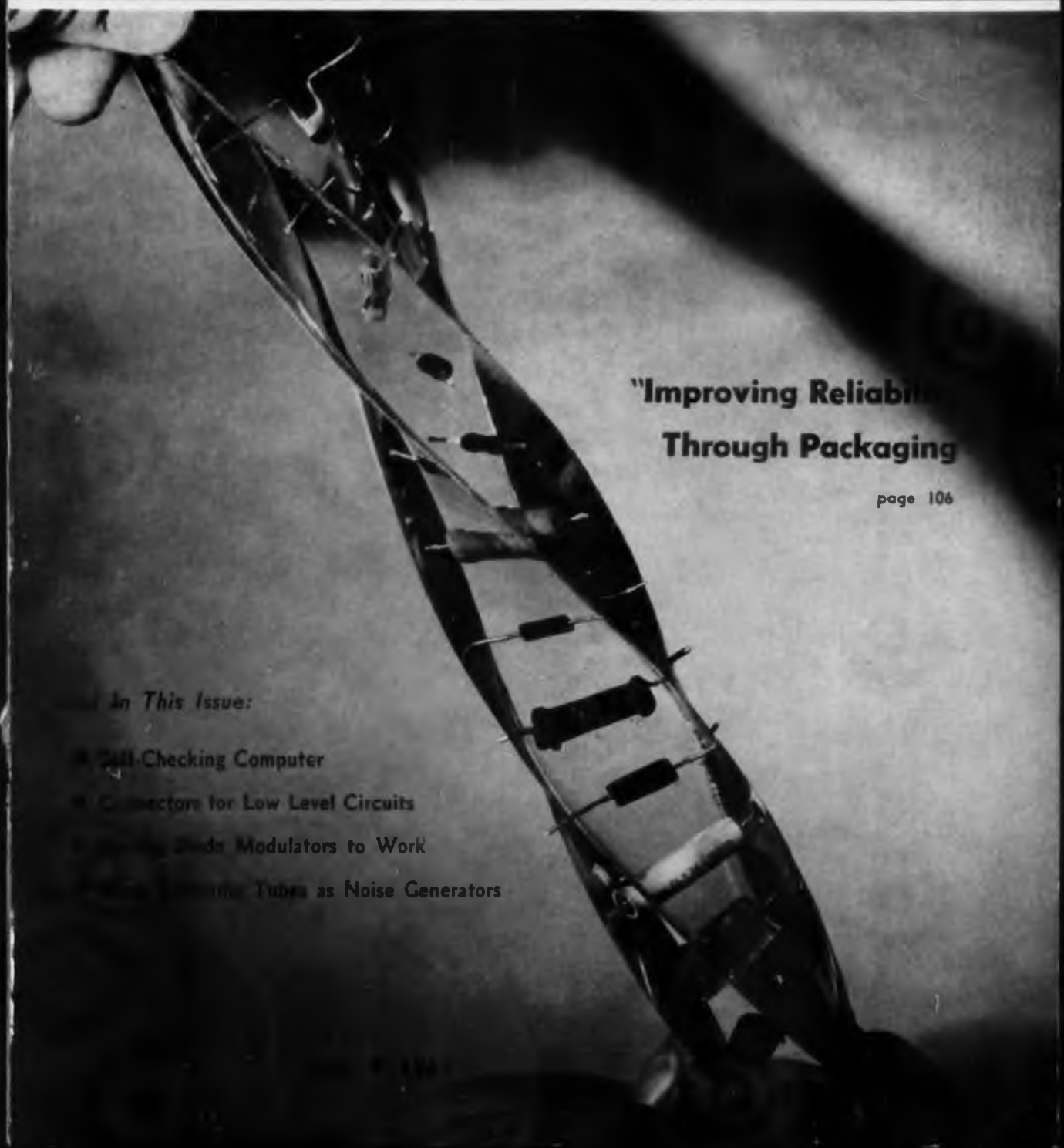
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION



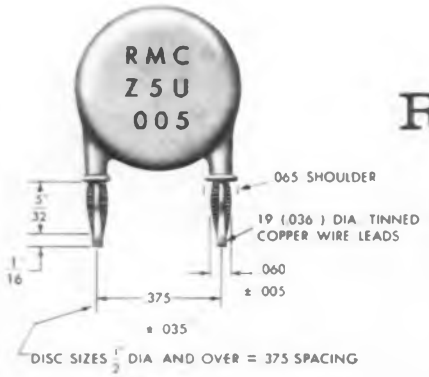
"Improving Reliabi[lity]
Through Packaging

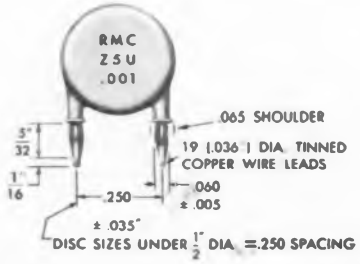
page 106

In This Issue:

- Self-Checking Computer
- Connectors for Low Level Circuits
- Getting Diode Modulators to Work
- Using Electron Tubes as Noise Generators

Take the CRIMP OUT of your assembly operation





RMC Fin-Lock DISCAPS

The unique design of RMC Fin-Lock leads eliminates lead crimping in assembly line operations. Designed for holes from .053 to .060 Fin-Lock leads are stopped in holes over .060 by the exclusive shoulder construction. These leads permit either automatic or hand assembly with assured stand up positioning.

Fin-Lock leads are available on all RMC DISCAPS of standard voltages, ratings and spacings.

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

Our Door Is Always Open . . .

AS part of the function of publishing technical articles, journals such as EI have always maintained a continuing effort aimed at inspiring engineers to write down descriptions of their work for possible publication.

We have never been as successful as we wished. There is still too much sophisticated engineering work going on that is never put into a form that can be passed on to other engineers. And only a small part of it is held back for security reasons.

But if we haven't been too successful in leading engineers to write we have apparently had a rather important influence on company managements. Over the past half dozen years or so we have seen numerous companies radically change their policies; throwing out their time-worn "security consciousness" and encouraging their engineers to participate in technical conferences, and to publish their papers and articles in technical journals. It has become accepted that solid technical articles are one of the most subtle, yet effective forms of advertising, and well-worth the engineering time involved. This has been most gratifying to all of us in the technical publishing field.

There is still a long way to go, however, and fortunately many firms in industry are now setting up incentive plans that will encourage their engineers to write. Just last month we heard of three more firms that have made arrangements to match the amount of money that the engineer receives from the magazine publisher. Another company is giving a bonus of $100 for each article published.

This is something of a recognition that the engineer is performing a service for the company far beyond the personal credit that he receives as the author.

Other firms are making sure that company newspapers mention the appearance of articles authored by their engineers.

For those ELECTRONIC INDUSTRIES readers who have been thinking of writing technical articles for EI, but are uncertain about how to go about it, here are our general requirements:

- Manuscripts should be between 2,500 and 3,500 words in length, typed double spaced on one side of the sheet. Paper should be preferably the conventional 8½ x 11 in. size.

- Art work greatly enhances presentation of technical articles. Ideally, a 3,000-word article should have 7-9 illustrations. Photos should be on glossy paper.

- Graphs and charts need not be professionally drawn. Our staff here includes an art department that handles that function. However, extensive redrawing will be reflected in the total cost of printing the article and eventually show up in the honorarium sent to the author.

As a general rule-of-thumb, authors receive $20 to $25 per page, depending on the length and the condition of the text and artwork when it is received in the editorial offices.

The requirements above are not rigid, but articles, for instance, that are much longer, may be considerably delayed in publication. Shorter articles, on the other hand, are likely to get into print rather quickly.

It is always a good idea to submit an outline before doing any substantial amount of work on your article. This practice can save a good deal of effort at both ends; for you, the author, because you can be certain that what you are writing is genuinely needed, and for us, here, because we are not faced with drastic re-writing jobs, although we do re-write all of the material that is submitted.

If an outline seems too tedious, just pick up the phone and give us a call. Our editors are always ready to discuss possible articles with you.

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ELECTRONIC INDUSTRIES, July, 1961. Vol. 20, No. 7. A monthly publication of Chilton Company. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. Accepted as controlled circulation publication at Phila., Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr. $18.00; 2 yrs. $30.00.

ELECTRONIC INDUSTRIES

Vol. 20, No. 7 July, 1961

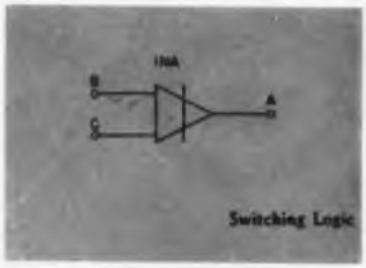
MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

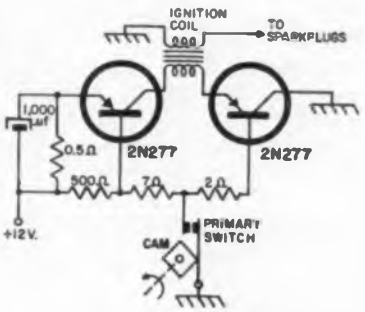
Highlights of this issue

Electronic Packaging



Switching Logic

Self Checking Computer



Electronic Ignition System

Distributing Electronic Parts

RADARSCOPE

COMPUTER COMPONENTS

At Republic Aviation's Guidance and Control Systems Lab scientist examines a capacitor one-millionth of an inch thick. Micro-miniature components, for airborne computers, are developed by depositing thin films of metallic materials on glass or ceramic strips.

NASA has authorized its field centers to step up hiring of qualified scientists and engineers. The accelerated recruiting will fill existing vacancies, and anticipate manpower requirements of an expanded space exploration program. NASA representatives last year interviewed nearly 3,000 persons on 100 college campuses.

FCC issued its 200,000th authorization in the Citizens Radio Service.

TV CAMERA TUBE which maintains a high signal modulation in the presence of excess scanning beam current has been developed for the Air Force. The tube permits a higher signal-to-noise ratio than can be achieved with tubes using orthicon scan.

PULSE GENERATOR that can detect short circuits, or breaks in transmission wires, has been developed by a Westinghouse engineer. The unit feeds a signal the length of the transmission line which carries the program from the transmitter to the antenna. The signal appears on an oscilloscope screen which is connected to the pulsing mechanism. A fault in the line shows up on the oscilloscope screen as an abnormal bump. A short circuit produces a positive bump; a broken line a negative bump.

NEARLY $300 MILLION in prime government contracts were awarded to small firms under the Small Business Administration's set-aside program during the first three months of this year. This represents an increase of 67.1% over the value of contracts awarded small firms under the program during the same period last year.

SOLID-STATE PHYSICISTS at Republic Aviation Corp. have produced a tunnel diode of thin-film dimensions that does not require super-cooling to be functional. Company scientists achieved the thin-film sandwich by capturing titanium vapor on a strip of glass, through a special oxidation technique, to form a dielectric coating less than one-millionth of an inch thick.

PURCHASERS OF NEW TV AND FM receivers are being urged to look for the seal or label on the set which indicates that it complies with the radiation requirements of the FCC. Receivers and tuners manufactured after December 31, 1957, have a seal or label affixed stating that they meet the radiation limits. Manufacturers and distributors are authorized to affix such a seal or label but only after the set has been tested for compliance.

GIANT POWER SUPPLY

Huge stack of capacitors (left) and insulator (right) are part of 100,000,000-watt power supply installed at Sperry's Electronic Tube Div., Great Neck, N. Y. It is used to check high power klystron tubes. Eight-inch walls protected by metallic shields separate this "non-liveable" area from the "liveable" section where tubes are checked.

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

THERE IS A MOVE to give federal protection to communications facilities that are used for military or civilian defense functions. The May 28th demolition of two radio relay microwave installations knocked out 3,000 interstate communication circuits. Many of these circuits were vital to the military and civilian defense of the U. S.

NEW SUPERCONDUCTOR which offers no resistance to appreciable quantities of electrical current has been developed by Atomics International, a division of North American Aviation, Inc., under a research contract with the AEC. A wire which can be easily coiled has been drawn from the new superconductor. At liquid helium temps. (−452°F.) the wire has conducted 100,000 a. of electrical current per square centimeter in a moderately high magnetic field (30,000 gauss).

ENGINEERS at Raytheon have incorporated the Raytheon avalanche mode silicon transistor in a microwave strip transmission line to achieve a switching speed under a millimicrosecond. It is the first time that a semiconductor has been combined in a switch circuit with microwave strip transmission line. Immediate applications include pulse generators and other instrumentation circuitry.

NATIONAL CITIZENS ADVISORY BOARD on radio and TV has been proposed in a bill introduced by U. S. Rep. Thomas Ludlow Ashley (D) Ohio. The measure calls for an 11-man board to make a continuing study of programming trends and to make annual recommendations, including suggested legislation, to both the Congress and the FCC.

NEW MICROMINIATURIZATION PROCESS which extends the concept of printed circuitry to include the formation of capacitors and resistors as well as conducting lines has been developed by the Air Force. The basic element in this process is the RC circuit plate—a ceramic wafer containing conductive, resistance, and dielectric layers. The plate is converted into an actual RC circuit by a series of stencilling and selective etching steps.

