega_o^2(\omega_o+a)^2\right]\right\}^{1/2}\right\}^{1/2} \qquad (16a)$$

$$\omega_1^- = \left\{ - \left[\omega_o (\omega_o + a) - 2\omega_o^2 - \frac{a^2}{2} \right] - \left\{ \left[\omega_o (\omega_o + a) - 2\omega_o^2 - \frac{a^2}{2} \right]^2 - \left[2\omega_o^4 - \omega_o^2 (\omega_o + a)^2 \right] \right\}^{1/2} \right\}^{1/2} \quad (16b)$$

When $a << \omega_o$, which is usually the case, Eqs. 16 take on the following simpler form:

$$\omega_1^+ \approx \omega_o \left[1 - \frac{a}{2\omega_o} (1 - \sqrt{3}) \right] = \omega_o \left[1 + 0.366 \frac{a}{\omega_o} \right] \quad (17a)$$

$$\omega_1^- \approx \omega_o \left[1 - \frac{a}{2\omega_o} (1 + \sqrt{3}) \right] = \omega_o \left[1 - 1.366 \frac{a}{\omega_o} \right] \quad (17b)$$

At $\omega = \omega_m$, $|C|$ is a maximum, $|C|_m$. The expressions for ω_m and $|C|_m$ are as follows:

$$\omega_m = \omega_o \left[\frac{1 + 3\left(\frac{a}{2\omega_o}\right)}{1 - \left(\frac{a}{2\omega_o}\right)} \right]^{1/2} \quad (18)$$

$$|C|_m = \left[\frac{2}{1 + 2\left(\frac{a}{2\omega_o}\right) - \left(\frac{a}{2\omega_o}\right)^2} \right]^{1/2} \quad (19)$$

For $a << \omega_o$ these Eqs. may be written as:

$$\omega_m \approx \omega_o \left[1 + 2\left(\frac{a}{2\omega_o}\right) \right] \quad (20)$$

$$|C|_m \approx \sqrt{2} \left[1 - \left(\frac{a}{2\omega_o}\right) \right] \quad (21)$$

For $\omega >> \omega_o$ the function $|C|$ asymptotically approaches the value of one, and for $\omega << \omega_o$ the function $|C|$ asymptotically approaches the value of

$$\left[\frac{\omega_o}{\omega_o + a} \right].$$

In any practical physical realization of this filter the function $|B\ (j\omega)|$ will not become infinite at $\omega = \omega_o$ (Fig. 6). Hence $|C|$ will not equal zero at $\omega = \omega_o$. At $\omega = \omega_o$, $|C|$ will be equal to some small value, call it $|C|_s$. To get a value for $|C|_s$ it is first necessary to use in Eq. 12 for C the form for B given by Eq. 10:

$$C = - \frac{s^2 + \delta s + \omega_1 \omega_2}{s^2 + (\delta + a) s + (\omega_1 \omega_2 + a \omega_1)} \quad (22)$$

From Eq. 22 an expression for $|C|$ may be calculated and set down as:

$$|C| = \left[\frac{\left[\omega_1 \omega_2 - \omega^2\right]^2 + \delta^2 \omega^2}{\left[(\omega_1 \omega_2 + a \omega_1) - \omega^2\right]^2 + (\delta + a)^2 \omega^2} \right]^{1/2} \quad (23)$$

For $\omega = \sqrt{\omega_1 \omega_2} = \omega_o$, the value of $|C|_s$ is found to be:

$$|C|_s = \left[\frac{1}{1 + 2\frac{a}{\delta} + \frac{a^2}{\delta^2} \frac{\omega_1 + \omega_2}{\omega_2}} \right]^{1/2} \quad (24)$$

(*Continued on following page*)

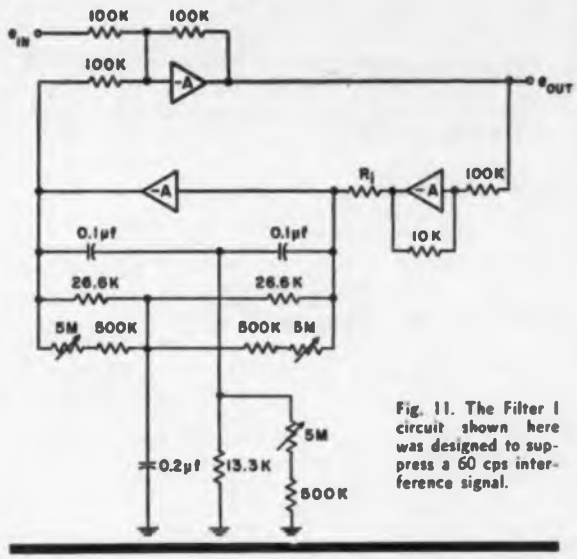


Fig. 11. The Filter I circuit shown here was designed to suppress a 60 cps interference signal.

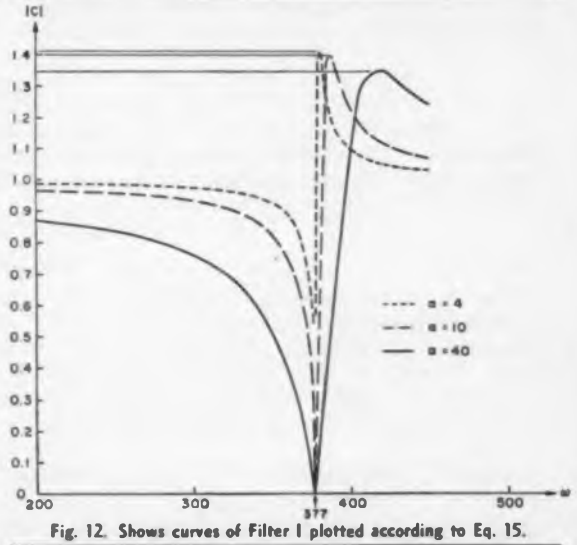


Fig. 12. Shows curves of Filter I plotted according to Eq. 15.

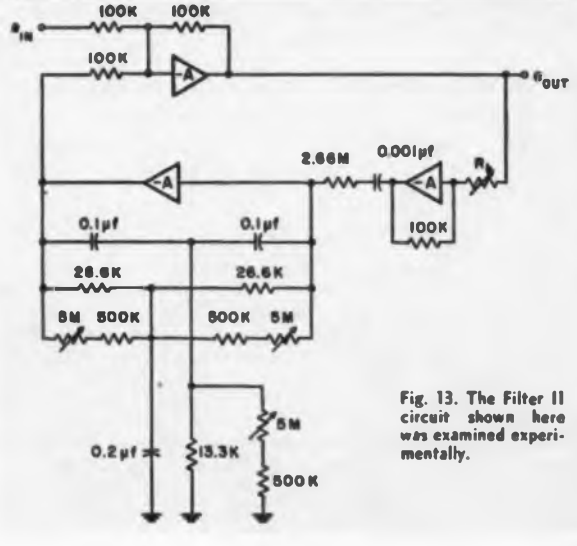


Fig. 13. The Filter II circuit shown here was examined experimentally.

Interference Frequency *(Continued)*

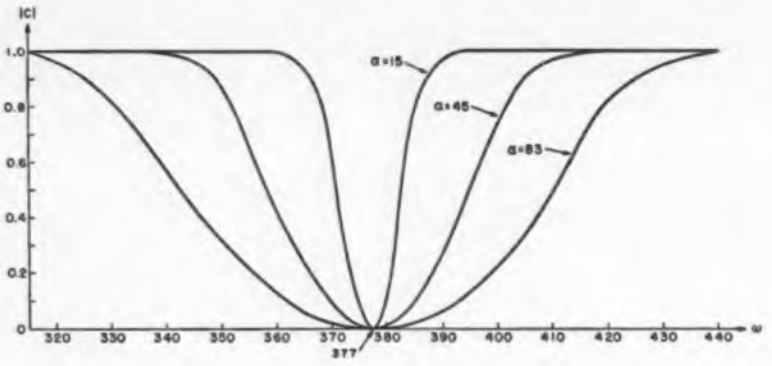


Fig. 14. Shows curves for Filter II plotted according to Eq. 30.

For $\delta << a$ and $\omega_1 \approx \omega_2$, a good approximation to $|C|_o$ is:

$$|C|_o \approx \frac{\delta}{\sqrt{2}\,a} \cdot \tag{25}$$

This is the same approximation that would be obtained by the following assumption on Eq. 12.

$$|C|_o \approx \frac{1}{|B(j\omega_o)|} \cdot \tag{26}$$

The stability of the filter will be governed by the pole positions of C. As long as $\delta + a > 0$, the filter will be stable. This is equivalent to requiring that:

$$\omega_1 > \omega_2 - a \cdot \tag{27}$$

Filter II

The circuit realization of this second filter, using operational amplifiers, is shown in Fig. 9.
The gain of this circuit is given by:

$$C = -\frac{1}{1 - \frac{R_a}{R_b} B} \cdot \tag{28}$$

Using Eq. 9 for B gives:

$$C = -\frac{s^2 + \omega_1 \omega_2}{s^2 + a\,s + \omega_1 \omega_2} , \tag{29}$$

where

$$a = \frac{R_a}{R_b} \frac{k}{R_i} \cdot$$

The magnitude of C for $s = j\omega$ may be expressed as:

$$|C| = \left[\frac{1}{1 + \left(\frac{a\,\omega}{\omega_o^2 - \omega^2}\right)^2}\right]^{1/2} , \tag{30}$$

where we have let $\omega_o = \sqrt{\omega_1 \omega_2}$. The sketch of $|C|$ in Fig. 10 shows how this function varies with frequency.

The frequencies at which $|C| = 1/\sqrt{2}$ are given by the following equations.

$$\omega_1^+ = \left\{\left[\omega_o^2 + \frac{a^2}{2}\right] + \left[\left(\omega_o^2 + \frac{a^2}{2}\right)^2 - \omega_o^4\right]^{\frac{1}{2}}\right\}^{1/2} \tag{31a}$$

$$\omega_1^- = \left\{\left[\omega_o^2 + \frac{a^2}{2}\right] - \left[\left(\omega_o^2 + \frac{a^2}{2}\right)^2 - \omega_o^4\right]^{\frac{1}{2}}\right\}^{1/2} \tag{31b}$$

For $a << \omega_o$, Eqs. 31 take on the following form:

$$\omega_1^+ \approx \omega_o \left[1 + \frac{a}{2\,\omega_o}\right] \tag{32a}$$

$$\omega_1^- \approx \omega_o \left[1 - \frac{a}{2\,\omega_o}\right] . \tag{32b}$$

For $\omega << \omega_o$ and $\omega >> \omega_o$ the function $|C|$ asymptotically approaches the value of one.

Using Eq. 11 for B in Eq. 28 for C gives:

$$C = -\frac{s^2 + \delta\,s + \omega_1 \omega_2}{s^2 + (a + \delta)\,s + \omega_1 \omega_2} \cdot \tag{33}$$

The value of $|C|_o$ for this filter may be calculated from Eq. 33 and found to be:

$$|C|_o = \frac{1}{1 + \frac{a}{\delta}} ; \tag{34}$$

and, if $\delta << a$, a good approximation to $|C|_o$ is:

$$|C|_o \approx \frac{\delta}{a} \cdot \tag{35}$$

The condition for the stability of this filter is the same as that for the previously considered filter (Eq. 27).

TABLE 1

Data on Filter 1

Calculated	ω_1^+		ω_1^-		ω_m		$\|C\|_o$	
Measured		ω_1^+		ω_1^-		ω_m		$\|C\|_o$
a = 4	378 rps	379 rps	373 rps	374 rps	381 rps	383 rps	1.41	1.40
a = 10	381	383	364	362	387	400	1.40	1.43
a = 40	392	392	319	323	418	424	1.34	1.36

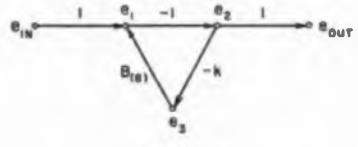
Investigation of Filter I

The circuit examined experimentally was designed to suppress a 60 cps interference signal. That is, the circuit parameters were chosen to set $\omega_1 = \omega_2 = \omega_3 = \omega_o = 2\pi \times 60$. The circuit is shown in Fig. 11. The potentiometers are used to adjust R_1 and R_2 to the correct values. A 60 cps signal is inserted at the input to the circuit and the resistors R_1 are adjusted to minimize the output signal. The resistor R_2 is then adjusted to further minimize it. This procedure is repeated until the output signal is minimized. If the adjustments are carried to the point of violating the condition for stability, the output signal will grow in amplitude until one of the amplifiers limits the signal.

The value for a for this circuit is:

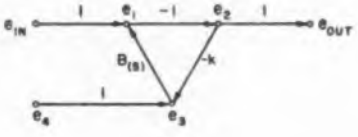
$$a = \frac{2 \times 10^4}{R_a} \cdot \tag{36}$$

Curves of $|C|$ versus ω for several values of a are plotted according to Eq. 15 in Fig. 12. A comparison of measured and theoretical points is given in Table I. The agreement between the calculated and measured data is quite good.



(a)

Fig. 15a. Shows the filters in flowgraph form.



(b)

Fig. 15b. With an interference signal added at e_3, the amount of signal e_4 contained in the output is given by expression 38.

The measured value of $|\delta|$ was no greater than 1/20. This made it possible to achieve small values of gain at 60 cps. The fact that $|\delta|$ may have been much less than 1/20 was difficult to ascertain because of interference signals at frequencies other than 60 cps.

Investigation of Filter II

The circuit examined experimentally is shown in Fig. 13. The procedure for adjusting the resistors R_1 and R_2 is the same as that for filter 1.

The value of a for this filter is:

TABLE 2

Data on Filter II

Calculated	ω_1^+		ω_1^-	
Measured		ω_1^+		ω_1^-
a = 15	384	383	369	370
a = 45	399	395	354	356
a = 83	416	421	335	337

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$$a = \frac{7.52 \times 10^4}{R_b} \cdot \tag{37}$$

Curves of $|C|$ versus ω for several values of a are plotted (Fig. 14) according to Eq. 30. A comparison of measured and theoretical points is given in Table II. The agreement between the calculated and measured data is satisfactory.

The measured value of $|\delta|$ was no greater than 1/20 for the other filter circuit.

Conclusions

The filters presented in this report appear to provide a satisfactory means of suppressing an undesired, almost monochromatic signal superimposed upon a desired signal. Theoretically, the bandwidth of the notch (at the frequency to be rejected) may be made as narrow as desired. However, if the notch is too narrow, it is difficult to properly locate the center frequency of the notch.

The filters are represented in flowgraph form in Fig. 15a.

If in some manner an interference signal, e_4, were to be added at node e_3 (Fig. 15b), the output signal would contain the amount of signal e_4 given by the following expression:

$$-\frac{B(s)}{1 - B(s)} e_4 \cdot \tag{38}$$

For $s = j\omega$ and $\omega \neq \omega_o$, this expression will be (for all practical purposes) zero. However, for $\omega \approx \omega_o$ the expression will be approximately equal to e_4. Thus, the interference signal introduced by the circuit at node e_3 must be negligible at or near the notch center frequency.

Nothing has been said about the effects if the resistances R_1 and the capacitances C_2, are not exactly equal. Satisfactory experimental results make it appear that this point is not too critical.

Finally, as an alternative scheme for adjusting the resistors R_1 and R_2 in the parallel Tee network, the circuit in Fig. 16 is presented.

This research was supported by the U.S.A.F. through WWRNGW of the Wright Air Development Division of the Air Research and Development Command.

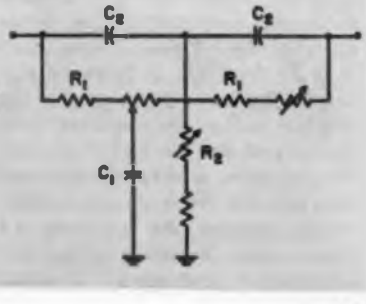

Fig. 16. An alternative scheme for adjusting the resistors R_1 and R_2 in the parallel Tee network is presented.

A technique has been developed for the continuous measuring of UHF phase angles. The phase difference between two audio frequency signals is used to measure the phase difference between two UHF signals. The UHF phase angles are monitored by an audio phase meter. The feasibility of the processes employed is mathematically proven.

UHF Phase Measurement

DEVELOPMENT of high frequency (h-f) phase measurement devices has lagged behind that of h-f voltage and frequency measurement devices. The difficulties involved and the limited applications of h-f phase measurement techniques make this lag understandable. This article describes a method of measuring UHF phase angles with a high degree of accuracy.

UHF phase information is changed to low frequency phase information by the processes of amplitude modulation (AM), mixing, and filtering. While some of the principles have been previously applied to h-f phase measurement, it is felt that the AM technique introduced herein may be useful.

Theory

The processes used in transferring r-f phase information to the a-f range are outlined in Fig. 1. Two modulators are simultaneously amplitude modulated by a 1 kc signal. The 1 kc signal is shifted so that the modulating signals to the first and second modulators are in quadrature to each other. The r-f signal inputs to the modulators are also in quadrature to each other. The later addition of the modulator outputs results in a carrier component and a lower sideband component. The latter contains the r-f phase angle which is to be detected. A large r-f signal, of the same frequency as the original carrier, is combined with the sum of the modulator outputs. This produces a new reference carrier, plus the lower sideband signal which contains the unknown r-f phase angle. Detection of the new combination produces a 1 kc signal containing the unknown r-f phase angle. A reference 1 kc signal and the detected 1 kc signal are fed into an audio phase meter. The unknown r-f phase angle is read from this meter.

The following mathematical analysis is more easily understood by referring to Fig. 1.

The UHF signal, $e_1 \sin(\omega_c t + \theta)$, whose phase angle θ is to be measured, is amplitude modulated by the reference audio signal $e_2 \sin \omega_m t$. The phase of the reference audio signal has been neglected for greater simplicity. The resultant signal may be expressed mathematically as:

$$e_{o1} = k_1 \sin(\omega_c t + \theta) + \frac{k_1 m_1}{2} \cos(\omega_c t + \theta - \omega_m t) - \frac{k_1 m_1}{2} \cos(\omega_c t + \theta + \omega_m t)$$

where k_1 is the modulator transfer function, and m_1

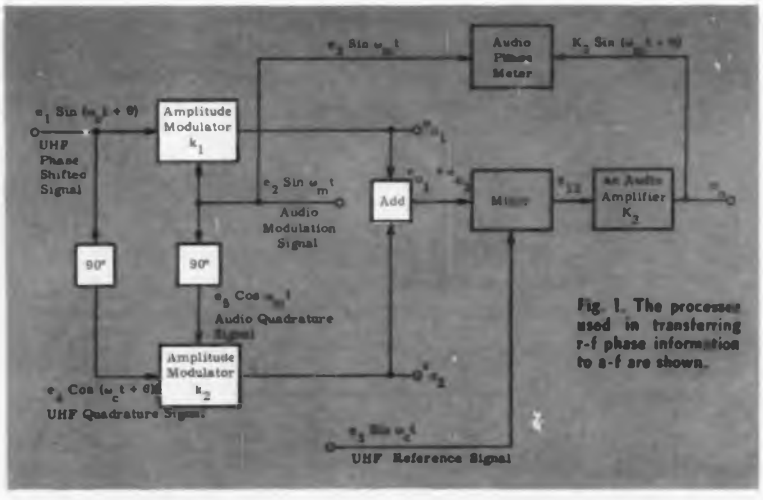

Fig. 1. The processes used in transferring r-f phase information to a-f are shown.

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The Martin Company
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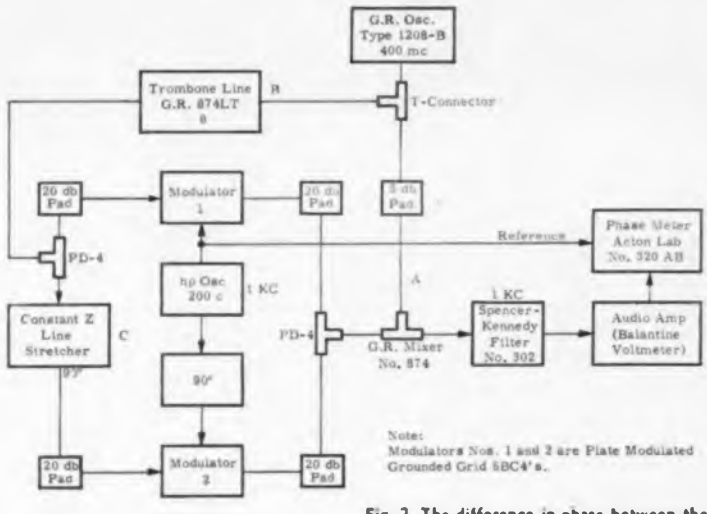

Fig. 2. The difference in phase between the two UHF signals was obtained by a variable trombone in the experimental test setup.

by an AM Process

the modulation factor. Modulation of less than 100% may be used.

The UHF signal, $e_1 \sin (\omega_c t + \theta)$, whose phase angle θ is to be measured, is also phase-shifted by 90°. The quadrature UHF signal, $e_4 \cos (\omega_c t + \theta)$, is amplitude modulated by the quadrature audio signal $e_5 \cos \omega_m t$. The resultant signal may be expressed mathematically as:

$$e_{o2} = k_2 \cos (\omega_c t + \theta) + \frac{k_2 m_2}{2} \cos (\omega_c t + \theta - \omega_m t) + \frac{k_2 m_2}{2} \cos (\omega_c t + \theta + \omega_m t)$$

where k_2 is the modulator transfer function and m_2 the modulation factor. Modulation of less than 100% may be used.

The two amplitude modulated signals, e_{o1} and e_{o2}, are added together and then mixed with the UHF reference signal $e_3 \sin \omega_c t$.

For identical modulation transfer functions, $k_1 = k_2$ and modulation factors, $m_1 = m_2$.

$$e_{o1} + e_{o2} = k_1 \sin (\omega_c t + \theta) + k_2 \cos (\omega_c t + \theta) + k_1 m_1 \cos (\omega_c t + \theta - \omega_m t)$$

A linear mixing process may be assumed for the UHF reference signal $e_3 \sin \omega_c t$ much greater than $e_{o1} + e_{o2}$, and may be expressed mathematically as:

$$e_{11} = k_1 e_3 \sin (\omega_c t + \theta) \sin \omega_c t + k_2 e_3 \cos (\omega_c t + \theta) \sin \omega_c t + k_1 m_1 e_3 \cos (\omega_c t + \theta - \omega_m t) \sin \omega_c t$$

After operation on the above equation:

$$e_{11} = \frac{k_1 e_3}{2} \cos (-\theta) - \cos (2\omega_c t + \theta) + \frac{k_2 e_3}{2} \sin (2\omega_c t + \theta) + \sin (-\theta) + \frac{k_1 m_1 e_3}{2} \sin (2\omega_c t + \theta - \omega_m t) + \sin (\omega_m t - \theta)$$

After filtering out the harmonic frequencies the signal input to the audio amplifier may be expressed as:

$$e_{12} = \frac{k_1 e_3}{2} \cos \theta - \frac{k_2 e_3}{2} \sin \theta + \frac{k_1 m_1 e_3}{2} \sin (\omega_m t - \theta)$$

The first two terms of the above equation represent a dc signal for each UHF phase angle θ. They are eliminated by passing the signal e_{12} through an ac amplifier of either negligible or known phase shift.

Assuming negligible phase shift in the audio amplifier, the resultant amplified signal e_o is:

$$e_o = K_3 \sin (\omega_m t - \theta)$$

where K_3 is the transfer function of the audio amplifier and includes $\frac{k_1 m_1 e_3}{2}$. The UHF phase angle θ has been transferred to the modulation frequency $\omega_m t$.

The amplified audio signal, e_o, is applied to one set of terminals of an a-f phase meter. The audio AM signal, $e_2 \sin \omega_m t$, or an audio reference signal is applied to the other set of terminals. The phase meter reads the phase difference between the two audio signals directly, even though they may be of unequal amplitudes. The measured phase difference, $-\theta$, is the negative of the phase difference between the two UHF signals; $e_3 \sin \omega_c t$, and $e_1 \sin (\omega_c t + \theta)$. If e_{o1} and e_{o2} were subtracted and then mixed, the new phase difference $+\theta$, would agree exactly with the UHF phase difference.

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Phase Measurement *(Continued)*

Experimental Circuitry

In the experimental setup (Fig 2), the difference in phase between the two UHF signals was obtained by a variable trombone line. A constant impedance line stretcher was used to obtain the 90° UHF phase shift. The mixing and UHF harmonic signal filtering is accomplished in the G.R. Mixer. Any audio harmonic frequencies were eliminated by the 1 kc band pass filter. RG 58 cable was used. Particular care was given to lead lengths.

The prime requirement is to obtain two UHF signals, equal in amplitude and in quadrature, at the output summation point of the two modulators. A procedure based on phase modulation may be used to check the UHF 90° phase shift by rearranging the equipment and using null techniques. The UHF 90° phase shift may also be checked by dc measurements at the mixer when point A is disconnected. A 90° phase shift is obtained when the constant impedance line stretcher is adjusted for one half the difference between settings for maximum and minimum dc output.

Fig. 3 is a schematic drawing of the audio phasing device and modulators. The 90° audio phase shift is accomplished in the RC phase shift circuit. The 50 k ohm potentiometer provides a phase range of zero to approximately 170°. The modulating signal on the plate of modulator 1 is set to be in quadrature with reference to the modulating signal on the plate of modulator 2. 12AU7 tubes were used as drivers for the 6AQ5 modulator tubes. The maximum modulation obtainable from the plate-modulated, grounded grid 6BC4's was approximately 90%. The doubly-tuned filters were tuned for a flat response from 400 mc to 420 mc. The UHF amplifier tubes were aligned for nearly equal frequency response, gain, and percentage modulation.

Test Results

Phase measurements were made by adjusting the trombone line. The resulting phase difference was observed on the audio phase meter. Figs. 4 and 5 are graphs showing the phase readings of a 417 mc signal. At that frequency, a 2 centimeter change in length of the trombone line should produce a calculated 10° phase change. All measurements were within the rated accuracy of the Acton Laboratories Model 320 phase meter which is 1% of full scale plus 3 degrees.

General Considerations

The accuracy of phase measurement is not limited to the care taken in alignment adjustments of the system nor to the rated accuracy of the audio phase

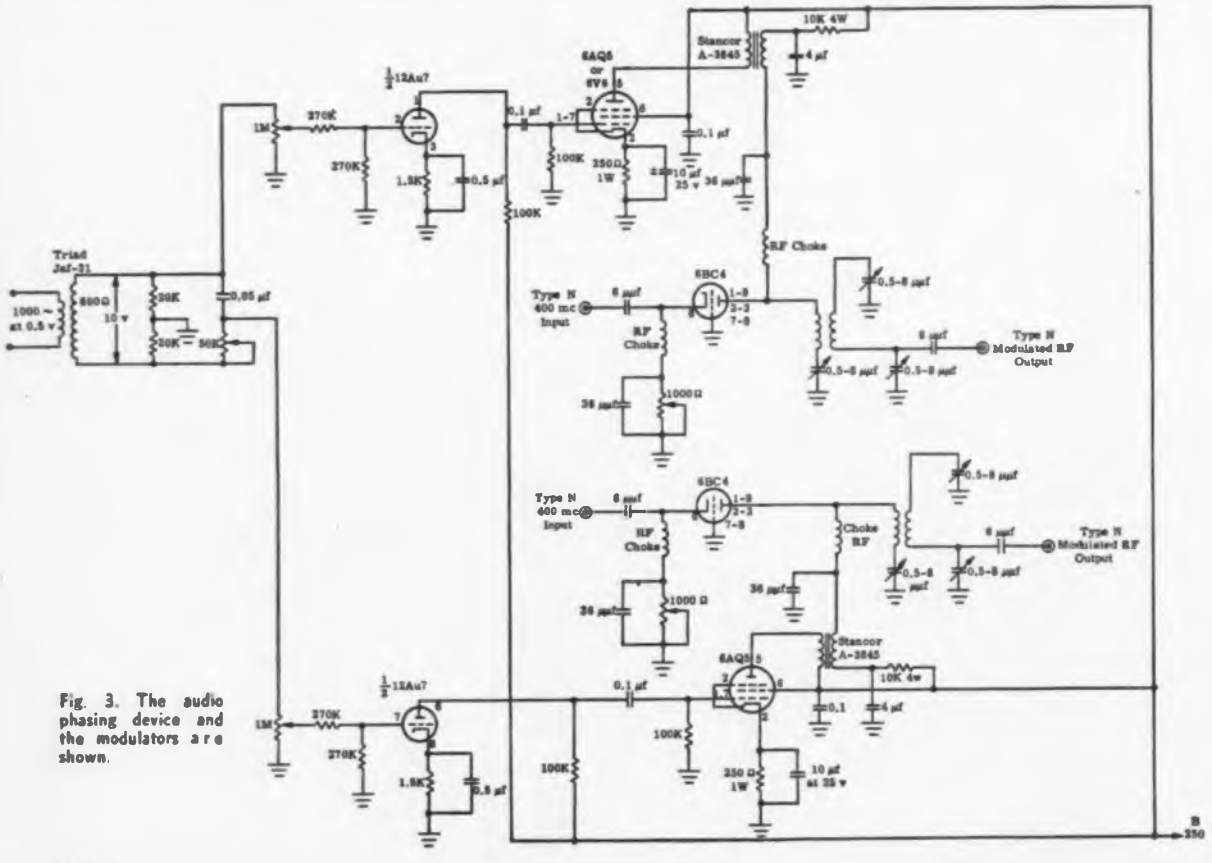

Fig. 3. The audio phasing device and the modulators are shown.

meter. There is a theoretical inaccuracy which was not taken into consideration. The input to the mixer consists of the resultant of the sum of the two carrier components of the two modulated waves, plus the lower side band, plus the new injected carrier signal. For proper mixing, the injected carrier signal would normally be about 1,000 times larger than carrier components of the amplitude modulated waves. However, in the mathematical analysis presented, all carrier components were neglected in the input to the mixer except the new injected carrier referred to as $e_3 \sin \omega_c t$. If it is accepted that $e_3 \sin \omega_c t$ is 1,000 times larger than the resultant carrier component of the modulation envelope and the latter component is neglected, then we assume a maximum theoretical phase error of less than 6% of 1 degree.

With this technique, an audio signal output e_o will always be available over a complete 360° phase shift of the UHF signal.

Grounded grid UHF amplifiers may be used as 100% modulation is not necessary. Suppressed carrier techniques may also be used as the carrier component of the amplitude modulated signal is not necessary in the mixing process as described. In fact, if suppressed carrier techniques are used, square law mixing may be used for identical results.

The audio modulation signal frequency may be selected for accuracy of phase measurements, and digital comparison techniques if desired for readout, convenience, or greater accuracy.

Although the measurements were for cw signals, the techniques may be applied to detect the phase of pulse UHF signals if the modulation frequency is much lower than the pulsed repetition frequency.

The AM technique may be substituted for the suppressed carrier technique used in the phase modulation method for null indications.

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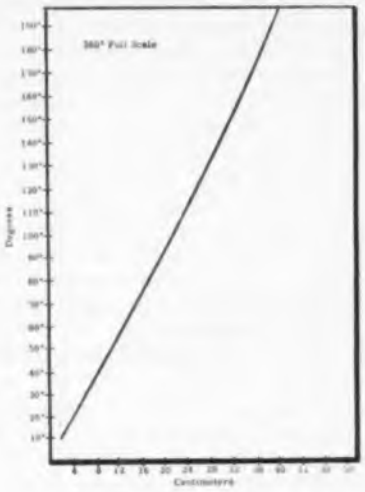

Fig. 4. Phase measurements of a 417 mc signal at 360° full scale.

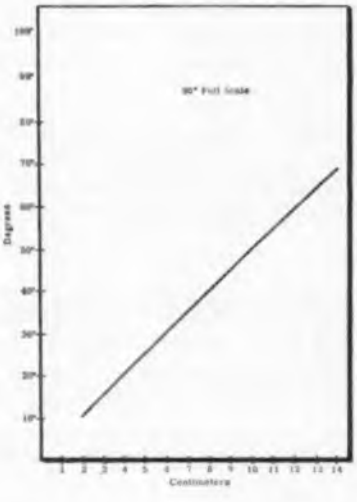

Fig. 5. Phase measurements of a 417 mc signal at 90° full scale.

Anti-jam Radar

FIRST operational member of a new family of advanced anti-jam search radar will be erected at Point Arena, Calif. Built by GE's Heavy Military Electronics Dept. for the Air Force, it will be used to detect and furnish warning against supersonic aircraft and air-breathing missiles.

First Operational AN/FPS-24 Search Radar is one of the world's largest rotating radar structures. The 84 ft. high concrete building will house electronic equipment and serve as antenna base.

Over 125 ft. wide and 50 ft. high, the system, AN/FPS-24, will need four 100 hp motors to rotate the 137-ton antenna on a ball bearing 10 ft. in dia.

Made of 51 sections, the reflector screen and support backup structure contains more than two mi. of high strength aluminum and low temperature steel. The 90-ton reflector is mounted on a 10-foot-high rotating pedestal.

FOR the purpose of this discussion, interference will be defined as any undesired received signal which reduces the intelligence content of a desired received signal. This annoying signal may be of friendly or unfriendly origin. It may be natural or man-made.

The first problem is to determine the level of degradation that can be tolerated. This question can only be answered for a specific situation. For example, suppose that a complete message must be received, but the time for transmitting the message is unlimited. Then, if the message is continuously repeated it is only necessary to receive a small portion of the message at each repetition and a high degree of interference is acceptable.

It should be noted that due to the redundancy of the English language, if only 50% of the words are intelligible, a sentence intelligibility of 80% can be achieved. Finally if the information must be received within a specified time limit even moderate interference may cause great difficulty.

Having established a quantitative performance limit, tests have to be performed to give qualitative levels which include various intelligibility tests. These tests have been devised in order to determine the degree of interference that can be tolerated.

Listener Tests

Many of these tests require the listener to identify as best he can each of a number of words picked at random. Other tests may provide the listener with a certain amount of information about the message to be expected. For example, the "Michigan Map Test"[1] provides the listener with only a limited number of possible next words.

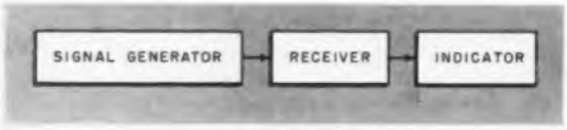

Fig. 1: The frequency of the signal generator is varied to check the receiver's susceptibility to spurious responses.

Each of the many tests in existence is designed to test some form of intelligibility under certain circumstances. Thus we have word or sentence intelligibility under requirements of maximum intelligibility regardless of time (allowing the message to be repeated many times), maximum intelligibility over limited time (the operator has the choice of going to the next word or repeating any previous word), etc. There are also tests which tend to eliminate the human operator.[2] Generally, 80% intelligibility is sufficient for messages.

The next phase of the analysis is to consider the types of interfering signals.

Interfering Signals

In this respect different methods of transmission and coding will produce a different degree of intelligibility for the same degree of interference present. Likewise, for one system of transmission and coding, different types of interference will produce a different end result. The following types of interference would be effective against an (FM/FM) multiplex system:

1. Pulse jamming.
2. Thermal and FM noises.
3. FM tones.
4. Frequency shift keying.
5. Single and multiple delayed voice repetitions.
6. Random sawtooth FM sweeps.
7. Jittered tone.
8. Single tone sine wave (AM).
9. Single tone square wave (AM).
10. Multi-tone AM.

Of these, the most detrimental to operation are random noise[3] (This includes both a direct noise input and a carrier frequency modulated by noise. The effects of both types have been shown to be of the same order of magnitude.) which tends to mask the incoming signal, and frequency shift keying[3] which will cause "capture" if the signal level of the undesired signal is sufficiently high. (At least one db above the desired signal.) Other types of interference will, in general, tend to approach, in their effects on intelligibility, the aforementioned two types. Multi-tone AM will approach the masking effect of random noise as a limit, and a strong undesired carrier at the frequency of the desired signal will produce the so-called "capture" effect.

Random Noise

Random noise causes the worst type of interference because the spectrum occupied by speech can be uniformly covered. Use of simple tones or even speech is not as effective as noise because of the computing and filtering ability of the human operator. It is relatively easy to tune out one voice in favor of another when the two are of similar loudness. Because of redundancy in the English language, a lesser signal to noise ratio (S/N) can be tolerated when transmitting a message, than when transmitting a single word.

Designing

There are three phases to the RFI reduction program in communications systems—prediction, design, and measurement. The equipment must be designed for a minimum of predicted interference and then tested to insure reaching this goal. Here the way is shown for achieving these steps.

RFI-Free Communication Systems

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In addition to the intentional types of interference, we must consider the various natural and man-made sources of interference. Among these are intermodulation, spurious responses, desensitization due to a strong carrier, etc., and the ever present noise (no carrier) whether natural or man-made.

Types of Interference

There are essentially two classes of interference with which the system must contend. One is "on frequency" interference (both intentional and unintentional) and the other may be lumped under the general heading of "off frequency" interference.

The "on frequency" interference, especially if it is intentional jamming, can sometimes be reduced by changes in geometry (example, location and beam width of antenna) and to a greater extent by the use of coded transmission.

The "off frequency" interference can be reduced by a judicious choice of receiver parameters.

The types of interference[4, 5, 6, 7] that should be considered in receiver design are: spurious responses, intermodulation, cross modulation, desensitization and interchannel interference.

Spurious responses will occur when harmonics of the incoming signal combine with harmonics of the local oscillator to produce an i-f signal. The equation that characterizes spurious responses is:

$$A f_o \pm B f_1 = i\text{-}f \qquad (1)$$

where A and B are positive integers and

f_o = local oscillator frequency

f_1 = signal frequency

i-f = the intermediate frequency

Intermodulation is actually a general case of spurious responses. It occurs when two or more signals enter a receiver and interact due to non-linearities in the equipment. A Taylor series expansion of receiver non-linearities shows that the worst intermodulation is due to odd order curvature in the recevier non-linear elements.

Cross-modulation is the amplitude modulation of one signal by another. This is an AM phenomena and should have negligible effect on an FM system.

Desensitization is due to the suppression of a weak desired signal by a strong undesired signal. The undesired signal need not be modulated, as illustrated by the "capture" effect for FM systems.

Interchannel interference refers to interference caused by a signal getting into a channel it was not intended for.

All of the above types of interference can, to a certain extent, be predicted and guarded against by proper design of equipment.

In general, the problem in the above types of interference is due to system non-linearities and insufficient attenuation of the undesired signal on its path to the point of non-linearity.

Good preselection, particularly in the case of spurious responses, is extremely helpful in reducing the

The transistorized calibrated field intensity receiver is specifically for mobile use. It operates in the 1 to 10 kmc range.

RFI Elimination
(Continued)

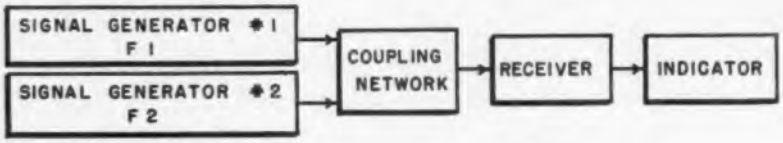

Fig. 2: Two signal generators are being used for an intermodulation test.

strength of undesired signals. It may be of interest to note here that filters have periodic structures and care should be exercised when using filters for preselection purposes. Sometimes several types of filters may have to be used to reduce spurious responses.

Equipment & Antenna Positioning

Judicious positioning of the equipment will, in many cases, reduce unintentional interference and may make the receiver a more difficult target for deliberate jamming.

Of prime importance in this respect is the positioning and characteristics of the antenna. Experimental evidence indicates that microwave antenna gain at spurious frequencies is substantially equal to the gain at the operating frequency up to at least the 3rd harmonic.[6] Thus, if a spurious signal were to fall within the beam width of the antenna, it would be little if at all reduced relative to the desired signal.

Proper placement and reduction in beam width of the receiving antenna are therefore important factors in controlling interference.

Measurement Program

The communications receiver needs to be checked for the following:

1. Spurious responses.
2. Intermodulation.
3. Cross-modulation (on AM receivers).
4. Inter-Channel interference.
5. Desensitization.
6. Antenna Patterns (if possible at spurious frequencies as well as in operating range).
7. Shielding effectiveness.
8. Degradation in intelligence due to various types of jamming (intelligibility tests).

Spurious Responses—The frequency of the signal generator (Fig. 1) is continuously varied over the range of interest. All frequencies at which an output is observed are noted. The rejection of the spurious signal by the equipment is computed as the power diference in db between the power input at the spurious frequency and the power input at the frequency to which the receiver is tuned, when the receiver indication is at some level (usually 3 db above noise).

When making this measurement two precautions must be taken. First, the spurious signal rejection is computed on the basis of power delivered to the receiver. The above necessitates checking of the receiver input impedance at the spurious frequencies, and the actual power delivered to the receiver computed. This is particularly troublesome when checking microwave receivers because of the necessity of providing proper waveguide to waveguide and waveguides to coax adapters as the signal generator frequency range changes.

The other problem comes about because the signal generators produce a great many harmonics. Care must be exercised, when checking for spurious responses at frequencies below the tuning range of the receiver, not to mistake a strong signal generator harmonic falling within the receiver pass band as a spurious response. Low pass filters having high attenuation at the receiver channel frequency are helpful in reducing false spurious indications.

Intermodulation—Presently there are two methods of intermodulation measurement. Both are based on the fact that two or more incoming signals will, due to system non-linearities, mix with each other, and an output will be obtained when such mixing produces an r-f or i-f frequency product.

Fig. 2 shows the block diagram for a two signal generator intermodulation test. The frequencies of the two signal generators are so adjusted that the sum or difference of the fundamentals or harmonics will produce an r-f or i-f signal. The intermodulation rejection is computed from the power difference between the intermodulating signals and a signal at the receiver frequency. The inputs are in both cases adjusted to produce a certain standard output (usually 3 or 6 db above noise).

The coupling network is necessary to provide isolation between the signal generators. If an isolation network is not employed, care must be taken not to interpret intermodulation products generating within the signal generators themselves as being caused by the receiver. Another precautionary measure would be to use low pass filters when the signal generators are set below the receiver frequency-wise. This arrangement reduces responses due to signal generator harmonics. Loss in the coupling network, filters and mismatch must be accounted for when computing the spurious power input.

Fig. 3 shows the block diagram for an impulse generator intermodulation test. This method of intermodulation testing is presently useful up to 10 KMC, this being the upper frequency of available impulse generators. Unlike the two signal generator test, the impulse generator method is a many frequency method. Test is performed by taking the difference in impulse generator spectral intensity required to obtain a discernible receiver output when the receiver is working properly and when the receiver oscillator is disabled.

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The pages in this section are perforated for easy removal and retention as valuable reference material.
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The theoretical basis for this test is as follows. The impulse generator signal is composed of a number of discreet sine waves, Fig. 4a, where the amplitude of these sine waves depends on the pulse amplitude of the impulse generator and the spacing depends on the PRR. After being amplified by the r-f amplifier, the spectrum takes on the shape of the r-f response curve shown in Fig. 4b.

The many frequencies which fall within the r-f amplifier pass band will, in the presence of r-f amplifier non-linearities, combine with each other to form frequencies not within the r-f pass band. Those frequencies which fall within the i-f pass band will be amplified by the i-f and indicated as a signal by the receiver.

The test is designed to check the degree of non-linearity in the r-f amplifiers, and the ability of the amplifiers to handle wide band high level interference.

Cross Modulation—Cross modulation pertains to the amplitude modulation of a desired signal by an undesired signal. Because of its nature, the effect of cross modulation of FM systems is negligible. A simple way of checking for cross modulation is to feed a desired and undesired (out of channel) signals into the receiver and check for a transfer of modulation from one to the other.

Inter-Channel Interference — Inter-channel interference essentially refers to cross-talk between channels. This can easily be checked by transmitting a typical signal and checking for cross-talk between channels.

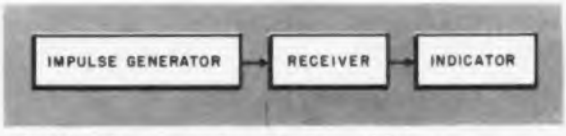

Fig. 3: Impulse generator is used for intermodulation testing

Desensitization—Desensitization refers to a loss in sensitivity to the desired signal caused by the presence of a strong undesired signal (usually unmodulated). In FM receivers this could be referred to as the "capture" effect. A typical measurement would consist of checking the loss in receiver audio output when a strong extraneous unmodulated signal is applied to the receiver input. The magnitude of the undesired signal required to produce a specified degradation in audio output is a measure of the desensitization properties of the receiver.

Shielding Effectiveness—Good shielding effectiveness is very important in order to eliminate all signals except those getting in through the front end of the equipment. Effective shielding against strong narrow beam signals permits the use of the terrain at the site for inter-system interference at a multi-receiver-transmitter installation. Shielding effectiveness is checked by subjecting the equipment to strong electromagnetic fields of various frequency (both on and off channel). The field strength or signal power input to the radiating antenna is used as a measure of the receiver shielding effectiveness. The antenna is removed when making tests at receiver frequency.

Antenna Patterns[10]—The beam width of the antenna will, in general, greatly influence the relative placement of antennas, when more than one antenna is involved. Antenna patterns are obtained by moving either the receiving or transmitting antenna in azimuth or elevation and determining the relative amount of power intercepted from a transmitting antenna as a function of angle. Once an antenna pattern is obtained, one can determine which antenna orientation, relative to transmitters whose reception is not desired, will produce least interference. It follows that the narrower the beam width and higher the antenna gain, the closer can the angle between the center of the main lobe and spurious transmissions be made.