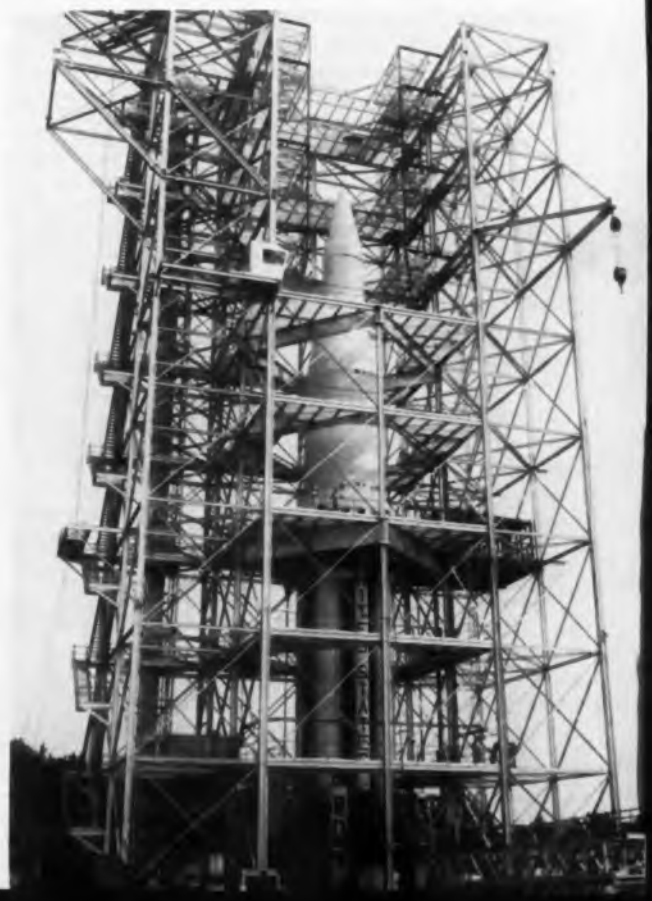
A SCIENTIFIC ADVISORY COUNCIL has been established by Hq. Office of Aerospace Research of the U. S. Air Force to furnish technical scientific advice and information to the highest levels of the Defense establishment. It is expected to fill the need for direct contact between the planners and the working scientists. Members of the 22-man Council, which met for the first time on May 31, are drawn from the OAR, basic research arm of the Air Force, and its Office of Scientific Research, Aeronautical Research Labs, Dayton, Ohio, and Cambridge Research Labs, located at Bedford, Mass.

ALUMINUM CLAD conductor cores are said to improve electrical power transmission. The relative merits of galvanized and aluminum coated steel cores of aluminum conductors, steel reinforced (ACSR) were discussed at the AIEE meeting, with the nod going to the aluminum coated cores. The latter have 4 to 10% less resistance and 5 to 8% less reactances.

RESEARCH AND DEVELOPMENT PROJECTS have become a prime source of business for the aerospace industry, but the Aerospace Industries Assoc. says that a complicated Government formula has reduced earnings of the companies to the danger point. The AIA says that the regulation under which the military services contract with industry sets the maximum of 10% profit on research and development work, but in practice it is rarely achieved. "In negotiation, practice has been to limit earnings on a research and development contract to from 5 to 7%, more frequently on the lower than on the higher side of the bracket. It is not at all uncommon to find that the 'return' is a negative one, a loss incurred became of excessive cost disallowances."

CHECKING OUT "SATURN"

First flight configuration of the giant Saturn C-1 heavy space vehicle is assembled in the test stand at the NASA Marshall Space Flight Center, Huntsville, Ala. The 3-stage rocket is 163 ft. in height; the tower is 204 ft. This new facility permits checking out the mechanical mating features of the rocket, and its bending characteristics.



New Nanosecond* Pulse Transformers for Ultra-miniature, Ultra-high Speed Applications

Digital circuit designers will find the new Sprague Type 43Z Nanosecond Pulse Transformers of considerable interest. These tiny transformers have been carefully designed for the all-important parameter of minimum rise time at high repetition rates up to 10 mc.

The new Type 43Z series is comprised of a broad line of 72 pulse transformers in 10 popular turns ratios. They are Sprague's latest addition to the most complete listing of pulse transformers offered by any manufacturer for use in digital computers and other low-level electronic circuitry.

Type 43Z Pulse Transformers are designed so that the product of leakage inductance and distributed capacitance is at a minimum. They are particularly well suited for transformer coupling in transistor circuits since transformers and transistors are very compatible low impedance devices. Nanosecond transformers are equally suitable for transmission line mode of operation, in twisted-pair transmission line coupling, and in regenerative circuits.

The epoxy-encapsulated "pancake" package is excellent for both etched wire board or conventional chassis mounting. To simplify etched-board design, these ultra-miniature pulse transformers are available with leads terminating at the side or the bottom of each unit.

For complete technical information on Type 43Z Nanosecond Pulse Transformers, write for Engineering Data Sheet 40235 to Technical Literature Section, Sprague Electric Co., 233 Marshall St., North Adams, Mass.

*millimicrosecond

Circle 78 on Inquiry Card

Something NEW in counting techniques!

Sprague type 73Z1 core-transistor DECADE COUNTERS

Here is a simple yet versatile, low-cost yet reliable component for counter applications. Counting to speeds of 10 kc, the 73Z1 decade counter provides an output signal for every 10 input pulses, then resets in preparation for the next cycle. For higher counting, two or more counters may be cascaded. Typical characteristics are shown below.

CHARACTERISTIC	INPUT	OUTPUT
Amplitude	1.5 to 8 volts	6.5 volts min.
Pulse Width	1 μsec min.	50 μsec nom.
Impedance	100 ohms	20 ohms

Utilizing two rectangular hysteresis loop magnetic cores and two junction transistors to perform the counting operation, the 73Z1 counter is encapsulated in epoxy resin for protection against adverse environmental conditions. It has five terminals −B+ (12v ±10%), input, output, ground, and manual reset.

The 73Z1 counter is available as a standard item. However, "customer engineered" designs can be supplied when other counting cycles, speeds, and package configurations are required for special applications.

For complete technical data or application assistance on the 73Z1 counter or other Sprague components, write to Special Products Division, Sprague Electric Co., 233 Marshall St., North Adams, Mass.

SPRAGUE®
THE MARK OF RELIABILITY

Circle 2 on Inquiry Card

New Line of Precision Toroidal Inductors For Practically Every Application

Designed for use in commercial, industrial, and military apparatus, Sprague Precision Toroidal Inductors are customarily supplied to the close inductance tolerance of ±1%. The broad line of Sprague inductors includes such styles as open coil, plastic-dipped, rigid encapsulated types with tapped or through-hole mounting, and hermetically-sealed inductors.

All styles, with the exception of the open-coil type, meet the requirements of Specification MIL-T-27A.

Several core permeabilities may be obtained in each of the five basic sizes of Sprague inductors to give the circuit designer the optimum selection of desired Q and current carrying abilities. Each of the core sizes is available with several degrees of stabilization. Inductors made with cores which have not been subjected to the stabilization process exhibit low inductance drift with time and have a low temperature coefficient of inductance. Where a greater degree of permanence of characteristics is required, cores with two different stabilization treatments can be used for most types of inductors.

Sprague toroidal inductors may be operated from −55C to +125C. Temperature cycling of finished inductors is a standard production procedure in order to equalize internal stresses and insure permanence of electrical characteristics.

For detailed information on Sprague Precision Toroidal Inductors, write on company letterhead for portfolio of engineering data sheets to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

As We Go To Press...

New Advances In Numerical Control

A new computer language giving greater design freedom, closer tolerances and cost savings in the use of numerically-controlled machine tools was unveiled by IBM, Data Processing Div., at a recent press conference.

Together with Pratt & Whitney, United Aircraft Corp., Aerospace Industries Assoc. of America and M.I.T., IBM has developed AUTOPROMT (AUTOmatic PROgramming of Machine Tools). With this program the part-programmer, instead of describing each individual tool path to be followed, now describes only the part to be machined, using dimensions directly from ordinary blueprints. In simple English, the vocabulary consists of 110 English-type words, the three-dimensional surfaces of the part are described in relation to each other. This information is then punched onto cards which are fed into a computer, causing the computer to select and generate the thousands of individual tool paths necessary. The magnetically taped instructions are converted to the punched tape which controls the automatic machining tool. Graphically demonstrated was the milling of a cover for a helicopter gear box. The complete process from blueprint to finished product takes less time than was previously spent on just programming tool path instructions.

MISSILE WHEEL PACKAGE

Technician aligns a wheel package on tension bolts during assembly of a missile electronic section at Convair (Pomona, Calif.) Div. of General Dynamics Corp. Wheels constitute the entire airframe of the electronic sections of some guided missiles produced at Convair.

Data Handling Systems For Overseas Stations

Two data handling systems for tracking antennas at Johannesburg, South Africa, and Woomera, Australia, are being designed and built by Datex Corp., Monrovia, Calif. The equipment, being built under contract with the National Aeronautical and Space Administration's Jet Propulsion Laboratory, will be used in space communication research.

Signal Generator Equipment Studied

All signal generators in current use by the Department of Defense will be analyzed, and recommendations made for necessary engineering modifications to minimize the number and variety of equipments now being employed by the military services.

Work will be done by Capehart's Military & Industrial Div., Richmond Hill, N. Y., under a Signal Corps contract covering studies and surveys of modulated signal generator equipment in connection with the Defense Department's standardization program.

New Guide to Government Contracts is Available

The revised third edition of "Federal Agencies Financing Research" provides information on the programs, procedures, and organization of each U. S. agency awarding research contracts, as well as the officer to approach for further specifics. Subtitled "The Complete 1961 Guide to Government Grants and Contracts," it is priced at $1 and is available from the Social Legislation Information Service, Inc., Washington 6. D. C.

More on Page 8

Affiliation Formed

Kierulff Electronics, Inc., Los Angeles, Calif., has formed an affiliation with Ducommun Metals & Supply Co. of Los Angeles. The alliance will make available additional capital for inventory coverage in depth and organizational expansion in industrial electronic marketing. Kierulff will function separately as "the wholly owned electronic division" of Ducommun. Total assets of the two companies are now more than $34,000,000.

Kierulff had sales of over $7,000,000 in industrial electronic components in 1960. Ducommun, a publicly held California corporation, had sales of over $55,000,000 in industrial supplies, steel, aluminum, copper and brass in 1960.

TV RELAY

Microwave "dish" beams network TV programs 136 miles in a direct line-of-sight from atop 9,000 ft Coon Peak in Utah to a receiving station in Idaho. In covering the distance, the RCA system's microwave beam traverses the entire length of Great Salt Lake and slices through a mountain pass.

Electronic SHORTS

▸ **The shell of a space ship and the equipment will furnish space travelers adequate protection without the addition of heavy shielding against radiation. Geophysicists at The Martin Co., Baltimore, Md., reached this conclusion after millions of man-hours devoted to designing vehicles which could travel in space for days, or even weeks.**

▸ The Institute of Science and Technology at The University of Mich. is experimenting with special data-processing techniques to be used in a sonar system being developed by the Office of Naval Research's Project ARTEMIS. The system will be used to detect and track submarines at very long ranges in large ocean areas.

▸ **A modern network of earthquake recording stations, spanning six continents, will be instrumented by the Coast and Geodetic Survey beginning in mid-1961. The equipment valued at approximately $2 million is being supplied by The Geotechnical Corporation of Garland, Texas.**

▸ Sperry Rand Corp. has been named prime contractor of a U. S. Air Force contract toward modernization and expansion of the Atlantic Missile Range. The contract calls for the conversion of two 11,000 ton troop carrier ships into mobile missile-tracking stations.

▸ **IBM has instituted a research program designed to improve the manufacture of paper through the use of computer control. A number of paper companies and manufacturers of paper machines are cooperating.**

▸ A special UHF TV antenna which will transmit from atop the Empire State Building will be developed by Melpar, Inc. It will be part of a system to assess the merits of UHF in comparison with LF transmissions in metropolitan areas.

▸ **The West German government and Fiat of Italy have awarded the International division of The Bendix Corporation contracts totaling over $12 million as part of the NATO Mutual Development Program. The contracts are to equip NATO military aircraft with advanced electronic navigational systems.**

▸ The U. S. Army's Transportation Research Command at Fort Eustis, Va. is testing a rubber and steel kit which inflates to become an electronically equipped deckhouse. It will convert a landing craft into a control boat or an open beach site into a living-room-sized command post.

▸ **An advanced version of the Sparrow III air-to-air guided missile has been developed for the Navy by Raytheon Company. Designated Sparrow III-B, the all weather system will become prime armament for the Navy's F4H-1 Phantom II supersonic jet interceptor.**

▸ NASA will negotiate with GE's Space Sciences Laboratory, Phila., Pa., on a contract to study electric engine technique. G.E. will investigate the feasibility of a magnetohydrodynamic (MHD) electric engine, which may some day be launched on space missions.

▸ **Aided by an IBM 704 computer, Gulf Oil Corporation research specialists have designed and built electronic filters which effectively suppress interference on seismic tapes. Areas which had defied seismic exploration are now being mapped by Gulf geological teams.**

▸ Senator Warren G. Magnuson (D., Wash.), Chairman of the Senate Committee on Interstate and Foreign Commerce, has introduced legislation to establish a new post of Assistant Secretary of Commerce to handle the "mushrooming role of science and technology" within the department. Magnuson says the legislation has the backing of Secretary of Commerce Luther Hodges.

▸ **A portable unit, designed to replace "a number of instruments" permanently installed on the bridge of submarines, is being manufactured by the Scintilla division of The Bendix Corp. The "command center" contains all instruments needed for the commander's information and communications while on the bridge. It can be plugged into the bridge when the ship surfaces.**

As We Go To Press (cont.)

TECHNOLOGY AWARD

James D. McLean (left) president of General Dynamics/Electronics, Rochester, N. Y. presents company award for 1960 for Science and Technology to George A. Franco (right) as Dr. Nisson Finkelstein looks on approvingly. The award—a commendation plaque and $2,000—was given Mr. Franco for his work on the DEFT (Dynamic Error Free Transmission) technique for high speed data transmission which is exceptionally resistant to jamming.

Microwave Data Service Launched

The Electronic Industries Association has arranged for a service to supply microwave equipment manufacturers, user organizations, and others with technical information essential in the design, installation, and operation of private microwave communication systems.

The service will utilize a standard form, developed by EIA with FCC cooperation, for compilation of all necessary technical data. These will include transmitting frequency and bandwidth; transmitter make, model, and rated power output; antenna type, input power, and location; and compass points with which the station is to communicate.

New Alloys Discovered

Discovery of a series of new alloys of molybdenum and technetium has been announced by Dr. B. T. Matthias of Bell Telephone Laboratories. Cryogenic experiments have shown that these alloys, which are very ductile, become superconducting at temperatures higher than for any other alloy. (Nb_3Sn, the superconductor with the highest known transition temperature, is a brittle compound.) Dr. Matthias reported his experiments showed that an alloy of molybdenum-technetium is superconducting at temperatures near 16° K.