Radio interference set covers from 0.15 to 25 mc. Several types of measurements are available by front panel selection.

Degradation in Intelligence—The characteristic of the receiving system that suffers most in the presence of a high ambient noise level (natural or man-made) is the sensitivity. The sensitivity of the receiving system (including antenna connecting cables, etc.) is, when considered in the context of the above statement, a function of the environment in which it is operating. The sensitivity, which is a measure of the required signal input to obtain a certain S/N output, will depend on the parameters of the receiver itself (noise figure, bandwidth, etc.) and on the ambient noise level that enters by way of the antenna. We can, once an output S/N is decided upon as being required for intelligible reception, perform sensitivity measurements as a function of various forms and strengths of the jamming signal.

Sensitivity measurements under normal (no interference) conditions would, of course, be made as part of the spurious response test, since the spurious response rejection is obtained by taking the difference between the sensitivity to the spurious and the desired signal. This method is simple to implement but not very realistic. The drawback comes from the fact that the filtering and computing properties of the human being are not being accounted for.

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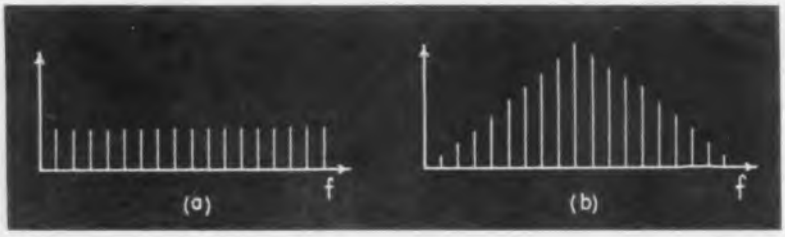

Fig. 4a: The output of the impulse generator is shown. 4b shows the response of the r-f amplifier with the oscillator disabled.

RFI Elimination *(Concluded)*

A more realistic, though much more tedious and expensive, approach is to run a standard articulation test. This method will indicate the anti-interference qualities of the equipment under actual operating conditions. The choice of the test to be performed would depend on the accuracy desired and the time and funds available.

The tests described thus far have all been intended for the receiver portion of the communications link. The transmitter portion of the communications link is, however, not interference free, and should, therefore be considered.

Transmitter Problems

Transmitter problems which need to be considered are: spurious emissions, intermodulation, cross modulation, side-band splatter and noise output. All of the above can be measured by means of field intensity meters or spectrum analyzer and appropriate coupling devices. (See Fig. 5.)

The choice of field intensity meter or spectrum analyzer depends on the test one is performing, on the power available, and the desired accuracy. The easiest way, for example, of measuring modulation splatter is to observe the actual transmitted spectrum by means of a spectrum analyzer. A sensitive receiver

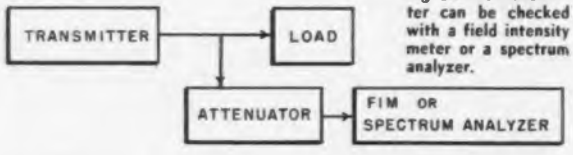

Fig. 5: The transmitter can be checked with a field intensity meter or a spectrum analyzer.

will, on the other hand, be more useful when measuring low power spurious responses. Another important difference between the two instruments is that a spectrum analyzer has a much narrower bandwidth than a field intensity meter. This characteristic could be advantageously exploited when checking for spurious responses in close proximity to the fundamental signal.

Conclusions

The solution to the interference problem is in many cases dependent on the question of whether the interference is intentional or unintentional. If, for example, the interference is intentional, the degree of intelligibility can be increased by a reduction in the rate of intelligence transmission or an increase of bandwidth so that the jammer will have to spread his available power over a larger bandwidth. An increase of bandwidth will, on the other hand, reduce the S/N ratio when the interference is unintentional.

The only way of improving the anti-jam properties of a communications system, is in the final analysis, to design these properties into the system. In general, though minor improvements can be made by the choice of such parameters as bandwidth, antenna characteristics, and physical positioning of the equipment, the only way to obtain good anti-interference properties is to use sophisticated methods of modulation and coding. The idea is to so design the coding that the jammer must either spread his signal power over a large bandwidth, spend time to decipher the code or find the frequency of transmission, or give the impression that intelligence is not being transmitted so that the jammer will not be interested.

Unintentional interference can best be eliminated by designing the equipment to minimize predicted trouble spots. Thus, for example, one can, using Eq. 1, predict spurious response frequencies for a given i-f amplifier frequency. This would indicate which choice of i-f is best, or if the intermediate frequency is fixed one can determine how much preselection is necessary.

The three phases of the susceptibility reduction program; prediction, design, and measurement are thus seen to complement each other. One must design for a minimum of predicted interference, and then make measurements to determine how well this goal was achieved.

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9. "Radio Frequency Interference Considerations in the TD-2 Radio Relay System," H. E. Curtis, *Bell System Technical Journal*, March 1960.

10. "Notes on Microwave Measurements," Polarad Electronics Corp.

11. "The Criterion in Speech Communication in Noise," J. P. Egan, Symposium on Electronic Counter Measures, 1956.

12. "Standard Practice Manual, T.O. 31-1-48 1957, Location, Identification, Suppression of Communications Electronics Interference."

13. "Standard Planning Manual, T.O. 31-1-49 Engineering Interference—Free Communications—Electronics Systems."

Circle 106 on Inquiry Card ⟶

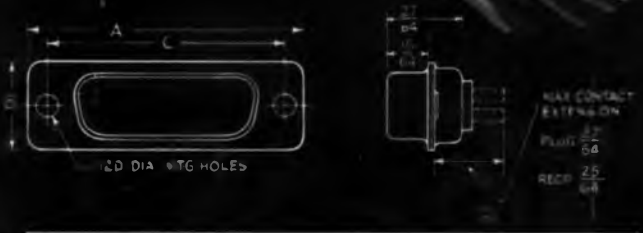
Cinch ELECTRONIC COMPONENTS

IMPROVED "D"-SUBMINIATURE* CONNECTORS

. . . ELIMINATE SOLDERING

MARK II GOLDEN "D"*

FEATURES CRIMP-ON, SNAP-IN, REMOVABLE PINS AND CONTACTS



- Monobloc Insulators of diallyl phthalate Type MDG per MIL-M-14E
- Pins & Contacts are copper base alloy, gold plated for high reliability
- Probe-proof, closed-entry socket contacts . . . designed to MS 3190
- Individual Contacts can be easily removed and replaced
- Fully interchangeable with Standard "D"
- Golden Iridite finish – per QQ–P–416A, Type II Class 2
- Insertion, Extraction and Crimp tools are also available from Cinch

For further information contact our sales office in your area

DIMENSIONS AND PART NUMBERS

No. of Contacts or Pins	Plug Part No.	Receptacle Part No.	A +1/32 −1/64	B +1/32 −1/64	C
9	DESM–9P	DESM–9S	1 13/64	31/64	0.983
15	DASM–15P	DASM–15S	1 17/64	31/64	1.312
25	DBSM–25P	DBSM–25S	2 5/64	31/64	1.955
37	DCSM–37P	DCSM–37S	2 13/32	31/64	2.598
50	DDSM–50P	DDSM–50S	2 7/8	39/64	3.305

DOT

CINCH MANUFACTURING COMPANY

1026 South Homan Ave., Chicago 24, Ill.

Division of United Carr Fastener Corporation
Boston, Massachusetts

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California, and St. Louis, Missouri

*Manufactured by agreement with Cannon Electric Company – Sales limited to U.S.A.

The microelectronics of solid networks appears as one solution to size reduction and reliability problems. New techniques in the semi-conductor field are causing the rapid expansion. The "growing" of complete circuit packages is also changing the role of system and device engineers.

A Growing Field . . . .

Solid Networks

By J. J. BOWE
Dept. Head
Research & Development
Microelectronic & Tunnel Diodes
Sperry Semiconductor Div.
Wilson Ave.
S. Norwalk, Conn.

A GROUP of new words has ushered in a revolution in the components and semiconductor industry. With somewhat vague meanings revealing the newness of the concepts, words like microelectronics, molecular engineering, molecular electronics, moletronics, microtronics, micromodules and microcircuitry appear with increasing frequency in the technical news.

Over two dozen companies are now actively engaged in the microelectronic field. The field is exploding more rapidly than its strongest advocates had foreseen. The government has already urged manufacturers to use microelectronic circuits in place of conventional sub-miniature circuitry. What are the reasons for this rapid growth, and what does the near future hold for this new product area?

There are four main divisions in microelectronics:

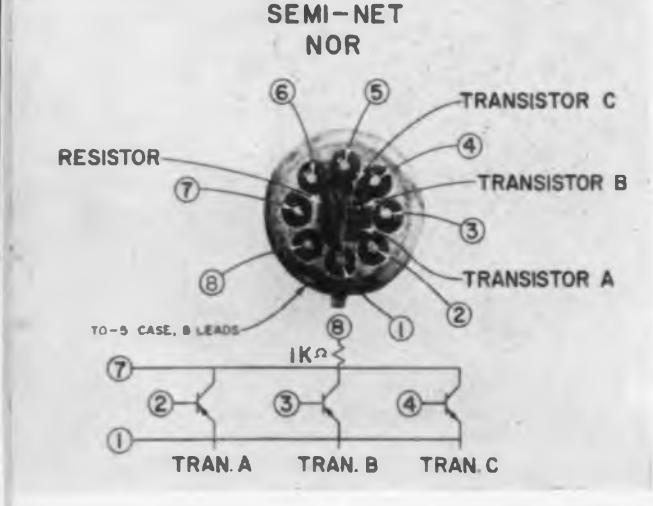
1. Micromodule.
2. Two-D (thin film).
3. Solid networks.
4. Blue sky microelectronics.

We will consider solid networks which offer the advantages of being, at the same time, both practical and of an advanced nature.

The microelectronics of solid networks is the science of building and using electronic blocks of solid semiconductor material to perform complex electronic functions. It has arrived on the present-day scene in a very logical way. In any practical production area, units are made in sizes and assemblies which are efficiently manufactured and handled. Then the units are joined to form larger collects.

In the electronic components industry it has been efficient to manufacture passive components such as resistors, capacitors, coils and diodes, and active components such as transistors and active diodes separately, to package them separately, and to vend them separately to a customer who assembles the packages into a large unit, a system of his own design. The system was designed with a particular component package in mind. These were either standard components or specially devised to the consumer's specifications. We have said that the individually packaged components were more efficiently manufactured. This is the equivalent of saying that this was the cheapest way of arriving at the final system.

Enlarged photo of a solid network has the elements identified



New Techniques

New manufacturing techniques developed in the last five years now (or very soon will) make the individual

component package concept less efficient than a composite package. The integrated circuit package, because of new techniques, will be more efficiently manufactured. It will, therefore, be cheaper than the older methods of arriving at a given operating circuit function or system.

New manufacturing techniques, incidentally, developed in the semiconductor field, are equally applicable in the general components industry. Techniques for reproducibly producing the purest materials known to man, techniques for introducing known impurity in small known amounts and for localizing the impurity, and techniques for handling, machining and attaching loads to the resulting material have been developed, out of necessity, in the semiconductor field.

Impurity contents of one part in a million are easily achievable. Of great importance in the microelectronic area is the technique of solid state diffusion. By the use of diffusion, impurities to form a junction are introduced into a semiconductor in a very controllable manner. The position of the junction changes during the process at rates in the order of 0.0001 inch per hour or less, so that the junction can be positioned precisely. Transistor base widths of 0.0001 inches are not uncommon.

The use of photo-resists and etching, and the use of oxide masks have made it possible to produce in semiconductor products, such as high speed transistors, functioning parts which are dimensionally the order of 0.001 inch x 0.005 inch. Wires of 0.001 inch to 0.004 inch diameters are attached as internal leads to devices by thermo-compression bonding processes.

Several hundred mesa transistors are fabricated in one ¾-inch slice of silicon a few mils thick, using diffusion and photo-etching techniques. These units are subsequently separated. Uniform diffusion is a technique which gives uniform results so that if one device in a slice of semiconductor material is good, the probability is high that all are good in that respect.

By using the above and similar techniques, individual components such as transistors and diodes are fabricated. Presently, the vast majority of these devices is then packaged individually. The packaging is the largest single cost in device production, and incidentally a large reliability problem.

It is becoming apparent that now is the time to begin to package components in large assemblies. There is a natural diversity of opinion as to just what the large assembly should be. Although, in general, there is agreement that the large assembly should perform a complete circuit function.

Consider the major steps in producing a mesa transistor. A slice of proper type and resistivity silicon is subject to two sequential diffusions to form two junctions properly spaced. By the use of proper masking, several hundred sets of two contacts (one emitter, one base) are evaporated on the surface, and subsequently alloyed in. Several hundred mesas are now etched into the slice, again with the aid of masking, so that several hundred transistors are now formed in the slice. These are separated, packaged, tested, etc.

Now, consider the production of a microelectronic circuit. A slice of proper type and resistivity silicon is, precisely as described before, subject to two sequential diffusions to form two properly spaced junctions. Again, by using masking, various contacts are evaporated on the surface and subsequently alloyed in. An etching process, with the aid of masking, gives the slice its proper configuration so that circuits with proper resistances, capacitances, diodes and transistors are now formed in the slice. These are separated and packaged.

It is clear that for approximately the same series of steps, the end product is in one case one active device, in the other case a whole circuit. This comparison in a sense sums up the reasons for the present rapid growth of microelectronics. It is a natural outgrowth of present techniques.

Yield Considerations

An important consideration in the cost and thus the feasibility of the solid network approach is that of yield. Assume a yield for individual transistors of 50%. If the process under consideration leads to a product in which individual transistors are good (or bad) more or less independently (as in alloying), the yield of n such transistors in the same block becomes $P = P^n_0$. It is clear that as the number n reaches only three or four, the total probability becomes deplorably small. However, in the case of diffused transistors, the probabilities are not independent, but show a rather strong dependence. The product on a single block tends to be all good or all bad. Thus the total yield of several transistors per block approaches that of a single transistor.

Beside the major factor of low potential cost, there

Table 1

Figures of Merit Packing Densities

Conventional Min-Components	5×10^4 comp/ft³
Weld-stick or Weld-pack	1.5×10^5 comp/ft³
Micromodule (per module)	2×10^5 comp/ft³
(per wafer)	6×10^5 comp/ft³
Subassemblies 2-D (DOFL)	1×10^6 comp/ft³
Microtronic Semi-Nets	1×10^7 comp/ft³

Table 2

Generalized Cost Factors in Semiconductor Devices

Packaging	— ¼ cost of any semiconductor device
Testing	— ¼ cost of any semiconductor device
Process	— Essentially same for all diffused devices: Mesa transistors, diffused diodes, Semi-Nets®

Table 3

Sources of Reliability Problems and Improvements in Microelectronics

1. Interconnection faults.	1. Eliminates up to 80% of internal connections.
2. Surface changes.	2. Reduces number of vulnerable surfaces.
3. Package faults.	3. Requires only one package in place of several.

Solid Networks *(Concluded)*

are other advantages in the use of microelectronics. Consider computer applications. Microtronic Semi-Nets*, such as Sperry Semiconductor is developing, offer between 100:1 and 1000:1 advantage in weight and volume reduction over conventional miniature components. Low power requirements lead to similar savings in the power pack. In given circumstances, either a smaller power plant is sufficient, or with a given power source more computer functions can be performed.

In addition to these obvious advantages, a major factor is increased reliability. This is, in many ways, an advantage second only to the low cost potential of the microelectronic product.

Reliability

Reliability is an important factor in computer components. In semiconductors a large proportion of failures is due to packaging and surface deterioration. Consequently, an improvement in reliability should certainly be the result of microelectronic packaging. Many components in microelectronic blocks have little or no surface because they have been fabricated in the bulk of the semiconductor material, and several individually vulnerable packages have been replaced by one to which more care can be given in assembly.

In many systems there is almost a one to one correlation between failure rate and the number of connections. This does not mean, of course, that all failures are due to connections—only that the failure rate increases with an increase in the number of connections. In microelectronics, internal circuit connections are rigorously minimized. Only those connections from the circuit to the outside world are necessarily retained. Some three-fourths of the connections hazard is thus removed. This offers an increased reliability. From these theoretical considerations it is clearly expected that reliability data now being gathered will reveal a better reliability factor.

High operational speed is, of course, a basic consideration in computers. Present microelectronic blocks operate in the megacycle range but very soon operation up to 10 MC is foreseen. At higher frequencies, especially in the 100 MC to 1000 MC range, lead lengths and interconnections act as delay lines. A nanosecond is the order of a light-foot. In this range, in the last analysis, microelectronics is the best way to fit the necessary computer elements close enough together to operate fast enough and avoid the necessity of using large amounts of unwieldy waveguides.

Changing Roles

The changing roles of systems engineer and device engineer are worth consideration. In processing a microtronic "solid system" the user supplies the complete specifications of the function desired. We may distinguish two relationships here. The first is the present arrangement which may hold for several years. In this, the user also specifies the package, the lead arrangement, and consults with the manufacturer in the design of the actual circuit to perform the function. Secondly, as the user becomes more familiar with the field of microelectronics, he may take over entirely the design of the circuit to perform the function. For example, circuit engineers design their circuits around standard values of resistance, and standard tubes, although many intermediate values and designs are theoretically possible. Similarly, they will design microelectronic circuits around values practical in microelectronics, although most any value is theoretically available.

There is a third possible consumer-manufacturer relationship in which the manufacturer supplies only "standard" circuits to all consumers, assuming all consumers can agree on "standard" circuits. The "standard" circuits, in computer systems for example, would perhaps perform the functions of logic symbols and be mutually compatible. It is clear that under this concept the systems engineer would become a manipulator of logic symbols and an assembler. All computer manufacturers would operate on a par and the competitive position gained through use of proprietary circuitry would be lost.

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

The interconnection problem will best be handled by the systems man, with device packages and interconnection design made compatible. Standard packages would hinder the development of interconnection design from the systems viewpoint. The ultimate in microelectronics is the functional package which will replace many circuits grouped together. The development of standard circuits is not compatible with this concept. The third possibility is not likely to become a widespread reality as long as computer designers desire to develop their own circuits and guide the microelectronic manufacturer.

We have restricted our discussion thus far to microelectronic transistor circuits. Microelectronics is rapidly employing other semiconductor phenomena, incorporating them into blocks, and using them for performance of block functions. Hall effect and other electromagnetic effects, photo-conductance and electro-optics, tunnel effects and avalanche effects will play significant roles in microelectronics.

Advanced techniques are being studied which will permit fabrication of more complex functional blocks. Among the most significant techniques under development today are epitaxial growth (which can be combined with diffusion in many interesting ways) and electron beam machining (to supersede chemical machining) for closer tolerance machining.

Because of the strong present position and the large number of future possibilities, it is reasonable to predict that the microelectronics field will grow as large as the present transistor area.

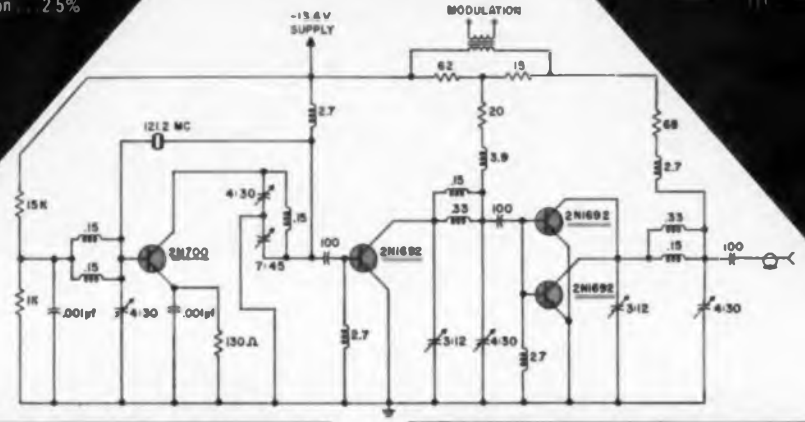
* Trademark of Sperry Rand Corp.

A TRANSISTORIZED 120 MC AIRCRAFT AM TRANSMITTER

PERFORMANCE—

Supply Voltage	13.6 V
Peak Power Output	1.5 W
Modulating Power	300 mW
Efficiency	26.5%
Demodulating Output Signal	3 V
Supply Current	155 mA
Envelope Distortion	2.5%

MOTOROLA MESA CIRCUITRY CUTS SIZE...SAVES WEIGHT ...INCREASES RELIABILITY



The transmitter circuit shown above provides more effective coverage than most conventional tube transmitters with higher RF power. Designed for airborne communications, it demonstrates only one of the many possible UHF-VHF applications for Motorola Germanium Mesa transistors.

The remarkable achievement of Motorola Mesas in critical missile/space equipment proves their ability to contribute substantially to total circuit reliability. Designed for applications to 1000 mc, Motorola Mesas are ideal for a wide range of communications applications. And, they are available in quantity, for immediate use.

For Complete Data on the Transistorized Transmitter shown above request Special Report No. 34 from your Motorola District Office or write Technical Information Department, Motorola Semiconductor Products Inc., 5005 East McDowell Road, Phoenix 10, Arizona. If you desire technical Data Sheets on the devices listed above, please request by "type number".

MOTOROLA DISTRICT OFFICES:
Belmont, Mass. / Burlingame, Calif. / Chicago / Clifton, N. J. / Dallas
Dayton / Detroit / Glenside, Pa. / Hollywood / Minneapolis / Orlando, Fla.
Silver Spring, Md. / Syracuse / Toronto, Canada.

MOTOROLA GERMANIUM MESA AMPLIFIER TRANSISTORS

TYPE NO.	V_{cb} volts	V_{ce} volts	P_D mW	PG_e @ f typical	P_o @ f typical	Case
2N700	25	20	75	24 db @ 70 mc	50 mW @ 70 mc	TO-17
2N700A	25	25	75	26 db @ 70 mc	55 mW @ 70 mc	TO-17
2N700A(Sig.C.)	25	25	75	28 db @ 70 mc	55 mW @ 70 mc	TO-17
2N741	15	15	300	27 db @ 30 mc	200 mW @ 30 mc	TO-18
2N741A	20	20	300	27 db @ 30 mc	230 mW @ 30 mc	TO-18
2N1561	25	25	3W	8 db @ 160 mc	.5 W @ 160 mc	—
2N1562	25	25	3W	7 db @ 160 mc	.4 W @ 160 mc	—
2N1692	25	25	3W	8 db @ 160 mc	.5 W @ 160 mc	stud
2N1693	25	25	3W	7 db @ 160 mc	.4 W @ 160 mc	stud

Immediate Availability — All Motorola Mesa amplifier transistors are available from your Motorola Semiconductor Distributor.

MOTOROLA
Semiconductor Products Inc.
A SUBSIDIARY OF MOTOROLA, INC.
5005 EAST McDOWELL ROAD • PHOENIX 10, ARIZONA

Circle 107 on Inquiry Card

New Products . . . for the Electronic Industries

VHF PREAMPLIFIER

Unit is designed for use in low noise receiving systems.

The RF75 is a wide-band r-f preamplifier with sufficient gain (over 15 db) to overcome the noise contribution of a following main amplifier. Typical specifications are: center frequency 160 MC, bandwidth greater than 75 MC ±1 db, gain greater than 15 db, noise figure less than 6 db, input and output impedance 50 Ω. LEL, Inc., 75 Akron St., Copiague, N. Y.

Circle 325 on Inquiry Card

LOGIC PACS

Transistor-diode logic pac has switching speed in the 20 nsec. range.

Silicon transistor-diode logic pacs with fan outs up to 5 diodes are available in engineering samples. Diodes are very fast switching silicon computer devices. The transistor used is a 2N1472, having a beta (h_{FE}) of typically 35, saturation voltage typically 0.1 v. at 10 ma and a gain bandwidth product (f_t) of 175 MC. Philco Corp., Lansdale Div., Lansdale, Pa.

Circle 327 on Inquiry Card

ANTENNA COIL

The RTC-9252 is designed for use in small radios.

The broadcast band High "Q" Ferrite Antenna Coil can be used with any variable capacitor with a maximum capacitance between 250 and 500 pf. The inductance is easily and accurately adjusted by means of a screw driver slot. The unit is supplied complete with 18 in. of polyethylene insulated antenna wire. Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill.

Circle 329 on Inquiry Card

HV SELENIUM RECTIFIER

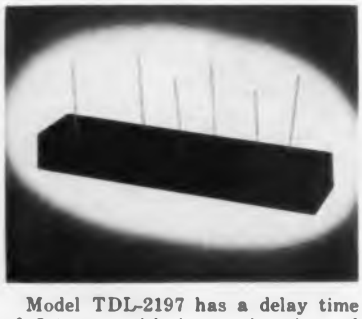
Rectifiers are available with PIV values to 20,000v.

Typical Super-Density Minisel Cartridge requires 75% less space. The cells used in these cartridges measure only 0.019 in. in thickness. Size reduction is shown by this example: 5000 v. peak inverse at 1 ma into a capacitive load at 40°C ambient, this cartridge is only 2 in. long and ⅛ in. in dia. These cells perform efficiently at plate temps. as high as 90°C. The cartridges are supplied in PIV values from 50 to 20,000 v., and for current output as high as 50 ma. Electronic Devices, Inc., 50 Webster Ave., New Rochelle, N. Y.

Circle 326 on Inquiry Card

DELAY LINES

New series of 3 Tapped Delay Lines is available.

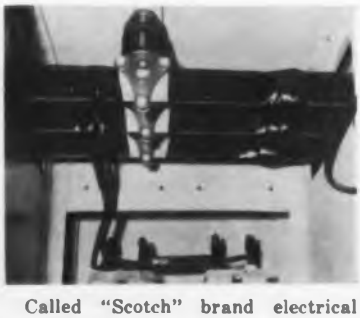


Model TDL-2197 has a delay time of 3.4 μsec with input rise time of 0.1 μsec and output rise time of 0.25 μsec max.; Model TDL-2194's delay time is 1 μsec with input rise time of 0.08 μsec and output rise time of 0.20 μsec max.; Model TDL-2195 provides a delay of 0.5 μsec, input rise time of 0.05 μsec and output rise time of 0.1 μsec max. Input impedance for 3 models is 500 Ω, dielectric is 250 vdc, attenuation is 1.0 db max. with max. distortion of 10%. Units are completely encapsulated in epoxy. Dresser Electronics, HST Div., 555 N. 5th St., Garland, Tex.

Circle 328 on Inquiry Card

HI TEMP. TAPE

Pressure-sensitive vinyl plastic tape is for operation at 105°C.



Called "Scotch" brand electrical tape No. 66, it is a black, polyvinyl chloride film coated on one side with a newly developed acrylic polymer pressure-sensitive adhesive. The new adhesive combines heat, oil and solvent resistance with resistance to plasticizers. Backing is resistant to sunlight, rain, snow, salt water and alkalis, and is self extinguishing. The tape is 11 mils thick; tensile strength, 35 lb./in. width; electric strength, 11,000 v., insulation resistance, 1 x 10^6 megohms. Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Circle 330 on Inquiry Card

New Products . . . for the Electronic Industries

GEAR TRAIN SERVO UNITS

Miniature gear train servo packages have 3 rotary elements.

Available in 2 models, they accommodate gear ratios up to 1000:1 from the motor to the first synchro, and up to 36:1 from the first synchro to the second synchro. One of the packages is 1¾ x 1¾ x 2¼ in. Each package weighs only 6 to 10 oz. depending on the materials and rotary components selected for the particular application. Enclosed gear train withstands varying environmental conditions. Clifton Prevision Products Co., Inc., 5050 State Rd., Drexel Hill, Pa.

Circle 331 on Inquiry Card

BAND PASS DELAY LINE

Units are for systems requiring time delay around a fixed center freq.

Typical applications are in radar and communication i-f amplifiers. The delay lines are available in various combinations of operation freqs. and time delays generally restricted to ultrasonic type delay lines. Typical time delay values of 0.22 μsec, at an operating freq. of 60 MC and a bandwidth of 10 MC are attainable in a unit measuring only 1 x 2 x 10 in. Insertion loss is 3 db. PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.

Circle 333 on Inquiry Card

PEAKING COILS

They are for use in telemetering and computer circuitry.

The 1300 series is comprised of 26 video peaking coils designed to assure proper bandwidth and wave shape in high freq. equipment. These coils range in inductance from 20. μh to 950 μh. All but 3 of the 26 coils are wound on 0.187 diameter x ⅜ in. long Phenolic form. Numbers 1307 and 1313 are on 22 K resistor form and 1310 on 30 K resistor form. Where resistors are required Mil-R-11 resistors are used. Delta Coils, Inc., 1128 Madison Ave., Paterson 3, N. J.

Circle 335 on Inquiry Card

HIGH VOLTAGE RECTIFIERS

Series goes to 17,000 PIV, 20 ma continuous duty and 1 a. surge.

High voltage selenium "channel" cartridge rectifiers are designed for high tension applications such as X-ray, beam welders, precipitators and test equipment. The rectifiers derive their name from the novel channel construction which makes them especially suitable for applications in oil. Dimensions range from 4½ in. long with a cross section ½ in. sq. to 8½ in. long with a ⅝ in. sq. cross section. Selenium Div., Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn 11, N. Y.

Circle 332 on Inquiry Card

PM MOTOR

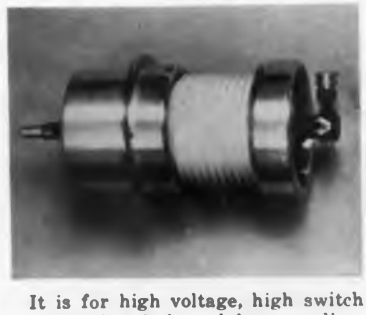
Proven in satellite use, the motor is now being used commercially.

Providing efficiencies as high as 54% through a high flux utilization, the PM-1 requires very low input current at full load. Weighing less than 2½ oz., the motor is only ⅞ in. in dia. and less than 2 in. long for use in restricted areas. The motor may be provided with internal r-f filters to eliminate obectional freqs. and a governor to control armature speed to within 0.5% of nominal speed under wide terminal voltage and load torque variations. Reflectone Electronics, Inc., Stamford, Conn.

Circle 334 on Inquiry Card

SWITCH TUBE

Hi voltage holdoff and hi current handling are featured.



It is for high voltage, high switch rate, floating deck modulator applications. The L-3408's design makes collector current relatively independent of collector voltage over a broad range, resulting in pentode-like current characteristics. Several features of the switch tube are 150 kv max. collector voltage, 20 a. peak collector current, max. 10kw collector dissipation. The tube is 20 x 8 in. and weighs approx. 45 lbs. Litton Industries Electron Tube Div., 960 Industrial Rd., San Carlos, Calif.

Circle 336 on Inquiry Card

New Products . . . for the Electronic Industries

STRAIGHT CABLE PLUG

Miniaturized Type 6000 is for RG-188/U and cables with similar diam.

The unit features Crimp-On design and reduces assembly time over 60%. The plug provides a screw-on connection for 50 Ω cables mating with cable jacks, bulkhead jacks, bulkhead receptacles, cable feedthroughs, printed wiring receptacles, right-angle printed wiring receptacles, and regular right-angle receptacles. The assembly is stronger in pull-out strength than the cable itself. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N. Y.

Circle 313 on Inquiry Card

REGULATING TRANSFORMER

Input and output are isolated physically and electrically.

The Sola Standard Sinusoidal Constant Voltage Transformer is completely automatic with continuous regulation. It has a response time of 1½ CPS or 25 millisec. at 60 CPS. With no moving parts, manual adjustment or maintenance is unnecessary. The CVS is self-protecting against short circuits on output or load circuit. Available in 29 primary-secondary voltage combinations; 60 to 7500 va. Sola Electric Co., Elk Grove Village, Ill.

Circle 315 on Inquiry Card

UNIVERSAL BLOWER

Specifically for ground support equipment, it works on ac or dc.

Vaneaxial blower, VAX-3-GN, operates on 115 vac, 60 CPS or 115 vdc delivering 65 cfm of air at 1.5 in. static pressure. The unit weighs 1 lb. Diameter is 3 in.; length 3¼ in. Mounting is made by clamping to servo rim at either end of the blower. Integral propeller shroud and motor housing is a black anodized aluminum precision casting and the unit is designed to meet pertinent MIL specs. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 317 on Inquiry Card

HIGH VACUUM PUMP

Pump uses no fluids, hot filaments or moving parts.

Tiny Vaclon® operates from 10^{-8} to 10^{-9} mm. Hg. at a pumping speed of 0.2 liters/sec. The electronic pump is designed to maintain high vacuums in sealed vacuum devices such as electronic vacuum tubes. Power consumption is less than 1 mw. Pump withstands temps. up to 550°C, magnet may be heated to 250°C. Mountable in any orientation. Dimensions are: 4⅛ x 2½ x 1 3/32 in. Pump weighs 80 g., magnet 300 g. Vacuum Products Div., Varian Assoc., 611 Hansen Way, Palo Alto, Calif.

Circle 314 on Inquiry Card

PULSE GENERATOR

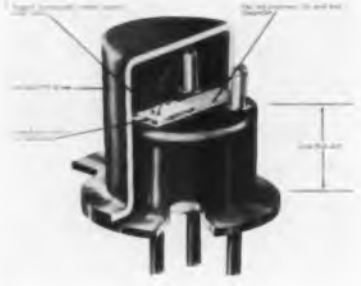
Unit features hi-repetition rates and fast rise and fall times.

The Solid State Model 6100 Clock Pulse Generator includes a 3-25 MC and a 25-100 MC unit, with appropriate overlap to provide continuous pulse sources from 3-100 MC. Specs. for the unit include rep. rates of 3-25 MC, 25-100 MC; rise/fall times of less than 4 nsec; a pulse width of less than 8 NSEC at ½ pulse height; 0-4 v. amplitude, continuously variable; and output impedance of 93 Ω. Texas Instruments Incorporated, Apparatus Div., Industrial Products Group, 3609 Buffalo Speedway, Houston 6, Texas.

Circle 316 on Inquiry Card

SWITCHING TRANSISTOR

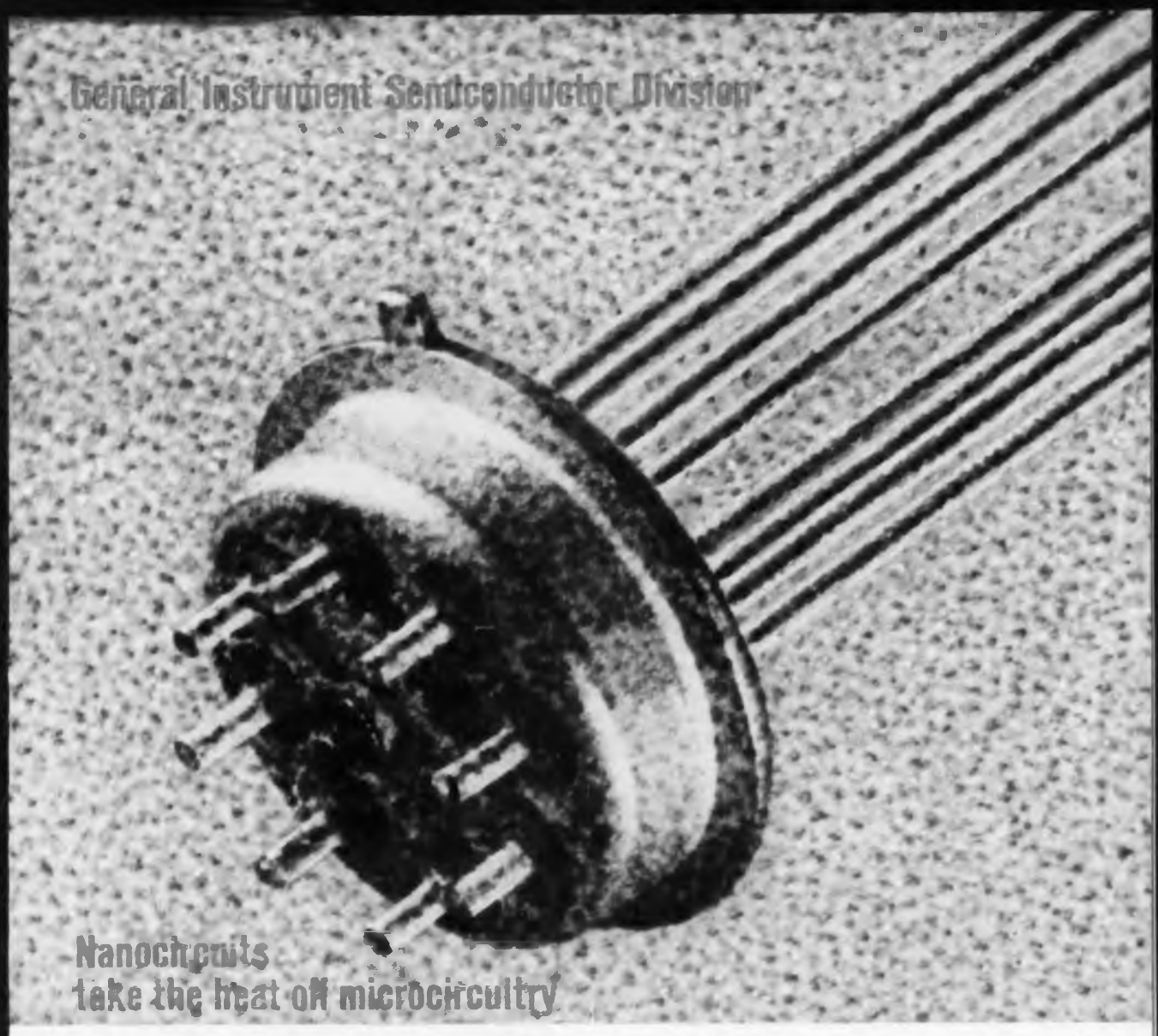
PADT-40 has the collector region gold doped for lower stored charge.



Germanium pnp is for hi and medium speed saturated-logic uses. Average total switching time of 135 nsec (td + tr = 50 nsec; ts + tf = 85 nsec), and a min. time of 80 nsec. It has closely controlled high current gain (h_{FE} = 30) and cut-off freq. (ft = 700 MC). It is ruggedly constructed with high voltage ratings (BV_{cbo} = 30 v.), and high thermal dissipation. Amperex Electronic Corp., Semiconductor & Special Purpose Tube Div., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 318 on Inquiry Card

General Instrument Semiconductor Division



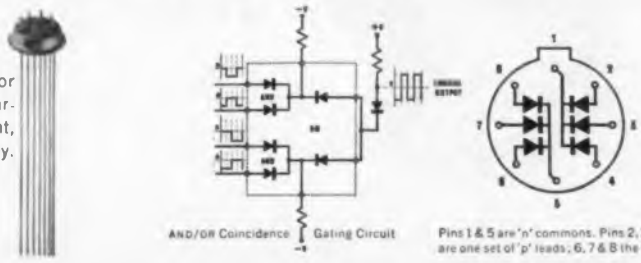
Nanocircuits take the heat off microcircuitry

Nanocircuits bring several important advantages to computer logic design, not the least of which is size reduction. This one packs six diodes (it could have been a diode-transistor combination) into a standard TO-5 case. ■ Equally important in the General Instrument concept: only the active components (surface-passivated for stability) are fused to the common substrate. The diodes are not exposed to the heat of such loss-generating components as resistors and capacitors whose demands differ from those of the active elements. ■ Not only is component reliability increased but, since the semiconductors are pre-selected from a 100%-tested standard product line, the designer can evaluate circuit reliability rather than that of individual components. This technique reduces the number of assembly and testing operations, so cost is lower, too. ■ General Instrument also allows the logic designer the flexibility of transferring new or existing circuits, breadboarded with conventional components, directly into nanocircuits. Let us show you how.

Circle 108 on Inquiry Card

Get complete details on nanocircuits and other semiconductor devices from one of our sales offices or the franchised distributor nearest you. Or write today for Bulletin NC-10 to General Instrument, Semiconductor Division, 65 Gouverneur Street, Newark, New Jersey.

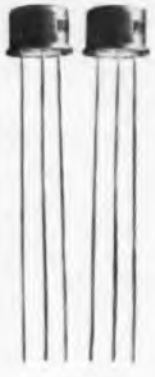
GENERAL INSTRUMENT SEMICONDUCTOR DIVISION



AND/OR Coincidence Gating Circuit

Pins 1 & 5 are 'n' commons. Pins 2, 3 & 4 are one set of 'p' leads; 6, 7 & 8 the other.

Good things come in pairs



Hughes Semiconductors now brings you 2N1131 and 2N1132 PNP double-diffused mesa silicon transistors... *plus advanced "A" versions of both types.*

Hughes, the quality leader in the semiconductor field, has available for immediate delivery new high-performance twins. ▪ First, the popular 2N1131 and 2N1132 silicon mesa transistors being used so extensively in advanced missile and satellite computer applications. ▪ Second, 2N1131A and 2N1132A, to meet your demands for even higher performance. These new types feature higher voltages, lower leakages, lower high-temperature leakages, lower output capacitances, *plus* guaranteed switching times. (See chart.)

For further information contact your nearest Hughes Semiconductor sales office or Hughes authorized distributor. Or write Hughes Semiconductor Division, Marketing Department, Newport Beach, California.

TYPICAL COMMON BASE CHARACTERISTICS for type 2N1132A

SPECIFICATIONS

	Collector to Base Voltage I_{CO} = −100μA	Lowest Voltage I_{CO} = −100mA	Collector Cutoff Current			DC Current Gain I_C = 150mA	Output Capacitance	Maximum Switching Times	
			V_{CB}	@ 150°C	@ 25°C			T_{on} (t_d + t_r)	T_{off} (t_s + t_f)
	BV_{CBO} Volts	$LV_{CEO(sus)}$ Volts	Volts	I_{CBO} μAmp.	I_{CBO} μAmp.	$h_{FE(pulsed)}$	C_{CB} pf	n sec	n sec
2N1131	50	35	−30	100	1.0	20 – 45	45		
2N1131A	60	40	−45	50	0.5	20 – 45	30	45	35
2N1132	50	35	−30	100	1.0	30 – 90	45		
2N1132A	60	40	−45	50	0.5	30 – 90	30	45	35

Creating a new world with Electronics

HUGHES

HUGHES AIRCRAFT COMPANY
SEMICONDUCTOR DIVISION

New Products . . . for the Electronic Industries

SERVO MOTOR

Motor operates under wide variety of environmental conditions.

Type 5351-01 is 1 in. long, weighs 0.7 oz., has 0.12 oz. in. torque at stall and 47,000 rad./sec.^{2} torque to inertia ratio. The unit can operate continuously at −55°C to +125°C temp. range. No load speed is 9,500 RPM min., rotor moment of inertia 0.18 gm.cm^2, time constant 0.020 sec. and reversing time 0.034 sec. Rated voltage at 400 CPS is 26 v. (can be available in 18 v. or 33 v.). John Oster Mfg. Co., Avionic Div., Racine, Wis.

Circle 319 on Inquiry Card

LAMP ADAPTER

T-1 with unit, will fit any standard miniature bayonet socket.

It is designed as an economical, convenient, easy-to-use adapter for holding the ultra-miniature lamp. Unit was created to fill the long-standing need by users of this ultra-small lamp for a fast, easy method of mounting and using the tiny lamp. The adapter is available with or without the T-1 ultra-miniature incandescent lamp. Industrial Electronic Engineers, Inc., 5528 Vineland Ave., N. Hollywood, Calif.

Circle 321 on Inquiry Card

SHIELDED TRANSFORMERS

Between-the-windings-shield permits use in hazardous locations.

This type of transformer is a code requirement for Class I div. 1 locations in which hazardous concentrations of flammable gases or vapors exist continuously, intermittently or periodically, under normal conditions, during maintenance, because of leakage or during breakdown or as a result of faulty equipment. The line includes ratings from 100 w. to 50 kva, 120 v. input, 120 v. output. Acme Electric Corp., Cuba, N. Y.

Circle 323 on Inquiry Card

TANTALUM AC CAPACITORS

Capacitances equal to conventional electrolytics 500 times their size.

Continuous duty solid slug tantalum ac capacitors operate at ambient temps. ranging from −80°C. to +125°C. and will operate as high as 85°C. without derating. Case sizes ranging from 0.155 x 0.600 in. to 0.350 x 1.600 in. Capacitance ranges from 1.2 μf to 170 μf. All units are hermetically sealed in a metal case. They have a stable dissipation factor of less than 0.05. The units operate at up to 35 v. peak 60 CPS. General Instrument Corp., Micamold Div., 65 Gouverneur St., Newark, N. J.

Circle 320 on Inquiry Card

CERAMIC ADHESIVE

High temp. adhesive bonds up to 2600°F. with low temp. curing.

MELBOND CA-100, a ceramic adhesive, is a ready-to-use material with a max. service temp. of 2600°F. after being cured at only 250°F. With good electrical properties (i.e., low dielectric constant and loss tangent), it attains a high degree of mechanical strength and will not flake or disintegrate during use. Having a paste-like consistency, it can also be used for coating items requiring high temp. protection. Special Products Div., Melpar, Inc., 3000 Arlington Blvd., Falls Church, Va.

Circle 322 on Inquiry Card

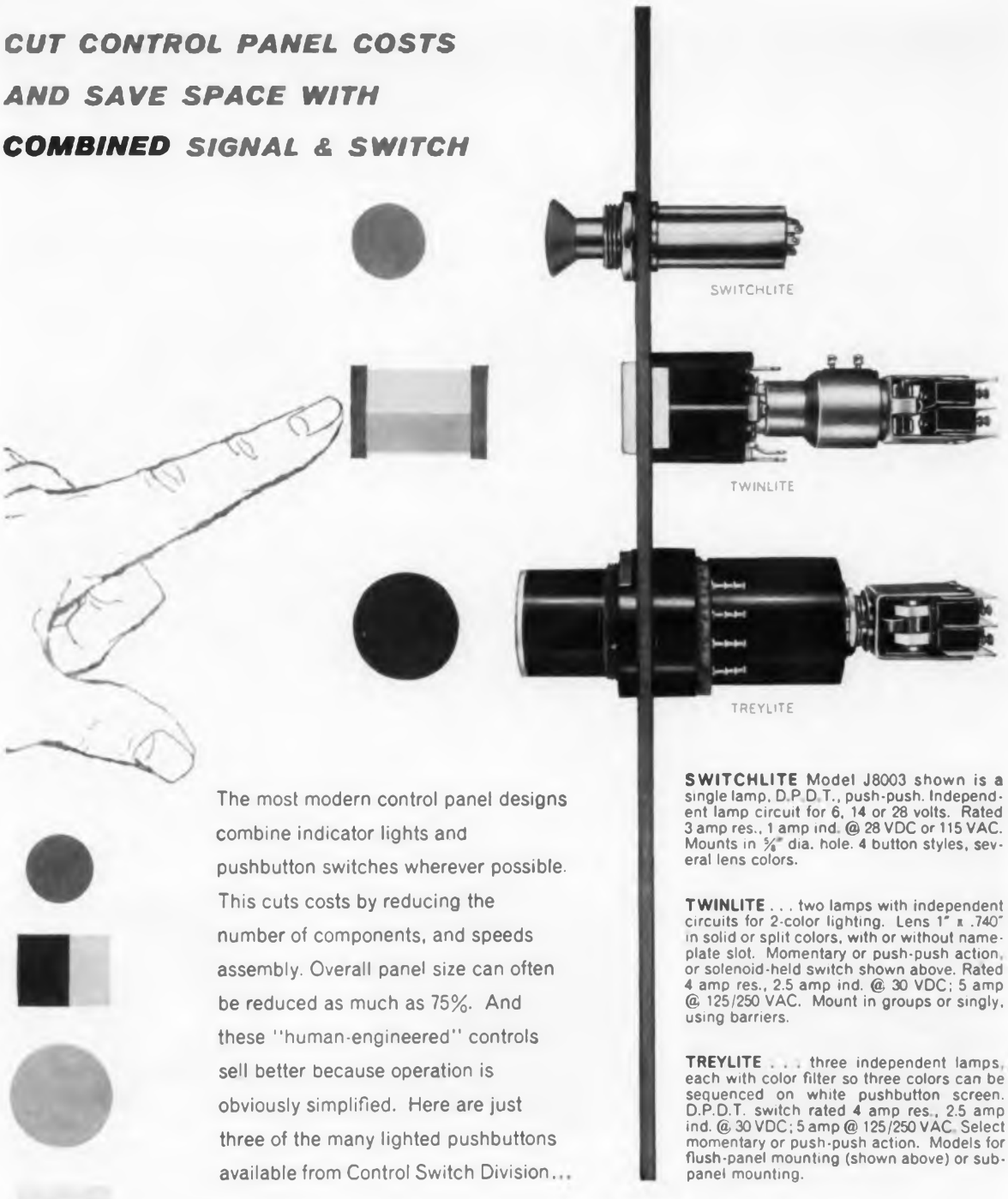
FUNCTION GENERATOR

Variety of waveforms are reproduced by changing cams.

Sine, triangle and arbitrarily modulated suppressed carrier signals of any carrier freq. to 5 kc are available. Applications are: ac or dc servo testing; vibration machine programming; and process control testing. Specs are: freq. range, 0.001 to 10 CPS in 4 ranges at ±3% of set freq.; output voltage, 20 v. max. peak to peak adjustable; load requirements: min. of 10K; output function: cams supplied are for sine and triangle waveforms. Tensor Electric Development Co., Brooklyn, N. Y.

Circle 324 on Inquiry Card

CUT CONTROL PANEL COSTS AND SAVE SPACE WITH COMBINED SIGNAL & SWITCH



The most modern control panel designs combine indicator lights and pushbutton switches wherever possible. This cuts costs by reducing the number of components, and speeds assembly. Overall panel size can often be reduced as much as 75%. And these "human-engineered" controls sell better because operation is obviously simplified. Here are just three of the many lighted pushbuttons available from Control Switch Division...

SWITCHLITE Model J8003 shown is a single lamp, D.P.D.T., push-push. Independent lamp circuit for 6, 14 or 28 volts. Rated 3 amp res., 1 amp ind. @ 28 VDC or 115 VAC. Mounts in ⅝" dia. hole. 4 button styles, several lens colors.

TWINLITE . . . two lamps with independent circuits for 2-color lighting. Lens 1" x .740" in solid or split colors, with or without nameplate slot. Momentary or push-push action, or solenoid-held switch shown above. Rated 4 amp res., 2.5 amp ind. @ 30 VDC; 5 amp @ 125/250 VAC. Mount in groups or singly, using barriers.

TREYLITE . . . three independent lamps, each with color filter so three colors can be sequenced on white pushbutton screen. D.P.D.T. switch rated 4 amp res., 2.5 amp ind. @ 30 VDC; 5 amp @ 125/250 VAC. Select momentary or push-push action. Models for flush-panel mounting (shown above) or subpanel mounting.

CONTROLS COMPANY OF AMERICA

CONTROL SWITCH DIVISION

1408 Delmar Drive • Folcroft, Pennsylvania • Telephone LUdlow 3-2100 • TWX SHRN-H-502

Write for FREE CATALOG on LIGHTED SWITCHES.

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 parts Distributors.

New Products . . . for the Electronic Industries

AUTOMATIC DATA LOGGER

Uses include calibrating dc millivoltmeters, recorders, and transducers.

The RS2, has been built as an integrated scanning, measuring and printing system. Unit provides 4-digit voltage readings with correct polarity and range. Its accuracy is 0.01% of full scale on each range. Functions include: scanning up to 20-double-pole channels; measuring dc voltage from ±0.001 to ±999.9 in ranges of ±9.999/99.99/999.9; printing channel number, 4-digit reading, polarity and decimal point placement. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 301 on Inquiry Card

BINARY CODED CONVERTER

New microminiature module approach reduces circuit costs.

The first BIPCO® module offered is a Binary Coded Decimal-to-Decimal Converter using the 4-2-2-1 code. This device contains 40 silicon diodes and is designed to drive a Nixie® indicator tube directly from inputs encoded in the binary coded decimal form. Typical specs. for the individual diodes are: minimum forward current at 1 v. = 10 ma; max. inverse current at 100 v., 25°C = 5 μ amps; PIV = 200 v. Burroughs Corp., Electronic Tube Div., P.O. Box 1226, Plainfield, N. J.

Circle 303 on Inquiry Card

MINIATURE CAPACITORS

They offer inherent advantages of foil capacitors in miniature size.

85°C Tantalytic® Foil "A Case" capacitors are near in size to small solid tantalum types. Available in ratings from 12 μf at 6 v. to 1.4 μf at 50 v., the units are double-ended for non-polar applications and either single-ended or double-ended for polar operation. The single-end polar type is 0.47 in. long and 0.131 in. in dia. The double-ended polar or non-polar design is 0.54 in. long and 0.131 in. in dia. General Electric Co., Electronic Specialty Capacitor Product Section, Irmo, S. C.

Circle 305 on Inquiry Card

ABSORPTION FILTERS

Filters are designed to eliminate harmonic radiations which cause RFI.

Seven filters for high-power microwave transmitters with fundamental freq. from 400 to 6,000 MC are available. Location is in the waveguide transmission line between the output tube and the antenna, as close as possible to the output tube. Filter family includes the MPF-2501 and MPF-2502 (S-band); MPF-1001 (L-band); MPF-400 (shown in photo) and MPF-800 (UHF); MPF-4000 (C-band); and ZMPF-2001 (l-band). General Electric Co., Traveling Wave Tube Product Section, Power Tube Dept., Palo Alto, Calif.

Circle 302 on Inquiry Card

DIODE TEST SET

Reverse voltage is metered and adjustable from 0.5 to 2000 v.

The forward current supply is metered and adjustable from 50 μa to 3 a. The forward voltage is measured in 3 ranges of 1, 3, and 10 v. full scale. Reverse currents from less than 1 na to 3 ma are read directly. This test set is power line operated and contains no batteries. Special features of the Model 1808 include a high freq. reverse voltage supply for operator safety and provisions for accurate "4 terminal" measurement of forward voltage drop. Dynatran Electronics Corp., 178 Herricks Rd., Mineola, N. Y.

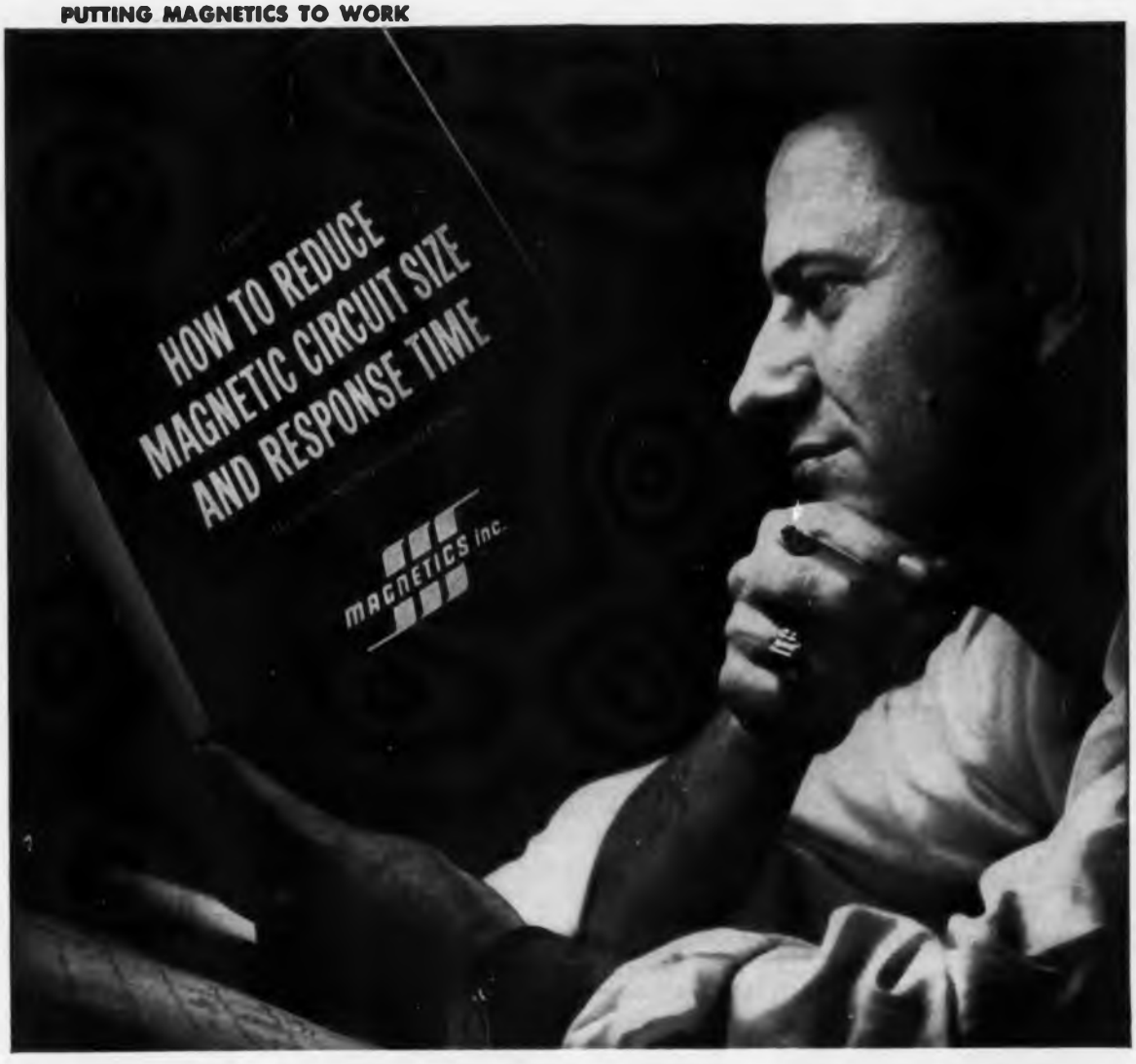
Circle 304 on Inquiry Card

CRYSTAL OVEN

Oven temperature is rigidly controlled.

Mercury thermal switch Crystal Oven permits use of a wider range of crystals in both size and freq. The Manson RD-135 Crystal Oven has typical mounting bases: T5½, HC-C/U, HC-13. The unit employs a precision mercury thermal switch, in the form of a miniature thermometer, to provide a constant drift-free reference for close oven control. The heater control circuit is transistorized. The internal structure is completely housed in a thermal bottle. Manson Laboratories, Inc., Stamford, Conn.

Circle 306 on Inquiry Card



Sign up for the Magnetics self-improvement course:

Here's free help to enable you to improve yourself—and your position as a magnetic circuit designer. You need it if:

You don't know how to work with $E = n\frac{d\phi}{dt}$ to reduce the size of magnetic amplifier circuits. Most men who design amplifiers for cramped operation in missiles have found it invaluable.

What's more, you may only vaguely remember $H = .4\pi\frac{NI}{\ell_m}$, so how can you use it to cut circuit size by two to ten times, and shorten response time proportionately?

It's quite possible that you, like many engineers, may have bypassed or been bypassed by magnetic circuit theory *as a working tool* while you were in school. Yet this science has opened frontiers of static control which makes an understanding imperative if you are to do your job—and further your career. For your sake (and for ours, too, because we manufacture and sell high permeability tape wound cores and bobbin cores which are used in amplifier circuits), we have started this course. Lesson 1, "How to Reduce Magnetic Circuit Size and Response Time," will be on its way to you immediately if you use the coupon below.

MAGNETICS inc.

MAGNETICS INC., DEPT. EI-86, BUTLER, PA.

Please enroll me in your free self-improvement course, and send me "How To Reduce Magnetic Circuit Size and Response Time."

name_____

title_____

company_____

address_____

New Products . . . for the Electronic Industries

FREQUENCY STANDARD

Instruments output signals stable to ± 2 parts in 1 billion/day.

Basic reference source is a precision-made high stability oscillator. A proportional type, thermistor-controlled crystal oven eliminates cycling variations due to ambient temp. The oscillator's 3 MC signal is fed through regenerative circuits to provide the output freqs. The unit has 1 MC, 100 KC and 10 KC output signals. The VLF Secondary Freq. Standard is phaselocked to either WWVL or NBA. Dept. P-126, Motorola, Inc., 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle 307 on Inquiry Card

RACK COOLING UNIT

Air cooling and filter unit fits under cabinet in "toe space."

The unit supports a load of 2000 lbs. and is equipped with heavy duty dual-wheel casters. It uses centrifugal blowers supplying forced air cooling and filtered ventilation to the entire cabinet. Heat is exhausted through louvres at the top of the cabinet. The blower motors, (heavy-duty, permanent split-capacitor types), can be oversized since they are housed in otherwise unused space. Units have either a 675 CFM or 350 performance rating. McLean Engineering Laboratories, Princeton, N. J.

Circle 309 on Inquiry Card

SWITCHING TIME TESTER

Test set measures switching time of transistors, diodes and circuits.

"Strobe scope" technique allows automatic sync without delay cables. It has built-in pulse sources, scope display, meter readout, bias supplies, and test jig. Time intervals from 1 nsec to 500 nsec can be measured with accuracies of from 3 to 5%. Unit's positionable marker bugs ride on O-scope waveform and set the time interval for the meter readout. The built-in pulse sources provide a 2 mc test rate with 7 v. into 50 Ω with a 1.5 nsec rise time. Wiltron Co., 717 Loma Verde Ave., Palo Alto, Calif.

Circle 311 on Inquiry Card

SERVO AMPLIFIERS

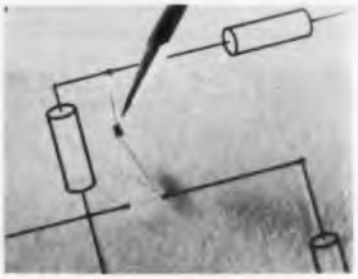
High temp. transistorized units maximum weight is 8 oz.

These amplifiers meet or exceed the new ABMA soldering spec PDS-C1 and Mil-E-5400A and Mil-E-5272A. Available in 3.5, 6 and 12 w. sizes (the 3.5 and 12 w. sizes are pictured). Power outputs and input impedances are: 3.5 w (size 11 motor) constant 10,000 Ω resistive; 6 w (size 15 motor) 25,000 Ω; and 12 w (size 18 motor) 50,000 Ω. The basic design of each includes push-pull output stage, driver stage and pre-amplifier, all use silicon transistors. Bulova Watch Co., Inc., Electronics Div., 40-01 61st St., Woodside 77, N. Y.

Circle 308 on Inquiry Card

DOUBLE-ENDED TRANSISTORS

Small silicon npn units are for amplification and switching.



The seven electrically-welded, hermetically-sealed subminiatures are the 2N902 through 2N908. Capable of dissipating 400 mw at 25°C they are electrically equivalent to a variety of single-ended types. Mounting possibilities: single and multiple-board configurations, feedthrough construction, welded assemblies and special assembly mods. such as jump-wiring and isolating inputs from outputs. It operates in temps. from −65° to +175°C. Raytheon Co., Semiconductor Div., 215 First Ave., Needham, Mass.

Circle 310 on Inquiry Card

MIKE & TRANSMITTER

Hi-fi unit is not much bigger than a pack of cigarettes.

The device consists of a small microphone and a transistorized 10 oz. transmitter. A fixed freq. FM receiver which picks up the transmission can be linked into broadcast or public address systems. The transmitter contains a crystal controlled oscillator operating at high freq. which is directly freq. modulated. It may be used with existing military operations, telemetering, and news and sports events. It covers 20 to 15,000 CPS. The Victoreen Instruments Co., 5806 Hough Ave., Cleveland, Ohio.

Circle 312 on Inquiry Card

Circle 111 on Inquiry Card ⟶

Ampex's Advanced Recorder/Reproducer, the FR-600 used for testing the Minuteman Missile.

A Quality Product requires ALLEN-BRADLEY Electronic Components

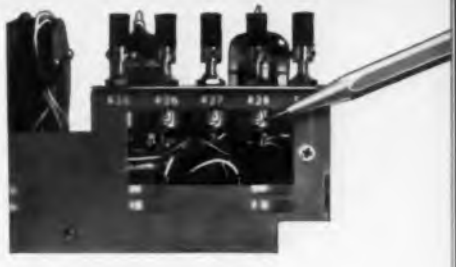
This shows a few of the A-B components in one of the Ampex recorder's modules

In the design of the highly sophisticated circuitry for this advanced recorder, engineers at Ampex selected Allen-Bradley quality electronic components to meet the critical requirements for reliability, long life, and quiet operation. For example, the use of Allen-Bradley potentiometers—with their exclusive solid, hot molded resistance element—assures smooth control at all times. There are never any abrupt changes in resistance during adjustment as in wire-wound resistors. Also the "noise" factor is extremely low initially, and it decreases with use.

Allen-Bradley composition fixed resistors—also made by an *exclusive* hot molding process—are fantastically uniform. Their electrical characteristics are so consistent from resistor to resistor that performance over long periods of time can be accurately predicted. *And catastrophic failure is unheard of*—when you use Allen-Bradley composition resistors.

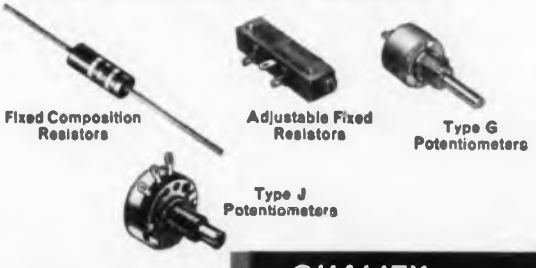
For the ultimate in reliability and performance, insist on Allen-Bradley *quality* electronic components. Send for Publication 6024 today.

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



Portion of one of 14 CRT monitors, each containing 8 A-B Type G Potentiometers.

A-B QUALITY ELECTRONIC COMPONENTS USED IN AMPEX WIDE-RANGE RECORDER



ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

4-61-E

A-B QUALITY

Dependability PROVED!

...in tests at 5 Times mil specs for shock, vibration and acceleration

Potentiometers Type J and Type K

Potentiometers Type G and Type L

Adjustable Fixed Resistors Type R

Hermetically Sealed Ceramic Encased Resistors Type TS Type CS Type ES

About the test

At the United States Testing Co., Inc.* the above Allen-Bradley resistors and potentiometers were subjected to a constant acceleration of 300g, impact shock of 150g and vibration of 50g from 55 to 2,000 cps. All tests were conducted in accordance with procedures outlined in the latest Mil Specs.

*Test Report #71801, Sept. 1960.

In these severe tests, Allen-Bradley resistors and potentiometers have demonstrated their complete dependability in environmental extremes.

The ruggedness of A-B fixed resistors is obtained through an *exclusive* process in which the resistance element and the insulating jacket are hot molded into an integral unit of unusual mechanical strength. This unit is then hermetically sealed in a ceramic tube. Also, please remember, A-B fixed resistors are *completely free from catastrophic failures.*

A-B potentiometers have the resistance elements molded into, and are an integral part of, the base; therefore, they are virtually indestructible. In addition, operation is quiet and smooth when the potentiometer is new, and these characteristics improve with use.

For maximum reliability under severe operating conditions, insist on Allen-Bradley *quality* electronic components.

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

4-61-E

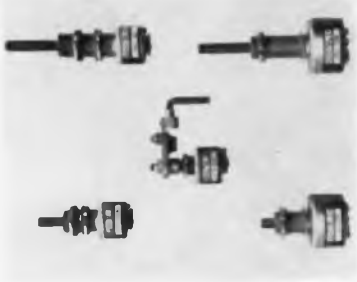
ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

New Products

HERMETIC SWITCHES

Switches feature ruggedness.



This group of hermetically-sealed, environment-free switches are ruggedly constructed and includes SPDT, 2 PDT, and 4 PDT. Most of these switches are rated at 5 a, 28 vdc res., 2.5 a. at 28 vdc ind., 4 a. motor, or 2.4 a. at 28 vdc lamp load. All these switches feature an ambient temp. range of −65° to +250°F and will pass immersion test Mil-E-5272. Control Switch Div., 1420 Delmar Dr., Folcroft, Pa.

Circle 343 on Inquiry Card

MINIATURE CABLE CLAMP

Nylon clamps cover subminiature to jumbo size applications.

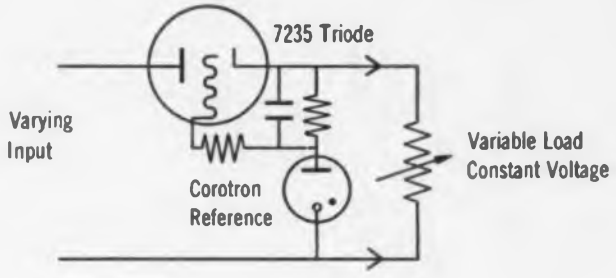
Type J, will hold a cable smaller than 1/16 in. dia. Type 9, will hold cables or bundles to 1¾ in. dia. Types for special applications are offered including flat clamps, molded half-clips and snap clips. Sizes from 0.160 in. wide, 0.030 in. thick for extreme close-quarter installation of small work, to ⅞ in. wide, 0.070 in. thick for larger jobs are offered. Units are recommended for service between −60°F and +275°F under load. The material is unaffected by petroleum oils and greases at temp. to 300°F. Clamps meet Mil-P-17091A and Amend. 2, 17091B and 20693 Type I; Mil-STD-242A and 242B (Ships) and MS-39014 (Ord.). Weckesser Co., Inc., Dept. ES-2, 5701 Northwest Hwy., Chicago 46, Ill.

Circle 344 on Inquiry Card

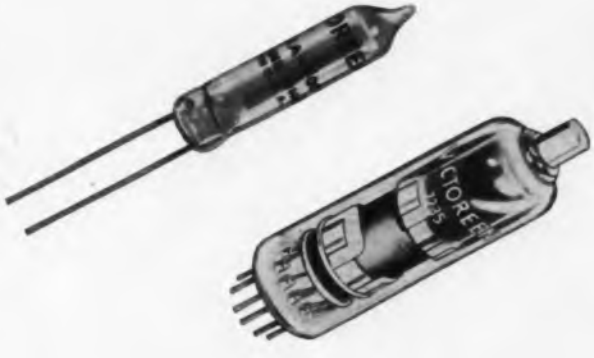
← Circle 112 on Inquiry Card

Hi-Voltage...

E_o = Constant



sophisticated results from simple circuit



- *regulation and stabilization*
- *400 to 25,000 volts*
- *reduces ripple*
- *higher reliability*
- *economy of cost, weight and space*

Victoreen

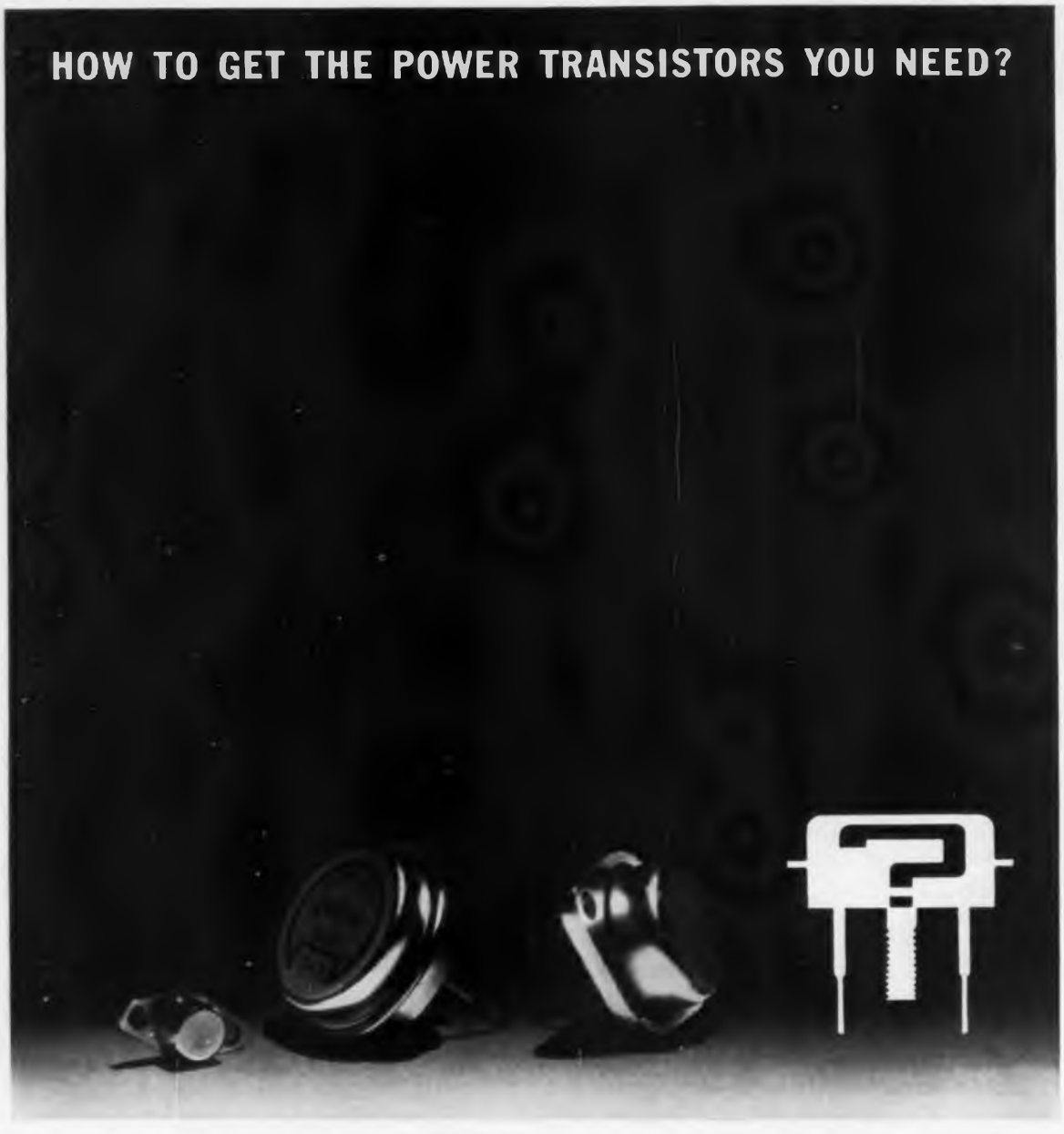
5806 HOUGH AVENUE • CLEVELAND 3, OHIO

EXPORT: 240 WEST 17TH ST. • NEW YORK 17, NEW YORK

A-4128A

Circle 113 on Inquiry Card

HOW TO GET THE POWER TRANSISTORS YOU NEED?



JUST ASK DELCO. For even though our catalog lists only a handful of germanium power transistors, there is only a handful out of all those ever catalogued that we don't make. And those only because nobody ever asked for them.

We've made, by the millions, both large and small power transistors. Both diamond and round base. Both industrial and military types. And each in a wide variety of parameters that have proved themselves reliable in nearly every conceivable application.

You get Delco transistors fast. You get Delco transistors in any quantity. And for all their high reliability, you get them reasonably priced. All you have to do is contact our nearest sales office—and ask for them.

Union, New Jersey
324 Chestnut Street
MUrdock 7-3770

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807

Chicago, Illinois
5750 West 51st Street
POrtsmouth 7-3500

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560

DELCO RADIO
DEPENDABILITY
RELIABILITY

Division of
General Motors
Kokomo, Indiana

DELCO SEMICONDUCTORS NOW AVAILABLE AT THESE DISTRIBUTORS:

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103 West 43rd St., New York 36, N. Y.
JU 2-1500

Chicago:
MERQUIP ELECTRONICS, INC.
5904 West Roosevelt, Chicago, Illinois
AU 7-6274

Detroit:
GLENDALE ELECTRONIC SUPPLY COMPANY
12530 Hamilton Ave., Detroit 3, Michigan
TU 3-1500

Philadelphia:
ALMO RADIO COMPANY
913 Arch St., Philadelphia, Pennsylvania
WA 2-5918

Baltimore:
RADIO ELECTRIC SERVICE
5 North Howard St., Baltimore, Maryland
LE 9-3835

Los Angeles:
RADIO PRODUCTS SALES, INC.
1501 South Hill St., Los Angeles 15, Calif.
RI 8-1271

San Francisco:
SCHAD ELECTRONIC SUPPLY, INC.
499 South Market St., San Jose 13, Calif.
CY 7-5858

Seattle:
C&G ELECTRONICS COMPANY
2221 Third Avenue, Seattle 1, Washington
MA 4-4354

Ask for a complete catalog

DELCO RADIO
DEPENDABILITY
RELIABILITY

New Products

HEAT SINK

Dissipator has heat resistance of 200°C for 48 hrs.

It will accommodate diameters varying from 0.325 to 0.335 and JEDEC outlines have TO-5, TO-9, TO-11 and TO-39. Unit meets military demands for continued performance even under severe vibration. Methode Mfg. Corp., 7447 W. Wilson Ave., Chicago 31, Ill.

Circle 339 on Inquiry Card

SOLENOIDS

Super-T line designed for dependable use under adverse conditions.

Laminated solenoid is more rugged in construction than its predecessor the CT and has a stronger seating pull without excessive ac hum. The re-designed plunger has a sturdier pull bar. Larger contact area between co-acting parts contributes materially toward longer, trouble-free performance. They may be supplied with coils completely encapsulated in epoxy resin. Three sizes are available, Models 1000, 2000 and 3000, for use in business and commercial machines, automation equipment, vending machines and small machine tools. Dormeyer Industries, Dept. ES-2, 3418 N. Milwaukee Ave., Chicago 41, Ill.

Circle 340 on Inquiry Card

WHATEVER HAPPENED TO A-C QUADRATURE?

Helipot got rid of it, that's what . . . by designing new A-C potentiometers with low quadrature and negligible phase shift!

They are the 3" diameter 5800 single-turn series and the 2" 7800 multi-turn series. Both have high input impedance and low output impedance. Which means: 1) reduced loading effects, and 2) you'll wonder where the quadrature went.

Helipot's new A-C versions straddle a frequency range of 400 to 1,000 cps. And they can be built to provide exceptional linearities . . . within resolution and without padding!

You'll also find it well to remember that Helipot's A-C potentiometers can be cascaded in series or parallel to obtain unique functions. (And, with low quadrature and all, they'll improve signal-to-noise ratios in high performance servos!)

To find out more about Helipot's A-C pots, ask for our new 32-page potentiometer catalog!

Beckman® / Helipot®

POTS : MOTORS : METERS

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California

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Circle 115 on Inquiry Card

Specify the new Amperex® P·A·D·T 40

the *2 times faster* PNP Germanium Switching Transistor

$$* \; U = \frac{1}{\text{nanoseconds} \times \text{pennies}}$$

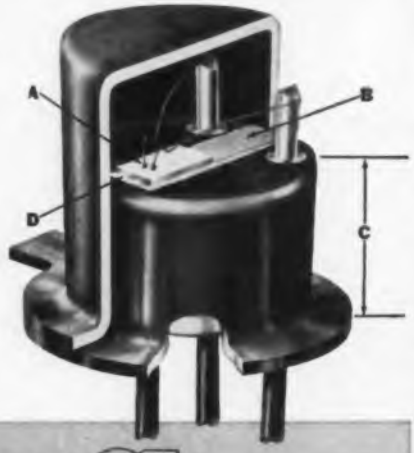
Right from the sketch-pad stage, plan your computer switching circuits with the new PADT-40.* The extreme speed and efficient design of the PADT-40 gives more U (usefulness factor) and lower cost x switching time. This results in fewer transistors to buy, less complicated circuits to design, and the elimination of many costly components because of multi-function circuit usage. But speed, of course, is only one of the cost-and-production advantages inherent in the PADT-40; **RELIABILITY**, as only the revolutionary Post Alloy Diffusion Technique can provide, is another; **AVAILABILITY**, as only the mass-production techniques employed at the new Amperex plant in Slatersville, R. I., can provide, is still another; **LOW PRICES** (no higher than for low-speed transistors) . . . plus **INTERCHANGEABILITY** with many conventional mesa transistors, round out our 'package'. Yes, the new Amperex PADT-40 is truly worth specifying . . . *now!*

High Speed, plus . . .

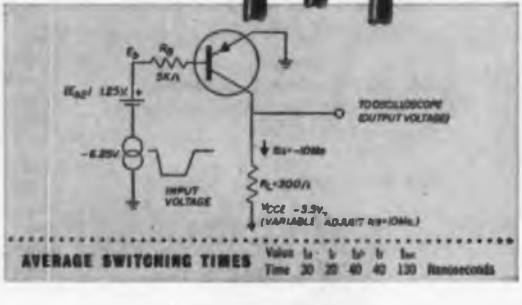
MECHANICAL RUGGEDNESS – guaranteed by the *only* process that combines the best qualities of both the alloy and the diffusion methods. As a result, the PADT-40 is resistant to vibration and shock.

PADT RELIABILITY – Hermetically sealed in a standard TO-18 case, the PADT-40 has a deep diffused and extremely thin active base region. As a result, the h_{FE} and switching time are virtually independent of surface effects and temperature changes.

- **A** *Rugged, mechanically reliable eutectic solder joints*
- **B** *Flat bed attachment for good heat dissipation*
- **C** *Long path prevents weld contamination of transistor*
- **D** *Gold doped for high speed*
- *Extremely high cut-off frequency*
- *High Beta • Low resistivity germanium*



TOTAL SWITCHING TIME
including Rise, Fall, Delay and Storage
...130 NANOSECONDS!



for complete data and new transistor brochure

AMPEREX ELECTRONIC CORPORATION
230 Duffy Avenue, Hicksville, L. I., N. Y.
In Canada: Rogers Electronic Tubes & Components, 116 Vanderhoof Ave., Toronto 17, Ont.

Circle 116 on Inquiry Card

New Products

PISTON CAPACITORS

Weight and size reductions are features of these trimmers.

Tiny-Trim capacitors are available in panel mount and printed circuit board types that meet Mil-C-14409A. 4 models ranging in capacity from 0.5 to 7.0 pf feature: overall dia.: ⅛ in.; double the sensitivity of JFD standard trimmers; operating temp.: −55° to +125°C.; low inductance for high freq. use; 500 vdc working voltage; 10⁴ Ω insulation resistance; Q factor of 500 (measured as per JFD 5178). JFD Electronics Corp., 6101 16th Ave., Brooklyn, N. Y.

Circle 369 on Inquiry Card

SERVO MOTOR TACHOMETER

Size 11 unit is shorter than models of equivalent dia.

Model BT1004MA measures 1.250 in. long. Designed to operate with transistorized circuitry the unit can also be supplied with any required gear train. Input to the motor is 115 v., 400 CPS fixed phase, 20 v. control phase, center tapped. Tachometer input is 26 v. The output voltage of the unit is 0.24 v./1000 RPM. Total weight of unit is 3.2 oz. Standard operating temp. range is −55°C to +125°C. IMC Magnetics Corp., Eastern Div., 570 Main St., Westbury, L. I., N. Y.

Circle 371 on Inquiry Card

COAXIAL RELAY

The CB series is available for a variety of coax line impedances.

Low VSWR permits use at freqs. up to 300 MC. Relays are ac or dc operated with SPDT internal contacts and up to DPDT auxiliary external contacts. Easy access to internal contacts is provided by a port in the housing. Both military and commercial connectors are available. Specs. are: Pull-in power: dc relay, 2 w; ac relay, 8-10 va. Contact rating: 5 a. res, 2 a. ind @ 26.5 vdc or 115 vac. Duty cycle: continuous. Elgin Advance Relays, Electronics Div., 2435 N. Naomi St., Burbank, Calif.

Circle 370 on Inquiry Card

COMMUNICATIONS SYSTEM

100 w SSB system is for civilian as well as military use.

The SC-910 locks onto any freq. between 2.0 and 30.0 MC. Consisting of separate receiver, exciter, and power amplifier, the unit offers cw freq. shift keying, and independent side band as well as upper side band, lower side band, and AM operation. Digital tuning which provides selection of any one of 28,000 freqs. is by selection of digits on a one knob per digit basis. Tuning is by turret selection of fixed components. Military Products Div., General Dynamics/Electronics, Rochester 3, N. Y.

Circle 372 on Inquiry Card

SAVE TIME AND MONEY
right from the start

with Amperex®
P·A·D·T40
PNP Germanium Switching Transistor

NOW AVAILABLE FROM THESE AND OTHER LEADING INDUSTRIAL ELECTRONICS DISTRIBUTORS:

CALIFORNIA
R. V. WEATHERFORD COMPANY, Glendale 1, Calif.
BRILL SEMICONDUCTOR CORP. Oakland 6, Calif.
ELMAR ELECTRONICS INC. Oakland 7, Calif.

COLORADO
INTERSTATE RADIO & SUPPLY Denver 4, Colorado

CONNECTICUT
RADIO SHACK CORP. Stamford, Conn. W. Hartford, Conn. New Haven 10, Conn.

FLORIDA
THUROW ELECTRONICS, INC. Cocoa, Fla. • Jacksonville, Fla. Miami, Fla. • Orlando, Fla. Pensacola, Fla. • Tampa, Fla.

ILLINOIS
NEWARK ELECTRONICS CORP. Chicago, Ill.

MASSACHUSETTS
RADIO SHACK CORP. Boston, Mass.

NEW YORK
MILO ELECTRONICS New York, N. Y.
ROME ELECTRONICS Rome, N. Y.

TEXAS
ADLETA COMPANY Dallas 1, Texas Fort Worth, Texas

Circle 116 on Inquiry Card

New Tech Data for Engineers

CC TV Camera

Model 700-S closed-circuit television camera is now available with complete built-in microphone and amplifier sound channel. Balanced output, 0 DB level. Some features are: simple installation, just "plug it in"; lightweight, portable, and automatic exposure compensator. Camera comes complete with all necessary cables and connectors. Tele-Tronics Corp., 12786 Western Ave., Garden Grove, Calif.

Circle 373 on Inquiry Card

Synchros and Resolvers

A 12-page brochure from Kearfott Div., General Precision, Inc., Little Falls, N. J., describes Kearfott's Size 8 synchros, resolvers, servomotors, servomotor tachometers, synchronous motors, gearheads, brake clutches and permanent magnet alternators. Complete specs., diagrams, and descriptions are included.

Circle 374 on Inquiry Card

Diodes

Shockely Transistor, a Unit of Clevite Transistor, Stanford Industrial Park, Palo Alto, Calif., is offering a catalog on Shockley 4-layer diodes. Eight types of diodes are offered with complete specs., diagrams, and photographs. The Shockley 4-layer is available in two series: commercial and Mil-line.

Circle 375 on Inquiry Card

Adapter Sockets

Catalog No. AS-1 covers adapter sockets for universal plug-in testing of all solder-terminal relays. Features of these units are dual insulated contacts for each pin on the header, accurate relay contact resistance measurement, acceptance of all terminal types and availability in wired adapter modules for use in RT-905 relay tester. Complete specs., characteristics, and diagrams are included. Electronic Engineering Co. of California, Automation Div., 1601 E. Chestnut Ave., Santa Ana, Calif.

Circle 376 on Inquiry Card

Test Equipment

Bulletin 700 is available from PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y. The bulletin features a complete line of coaxial and waveguide freq. meters available, and describes, in detail, more than 50 different models from which to choose from in a variety of ranges covering 0.1 to 40 GC. Featured are coaxial and waveguide direct reading freq. meters, Mil Spec. freq. meters and precision heterodyne and freq. standard multipliers. Charts and photographs indicate freq., type, accuracy, dimensions, length, etc.

Circle 377 on Inquiry Card

Industrial Ceramics

A new 20-page catalog covers Saxonburg Ceramics, Inc., Saxonburg, Pa. complete line of industrial ceramic products. The catalog includes, photos, descriptive material, sizes on beads, tubing and rods, swageable thermocouple tubing, end seals, castables, laboratory ceramics, and special shapes. Information on materials, electrical and mechanical properties, design recommendations and summary of facilities is included.

Circle 378 on Inquiry Card

Microwave Components

The Comet line of microwave components by Don-Lan Electronics Inc., 1131 Olympic Blvd., Santa Monica, Calif., is featured in a brochure entitled "A Galaxy of Microwave Components." Units featured are DI-OPTIC Antennas, coaxial r-f attenuators, coaxial switches, RODOSTUB tuner, coaxial lobing switch, cable connectors and waveguide switch.

Circle 379 on Inquiry Card

Potting Compound

A new illustrated bulletin describing GE's recently developed clear silicone potting compound (LTV-602) is now available from General Electric's Silicone Products Dept., Waterford, N. Y. Bulletin CDS-280 lists the complete properties of the low temp. vulcanizing compound, designed to provide mechanical and dielectric protection for electronic components and assemblies. It is available in liquid form and cures at 70° to 80°C to a flexible, resilient solid.

Circle 380 on Inquiry Card

Voltage Regulator Tubes

Photographs, graphs, schematics and application information is included in tech. data sheets available from Red Bank Div., Electron Tube Products, Bendix Corp., Eatontown, N. J. The regulator and reference types produced by Bendix, are designed to yield fast firing times.

Circle 381 on Inquiry Card

Single Crystal Silicon

Monsanto Chemical Co., Inorganic Chemicals Div., 800 N. Lindbergh Blvd., St. Louis 66, Mo., is making available to semiconductor device manufacturers an evaluation procedures manual for float-zone single crystal silicon. The technical publication describes procedures for measurement of lifetime, resistivity and dislocation density for single crystal silicon. Included is a timesaving and effective method of applying contacts to silicon crystals for lifetime measurement.

Circle 382 on Inquiry Card

Panel Meters

A new 1961 catalog of miniature panel meters, side indicators and other miniature components is available from International Instruments, Inc., 88 Marsh Hill Rd., Orange, Conn. Featured is an extensive line of subminiature 1 in. barrel diameter meters, internally illuminated models available in both the 1½ in. and side-indicator meters. Model 2547 electronic control meter which serves as an indicator and a control is also featured.

Circle 383 on Inquiry Card

Vacuum Ion Pumps

Diagrams, photographs, specs., and graphs describe Consolidated Vacuum Corp.'s, Rochester 3, N. Y. dry vacuum ion pumps, pumps that use no fluid; need no baffles; pumps with no outlets. Bulletin 6-2 gives operating principles, features and characteristics of two Drivac pumps and an Evapor-ion pump.

Circle 384 on Inquiry Card

Automatic Machinery

A wide range of machines and equipment designed to automate metal finishing operations is described in a fully illustrated 29-page "Guide," published by The Meaker Co., sub. of Sel-Rex Corp., Nutley 10, N. J. Entitled, "When to Automate" the booklet also illustrates new types of automatic machinery currently in use by electronic firms for mass production processing of vital components.