More News on Page 14

HIGH COMPONENT DENSITY RELAYS

LOW

thermally generated voltages

ACTUAL SIZE
MWB-2600
Two Capsule
Relay

ACTUAL SIZE
MWB-1600
Single
Capsule
Relay

Molded in epoxy resin, Adlake MWB type relays are designed for use on printed circuit boards. High component density makes them ideal for computor and peripheral equipment applications. Other advantages include: low thermally generated voltages; low contact resistance throughout life—which is estimated at billions of operations; absence of pitting or dirt; positive closure; operating speeds of up to 100 operations per second; and ability to handle loads up to 250 va., 500 volts—5 ampere maximums. Relays are available in single and double contact versions. Terminal pin arrangement is to the 0.2" grid, however, configurations can be made to fit requirements. Mail coupon today for further information.

Visit our Booth 933 at the I.S.A. Show

A+dlake
MERCURY WETTED
CONTACT RELAYS

THE ADAMS & WESTLAKE CO., Dept. L-8807
Relay Division, Elkhart, Indiana

NAME _____

COMPANY _____

ADDRESS _____

CITY AND STATE _____

R-L-C Standards and Components . . . No. 1 of a Series

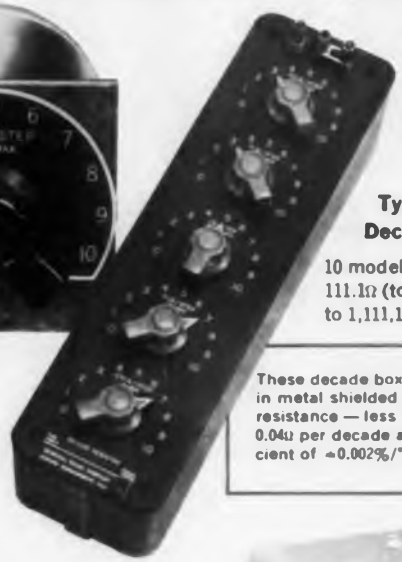
Resistance...

These resistance standards incorporate optimum construction for wide-band applications (useful to several hundred kc, as well as dc) . . . low residual reactance . . . preaged at high temperatures to insure excellent stability . . . 100% inspection.

Type 510
Decade Resistance Units

9 models in ranges from 0.1Ω (total) to 1.0 MΩ (total) — $14 - $35.

Accuracy of ±0.05% for most units, except 10Ω (total) decade which is ±0.15%; 1Ω decade ±0.5%; and 0.1Ω decade ±2%. Supplied with aluminum shield can, knob, dial plate.



Type 1432
Decade Resistance Boxes

10 models in ranges from 111.1Ω (total) to 1,111,100Ω (total) — $95-$160.

These decade boxes are assemblies of 510 models in metal shielded cabinets. They feature low zero resistance — less than 0.002Ω per decade at dc, 0.04Ω per decade at 1 Mc. Low temperature coefficient of ±0.002%/°C, except for 0.1Ω decade.

Type 500
Fixed Precision Resistors

18 models in ranges from 10Ω to 1 MΩ in 1-2-5 sequence; 1Ω and 600Ω units also available — $6-$27.

±0.05% accuracy for all but 1Ω unit (±0.15%). Sealed from moisture in phenolic case — banana plugs permit direct connection to standard ⅜"-spaced terminals.

Type 1450 Decade Attenuators

2 models: 110-db total in 1-db steps, $285; and 111-db total in 0.1-db steps, $390.

These are 600Ω, T-section attenuators for power-level, gain, loss, or transmission efficiency measurements. Low-frequency error is less than +0.006 db ±0.25% of dial reading for 1-db-per-step decade; less than +0.009 db ±0.25% for 0.1 db-per-step decade.

Type 1454 Decade Voltage Dividers

2 models provide voltage ratios from 0.0001 to 1.0000 in 0.0001 steps — $150 each.

Accuracy is 0.04% of ratio at input voltages below 120v . . . negligible thermal emf . . . valuable for linearity measurements, meter calibration, and in determining voltage transmission ratios . . . constant input 10kΩ for 1454-A, 100kΩ for 1454-AH.

Special units can be custom built

Write For Complete Information

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

The Best Instruments In Electronics

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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 4 on Inquiry Card

Coming Events in the electronic industry

June 26-30: Annual Mtg. of American Soc. for Engineering Education. Univ. of Ky., Lexington, Ky.

June 26-30: Technical Conf. AIEE, Aerospace Transportation Comm. (AIEE); Benjamin Franklin Hotel, Phila., Pa.

June 28-30: 2nd Joint Automatic Control Conf., IRE, AIEE, ASME, ISA, AIChE; Univ. of Colorado, Boulder, Colo.

June 29: Mtg. on High Precision Connectors, Boulder Labs., Nat'l. Bureau of Standards, Boulder, Colo.

July 3-8: Annual Mtg. of Nat'l. Soc. of Professional Engineers; Olympic Hotel, Seattle, Wash.

July 5-8: 1st Internat'l. Univ. of Calif. Materials Conf., Inorganic Materials Research Div. of Lawrence Radiation Lab., AEC, Univ. of Calif.; Univ. of Calif., Berkeley, Calif.

July 10-14: Annual Summer Institute in Technical and Industrial Communications, Colorado State Univ., Fort Collins, Colo.

July 16-20: Nat'l. Music Industry Conv. and Trade Show, Nat'l. Assoc. of Music Merchants, Inc.; Palmer House, Chicago, Ill.

July 16-21: 4th Internat'l. Conf. on Medical Electronics & 14th Conf. on Electrical Techniques in Medicine and Biology, IFME, JECMB (IRE, AIEE, ISA); Waldorf-Astoria Hotel, New York, N. Y.

July 19-26: Symp. on Nomenclature of Organic Chemistry, NAS, AFOSR/ Chemical Sciences Dir.; Columbus, Ohio.

July 22-25: Conv. & Exhibition of National Audio-Visual Assoc., Morrison Hotel, Chicago, Ill.

July 24-26: Nat'l. Symp. on FAA Air Traffic Control Facilities, EMEA; Mayflower Hotel, Washington, D. C.

July 31-Aug. 4: Differential Equations in Non-Linear Mechanics, AFOSR/ Aeronautical Sciences Dir. & RIAS; Air Force Academy, Colorado Springs, Colo.

Foreign

June 20-24: 4th Internat'l. Powder Metallurgy Cong., Reutte, Tyrol, Austria.

June 22-24: Mtg. of American Physical Soc., Mexico City, Mexico.

July 6-7: 5th Internat'l. Symp. on Free Radicals, Swedish Govt., U. S. Army, AFOSR / Propulsion Div.; Univ. of Uppsala, Uppsala, Sweden.

July 7-29: Russian Trade Fair; Earls Court, London, England.

July 31-Aug. 4: Internat'l. Biophysics Cong.; NAS, NIH, NSF, AEC, AFOSR/Life Sciences Dir.; Stockholm, Sweden.

Aug. 1-12: Sydney Trade Fair; Sydney, Australia.

Highlights '62

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

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

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

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

"CALL FOR PAPERS"

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

1961 Electron Devices Mtg., Oct. 26-28, 1961, Sheraton Park Hotel, Washington, D. C. Papers should deal with material of an applied or developed nature in the field of electron devices. **Deadline** for 200 word abstracts (original and 4 copies): **Aug. 1, 1961. Forward to:** I. M. Ross, Technical Program Chairman, Room 2A-329, Bell Telephone Laboratories, Murray Hill, N. J.

Special Tech. Conf. on Non-linear Magnetics, Nov. 6-8, 1961, Statler-Hilton Hotel, Los Angeles, Calif. Papers to deal with non-linear magnetics, magnetic amplifiers and computer applications. **Deadline** for papers: **Aug. 1, 1961.** Forward to: Dr. T. Bernstein, Space Technology Laboratories, Inc., P. O. Box 95001, Los Angeles 45, Calif.

7th Annual Internat'l. Conf. on Magnetism and Magnetic Materials, Nov. 13-16, 1961. Westward Ho Hotel, Phoenix, Ariz. Papers to cover basic theoretical and experimental investigations, potential engineering applications, and apparatus and techniques using recent advances in magnetism. **Deadline** for papers: **August 18, 1961.** Forward to: Dr. F. E. Luborsky, General Electric Co., Research Laboratory, P. O. Box 1088, Schenectady, N. Y.

East Coast Conf. on Aerospace and Navigational Electronics (ECCANE), Oct. 23-25, 1961. Lord Baltimore Hotel, Baltimore, Md. Conf. will emphasize engineering developments, electronic techniques, and scientific accomplishments related to missiles, aircraft and space vehicles. Deadline for 500 word abstracts is July 5, 1961. Deadline for complete papers is September 1, 1961. Forward abstracts (3 copies) to: William C. Vergara, Director, Advanced Research Dept., Bendix Radio, Towson 4, Md.

13th Annual Fall Conv. & Technical Exhibit of the Audio Engineering Society, Oct. 10-13, 1961, Hotel New Yorker, New York, N. Y. Some of the topics to be covered: Disc Recording, and Reproducing, Loudspeakers and Systems, Artificial Reverberation, Standards of Measurement and performance, Psychoacoustical Engineering and Bioacoustics. Deadline for abstracts of papers is August 15, 1961. Forward papers to: Hermon H. Scott, Chairman Convention Committee, AES, 111 Powder Mill Rd., Maynard, Mass.

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

2nd International Congress on Infor-

(*Continued on page* 12)

Coming Events

(*Continued from page* 11)

mation Processing, Aug. 27-Sept. 1, 1962, Munich, Germany. All aspects of Information Processing and Digital Computers will be covered. Deadline for 500-1000 word abstracts is Sept. 15, 1961. Forward to: Dr. E. L. Harder, Chairman American Arrangements, Westinghouse Electric Corp., East Pittsburgh, Pa.

ENGINEERING EDUCATION

Superconductivity

Massachusetts Institute of Technology is holding a Special Summer Program on Superconductivity and its Engineering Applications. The course, scheduled for **August 14-25, 1961,** will give an integrated picture of the physics of superconductivity, the properties of superconductive materials, and their use in computer circuits. No previous knowledge of superconductivity is assumed.

Inquiries and applications should be addressed to: Professor Peter Elias, Head, Dept. of Electrical Engineering, Room 4-202, Massachusetts Institute of Technology, Cambridge 39, Mass.

Plant Layout

Univ. of California, Depts. of Engineering and Engineering Extension, is offering a one-week Short Course, **Sept. 17-22, 1961,** in Plant Layout, Material Handling, Warehousing and Shipping. Seminar and workshop for management and supervisory personnel is open to men and firms anywhere in U. S. For program and application write to: Dr. Sam Houston, Dept. K, Univ. Extension, Univ. of Calif., Los Angeles 24, Calif.

Nonlinear Systems

Case Institute of Technology is offering a two-week study course in nonlinear system analysis for engineers and others in areas of feedback control systems and networks. **Date: July 10-21, 1961.**

Process Control Theory — intensive three-week summer study course in systems dynamics and control theory. Designed for practicing engineers requiring training in up-to-date techniques in the automatic control field. **Date: July 10-28, 1961.**

Digital Control Systems Engineering —two-week study course meeting the needs of military and industrial engineers entering or engaged in advanced military guidance, control and data systems; industrial numerical process control and manufacturing process systems with numerically controlled machines. **Date: July 31-Aug. 11, 1961.** Address inquiries to: Herbert B. Schultz, Jr., Manager of Special Programs, Case Institute of Technology, University Circle, Cleveland 6, Ohio.

DALE *A favored resistor name on the Best Production Lines*

While answering quality control's demand for inherent stability, Dale resistors also meet production's need for easy assembly.

Conveniently packaged Dale resistors are available in a wide variety of sizes and terminations to fit every circuit. Meanwhile, inherent stability is assured through Dale's advanced design and stringently controlled methods of manufacture—methods which are at new levels of achievement as part of Dale's super-high reliability development program.

SPECIAL PROBLEMS? Let us help you with your requirements for special resistance problems. 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

A subsidiary of **HATHAWAY INSTRUMENTS INC.**

DALE TYPE DCH RESISTORS

CARBON FILM • CLASS A SEAL
(Clip or lead mounting; available with weldable leads)

Excellent high frequency characteristics; best stability available in carbon film resistors; long, reliable load life. Hermetically sealed in non-hygroscopic ceramic envelope; designed to provide complete insulation and protection from moisture, salt spray and other severe environmental conditions, including mechanical shock.

- MEET functional requirements of MIL-R-10509C.
- RATED at 1/10, 1/8, 1/4, 1/2, 1 and 2 watts; 10 sizes.
- TOLERANCE 1%.
- RESISTANCE RANGE from 1 ohm to 150 megohms.
- FULL LOAD OPERATION to 70° C, derating to 0 at 150° C.

Write for Bulletin R-27

Circle 98 on Inquiry Card

As We Go To Press . . .

Air Force Systems Command Established

A new major Air Force command responsible for the research, development, production, and procurement actions required to place a complete aerospace system in operational use has been established. The new organization (AFSC) is made up of elements of two former commands, the Air Research and Development Command (ARDC) and the Air Material Command (AMC).

AFSC's mission is to deliver complete, timely and operable systems to using commands such as the Strategic Air Command, Tactical Air Command, and Air Defense Command.

Communication Huts Tested by Services

The Marine Corps and Army are compiling field employment data on production models of the TSC-15 which is a "six-foot-cube communication hut" featuring multichannel single sideband communication.

Designed and developed for the Marine Corps by Collins Radio Co. and its subsidiary, the Alpha Corp. of Dallas, Texas, the TSC-15 may be transported by suspension from a helicopter or in a cargo plane. The system permits simultaneous communication on three voice channels and four teletypewriter channels. Any one of 28,000 radio channels may be automatically tuned between 2 and 30 MCS.

SATURN TEST STAND

Saturn "dynamic test stand," in which the giant space vehicle's early three-stage flight model and second generation C-2 configuration will be assembled and tested, nears completion at the George C. Marshall Space Flight Center, Huntsville, Ala. The tower is 204 ft. high and incorporates some 600 tons of structural steel.

Radio Controlled Crane

A radio controlled bridge crane, reportedly the first to be operated in any steel service center in the country, is in operation at the Chicago plant of Joseph T. Ryerson & Son, Inc.

An existing crane was adapted for remote control which is accomplished by means of a battery operated transmitter worn by the operator on the floor. The transmitter contains three controls which give a range of five speeds forward and reverse on the hoist and bridge. The crane can also be operated from the cab in the conventional manner.

BLUE SCOUT II

Combined systems check of equipment in USAF spacecraft (payload carrier) is carried out at Aeronutronic Div. of Ford Motor Co., Newport Beach, Calif. Check insures that standard intelligence equipment and space experimental equipment is in working order prior to assembly in the fore section of the four-stage vehicle.

R&D Contracts Listed By Commerce Department

Proposed unclassified NASA research and development contracts leading to prime contract awards of $100,000 or more are now published in the Commerce Dept.'s "Synopsis of U. S. Government Proposed Procurement, Sales and Contract Awards." The Synopsis will include a summary of the request for proposals together with the names and addresses of the firms which have been invited by NASA to submit proposals.

Officials believe the new publication program will provide maximum opportunities for small business firms and firms located in surplus labor areas to participate as subcontractors in NASA research programs. In the past, information on most NASA R&D prime contracts became generally available only with the award announcement.

RUN-IN ROOM FOR SWITCHES

Technician at Automatic Electric Company's plant in Northlake, Ill. sets up rotary stepping switch for "wear-in" period before final adjustment. Each switch is run for at least 100,000 steps.

Cooperative Program For Communication Satellites

England and France have agreed to provide ground stations in Europe for transmission of multichannel telephone, telegraph and television signals using satellites to be launched by the National Aeronautics and Space Administration during 1962 and 1963 in Projects Relay and Rebound.

The stations will be equipped with advanced radio facilities having extremely accurate tracking and antenna pointing qualities and capable of conducting tests with active and passive satellites at high frequencies and low power. Surveys are currently being made to determine their locations.

FILMISTOR® 'C'

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

RUGGED END-CAP CONSTRUCTION FOR LONG TERM STABILITY

• • •

EXCEPTIONAL RESISTANCE TO MOISTURE AND MECHANICAL DAMAGE

• • •

SURPASS MIL-R-10509 PERFORMANCE REQUIREMENTS

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

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

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

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

Filmistor "C" Resistors, in ⅛, ¼, ½ and 1 watt ratings, surpass stringent performance requirements of MIL-R-10509C, Characteristic C. Write for Engineering Bulletin No. 7025 to: Technical Literature Section, Sprague Electric Co., 233 Marshall Street, North Adams, Mass.

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

SPRAGUE COMPONENTS

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

SPRAGUE®
THE MARK OF RELIABILITY

When you've got to attach a connector contact to the end of a coaxial wire, a single precise stroke of a crimping tool (one that crimps braid and inner conductor to the contact simultaneously) is the fastest way, the lowest-installed-cost way, the way that cuts human error in half . . . THE AMP WAY.

Our COAXICON® contact is designed on this principle: two strokes here is one too many!

COAXICON is a one-piece contact. It can be attached, simultaneously, with a single crimping tool stroke, to the braid and inner conductor of 37 sizes of RG/U coaxial cable up to ¼" O.D. (see size numbers above). And AMP makes the tools — hand and automatic — that control the crimp.

COAXICON consists of polarized, concentric male and female shells, made from drawn parts. The inner contacts, assembled in the shells, will attach equally to solid or stranded conductors. Where contact density is important, a miniature COAXICON fulfills the requirement.

COAXICON connectors will match cable impedances in the 50-100 ohm range, at frequencies as high as 150 megacycles. Impedance mis-match, incidentally, is only 1.06 to 1.09, even at 500 megacycles.

Write today for complete product information.

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


RELIABILITY IN VOLUME...
CLEVITE TRANSISTOR
WALTHAM MASSACHUSETTS

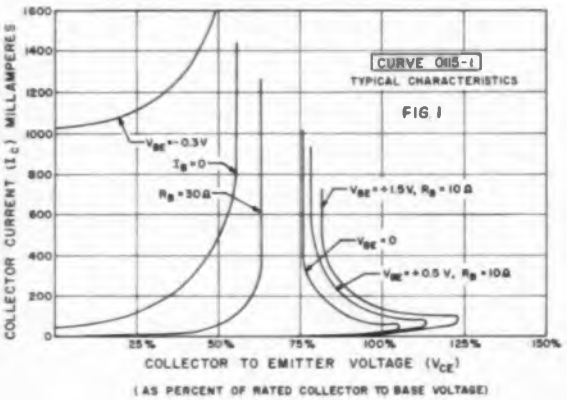
How Siegler built ultra-reliability into its new 3 KVA Inverter

by RAYMOND F. KEEGAN
Commercial Engineer, Clevite Transistor

Magnetic Amplifiers Division of The Siegler Corporation has announced the development of a 3 KVA Static Inverter featuring high conversion efficiency, precision voltage regulation, synchronized phase locking, short circuit protection with automatic recovery, and reliable high performance operation in the presence of transient line voltages. The unit is designed for minimum space-weight requirements and meets with Mil Specs MIL-E-5400 and 5272.

Developed to convert nominal 28 VDC to regulated 200 V 400 CPS 3 phase, the unit is designed for military reliability in aircraft, missiles, space vehicles, ground guidance and detection systems.

COLLECTOR BREAKDOWN CHARACTERISTICS

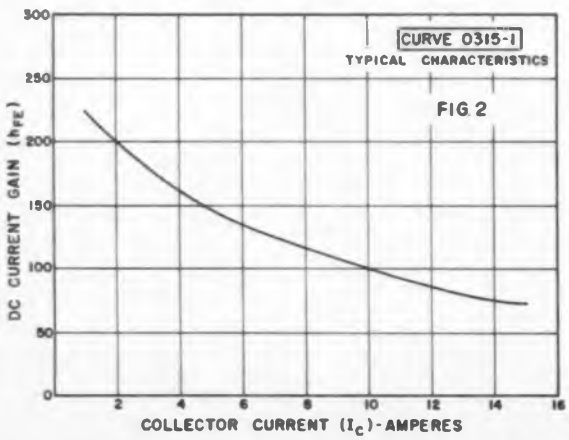


DESIGN CONSIDERATIONS

Because of the need for highly stabilized output voltages at high current levels, power transistors capable of handling these currents with uniform gain characteristics over a wide operating range were required (Fig. 1). Guaranteed gain spread and low saturation voltage were important factors.

Since aircraft power sources are subject to transient voltages which may damage transistor junctions, extra consideration was given to the selection of power transistors with known collector to emitter voltage capabilities.

CURRENT GAIN VS COLLECTOR CURRENT



The ability of Clevite 2N1146B power transistors to meet the requirements of the design caused Siegler to select them for the high power output and driver stages of the system. Clevite's 2N1146 series of transistors has specified minimum values of collector to emitter voltage under shorted and open base conditions both measured at high values of collector current to preclude the possibility of secondary breakdown caused by high local current densities (Fig. 2). Collector to base junction leakage current is specified as a maximum value at two voltages at room temperature and at the shorted base collector to emitter voltage at the maximum rated junction temperature.

The Clevite 2N1146 series of high current power transistors is conservatively rated for use in applications

Electrical Characteristics	Symbol	Measurement Conditions		2N1146B Min	Mode	Max
D C Current Gain	h_{FE}	I_C =5A V_{CE} =−2.0V		60	100	150
Base Input Voltage	V_{EB}	I_C =15A V_{CE} =−2.0V			1.0	2.0
Collector to Emitter Saturation Voltage	$V_{CE(SAT)}$	I_C =15A I_B =1.0A			0.5	1.0
Thermal Resistance	R_t					0.8
Collector to Base Breakdown Voltage	BV_{CBO}	I_{CBO}= 15mA		80		
Emitter to Base Breakdown Voltage	BV_{EBO}	I_{EBO}= 10mA		30		
Collector to Emitter Sustain Voltage	$V_{CES(SUS)}$	I_C =500mA Swept to 750mA Shorted Base V_{EB}=0		60		
Collector to Emitter Sustain Voltage	$V_{CEO(SUS)}$	I_C =1500mA Open Base I_B=0		40		
Collector Cutoff Current	I_{CBO}	95°C	60 Vdc			40
Collector Cutoff Current	I_{CBO}	25°C	20 Vdc			
			30 Vdc			
			40 Vdc		2.0	4.0
			50 Vdc			

requiring a combination of high current gain at high operating currents and high collector to emitter breakdown voltages.

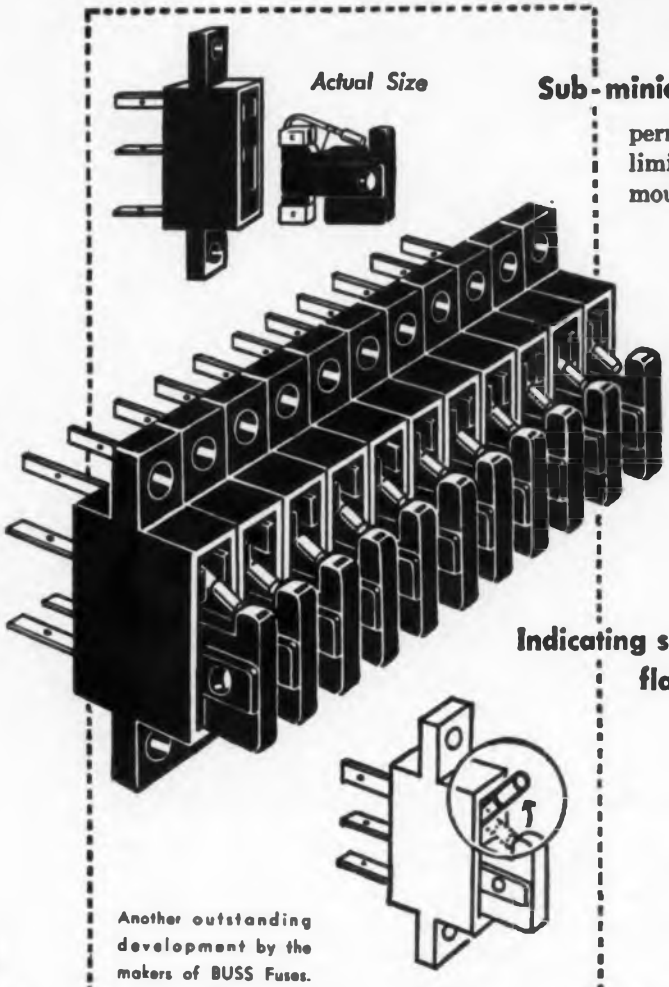
For more complete information write for Bulletin B221-1A

CLEVITE TRANSISTOR
Waltham, Massachusetts

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.

761

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
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS
McGRAW EDISON

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

TYPICAL BOOT IN POSITION

MOISTURE-PROOF

AFTER 8 SECONDS AT 275°F

heat shrinkable

BOOTS...

FOR MOISTURE-PROOFING CONNECTORS

THERMOFIT®

Heat-shrinkable Thermofit® boots used in conjunction with Rayclad adhesive provides a moisture-proof seal at the point where a coaxial cable enters the connector. This completely eliminates moisture wicking and consequent loss of insulation values and dielectric strength. Thermofit® boots are supplied in an expanded form which permits easy installation after the connector assembly is completed. Exposure for a few seconds to heat in excess of 250°F. then shrinks the boot tightly into place.

RAYCLAD TUBES
INCORPORATED

A SUBSIDIARY OF
RAYCHEM
CORPORATION

OAKSIDE AT NORTHSIDE REDWOOD CITY, CALIFORNIA

News Briefs

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

EAST

ROTRON MFG. CO., INC., Woodstock, N. Y., has recently occupied a new 14,000 sq. ft building which provides operating facilities for sales engineering and the Research and Development Laboratories. The 2-story building provides room for Rotron's Aerodynamic, Metallurgical and Chemical, and Electrical Laboratories as well as Model Shop and Sales Dept.

SPERRY MICROWAVE ELECTRONICS CO., Div. of Sperry Rand Corp., Clearwater, Fla., has been awarded a $700,000 contract from the Bureau of Weapons for parametric amplifiers. The division is also engaged in research and development and manufacture of radar test sets for Army, Navy and Air Force radar systems.

CHATHAM ELECTRONICS DIV., TUNG-SOL ELECTRIC, INC., Newark, N. J., has been awarded two contracts totaling $350,000 for supplying airborne power conversion equipment for the B-52H Stratofort missile bomber built by Boeing Airplane Co. The power supplies called for by the initial contracts utilise special purpose ruggedized silicon rectifiers also manufactured by Tung-Sol.

GENERAL INSTRUMENT CORP. in its second major expansion through merger in the past year, has acquired Pyramid Electric Co. and announces formation of a new General Instrument Capacitor Div. with four manufacturing plants in Southern and Eastern United States.

PHILCO CORP. formally opened a new $1 million, 70,000 sq. ft. building in Ft. Washington Industrial Park, Pa. The building provided facilities for the development of large communications systems for government and industry.

GENERAL ELECTRIC CO.'s HEAVY MILITARY ELECTRONICS DEPT., Syracuse, N. Y., has been awarded a $36 million contract for production of the Navy's new AN/SPS-30 long range, height-finding radar. The new shipboard radars are for use on missile cruisers and carrier. First operational units are scheduled for delivery to the Navy in May 1962.

MELPAR, INC., Falls Church, Va., has announced that new contracts, amendments and change orders awarded to Melpar during April totaled nearly $5 million. Total contract awards for the first quarter of 1961 plus April come to over $12.4 million.

THE BENDIX CORP., Ann Arbor, Mich., has been granted, by the U. S. Navy Bureau of Ships, a $670,000 dispatch contract to begin work on an expected $3 million program to develop a shipboard communications terminal for use in connection with the Advent satellite communications program. This is in addition to a $17,260,000 contract recently announced to develop the over-all communications system for the Advent satellite.

GENERAL ELECTRIC's MISSILE & SPACE VEHICLE DEPT., Philadelphia, Pa., has received a $6 million contract to develop a satellite control system that will seek out stars with an accuracy equal to "drawing a bead" on the head of a pin at 5 miles. The control system will be part of the future Orbiting Astronomical Observatory (OAO).

ARCO ELECTRONICS, INC., has dedicated a new 46,000 sq. ft. headquarters plant in the Lake Success Business and Professional Park, Great Neck, L. I., N. Y. 15,000 sq. ft. will be given over to the company's PFC Div. producer of components for use in communications, missile and aircraft guidance and control systems.

RADIO CORP. OF AMERICA, has dedicated its new $4 million data processing center at Palm Beach Gardens, Fla. Special feature of the dedication ceremonies was a turning over of the first RCA 301 electronic data processing system produced in the new Center to the Chase Manhattan Bank.