Circle 385 on Inquiry Card

Transformer Catalog

A new 20-page, illustrated catalog describes a complete line of miniature toroidal transformers, inductors, magnetic amplifiers and other magnetic devices. Fully encapsulated and hermetically sealed, units meet the environmental requirements of Mil-E-5272 and Mil-T-27A. Included in the catalog are tech. specs., dimensional drawings, circuit diagrams, typical curves, facility photographs, and complete ordering information. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 386 on Inquiry Card

Silicon Rectifiers

A brochure on silicon high voltage potted rectifier assemblies includes information on how to select a potted rectifier assembly and detailed specs. on various rectifier circuits requiring multiple potted blocks. Also included are 5 charts showing performance of the potted assemblies under various operating conditions. Publication ECG 487. General Electric Co., Rectifier Components Dept., Auburn, N. Y.

Circle 387 on Inquiry Card

POINT OF NO RETURNS

Desk-eye view of a computer logic circuit utilizing Sperry 2N706 Silicon Mesa Transistors.

SPERRY

SPERRY SEMICONDUCTOR DIVISION

OF

SPERRY RAND CORPORATION

NORWALK, CONNECTICUT

Here's where you put your experience on the line.

Will the vendor you select confirm the confidence of your decision . . . or will the transistors he delivers return to haunt him — and you?

63 QC checks before and during mechanized manufacture. Our way of trying to make your confidence our only return!

Circle 117 on Inquiry Card

SEMICONDUCTOR IS OUR MIDDLE NAME . . . SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS*), TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES. SALES OFFICES: CHICAGO, ILLINOIS; EL SEGUNDO, CALIFORNIA; WESTWOOD, NEW JERSEY; TEWKSBURY, MASSACHUSETTS; STAMFORD, CONNECTICUT; TOWSON, MARYLAND; MASSAPEQUA PARK, NEW YORK.

SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS

*Trade Mark, Sperry Rand Corporation

New Tech Data for Engineers

Magnetic Amplifiers

Acromag, Inc., 22515 Telegraph Rd., Southfield (Detroit), Mich., has a new 6-page technical bulletin, No. 10-C, describing the use of magnetic amplifiers for the thermocouples, strain gages, photocells, and other low level dc signals. The data includes 4 pages of schematics and detailed application information.

Circle 388 on Inquiry Card

Display Lites

A new tech bulletin illustrates and describes the "TEC-Lite MDL Series" of low cost miniature indicator lites. Described are a full line of high quality display units which provide flexibility for use through a selection of lens and body colors, lamp types, internal resistors and terminal options. Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn.

Circle 389 on Inquiry Card

Torque Testers

A new 12-page brochure illustrates how to measure the torque characteristics and speed of motors, gear trains, servo mechanisms, and potentiometers. Covers torque ranges from ¼ gm-cm to 200 lb./in. Includes formulas for computing power and efficiency, and methods of using stroboscopes and tachometers for analyzing rotating motion. Power Instruments, Inc., 7352 N. Lawndale Ave., Skokie, Ill.

Circle 390 on Inquiry Card

Component Catalog

New products for 1961 catalog from Burroughs Corp., Electronic Tube Div., P.O. Box 1226, Plainfield, N. J., contains photographs and data on new product developments. Included is a new series of NIXIE® indicator tubes; BIPCO™ modules, and BEAM-X™ modules. Also described in this catalog is the entire family of BEAM-X switches including the standard shielded and high current types. Data and photographs of decade counters, sphericular optic displays and the TRIXIE® modules are also included.

Circle 391 on Inquiry Card

Capacitors

Metalized Mylar capacitors, a new catalog, Form 795 available from The Potter Co., 1950 Sheridan Rd., N. Chicago, Ill., describes their expanded line of miniature, hermetically sealed, metalized mylar types suitable for miniaturized applications such as transistor circuitry or printed circuits. Engineering data, descriptions and dimensions cover 3 series of mylar wrap epoxy end seal types and 2 series of mylar units in ceramic tubes; all in 200, 400 and 600 wvdc ranges.

Circle 392 on Inquiry Card

Diode

By means of graphs, charts and silent-motion-picture-era photographs, Hoffman Electronics Corp., Semiconductor Div., 1001 N. Arden Dr., El Monte, Calif., presents complete information on their Uni-Tunnel Diode. The booklet, entitled "Tale of the Hoffman Uni-Tunnel Diode or How Low can you Get," includes characteristics and application notes. The unitunnel diode, because of its forward characteristic similar to the reverse characteristic of the tunnel diode, is sometimes referred to as a "backward" diode. Reverse/forward impedance ratios are greater than 100:1.

Circle 393 on Inquiry Card

Facilities Brochure

Omnitronics, Inc., Sub. of Borg-Warner Corp., 511 N. Broad St., Phila. 23, Pa., has available a facilities brochure featuring their research and development facilities. Everything from basic research and study to supplying completed devices and subsystems is available. Digital communication systems, space electronic devices and systems, digital data handling equipment and communication terminal equipment are some of the fields specialized in.

Circle 394 on Inquiry Card

High Voltage Devices

Jennings Radio Mfg. Corp., 970 McLaughlin Ave., P. O. Box 1278, San Jose 8, Calif. is offering a 12-page, 3-color brochure on vacuum power switches. Photographs, drawings, schematics and graphs tell in detail of the many uses and applications of their complete line of high voltage interrupter devices. Design notes are included.

Circle 395 on Inquiry Card

Industrial Tubes

A new 23-page booklet on the practical maintenance approach to industrial electronic equipment problems is available. This booklet gives maintenance hints for equipments using ignitrons, thyratrons, and gas filled rectifiers. Practical suggestions for solving maintenance problems on industrial electronic equipments are offered. This booklet can be procured by enclosing twenty-five cents (25¢) with written request to National Electronics, Inc., Geneva, Ill.

Circle 396 on Inquiry Card

Coil Winding Machines

A 12-page, 2-color catalog No. 61 HD by the Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 46, Ill., illustrates and gives full technical details on 14 heavy duty transformer and field coil winding machines and 3 heavy duty tensions.

Circle 397 on Inquiry Card

Servo System

Tech Bulletin 107 covers Model 6102 Solid State Servo Amplifier, a versatile servo system when used in conjunction with the reversible non-synchronous motor for which it was designed. The carefully designed circuits function without complaint even if the dc power source fluctuates ±20% and the 60 CPS chopper switching voltage fluctuates +100%. Optional gear ratios can be provided from 50:1 to 12,000:1. Solar Electronics Co., 1145 N. McCadden Place, Hollywood 38, Calif.

Circle 398 on Inquiry Card

Test Equipment

Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill., offers a 14-page multi-colored brochure LAB-200 on laboratory test equipment. Included are wide band oscilloscopes, pulse generators, self-powered labs standard calibrators, portable equipment, vacuum tube voltmeters, multitesters, volt-ohm-milliammeters, and temp. indicating instruments and accessories.

Circle 399 on Inquiry Card

Digital Instrumentation

Beckman/Berkeley Div., 2200 Wright Ave., Richmond, Calif., offers a 17-page brochure on their line of measurement, counting and control instruments. Some of the instruments included are frequency counters, totalizing counters, time interval meters, transducers, data converters, scanners, and programmers. Information on transducers and standard modifications to electronic counters is included.

Circle 400 on Inquiry Card

Waveguide Components

Tech. information is available from the Waveguide Systems Div. of Microwave Associates, Burlington, Mass. on their line of high quality cast waveguide components. Compensated cast bends, folded hybrid tees, E/H and straight adapters, sidewall hybrid couplers, and waveguide-to-waveguide couplers are available for use at freq. from 1.2 to 40 GC.

Circle 401 on Inquiry Card

Transistor Transformers

"Mites" are for max. use of chassis space, and "Buds" are for high module stacking efficiency. These units are epoxy encased in drawn steel cans and have a freq. response of 200 to 50,000 CPS. Layout diagrams, graphs, and pipe charts are included. The diameter of Mites is only ⅜ in. The actual height of Buds is 5/16 in. Decco, Inc., 2025 Farrington, Dallas 7, Tex. Catalog Supplement No. 2.

Circle 402 on Inquiry Card

TAKEN FROM TOMORROW

BIPCO™ Modules — Built-In-Place Components In Modular Form . . .

The Burroughs Corporation announces the commercial availability of tomorrow's techniques . . . today. BIPCO modules combine the reality of performance, low cost and immediate availability, to signal a major transition in the state of the art.

Thin Film Memory Planes and Solid State Multi-element Modules are the first of the BIPCO module family. The Thin Film Memory is capable of storing 20 words of 8 bits each for a total of 160 bits of information, and has a cycle time of 0.2 microsecond. The Solid State Module is a binary coded decimal to decimal diode converter which utilizes 40 diodes in matrix logic.

Burroughs Corporation's breakthrough in Built-in-Place Components is made possible by the unique combination of two major new techniques. First, multi-element components are simultaneously fabricated within a single device. Second, these elements are placed in a predetermined pattern in such a manner as to facilitate complex internal connections.

This combination of techniques has resulted in BIPCO Modular Devices with simple inputs and outputs which perform functions normally requiring myriads of elements and connectors.

Write for BIPCO Module Technical Brochure.

Circle 120 on Inquiry Card

ANOTHER ELECTRONIC CONTRIBUTION BY

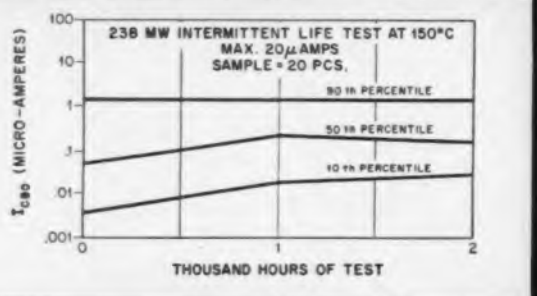
Burroughs Corporation

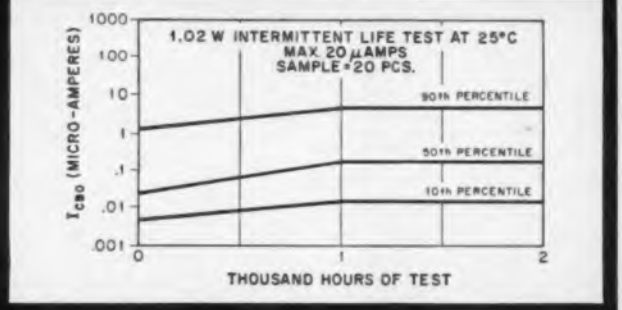
ELECTRONIC COMPONENTS DIVISION

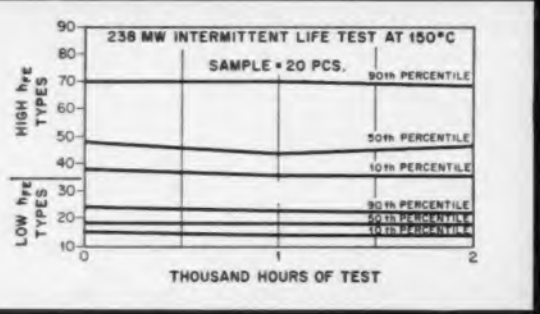
PLAINFIELD, NEW JERSEY

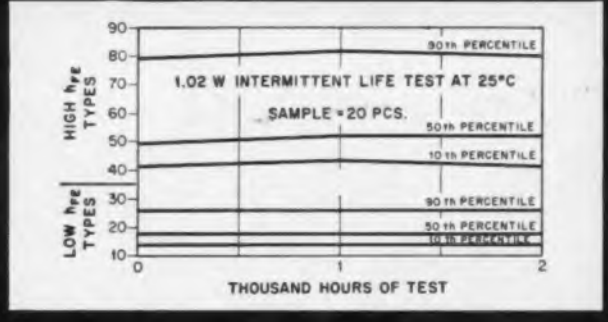
Formerly Electronic Tube Division

The industry's most thoroughly characterized and medium power silicon Mesa transistors...2N497A,









Absolute Maximum Ratings (25°C)

		2N497A	2N498A	2N656A	2N657A	
Voltages						
Collector to Base	V_{CBO}	60	100	60	100	volts
Collector to Emitter	V_{CEO}	60	100	60	100	volts
Emitter to Base	V_{EBO}	8	8	8	8	volts
Temperatures						
Storage	T_{STG}	−65 to 200°C				
Operating Junction	T_J	−65 to 200°C				

Total Dissipation
Free Air @ 25°C — 1 watt*
Case Temperature @ 25°C — 5 watts**

*Derate 5.72 mw/°C increase in ambient temperature above 25°C
**Derate 28.6 mw/°C increase in case temperature above 25°C

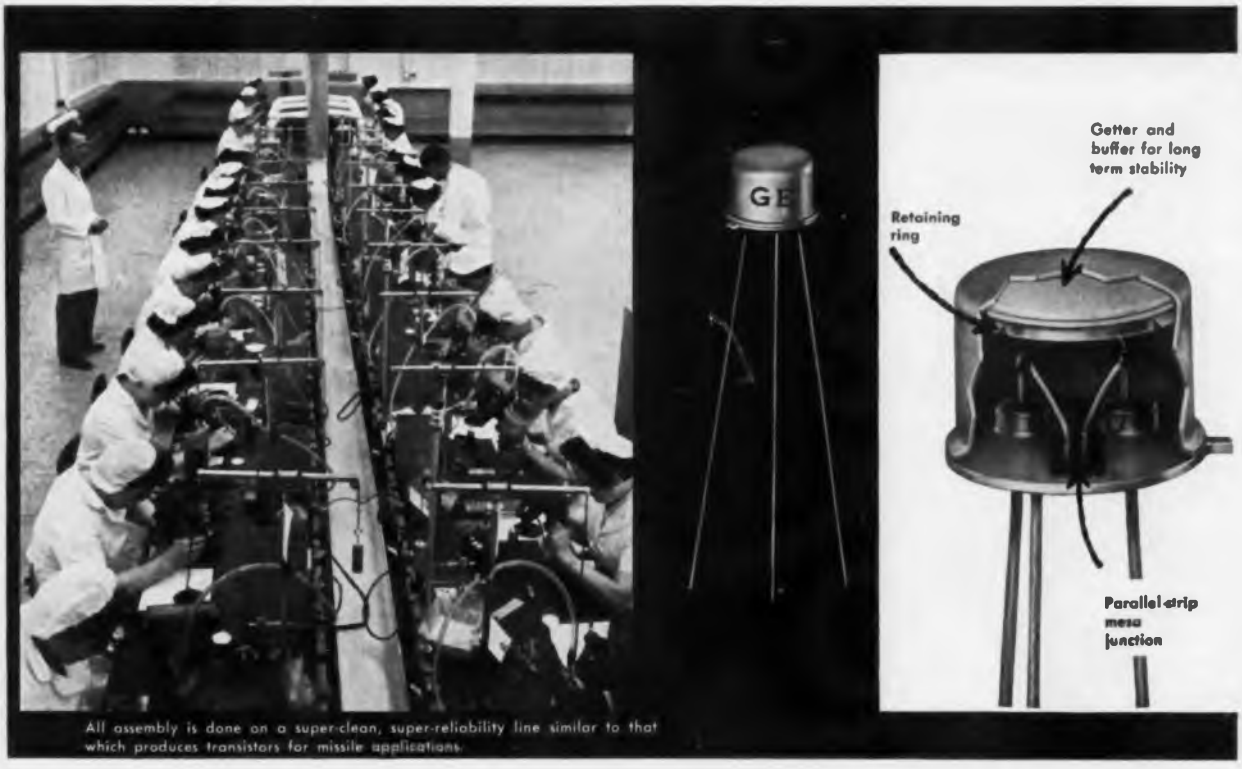
Electrical Characteristics (25°C) unless otherwise specified

D-C Characteristics		2N497A Min.	2N497A Max.	2N498A Min.	2N498A Max.	2N656A Min.	2N656A Max.	2N657A Min.	2N657A Max.	
Collector to Base Voltage (I_C=100 μa, I_E=0)	V_{CBO}	60		100		60		100		volts
Collector to Emitter Voltage (I_C=250 μa)	V_{CEO}	60		100		60		100		volts
Collector to Emitter Voltage (I_C=16 ma)	V_{CEO}	60				60				volts
Collector to Emitter Voltage (I_C=10 ma)	V_{CEO}			100				100		volts
Emitter to Base Voltage (I_E=250 μa, I_C=0)	V_{EBO}	8		8		8		8		volts
Forward Current Transfer Ratio* (I_C=200 ma, V_{CE}=10V)	h_{FE}	12	36	12	36	30	90	30	90	
Base Input Resistance* (I_B=8 ma, V_{CE}=10V)	h_{IE}		200		200		200		200	ohms
Saturation Resistance* (I_B=40 ma, I_C=200 ma)	$r_{CE\ (sat)}$		10		10		10		10	ohms
Cutoff Characteristics										
Collector Current (I_E=0, V_{CB}=30V)	I_{CO}		10		10		10		10	μa
Collector Current (High Temperature) (I_E=0, V_{CB}=30V, TA=150°C)	I_{CO}		250		250		250		250	μa

*Pulse Test: 300 μsec. 2% Duty Cycle

Specifications also available for 2N497,498, 2N656,657 mesa transistors

tested
98A, 2N656A, 57A...come from General Electric



All assembly is done on a super-clean, super-reliability line similar to that which produces transistors for missile applications.

Positive internal atmospheric control achieved through the use of General Electric's buffered-sieve encapsulation technique, higher power dissipation with lower saturation resistance and lower input impedance are important features of this line of top quality one to five watt audio switches. Especially well suited for either high level linear amplifier or switching applications, these are the industry's most thoroughly characterized and tested medium power silicon double diffused NPN transistors available today. Just take a look at the extended life test charts illustrated for convincing evidence of long term stability and reliability.

Semiconductor Products Department, Section 24E96, Electronics Park, Syracuse, New York.

For fast delivery of medium power Mesa transistors at factory-low prices in quantities up to 999 call your G-E semiconductor distributor.

Progress Is Our Most Important Product

GENERAL ELECTRIC

TINSLEY DELIVERS

CORNING GLASS FILTERS

IN 3-5 DAYS

Wherever you are in the United States you can get standard thickness Corning Glass color filters in 3-5 days from Tinsley Laboratories. Fast delivery, too, on special sizes and thicknesses, custom ground and pitch-polished in our laboratories. You can depend upon Tinsley and on the Corning filters we finish and supply. They are particularly useful in colorimetric work and other applications in which specific regions of the radiant spectrum must be isolated. Send for a free copy of our price list.

2448 Sixth Street • Berkeley 10, California

Circle 122 on Inquiry Card

New Tech Data for Engineers

Silicon Rectifiers

Bulletin No. 300, illustrated in color, includes a list of more than 350 JEDEC types of silicon rectifiers. Condensed electrical and mechanical specs. of the units and stacks are given in the catalog's tables. In addition, typical operating characteristics are shown in curves displaying forward current rating levels and derating curves for raised ambient temps. The silicon rectifier's stacks have a certification and guarantee policy. Semiconductor Div., Syntron Co., Homer City, Pa.

Circle 403 on Inquiry Card

Digital Translator

The TR-100 series transistorized digital translator is designed to convert binary-coded decimal input signals to decimal and/or binary-coded decimal outputs. Max. capacity with single output is 10 decimal digits; 8 decimal digits can be handled with dual output. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 404 on Inquiry Card

Synchros and Resolvers

A 27-page illustrated technical discussion of the electrical characteristics of synchros and resolvers is being offered by the Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J. The manual describes in detail the application and significance of such parameters as electrical error, electrical zero, fundamental null, total null, transformation ratio, and phase shift. Methods of measurement and the basic specs. for test equipment are also included.

Circle 405 on Inquiry Card

Variable Resistors

A brochure, Bulletin No. 42-1051 describes in detail Centralab Model 7 linear motion variable resistors. It contains specs on 6 types of Model 7 units. In addition to general electrical specs., detailed information on mechanical and environmental inspection and test specs. are included. The brochure also contains dimensional drawings of encapsulated and nonencapsulated types. Centralab, Electronics Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Circle 406 on Inquiry Card

Impedance Plotter

Tech. data Bulletin 60-3, is available from Dielectric Products Engineering Co., Inc., Raymond, Me., on their new Smith Chart Impedance Plotter. The unit provides instantaneous display of impedance as a continuous function of freq. in the 10 to 3000 MC range. The unit is designed for obtaining impedance and admittance measurements of such components as antennas, filters, load resistors, transformers and other r-f networks.

Circle 407 on Inquiry Card

Nuclear Gages

A new 6-page, 2-color fold out folder describes details of basic systems employing nuclear gauges for controlling specific gravity or density and liquid or interface levels. Fundamental ideas of using gamma radiation are described as well as components required for a complete system. Schematic diagrams visualize installations and photos show equipment. The Ohmart Corp., 2236 Bogen St., Cincinnati 22, Ohio. Bulletin No. 105-C.

Circle 408 on Inquiry Card

Modular Packaging

An 8-page booklet describes a new concept in 3-dimensional modular packaging and interconnecting of electronic components available from AMP Inc., Harrisburg, Pa. The new concept called AMP-MECA (Maintainable Electronic Component Assemblies) is described in detail, with characteristics and functions of the system. The kinds of interconnections made possible because of the modular-cell design are discussed, with illustrations.

Circle 409 on Inquiry Card

Compression Terminals

Two technical bulletins, SCT-59-101 and TCT-61-102 give complete information on glass-to-metal single lead and tubular singular lead compression terminals. A wide variety of types, sizes, voltage ratings, and current capacity terminals are offered. Electrical Industries, Div. of Philips Electronics and Pharmaceutical Industries Corp., 691 Central Ave., Murray Hill, N. J.

Circle 410 on Inquiry Card

Filters

A 6-page brochure contains complete specs. for a standard line of precision wavemeters, preselector-balanced mixers, and bandpass and low pass filters. Specs. are also provided for a custom line of bandpass filters, dual mode discriminator cavities, diplexers, wave traps and reference cavities. Frequency Standards, P.O. Box 504, Asbury Park, N. J.

Circle 411 on Inquiry Card

Computer Diodes

Tech. information is available from Princeton Electronics Corp., P.O. Box 127, Princeton, N. J., on diffused silicon mesa computer diodes, types 1N914 and 1N916. These diodes with rugged internal construction capable of meeting Mil requirements operate at 75 ma rectified forward current. They are designed for 4 nsec. max. recovery time and low capacitance.

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Two million watts will blast the U. S. Navy's radio signal anywhere in the world . . . even to a submerged submarine on the other side of the earth!

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U. S. Army's most powerful transmitter
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Circle 123 on Inquiry Card

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Circle 124 on Inquiry Card

Tech Data
for Engineers

Silicon Diodes

Laminar diodes are high performance diodes consisting of a multi-layered structure, surface passivated, double hermetically sealed and constructed to eliminate front contact failure due to shock or vibration. Positive front contact is achieved by decisively embedding the tungsten whisker into a gold laminated tab. 1N3257 and 1N3258 are two new types produced by this process. Pacific Semiconductors, Inc., 12955 Chadron Ave., Hawthorne, Calif.

Circle 413 on Inquiry Card

Precision Resistors

Specs., dimensions, performance data at various confidence levels, characteristics, derating curve, surface temp. rise vs. load charts are included in a brochure from Burlington Div., International Resistance Co., P.O. Box 502, Burlington, Iowa. Molded metal film resistors are half the weight in volume of precision wire wound resistors. Units have the same low temp. coefficient at all resistance values from lowest to highest.

Circle 414 on Inquiry Card

Temperature Controls

An 8-page brochure, MC-195, describes Fenwal Inc., Pleasant St., Ashland, Mass. new "500" line temp. controllers and indicators. The brochure gives complete details of 3 models in the line and brief descriptions of other instruments offering thermistor sensing. Also included are details on how various units can be combined from multi-point control or monitoring with a variety of optional features.

Circle 415 on Inquiry Card

Antennas

A 16-page, 3-color microwave catalog No. 100 on microwave antennas is offered by the Technical Appliance Corp., Sherburne, N. Y. Specs., graphs and photographs cover their line of dual-polarized, plane-polarized and parabolic antennas. Information on anti-icing equip. is included.

Circle 416 on Inquiry Card

Facilities Brochure

A 24-page illustrated brochure entitled "This is the New Clary" is now available from Clary Corp., Dept. 691, 408 Junipero St., San Gabriel, Calif. The booklet describes the capabilities, facilities, products and achievements of the company, which now designs, engineers and manufactures a line of computer and data handling equipment and missile components. Features in the booklet are the DE-60 computer, an arithmetic center, standard data and militarized printers, add-punches, sales recording devices and various types of peripheral equipment compatible with nearly all systems concepts.

Circle 417 on Inquiry Card

Glass-Ceramics

A revised edition of "This is Glass," a comprehensive story of glass and glass-ceramics, has been published by Corning Glass Works, Corning, N. Y. The 68-page illustrated booklet reviews the history of glass and details the basic types of glass. Included is a section on Corning's new glass-ceramic materials, trademarked Pyroceram and a 2-page chart giving properties of selected glasses and glass-ceramics. A preview of the future of glass and glass-ceramics describes the extensive research being done with these basic engineering materials.

Circle 418 on Inquiry Card

Synchros and Resolvers

American Electronics, Inc., Instrument Div., 9503 W. Jefferson Blvd., Culver City, Calif., is making available a handy quick-reference catalog of some 200 resolvers and synchros. It is for the convenience and aid of systems and computer design engineers. The catalog offers fundamental engineering data in easy-to-read form. Ten basic parameters are covered for each unit. A quick reference to the input voltage, impedance and transformation ratio values along with typical views of the units, dimensional drawings and circuit diagrams is included.

Circle 419 on Inquiry Card

Hi-Speed Rotary Switches

A new brochure from Instrument Development Laboratories, Inc., Sub. of Royal McBee Corp., Attleboro, Mass., describes their line of "Standard" high speed rotary switches. The brochure contains facts about the units for telemetering, programming, commutating, sampling, multi-plexing, and computing with descriptions and application data for the complete line of IDL switches.

Circle 420 on Inquiry Card

TIMM

A 16-page brochure entitled "TIMM circuits are the Answer" describes by means of photographs, schematics and drawings GE Receiving Tube Dept.'s, concept of thermionic integrated micro modules. These circuits operate in high ambient temps. to 600°C. Since these modules are of metal and ceramic construction, radiation problems are reduced in consequence. General Electric Co., Receiving Tube Dept., Owensboro, Ky.

Circle 421 on Inquiry Card

Plastic Protectors

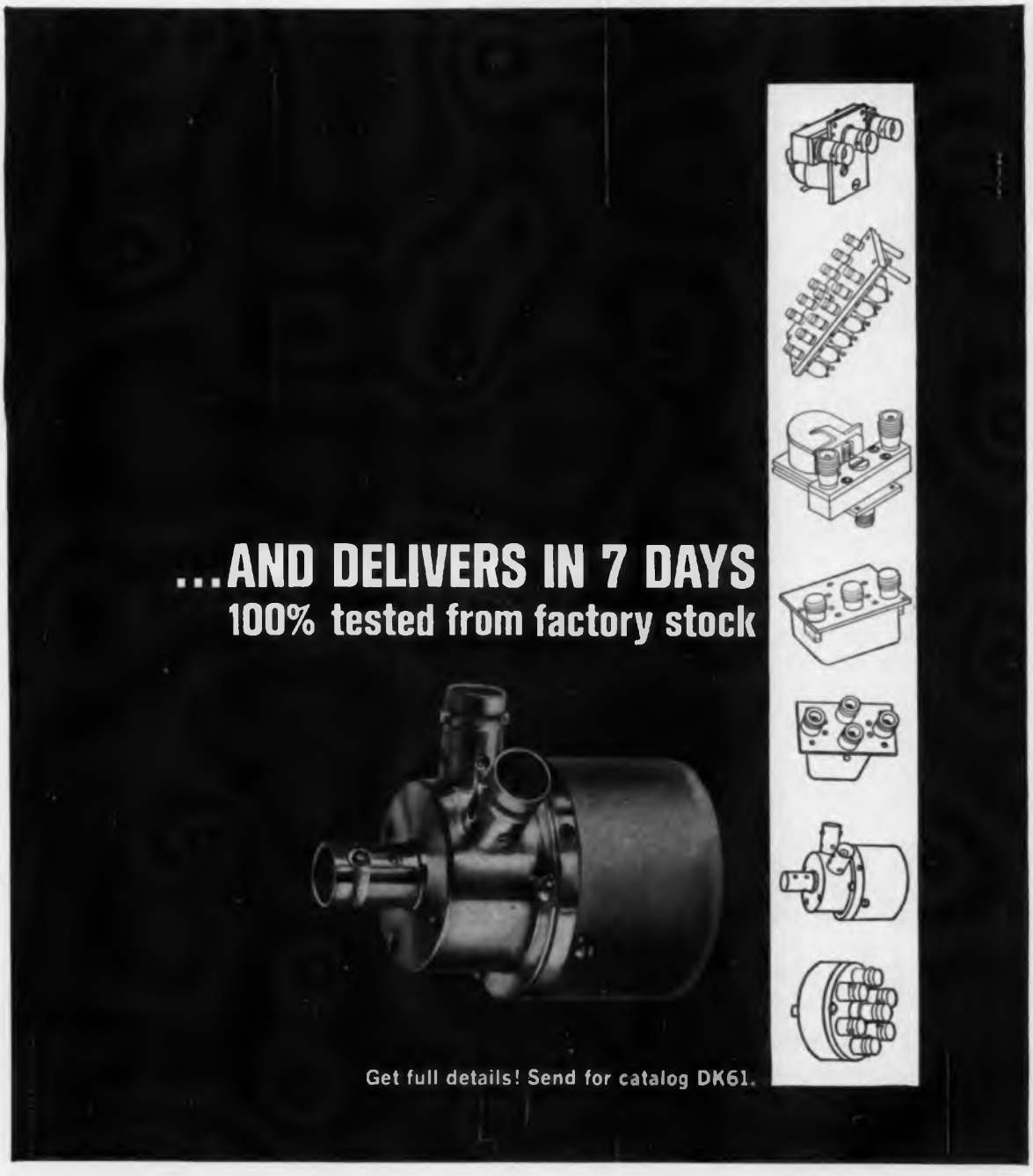
Bulletin P-6012 describes new rectangular plastic protectors for miniature electronic pin connectors. Rectangular caps prevent damage to connectors during assembly, shipping, storage, and on-site installation. Complete dimensions, weights and prices are listed in the bulletin. Plastics Div., Dept. WLT, S. S. White Industrial Div., 10 E. 40th St., New York 16, N. Y.

Circle 422 on Inquiry Card

RF PRODUCTS BUILDS ANVIL RUGGEDNESS INTO PRECISION COAXIAL SWITCHES-RELAYS...

Spring-leaf switching blades, gold-plated silver contacts and impedance matched connectors keep insertion loss and VSWR (1.3 @ 4,000 MCs) low, Crosstalk high (in decibels down). Electro-mechanically actuated models operate and release in 8 to 20 milliseconds, depending on type and function, with a proven mechanical life of 1,000,000 cycles minimum when operated under 10 cps. / Available for fast delivery from factory stock in a large variety of configurations and functions, including SPDT, DPDT, 1P4T, 1P6T, 1P12T and Transfer types.

A DIVISION OF AMPHENOL-BORG ELECTRONICS **RF PRODUCTS** AMPHENOL DANBURY CONN.



Circle 126 on Inquiry Card

Tech Data

for Engineers

Terminals

A new press-fit teflon terminal catalog shows the entire line of units available from Sealectro Corp., 610 Fayette Ave., Mamaroneck, N. Y. The press-fit line includes a wide choice of subminiature stand-offs, subminiature feedthrough, probes and plugs, miniature stand-offs, miniature feedthrough, connectors and test jacks.

Circle 423 on Inquiry Card

Photo Diodes

Graphs, layout diagrams, schematics, and charts are included in a 16-page brochure from Nucleonic Products Co., Inc., 1601 Grande Vista Ave., Los Angeles 23, Calif. Four types of germanium photo diodes are discussed as is a grain boundary photo-diode type KF 11. Operating characteristic and conditions, ratings and spectral response notes are included.

Circle 424 on Inquiry Card

Precision Resistors

An 8-page 1961 catalog is available from Pyrofilm Resistor Co., Inc., U. S. Highway 46, Parsippany, N. J., describing the companies' complete line of precision deposited carbon film resistors for commercial, subminiature, Mil Type, high resistance, high voltage and microwave resistor applications.

Circle 425 on Inquiry Card

Silicon Transistors

Two 4-page, 3-color tech data sheets are available on 8 new silicon mesa transistors designed for medium power audio to medium freq. applications. ECG-528 and ECG-538 describe JEDEC types designated, 2N497, 2N497A, 2N498, 2N398A, 2N656, 2N656A, 2N657 and 2N657A. General Electric Co., Kelley Bldg., Liverpool, N. Y.

Circle 426 on Inquiry Card

Piezoelectric Ceramics

Bulletin No. 6900A gives detailed information on Sprague piezoelectric ceramics. A complete line is available in an unlimited number of shapes and sizes. Typical properties of 6 ceramic bodies are listed in the bulletin. Technical Literature Section, Sprague Electric Co., 233 Marshall St., N. Adams, Mass.

Circle 427 on Inquiry Card

Air Distribution Units

Barber-Colman Co., 1300 Rock St., Rockford, Ill., is offering a condensed catalog on air distribution equipment. This handy 8-page booklet allows designers of air distribution systems to quickly survey the wide range of equipment designs, sizes, finishes, and applications available. Catalog No. F-4471-8.

Circle 428 on Inquiry Card

Capabilities Brochure

This multi-color, 12-page brochure entitled "Data from Space" tells of Lockheed Missiles and Space Div.'s capabilities in the field of radio telemetry. Information on their pulse amplitude modulation (PAM-FM) and pulse code modulation (PCM-FM) sampled-data systems is featured. Lockheed Missiles and Space Div., Sunnyvale, Calif.

Circle 429 on Inquiry Card

Silicone Insulated Wire

A 4-page illustrated bulletin describes and provides data on the various kinds of silicone-insulated cable manufactured by Boston Insulated Wire and Cable Co., 63 Bay St., Boston 25, Mass. Entitled "Single and Multi-Conductor Cable with Silicone Rubber," the new bulletin features power and lighting cable, hook-up wire, ignition cable, as well as a list of conductor cable for shipboard, missiles and nuclear power purposes. A second bulletin entitled "Wire and Cable Application Cast Histories" outlines case histories involving radiation resistant cables and miniaturized switchboard wires, using silcone rubber insulation.

Circle 430 on Inquiry Card

Interval Timers

Electronic Products Corp., 4642 Belair Rd., Baltimore 6, Md., is making available an engineering bulletin No. IT-2 which covers four of their interval timers. Schematics, layout diagrams, diagrams and electrical and mechanical specs are included. Two relay type and 2 solid-state type interval timers are offered.

Circle 431 on Inquiry Card

Tuning Fork Oscillator

A bulletin is available from Fork Standards, Inc., 1915 N. Harlem Ave., Chicago 35, Ill., on a precision, miniature, signal generator which has its freq. stabilized by a temp. compensated tuning fork and provides a 1 mw output in either a sine or square wave. This transistorized unit is potted and hermetically sealed in a box approx. 6 cu. in.

Circle 432 on Inquiry Card

Capacitor Catalog

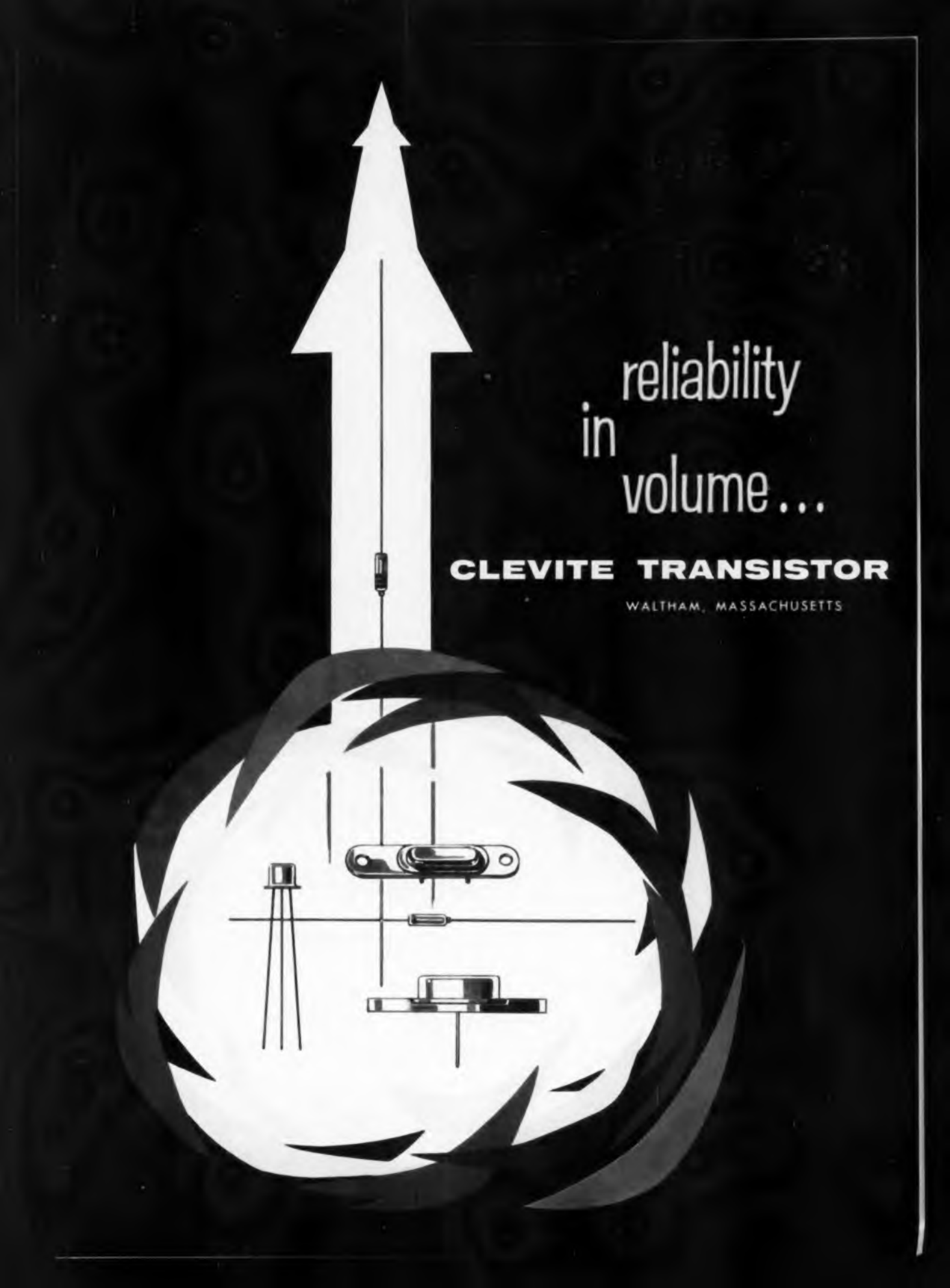
Chicago Condenser Corp., 3255 W. Armitage, Chicago 47, Ill., is offering a 27-page, multi-colored, catalog covering their line of Mylar paper, polystyrene, AM film, ES film, Teflon, Metalized mylar (MET-A-CAPS), Kraft Tissue, and Metalized Paper Capacitors. Also included are references on their miniature dc power supplies.

Circle 433 on Inquiry Card

Miniature Fuse Posts

A new catalog illustrates, describes and gives full tech. specs. on Mil approved 3AG miniature fuse posts that offer combinations of fluted or knurled knobs with straight and right angle bottom terminals is available from Littlefuse, Inc., 1865 Miner St., Des Plaines, Ill.

Circle 434 on Inquiry Card


reliability
in
volume...
CLEVITE TRANSISTOR
WALTHAM, MASSACHUSETTS

How to establish rating values for power transistors

by RICHARD F. MOREY, JR.

Manager, Applications Engineering, Clevite Transistor Division of Clevite Corporation

Every manufacturer of power transistors provides information on the various circuit valves within which a given transistor will satisfactorily perform. These valves or "ratings" are established on the absolute maximum system and are defined so that "the rating values, if exceeded, will cause permanent impairment of the device." Since permanent damage can occur as a result of exceeding rating limits or as a result of an unqualified rating, Clevite Transistor exercises great care in the development of ratings and the proof of their validity.

Clevite places particular emphasis on ratings for junction temperature, power dissipation, collector current, and collector voltage. Each of these ratings is independent and it is not generally possible to approach more than one rating simultaneously. Therefore, specific tests are performed such as "thermal resistance" to establish maximum power dissipation and collector diode leakage current I_{CBO} at both room temperature and high operating temperature to establish maximum rated collector to base voltage. Figure 1 is a diagram of the Thermal resistance test, while Figure 2 indicates the testing configuration for establishing essential collector to emitter voltage ratings.

Other tests are performed to determine collector current and junction temperature. High-temperature-storage life tests to establish maximum junction temperature are further supplemented by Clevite's process of aging transistors at temperatures in excess of the eventual maximum rating.

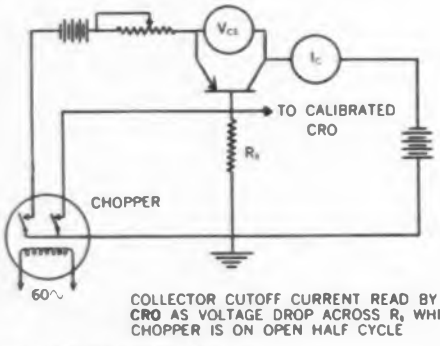


Fig. 1. Thermal resistance test

Perhaps the most important tests are the collector to emitter breakdown tests ($V_{CES\ (sus.)}$ and $V_{CEO\ (sus.)}$) which are used to determine the maximum collector to emitter voltage. Figure 3 indicates a typical germanium power transistor operating in breakdown region. Observe that the bias applied between emitter and base differs for each of the seven curves. This bias differential causes the curves to differ significantly. Curve 1 breaks down sharply at 45 volts, while curve 6 breaks down initially at 118 volts, but upon transversing the curve, the voltage drops and another breakdown occurs at a point slightly greater than 60 volts. Curves 2, 3, 4, and 5 are somewhere between.

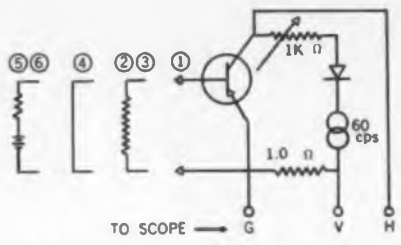


Fig. 2. Collector to emitter voltage test

Curve 7 is simply the curve of the collector to base diode and is shown here for reference purposes.

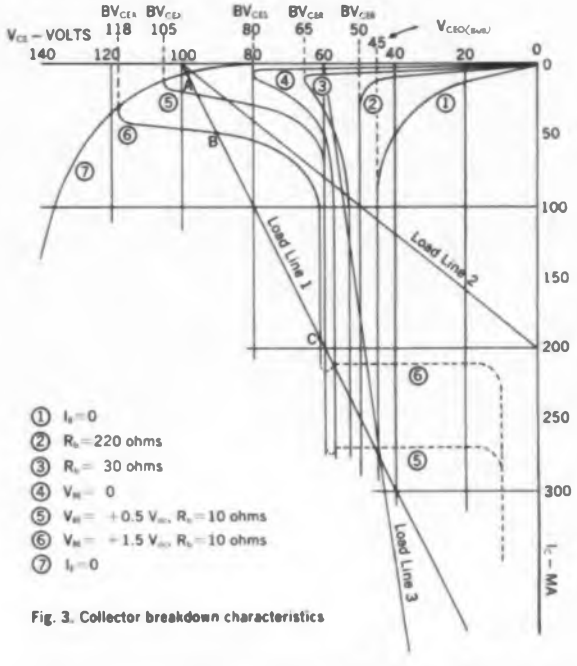


Fig. 3. Collector breakdown characteristics

It may be noted in a particular instance, such as curve 1, that at some voltage (in this case 45 volts) collector current increases without limit. This is the voltage at which collector multiplication causes the overall current gain (alpha) to equal unity.

The remaining curves serve to indicate the effect of a change in bias at different voltage and current conditions.

The tests and data shown here are only a segment of the total program undertaken by Clevite Transistor to assure a continuous high standard of product quality . . . "reliability in volume."

Detailed Technical Data Bulletins are available on all Clevite's Power Transistors and Diodes. To obtain technical information, please request Application Bulletins 1 & 2.

CT CLEVITE TRANSISTOR • Waltham, Massachusetts

Tele-Tech's ELECTRONIC OPERATIONS

The System Engineering Section of ELECTRONIC INDUSTRIES · MAY 1961

SYSTEMS—WISE . . .

Weather information will be available almost instantly with a system called the Wind Sonde, an air-launched missile from Allied Research Assoc., subsidiary of Boeing Airplane Co. To find wind characteristics in storms and hurricanes, etc., spinning is used along with an accelerometer and a magnetometer to read wind velocity and direction. Information is continuously telemetered to the launch aircraft, modified by a computer and made available for immediate use. No ground stations are required.

United Air Lines has ordered 51 air traffic control transponders from RCA's Industrial Electronic Products. Transponders will be installed on United's Caravelle Jets due to enter service this summer. The transponder, which generates its own signal, is triggered by air traffic radar on the ground.

A new space chamber for the dress rehearsal of large satellites prior to launch into orbit is being built. The vacuum test chamber will be 20 ft. in dia. and 27 ft. long. Bendix Corp. is building the chamber. A battery of 8 oil diffusion pumps creates the vacuum.