IBM, Yorktown, N. Y., has opened its new crescent-shaped 1,091 ft. long Thomas J. Watson Research Center. The three-level building houses labs for general science, solid state science, experimental systems, experimental machines, engineering science and mathematical sciences. These labs deal primarily with basic research.

PHILCO CORP., Blue Bell, Pa., has opened their new 200,000 sq. ft. Research Center which houses special facilities including a radio chemical laboratory; 1-mile long antenna testing range; a laboratory for studying solar power devices; equipment for producing ultra-pure water; and a "white room" for controlled experiments.

MIDWEST

CURTISS-WRIGHT CORP., Wood-Ridge, N. J., has acquired the assets and product lines of the Abrams Instrument Corp., Lansing, Mich. Abrams Instrument will operate as a wholly-owned subsidiary of Curtiss-Wright.

CONTROL DATA CORP., Minneapolis, Minn., has been awarded an order for a $1½ million 1604 computer system for the Defense Atomic Support Agency (DASA) for the new Dept. of Defense Damage Assessment Center (DODDAC), an inter-service agency.

ARMOUR RESEARCH FOUNDATION of Illinois Institute of Technology has been awarded a $2 million contract for technical support of a tri-service program to analyze and control radio interference in this country and abroad. ARF was awarded a contract by the Electronic Systems Div., Hansom Field, Mass., of the Air Force Systems Command.

WESTINGHOUSE ELECTRIC CORP., Pittsburgh, Pa., has been awarded a contract in excess of $1 million by Boeing Co. for work on the Dynasoar manned space glider. Westinghouse Aerospace Electrical Dept. will develop a generator and control unit for the delta-winged, rocket-boosted Air Force space glider.

THE VICTOREEN INSTRUMENT CO., Cleveland, Ohio, has been awarded contracts totaling approximately $600,000 for development and manufacture of specialized miniaturized components. Components will be produced for the F. W. Sickles Div. of General Instrument Corp. and The Wurlitzer Co., prime contractors for the Army Ordnance.

BELDEN MFG. CO., Chicago, Ill., has issued a license to Channel Master Corp., Ellenville, N. Y., for the manufacture of Belden twin-lead foamed polyethylene transmission line cable—U. S. Patent #2,782,251.

COLLINS RADIO CO., Cedar Rapids, Iowa, has received a letter contract for $1.5 million, from the Navy Bureau of Weapons, for the delivery of communication, navigation and identification (CNI) systems for use aboard Navy's McDonnell Phantom II, North American Vigilante and Grumman Intruder aircraft.

F. W. BELL, INC., Columbus, Ohio, has opened a new "Micro-Graphics" Div. to handle the design and production of printed circuitry, miniaturized circuitry and chemical milling.

WEST

TEXAS INSTRUMENTS INCORPORATED has been awarded a contract for $1,001,108 for the production of AN/APS-88 radar systems for the Bureau of Naval Weapons. The airborne radar will be used for anti-submarine warfare, weather-warning and general-purpose search and will be installed in the carrier-based S2F-3 built by Grumman Aircraft and Engineering Corp.

SIERRA ELECTRIC CORP., Gardena, Calif., has purchased all rights, inventories and tooling for the low-voltage electrical control system currently produced by the Square D Co.

HUGHES AIRCRAFT CO., Semiconductor Div., Newport Beach, Calif., has been awarded a transistor contract totaling more than $500,000 by Convair (Astronautics) Div. of General Dynamics Corp. The devices will be used in Convair's Atlas IBM.

SPACE TECHNOLOGY LABORATORIES, INC., Los Angeles, Calif., has been awarded a $95,585 contract to study the use of an electronic device for generating electromagnetic radiation. The contract was awarded by the Air Force Systems Command through the Rome Air Development Center, Griffiss Air Force Base, N. Y.

GENERAL DYNAMICS CORP. has announced the creation of 5 new operating divisions. The new divisions, all formerly components of the Convair Div., are: General Dynamics/Astronautics; General Dynamics/Ft. Worth; General Dynamics/Pomona; General Dynamics/San Diego and General Dynamics/-Daingerfield.

AUTONETICS, Div. of North American Aviation, Inc., Downey, Calif., has been awarded contracts approximating $21 million to produce Ship's Inertial Navigation Systems (SINS) for all nine of the currently-authorized, larger Lafayette-class Polaris Fleet, Ballistic Missile submarines.

AEROJET-GENERAL CORP., Sub General Tire & Rubber Co., Azusa, Calif., is constructing a $1¼ million, 30,000 sq. ft. facility at its Azusa Plant to test and manufacture infrared subsystems for the Air Force MIDAS satellite.

MOTOROLA SEMICONDUCTOR PRODUCTS INC., Phoenix, Ariz., has opened a new 315,000 sq. ft. addition to its manufacturing facility. The new structure costing approximately $4.8 million will have an estimated $2 million worth of manufacturing and research equipment. Total floor space for the semiconductor production facility now totals 675,-000 sq. ft.

THE GARRET CORP.'s AiRESEARCH MFG. DIV., Los Angeles, Calif., has been awarded a contract for the development of a miniature turbogenerator designed for one-shot missile applications, by the Picatinny Arsenal, Ordnance Corps, U. S. Army, Dover, N. J.

ANTENNA SYSTEMS, INC., Hingham, Mass., has announced that it has formed a Pacific Div. located at 2200 Cleveland Ave., National City, Calif. Division has facilities for complete antenna service.

150 mw POWER DISSIPATION MADT®

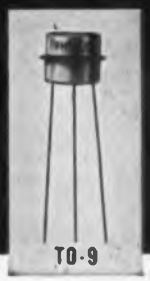
NEW LINK

in Industry's Strongest Chain of Transistor Performance

PHILCO

2N2048

GERMANIUM SWITCH



ABSOLUTE MAXIMUM RATINGS

Storage Temperature	−65 to +100°C
Collector Voltage, V_{CB}	−20 volts
Collector Voltage, V_{CES}	−20 volts
Collector Voltage, V_{CEO}	−15 volts
Collector Current, I_C	−100 ma
Total Device Dissipation @ 25°C	150 mw

ELECTRICAL CHARACTERISTICS (@ 25° C)

Characteristics	Conditions	Min.	Max.	
Collector Cutoff Current, I_{CBO}	V_{CB} = −5v		3	μa
DC Current Amplification Factor, h_{FE}	V_{CE} = −0.5v, I_C = −50 ma	35		
DC Current Amplification Factor, h_{FE}	V_{CE} = −0.5v, I_C = −10 ma	50	300	
Collector Saturation Voltage, $V_{CE\ (SAT)}$	I_C = −10 ma, I_B = −0.5 ma	.050	0.140	volt
Base Input Voltage, V_{BE}	I_C = −10 ma, I_B = −0.5 ma	0.25	0.35	volt
Hole Storage Factor, K's	I_B = −2.5 ma		100	nsec
Gain Bandwidth Product, f_T	V_{CE} = −10v, I_E = −5ma	150		mc

Philco's new 2N2048 is the forerunner of a broad line of 150 mw MADT switching transistors. The new power dissipation capability is available in uniformly reliable high-speed units, at surprisingly low cost, via proven MADT automation.

Intended for both saturated and non-saturated logic circuits, the Philco 2N2048 gives you more than comparably priced transistors—more drive per transistor, more switching speed per dollar invested in transistors, and the extra capability of extra power dissipation for applications that require it.

Philco 2N2048 features include minimum h_{FE} of 50, maximum V(SAT) of 0.14V., minimum f_T of 150 mc., and tightly controlled V_{BE} ranging from 0.25V. minimum to 0.35V. maximum. For complete information write Dept. EI761.

Immediately available in quantities 1-999 from your Philco Industrial Semiconductor Distributor

PHILCO®

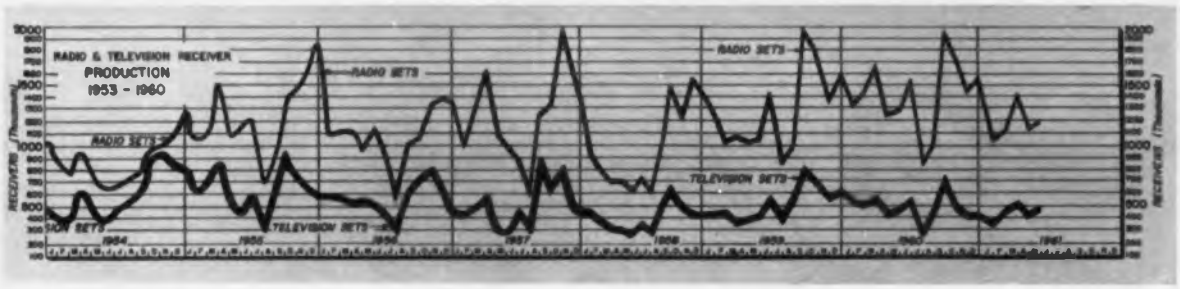
Famous for Quality the World Over

LANSDALE DIVISION, LANSDALE, PENNSYLVANIA

Circle 11 on Inquiry Card

TRANSISTOR CENTER U.S.A.

ELECTRONIC INDUSTRIES TOTALS



Quantity and Value of Shipments of Home-Type Radio Receivers and Television Sets, Automobile Radios, Phonographs and Record Players: 1960 and 1959

	1960		1959	
	Quantity (1,000 units)	Value ($1,000)	Quantity (1,000 units)	Value ($1,000)
Home-type TV receivers, direct view, complete sets, total	5,611	775,191	5,979	815,361
Table models, includes portable sets (with or without conventional radio), total	3,157	355,237	3,451	376,843
Console and consolette models (with or without conventional radio)	2,267	368,649	2,360	397,115
Radio-phonograph-TV combination models	187	51,305	168	41,403
Chassis for home-type TV receivers, for sale separately, total	45	2,750	40	2,691
Sold to radio and TV manufacturers	45	2,750	40	2,691
Sold to others				
Home-type radio-receivers, complete sets (except radio phonograph combinations and television sets), total	9,763	180,062	9,568	189,926
Socket powered, total	5,683	94,920	5,471	94,563
Table models, except clock, total	3,114	50,030	2,923	48,770
AM[1]	2,530	32,256	2,514	34,824
AM-FM and FM only	584	17,774	409	13,946
Clock models (AM and AM-FM)	2,569	44,890	2,548	45,793
Battery powered table and console models (except portable)	(2)	(2)	63	1,644
Portable radio receivers, total	4,080	85,142	4,034	93,719
3-way (A.C., D.C., and battery)	125	2,865	351	8,419
Transistor	3,935	81,882	3,615	84,329
Other portable radio receivers	[2]20	[2]395	68	971
Chassis for home-type radio receivers, sold separately, total	69	2,749	37	2,123
Sold to radio and TV manufacturers	69	2,749	37	2,123
Sold to others				
Home-type radio-phonograph combinations, complete sets (including built-in recorders, excluding TV sets), total	654	91,396	771	99,159
Table models, including portable sets, AM and AM-FM	209	14,222	321	20,234
Console models, total	445	77,174	450	78,925
AM	189	27,730	185	27,171
AM-FM	256	49,444	265	51,754
Automobile radios (broadcast receivers only)	5,959	142,517	5,656	132,637
Phonographs, total	3,242	166,504	3,481	190,062
Mechanical acoustical reproduction phonographs (with spring electric motor)	373	3,845	391	3,641
Electronic phonographs (with speaker), total	2,869	162,659	3,090	186,421
Coin operated	46	32,913	54	38,815
Non-coin operated	2,823	129,746	3,036	147,606
Record player attachments (including record players with automatic record changing devices), total	396	9,702	536	14,753
Complete with case (plug-in or induction types only)	172	5,105	333	9,710
For installation in combination sets and custom-built sets	224	4,597	203	5,043

[1] Figures include a negligible amount of console models.
[2] In 1960 data for battery powered table and console models are included with other portable radio receivers in order to avoid disclosing individual company figures.

Government Contract Awards which usually appear on this page, begin this month on page 66.

Now, you can save time and insure reliability... by specifying DK Coaxial switches in your design

It's easy. DK Coaxial switches are available in scores of shapes, sizes, and functions *from factory stock*. RF Products' new DK Coaxial switch catalog lists over 130 variations of 16 basic coax switch designs, covering a proven 90% of all known applications. All the facts and figures on the industry's most complete line of coaxial switches are at your finger tips.

You'll also find that these switches successfully combine ruggedness with the highest standards of precision: 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.

And, don't forget that RF Products, pioneers in the development of the coaxial switch, will continue to offer you design and engineering services whenever you need them. Whether you order a switch from the catalog or a switch designed to meet your exact specifications, you can be assured of the same high quality and service.

For details on our new line of standard switches, write for catalog DK 61.

RF PRODUCTS | ipc AMPHENOL

DIVISION OF AMPHENOL-BORG ELECTRONICS CORPORATION • 33 EAST FRANKLIN ST., DANBURY, CONN.

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FIRST PORTABLE LOW COST DUAL GUN OSCILLOSCOPE

Featuring ★ DC to 5 Mc Bandwidth ★ 1 mv/cm sensitivity ★

AT HALF THE EXPECTED PRICE $495

Available now for the first time — the only light weight, 5 Mc dual gun oscilloscope with all these features:

VERTICAL AMPLIFIERS: DC to 5 Mc bandwidth (3 db); 70 nanoseconds rise time; 100 v/cm to 100 mv/cm on both amplifiers, 1 mv/cm preamplifier on lower amplifier.
INPUT IMPEDANCE: (each channel) 30 picofarads across 1 Megohm.
HORIZONTAL SWEEP: 1 microsecond/cm to 1 second/cm in 5 steps.
TRIGGER: Internal; free running, or with 0.5 cm excursion by either beam; External; ±0.5 v to 2.5 v ; TV frame and TV line.
WEIGHT: 22 pounds **SIZE:** 9½" x 8½" x 13"
Price: Model 5Mc-2 Oscilloscope with 2 Probes $495.00
Immediate delivery. All prices are quoted f.o.b. Los Angeles, and are subject to change without notice.