An advanced closed circuit color TV system, manufactured by Foto-Video Electronics, Inc., is nearing completion at the U. S. Air Force H. Q. in the Pentagon. The system was specified by the USAF for more effective, faster and more secure briefing of decision-making personnel.

A third giant surveillance radar system has been accepted by the Air Force. Sperry Gyroscope Co. was responsible, under the Rome (N. Y.) ADC, for the FPS-35. The 80,000-lb., 150 ft. long, 40 ft. high antenna rests on a 85 ft. concrete tower. Six 100 hp motors rotate the antenna, which rests on a 7,500 lb. bearing.

The FCC has authorized AT&T to land and operate the U. S. terminal of the first transatlantic telephone cable between the U. S. and Great Britain. The new cable, laying to be completed in 1963, will extend about 3,500 nautical miles. It will be owned jointly by AT&T and the British Post Office.

ASW DISPLAY AND COMPUTER SYSTEM

The AN/ASN-30 Tactical ASW Display and Computer System, developed under contract from the Aeronautical Instrument Laboratory of the Naval Air Development Center, will be a significant addition to the Grumman Aircraft Co.'s new S2F-3 ASW "Hunter-Killer" Aircraft. This system displays input data from anti-submarine detection equipment and "pinpoints" target location.

Computers are being turned to weather forecasting through a new automatic meteorological station developed by The Siegler Corp.'s Olympic Radio and Television Div. This electronic data processing system, the AN/FMQ-5, takes meteorological information from both electronic sensing devices and human weather observers and stores, computes and distributes these data as needed over telephone lines or by radio.

Pulsed Neutron Generator

Completed by the Matsuda Research Lab. of the Tokyo Shibaura Electric Co., Ltd., it will be installed at the Japan Atomic Energy Research Institute. Capability ranges from 10 to 100 billion neutrons.

An electrical system which will be used in checking out and launching the Saturn booster has been developed by the Guidance and Control Div. at the NASA George C. Marshall Space Flight Center. Monitoring over 100 functions, the system will stop the launch sequence in the event of malfunction, otherwise it performs some 50 sequential functions within the Saturn to achieve liftoff.

Station WFAA-AM-FM-TV's new Communications Center is equipped with a GE 4-channel stereo audio system. It provides for live broadcasting, network programming, recording and rehearsals at the same time. The system's audio nerve center is a transistorized stereo master control switching facility for AM, FM and TV sound. It consists of 11 stereo or 22 monophonic input channels.

Texas Instruments Incorporated has been awarded a contract from the Air Force Missile Test Center (AFMTC), Patrick Air Force Base, Fla., for PCM data recording systems. The completely transistorized ground equipment will process, record, and display PCM data in any of the standardized formats or from systems with special formats such as Minuteman and Polaris.

The first operational member of a new family of advanced anti-jam search radars built by GE will be erected at Point Arena, Calif. The largest rotating antenna system to be installed on the West Coast, it will be used to detect and furnish warning against supersonic aircraft and air-breathing missiles. It is 125 ft wide and 50 ft. high.

Collins Radio has announced initial deliveries on a $1,008,990 order for airborne high freq. SSB systems to the British Ministry of Aviation. The system, HF-103, provides world-wide as well as short range communication in the 2-30 MC range on 28,000 directly selectable channels.

The unit described here was originally designed for recording gas meter readings. However, the design thinking explained lends itself very well to other flow meter applications. It has many benefits such as eliminating human reading errors, recording from a remote position, and supplying data on punched cards.

At Remote Locations . . .

Recording Flow Meter Readings

By PAUL C. CONSTANT, JR.
Systems Engineering Sect.
Midwest Research Inst.
425 Volker Blvd.
Kansas City 10, Mo.

TODAY domestic gas consumption data are obtained by visual means. A utility employee makes his rounds, periodically, on a prescribed route, reading each meter's visual dial indications of gas consumption. He records his observations on a prescribed form. This recorded data of gas consumption form the basis for billing the customers for their quantity of consumption of the company's product.

The present method of obtaining gas consumption data is practicable; but it has some obvious disadvantages. Two of these disadvantages are that the method of obtaining consumption data is (a) time consuming and (b) it requires visual-manual recording techniques.

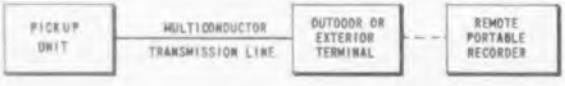


Fig. 1: Block diagram illustrates, basically, the recorder system

Basic System

The consumption data registered on the gas meter is visually displayed decimal information (Fig. 4). The normal units read are 1,000's, 10,000's, 100,000's, and 1,000,000's of cubic feet. Usually, the display consists of several dial plates, each having a dial hand sweeping a decimal-calibrated face plate. This allows the correct data to be ascertained at any time.

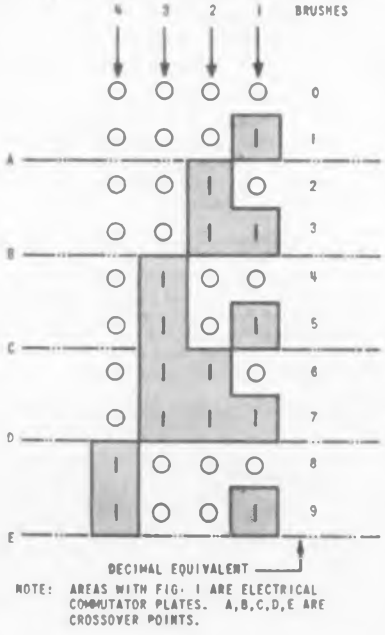
The system described here uses an electrical pickup device attached to each dial unit in the gas meter. These pickup units, with associated equipment, enable electrical signals to be sent (via a multiconductor cable) to a point remote from the meter where they are automatically recorded on a portable recorder.

The basis for the remote recording system is the commutator plates which are embedded in a drum unit. There is one drum unit attached to each dial shaft, affording a means to obtain gas consumption data as it is registered on the dial indicators. Since there are normally 4 units read, i.e., the thousands, ten thousands, hundred thousands and millions of cubic feet indicators, four drum units are required for each meter.

The complete system for automatically recording gas consumption data at a remote point is quite simple and is given in block-diagram form in Fig. 1.

As was noted previously, the visual display on the meter gives the gas consumption in the decimal system of counting. Although the pickup units employed essentially indicate shaft rotation (as do the

Fig. 2: Cross over regions on commutator plate. This method will give erroneous readings



visual dial indicators), the information transmitted to the portable recorder is in binary form and is based on a cyclic system (Gray code) of counting. The recorder accepts this binary information, and decodes and converts it to decimal form for presentation.

The System Used

Using the binary system of counting, it is possible to represent decimal numbers using zeros and ones. Table 1 gives the binary representation of decimal numbers from 0 to 15. By referring to Table 1, it is easily seen that 3 binary digits are required to represent the decimal digits, 0 to 8, and 4 binary digits (bits) are needed to represent decimal numbers of magnitude 8 through 15. Therefore, in order to read the decimal digits which are used in gas meters, a system containing four binary digits is required.

A necessary requirement of the counting system is that it is cyclic. This is because the dial shaft rotates continuously in the same direction (clockwise or counter clockwise), repeating the decimal cycle 0 through 9, each 360° of shaft rotation. In addition, the digits must follow a definite sequence. The sequence of binary numbers given in Table 2 can be used. However, such a sequence can give ambiguous readings. Therefore the sequence shown in Table 3 is used.

To see how ambiguities in readings come about using the sequence of binary numbers given in Table 2, a commutator plate using this sequence as a basis for its design is shown in Fig. 2. Looking at the crossover points A, B, C, D and E (Fig. 2), it is readily seen that the brushes can be in positions such as to give incorrect readings. For example, at crossover point A, brush 1 can be in electrical contact with the commutator plate at the same time brush 2 also is in contact with it, thus indicating the decimal reading of three instead of one or two. Similar situations occur at the other crossover or boundary points B, C, D and E. The reason for the ambiguities is that there is more than one change in bits of information between consecutive numbers in the sequence. It can be noted that at the remaining crossover points, those other than A, B, C, D and E, there is no chance for ambiguities. This is because there is a change of only one bit when advancing from one digit to the next in the sequence. Consequently, a sequence of numbering is required where there will be only one bit change in advancing digit by digit in the number sequence. Such a sequence is given in Table 3, and is the basis for the commutator plate used (Fig. 3).

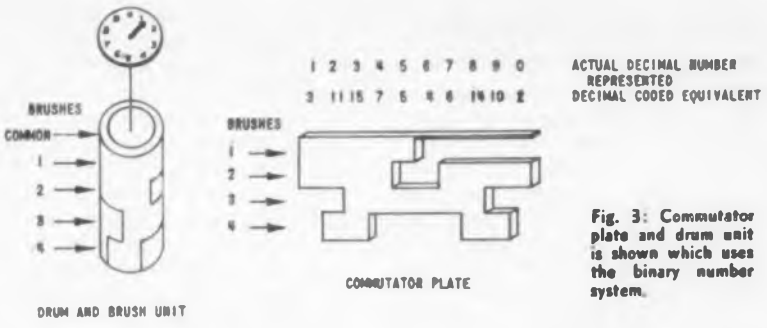


Fig. 3: Commutator plate and drum unit is shown which uses the binary number system.

The sequence of binary numbers which form the basis for the commutator plate design given in Fig. 3 is obtained from the binary equivalents (see Table 1) of the decimal numbers, 0 through 15. The sequence 3, 11, 15, 7, 5, 4, 6, 14, 10, 2 is used since it forms the cyclic pattern needed and there is only one bit change from number to number. Although this particular sequence does not give an apparent usable sequence of decimal numbers, it is quite workable. Hence the sequence 3, 11, 15, 7, 5, 4, 6, 14, 10, 2 is a coded representation of the basic binary information. This information is decoded and converted into the decimal sequence in the portable recorder.

Commutator Plate

The commutator plate or drum assembly is, in essence, the transmitting device. The electrical signals originate at the drum assembly and are transmitted, via a multiconductor cable, to a distant point.

The geometry of the commutator is quite important, and is based upon the cyclic system previously discussed.

Figure 3 shows a plane view of the commutator plate. This plate is a physical design of the cyclic system of binary numbers given in Table 3. The row of numbers directly above the plate represents the decimal equivalents of the binary numbers which are built into the commutator plate, i.e., the decimal digit 3 is the binary number 0011; the decimal number 11 is

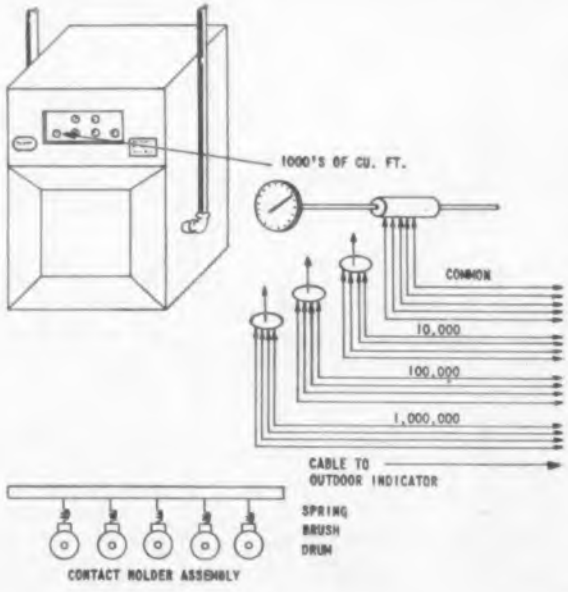


Fig. 4: Drawings illustrate the method of transferring stored information

Portable Recorder

(Continued)

the binary number 1011; etc. It is to be noted that the *ones* are represented by the metal forming the commutator plate. The *zeros* are represented by the absence of metal. The top row of decimal numbers above the commutator plate in Fig. 3 are the decimal digits (0 through 9) which actually result in the print or punch out at the recording end.

Pickup Units

The pickup units (Fig. 3) consist of one commutator drum per digit recorded and 5 brushes per drum.

Each electrical insulator drum is secured to a dial indicator shaft of the meter. Embedded in the drum are the electrical commutator plates, commonly connected (Fig. 3). The surfaces of these plates are flush with the outside surface of the insulator drum. Figure 4 shows the method of transfer of stored knowledge to the recording device. Required is a spring-loaded, 5-brush assembly (the fifth brush is used for the common or return path) per drum. These 5 brushes are in continual contact with the surface of the drum and wipe the commutator plate as the commutator drum rotates. By this means, 5 contacts are required to transmit the angular position of the digit shaft on the meter to an outside location, the information actually being in binary form.

The transmission cable is a multiconductor transmission line of nominal length. The number of conductors are one plus four times the number of digit shafts employed. The extra conductor is the common conductor. Each group of 4 conductors is used for the transmission of a decimal digit of information. Thus the recording system employs a 17 conductor cable for the transmission of 4 decimal digits of information.

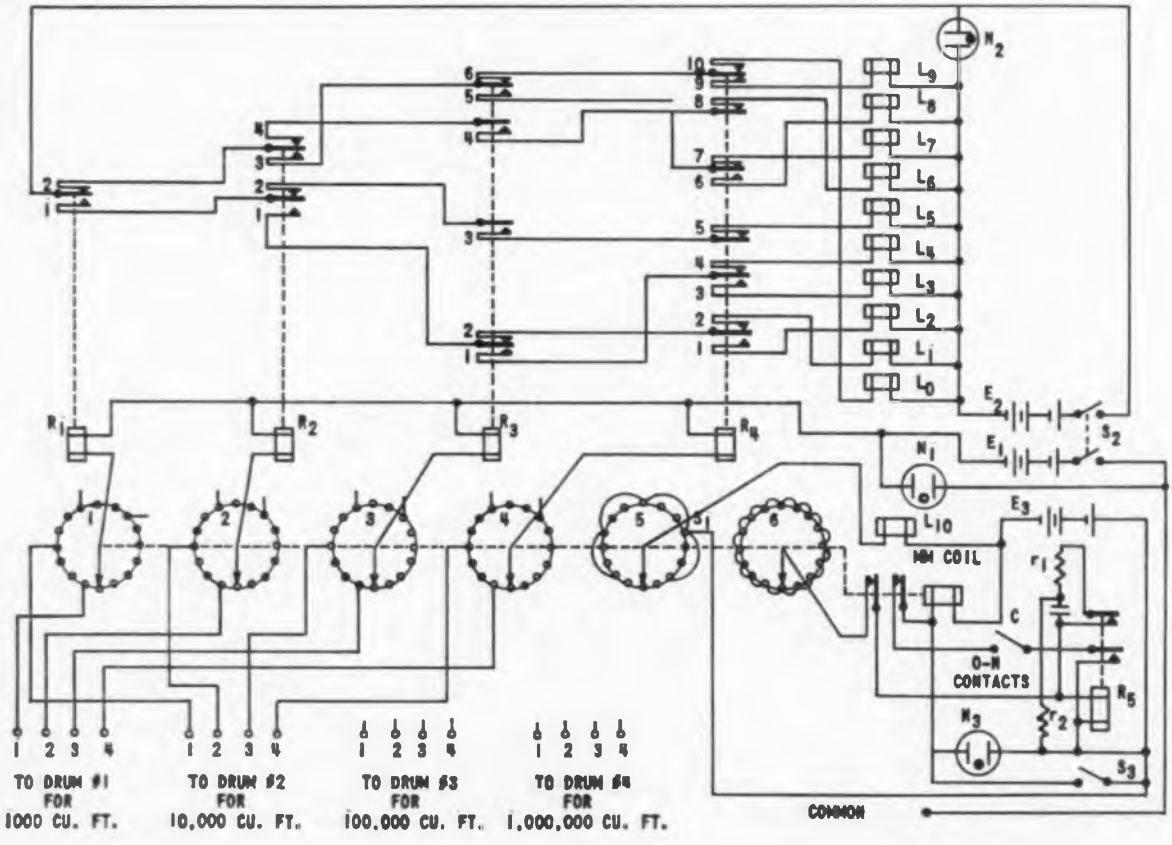
The Recorder

The recorder is a portable, lightweight, relatively inexpensive, electrical-mechanical device which automatically records (prints or punches) gas consumption data on a card. The unit is self powered with batteries and easy to operate. A schematic diagram of the electrical circuitry is given in Fig. 5.

Basically the recorder consists of (a) a decoder-converter, (b) a power source, (c) an automatic control unit, and (d) the read-out mechanism. In addition, there are control switches, indicator lights, and mechanisms for card feeding.

A card is placed into a feed mechanism which is controlled by solenoid L_{10}. When S_3, a manually operated momentarily-on switch, is depressed, and S_2 closed, the recorder automatically records the meter reading. The reading is punched (can be punched and/or printed) on a card in decimal form via solenoids L_0 through L_9 (which punch decimal digits 0 through 9, respectively). These solenoids receive power through the decoder-converter unit which consists of relays, R_1, R_2, R_3, and R_4. These 4

Fig. 5: Schematic diagram of the portable recorder shows simplicity of design.



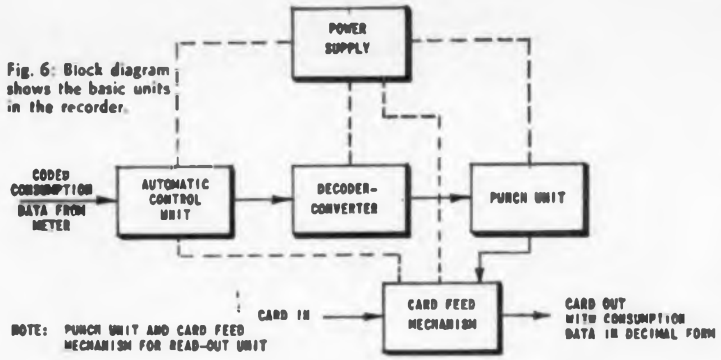


Fig. 6: Block diagram shows the basic units in the recorder.

relays are activated by electrical signals from the drum pickup units which are controlled by S_1.

The stepping switch, S_1, is used so that the lines from the four drum units stationed at each meter, may be switched in the proper order. By this means, the 10 punch-solenoids (L_0-L_9) are used for each decimal digit punched, thereby reducing the number of punch-solenoids required.

The system is powered by 3 batteries, E_1, E_2, and E_3. Source E_1 is for the card feed mechanism; E_2 supplies power for the punch-solenoids; and E_3 supplies power to pulse S_1 and the relays in the decoder-converter unit.

A time delay circuit r_2, C, adjusts the stepping time of S_1 so that the proper timing sequence for the events of card feed and punching may be obtained. The relay R_5 serves as a control unit in the delay circuit and the pulsing circuit (which automatically advances wipers of S_1).

The lights N_1, N_2, and N_3 serve to indicate power operating conditions for the different circuits.

The motor magnet (MM coil) is connected through the interrupter contacts (of the MM coil relay) and off-normal contact springs to a homing circuit which is under the control of relay R_5. Relay R_5 is normally operated while the switching circuit (steps wipers on S_1) is in use. The off-normal springs (an integral part of S_1) close when the wipers are stepped away from home position and prepare a circuit to the magnet (MM coil). The stepping pulses from E_3 are controlled by terminal deck No. 6 of S_1 and relay R_5, and will allow S_1 to home automatically, releasing O-N contacts in the home position.

The decoder-converter unit accepts signals from the drum units at the meter through S_1. The signals are generated as a result of power being supplied to the commutator plates from source E_3. Depending upon which brushes are in contact with the commutator plate on a drum unit, one or more of the relays R_1-R_4 will be activated, thus allowing the correct solenoids (one of the L_0-L_9) to be energized through the proper relay contacts of the decoder-converter unit. As an example, on drum No. 1 of a meter, the binary number 0011, is read, therefore brushes 1 and 2 allow an electrical signal (via S_1) to activate R_1 and R_2. Contact 1 of R_1 and contact 1 of R_2 close, allowing power to be supplied to L_3 through contacts Nos. 1 of R_1 and R_2 and through contacts Nos. 2 of R_3 and R_4. Hence, the binary information from the meter is converted to decimal form and punched on a card for a permanent record from which billings may be made.

The device described will permit a reading of domestic utility meters at a location remote from the meter itself, usually outside the building or home of the consumer.

Electrical Components in Recorder

R_1, R_2, R_3, R_4—D.C. relays for decoder-converter.

L_0, L_1, L_2, L_3, L_4, L_5, L_6, L_7, L_8, L_9—Card punch or print solenoids.

L_{10}—Card positioning solenoid.

S_1—Stepping switch.

S_2—Power switch, DPST—manual operation.

S_3—Momentarily on—manual operation.

R_5—Control relay in automatic switching circuit.

MM Coil—Motor magnet of S_1.

r_1—Discharge resistor.

r_2—Time delay resistance.

C—Time delay capacitor.

N_1, N_2, N_3—Indicator lights.

E_1, E_2, E_3—Battery power sources.

O-N Contacts — Off-normal contact springs, close as S_1 Steps off "Home" position.

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

It will substantially reduce the time required in securing access to the utility meters which are often located in remote locations in consumer buildings. In addition to the convenience this system offers the consumer, it is estimated that the costs entailed in the present systems for reading meters could be essentially cut in half.

Table 1

Binary Representation of Decimal Numbers

Decimal Numbers	Binary Equivalent
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Table 2

Binary Equivalence of Decimal Digits Used in Gas Meters

Decimal Digit	Binary Equivalent
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

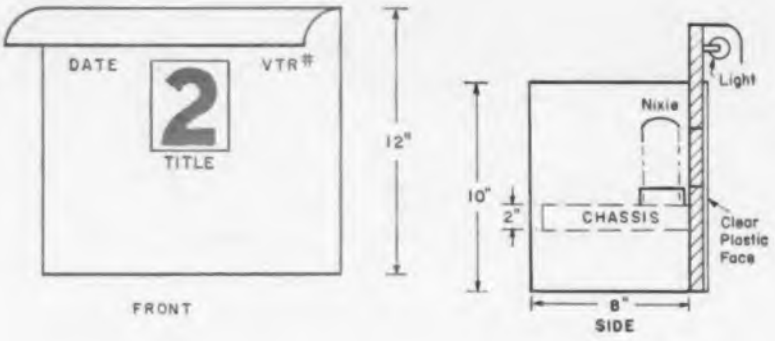
Table 3

Binary Sequence of Numbers Used

Binary Numbers	Decimal Equivalent
0011	3
1011	11
1111	15
0111	7
0101	5
0100	4
0110	6
1110	14
1010	10
0010	2

CUES

for Broadcasters



Two views of cuing unit are shown. A grease pencil can be used to write on the plastic face.

Construction Details For . . . . . .

A Video Tape Cuing Unit

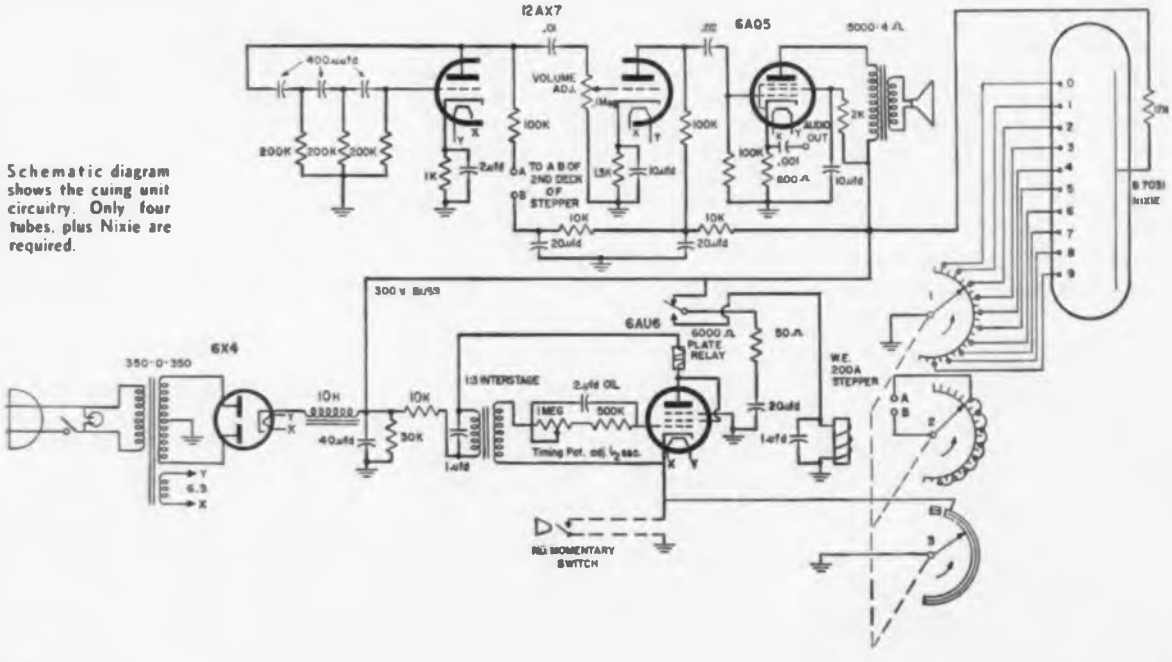
By STAN DAVIDSON
Engineering Dept.
Meredith WOW-TV
3507 Farnam St.
Omaha, Nebr.

AN adequate cuing system for a well integrated video-tape program is an absolute necessity. The conventional methods of cuing consist of either putting an audible cue on the sound track, or backtiming from the beginning of the first video with some sort of timer or timing leader. These methods, while serving their purpose, can sometimes be inaccurate.

The following describes a unit which, when picked up on a television camera and recorded on video-tape, will give on playback a series of cues similar to that of academy timing leader used in cuing up film.

The cue consists of a video numerical countdown with a 500 cycle, half-second tone burst from nine seconds. On play back this allows the video-tape machine to

(*Continued on page* 168)



Schematic diagram shows the cuing unit circuitry. Only four tubes, plus Nixie are required.

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Wire Stripping Plier
ST55

Long Nose Special Wire Cutter
LC56

WASHINGTON News Letter

AUTOMATION KEY THEME—The engineering sessions at the National Association of Broadcasters convention in Washington, May 7-10, will be keynoted with discussions and presentations centered on automation and miniaturization, particularly transistorized equipment. The sessions may have the largest attendance of engineering officials from the radio and television fields in NAB's history. There will be more than 50 manufacturing exhibits, the largest number in broadcast convention records. According to NAB officials, the technical reports will present a number of significant developments affecting future progress of radio and television.

OUTSTANDING SPEAKERS—For the first time in NAB convention history, the engineering conference will have its own luncheon speakers. The trio who will appear are outstanding authorities in their fields. Henry Loomis, Director of the Voice of America of the U. S. Information Agency, will speak at the May 8 luncheon. Major General J. B. Medaris, former chief of the Army's ballistic and space program and now President of the Lionel Corporation, will be the speaker May 9. Dr. Edward Teller, atomic scientist, "father" of the hydrogen bomb and now Professor of Physics at the University of California, will address the final engineering conference luncheon May 10.

SELF-REGULATION AND FUTURE — Two key themes underlie the management sessions of the NAB convention, both in the presentations of the speakers and in the meetings of radio-television network and station executives. They are: self regulation instruments through the NAB codes to improve the status of broadcasting and the future policies of the Federal Communications Commission regarding television allocations and programming. NAB President, former Florida Governor LeRoy Collins, will preside over this years convention. He will deliver the keynote address at the May 8 opening general assembly, and the luncheon address that day. FCC Chairman Newton Minow will make his first major address to the broadcasting industry's management and station owners at the May 9 luncheon. On the final day, May 10, Chairman Minow and his fellow Commissioners will participate in a question-and-answer session of the NAB management and engineering convention delegates.

VIEWS ON SPACE—The FCC has asked communications industry organizations for their views on legal and policy questions which may arise if the Commission decides to authorize a single or limited number of commercial space communications systems. These views are to be submitted by May 1. This was the third such inquiry into space communications questions by the Commission in a period of less than a year. The FCC propounded as basic issues—what plan of participation is best designed for access to, and non-discriminatory use of, satellite communications facilities by existing and future international communication common carriers, and the participation of manufacturers of satellite communication and launching equipment.

NO SPACE MONOPOLY—A monopoly in satellite communications is not sought by the Bell System. The FCC has been advised by the American Telephone & Telegraph Co. that it desires only "the opportunity to employ private initiative, management and capital in the public interest and under publice regulation in a manner wholly consistent with traditional public policy with respect to international communications." The Commission was also informed by AT&T that the "low-orbit system," proposed by AT&T is "the preferred space communications system at this time since the technology is well advanced for the low-orbit satellite."

EIA MEDAL OF HONOR—The Electronic Industries Association is awarding its 1961 Medal of Honor to Dr. Jerome B. Wiesner, President Kennedy's special assistant and advisor for science and technology, for his "distinguished service contributing to the advancement of the electronics industry." Dr. Wiesner is now on leave as Director of the Massachusetts Institute of Technology Research Laboratory of Electronics. He was also chairman of the steering committee of the MIT Center for Communication Sciences established in 1958 to study both man-made and natural communication systems.

National Press Building
Washington 4

ROLAND C. DAVIES

GOVERNMENT PROCUREMENT POLICY of withholding 20% of costs incurred by contractors fulfilling certain categories of cost reimbursement contracts until they had delivered end items has been rescinded. With the cancellation, contractors are now paid in full for their incurred cost as they accrue in work on future contracts of this type, and second, the military departments are authorized to pay present contractors the amounts currently deferred to the extent these contractors are willing to renegotiate their fee. It is estimated that some $175 million of deferred payments to contractors could be accelerated if contractors avail themselves of this provision.

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Bendix Bulletin

ANOTHER BENDIX FIRST! 120-VOLT, 110°C. DAP TRANSISTORS

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Type Number	Absolute Maximum Ratings				Electrical Characteristics Current gain	
	Vce Vdc	Ic Adc	Pc W	Tj °C.	hFE	@Ic
2N 1073	40	10	60	110	20-60	5 Adc
2N 1073A	80	10	60	110	20-60	5
2N 1073B	120	10	60	110	20-60	5
*BC 1073	40	10	60	110	20-60	5
*BC 1073A	80	10	60	110	20-60	5
*BC 1073B	120	10	60	110	20-60	5
B 1274	40	10	60	110	50-120	5 Adc
B 1274A	80	10	60	110	50-120	5
B 1274B	120	10	60	110	50-120	5
*BC 1274	40	10	60	110	50-120	5
*BC 1274A	80	10	60	110	50-120	5
*BC 1274B	120	10	60	110	50-120	5
**2N 1430	100	10	60	110	20 min. 30-120	10 Adc 5
2N 1651	60	25	100	110	20 min.	25 Adc
2N 1652	100	25	100	110	20 min.	25
2N 1653	120	25	100	110	20 min.	25

*The BC DAP transistor series uses Cerameterm ceramic-metal terminals for increased reliability.
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What's New . . .

Breadboards Speed Electro-Mechanical Design

LET'S start at the design engineer. In the early stages, after turning over various aspects of the project in his mind, the design engineer more than likely comes up with a rough sketch.

Normally the next step would be for the designer to prepare a scale drawing from the rough sketch. However, by using templates (available free of charge from PIC Design Corp.), this sketch can now be turned over to a draftsman or engineering assistant. He can quickly furnish a full-scale drawing. After the drawing has been finished, the parts are ordered.

The first step in assembling a model is to assemble the leg posts to the slotted mounting plate. This is accomplished by using wing nut-screws. Next, spur gears, couplings, differentials, clutches, etc., are fitted to the shafts of electrical components. The electrical components are then secured in component hangers.

Electrical components are mounted in the approximate position indicated on the drawing. The thumb screws are not securely tightened until all equipment has been mounted and can be accurately aligned. General practice is to start installing at one side of the board and work across.

The design engineer turns a rough sketch over to a draftsman who uses templates supplied free to make a completed drawing.

Breadboard parts are assembled according to design drawing. Design can be easily changed if system does not operate as desired.

Again working across the board, shafts are fitted with gears, shaft hangers, and other components such as differentials, dials, cams, etc., and mounted in place according to the drawing.

Once all the equipment has been assembled and placed on the board, it is aligned with a square using the machined edges of the slotted plate as a guide. The thumb screws are then securely tightened.

Terminal strips are available to facilitate wiring of electric circuits.

Once the breadboard has been completed it can be operated under all electrical or mechanical conditions which might be encountered in practice. Weak points can be corrected, improved spacing arranged and a complete range of operating characteristics obtained for evaluation and study.

Depending on the particular requirements, the project can be followed further. Let us assume that this unit is to be built in production of approximately 100 systems. One can now, from the tried, tested, and approved schematic layout and breadboard, design this unit into a package, depending on space and specification requirements.

After the production design layout is completed, detail drawings of the few special parts, such as plates, castings, etc., are made, and a bill of materials provided which lists all standard stock items and special parts, hardware, etc.

Finally, one or two prototype units should be made in order to prove out the final production design, tolerances, fits, and mechanical clearances.

After the prototype unit is completed and tested, all corrections are made, and production manufacturing procedures finalized. All components can be ordered from stock. No delays are encountered in waiting to tool up for and produce special parts; costs are on a mass production basis.

Original production costs have been cut as much as 50% on many previously designed systems and redesigned units as a result of using stock precision instrument components.

Material for this article was supplied by PIC Design Corp., 477 Atlantic Ave., East Rockaway, N. Y.

Illuminated Indicator Switch

A NEW illuminated push-button switch for a wide range of electronic and electrical control applications has been introduced by Sylvania Electric Products Inc. Among the applications of this device are: electronic instruments and devices, detector equipment, remotely controlled motor installations, conveyor installations, electric activating equipment, and as an indicating switch on any type of electric equipment of suitable load.

The new switch accepts Sylvania indicator lamps of 4, 6, 10, 12, 16, 24, 28, and 48 volt sizes. A change in circuits merely requires a change in lamps. The lamps and also the colored push buttons can be replaced from the front of the mounting panel. The translucent nylon caps come in red, yellow, green, white and blue.

The construction of the switch incorporates four contacts for separate indicating and load circuits and it is rated at 5 amps capacity at 250 volts. The spring loaded mechanism has a one million index life. The terminals are "78" Series Amp Faston Connectors which are numbered to facilitate wiring. The switch is a single pole, double throw switch with wiping contacts.

Sylvania's new illuminated pushbutton switch incorporates four contacts for separate indicating and load circuits (right). Lamps can be replaced from the front of panels (below).

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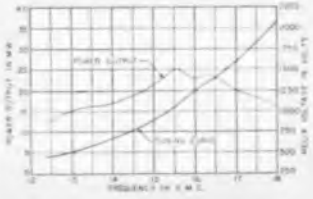
Oscillating at 18 kmc and delivering 15 milliwatts of power, a Stewart OD 12-18 BWO can be expected—and is **guaranteed**—to offer a minimum of 500 hours of high-performance service. In actual use, Stewart backward wave oscillators normally outlive their guarantees many times over.

Stewart BWOs offer particularly attractive possibilities as a source of microwave signals for microwave swept signal generators, and for receivers and transmitters requiring rapid programmed swept signal excursions, because of their excellent wide-band, electronic tunability characteristics. Performance curves for the OD 12-18 are shown here.



Whether or not you're interested in 3.24 x 10^{16} oscillations, we think you'll want to see a copy of the specification sheets for the complete line of Stewart BWOs. Drop us a note today.

STEWART ENGINEERING CORPORATION

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Tape Cuing *(Concluded)*

be stopped on any desired number from nine down, with the number selected indicating the remaining time before the start of the show. Six seconds is generally used. This leaves ample time for the videotape machine to come up to speed.

The countdown number appears in the center of an identification card. The card also includes the title of the show, take number and play back date.

In practice the countdown is recorded by a stand-by camera until the number "two" appears. At "two" black is taken while the count continues on the camera monitor. At "zero" the show is switched up and the program recorded. This allows accurate timing between the starting of the tape machine and the beginning of the show.

The countdown circuit combines an audio oscillator with a computer-type readout indicator (Burroughs Nixie 8703I) which has over a two inch display of numbers from zero to nine. The Nixie tube requires 300 vdc for proper operation and gives ample light output for pickup on an image orthicon camera.

Operation of the circuit is as follows. Accurate half-second timing pulses are generated by a 6AU6 blocking oscillator when the start button is depressed. A relay in the plate circuit of the 6AU6 discharges a 20 mfd capacitor across the stepping relay. This keys the 500 cycle 12AX7 phase-shift audio oscillator on and off, and also controls the Nixie indicator tube.

The stepping relay, which is a Western Electric 200A, has six decks with 22 positions. Since the first two positions are not used, the relay must step for one second before the countdown starts. Thereafter every other position is used, allowing counts from nine to zero with half-second blanks between counts.

Ground is applied to the Nixie tube cathodes in proper sequence by the rotor-wiper contact of the first deck. This completes the circuit ionizing the gas surrounding the numeral, causing it to glow. The rotor of the second deck of the stepping relay is connected in the plate circuit of the audio oscillator, switching plate voltage to the tube coincident with the number. Every other position is paralleled down to two. The audio is stopped at two to prevent any chance of the tone getting on the air. It is then amplified by a 6AQ5 and fed to a speaker mounted in the unit for pick-up on a mike. An output is also available from the cathode circuit for feeding tone directly into an audio console.

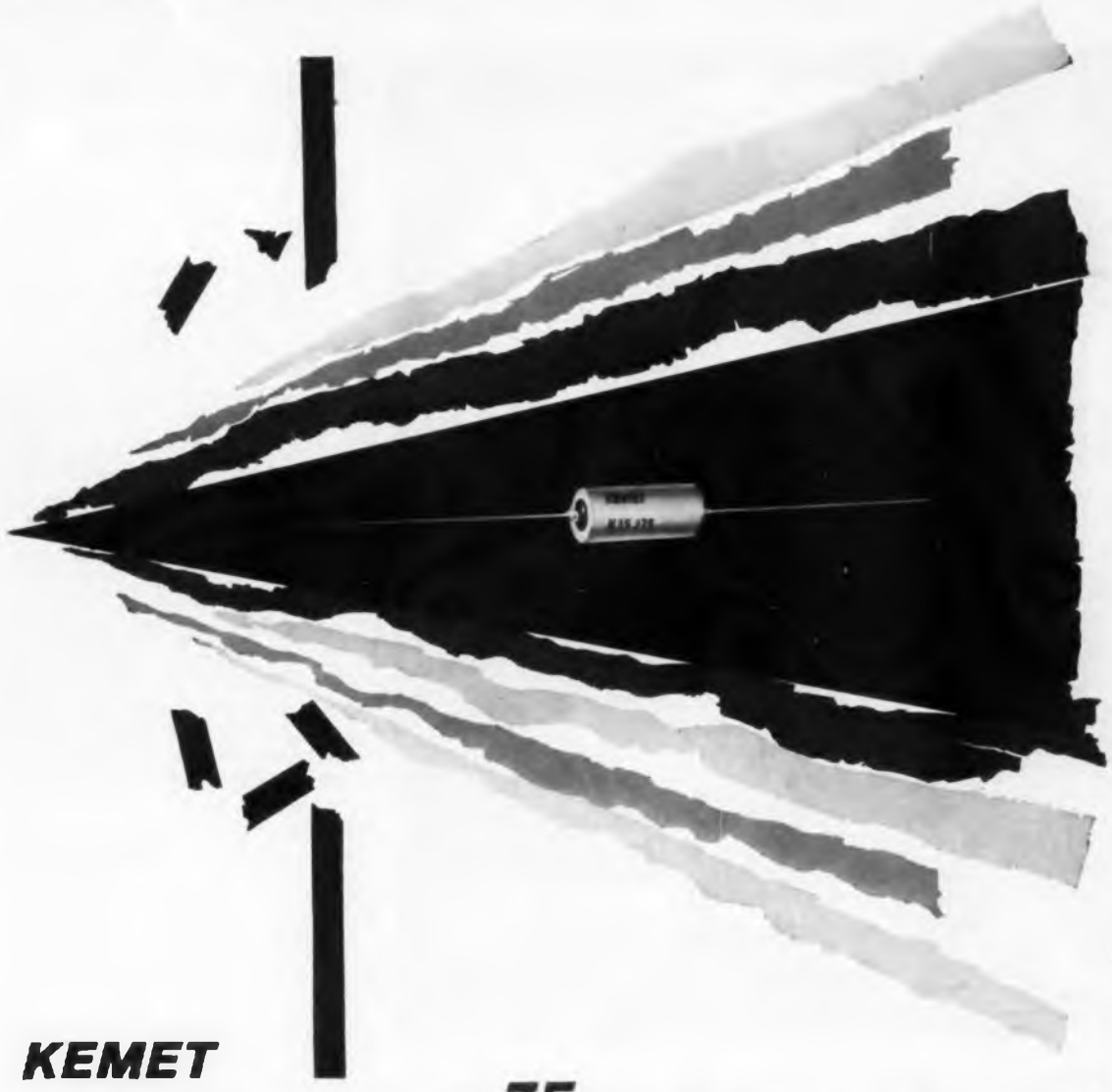
Several of the decks on the stepping relay are of the continuous wiping type with an "off" position. One of these is used to ground the cathode of the 6AU6 timing generator, allowing the stepping operation to proceed until the "off" position is reached. Depressing the start button shorts the cathode until the continuous wiper completes the circuit. The relay has several unused decks which could be used to directly key the oscillator in the cue channel of the tape recorder.

The entire unit is constructed in an 8x10x10 box with a two inch chassis attached to the front panel. All controls are mounted on the front. The Nixie tube is mounted to the rear and displays through a hole cut in the back panel. The title board is attached to this back panel. This leaves the tube slightly recessed which helps to reduce stray light.

A strip light is mounted above the title board to provide illumination for the necessary data accompanying the cue. A clear plastic face is placed over the title board to allow for easy cleaning between uses. The unit can be placed near a camera on a tote board. The start button is on the end of a short cable which allows the operation of the unit from a position near the camera.

Paper or oil capacitors should be used in the grid circuit of the 6AU6 since this capacitor, along with the timing potentiometer, adjusts the frequency of the blocking oscillator. The plate circuit relay is a SPDT sensitive, high resistance type with five amp contacts.

After construction the time can be accurately set by observing the pulses at the plate of the 6AU6 on a scope with a calibrated sweep or by timing the count with an accurate stop watch.



KEMET

breaks through with new 75 v. Solid Tantalum Capacitor...

highest rated working voltage unit of its kind available today!

CAPACITANCE VALUES: .1 to 15. Microfarads • TEMPERATURE RANGE: −55 to +125° C.

A new frontier in capacitor technology has been opened by "Kemet's" successful achievement of a new 75-volt solid tantalum capacitor!

"Kemet's" breakthrough comprises 14 catalog types, hermetically sealed in the four case sizes specified in MIL-C26655A for CS12 and CS13 styles . . . providing Standard E.I.A. capacitance values in tolerances of ±20%, ±10%, and ±5%.

"Kemet's" latest addition to its complete line of solid tantalum capacitors supplements its popular J-Series . . . available in capacitance values ranging from .33 to 330 microfarads and working voltages of 6, 10, 15, 20, 35, and 50.

Solid construction and utmost operating dependability have made "Kemet" tantalum capacitors the leader in their field. They can be specified and installed with confidence, because they have been subjected to the most exacting tests for life, temperature, humidity, vibration, and acceleration.

For data on "Kemet's" new 75-volt J-Series tantalum capacitors, write for Bulletin #3B to Kemet Company, Division of Union Carbide Corporation, 11901 Madison Ave., Cleveland 1.

"Kemet" and "Union Carbide" are registered trade-marks for products of

KEMET COMPANY

UNION CARBIDE

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MIDDLE ATLANTIC, Cleveland 1—R. G. Sidnell & Co., 1229 W. Lake Ave.
South Whitley, Ind.—Warner, Kesler & Associates, P. O. Box 338

MIDWEST, Chicago 45—D. Dolin Sales, 3553 West Peterson Avenue

MINNESOTA, Minneapolis 19—Stan Clothier Co., Inc., 12 West 58th St.

SOUTHWEST, Dallas, Texas—Ammon & Champion Company, 2714 Bomar Street

NORTHWEST, Seattle 8—Samuel N. Stroum Co., Inc., 621 Michigan Street

ROCKY MOUNTAIN AREA, Denver 26—Barnhill Associates, 1170 South Sheridan

WEST COAST, San Marino, Cal.—G. S. Marshall Company, 2065 Huntington Drive

New narrow ultra-thin strip—the smallest strip produced today in quantity—is now available to meet specifications for microminiaturization in electronic and magnetic systems. Moly Permalloy and other high permeability alloys in thicknesses down to .0001" and .015" widths are available in production quantities. For special applications, magnetic strip only .005" wide can also be produced commercially.

This unique material is used in precision magnetic components such as twisters and tape wound bobbin cores for pulse transformers and magnetic amplifiers.

Rod, bar, foil and wire can also be supplied to meet close dimensional tolerances and physical requirements. For further information write today for Technical Data Sheet 501—Dept. EI-5.

HAMILTON
WATCH COMPANY / **Metals and Electronics Division**
Lancaster, Pennsylvania

Tube-cavity Combination

A SIGNIFICANT advance in design of microwave equipment is seen in the development of a tube-cavity combination by General Electric's Receiving Tube Department. The developmental C-band device operates over the 5250 to 6050 megacycle frequency range with a power output of 4 to 10 milliwatts. It is designed to act as a very stable oscillator, however the output coupling can be increased to provide adequate power to pump a parametric amplifier.

The new device may eventually replace small klystrons. The success achieved with the C-band device suggests that integral tube-cavity combinations may be designed for X-band applications.

Maintenance procedures requiring replacement of tubes in microwave equipment will be simplified by the use of a tube-cavity combination. In the field, all that will be required is to replace the old tube-cavity with a new one, and to make a simple one-knob frequency adjustment.

Advantages of the tube-cavity oscillator over a klystron or magnetron are that it has relatively simple power supply requirements, greater frequency stability, and is physically simpler to install and adjust.

The development and design work is scheduled for early completion.

Fluxless Solder

A NEW low heat fluxless solder, Tin-a-lum, which can join any metal with the exception of cast iron has been developed. It can be used with almost any type of heat except a flame of sooty nature. The material to be joined is first heated to approximately 210 degrees C., and the solder applied without the use of the flame. The heat in the metal is used to melt or fuse the Tin-a-lum to the parent metals. When applied proper-

(*Continued on page* 172)

New

CORNING CYFM CAPACITOR has reliability you can see

You get total protection against environment for less money than ever before

The new Corning CYFM capacitor gives you reliability at a markedly lower cost than that of any like capacitor.

The CYFM goes far beyond MIL-C-11272B specs. It has proved its performance through more than 3,000,000 hours of testing. It took a 50-day MIL moisture test and a 96-hour salt spray test with no measurable effects. We stopped testing only when it became evident that no more significant data could be developed. The CYFM went through other tests, with solvents, fluxes, boiling salt, and steam, to make sure it is the most completely sealed capacitor you can buy.

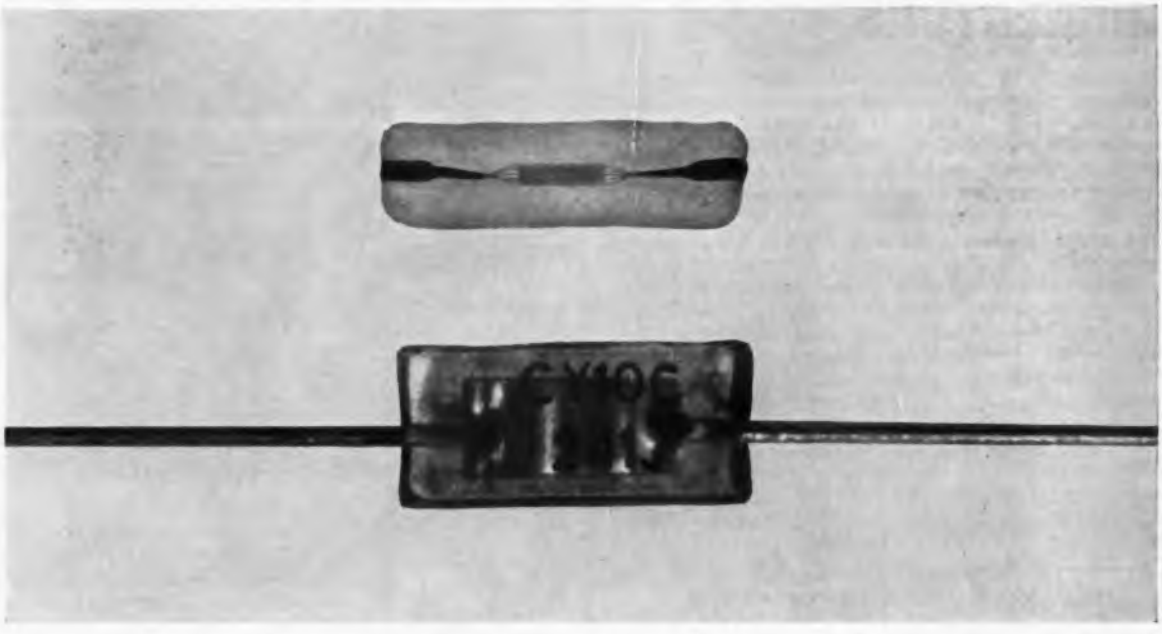
You'll see why the CYFM can take such torture when you check its design. We stack alternate layers of stable ribbon glass and aluminum foil. Then we weld the foils to the bead-terminal assembly, which has a glass bead sealed to the Dumet wire lead. With heat and pressure, the entire capacitive element is frozen in glass for complete protection against environment and for structured protection against physical shock.

True glass-to-metal seals at the weld area and along the leads bar moisture. The seal of the leads to the glass shifts stresses from the leads to the entire monolithic unit, guarding the capacitance area. Of course, you get electrical performance to match this environmental stability, since the CYFM has our glass-foil capacitor construction.

The CYFM is machine made . . . each capacitor is the same as every other, to give you uniformity which hand production cannot match.

You can get immediate delivery on the CYFM in two types. The CYFM-10 gives capacitance values from 1 to 300 *pf*. The CYFM-15 provides values from 220 to 1200 *pf*.

For the rest of the story on this capacitor, send for our data sheet. Write to Corning Glass Works, 546 High Street, Bradford, Pa.



This is the CYFM capacitor. 6 times actual size. The dark areas between the ends of the glass and the capacitance element are your visual proof of the complete glass-to-metal seal.

CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.

Circle 137 on Inquiry Card

Why "tool-up time" is all the time for CONTINENTAL CONNECTORS

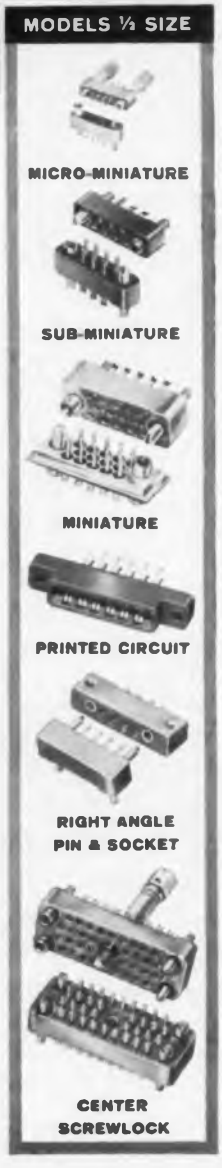
Continental Connector makes a wide variety of standard connectors in the types shown in the panel. Naturally we are pleased when our customers use these proven types. However, with the constant development of new equipment for missiles, aircraft, computers and communications, customers often need special connectors outside the specifications of our catalog line.

When this happens to you, why not take advantage of Continental's many years' experience designing and developing new connectors for the biggest names in the electronics field. In Continental Connector you will find a leader anticipating the precision connector requirements of a fast-moving industry that demands proven reliability under the most exacting environmental conditions. Our tool room (pictured above) can "tool-up" on short notice to produce new dies for your special connector applications.

Next time you are faced with a connector design or production problem, try Continental Connector, and see how our finished product measures up to your critical electrical and mechanical specifications. A condensed catalog of our complete line is available free on request. Write to:

Electronic Sales Division
DeJUR-AMSCO CORPORATION
Northern Boulevard at 45th Street, Long Island City 1, N. Y.
Exclusive Sales Agent

CONTINENTAL CONNECTOR CORPORATION
AMERICA'S FASTEST GROWING LINE OF PRECISION CONNECTORS



(*Continued from page* 170)

ly Tin-a-lum has good machineability. The finish obtained is much the same as the parent metal.

The greatest danger with aluminum is corrosion. Tests show that Tin-a-lum is less corrosive than aluminum. Where it is placed on the parent metal the risk of corrosion is less likely. The main causes of corrosion have been found to be overheating the parent metal, especially rolled aluminum and light gauge materials. These tend to lose their protective coating and then become more liable to corrosion than before. The other danger is the use of an oxidizing flame. To help the layman and others, Tin-a-lum has been produced to be used with a soldering iron.

Metals including aluminum and its alloys can now be soldered with an ordinary soldering iron and without the use of flux.

Tin-a-lum is a product of Metals for Industry, Inc., Jersey City, N. J.

New Hawaiian Cable

Lenkurt Electric's Type 23A D A T A T E L telegraph multiplex equipment has been selected for use on the new 1,900-mile Hawaiian cable. It will be used for out-of-band supervisory signaling and dialing. Voice circuits on the cable employ the new "TASI" technique (time assignment speech interpolation), and can handle about twice as many channels as would be possible otherwise.

Type 23A uses frequency shift modulation, is fully transistorized, and operates at 80 bits per second, or 100 wpm. Due to comparatively narrow 120-cycle spacing between channels, 23A will permit more channels in a given band. In this case it provides six additional channels.

Preserving Diagrams

Kenmore Sales Co., Lowell, Mass., can take diagrams and laminate them to a plaque which will have an indestructible surface. The surface will withstand all kinds of stains, abrasions, weathering, water and yellowing. It will last in its original state for longer than the equipment. There are certain limitations as to the type of paper which can be preserved, but none on size.

← Circle 138 on Inquiry Card

SILICON NEWS from Dow Corning

The Untouchables (Part 4)

Specify Crucible Charges of Deposited Hyper-Pure Silicon

Pre-packaged single piece crucible charges . . . in sizes and weights to meet the exact requirements of your Czochralski crystal growing equipment . . . are now available from Dow Corning.

Accurately Pre-weighed, these single piece crucible charges assure easy handling . . . smallest surface area . . . highest purity . . . an exceptionally clean melt and a savings in crucible costs.

High Quality is inherent in Dow Corning crucible charges. The *deposited* polycrystalline silicon in these charges has never touched a mold. Result — highest purity.

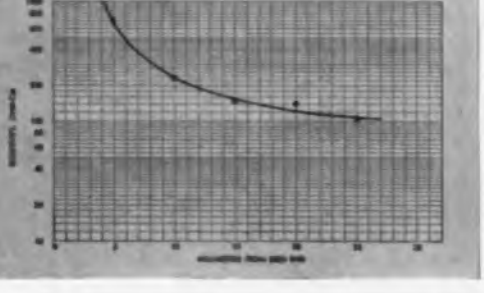
This High Purity means consistently higher quality crystals — simplifies doping procedures — increases device yield. Typical resistivity of N-type crystals grown from Dow Corning prepackaged crucible charges is greater than 100-ohms centimeter for 80% of the crystal; maximum boron content, 0.3 parts per billion atoms; maximum donor impurity, 2.0 parts per billion.

Now You Specify the Weight and Diameter, up to 38 mm (about 1½"), best suited for each crucible of your Czochralski crystal growing machines. Your crucible charges will be supplied in the appropriate length to provide the exact weight you require in just one piece.

Protective Packaging guards initial *deposited* purity right through crucible charging. Charges are individually wrapped in special cellophane, and sealed in airtight polyethylene envelopes to assure untouchable purity.

Whatever your need — deposited silicon crucible charges; polycrystalline rod or chunk; high resistivity P-type single crystal rod; single crystal rod doped to your specifications — Dow Corning should lead your list of sources.

Profile of Crystal Grown from Pre-Packaged Charge



Free brochure — "Hyper-Pure Silicon for Semiconductor Devices." Write Dept. 3417.

HYPER-PURE SILICON DIVISION
Address: HEMLOCK, MICHIGAN

Dow Corning CORPORATION
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ELECTRONIC ENGINEERS
MATHEMATICIANS - PHYSICISTS

Current Positions Available For:

Program Systems Analysts

Will be responsible for the overall planning and supervision of computer programs. Will assign, outline and coordinate work of programmers and write and debug complex programs involving mathematical equations. Requires BSEE, Mathematics, or Physics, with experience in the operation and programming of the AN/FSQ-7N8.

Computer Programmers

To develop and/or analyze logic diagrams, translate detailed flow charts into coded machine instructions, test run programs and write descriptions of completed programs. Requires BS in Math. with programming experience on the AN/FSQ-7N8 preferred, although IBM 700 series will be acceptable.

Computer Operators

To maintain data reduction and utility tape files, card files and program listings. Will utilize the BTL version of the SDC compass utility system and aid programmers in program checkout. Requires BSEE, Mathematics, or Physics with experience in the operation and programming of the AN/FSQ-7N8 computer.

System Test Engineers

To plan, prepare and generate system test, data reduction and analysis specifications. Maintain liaison with the using agency. Resolve problems between the specifications, test methods and actual procedures in use.

Sub-System Engineers

To plan, prepare and generate specs for sub-systems tests and data reduction and analysis programs. Will be responsible for test instrumentation, personnel and other requirements to implement test design, and effect the liaison with programming, test instrumentation and testing personnel.

All qualified applicants will continue to receive consideration for employment without regard to race, creed, color or national origin

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As the pioneer in electronic field engineering, PHILCO's capabilities are now being integrated into the more complex field of systems engineering.

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D. E. DIMMIG, *Employment Manager*

PHILCO TECHREP DIVISION

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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

Defense Contracts Urged For Depressed Areas

Senator Jacob K. Javits (R-N.Y.), in presenting his latest analysis of defense contract awards said that prime defense contracts to high unemployment areas in New York State dropped by 60% during the last quarter of 1960.

Of prime contracts of $10,000 or more, twelve major and smaller New York State areas listed by the Department of Labor as having substantial labor surplus received only $36,579,000 during the October-December, 1960 period. "These are very disturbing figures," Senator Javits said, "and they stress the need for improving our machinery for channelling more defense contracts to areas of high unemployment."

New York State as a whole is continuing to increase its share of U. S. defense business. For the half-year period, July-December 1960, New York firms received 12.6% of all contracts awarded nationally. This represents the highest percentage share for this period in five years. During the same period in 1960, California saw its percentage share decline slightly to 24.9% of all awards. Sens. Javits, and Keating, and the New York State Congressional Delegation have been fighting to reverse the trend of defense contract awards to California at the expense of many industries located in New York and other parts of the East.

Senator Javits said, "It is significant that the entire amount of the more than $50 million decline in awards to New York State, during the October-December 1960 quarter, was absorbed by areas of substantial labor surplus. There must be a thorough revaluation of government procurement policies that permit the entire impact of this decline in defense purchases to fall upon areas whose economic problems and high unemployment are the issues of primary concern.

Demand For Engineers Continues High—Salaries, Costs of Recruiting Rise

The so-called recession is not being felt by electronic engineers. Neither those long established in the business nor those just entering from engineering schools are experiencing very great difficulties in obtaining jobs.

The Engineering Manpower Commission of the Engineers Joint Council reports engineering salaries at an all time high. Salary levels for all engineers rose about 5% last year. This continues a pattern established several years ago. The rate increase is well above increases in the Consumer Price Index and the rate increases for production workers.

Median salary (all engineers in industry, education, and Government) is $9,600. Median starting salaries range from $5,375 for those accepting Government positions to $6,775 for those starting in industry. The median starting salary is $6,725.

Company recruiters are as busy (if not busier) this year as they were last year and the year before. Some company execs are shuddering, though, over recruiting costs. They are also concerned over the false impression of industry these recruiting tactics are giving the newly-graduated engineer.

Recruiters use a whole bagful of tricks to capture the engineer—especially the bright boys at the top third of their class. Inducements include: putting the recruit on half salary as soon as he signs up; picking up the tab for expensive hotel rooms and entertainment; bird-dogging (putting pressure on prime prospects before official recruiting begins), etc.

Many college placement officials look the other way—especially if the recruiter is from a company that contributes to the college—but, many others are seriously concerned. The College Placement Council has drawn up a code of ethics which lays down ground rules for both recruiter and placement officials, but they find that enforcing the code is not too easy.

INVESTMENT FIRM

Samuel J. Solomon (left) receives a small business firm license from John E. Horne, Administrator, Small Business Administration. Mr. Solomon is president of the new firm, Aviation Growth Investments, Inc., which will provide financial assistance to small companies in the aviation industry.

400 Computer Men Wanted

Minneapolis - Honeywell's Electronic Data Processing Div. is planning to hire about 400 electronics service engineers in a major expansion of its field service and systems test operations. The engineers will receive more than six months training in the check-out, programming, operation and maintenance of the Honeywell 800 and the 400 EDP systems.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 189.

More and more, engineers are drawn into the economic web of management. And why not? Are they not the ones who know best a project's technical requirements? Should they not be able to estimate the time requirements to accomplish these tasks? We think so— and here's a handy chart to help.

Budgeting Manpower

By H. E. MATUSZEWSKI
Senior Staff Engineer
Electrical/Electronic Systems
Aerojet-General Corp.
11711 South Woodruff Avenue
Downey, California

HOW often do you dread the thought of costing a proposal? Budgeting a work effort? Determining time - until - completion? Many engineers have to do these tasks as part of their normal work. The chart presented here is by no means the final answer, but it can assist greatly as a guide.

The chart can be used in several ways. It is based on the average 173.3 work-hour month and rounded off to the nearest whole hour. The lower part of the chart is based on a 40 hour week and can be used when exact monthly estimates are required. The examples show a few uses.

Example 1

Given: 9 months and 6 men for the project.

Problem: How many hours will they expend? (No overtime please!)

Solution: 9360 hours. See vertical column 6 and horizontal column 9.

Example 2

Given: 1083 hours to complete work.

Problem: How many months for one person?

Solution: See vertical column 1. The nearest number is 1040 hours or 6 months. The additional 43 hours is read as ¼ month in column 1. Therefore, it will take 6¼ months.

Example 3

Given: May 1961 has 22 working days. 3 men will be on overhead for the full month.

Problem: How many hours in May on the overhead budget?

Solution: 528 hours. See vertical column 3 and horizontal column 22.

Example 4

A final example will prove useful for large complex organizations.

Given: 145 engineers will work for 2 months.

Problem: How many hours will they accumulate in 2 average months?

Solution: Find horizontal column 2 and vertical columns ½, 4, and 10. Add and multiply by 10. $10 \times (173 + 1387 + 3467) =$ 50,270 hours (which is very close to the true figure of 50,266.6 hours as done on a calculator).

* * *

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

MANPOWER CHART

Staff vs. Time

NUMBER of MONTHS	NUMBER of MEN														
	1/4	1/3	1/2	2/3	3/4	1	2	3	4	5	6	7	8	9	10
1/4	11	14	22	29	33	43	87	130	173	217	260	303	347	390	433
1/2	22	29	43	58	65	87	173	260	347	433	520	607	693	780	867
3/4	33	43	65	87	98	130	260	390	520	650	780	910	1040	1170	1300
1	43	58	87	116	130	173	347	520	693	867	1040	1213	1387	1560	1733
2	87	115	173	231	260	347	693	1040	1387	1733	2080	2427	2773	3120	3467
3	130	173	260	347	390	520	1040	1560	2080	2600	3120	3640	4160	4680	5200
4	173	231	347	462	520	693	1387	2080	2773	3467	4160	4853	5547	6240	6933
5	217	289	433	578	650	867	1733	2600	3467	4333	5200	6067	6933	7800	8667
6	260	346	520	694	780	1040	2080	3120	4160	5200	6240	7280	8320	9360	10400
7	303	404	607	809	910	1213	2427	3640	4853	6067	7280	8493	9707	10920	12133
8	347	462	693	925	1040	1387	2773	4160	5547	6933	8320	9707	11093	12480	13867
9	390	519	780	1040	1170	1560	3120	4680	6240	7800	9360	10920	12480	14040	15600
10	433	577	867	1156	1300	1733	3467	5200	6933	8667	10400	12133	13867	15600	17333
11	477	635	953	1272	1430	1907	3813	5720	7627	9533	11440	13347	15253	17160	19067
12	520	693	1040	1387	1560	2080	4160	6240	8320	10400	12480	14560	16640	18720	20800
17	34	45	68	91	102	136	272	408	544	680	816	952	1088	1244	1360
18	36	48	72	96	108	144	288	432	576	720	864	1008	1152	1296	1440
19	38	51	76	101	114	152	304	456	608	760	912	1064	1216	1368	1520
20	40	53	80	107	120	160	320	480	640	800	960	1120	1280	1440	1600
21	42	56	84	112	126	168	336	504	672	840	1008	1176	1344	1512	1680
22	44	59	88	117	132	176	352	528	704	880	1056	1232	1408	1584	1760
23	46	61	92	123	138	184	368	552	736	920	1104	1288	1472	1656	1840
24	48	64	96	128	144	192	384	576	768	960	1152	1344	1536	1728	1920
25	50	67	100	133	150	200	400	600	800	1000	1200	1400	1600	1800	2000
26	52	69	104	139	156	208	416	624	832	1040	1248	1456	1664	1872	2080
27	54	72	108	144	162	216	432	648	864	1080	1296	1512	1728	1944	2160
28	56	75	112	149	168	224	448	672	896	1120	1344	1568	1792	2016	2240
29	58	77	116	155	174	232	464	696	928	1160	1392	1624	1856	2088	2320
30	60	80	120	160	180	240	480	720	960	1200	1440	1680	1920	2160	2400
31	62	83	124	165	186	248	496	744	992	1240	1488	1736	1984	2232	2480

WORKING DAYS per MONTH

THERE IS NO CEILING ON IDEAS

• *Advanced hydrogen systems being developed by The Garrett Corporation solve the problem of keeping men alive and equipment operating for long periods of time in future satellites and space capsules.*

Engineers at The Garrett Corporation's AiResearch Manufacturing Divisions are dealing with challenging problems in fast-moving fields.

Diversification of effort and vigorous leadership have made Garrett the world's largest manufacturer of aircraft components and systems and a leader in specialized missile and spacecraft systems.

Major fields of interest are:

- Environmental Control Systems—Pioneer, leading developer and supplier of air conditioning and pressurization systems for commercial and military aircraft, and life support systems for satellites and space vehicles.
- Aircraft Flight and Electronic Systems—Largest supplier of airborne centralized flight data systems; also working with other electronic controls and instruments including missile and submarine applications.
- Missile Systems—Largest supplier of accessory power units, AiResearch is also working with hydraulic, hot gas and hydrogen systems for missiles, liquid and gas cryogenic valves and controls for ground support.
- Gas Turbine Engines—World's largest producer of small gas turbine engines, with more than 9000 delivered in the 30–850 hp class. Studies include industrial and nuclear applications.

Excellent positions are available for qualified men with M.S., Ph. D. and Sc. D. degrees for work in these areas.

Send resume to: Mr. R. H. Horst

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Industry News

Cortlandt Van Rensselaer—named General Manager of a new division for Engineering and Manufacturing Oscilloscopes of Hewlett-Packard Co., Palo Alto, Calif.

Ralph L. Shapcott—appointed Director of Manufacturing and Assistant General Manager of Daystrom, Inc., Weston Instruments Div., Poughkeepsie, N.Y.

William S. Strout — named Vice President Purchasing, of Oak Mfg. Co., Crystal Lake, Ill.

J. C. Schraa—appointed Vice President Finance, of Illumitronic Systems Corp. and Illumitronic Engineering, affiliated Sunnyvale Calif. companies.

Zeke R. Smith—named Executive Vice President and General Manager of Potter & Brumfield, Div. of American Machine & Foundry Co., Princeton, Ind.

Z. R. Smith

Dr. G. Krsek

Dr. George Krsek has joined International Rectifier Corp., El Segundo, Calif., as Executive Vice President and General Manager.

Clifton P. Walker—named Director of Amphenol-Borg Electronics Corp., Broadview, Ill.

Edward H. DaCosta—elected President of Taylor Fibre Co., Norristown, Pa.

Everett M. Kruger—appointed Manager of Systems and Procedures, RCA Electronic Data Processing Div., Camden, N. J.

William Lawrence has been appointed General Manager and **Howard L. Gates** as Manager of Operations of the San Diego Facilities of General Dynamics/Electronic's Military Products Div.

Herbert A. Finke — named Vice President and General Manager of Bomac Laboratories Inc., Beverly, Mass.

Stanley T. Rose—elected President of the Kolux Corp., Kokomo, Ind., sub. of The Victoreen Instrument Co., Cleveland, Ohio.

Sydney L. Capell and **Roy W. Pratt** have been elected Vice-Presidents of Zenith Radio Corp. of Canada, Ltd., Toronto, Canada.

Leonard K. Adams—named Director of Export Activities for Fansteel Metallurgical Corp., N. Chicago, Ill.

(Continued on page 182)

Said Johann Kepler: *"The planets move in elliptical orbits about the sun, and the square of their periods of revolution are proportional to the cube of their mean distances from the sun."*

With interplanetary voyages fast becoming a reality, complete information regarding the velocity requirements for travel between planets is of vital importance. With these data available, it is possible to analyze propulsion requirements, plan ultimate system configurations, and conduct feasibility studies for any particular mission.

Lockheed Missiles and Space Division scientists have actually evolved a rapid-calculation method, utilizing a high-speed computer. This has produced literally thousands of orbits, velocity requirements, and elapsed time, for design studies of trips to and from both Mars and Venus—every tenth day from now until January, 1970.

More simple to analyze are many factors which make Lockheed Missiles and Space Division a wonderful place to live and work. Located in Sunnyvale and Palo Alto, California, on the beautiful San Francisco Peninsula, Lockheed is Systems Manager for such programs as the DISCOVERER and MIDAS satellites and the POLARIS FBM. These, together with research and development projects in all disciplines, make possible a wide diversity of positions for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-14C, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs

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Industry News

(*Continued from page* 180)

G. Richard Tingley—appointed Vice President, Military and Industrial Systems Dept., CBS Laboratories, Div. of Columbia Broadcasting System, Inc., Stamford, Conn.

Hoffman Electronics Corp., Los Angeles, Calif., announces the following appointments: **Jack Kuhner** — Vice President in Charge of Administration; **H. Edward White**—Director of Industrial Relations; **Capt. Will I. Bull**—General Manager of the Military Products Div.; **Marvin G. Whitney**—Director of operations, Semiconductor Div.; and Vice President **Theodore S. Hoffman** — Director of Operations, Evanson, Ill. facility of the Semiconductor Div.

Thomas C. Weston, Jr.—appointed Marketing Manager of Hughes Aircraft Co.'s Communications Div., Culver City, Calif.

Donn L. Williams — named Vice President and General Manager for the Armament and Flight Control Operations of Autonetics, a Div. of North American Aviation, Inc., Downey, Calif.

Edward A. Williams—elected Vice President Operations Control, of Collins Radio Co., Cedar Rapids, Iowa.

E. A. Williams

T. R. Finch

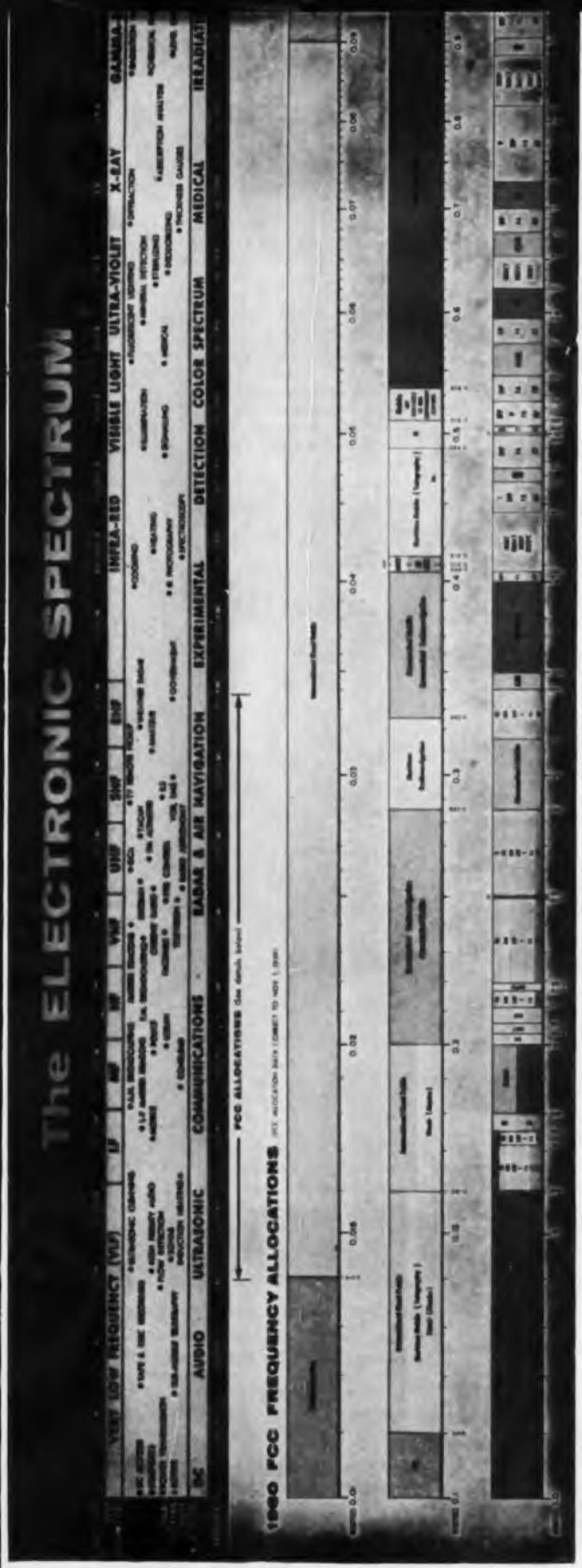
Tudor R. Finch—named Assistant General Manager of Motorola's Semiconductor Products Div., Phoenix, Ariz.

Dr. Donald M. Allison, Jr.—named President of Vitro Electronics, Div. of Vitro Corp. of America, New York, N. Y.

Dr. Ernest Wantuch — appointed Vice President of the Advanced Devices Laboratory of Airtron, sub. of Litton Industries.

American Systems Inc., announces the appointments of **Louis M. Ballard**—Head of the Instrument Div.; **Bernard Diener**—Head of the Component Development Div.; **William Wagenseil**—Head of the Instruction Div.; **Dr. Robert E. Fagen**—Director of the Information Sciences Div.; **M. Donald Adcock**—Head of the Electromagnetic Systems Div.; **John W. Bozeman**—Head of Command and Control Div.; and **Arthur W. Vance**—Head of the Research Laboratories Div.

(*Continued on page* 184)



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Model RC41 CA1

Model RC43 LCA1

NEW *VACUUM COAXIAL RELAYS — For higher pulse power at higher frequencies*

Jennings announces an entirely new series of vacuum coaxial relays for use at frequencies up to 600 mc. Small, efficient vacuum transfer relays in a specially designed coax housing enable these relays to carry up to 15 kw peak power at 600 mc.

These relays are singularly effective for use as a transmit-receive relay. Vacuum guarantees permanently low contact resistance that does not change even if the relay is accidentally switched under load. The result is a low and stable VSWR in any environment. Some units weigh as little as 11 ounces and range in size from only 3-1/4 inches to 4-1/16 inches high.

Four different sizes of housings are available to accommodate a variety of standard coaxial connectors for different power level requirements. Housings are available with the following connectors: BNC, TNC, N, UHF, C, HN, and LC.

Consider the performance characteristics of these two relays:

Model RC41 CA1:	
Characteristic Impedance:	50 ohms
Power Rating:	2 kw average at 30 mc
Frequency Range:	0 to 600 mc
VSWR:	1.05:1 max.
Crosstalk:	Greater than —30 db isolation at 400 mc
Insertion Loss:	0.05 db max.
Actuating Voltage:	24 or 115 vdc
Model RC43 LCA1:	
Characteristic Impedance:	50 ohms
Power Rating:	1 kw average, 15 kw peak at 600 mc
Frequency Range:	0 to 600 mc
VSWR:	1.05:1 max.
Crosstalk:	Greater than —30 db isolation at 400 mc
Insertion Loss:	0.05 db max.
Actuating Voltage:	24 or 115 vdc

Write for more detailed literature on Jennings complete line of coaxial and other vacuum relays.

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Industry News

FXR, Inc., Woodside, N. Y., has announced that **Henry Feldmann** has resumed the Presidency of the company and **Walter I. Reich**, Secretary-Treasurer and Controller of FXR has been elected to the company's Board of Directors.

General Dynamics-Electronics has announced the appointments of **Orval L. Buckner** as Manager of Quality Control, Commercial Products Div. and **Otto J. Howe**, Manager of Production Control, Commercial Products Div.

Wilson R. Smith has been named Plant Manager, Semiconductors for CBS Electronics, Manufacturing Div. of Columbia Broadcasting System, Inc.

Wilson R. Smith

Herbert H. Rickert

Herbert H. Rickert has been appointed Chief Engineer of Douglas Research Corp., a div. of Douglas Microwave Co., Inc., Mt. Vernon, N. Y.

The Victoreen Instrument Co., Cleveland, Ohio has named **George R. Lippert** as Manager and **George H. Lister** as Chief Engineer of their new Communications Div.

Bendix-Pacific Div., Bendix Corp., North Hollywood, Calif., announces the following appointments: **Dr. John A. F. Gerrard** as Director of Electronics Engineering; and in the Bendix Computer Div.: **Ronald V. Johnson** and **Jacob Chapsky**, Senior Engineers and **William B. Ellern** as Engineer.

R. C. Bertelsen—promoted to Manager of 3M's St. Paul, Minn., tape plant, and **A. F. Jacobson** is named Manager of 3M's tape and adhesives, coatings and sealers plant in Bristol, Pa.

The General Electric Co., Schenectady, N. Y., has announced the appointments of **W. H. Roberts** to head Development Engineering in the electrolytic capacitor program; **Dr. R. Beringer Frank**, Manager of Low Power Traveling Wave Tube Engineering; **G. E. Lewis**, Manager of Engineering; and **Robert E. Stewart**, Manager of Quality Control at GE's electronic tube plant in Palo Alto, Calif.

TANTALUM CAPACITORS...NEW HEIGHTS IN RELIABILITY

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When Pyramid tantalum capacitors with proven dependability are incorporated into essential electronic equipment you manufacture . . . greater reliability of your product is assured.

To design engineers searching for miniature electrolytic capacitors with unusual capacitance stability and a low dissipation factor over a wide temperature range, soundly constructed tantalum capacitors are gratifying discoveries.

If the equipment you make demands small capacitors with explicit reliability and peak performance, look to Pyramid for tantalum capacitors that meet your most exacting requirements.

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With the revolutionary new Potter High Density Recording System, one tape transport has the capacity of 5 or more conventional transports.

For highly reliable computer applications, Potter High Density Recording can give you data transfer rates of 360,000 alpha-numeric characters per second, at densities up to 1500 bits per inch on 1-inch tape. Sixteen parallel channels can be accommodated on one-inch tape. Because Potter has made the information channels self-clocking, no separate clock channel is needed, and multichannel data can be read out in true parallel form, despite interchannel time displacement.

In production units delivered by Potter for the BENDIX G-20 COMPUTING SYSTEM at the Carnegie Institute of Technology, this dramatic new technique makes recording so reliable that in 40 hours of continuous operation less than 2 seconds re-read time are required to recover information lost through transient error. Dropouts are fewer than 1 bit in 10 billion at 1100 alpha-numeric characters per inch. More than 20,000 passes of the tape can be made without losing information or significantly increasing the reading error rate.

Tested and proven in computer systems, Potter High Density Recording is presently available in the Potter 906II High Speed Digital Magnetic Tape Handler, and will be available in other Potter Tape Systems.

Write today for details on how High Density Recording can be applied to your data handling problem.

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Industry News

John E. Lillich—elected Vice President in Charge of Manufacturing, Shallcross Mfg. Co., Selma, N. C.

James R. Coleman has been named to the position of Sales Manager of Dynatran Electronics Corp., Mineola, N. Y.

Andrew E. Kimball has been named Manager of Advanced Marketing Research, Advanced Product Planning Operation, General Electric Co., Electronic Components Div., Schenectady, N. Y.

James R. Muroski has been named to the position of Sales Manager for the Thermistor Div., Keystone Carbon Co., St. Marys, Pa.

Myran A. Angier—named General Sales Manager for the Remington Rand Univac Div. of Sperry Rand Corp., New York, N. Y.

M. A. Angier

J. M. Taylor

John M. Taylor—elected Chairman of the Board of the Taylor Fibre Co., Norristown, Pa.

D. Scott Bowman has been appointed Director of Marketing, Amphenol-Borg Electronics Corp., Broadview, Ill.

Robert A. Newman has been appointed Product Manager of Wheelock Signals, Inc., Long Branch, N. J.

John L. Gray has been named Vice President and Eastern Area Sales Manager for Motorola Semiconductor Products Inc., Phoenix, Ariz.

Richard J. Guglielmetti has been named Manager of the Market Research Dept. of Eitel-McCullough, Inc., San Carlos, Calif.

James D. Monk has been named Manager, Marketing Administration and Personnel Development for General Electric's Light Military Electronics Dept., Utica, N. Y.

Harvey J. Finison, has been appointed Director, Business Planning and Development, Electronic Components and Devices Group, Semiconductor Div., Raytheon Co., Waltham, Mass.

Leo A. Pfankuck, President of Shur-Lok Marine Corp., Anaheim, Calif., has been elected a Member of the Board of Directors of Telecomputing Corp., Los Angeles, Calif.

DRIREED ELECTRONIC COMMUTATORS

the Newest and Best!

The NEW Hathaway DRIREED Electronic Commutator, designed to utilize Hathaway's DRIREED contact, is illustrated above in a typical rack mounted unit. Applications include telemetry, thermocouple scanning, computer inputs, strain gage scanning, transducer scanning, and PDM coding.
The unit can be packaged and tailored to fit your particular requirements.

FEATURES:

- **Eliminates the transfer gain problem—closed circuit resistance less than 100 milliohms.**
- **No back current or channel to channel crosstalk—open circuit resistance greater than 3×10^{12} ohms.**
- **Output isolated from power ground and needs no "common"—isolated dual ended contacts.**
- **Solid state drive circuit—transistor logic control of mechanical contact operation.**
- **Up to 1,000 sequential data points per second—DRIREED has resonant frequency of above 2700 cps.**
- **Long life, highest reliability—contact rating 10 million operations at 100 milliampere, 115 volts 60 cps, resistive load; 1 billion operations at low signal levels.**

PRICE AND PERFORMANCE of this commutator make it worth considering in your application. Please address your inquiries to the address below.

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JFD MINIATURE METALIZED INDUCTORS MAKE THE DIFFERENCE!

JFD Metalized Inductors provide outstanding electrical performance under severe environmental conditions - - in a small package.

Utilizing a silver film fired permanently to a high dielectric constant glass, they offer the ultimate in inductor simplicity and stability. This inherently rugged construction results in extraordinary reliability under extremely severe environments - - especially those of shock, vibration, temperature and altitude.

The inductance, types of windings, size, distributed capacitance, Q and other parameters of JFD Metalized Inductors can be designed to meet your specific needs. Why don't you write for bulletin 223 and see the difference they can make in your circuitry?

Features

1. Rugged construction affords unusually high stability under conditions of severe shock and vibration.
2. Use of glass dielectric assures low temperature coefficient of inductance and operation without derating over extremely severe environmental conditions.
3. Low distributed capacity.
4. Special alloy plating protects metal parts from corrosion.
5. A high Q over a broad frequency range.
6. Silver plated copper leads.
7. Available in panel mount and printed circuit mount types.
8. JFD Variable Inductors can also be supplied to order. Write for questionnaire or contact the JFD sales office or representative nearest you.

Miniature Metalized Inductors,

LF1P and LF2W Series

Ranges: Available in 23 values from 0.05 to 2.00 μhy.
Q: From 100 to 180.
Lengths: Panel Mounts—up to 1 1/32 inches.
Wire Mounts—up to 1 1/4 inches.
Frequency of Operation: below 10 mc—over 800 mc.
O.D.: = 15/32 inches.

ACTUAL SIZE

New Miniature Metalized Inductors,

LF3P and LF4W Series

Ranges: Available in 22 values from 0.05 to 1.0 μhy.
Q: More than 150.
Lengths: Panel Mounts—up to 1 1/32 inches.
Wire Mounts—up to 1 1/4 inches.
Frequency of Operation: below 10 mc—over 700 mc.
O.D.: = 0.290 inches.

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172 Allied Control—6 Pole sub-miniature relay.
82 American Airlines—Air transportation.
141 American Electrical Heater Company—Resistance soldering iron.
188 American Machine & Foundry Company—Catalog of precision meters.
102 American Time Products, Inc. — Frequency standards.
76 AMP Incorporated—Terminal blocks.
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116 Amperex Electronic Corporation—PNP germanium switching transistor.
27 Amphenol Connector Division—Hermetically sealed electrical connectors.
72 Arnold Engineering Company—Magnetic cores.
75 Amphenol-Borg Electronics Corporattion—Precision turns-counting dial.
125 Amphenol-Borg Electronics Corp., RF Products—Coaxial switches-relays.

81 Ballantine Laboratories, Inc.—Vacuum tube voltmeter.
115 Beckman Helipot—A-C potentiometers.
187 Bell, Inc.—Portable gaussmeter.
130 Bendix Corporation — Diffused alloy power transistors.
184 Bendix Corp., Pioneer Central—Ultrasonic cleaning equipment.
87 Berkeley Division of Beckman Instruments, Inc.—Modular digital multimeter.
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199 Bradley Semiconductor Corp.—Miniature silicon rectifiers.
176 W. H. Brady Co.—Micro-miniature component markers.
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120 Burroughs Corporation — Modular components.
84 Bussmann Mfg. Division—GMT fuse & HLT fuseholder.
103 Brush Instruments Division of Clevite Corporation—Operations monitors.
104 Brush Instruments Division of Clevite Corporation—Transistor switches.

153 Cambridge Thermionic Corporation—Insulated terminals.
200 CBS Electronics — MADT & epitaxial planar.
31 Centralab Linear motion variable resistors.
106 Cinch Manufacturing Company — "D" Subminiature connectors.
38 C. P. Clare & Co.—Printed circuit relays.
128 Clevite Transistor—Power transistors.
128 Continental Electronics — Super-power transmitters
138 Continental Connector Corporation — Connectors
110 Controls Company of America — Continued indicator lights and pushbutton switches.
131 Cornell Dubilter Electronic Corp.—Capacitors
137 Corning Electronic Components—Glass-foil capacitor
156 Curtiss Wright Corporation—Ultrasonic delay lines.
152 Curtiss-Wright Corporation — Thermal time delay relays.
162 Custom Components, Inc.—Permeable dielectric.

98 Dale Electronics, Inc.—Precision resistors.
175 Daven Co.—Miniaturized precision wire wound resistors.
114 Delco Radio—Power transistors.
86 Delco Radio—Digital modules.
155 Design Tool Co.—Metalworking automatic machines.
69 Deutsch Electronic Components Division—Bayonet-locking electrical connector.
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90 DIt MCO, Inc.—Logic circuit testing equipment.
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139 Dow Corning Corporation — Deposited hyper-pure silicon.

196 EICO—Electronics catalog.

88 Fairchild Controls Corporation—Pressure transducer.
89 Fairchild Semiconductor—Silicon transistors.
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78 FXR, Inc.—Coaxial slide screw tuner.

28 General Electric, Power Tube Dept.—Advanced-design camera tubes.
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151 G-V Controls Inc.—Thermal relay.

136 Hamilton Watch Company — Magnetic alloy strip.
30 Hathaway Denver—Electronic commutators.
23 Hewlett-Packard Company — Precision voltmeters, ammeters.
24 Hewlett-Packard Company — Precision oscillators.

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ADVERTISERS IN THIS ISSUE

ADVERTISERS FROM WHOM YOU DESIRE FURTHER INFORMATION

88 Hewlett-Packard Company—Clip on DC milliammeter.

79 Honeywell Precision Meters—AC panel meters.

186 Howard Industries, Inc.—Fractional H.P. induction motor.

163 Hughes Aircraft Company, Vacuum Tube Products Division—Electronic welding equipment.

109 Hughes Aircraft Company, Semiconductors Division — Double-diffused mesa silicon transistors.

181 Industrial Electronic Engineers, Inc.—Self-decoding alpha-numeric readout.

178 Industrial Test Equipment Co.—Phase meter.

PROFESSIONAL ENGINEERING OPPORTUNITIES

Circle number of company on card at right from whom you desire further information.

161 Philco Techrep Division.

91 Inland Motor Corporation of Virginia—100-watt D-C amplifier.

16 International Resistance Corp. — Metal film resistor.

132 Jennings Radio Mfg. Corp. — Vacuum coaxial relays.

119 Johnson Co., E. F.—Variable capacitor.

180 Jones Division, Howard B., Cinch Mfg. Corp.— Plugs and sockets.

25 M. C. Jones Electronics Co., Inc.—RF power and VSWR measuring instruments.

145 JFD Electronics—Trimmer capacitors

193 Kay Electric Company—High frequency attenuators.

182 Kemet Company—Solid tantalum capacitors.

7 Lenz Electric Manufacturing Co.—Double channel audio cable.

177 Lepel High Frequency Laboratories, Inc. —High frequency induction heating equipment.

17 Litton Industries Electron Tube Division — Miniature gas discharge noise sources.

170 Magnecraft Electric Co.—Latch-in relays.

133 Magnetic Shield Division Perfection Mica —Magnetic shields of any size or shape.

192 Masterite Industries—Component holders.

152 Marconi Instruments—Q meter.

197 Miller Company, J. W.—Molded choke coils.

14 Minnesota Mining & Manufacturing Co., Minicom Division—Video instrumentation recorder reproducer.

21 Minnesota Mining & Manufacturing Co., Irvington Division—Coated glass insulation.

187 Motorola Semiconductor Products Inc.—Germanium mesa amplifier transistors.

138 Newman Corporation, M. M.—Spirally-cut plastic tubing.

83 Nothelfer Winding Laboratories, Inc.—Portable AC power supply.

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 175 of this issue.

Postcard valid 8 weeks only. After that use own letterhead describing item wanted. **MAY 1961**

PROFESSIONAL ENGINEERING OPPORTUNITIES

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

YOUR NAME .....TITLE.....

HOME ADDRESS .....

CITY or TOWN .....ZONE.....STATE.....

MAY 1961

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Name: Position

Company Address:

City: Zone State

Specific Products Manufactured

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FIRM .....

FIRM ADDRESS .....

CITY OR TOWN.....ZONE.....STATE.....

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10 Ohmite Manufacturing Company—Vitreous-enameled resistor.