For complete information and demonstration contact nearest representative.
Anderson-Stone Engineering, Newton, Mass.
Brogan Associates, Mineola, Long Island; Syracuse, New York
J. E. Cuesta Company, Paoli, Pennsylvania
Datronics, Houston, Dallas, Fort Worth, Texas
Kittleson Company, Los Angeles, Palo Alto, California
S. S. Lee Associates, Washington, D.C.; Baltimore, Maryland; Winston-Salem, North Carolina; Orlando, Florida
Pivan Engineering, Chicago, Illinois; Indianapolis, Indiana

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ENGINEERING BEYOND THE EXPECTED

12333 West Olympic Boulevard, Los Angeles 64, California

SPACE CREATURES?

These "space creatures" are actually various types of transistors used by the Autonetics division of North American Aviation, Incorporated, Downey, California. They are shown standing in gravel rock which is more commonly found in ordinary ash trays.

Snapshots . . .

of the Electronic Industries

RADIO ANTENNA INSULATOR

One of the world's largest radio antenna insulators is shown at G.E. Insulator Dept.'s Laboratory in Baltimore, Md. Now in use at the Navy's Cutler, Me. radio station, it is filled with SF_6 gas for insulation. The bushing is mounted through an opening in the roof structure.

ELECTRONIC COACH

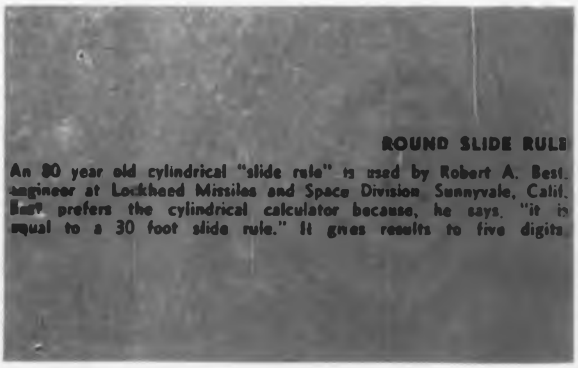
Tokyo Shibaura Electric Company's electronic coach is equipped with a radio receiver and loudspeaker which broadcast instructions from the coach. The pace setter's speed can also be set in advance and controlled by magnetic tape or changed by remote control.

SOLAR CELLS

Covered by thousands of thin slices of sapphire to protect them from space radiation, solar cells are placed on communications satellite by Bell Telephone Laboratories engineer Robert J. Nielsen.

MONITORING THE STRETCH COMPUTER SYSTEM

IBM engineer monitors electronic process taking place within system's central processing unit. Patterns of light displayed on the console indicate actions being taken by the computer. System was built for the Los Almos Scientific Laboratory in New Mexico.



ROUND SLIDE RULE

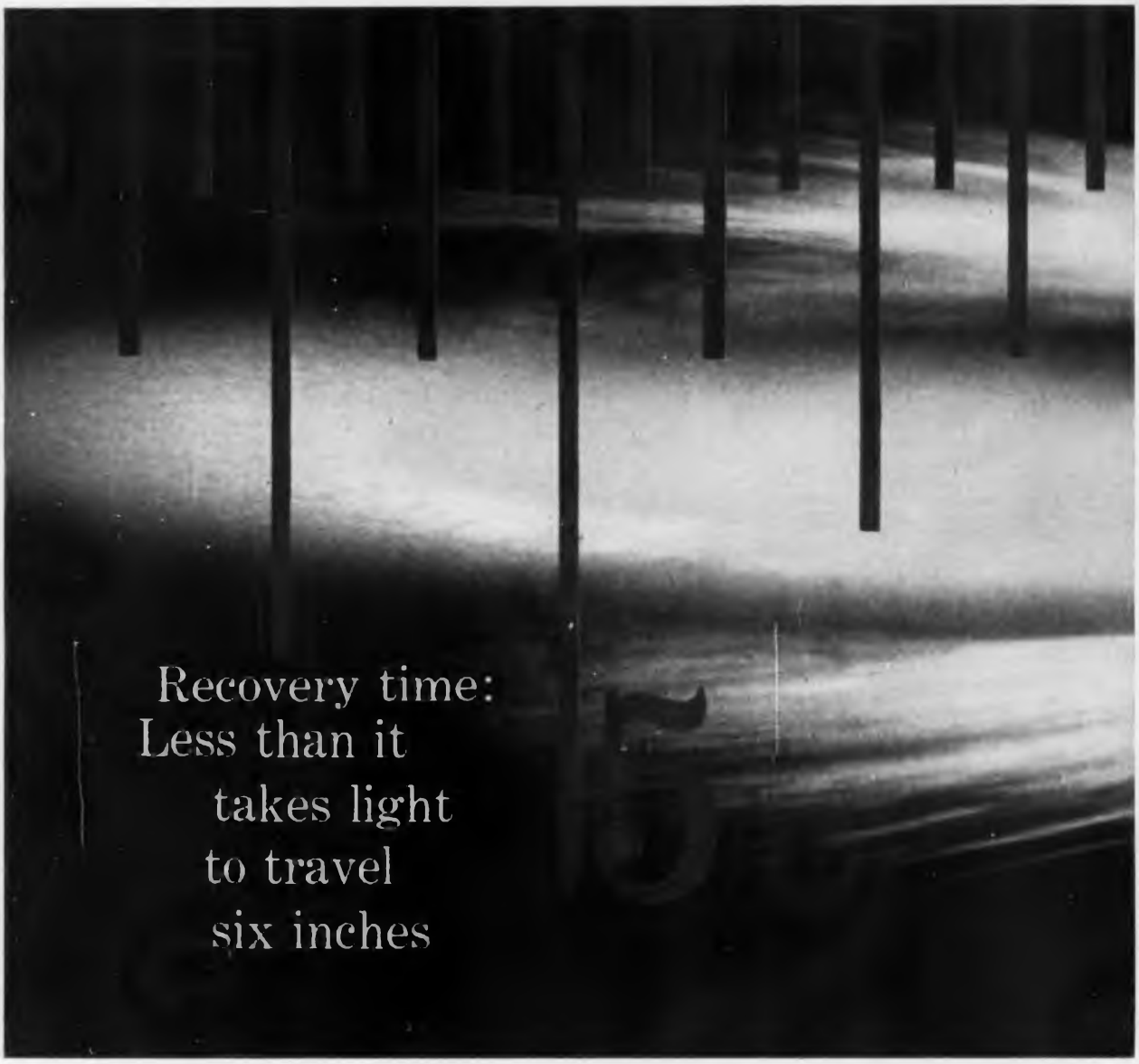
An 80 year old cylindrical "slide rule" is used by Robert A. Best, engineer at Lockheed Missiles and Space Division Sunnyvale, Calif. Best prefers the cylindrical calculator because, he says, "it is equal to a 30 foot slide rule." It gives results to five digits.

HEARING EVALUATOR

Consultants may test both ears individually or binaurally for either air or bone conduction using the hearing evaluator made by UNEX Laboratories of Hathorne, Mass.

CONTROL DISPLAY SYSTEM

Data from Project Mercury's orbital capsule will feed the display system built by the Information Technology Division of General Dynamics Electronics, San Diego, California. World map displays capsule's path in orbit and locations of the remote tracking stations.



The recovery time of the new Hughes® HD-5000 Diodes is guaranteed less than half a nanosecond! These are the fastest switching devices commercially available today. They are so fast, in fact, that storage time can't even be measured.

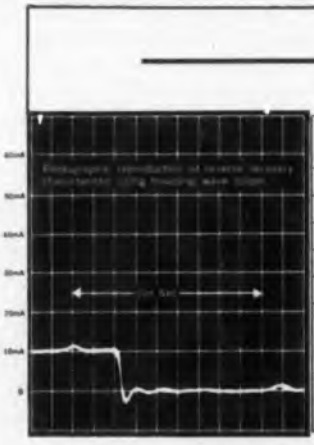
Now computer circuits can be designed that work 10 times faster than ever before. This important speed break-through was made possible through an exclusive bonding process developed by Hughes research. The result is a low-capacity diode that solves recovery time problems.

The HD-5000 diode series is available now from Hughes. Call your local Hughes Semiconductor sales engineer or distributor. Or write Hughes Semiconductor Division, Marketing Department, Newport Beach, California.
For export write: Hughes International, Culver City 5, California.

CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
SEMICONDUCTOR DIVISION



Type	I_F@1V (mA)	Es@—100μA (volts)	I_R(μA) @25°C	I_R(μA) @100°C	@—5V Recovery n sec.
HD 5000	5	20	0.2	2.0	<0.5
HD 5001	5	20	1.0	10.0	<0.5
HD 5002	2	20	0.2	2.0	<0.5
HD 5003	2	20	1.0	10.0	<0.5
HD 5004	2	15	1.0	20.0	<0.5

The recovery circuit uses a high-speed sampling scope and attachments. The switching is 10mA forward to 6V reverse; recover to 1mA reverse. Loop impedance is 100 ohms. Typical capacitance: 0.8 pf. Typical rectification efficiency: 60% at 100 Mc.

EI's International News

JAPAN

"Job Jumping" Little Known in Jap Electronics

Edward Keonjian of American Bosch Arma Corp., at a recent meeting of the Radio Club of America in New York, described what he saw on his recent trip to Japan.

Japanese engineers are very competent: due primarily to rigorous competition for jobs. Since only the top 20% of college graduates are even offered jobs, the engineer and company both consider the position as a lifetime contract. There is very little "job jumping": rare is the engineer who has worked for two or more companies in his lifetime.

With stringent college requirements, almost constant study, and the necessity of placing in the top 20% of his class; the graduate engineer is only offered around $110 per month. This is a good salary, in a country where a college degree is a must, not for advancement, but just to subsist at a mediocre level.

If the new engineer does obtain a job, many fringe benefits follow, not the least of which are, company housing and transportation to and from work. As the man moves up the ladder, from plant manager on up, he rates a chauffered auto.

The chief labor force in the factories is teen-age girls, who work for about $20 per month. Companies, to by-pass government regulations stating teen-agers will not work after 9 p.m., have split the working day into two shifts: 5 a.m.-1 p.m. and 1 p.m.-9 p.m. The girls live in company dorms, so they will be close to work.

At the present time there are no unions, but they are coming. This will force the Japanese management, in Mr. Keonjian's opinion, to automation, rather than to higher wages.

An International Computer

The records of the USAF Accounting and Finance for 72 countries and the U.S. are rapidly processed on this RCA 501 Computer. Installed at Denver, Colo., it can process 18,000 allotment checks an hour, and consolidate information from all over the world concerning the Air Force. Brig. General Paul W. Schiedecker, Commander AFAF, is shown inspecting the facility.

AUSTRALIA

Manufacturing License Sought

A licensing arrangement with a United States electronics firm is proposed by Admiral of Australia (Pty.) Ltd. who are now producing domestic radios, radio-phonographs, TV receivers. The firm desires to diversify its activities by manufacturing, or assembly of U. S. products. The 120,000 sq. ft. plant at Bankstown is capable of employing 600 operators, now employs only 120. The factory has an engineering and development section fully equipped with test and measuring equipment, including a press shop and tool room. The Australian company has good marketing facilities with sales outlets throughout the country, and also warehousing branches in all states. Interested firms are invited to write to Admiral of Australia (Pty.) Ltd. Gow St., Bankstown, N.S.W. Australia.

Fourth Tokyo International Trade Fair, T.M.C. stand. More than a million people visited the American Pavilion to view the products of the 28 American firms which cooperated with the Office of International Trade Fairs, U.S. Dept. of Commerce, in sponsoring the U.S. Exhibition.

ENGLAND

Suitcase Computer

Elliott Brothers (London) Ltd. announced agreement with Autonetics Div. of North American Aviation Inc. to make and sell the "VERDAN" digital computer in the United Kingdom. "VERDAN" is the first small digital computer available in Britain; it weighs 82 lbs. and is less than 1½ cubic ft. Developed in America for military use—reliability tests cost $35 million—it is capable of performing all the computations required to fix the launch position of the Polaris-carrying submarines. The main British use will be for aircraft control applications, including anti-collision action.

NETHERLANDS

Reactor Evaluated for Safety

Netherlands—At the request of the Netherlands Government and through arrangements by the International Atomic Energy Agency, an advisory panel appointed by IAEA recently completed a safety evaluation of a reactor project in the Netherlands. The 20-megawatt experimental reactor evaluated, now nearing completion at the Netherlands reactor center at Petten, will use enriched fuel, will be moderated by ordinary water and will have a high neutron flux. It is of the same type as the Oak Ridge research reactor in the United States. It is expected to be a valuable tool in nuclear research and testing, IAEA commented in announcing completion of the evaluation.

FRANCE

Sperry Sets Up European Company

New York—Formation of the Sperry Europe Continental Co. to handle sales and service of Sperry equipment in Western Europe was announced by the Sperry Gyroscope Co., a division of Sperry Rand Corp. The new organization, with headquarters in Paris, will represent Sperry in the negotiation of patents, licenses and contracts, throughout the European nations where Sperry has commitments with government, commercial and industrial customers.

Mr. Carl A. Frische, President of Sperry Gyroscope Co., stated "we plan to build a network of offices and representatives in several countries to expedite the sale and service of a wide variety of land, sea, air and space equipment."

(*Continued on page* 34)

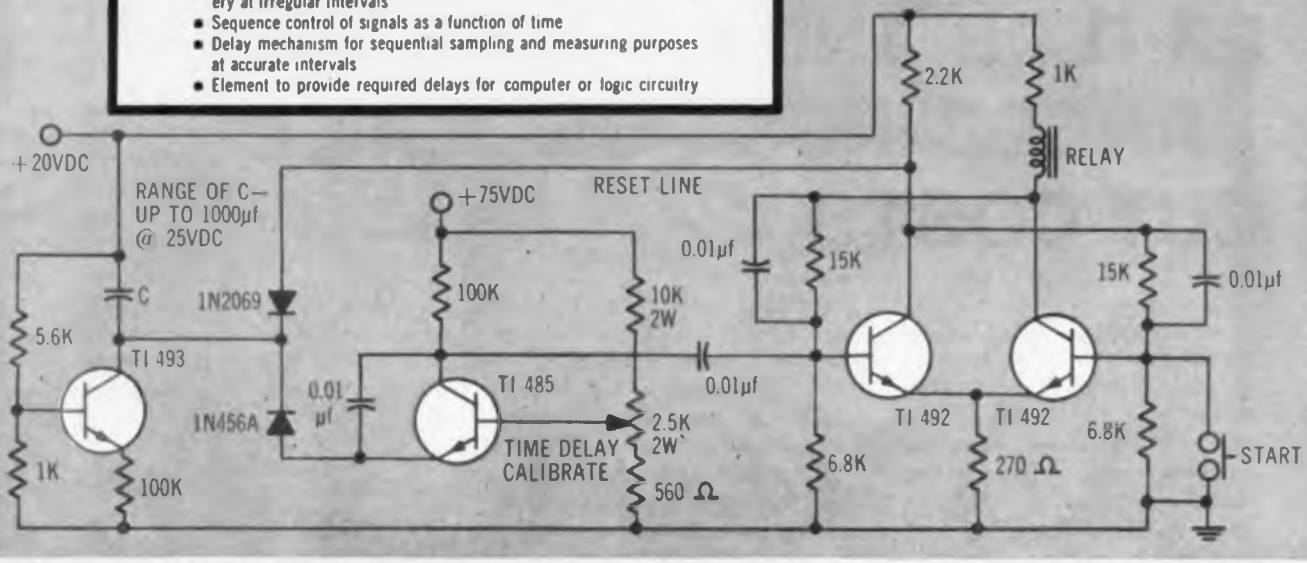
Variable Delay Timing Circuit

Typical Applications

- Safety device for sequential application of signals
- Warm-up delay mechanism for starting complex machinery
- Automatic on/off control to facilitate adjustment of process machinery at irregular intervals
- Sequence control of signals as a function of time
- Delay mechanism for sequential sampling and measuring purposes at accurate intervals
- Element to provide required delays for computer or logic circuitry

Features

Time Delay From 25 milliseconds to 3 minutes
Self Resetting or Externally Cycled
Temperature Range −40°C to +125°C
ON/OFF Relay Actuator



HOW TO GET HIGH TEMPERATURE STABILITY AND INDUSTRIAL ECONOMY

With New TI Low-Cost Silicon Industrial Transistors...

You can assure your customers optimum circuit performance up to 125°C when you design-in new, low-cost TI silicon industrial transistors. Priced comparable to lower-temperature industrial devices, these new TI silicon industrial units provide the high performance your industrial designs require.

Get greater margins of operational safety by applying these new silicon industrial transistors to your process control, communication, aviation system, electronic instrumentation, and computer applications today.

CHARACTERISTICS					APPLICATIONS					
TYPE	MIN BV_{CBO}	DC Beta Range	MAX I_{CBO} @ 100°C	$f_{\alpha b}$ (typ)						
TI 480	50 v	9—36* @ 5 ma	50 μa @ 30 v	1 mc	TI 480					
TI 481	80 v	9—36* @ 5 ma	50 μa @ 30 v	1 mc	TI 481					
TI 482	20 v	>20 @ 30 & 150 ma	50 μa @ 10 v†	60 mc			TI 482	TI 482		
TI 483	40 v	20—60 @ 150 ma	50 μa @ 30 v†	60 mc			TI 483	TI 483		
TI 484	40 v	40—120 @ 150 ma	50 μa @ 30 v†	60 mc			TI 484	TI 484		
TI 485	20 v	15—60 @ 10 ma	20 μa @ 15 v†	200 mc					TI 485	
TI 486	80 v	20—80 @ 200 ma	300 μa @ 60 v‡	15 mc			TI 486			
TI 487	80 v	20—80 @ 200 ma	300 μa @ 60 v‡	15 mc			TI 487			
TI 492	40 v	15—45* @ 1 ma	50 μa @ 30 v	8 mc		TI 492				
TI 493	40 v	15—45 @ 10 ma	50 μa @ 20 v	20 mc		TI 493				
TI 494	40 v	40—125 @ 10 ma	50 μa @ 20 v	20 mc		TI 494				
TI 495	40 v	120—250 @ 10 ma	50 μa @ 20 v	20 mc		TI 495				
TI 496	40 v #	>10 @ 3 ma	75 μa @ 40 v	1 mc						TI 496

*AC Beta † I_{CBO} @ 125°C ‡ I_{CBO} @ 150°C § 100 μa to 20 ma **20 ma to 500 ma # BV_{CEX}

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DELAY LINES, INDUCTORS, FILTERS AND CHOKES... ARNOLD IRON POWDER CORES CUT COSTS

Iron powder cores are commonly specified for such applications as delay lines (illustrated below), inductors, filters and filter chokes because of their inherent low cost. And Arnold cores are your logical choice, for the principal reasons of superior dependability and the wide selection available to you.

Arnold's overall magnetic knowledge, and unequalled facilities for manufacture and test, are of prime importance in assuring you a source of cores that are highly uniform, shipment after shipment. You'll find them dependable, not only in permeability and resultant inductance at high frequencies, but in high mechanical strength and dimensional accuracy as well.

The Arnold line also offers a wider range of shapes and sizes of iron powder cores for your selection than any other one brand on the market. It includes bobbin cores, cups, toroids, plain, sleeve and hollow cores, threaded cores and insert cores, etc. Facilities for special cores to your order. Ask for new Bulletin PC-109A. ● Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Illinois.*

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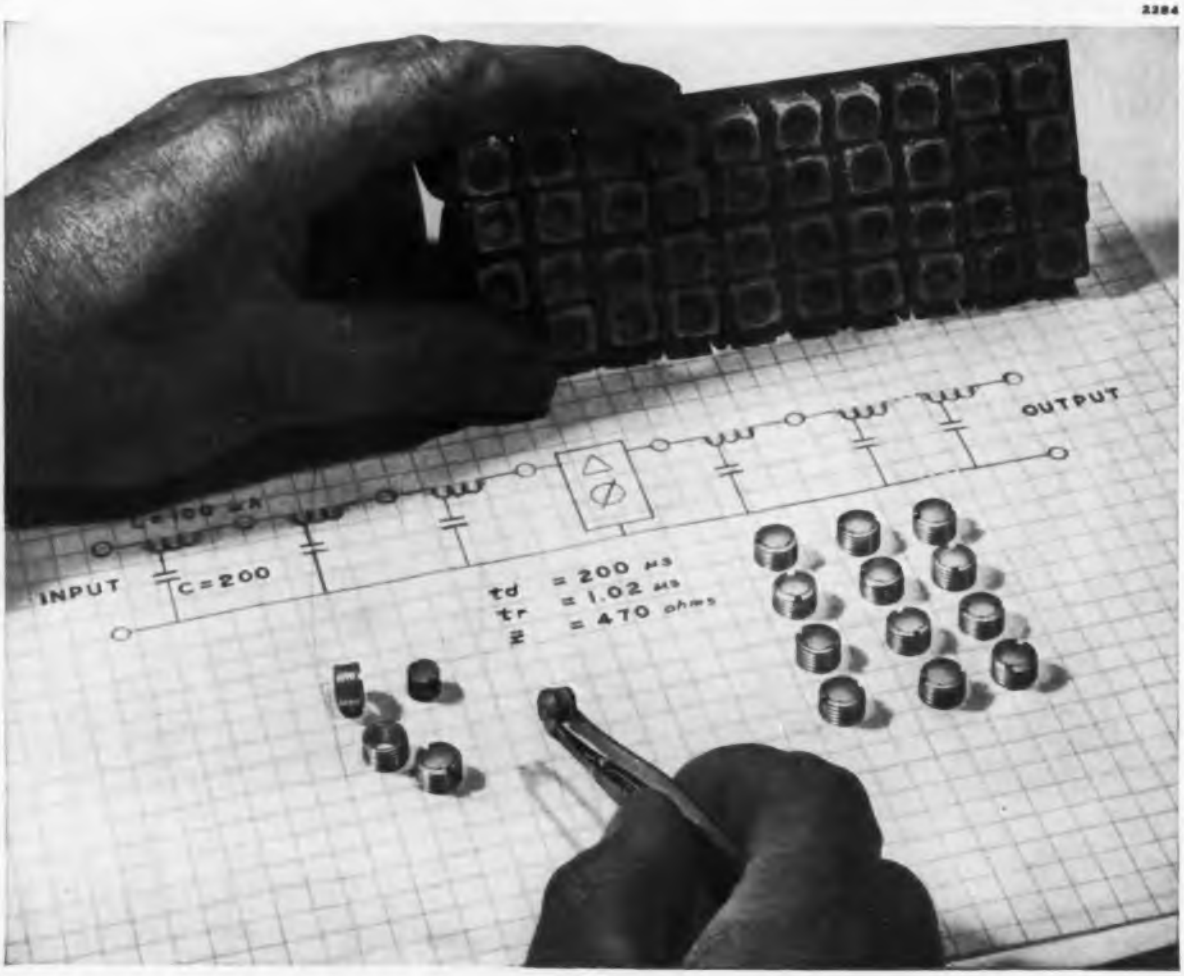


NOW... in a low-cost Tektronix Oscilloscope...
you choose the type and degree of performance you demand for a particular application

TYPE 561 OSCILLOSCOPE
— basically an Indicator which accepts a wide range of plug-in units in both channels.

Type 561 Indicator . . . $425
5-inch monoaccelerator cathode-ray tube • 3.5 kilovolts accelerating potential • 8 by 10 centimeter viewing area Z-axis input • 18 calibrated square-wave voltages, approximately 2 μsec risetime, at line frequency (for time-base calibration) • Regulated dc heater voltage thru separate regulator circuitry.

Regulated dc supply operates between 105 to 125 volts or 210 to 250 volts, 50 to 800 cycles . . . *provides 85 watts for powering all present and future plug-in units in this series.*

Type 560 Indicator . . . $325
Similar to the Type 561, but not as adaptable, the Type 560 Oscilloscope—with 30 watts of power—will accept only those plug-ins numbered below 70.

with... easily interchangeable PLUG-IN UNITS

. . . which drive the crt deflection plates directly.
. . . which house approximately 2/3 of the circuitry.
. . . which contain minimum components and controls.

AVAILABLE NOW

Type 50 Vertical Amplifier **$115**
Passband—15 cps to 200 kc.
Sensitivity—1 mv/cm.

Type 51 Time-Base Unit **$135**
Sweep rate—5 ms/cm, calibrated.
Magnifier—Variable, uncalibrated, from 1X to 20X.
Triggering—Automatic or free-run.

Type 59 Basic Amplifier **$50**
Passband—dc to 400 kc, at maximum sensitivity.
Sensitivity—approximately 1 v/cm, attenuation provided by variable potentiometer at the input.
Maximum Input Voltage—600 volts.

Type 60 1-MC Amplifier **$99.50**
Passband—dc to 1 mc.
Sensitivity—50 mv/cm to 50 v/cm, calibrated decade-step attenuator (4 steps), with variable control.

Type 63 Differential Unit **$125**
Differential input, 50-to-1 rejection ratio at maximum sensitivity.
Passband—dc to 300 kc.
Sensitivity—1 mv/cm to 20 v/cm in 14 calibrated steps, with variable control.

Type 67 Time-Base Unit **$150**
Sweep rates—21 calibrated steps from 1 μsec/cm to 5 sec/cm, accurate within 3%.
Magnifier—5X.
Triggering—Amplitude-level selection, automatic, or free-run, ac-coupled or dc-coupled, rising or falling slope, internal source, external source, or line frequency.
External Input to Sweep Amplifier—1 v/cm sensitivity.

Skeleton Plug-In Unit **$15**
Contains 24-pin connector, latch, front-panel overlay... for constructing your own circuits.

Type 72 Dual-Trace Unit **$250**
Identical Channels—5 operating modes: alternate sweeps, chopped, Channel A only (may be inverted), Channel B only, both channels combined at output (B ± A).
Passband—dc to 650 kc.
Sensitivity—10 mv/cm to 20 v/cm in 11 calibrated steps, with variable control.

Type 75 Wide-Band Unit **$175**
Passband—dc to 4 mc.
Sensitivity—50 mv/cm to 20 v/cm in 9 calibrated steps, with variable control.
Risetime—approximately 85 nanoseconds.

Prices F.O.B. Factory

For a demonstration, please call your Tektronix Field Engineer.

Plug-in units under development include those for pulse-sampling, four-trace work, high-gain measurements, strain gage and other transducer applications.

Tektronix, Inc. *P O. BOX 500 · BEAVERTON, OREGON / Mitchell 4-0161 · TWX—BEAV 311 · Cable: TEKTRONIX*

TEKTRONIX FIELD OFFICES: Albuquerque, N. Mex. • Atlanta, Ga. • Baltimore (Towson) Md. • Boston (Lexington) Mass. • Buffalo, N.Y. • Chicago (Park Ridge) Ill. • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio • Denver, Colo. • Detroit (Lathrup Village) Mich. • Endicott (Endwell) N.Y. • Greensboro, N.C. • Houston, Texas • Indianapolis, Ind. • Kansas City (Mission) Kan. • Los Angeles, Calif. Area (East Los Angeles, Encino • West Los Angeles) • Minneapolis, Minn. • Montreal, Quebec, Canada • New York City Area (Albertson, L.I., N.Y. • Stamford, Conn. • Union, N.J.) • Orlando, Fla. • Philadelphia, Pa. • Phoenix (Scottsdale) Ariz. • Poughkeepsie, N.Y. • San Diego, Calif. • San Francisco, Calif. Area (Lafayette, Palo Alto) • St. Petersburg, Fla. • Syracuse, N.Y. • Toronto (Willowdale) Ont., Canada • Washington, D.C. (Annandale, Va.).

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations.

In Europe please contact Tektronix International A.G., Terrassenweg 1A, Zug, Switzerland, Phone (042) 4-91-92, for the address of the Tektronix Representative in your country.

International News

(*Continued from page* 30)

INDIA

Nuclear Instrumentation Helps Solve Food Problems

Waltham, Mass.—An order, to supply complete nuclear instrumentation to the oldest and largest nutritional research institute in Asia, The Nutrition Research Laboratories of the Indian Council of Medical Research in Hyderabad, India, has been announced by Export Manager, Hans P. Bryers of Tracerlab.

The equipment order, including several fully automatic radioisotope counting systems, will make it possible for the institute research staff to apply the latest analytical radioisotope "tracer" techniques, in their search for methods of dealing with the perennial nutritional problems of the burgeoning Indian population.

CANADA

Litton Ltd's New V.P.

J. M. "Monty" Bridgman has been appointed Vice President and General Manager of Litton Systems (Canada) Ltd. He had been serving since November 29 as Manager of the firm.