8 Pacific Semiconductors, Inc.—Saturated logic switching transistors.

9 Pacific Semiconductors, Inc.—Saturated logic switching transistors.

165 Panoramic Radio Product Co.—Spectrum analyzer.

179 Pennwood Numechron Co.—Digital clock.

124 George A. Philbrick Researches, Inc.—Operational amplifier.

12 Philco—Lansdale Division—Transistors.

174 Plastic Capacitors, Inc.—High voltage capacitors.

144 Potter Instrument Company, Inc.—Tape transport.

154 Power Designs Inc.—Semiconductorized power supply.

167 Powertron Ultrasonics Corporation—Ultrasonic cleaning equipment.

146 PRD Electronics, Inc.—Klystron power supply.

19 Precision Instrument Company—Instrumentation magnetic tape recorder.

143 Pyramid Electric Company — Tantalum capacitors.

159 Quan-Tech Laboratories—Resistor noise test set.

92 Radio Frequency Laboratories, Inc.—Magnet charger.

1 Radio Materials Company—Ceramic capacitors.

11 Rayclad, Tubes Incorporated—Preformed covers.

127 Raytheon Company—Spectrum analyzer.

157 Raytheon Company—Cathode ray tubes.

20 Reeves Instrument Corporation—Miniature floated integrating gyros.

74 Sarkes Tarzian, Inc.—Silicon voltage regulators.

71 Scientific-Atlanta, Inc.—Tri-axial antenna positioner.

158 Sekonic Inc.—Meters.

15 Shockley Transistor, Unit of Clevite Transistor—4-layer diode.

126 Sonotone Electronic Applications Division—Tubes.

117 Sperry Semiconductor Division—Silicon mesa transistors.

2 Sprague Electric Company — Synthetic polyester film capacitors.

4 Sprague Electric Company—Germanium micro-alloy diffused-base transistors.

149 Sprague Electric Company — Foil-type tantalum capacitors.

150 Sprague Electric Company—Isofarad capacitors.

166 Sprague Electric Company—Interference locator.

6 Stevens Manufacturing Company, Inc.—Thermostats.

134 Stewart Engineering Corporation—Backward wave oscillators.

161 Stromberg-Carlson — Telephone handset cradle.

95 Sylvania Electric Products Inc., Semiconductor Div. — Germanium mesa transistors.

96 Taylor Laminated Plastics Vulcanized Fibre — Punched laminated plastics parts.

94 Tektronix, Inc.—Oscilloscopes.

160 Tele-Dynamics Division American Bosch Arma Corporation—Subcarrier oscillator.

101 Tele-Dynamics Division American Bosch Arma Corporation—Airborne PCM system.

5 Texas Instruments Incorporated—Silicon epitaxial transistors.

97 Texas Instruments Incorporated—Silicon diodes.

122 Tinsley Laboratories, Inc.—Corning glass filters.

147 Trak Microwave Corporation—Oscillator cavity.

26 Transitron Electronic Corporation—Mesa micro-transistors.

168 Turbo Machine Co. — Microwave delay lines.

113 Victoreen—Triodes.

29 Waveline, Inc. — Waveguide directional couplers.

173 Western Rubber Co.—Grommets.

195 Western Sky Industries—Grommets one-piece nylon.

17 Westinghouse—Silicon power transistor.

73 S. S. White—Air abrasive units.

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Philadelphia 4, Pennsylvania

PORTABLE KLYSTRON POWER SUPPLY 809-A

featuring: • New compact size: 8" x 12" x 15" • New low in reflector voltage ripple: less than 1 mv rms • New planetary gears to give finer adjustment of reflector voltage • New design including internal blower, built-in cabinet tilt stand, PRD expansion coil cord with polarized ac plug • Direct reading of beam voltage or current on front panel meter.

Regulated beam voltage 250 to 600 volts; regulated reflector voltage 0 to −900 volts; 6.3 volt ac filament supply. Reflector voltage available either unmodulated or internally modulated by square wave or sawtooth. Send for data! **PRD ELECTRONICS, INC.:** 202 Tillary St., Brooklyn 1, New York, ULster 2-6800; 1608 Centinela Ave., Inglewood, California, ORegon 8-9048. *A Subsidiary of Harris-Intertype Corporation.*

HARRIS INTERTYPE CORPORATION

New from PRD!

NEW—TRAK OSCILLATOR CAVITY FOR CW SERVICE!

This MINIATURE TRAK Type 9127-SL(CW) Microwave Cavity is ideal as a local oscillator or low power transmitter in the new 2.2—2.3 KMc telemetry band. With a power output in excess of 100 mw, it is also suitable for use as a parametric pump, or the energy source for harmonic generators.

Specifications are:

Frequency	Tunable 2.15—2.45 KMc
CW Power Out	Greater than 50 mw over entire tuning range Greater than 100 mw over 2.2—2.4 KMc range
Power Input	150 VDC at 10 ma and 6.5 V at 240 ma
Temperature Stability	Less than 1 Mc drift with a temperature variation of 80°C. Operable from −70° to +120°C.
Size	1" diameter by 4¾" long
Weight	7 ounces

TRAK MICROWAVE has miniature CW Oscillators with output power of 10 mw to 2 watts at frequencies between 800 and 7000 Mc. Also, Oscillators engineered to your specifications!

Write today for **new** Catalog 61A, full of oscillators for CW, grid pulse and plate pulse service.

Microwave Oscillator Engineers Wanted

See these CAVITIES at TRAK ELECTRONICS' IRE SHOW booth 3803

TRAK Microwave

TRAK MICROWAVE CORPORATION
Subsidiary of
TRAK Electronics Company
5006 N. Coolidge Avenue
Tampa 3, Florida
REdwood 6-6422

Circle 147 on Inquiry Card

News of Mfrs' Representatives

Electronic Products Corp., Baltimore, Md., has appointed **Adams McGregor**, Lincoln, R. I.; **Fred B. Hill Co.**, Minneapolis, Minn.; **Mark Electronics Sales Co.**, No. Miami, Fla.; **McDowell Redlingshafer**, Kansas City, Mo.; **Sydney Justin Assoc.**, New York 1, N. Y.; and **West Eleven, Inc.**, Los Angeles, Calif., to be its representatives in their respective territories.

Ace Electronics Assoc., Inc., Somerville, Mass., has named as its sales representatives the **F. W. Moulthrop Co.**, San Francisco, Calif., to cover North California and Nevada and the **Bauman & Bluzat Co.**, to cover Illinois, Wisconsin, and N.W. Indiana.

The International Rectifier Corp., El Segundo, Calif., has named **R. G. Bowen Co., Inc.**, as Rocky Mountain Area representative; and **Bowen and Carlberg Co.**, Albuquerque, N. M., to cover New Mexico and the El Paso, Tex. area.

Pentron Electronics Corp., Chicago, Ill., announces the following representative appointments: **Allied Appliances Inc.**, Boston, to cover six counties in the Boston Metropolitan area; **J. B. Charters Inc.**, Detroit, for Detroit and E. Michigan; and **Allied Appliances Inc.**, Denver, for Colorado.

Packaged Electronics Div., Amphenol-Borg Electronics Corp., Broadview, Ill., names the following representatives: **Leslie M. DeVoe Co.**, Indianapolis, Ind., for Indiana except Lake and Porter Counties and Kentucky; **Fred B. Hill Co.**, Minneapolis, for N. & S. Dakota, Minnesota and Western Wisconsin; and **Tech-Ser, Inc.**, Los Angeles, Calif. for California, Arizona and Nevada.

Servo Corp. of America has named the following representatives: **Western Dynamics Corp.**, Seattle, Wash., to cover Washington, Oregon, and Idaho; **Gentry Assoc.**, Orlando, Fla., for Alabama, Florida, Georgia and Mississippi; and **Radionics, Ltd.**, Montreal, for the Canadian provinces.

Tru-Ohm Products, Div. of Model Engineering & Mfg., Inc., has announced the appointment as representatives: **Peyser & Co.**, Colorado Springs, Colo., for Colorado; **Robert C. Foster**, Rochester, N. Y. for upper New York; **Scott Technical Sales**, Dallas, Tex., for Texas; **E. A. Dickinson & Associates**, Milwaukee, Wis., for Wisconsin.

The Potter Co., No. Chicago, Ill., announces the appointment of **W. R. Punt Co.**, Floral Park, N. Y., as their representative in the metropolitan New York area.

Oxford Components Div. of Oxford Electric Corp., Chicago, Ill., has appointed the following representatives: **Mike Bermann Sales** to cover Illinois and Wisconsin; **Charles Scheffler Co.** for Indiana and Kentucky; and **Carmine A. Vignola Associates** for Iowa, Kansas, Missouri, Nebraska and Southern Illinois.

Schenectady Varnish Co., Inc., Schenectady, N. Y., announces the appointment as representative of **Southern Electric Sales Co.**, Dallas, Tex., to cover from the Oklahoma border south to Austin and from the Texarkana/Shreveport area to Lubbock in the west.

Kraeuter & Co., Inc., Newark, N. J., announces the appointment of **D. R. Spickler Co.**, No. Kansas City, Mo., as sales representatives to cover a five-state area.

Western Transistor Corp., Gardena, Calif., has appointed the **Dave Miller Sales Co.**, Seattle, Wash., as representatives to cover the states of Oregon, Washington, Montana, and Northern Idaho.

AT Electronics, Inc., New Haven, Conn., has appointed the following representatives: **Claude R. Booth & Assoc.**, Chicago, Ill., to cover Northern Illinois, Southern Wisconsin and Northern Indiana; and **Robert R. Stone & Assoc.**, Cleveland Heights, Ohio, to cover Ohio, Western Pennsylvania and West Virginia.

Dickson Electronics, Inc., Scottsdale, Ariz., announces the appointment as representatives: **Adelphi Electronics**, Mineola, L. I. and **Astronetics, Inc.**, Red Bank, N. J.

Tensolite Insulated Wire Co., Inc., Tarrytown, N. Y., has appointed the following representatives: **Farwest Agencies**, Seattle, Wash., to cover Washington and Oregon; **Anderson and Assoc.**, Minneapolis, Minn., for North and South Dakota and Minnesota; **Massey Assoc.**, Orlando, Fla., for Florida.

Cushman Electronics, Sunnyvale, Calif., has appointed **A. W. Weart Bros.**, Compton, Calif., as representatives to cover the states of Utah, Nevada, Arizona and Southern California.

The Sessions Clock Co., Forestville, Conn., announces the following appointments as representatives; **Latimer and Ziegler & Assoc.**, to cover Michigan (lower part of the state) and Lucas County in Ohio (Toledo); and **Nulick and Strobel**, Wilowick, Ohio, to cover Ohio, North of Route 40, except Lucas County.

News of Mfrs' Representatives

REPRESENTATIVES WANTED

Electronic Firm seeks representatives for its complete line of relay and solid-state interval timers. Respondents should be calling largely on OEMs and military. Almost all territories are still available. (Box 5-1, Editor, Electronic Industries.)

Business Management Institutes

The **Electronic Representatives Assoc.** is scheduling three Business Management Institutes for members in 1961. One session will be held on the **East Coast, June 25-30** at American University in Washington, D. C. The University of Illinois will again be the site of the **central regional** institute, to be held **June 11-16.** For members who attended last year's institute, an Advanced Management Institute will be held June 13-16, at the University of Illinois. An institute is also tentatively scheduled for Stanford University, Palo Alto, Calif., **Sept. 12-16 for West Coast** members.

Mr. P. Andress also announces that due to limited quotas, ERA members will be registered on a first come, first served basis.

Clevite Transistor, Waltham, Mass., announces the appointment of **Statewide Electronics Supply Co., Inc.,** Syracuse, N. Y., as its distributor in the Upper New York State area.

American Scale Co. of Los Angeles, Calif., has appointed **Wesrep Corp.,** Los Angeles, Calif., as their national representative.

Wiltron Co., Palo Alto, Calif., announces the appointment of **John Francis O'Halloran and Assoc.,** No. Hollywood, Calif., as its representative for California, Nevada, and Arizona.

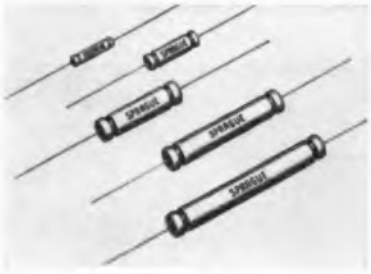
Polyphase Instrument Co., announces the appointment of **Staff & Holder, Inc.,** as their representatives for New York State with the exception of the counties of Suffolk, Nassau, Westchester, Rockland, New York, Richmond, Queens, Kings, and Bronx.

Pyramid Electric Co., Darlington, D. C., has appointed as representatives, the **B. F. Connelly Co.,** Seattle, Wash., to cover the Northwest area.

CRS Industries, Inc., Phila., Pa., announces the appointment of **Schultz & James Inc.,** Richmond, Va., to cover Virginia except for three northern counties; and **Atech Supply Co.,** Detroit, Mich., to cover Michigan.

Quan-Tech Laboratories, Inc., Boonton, N. J., has appointed two representatives: **Jay Stone & Assoc.** Sunnyvale, Calif., to cover Nevada and northern California; and **Dannemiller-Smith, Inc.,** Dallas, Tex., to cover Oklahoma, Arkansas, Louisiana, Mississippi and Texas.

Foil-type Tantalum Capacitors Now Available in Ratings to 250 V



Sprague Electric Company has announced another major capacitor improvement. Higher voltage ratings, sorely-needed by circuit designers of military and industrial electronic equipment, are now available in Sprague's family of Tantalex® Foil-type Tantalum Capacitors.

Plain-foil 125 C types, previously limited to 150 volts, may now be obtained in 200 volt ratings. Plain-foil capacitors designed for 85 C operation, with a previous maximum of 150 volts, are now available in 250 volt ratings. Type numbers and pertinent characteristics are shown in the following table.

Capacitor Type	Polarity	Anode	D-C Voltage Range
85 C Max. Operating Temperature			
110D (MIL CL34, CL35)	polar	plain foil	3 to 250
111D	non-polar	plain foil	6 to 250
112D (MIL CL24, CL25)	polar	etched foil	15 to 150
113D	non-polar	etched foil	15 to 150
125 C Max. Operating Temperature			
120D	polar	plain foil	10 to 200
121D	non-polar	plain foil	10 to 200
122D	polar	etched foil	10 to 100
123D	non-polar	etched foil	10 to 100

Manufactured to meet or exceed the performance requirements of Specification MIL-C-3965B, this series of Tantalex Capacitors sets new standards of reliability for all types of military and industrial applications.

Tantalex Capacitors are available promptly in production quantities. For off-the-shelf delivery at factory prices on pilot quantities to 499 pieces, Sprague industrial distributors stock the more popular items in Types 110D, 111D, 112D, 113D, 120D, and 121D, as well as MIL Types CL24, CL25, CL34, and CL35.

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

Circle 149 on Inquiry Card

ISOFARAD CAPACITORS

. . . for unmatched capacitance stability at moderate cost

Hold that capacitance! **. . . with ISOFARAD Film Capacitors. Where capacitance stability is an absolute must, ISOFARAD is the one capacitor most likely to succeed. The patented duplex plastic film dielectric used in these capacitors has practically no capacitance change over operating temperature ranges up to +85°C. Retrace on return to room temperature is within ±0.10%.**

ISOFARAD Capacitors have insulation resistance and dielectric absorption characteristics which approach those of polystyrene capacitors . . . and they're smaller. Type 145P capacitors are superior to silvered mica capacitors in insulation resistance . . . are tubular in shape so they are more adaptable to machine insertion on printed wiring boards . . . and have a capacitance stability in use which is equivalent for most practical purposes to the more expensive silvered mica units.

Capacitor sections are of the extended-foil design and are housed in pre-molded phenolic shells with plastic-resin end seals for protection against moisture and mechanical damage.

For complete technical data on ISOFARAD Capacitors, write for Engineering Bulletin 2037A to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

Circle 150 on Inquiry Card

New MADT & Epitaxial Planar

CBS Electronics Opens $5 Million Engineering and Production Facility

Diffusion Furnaces *shown here process thin epitaxial layers of high-resistivity material for CBS planar transistors.*

In modern architecture, form follows function.

This concept is dramatically demonstrated by the new CBS Lowell Progress Center which specializes in semiconductors for computer circuitry. This most modern engineering and production facility is designed to advance immediate and long-range developments in solid state technology and processes.

The Lowell Progress Center is currently supplying industry with a broad line of rugged and reliable semiconductors: *MADT, *MAT and *SBT switching transistors—PNP and NPN germanium high-power transistors—gold-bonded and point-contact diodes. An advanced line of CBS epitaxial-planar silicon transistors will soon be available in production quantities.

Close cooperation between CBS Electronics and CBS Laboratories is helping to shape the future of solid-state technology through the CBS microelectronics program. Under way for the past two years, this program concentrates on basic approaches to thin-film deposition on inert substrates. It stresses also the development of microminiature devices featuring increased packing densities and reduced power levels for use in compact computers.

Learn about present and future semiconductor advances coming from the Lowell Progress Center. Investigate how the broad capabilities of CBS Electronics can help you achieve your solid-state objectives. Write today to CBS Electronics, Semiconductor Operations, Lowell, Massachusetts.

*MADT: Micro Alloy Diffused-base Transistor, *MAT: Micro Alloy Transistor.
*SBT: Surface Barrier Transistor, Trade-marks of Philco Corp.

Semiconductor Progress Center

Lowell Progress Center *concentrates on the engineering and production of CBS semiconductors for computer circuitry. Functional design gives the 200,000 square feet of plant space built-in flexibility to help in achieving highest standards of quality and reliability. Close cooperation with CBS Laboratories promises new and exciting solid-state developments for the future.*

Mass Production *of MADT high-speed switching transistors is accomplished on the most up-to-date equipment in the semiconductor industry. Exceptional reliability and uniformity are assured by automatic in-line production permitting 100% in-process quality control of each transistor.*

CBS® **semiconductors**

More Reliable Products through Advanced Engineering

CBS ELECTRONICS, Semiconductor Operations, Lowell, Massachusetts

A Division of Columbia Broadcasting System, Inc. • Semiconductors • tubes • audio components • microelectronics

Sales Offices: Lowell, Mass., 900 Chelmsford St., GLenview 2-8961 • Newark, N. J., 231 Johnson Ave., TAlbert 4-2450 • Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAymond 3-9081 • Toronto, Ont., Canadian General Electric Co., Ltd., LEnnox 4-6311.

Circle 200 on Inquiry Card

Instant Reset

Voltage Compensated

Vibration Resistant

Thermal Time Delay Relays

Precision-built Curtiss-Wright thermal time delay relays reset instantly when de-energized — provide the same delay period for each succeeding cycle. Compensated for wide voltage variations. Available in either 28V DC or 115V AC, 60 or 400 cps. Chatter-free operation, under severe shock and vibration conditions. Small sized, hermetically sealed, temperature compensated for precise, reliable operation and long life. Preset time delays from 10 to 180 seconds with SPST, SPDT or DPDT snap action contacts.

Write for latest complete components catalog #504

TIME DELAY RELAYS • DELAY LINES • ROTARY SOLENOIDS • DIGITAL MOTORS • TIMING DEVICES • DUAL RELAYS • SOLID STATE COMPONENTS

Electronics Division

CURTISS-WRIGHT CORPORATION

East Paterson, New Jersey

Circle 152 on Inquiry Card

News of Mfrs' Representatives

Elm Instrument Corp., Hempstead, N. Y., announces the following appointments of representatives: **Martin & Ozier**, Hawthorne, Calif., in California, Arizona, Nevada, and New Mexico; **L. E. Barnhart**, Jacksonville, Fla., in Florida, Georgia, and North and South Carolina; **Edwin A. Schulz Co.**, Indianapolis, Ind., in Indiana and Kentucky.

North Hills Electronics, Inc., Glen Cove, L. I., N. Y., has announced the appointment of **Terminal Radio International, Ltd.**, New York, N. Y., as their foreign representative.

Scientific Components Div. of Intellux, Inc., Santa Barbara, Calif., has appointed **Ault Associates**, Menlo Park, Calif., to cover Northern California and Nevada.

The **James S. Heaton Co.**, Redwood City, Calif., will represent the Elgin National Watch Co., Electronics Div., Burbank, Calif., in Northern California and Northwest Nevada.

The Monitor Relays Div. of Atlee Corp., Joliet, Ill., has appointed the following representatives: **Ellinger Sales**, Chicago, Ill., to cover Indiana, Iowa, Nebraska, Illinois, Kansas, Missouri and Wisconsin; and the **Reed & Riddett Co.** for New England states as well as New York City, Long Island and Northern New Jersey.

NOW!

CONTINUOUS PRODUCTION

permits a

PRICE REDUCTION

$229.50

F.O.B. NEW YORK

SEMICONDUCTORIZED

POWER SUPPLY

MODEL 5015

1-50 V.D.C. • 0-1.5 AMP

WITH • .05% regulation—500 μV ripple.

over 10,000 in use!

• ROBOTEC short circuit protection.

• HEATRAN electronic heat transfer.

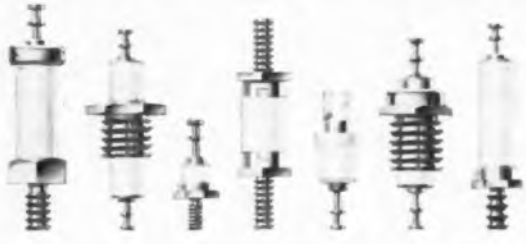
IMMEDIATE DELIVERY

Power Designs inc.

1700 SHAMES DRIVE, WESTBURY, NEW YORK

EDgewood 3-6200 (LD Area Code 516)

Circle 154 on Inquiry Card



Meet all conditions... with Cambion® insulated terminals

To give terminals positive protection against all known service risks, CAMBION uses five different insulating materials: *Diallyl Phthalate, Teflon*, Ceramic, Melamine and Phenolic*. CAMBION Diallyl Phthalate terminals maintain superior insulating qualities and dimensional stability under toughest service conditions, are moisture-proof, non-corrosive and have high resistance to chemicals. Teflon push-mount terminals meet special mounting requirements and withstand severe exposure conditions. Ceramic terminals prevent dielectric losses over a broad humidity range. For facts on all CAMBION insulated terminals write Cambridge Thermionic Corporation, 504 Concord Ave., Cambridge 38, Massachusetts.

*Reg. Dupont T.M.

CAMBRIDGE THERMIONIC CORPORATION

CAMBION®

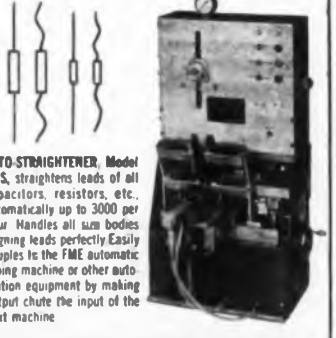
The guaranteed electronic components

Circle 153 on Inquiry Card

BOOST PRODUCTION with FME Automatic Machines

AUTO-FORMER, Model UF2RL, with optional handy hopper feed attachment, automatically cuts and forms pig-tails (leads of resistors, capacitors, etc.) up to 5000 per hour. This versatile machine will cut and shape any conceivable lead form on any component body with coaxial leads. Handles short-run production economically. Pays for itself quickly in time saved and quality of work.

ECONOMY BENDER, Model ECB, cuts and bends all leads automatically to any length up to 5000 per hour. Can be reset in minutes. Prepares leads of diodes and resistors for fast assembly in printed circuits or conventional wiring. Adjustable card feed chute permits rapid loading. Stellite tipped cutters assure trouble-free performance.



AUTO-STRAIGHTENER, Model AUS, straightens leads of all capacitors, resistors, etc., automatically up to 3000 per hour. Handles all size bodies aligning leads perfectly. Easily couples to the FME automatic taping machine or other automation equipment by making output chute the input of the next machine.

WRITE FOR DETAILED SPECIFICATION SHEETS TODAY.

DESIGN TOOL CO.
A Division of
Federal Manufacturing & Engineering Corp.
1055 Stewart Ave., Garden City, N.Y. • PI 2-7400

Circle 155 on Inquiry Card

New Products

WAVE GUIDE SWITCHES

Compact SPDT unit is rated at 300 kw unpressurized and 500 kw pressurized.

The MA-1064 switches may be pressurized to 45 psi. A low insertion loss of 0.15 db and a max. VSWR of 1.10 over the entire waveguide band are featured. Isolation in excess of 35 db is achieved by design of internal chokes and precision machining. Low holding current of 150 MA is achieved without using dropping resistors. This low holding power minimizes heating allowing operation at ambient temps up to 125°C. Waveguide Systems Div., Microwave Associates, Inc., Burlington, Mass.

Circle 341 on Inquiry Card

DC POTENTIOMETER

This unit is completely "self checking."

The Type 9144 is a 4 dial, 6 figure, dual range (x1:x0.1) dc vernier potentiometer with a total measuring capability of 2.101010 v. accuracy is ±0.001% warranted for a period of 5 yrs. Initial adjustment is guaranteed to be with ±0.0002% (2 ppm). Stability is guaranteed to be within ±0.00015% (1.5 ppm) per year or better. Thermal EMF's: Less than 1 μv; Resolution: 0.1 μv.; Functions include: a resistance comparator accurate to 2 ppm; a saturated standard cell comparator that will detect differences of 1 μv. Sensitive Research Instrument Corp., 310 Main St., New Rochelle, N. Y.

Circle 342 on Inquiry Card

ULTRASONIC DELAY LINES

For:

Memory in computers

Coding in telemetering and navigation

Range Marking in MTI Radar

Time Delay in precision delayed sweeps

Magnetostrictive delay lines for missile, aircraft, marine and ground based equipment. Wide delay application — 5 to 10,000 microseconds — with stability over a broad temperature range.

Small size, low cost, rugged, lightweight construction. Pulse repetition rate to one megacycle. Wide range of input and output impedances. Standard and custom built models.

Write for latest complete components catalog #510

TIME DELAY RELAYS • DELAY LINES • ROTARY SOLENOIDS • SOLID STATE COMPONENTS • DUAL RELAYS • DIGITAL MOTORS • TIMING DEVICES

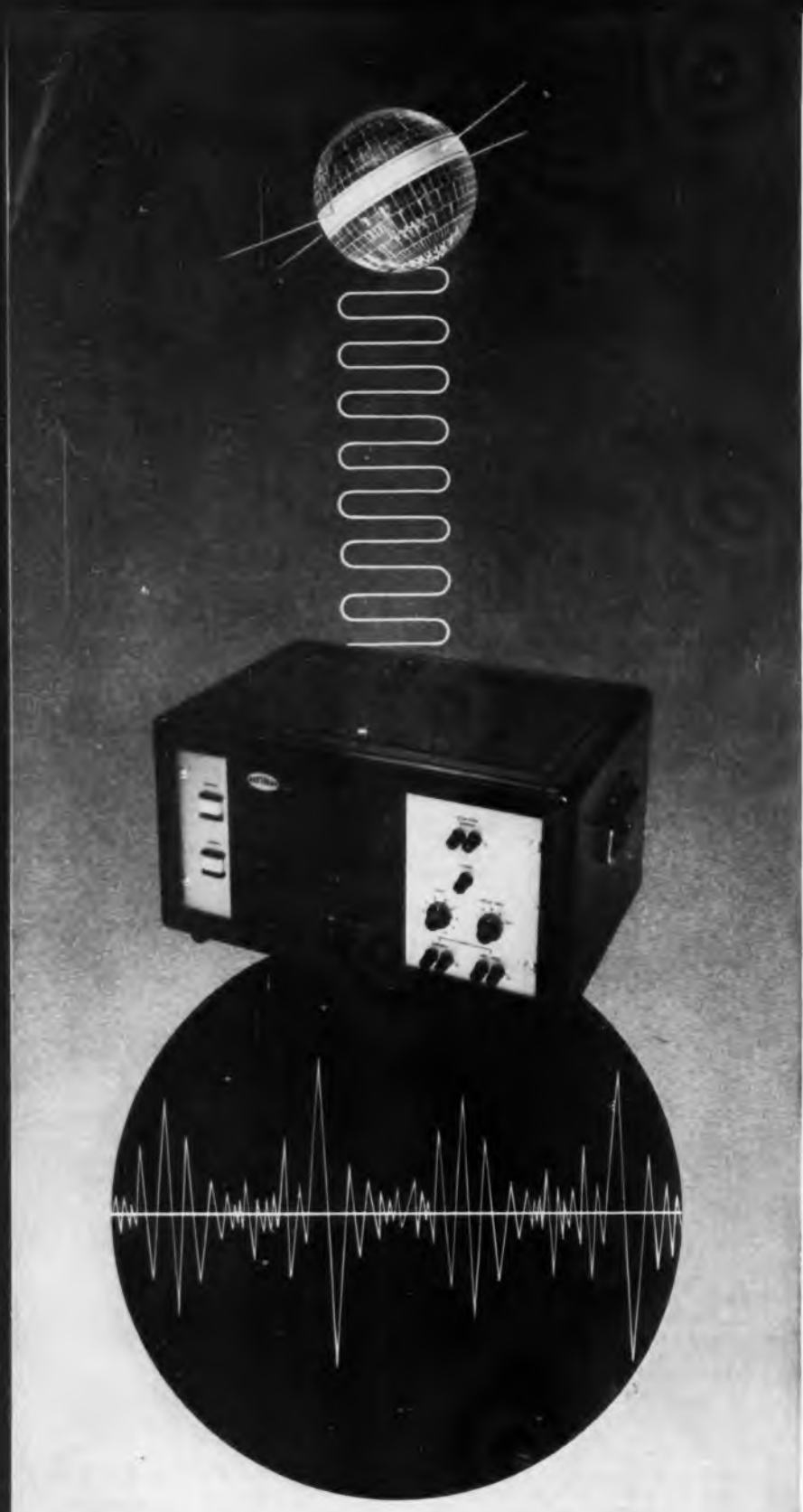
AD NO 4519

ELECTRONICS DIVISION

CURTISS WRIGHT

CORPORATION
EAST PATERSON, NEW JERSEY

Circle 156 on Inquiry Card



High Speed, High Resolution, High Sensitivity Spectrum Analysis With *Rayspan*

SPECTRUM ANALYZER

Raytheon Rayspan Spectrum Analyzers provide several important benefits not available with sweeping gate single filter type analyzers. Through a unique application of multiple filters, it is capable of analyzing entire spectrums as wide as 33 kc at scanning rates as high as 200 times per second with excellent resolution and sensitivity. Frequencies as low as 20 cps can be identified. Resolution for two equal-amplitude signals is approximately 0.7% or 3% of the analysis band depending on the Rayspan model employed. Dynamic range of 40 db.

Any model can be adapted for use with high speed, helix recorders to provide permanent records of frequency versus real time. A built-in timing pulse generator allows scan-by-scan synchronization of Rayspan with an oscilloscope.

The ability to analyze a wide frequency range rapidly and continuously, makes it the most versatile analyzer available for such application as Telemetered Data Analysis, Industrial Noise Reduction, Shock and Vibration Studies, Complex Waveform Analysis, Transmission Surveillance, Speech Analysis, Acoustic Studies, Equipment Inspection. For complete technical data please write to: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

Circle 127 on Inquiry Card

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

RAYTHEON

Raytheon Cathode Ray Tubes Operate at 100,000 feet without Corona

The Raytheon CK1354 and CK1355 display cathode ray tubes, used in the SAC "Hustler," are designed to operate in unpressurized areas of aircraft at altitudes up to 100,000 feet without corona. The CK1354, a three inch tube, is used for photographic purposes and the seven inch CK1355 is used in a direct visual application. Quick disconnect features eliminate potting of high voltage terminals and allow rapid replacement.

Both tubes are designed to meet exacting mechanical dimensions for rotating deflection yoke assemblies, and the high altitude requirements of Mil-I-6181-B.

If the development of airborne radar equipment is currently of interest to you, then investigate the many advantages offered by these remarkable tubes. Also inquire about the other types of industrial and military cathode ray tubes in Raytheon's comprehensive line.

For technical information or design assistance please write to Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

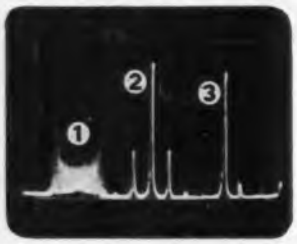
Circle 157 on Inquiry Card

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

RAYTHEON

Lab setup shows SB-15a versatility. (1) FM display measures dynamic deviation. (2) and (3) are AM and SSB signals, respectively, with sine wave modulation.



MORE ULTRASONIC ANALYSES *faster easier high accuracy*

PANORAMIC'S NEW, IMPROVED SB-15a spectrum analyzer 0.1 kc to 600 kc

Find, identify and analyze more types of ultrasonic signals with Panoramic's advanced Model SB-15a . . . economical, compact and completely self-contained.

• Noise, vibration & harmonic analysis • Filter and transmission line checks • Telemetry analysis • Communication System Monitoring . . . and more—Power Spectral Density Analysis and Frequency Response Plotting (with companion equipment).

SB-15a specifications:

• *Frequency Range:* 0.1 kc to 600 kc • *Sweep-width:* variable, calibrated from 1 kc to 200 kc • *Center Frequency:* variable calibrated from 0 to 500 kc • *Markers:* crystal controlled at 10 kc and 100 kc intervals • *IF Bandwidth:* variable 100 cps to 1 kc • *Sweep rate:* variable, 1 cps to 60 cps • *Amplitude Scales:* Lin, 40 db log (extendable to 60 db), 2.5 db expanded • *Sensitivity:* 200 μv to 200 v full scale • *Accuracy:* ± 0.5 db.

Write today for detailed technical data on the SB-15a . . . NEW CATALOG DIGEST . . . and regular mailing of THE PANORAMIC ANALYZER, featuring application data.

dependable CERTIFIED SPECIFICATIONS for accurate data

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540 So. Fulton Ave., Mt. Vernon, N. Y.
OWens 9-4600 • TWX: MT-V-NY-5229
Cables: Panoramic, Mt. Vernon, N. Y. State

Circle 165 on Inquiry Card

New Products

LIGHTNING ARRESTOR

Type LA-4 uses a magnetic type spark gap.

Normally used as a transmitter arrestor, this unit has a mounting flange that can be adapted to fit into an antenna coupler or can be employed by itself. Specs are: shunt capacity: 10.5 μf; r-f spark gap voltage: 11,250, peak 2 MC; lightning stroke: exceeds Mil-A-9094C; freq. range: 2-32 MC; max. r-f current at 2 MC: 15 a. RMS; impact and vibration: meets Mil-A-9094C; series capacitor: 0.002 μf min., 20,000 vdc test; temp. range: —55°C to 110°C. Dale Electronics, Inc., Columbus, Nebr.

Circle 348 on Inquiry Card

CAM FOLLOWERS

Miniature stainless steel units are for precision timing applications.

Available in face widths from 0.1406 to 0.1960, the units incorporate a shielded ABEC 7 tolerance ball bearing fitted on a concentric ground shaft to insure full-contact tracking and smooth, reliable operation. Outside dia. ranges from ¼ to ⅝ in. PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.

Circle 345 on Inquiry Card

PRINTED CIRCUIT KITS

Kit has all materials needed for "at-the-desk" prototype make-up.

Using the kit's copper-clad Fotoceram grid boards, resist materials to lay out circuit patterns, and etching materials to etch away copper beyond the circuit runs, a designer can produce a printed circuit on glass-ceramic substrate in 15 minutes, without leaving his desk. Corning Glass Works, Corning, N. Y.

Circle 347 on Inquiry Card

ADHESIVE APPLICATOR

Push button controlled unit has easy, instantaneous, regulated flow.

The applicator, Model B, feeds solvent and water-based adhesives through a flexible hose directly into the brush under ordinary factory air pressure. It includes a pressure tank which dispenses adhesives of average viscosity at 20 lbs. pressure and an air regulator allowing accurate setting at any desired pressure. Three outlets on the tank permit 3 operators to work from one unit. Bostik Adhesives, B. B. Chemical Co., Subsidiary of United Shoe Machinery Corp., 784 Memorial Dr., Cambridge 39, Mass.

Circle 346 on Inquiry Card

THERMISTOR PROBE

Model G-379 is for small close work.

It is a 27 gauge hypodermic needle, made of stainless steel, and has a diameter of 0.022 in. It will accommodate a variety of different thermistors and is useful as a fast time-constant temperature probe. Fenwal Electronics, Inc., 51 Mellen St., Framingham, Mass.

Circle 349 on Inquiry Card

COPPER-CLAD LAMINATE

Micarta grade 65M24 is classified as a non-burning material.

This new epoxy resin/paper base laminate is for printed circuit applications requiring high strength and consistent electrical properties over a wide range of humidity levels. Electrical properties include: a dissipation factor of 0.034 at 1 MC; dielectric constant of 4.5 at 1 MC; insulation resistance of 100,000 megohms; volume resistivity of 1,000,000 megohms/centimeter; and a surface resistance of 1000 megohms. The material is available in sheets 36 x 36 in. or 36 x 72 in. and thicknesses ranging from 1/32 in. to ¼ in. Micarta Div., Westinghouse Electric Corp., Hampton, S. C.

Circle 350 on Inquiry Card

QUANTITATIVE MEASUREMENT OF RESISTOR NOISE

WITH

Model 315 Resistor Noise Test Set

The QUAN-TECH Model 315 Resistor Noise Test set is a highly compact unit for making precise quantitative measurements of excess noise resulting from current through resistors.

Testing with the Model 315 is rapid—operating procedures are simple. Resistors of any type within the ohmic values specified below may be tested. Index of measurement is microvolts-per-volt in a decade of frequency, as recommended by the National Bureau of Standards.

- Conforms to system and specifications recommended by the National Bureau of Standards
- Accepts any type of resistor
- Simple operation; adaptable to production line "go-no-go" use
- Single, compact, bench-size unit

In addition to the front-panel indication, outputs are available for data processing, driving go-no-go indicators, or for external monitoring.

Write for complete details

MAJOR SPECIFICATIONS

Range:	Resistor test range 100 ohms to 22 megohms Noise voltage 0.6 μvolts in a decade to 1000 μvolts in a decade Applied DC voltage 3 to 300 volts
Filter:	Flat-topped, 1000 cycle bandpass. Geometric mean at 1000 cycles
Detector:	Pure RMS
Output:	Indicated for both noise voltage and applied DC voltage on separate front-panel meters. Analog outputs for data processing. AC monitor jack.
Accuracy of Noise Voltage Measurement:	±5%
Price*:	$1550 f.o.b. Boonton, N. J.

*Optional remote measuring cable, $75.00

Quan-Tech LABORATORIES
Boonton, New Jersey

Circle 159 on Inquiry Card

TELEMETRY BY TELE-DYNAMICS

Universal Millivolt Subcarrier Oscillator

For your aerospace telemetry needs here is a new Subcarrier Oscillator with true differential input . . . direct actuation from outputs of grounded or ungrounded thermocouples, strain gage bridges and any transducer with millivolt level output. Other features include isolated input and output, high common mode rejection with no D.C. level restrictions and all silicon semiconductors.

Tele-Dynamics' Type 1254A directly replaces the combination of preamplifier and high-level subcarrier oscillator now used in FM telemetry and assures reliable operation in aerospace environments.

For detailed technical bulletins, call the American Bosch Arma marketing offices in Washington, Dayton or Los Angeles. Or write or call Tele-Dynamics Division, American Bosch Arma Corporation, 5000 Parkside Avenue, Philadelphia 31, Pa. Telephone: TRinity 8-3000.

See this and other new Tele-Dynamics' components in Booth E 50 at the National Telemetering Conference May 22nd, 23rd, 24th at Sheraton Towers, Chicago.

TELE-DYNAMICS
DIVISION
AMERICAN BOSCH ARMA CORPORATION

Circle 160 on Inquiry Card

New Products

CONTOUR CABLE

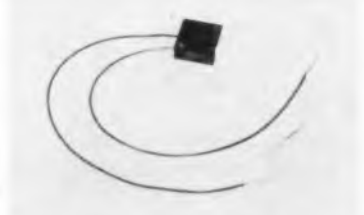
Flat cable saves space and weight in missiles and aircraft.

It consists of imbedded flat metallic strips in a plastic dielectric ribbon. Up to 40 separate conductors may be contained in a single cable. Whereas 1000 ft. of conventional cable (20-conductor, 22-gauge aircraft type) weighs 82 lbs.; contour cable weighs 52 lbs. for the same current carrying capacity. By applying an adhesive to the cable and sticking it to an inner missile airframe, space is saved. Hughes Aircraft Co., El Segundo, Calif.

Circle 337 on Inquiry Card

POTENTIOMETER

Resolution at 50 kilohms is 0.086%.



New Daystrom Squaretrim® Model 355 provides a subminiature high-temp. precision trimming potentiometer in a high-density package ½ x ½ x 0.2 in. Resistance values run from 10 Ω to 50 kΩ over an operating temp. range from −55°C to +200°C. Three 4 in., 30 AWG, Teflon-insulated wire leads are positioned at the narrow end. Unit is for matching, balancing, and adjusting variables in precision control, computing and telemetering circuits. Daystrom, Inc., Potentiometer Div., Archbald, Pa.

Circle 338 on Inquiry Card

NEW STROMBERG-CARLSON TELEPHONE HANDSET CRADLE

. . . for positive retention in all mobile applications

There's no jump, no sway—when a telephone handset is in the firm grip of this new Stromberg-Carlson® handset cradle.

Retaining clip spring assembly assures positive retention in any mobile application on land or sea, or in the air. Even extremely severe jars, jolts and vibrations fail to dislodge the handset.

The cradle is strong and resilient, fits any Stromberg-Carlson handset. Different models provide varying switch combinations with 2 or 4 Form C contacts. All models available with or without the clip assembly.

Details on request from these Stromberg-Carlson offices: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

STROMBERG-CARLSON
A PRODUCT OF GENERAL DYNAMICS | ELECTRONICS

Circle 161 on Inquiry Card

WHEN IS AN ABSORBER AN ABSORBER?

When it's a symbol on the drawing board ... a sample under test ... a finished product?

The same question can be asked about a dielectric material, a ferrite, a core.

The answer: any microwave or rf attenuator is satisfactory only when it fulfills the requirements of the system.

As our name implies, Custom Components is more than a manufacturer of attenuator materials. We are a facility that translates the performance specifications of your system into specific materials, shapes, weights and sizes.

When is an absorber an absorber? When your attenuation problem becomes our attenuation problem!

CUSTOM COMPONENTS, inc.

P.O. Box 248, Caldwell, N.J.
CApital 6-3404

Circle 162 on Inquiry Card

New Products

DIRECTIONAL COUPLERS

These waveguide instruments cover from 2.60 to 40.0 GC.

This series of 8 models in 5 basic design configurations offers crossguide, narrow-wall and prevision broad wall versions. All models are available with standard values of coupling. Other electrical characteristics, such as: directivity, coupling, sensitivity, and VSWR are optimized over the complete waveguide freq. range. These units are manufactured of rugged brass construction with silver plating and instrument grey enamel finish. Waveline Inc., Caldwell, N. J.

Circle 361 on Inquiry Card

TEST CHAMBER

Chamber is for environmental testing of electronic components.

Unit has full front opening door and is portable. Model TEC-6R, a floor standing unit is mechanically refrigerated and electrically heated with an operating temp. range of −100°F to +400°F. The stainless steel chamber has a working volume of 1.5 cu. ft. A circulating fan maintains a max. of ± 2°F temp. gradient throughout the chamber. Temp. change rates are ambient to −100°F in 30 min. and ambient to +400°F in 20 min. Auto-Control Laboratories, Inc., 5251 W. Imperial Hwy., Los Angeles 45, Calif.

Circle 362 on Inquiry Card

Q:

How important is
PULSE WIDTH
in electronic welding?

A:

Very important!

Too-long pulses waste weld energy—cause discoloration and deformation. Too-short pulses can also give unsatisfactory welds. ■ An exhaustive research study, just completed, shows the results of pulse width tests of Hughes welding power supplies. ■ Tests were made during actual welding of high and low conductivity metals. Pulse widths varied from 0.0008 to 0.0025 sec. ■ 'Scope photos show how proper design of the weld transformer to match capacitor discharge characteristics produces the shortest *practical* welding pulse.

Copies of this valuable illustrated study, the first of its kind released by any manufacturer, are available on request. Write or wire today for your FREE copy of the PULSE STUDY.

CREATING A NEW WORLD WITH ELECTRONICS
HUGHES
HUGHES AIRCRAFT COMPANY
VACUUM TUBE PRODUCTS DIVISION
2020 Short Street, Oceanside, California

Circle 163 on Inquiry Card

IN LESS THAN 4 SECONDS

FROM THIS

TO THIS

OR THIS

WITH THE REVOLUTIONARY PRODUCTION AID TOOL!

"PIG-TAILOR"®

Foot operated
No accessories
3 minute set up

$125.00

"PIG-TAILORING"

a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.

PIG-TAILORING eliminates: • Diagonal cutters • Long nose pliers • Operator judgment • 90% operator training time • Broken components • Broken leads • Short circuits from clippings • 65% chassis handling • Excessive lead tautness • Haphazard assembly methods.

PIG-TAILORING provides: • Uniform component position • Uniform marking exposure • Miniaturization spacing control • "S" leads for terminals • "U" leads for printed circuits • Individual cut and bend lengths • Better time/rate analysis • Closer cost control • Invaluable labor saving • Immediate cost recovery.

Pays for itself in 2 weeks

"SPIN-PIN"®

Close-up views of "SPIN-PIN" illustrate fast assembly of tailored-lead wire to terminal.

- No Training
- No Pliers
- No Clippings
- Uniform Crimps
- 22 Sizes

PAYS FOR ITSELF THE FIRST DAY!

$5.00 EACH

Write for illustrated book to Dept. EI-5

BRUNO-NEW YORK INDUSTRIES CORP.

DESIGNERS & MANUFACTURERS OF ELECTRONIC EQUIPMENT

Circle 164 on Inquiry Card

New Products

HIGH TEMP. VACUUM OVEN

Oven operates at Temps. up to 800°C and pressures down to 0.000001 mm.

Temp. uniformity is maintained ±3°C at 0 to 800°C. The internal construction of the high vacuum oven is a suspended muffle heated by radiant heaters and reflective shielding. Ovens are offerd with or without one of several different vacuum pumping systems, depending on requirements. Two oven sizes 8 x 8 x 14 in. and 14 x 14 x 16 in. (inside dimensions) are offered. Provision for a total of 6 thermocouples for temp. studies is also included. Tri Metal Works, Inc., 1600 Bannard St., Riverton, N. J.

Circle 359 on Inquiry Card

ELECTROLYTIC CAPACITORS

These units are designed for max. capacitance in small physical size.

Powerlytic® Aluminum Electrolytics find wide use in power supplies for digital computers, industrial controls, and allied equipment. Ratings to 150,000 μf at 3 v. or 1000 μf at 450 v. are in a standard case size of only 3 in. dia. x 4⅝ in. high. Standard ratings in working voltages from 3 to 450 vdc at 65°C max. ambient temp. are available. Sprague Electric Co., 233 Marshall St., N. Adams, Mass.

Circle 358 on Inquiry Card

MINIATURE ATTENUATORS

Rugged, compact design for use where space is at a premium.

Printed circuit types enable circuit arrangement to provide up to 20 steps of attenuation. Accurate composition ½ w resistors are featured in these units with wire-wounds available. Attenuation is increased with counter clockwise rotation. These units are available in the ladder and potentiometer. Specific requirements and performance are the same as the standard type specifications. Cinema Engineering Div. of Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

Circle 357 on Inquiry Card

SHIELDED CONTAINER

Ruggedized for transporting or storing magnetic tapes.

The container is constructed of stress reinforced Netic S-3 magnetic shielding alloy, meeting Mil. drop and environmental specs. Shock absorbing liner allows simple positioning of ¼ to 2 in. wide tapes in any combination. Rubber gasket, pressure seals upon locking, make the container virtually moisture proof. Containers are currently available for 14 in. reels; other sizes can be fabricated. Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.

Circle 360 on Inquiry Card

SPRAGUE®

MODEL 500 INTERFERENCE LOCATOR

LOCATE rf NOISE SOURCES QUICKLY

This versatile instrument is a highly sensitive interference locator—*with the widest frequency range of any standard available unit!* Model 500 tunes across the entire standard and FM broadcast, shortwave, and VHF-TV spectrums from 550 kc. to 220 mc. in 6 bands.

It's a compact, portable, rugged, versatile instrument—engineered and designed for most efficient operation *in practical field use.* It features a transistorized power supply, meter indications proportional to carrier strength as well as sensitivity of 5 microvolts minimum for 5% meter deflection over entire tuning range.

For full details, send for brochure IL-106.

SPRAGUE ELECTRIC COMPANY
233 Marshall Street, North Adams, Mass.

SPRAGUE®
THE MARK OF RELIABILITY

Circle 166 on Inquiry Card

New Products

KLYSTRON

Use of a "one way" electron beam eliminates hysteresis problems.

Model LKC-5 is a single cavity oscillator with high efficiency, light weight and no magnetic field requirements. For operation at freqs. from 800 to 13,000 MC, these tubes require only one adjustment to fix oscillation freq. Characteristics are: power output, 5 w cw; beam voltage, 1200 ± 50 vdc; control electrode voltage, 60 v. max.; beam current, 60 ma. max.; half power bandwidth, 7.5 MC. Lewis and Kaufman Electronics Corp., Tube Div., P. O. Box 337, Los Gatos, Calif.

Circle 367 on Inquiry Card

COMPUTER RELAY

Hi speed units for transistor circuits operate in less than 750 μ sec.

Driving voltage is a nominal 20 v. They have polarized driving systems with center tapped driving coils. Switching circuits are for dry to 10 v. levels with 100 million operations reliability. Models include DPDT and SPDT. Normally open and normally closed circuits are available. James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Circle 368 on Inquiry Card

300% FASTER ULTRASONIC CLEANING*

WITH THE NEW SELF TUNING AUTOSONIC BY POWERTRON

Powertron Autosonics are the only cleaners that continuously tune themselves electronically to give you peak cleaning efficiency. Regardless of load changes, liquid level, liquid temperature, or operator inattention, you get top cleaning performance hour after hour with no controls other than a single switch

The Powertron self tuning feature is available in a complete line of Autosonic tank units, consoles, cabinet models, immersible transducers, and vapor degreasers that...

ELIMINATE OPERATOR TRAINING AND MONITORING
IMPROVE QUALITY
REDUCE REJECTS
CUT LABOR AND SOLVENT COSTS

*Case histories on file show up to 900% faster cleaning consistently and savings as high as $3,000 a month in labor costs under ideal conditions.

Send for Powertron's free booklet 60-1, "How to Clean Ultrasonically with Self Tuning."

POWERTRON ULTRASONICS CORPORATION

DEPT. EI-5 • PATTERSON PL., ROOSEVELT FIELD
GARDEN CITY, L.I., N.Y. • Pioneer 1-3220

Circle 167 on Inquiry Card

MICROWAVE DELAY LINES

where accuracy counts

In delay lines, where exacting design and construction standards apply, look to Turbo.

Turbo designs are available, with complete testing, for both fixed and variable systems, for waveguide and coaxial lines, from 1 to 26 kmc, from 0.01 to 2.5 microsecond. Write for complete specification and price data for standard units. Or ask about special designs involving problems of space, configuration, and performance.

TURBO MACHINE CO., Lansdale, Pa.
Telephone: ULysses 5-5131

TURBO

Circle 168 on Inquiry Card

Siemens Hallgenerators

GRH Gaussmeters

GRH Coercimeters

available from stock ranges from 0-50 up to 0-20000 gauss, no amplifier for instant indication of H_c

GRH Halltest Company

authorized US representative for Siemens Hallgenerators

157 S. Morgan Blvd., Valparaiso, Ind.

GRH

New Products

AMPLIFIER

Dual-channel, direct-coupled amplifier is for use in analog computers.

The amplifier, designated Model 508-DR, has a bandpass of 3 db down at 100 kc. It features long term stability, minimum phase shift, low noise level and a phase margin of 6.8. In addition to its application to standard dc analog computers, the unit is suited for special instrumentation problems, precision test equipment and special purpose analog computers. Computer Systems, Inc., Culver Rd., Monmouth Junction, N. J.

Circle 351 on Inquiry Card

RECORDER/REPRODUCER

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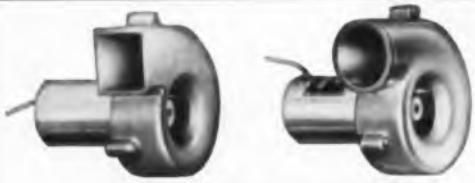

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2"	FC a.c.	50	1½"	MC a.c.	17.5
2"	LL d.c.	36	1½"	MM d.c.	13
			2"	FC a.c.	20
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Committee Set Up By EIA

Electronic Industries Association's Subcommittee on Microminiature Components for Computer Use has been given full committee status within the EIA Engineering Dept. It will function as an advisory committee on user recommendations for discrete microminiature components for all applications. The group, re-designated the Microminiature Components Advisory Committee, has been given an "across the board" advisory function.

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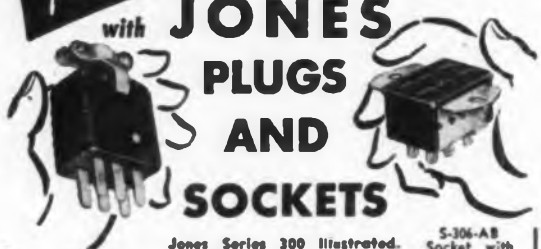

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International Electronic Sources

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CIRCUITS

Some Circuits of Half-Cycle (High-Speed) Magnetic Amplifiers for Servodrive, V. G. Lenkov, et al. "Avto. i Tel." February 1961. 9 pp. Three circuits of high-speed magnetic amplifiers for a servodrive are considered. Their peculiarities are discussed. (U.S.S.R.)

Self-Saturating Magnetic Amplifier According to Voltage Doubling Circuit, A. Lipman, A. I. Monkalev. "Avto. i Tel." February 1961. 7 pp. A dc output self-saturating magnetic amplifier designed according to a doubling rectifier circuit is considered. (U.S.S.R.)

Second Harmonic Magnetic Modulator with Supply from Quadrature Drift Circuit, M. A. Rakov, L. A. Sinitzky. "Avto. i Tel." February 1961. 5 pp. Possibility of supply of a second harmonic magnetic modulator from quadrature drift circuits is considered, that eliminates filters from excitement nets and modulator control nets. (U.S.S.R.)

To Calculation of Thermal Resistance Circuit with Relay Behavior, V. F. Backmutsky. "Avto. i Tel." January 1961. 4 pp. The calculation technique for a thermal resistance circuit with a relay behavior for a set diapason of controlled temperature is explained. (U.S.S.R.)

Simple Transistor Circuits, R. Gondry. "El. et Auto." Feb. 1961. 2 pp. Four simple transistor circuits are described. (France.)

Trochotron Driving Circuits. "El. et Auto." Feb. 1961. 3 pp. This article describes some semiconductor circuits specially designed for trochotron tubes. (France.)

The Use of Karnaugh's Mirror Symbol for Transfluxors, F. Scheiber. "Freq." Feb. 1961. 4 pp. To facilitate work with transfluxor circuits, a suitable transfluxor symbol is proposed, which is patterned after the well-known mirror symbol for toroidal cores by Karnaugh and adopts its advantages of simplicity and clarity. (Germany.)

Counter Algebra—A Symbolic Analysis of General Counts of Multiple Coincidence, F. A. Behringer. "Nach. Z." February 1961. 4 pp. The main subject of this paper is a proof of the fact that any pulse count which has to be carried out by means of a complicated multiple coincidence circuit, can be substituted by several partial counts requiring only simple basic circuits. (Germany.)

The Four-Layer Silicon Diode and Its Uses as a Circuit Element, H. Keller & G. Wieczorek. "Freq." Feb. 1961. 7 pp. The paper discusses basic and well-proven circuits and gives a survey of the wide potentialities of this novel circuit element. (Germany.)

The Magnetic Flux Counter, G. Muller. "Nach. Z." February 1961. 7 pp. The principle of multi-stable magnetic storage is explained by means of basic counting circuits and by a mathematical description of the inversion of the magnetic field and the counting process. (Germany.)

A Selective RC-Amplifier Circuit, V. S. Adreyev. "Radiotek" 16, No. 1, 1961. 8 pp. The author analyzes a selective RC-amplifier, based on a phase-inverting cascade and a Wien-bridge, and considers the possibility to raise its equivalent efficiency by the addition of an extra amplifier. (U.S.S.R.)

Parameters of Complex Electronic Circuits and Their Application to Analyses. N. I. Smirnoff. "Radiotek" 16, No. 1, 1961. 8 pp. In the design of complex electronic circuits, it is required to perform many similar matrix conversions. Such conversions could be performed on a more general way once to reduce the total number of operations. However, for a multipole circuit, it presents considerable difficulties. In this article, these difficulties are solved to a certain extent, and relatively simple expressions are obtained for circuit parameters which do not contain matrix conversions. (U.S.S.R.)

COMPONENTS

Some Aspects of Component Reliability, J. G. Assenheim. "Brit. C.&E." March 1961. 4 pp. This article describes how the reliability of electronic components, including transistors, semiconductor diodes, capacitors and resistors, is largely dependent upon operating conditions, and how important these are when determining reliability. (England.)

New Results of Investigating Digital Mechanical Control and Operational Components, H. H. Glattli. "El. Rund." Feb. 1961. 3 pp. Hydraulic and pneumatic components are faster and more adaptable than conventional mechanical components. Development of these hydraulic and pneumatic components aims at small dimensions and high reliability. Basic components, simple circuits, test results and design examples give an impression of the state of the art. (Germany.)

The Long-Term Behavior of Materials and Electronic Components, J. Tretter. "Freq." Feb. 1961. 9 pp. The paper shows the progress in time of disaccommodation, aging, recovery, and regeneration processes on semiconductors, ferroelectric, ferromagnetic, plastic, and other materials, pointing out what is common and generally applicable in the behavior and attempting to give a theoretical explanation. (Germany.)

COMPUTERS

Electronic Decode and Code Functional Generators, V. B. Smolov. "Avto. i Tel." February

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 Uebertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
Nach. Z. Nachrichtentechnische Zeitschrift
Rt. Regelungstechnik
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Valuum-Technik

POLAND

Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechnizne

USSR

Avto. i Tel. Artomatika 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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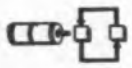
International ELECTRONIC SOURCES

1961. 7 pp. Digital-analog computers which can be used for functional decoding of digital information and for functional coding of analog information are described. (U.S.S.R.)

Method of Selecting Optimum Structure of Digital Analog Computers, A. V. Shileiko. "Avto. i Tel." January 1961. 8 pp. A method of selecting the digital computer optimum structure is presented. (U.S.S.R.)

Telemetering in Process Control, E. Wintergerst. "rt." Jan. 1961. 7 pp. The article begins with mathematical and experimental investigations into the speed transmission with pneumatic tele-transmission of measured values. This is followed by a comparison between the transport lag with pneumatic and electrical telemetering respectively. The article ends with a description of simple computers used in direct conjunction with telemetering systems. (Germany.)

Optimizing the Control of a Sinter Process by Means of a Digital Computer, K. J. Lesemann. "rt." Jan. 1961. 8 pp. A sinter plant is chosen as example to prove that it is possible by using a digital computer for data processing and as a kind of superior control system, to obtain optimal process control conditions dispensing with process equations. (Germany.)



CONTROLS

Concerning Estimation of Self-Oscillation Parameters in Non-Linear Control Systems, V. R. Andrievsky. "Avto. i Tel." February 1961. 5 pp. The paper deals with an estimation of self-oscillation parameters in non-linear control systems which permit to use the describing function principle. (U.S.S.R.)

New Elaborations Concerning Remote Control High-Frequency Channels, Ya. L. Bykhovsky, et al. "Avto. i Tel." February 1961. 8 pp. The paper deals with the elaborations concerning remote control high-frequency channels which were developed at the All-Union Scientific Institute of Electrical Power. (U.S.S.R.)

Transient Processes in Extremum Control Systems with Dynamic Sensitive Unit, A. P. Yurkevich. "Avto. i Tel." February 1961. 9 pp. Peculiarities of transient processes in an extremum control system with a memory and a sensitive unit of a dynamic type are considered. (U.S.S.R.)

Dual Control Theory IV, A. A. Feldbaum. "Avto. i Tel." February 1961. 14 pp. A generalized algorithm for dual control optimum strategy of a controlled object with memory and some inputs and outputs is deduced. An example of application of the algorithm is given. (U.S.S.R.)

Optimum Processes in Systems with Distributed Parameters, A. G. Butkovsky. "Avto. i Tel." January 1961. 10 pp. A problem of optimum control is considered for systems which motion is described in general case by non-linear integral equations connecting output coordinates of the system with control actions. (U.S.S.R.)

Some Problems of Design of Systems with Self-Adaptive Extremum Corrective Devices, V. N. Varygin. "Avto. i Tel." January 1961. 10 pp. Equations are obtained for an extremum self-adjustment of corrective devices of linear systems with scan oscillation frequency which is camparable to natural frequency of control main circuit. (U.S.S.R.)

Certain Numerical Methods for Determining Periodical Motions of Automatic Control Systems, Yu. I. Neimark. "Avto. i Tel." January 1961. 10 pp. Certain numerical methods for determining periodical motions of automatic control systems are recommended. (U.S.S.R.)

Theory of Dual Control, A. A. Feldbaum. "Avto. i Tel." January 1961. 14 pp. Two cases of an optimal dual control system synthesis are considered. (U.S.S.R.)

On-Selecting Parameter Correlations of Two Types of Third Order Single-Loop Automatic Control Systems with Additional Pulse on Derivative, L. G. Sobolev. "Avto. i Tel." January 1961. 4 pp. Recommendations concerning the selection of parameter correlations of two types of third order single-loop automatic control systems are given. (U.S.S.R.)

Sequence Controllers Acting as Regulating Elements in Principal Control Loops, R. Oetker. "rt." Jan. 1961. 5 pp. The fundamentals of such structures are developed and explained with the help of examples dealing with cascade, computer, and optimizing control systems. (Germany.)

Control Techniques at the 1960 Interkama Exhibition, H. Kronmuller. "rt." Jan. 1961. 6 pp. This report gives a review of the state of the measuring and control techniques as observed at the 1960 Interkama Exhibition. (Germany.)

Regulating Behavior and Disturbance Response in Combustion Control Systems, A. Schneider. "rt." Jan. 1961. 7 pp. The controlled plant dealt with comprises the entire combustion process from the fuel and air intake to the generation of heat. (Germany.)

GENERAL

Law Determination for Piloting Planes in Order to Obtain Optimal Trajectory When Piloting with the Wind Changing, V. D. Matytzin. "Avto. i Tel." January 1961. 10 pp. An extremum problem for determining the conditions required for the quickest flight of a plane from one to another point of the space, with the wind changing in coordinates and in time dependence is considered. (USSR.)

A Low Cost Trunk Cable System, R. N. Burton. "Brit. C.&E." March 1961. 4 pp. The considerations determining the choice between open wire lines on poles and underground cable are rather different in under-developed areas compared to developed ones. This article describes the particular requirements in The Sudan and the methods used to meet them. (England.)

Stability of Multistage Magnetic Amplifiers with Negative Feedback, M. A. Rozenblat, G. V. Subbotina. "Avto. i Tel." Jan. 1961. 10 pp. A multistage magnetic amplifier is considered as a linear system with time-delay; frequency criterion is used to investigate the stability of the amplifier with a negative feedback. (USSR.)

Telemetry Signals from Sputnik III, R. E. Henderson. "El. Tech." March 1961. 4 pp. Equipment is described for transcribing telemetry signals from Sputnik III from magnetic tape on to photographic film. (England.)

Automatic Optimization of Space Distribution, L. N. Fitzner. "Avto. i Tel." Jan. 1961. 10 pp. The principles of automating the distribution process of some physical value in the space are considered. (USSR.)

Limited Dynamic Properties of Power Executive Components of Servosystems. II, G. A. Nadzhafova. "Avto. i Tel." February 1961. 14 pp. Limited dynamic properties of dc electrical executive mechanisms with independent excitation which are loaded with a moment of dry forces are determined. (USSR.)

About Experimental Determination of Dynamic Characteristics of Pneumatic Pipes, A. M. Smirnov. "Avto. i Tel." Jan. 1961. 2 pp. An apparature for determining dynamic characteristics of pneumatic pipes by means of the frequency characteristic method is briefly described. (USSR.)

On the Summation of Two Oscillation Fields, J. Owczarek. "Roz. Elek," Vol. 6, No. 4. 22 pp. The paper deals with oscillation fields varying sinusoidally with the same frequency of oscillation. The analysis of their summing is carried out by using the method of investigating a curve of the second degree. (Poland.)

Anti-Symmetric Feedback Two-Channel Servo System with Random Disturbances, "Avto. i Tel." Feb. 1961. 14 pp. Common ways of analyzing random stationery processes in linear systems are generalized for systems with complex transfer and weight functions. (USSR.)

Description of Two New Fixed Station Shortwave Receivers for Telephone and Telegraph Service, D. Leypold, et al. "Freq." Feb. 1961. 8 pp. The receivers of the Types 135 E 103 and 125 E 101 were developed to supplant the shortwave receivers KW2/6 and 2KW1/3 for single-sideband and telegraph diversity operation, respectively; the paper reports about their principal features. (Germany.)

Description of the Telegraph Section of the New Fixed Station Shortwave Receivers, H. Meissner. "Freq." Feb. 1961. 3 pp. The paper describes the telegraph section of a new shortwave receiver for fixed stations. (Germany.)

The Question of Dialing by Code and Push Button, F. Etzel. "Nach. Z." Feb. 1961. 5 pp. At present the question of coded and push-button dialing in telephone exchange techniques is heavily discussed. It is shown that the main advantages of coded number transmission depends substantially on the type of the exchange system. (Germany.)

The Problems of Push Button Dialing, H. Oden. "Nach. Z." Feb. 1961. 7 pp. Early agreements are required in order to establish in the operation of push-button dialing the uniformity which corresponds to the international character of telecommunications. The points on which agreements should be reached are mentioned in the form of 14 questions. (Germany.)

Radioencephalography, F. Juster. "El. et Auto." Feb. 1961. 3 pp. This first part of a two-part paper studies a radio-encephalograph using subminiature tubes. The second part will describe transistorized equipment. (France.)

Magnetostrictive Ferrites with a High Mechanical Quality Factor, Z. Kaczkowski. "Roz. Elek." Vol. 6, No. 4. 24 pp. Basic definitions for the magnitudes determining magnetostrictive properties of magnetic materials are given. The problem of the mechanical Q factor of Ni-Zn ferrites as compared with other magneto-mechanical properties is discussed by way of example. (Poland.)

X-Ray Determination of Crystal Structures, P. B. Braun and A. J. van Bommel. "Phil. Tech." #4, 1961. 13 pp. The article deals with the principles underlying X-ray diffraction, discussing the relation between the structure and the diffraction patterns, and how the one can be derived from the other. (Netherlands, in English.)

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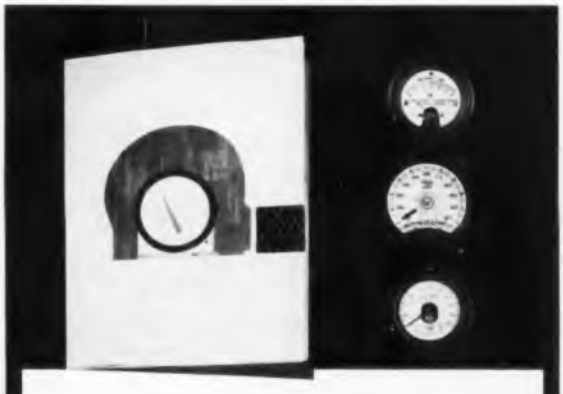

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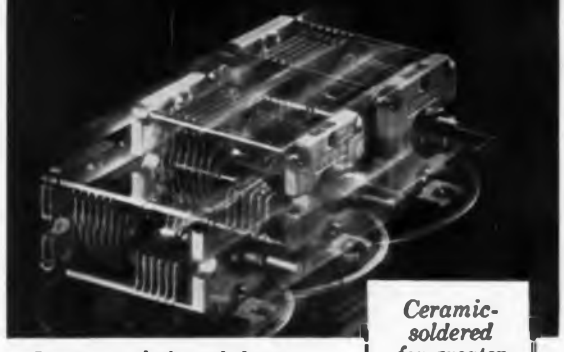

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International ELECTRONIC SOURCES

Germanium Double Crystals in Grain Boundary Photocells I. H. F. Matare. "El. Rund." Feb. 1961. 4 pp. The first part of this paper deals with the mechanical and chemical structures of the grain boundary, especially the potential field produced by free bonds and the resulting change of the electronic band distance. (Germany.)

Influence of Flaws on the Field Distribution in the Railway Bar and Directions for Magnetical Flaw Detection. "Roz. Elek," Vol. 6, No. 4. 60 pp. This article includes analytical determination of the field in a rectangular bar with a thin transverse crack. (Poland.)

Strip-lines and Troughs with Rectangular Flanges. A. Y. Yashkin, N. N. Borisoff. "Radiotek" 16, No. 1, 1961. 7 pp. In this article equations are derived relating the dimensions of rectangular protruding flanges to critical type H waves. The derived equations are applied to concrete designs of certain types of troughs and strips. (USSR.)

Recording Density of Wide-Band Signals. I. E. Goron, Y. P. Drobyshev. "Radiotek" 16, No. 1, 1961. 8 pp. In this article several feasible methods for magnetic recording of wide-band signals are considered. These methods are based on various principles of signal division. (USSR.)

Discrete Representation of a Time-Limited Signal. V. V. Lebedeff. "Radiotek" 16, No. 1, 1961. 6 pp. An interpolation function is considered for the representation of a time-limited signal by a set of discrete values. (USSR.)

INDUSTRIAL ELECTRONICS

A Nucleonic Coal Sensing Instrument. L. R. Cooper. "Brit. C.&E." Mar. 1961. 5 pp. This article, the last in a series from the Mining Research Establishment of the National Coal Board, described a nucleonic coal sensing system. (England.)

Fuel Cells. C. Denys. "El. et Auto." Feb. 1961. 7 pp. Among the new devices designed to provide a more efficient conversion of energy, fuel cells seem to offer more promises for the immediate future. Various types are studied. (France.)

New System of Pneumatic Computers. G. T. Berezovetz, et al. "Avto. i Tel." Jan. 1961. 8 pp. Methods of constructing pneumatic computers with continuous action based on the application of pneumatic operational amplifiers working at low pressure (0-100 mm of the water column) are described. (USSR.)

MEASURE & TESTING

Waveguide Equipment for 2 mm Microwaves. C. W. van Es, et al. "Phil. Tech." 24, 1961. 13 pp. Special equipment is needed for the measurement of frequency, phase, power, absorption and reflection coefficient in the microwave region. The article below is Part I of a survey of equipment developed at Philips for 2 mm waves. Part II, to be published later, will describe various setups for microwave measurements at wavelengths of 2 mm. (Netherlands, in English.)

Numerical Display Automatic Millivoltmeter. P. Lagadec. "El. et Auto." Feb. 1961. 7 pp. The use of functional electronic sub-assemblies, or block-circuits, facilitates in a large measure the design and construction of complex equipment. An example is provided by this automatic digital voltmeter with numerical display on dicator tubes. (France.)

Application of Magnetic Amplifiers to Measure Complete Resistances with the Help of Magnetically Connected Net Method. O. G. Malkina. "Avto. i Tel." Feb. 1961. 7 pp. An idea and advantages of a new method for measuring components of a complete resistance (R and X) are briefly described. (USSR.)

Principles of Flux-Gate Magnetometers with All-Even Harmonic Output. J. Kulikowski, M. Naleez. "Roz. Elek," Vol. 6, No. 4. 18 pp. The paper deals with flux-gate magnetometers with all-even harmonic pulse output which are used for measuring direct magnetic fields of the smallest intensity about 10^{-3} A/m. (Poland.)

A New Electronic Device for Surge Voltage Measurement. W. Kuzniar. "Roz. Elek." Vol. 6, No. 4. 46 pp. The method considered in this paper is based on a reversed mass-spectrograph principle; it was already applied by W. Ehrenberg and H. Hirsch (9) to constant voltage measurements. (Poland.)

Signal Generator for the S-Band Radar Sets. R. Dick. "El. Rund." Feb. 1961. 3 pp. A pulse modulated SHF generator for the band 2600 to 3400 Mc/s is described. (Germany.)

Some New Video Measurement Techniques and Apparatus. L. E. Weaver. "Rundfunk." Feb. 1961. 7 pp. The paper attempts to give a representative idea of the work which has been carried out recently by the BBC in the field of video measurement techniques and apparatus. (Germany.)

A Survey of Servo System Test Equipment. E. J. Sumray. "Brit. C.&E." Mar. 1961. 7 pp. In this article, the operating principles, ranges and accuracy are given of some commercially available systems for transfer function measurements. (England.)

Tests Made on 50 Year Old Wire from the Antartic. Fergus G. McDonald. "Brit. C.&E." Mar. 1961. 3 pp. Some bare aluminum wire used in a telephone circuit by Scott's last Antarctic expedition was found recently by a New Zealand party. This article describes, with original photographs, the use made of the wire, and gives the results of tests carried out on it after fifty years of exposure in the Antarctic. (England.)

SEMICONDUCTORS

Germanium High Frequency Mesa Transistors. R. E. Warren. "Brit. C.&E." Mar. 1961. 4 pp. Some of the difficult problems of manufacturing control involved in the production of high frequency mesa transistors are outlined in this article. (England.)

Transistor Frequency Response. J. R. James and D. J. Bradley. "El. Tech." Mar. 1961. 3 pp. Recent transistor specifications usually include typical values of fT. This article describes a graphical presentation of fT as a function of the dc working point and the advantages of this method. (England.)

Thermal Problems of Transistors. H. J. Thuy. "El. Rund." Feb. 1961. 5 pp. The author discusses various ways of measuring the thermal internal resistance, and describes several test circuits. (Germany.)

Transistorized Regulated Power Supply. P. Pierre. "El. et Auto." Feb. 1961. 8 pp. The regulated power supply Hemlett-Packard HP 721A uses only semiconductors. (France.)

Saturated Core Converters. C. Pontier. "El. et Auto." Feb. 1961. 3 pp. Because of their high efficiency, transistors are commonly used in dc to dc static converters. (France.)

Tecnetron and its Applications. A. V. J. Martin. "El. et Auto." Feb. 1961. 7 pp. Several different types of tecnetrons have been produced or are being developed. These devices are described and their properties briefly reviewed. (France.)

High Efficiency DC Reversive Magnetic Amplifier. O. A. Kossov, E. A. Manychkina. "Avto. i Tel." Feb. 1961. 7 pp. A dc reversive magnetic amplifier with high efficiency proved by switching transistors is considered. It is shown that the amplifier can operate under complex loading. (USSR.)

Elements and Units of Ferrite-Transistor Cell One-Cycle Parallel Arithmetic Device of Digital Computer. M. L. Petrukhin. "Avto. i Tel." Feb. 1961. 10 pp. Some principles of designing one-cycle circuits of delay elements, a symmetric output trigger, a shift register and of a counter-type adder for a ferrite-transistor cell parallel arithmetic device are considered. (USSR.)

On Application of Pulse Supplying Measuring Bridge Circuits with Semiconductor Thermoresistances in Devices of Temperature Two-Position Control. V. G. Hakhmutsky, I. I. Vinstein. "Avto. i Tel." Feb. 1961. 4 pp. Thermal regime of a semiconductor thermoresistance with pulse supply is considered. (USSR.)

TELEVISION

A Mobile Laboratory for UHF and VHF Television Surveys. "BBC Mono." Feb. 1961. 12 pp. This report describes the mobile laboratory used by the BBC Research Dept. for assessing the reception conditions during the Band I Band V comparison tests carried out in 1957-8. (England.)

Image Orthicons with Field Mesh. K. Frank. "El. Rund." Feb. 1961. 3 pp. The discussion results in important viewpoints for the design and the construction of field-mesh tubes. (Germany.)

Technical Equipment and Facilities of the BBC Television Centre. London, Sir Harold Bishop. "Rundfunk." Feb. 1961. 8 pp. The article summarizes the most important considerations involved in planning the technical facilities and equipment of the new BBC Television Centre in London. (Germany.)

Mobile Eurovision Installation of the Osterreichischer Rundfunk. Franz Brunner. "Rundfunk." Feb. 1961. 4 pp. The installation described comprises all the technical equipment and facilities that are required at the point of origin of Eurovision transmissions, with the exception of the actual television outside-broadcast vehicle. (Germany.)

A Survey of Simplified Image Orthicon Operation. T. Mayer and G. E. Partington. "Rundfunk." Feb. 1961. 7 pp. The 4½ in. I.O. was introduced in England in 1955 because of its better resolution, signal to noise ratio, grey scale and freedom from spurious effects, and has been found to be very stable in operation. The BBC conducted exhaustive investigations in order to find out which circuits were the most important to provide a camera channel of the highest stability, and these are described. (Germany.)

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THEORY

Significance and Applications of Distributions in the Circuit Theory. J. Osiowski. "Roz. Elek." Vol. 6, No. 4. 62 pp. The paper is composed of two parts. The first part is devoted to mathematical foundations of the distributions theory of one variable. Particular attention is paid to the problem of Fourier and Laplace transformation in the field of distributions as being of essential significance to the circuit theory. The second part contains a review of selected problems of the circuit theory which are treated and solved in terms of distributions. (Poland.)

Determination of Optimal Way for Changing Signal and Noise Carrier Frequency in Detection Problems Based on the Theory of Games. M. Yu. Gadzhiev. "Avto. i Tel." Jan. 1961. 10 pp. A conflicting situation arising during the reception of signal against noise when the carrier frequency of the signal and the noise may change within the given frequency range is described. (USSR.)

Passage of Radio Pulses Through a Multi-Band Filter Array. M. I. Finkelstein. "Radiotek" 16, No. 1, 1961. 7 pp. The author analyzes the passage of N rectangular coherent radio pulses through a multi-band filter array. A method is offered for the determination of the envelope form of outcoming pulses. It is shown that in a realistic filter as the number of pulses increases, their amplitudes increase exponentially and does not result in an improvement of the wave form shape. (USSR.)

Induced Current in the Plate Circuit of a Triode. G. A. Zeytlionok. "Radiotek" 16, No. 1, 1961. 11 pp. The article deals with the determination of the active and reactive components of the induced current in the plate circuit of a triode at high signal amplitudes. (USSR.)

General Theory on Regeneration Circuits with Variable Parameters. M. K. Belkin. "Radiotek" 16, No. 1, 1961. 8 pp. The purpose of this article is to generalize the analysis of regenerative circuits with variable parameters and to extend its application to parametric super-regenerative amplification. The variable parameters covered in this analysis are rapidly varying reactance and slowly varying attenuation. (USSR.)

An Investigation of the Operating Stability of a Pulse Generator. S. M. Zaydell. "Radiotek" 16, No. 1, 1961. 7 pp. The stability of forced oscillations is analyzed for a system consisting of an oscillator and a non-linear load. A characteristic equation determining the stability of the system is derived from the equation of the deviation from stationary operation. (USSR.)

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SOURCES

TRANSMISSION

Comparison of Signal Parameters as Applied to Signal Transmission, N. T. Petrovitch. "Radiotek" 16, No. 1, 1961. 8 pp. A method for signal transmission is presented, which, based on comparison of discrete signals, creates new possibilities in the technique of message transmission. Its application in message carrier frequency phase comparison is discussed. (USSR.)

Conversion of Certain Non-Electric Values into Electric Signals when Required to be Used in Contactless Telemechanic Systems, M. V. Kadzharov. "Avto. i Tel." Feb. 1961. 3 pp. The conversion of certain non-electric values, such as: Level radiant energy, some friable body volumes, pressure and level of liquids, into electric signals suitable for teletransmission when required to be used in contactless telemechanic systems constructed on ferrite-diode cells is considered. (USSR.)

The Theory of Waveguides and Cavities, R. A. Waldron. "El. Tech." March 1961. 8 pp. An outline is given of a general approach to the study of waveguides and cavities. The mathematics is not given in detail, but the difficulties encountered in setting up the mathematical problem for a given physical situation, and the physical principles involved in the treatment, are discussed at length. (England.)

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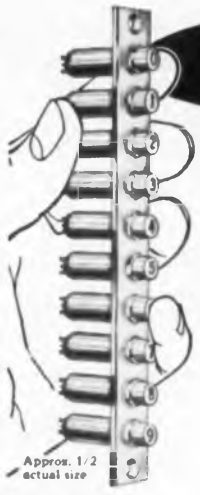

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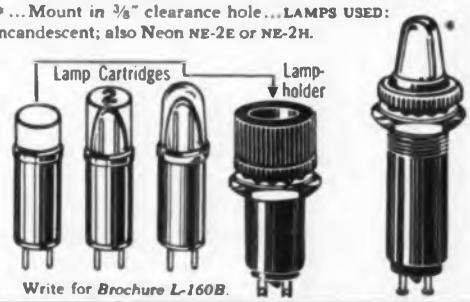

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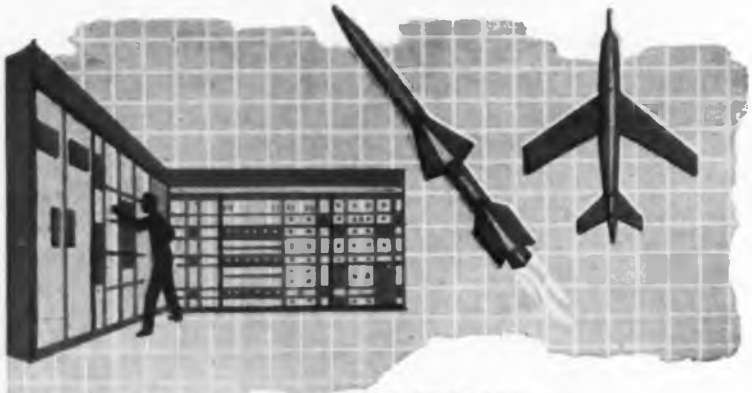

HIGH-TEMPERATURE

METALLIZED PAPER CAPACITORS

P123ZN—
rated at 50 VDC. Full voltage rating to +100°C. Rated from 150 VDC to 600 VDC. Full voltage to 100°C and to +125°C at 75% of voltage rating.

P323ZN—
full rated voltage to 125°C.

P30ZN
(bathtub) and PM0ZN (rectangular). Full rated voltage to 125°C.

Designed specifically to meet critical operating requirements, Aerovox metallized paper capacitors offer many important advantages, including minimum size for space-tight applications... reliability and long service life... low radio frequency impedance... and a wide range of case styles for operation to +125°C **without voltage derating.**

Aerolene® impregnated units are available in the temperature ranges shown at left:

Want complete technical data? Call your nearest Aerovox representative... or write today for your free copy of catalog 131B8.

*Capaci-bility An Aerovox characteristic. Capability to design, develop, and manufacture capacitors to best meet customers' requirements.

AEROVOX CORPORATION
NEW BEDFORD DIVISION NEW BEDFORD, MASS.

Technical Leadership — Manufacturing Excellence

Optical Radar Could Map Moon from Earth

A "light-beam radar" for many scientific explorations, including mapping the moon more accurately than before, has been developed by Hughes Aircraft Co. as a research companion to its new "Colidar" spacecraft radar.

Eventually an optical radar operating from Earth could spotlight its beam on a moon area only 10 miles in diameter, a company scientist said. This would make possible sharper pictures (even determining more accurately the height of moon mountains) than those now made by "illuminating" the moon with radar or microwave signals from ordinary radar which disperses its beam over such large areas that their intensity is dissipated.

EQUIPMENT, MATERIALS, PARTS & COMPONENTS

Allen-Bradley
QUALITY RESISTORS
Complete Inventory in Stock
Immediate Delivery
1/10W, 1/4W, 1/2W, 1W, 2W, 5%—10%
Write for Illustrated Catalog and Prices
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RE 4-1173	WO 2-5729

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Established 1943

ELECTRONIC INDUSTRIES Advertisers—May 1961

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MOLDED CHOKE COILS

MILLER QUALITY PRODUCTS

ACTUAL SIZE
10,000 UH

Nicknamed the "Micro Mite", these reliable, rugged coils exhibit high Q, very low distributed capacity, all concentrated into an amazingly small package.

Miller's new "Micro Mite" coils are perfect for use where weight, space and high Q considerations are involved. Their volumetric reduction ranges up to 80%, with current ratings approximately 75-300 millamps and standard series values up to 10,000 uh.

The "Micro Mite" coil construction permits miniaturization without the use of ferrite materials, thus maintaining temperature stability to 125° C. These hermetically sealed molded coils conform to MIL-C-15305A.

ASK FOR OUR MICRO-MITE BULLETIN

J. W. MILLER COMPANY • 5917 So. Main St., Los Angeles 3, Calif.

Circle 197 on Inquiry Card

Bind Wires Fast... At Low Cost with Heli-Tube®

HELI-TUBE is a spirally-cut plastic tubing. Its shape-retaining characteristics make it ideal for binding electrical wires into cables. Wraps on like tape; holds wires together tightly; individual wires, taps, or lead-offs can be led out at any point. Earns cost back in time and labor-saving.

Available in 5 forms . . .

- **Clear** for general applications
- **Nylon**—wide temperature range . . . very light weight
- **Ultraviolet-Resistant**
- **Fire-Resistant**
- **Type 275 F** (High-temperature)

Each form in three diameters:

Instrument Size: 1/8" O.D. — for bundles up to 1/2" dia.
Harness Size: 1/4" O.D. — for bundles up to 2" dia.
Giant Cable Size: 1/2" O.D. — for bundles up to 4" dia.

At your distributor for immediate delivery or write

M. M. NEWMAN CORPORATION, DEPT. 12
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Bradley PRODUCT

A Revolutionary Solution to Reliability and Space Needs . . . BC100 Miniature Silicon Rectifiers!

RATED at 1.0 Amps at 50°C with PRV from 50 to 1000 Volts. ONLY .105" Dia. by .250" in Length.

Some of the outstanding features

- **Operating temperature up to 175° C**
- **Double diffused junction**
- **Requires no heat sink**
- **Ceramic case**
- **Hermetically sealed • High surge**
- **Low forward voltage drop**
- **Ultra low reverse leakage**
- **High thermal shock ability**
- **Designed for equipment requiring miniaturization of components, yet relatively high power; economy, yet reliability**
- **JEDEC Numbers assigned**

Ask for data sheets on SILICON, SELENIUM or COPPER OXIDE rectifiers.

Bradley Semiconductor Corp.
quality semiconductors since 1939
275F Walton St., New Haven 11, Conn.

Circle 199 on Inquiry Card

New Products

SILICON DIODES

Low leakage, 1 μa @ 150°C and high forward conductance, 100 ma min. @ 1 v.

Three mil-qualified silicon diodes are USN 1N483B, USN 1N485B and USN 1N486B, per MIL-S-19500/118. The 1N486B will pass all electrical specs for the older JAN types 1N457, 1N458 and 1N459, making standardization possible. The reverse voltages range up to 250 v. They are in standard glass, hermetically sealed DO-7 JEDEC outline packages. Rheem Semiconductor Corp., 350 Ellis St., Mountain View, Calif.

Circle 363 on Inquiry Card

ANTENNA MULTICOUPLER

Eight receivers can be operated simultaneously from one antenna.

Offering miniaturized, solid-state, modular construction, it operates from 2 to 32 MC in one band, while requiring only 30 w. input power, with low heat dissipation. Model #7 is designed for use in h-f direction finding or communications systems. Gain is flat over the 2-32 MC band and is constant between channels and units. Output VSWR is 1.14 throughout the freq. range. Input VSWR is 1.7:1. Insertion gain is 2 ± 1 db. Noise figure is less than 8 db. Min. output isolation is 40 db. Trak Electronics Co., Inc., Wilton, Conn.

Circle 364 on Inquiry Card

The most precise, sturdiest thermal relay ever built... best for missile applications

... from the leader in thermal relay design!

Now, for missile environments and for all applications where greater precision is necessary, G-V Controls offers the revolutionary new PT Thermal Relay—the most **precise** thermal relay ever built!

And the PT's **sturdiness** is unequalled in thermal relays. It withstands missile vibration and shock far better than any other thermal relay.

SPECIFICATIONS

Time Delay: 3 to 60 seconds (Factory Set)
Setting Tolerance: ±5% (±¼ sec. min.)
Temperature Compensation: Within ±5% over −65°C. to +125°C. range (±¼ sec. min.)
Heater Voltages: 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.
Power Input: 4 watts. Rated for continuous energization at 125°C.
Contacts: SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

Write for Product Data Bulletin #PD-1015

Insulation Resistance: 1,000 megohms
Dielectric Strength: 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.
Vibration: Operating or non-operating, 20 g up to 2000 cps
Shock: Operating or non-operating, 50 g for 11 milliseconds
Unidirectional Acceleration: 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.
Weight: 2 to 2¼ ounces.

G-V CONTROLS INC.
Livingston, New Jersey

G-V

Circle 151 on Inquiry Card

Now in 2 Case Sizes for
Your Computer Designs

TO-5

NOW SMALLER
IN TO-18 CASE

RCA Adds To The 2N1301 Family

THREE NEW MESAS IN THE TO-18 CASE

- Minimum Betas of 30, 40, 50
- Typical G-BP* of 40, 60, 80 Mc.
- Pulse Repetition Rates Up to 10 Mc.

NEW IN TO-18 CASE: RCA 2N794, 2N795, 2N796. IN TO-5 CASE: RCA 2N1300, 2N1301, 2N1683

Once again RCA meets the stringent demands of the dynamic computer industry with new high-speed switching transistors specifically designed for today's military and industrial data processing applications. Here are some of the outstanding features of these high performance types:

- **High Power-Dissipation Capability**–150 mw (max.) at 25°C.
- **High Gain-Bandwidth Product***–40 (2N1300, 2N794), 60 (2N1301, 2N795), 80 (2N1683, 2N796). (Typical Values).
- **High Beta (h_{FE})**–30 min. (2N1300, 2N794), 40 min. (2N1301, 2N795), 50 min. (2N1683, 2N796).
- **Low Total Stored Charge In Saturating Circuits**–400 μμcoulombs (2N1300, 2N794), 325 μμcoulombs (2N1301, 2N795), 160 μμcoulombs (2N1683, 2N796). (Max. Values).
- **Rugged Mesa Structure**
- **Economy Performance**–Top Performance at Low Cost.

Contact your RCA Representative now for complete price and delivery information. For additional technical information, write RCA Semiconductor and Materials Division, Commercial Engineering, Section E-50-NN, Somerville, N. J.

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