AUSTRIA

Metallurgical Combine Announces $5 Million Expansion

Reutte, Tyrol, Austria—A $5 million expansion program for the Metallwerk Plansee, Reutte, Tyrol, Austria, Europe's largest powder metallurgical combine, was announced by Dr. Paul Schwarzkopf, owner and President of the European enterprise and President of Schwarzkopf Development Corp., New York City.

In Reutte, a new building for centralized final inspection of all products has already been finished. A second building, representing the first unit of greatly enlarged production facilities, has just been started.

"The steadily increasing demand for refractory metals in electronics," Dr. Schwarzkopf has stated, "which is the mother of automation, rocketry, television and many other new developments, the tendency toward higher and higher service temperatures in many industries, a demand which cannot be satisfied without products from our field of activities, and apparently also

(*Continued on page* 38)

NUMBER 16–NEW PRODUCT SERIES

High-Performance Commercial Potentiometer—Under $1

Now—solve the quality-price dilemma with Bourns E-Z Trim® commercial potentiometers. These subminiature thoroughbreds are direct descendants of the time-proven Trimpot® potentiometer, and their performance shows it. They stand up to steady-state humidity and fully satisfy the requirements for such demanding applications as industrial controls.

Settings you make with E-Z Trim units are pinpoint-sharp, thanks to the superior angular resolution afforded by the 15-turn shaft. They stay that way, too, because the shaft is self-locking. Adjustments are fast and simple—an ordinary screwdriver does the job.

Take your choice of wirewound or Resiston® carbon units. Wirewound Model 3067 handles a hefty ½ watt at room temperature, is available with resistances of 100 ohms to 20K. Carbon Model 3068 offers resistances of 20K to 1 Meg. Both units have either printed circuit pins or solder lug terminals.

Order in production quantities of 1000 or more, and these exceptional potentiometers are yours for under $1 each. Tell us you're in a hurry, and you'll have them within 48 hours —they're on the shelf from coast to coast. Write now for complete data and list of stocking distributors.

Manufacturer: Trimpot® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, California; Ames, Iowa; and Toronto, Canada

SHOCKING NEWS FROM EIMAC: there's now a 250-watt tetrode that can withstand shock of 90G for 11 milliseconds and vibration from 20-750 cps at 10G, with maximum rated voltages applied! It's Eimac's 4CX250R (shown 1½ times actual size). This new tube in the 4CX250B family is electrically equivalent to Eimac's 7580. The difference: the 4CX250R is ruggedized for extreme environments—as are other members of the family. And what a difference! Call your Eimac representative or write: Power Grid Tube Marketing, Eitel-McCullough, Inc., San Carlos, Calif.

International News

(*Continued from page 34*)

the recognition, given to the products of the Metallwerk Plansee in the 35 countries which we supply, are some of the reasons for this impressive growth." Dr. Schwarzkopf pointed out that, increased automation at his plants has become necessary due to the great shortage of skilled labor in western Europe. Training of metallurgists and tool makers takes place in the Metallwerk Plansee's own schools.

RUMANIA

Record Industry Expands

Bucharest, Rumania — The Rumanian record industry is expanding its facilities, ordering new recording equipment in both the mono and stereo areas.

EMI Electronics Ltd., England, has shipped its first two models of a new type 10-way mono-stereo mixing control console including it in two recording suites. Included in the order are ten TR90 stereo magnetic tape recording consoles, two dubbing mixing consoles, two disc replay units, eight large studio monitor loudspeakers and associated equipment.

WESTERN GERMANY

Recently, some sixty American editors of various business and trade publications were taken on a most unusual plant tour. The novelty—a jet-flight across the Atlantic Ocean. The host—Volkswagen.

The trip afforded the editors an opportunity to see how this industrial giant, located only 5 miles from the East German border, has proven what can be done in a democracy.

Secondary purpose of the tour was to "nip in the bud" two major problems: the compact car trend of American auto makers; and, President Kennedy's "Buy American" request. Volkswagen subtly pointed out the heavy machinery and materials which they purchase from America. A little reciprocity would probably be appreciated.

EI associate editor Dick Stranix gets an explanation of Volkswagen's use of punched cards for control of manufacturing.

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.

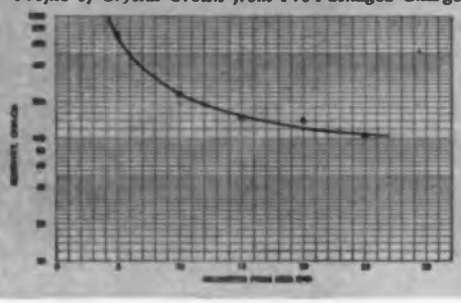
This High Purity means consistently higher quality crystals — simplifies doping procedures — increases device yield. Typical resistivity of N-type crystals grown from Dow Corning prepackaged crucible charges is greater than 100-ohms centimeter for 80% of the crystal; maximum boron content, 0.3 parts 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. 4119.

HYPER-PURE SILICON DIVISION
Address: HEMLOCK, MICHIGAN

Dow Corning CORPORATION
MIDLAND, MICHIGAN
ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

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.

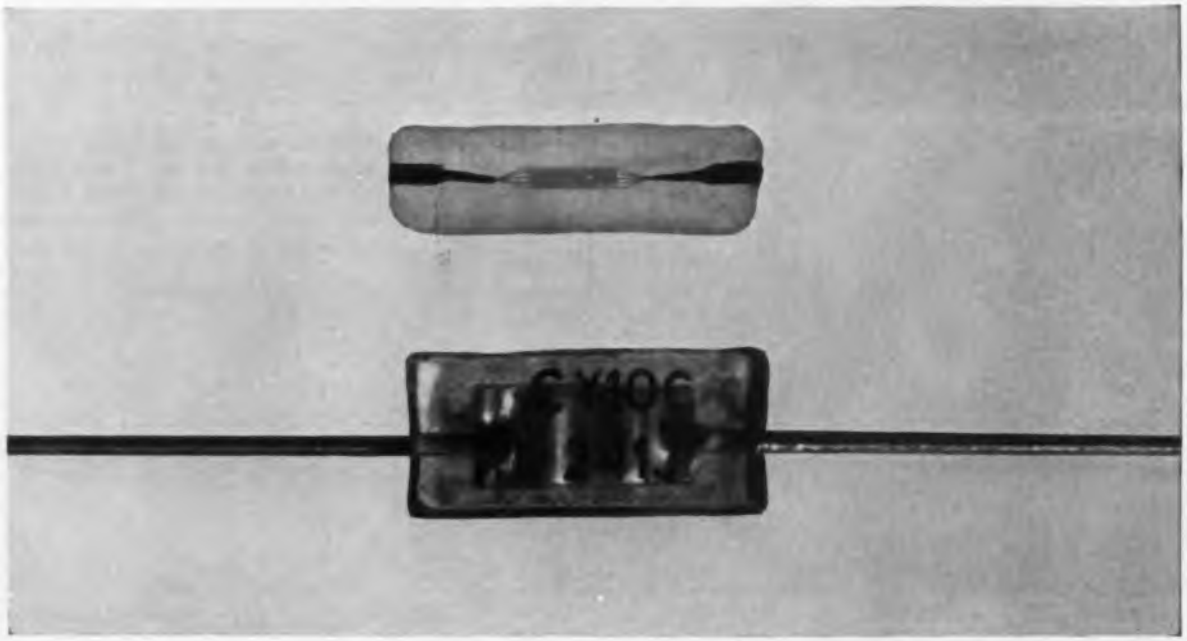
You'll see why the CYFM can take such torture when you check its design. We stack alternate layers of stable ribbon glass and aluminum foil. Then we weld the foils to the bead-terminal assembly, which has a glass bead sealed to the Dumet wire lead. With heat and pressure, the entire capacitive element 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, 548 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.

3 WATTS at 1120 Mc from 7 WATTS at 140 Mc

A VARACTOR FOR EVERY PURPOSE

220 new epitaxial silicon high power varactors in four package styles — subminiature glass case • double-ended cartridge • "pill" case • new "coaxial pill" case — all hermetically sealed, make *this* kind of harmonic generation possible now.

A WIDE VARIETY of PIV ratings and capacitance values allows selection of the optimum diode in each case style for your circuit application.

The data reported below was obtained by the Waveguide Systems Division of Microwave Associates* in a tandem chain of three doubler stages, each using a selected single Microwave Associates' epitaxial silicon high power varactor.

This high power output and remarkable harmonic efficiency was achieved without boosters, without power supply, in passive circuits.

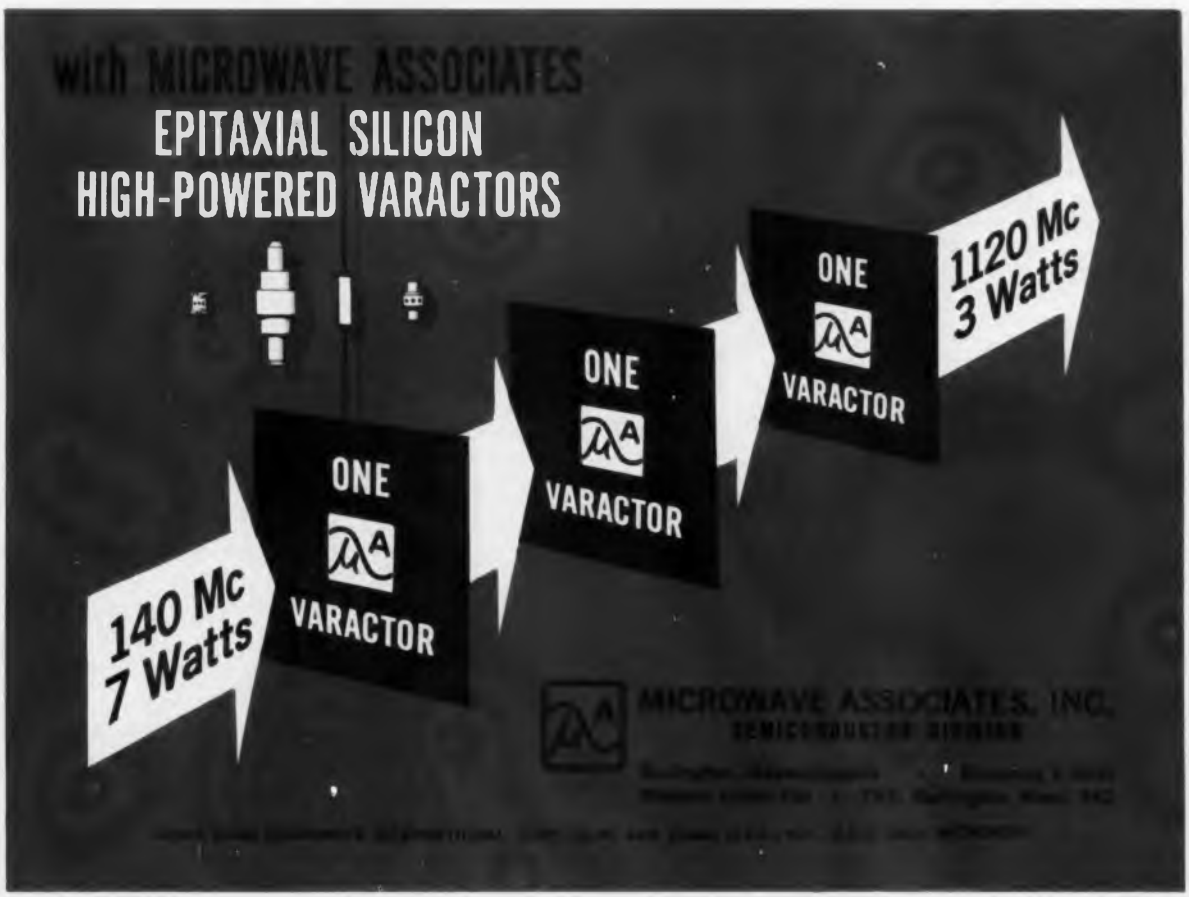
Since the initial introduction of varactors on a commercial basis by Microwave Associates, we have continued to lead the way in varactor technology.

Microwave Associates' unsurpassed varactor circuit capabilities are your assurance of varactors tested to meet specific harmonic generation requirements.

The Waveguide Systems Division of Microwave Associates offers capabilities for the design and delivery of complete harmonic generator circuits.

Write for a copy of "SELECTION OF VARACTORS FOR POWER HARMONIC GENERATION" and for the 1961 Semiconductor Division Short Form Catalog.

* Support received by (USAF) ETL Aeronautical Systems Division Contract #AF33 (616) — 7232.



WHICH OF THESE 7 DC POWER

You want flexibility and versatility in the power supply line of highly regulated, ripple-free, temperature-current supplies, to heavy current-low voltage instruments,

NEW!

723A, 500 ma output, 0 to 40 v. Transistorized, programmable remotely

723A can be programmed remotely and is especially useful in systems applications where a number of measurements are made automatically at different voltages. Output voltage may be changed merely by changing the value of an external resistance, as with stepping switches for programmed tests. Low noise and ripple make the 723A particularly applicable to low level measurement. New, modular package combines compactness with rack-mount and bench-top versatility.

SPECIFICATIONS

Regulated Output:	0 to 40 v dc; 0 to 500 ma dc
Load Regulation:	< 0.1% or 2 mv (whichever is greater) change from 0 to 500 ma
Line Regulation:	< 0.05% or 3 mv for ± 10% line voltage change
Noise and Ripple:	< 200 μv
Remote Programming:	External resistance can control output voltage at rate of 25 ohms/volt
Output Impedance:	< 30 milliohms at 10 cps
Size:	6¼" x 5⅛" x 11"; 21 lbs.
Price:	$225.00

722AR, 2 amps, 60 v output. Transistorized, easy monitoring

High regulation over complete voltage range, highly stable output. Extremely low noise and ripple insure clean measurements. High impedance remote sensing input, which connects directly to the load through wires independent from supply leads regulates the voltage at the load itself despite an IR drop in long supply leads. Separate meters measure current and voltage continuously for easy monitoring. Continuously variable control limits output current.

SPECIFICATIONS

Regulated Output:	0 to 60 v dc; 0 to 2 amps dc
Load Regulation:	< 5 mv change for 0 to 2 amps change
Line Regulation:	< 2.5 mv change for ± 10% line voltage change
Noise and Ripple:	< 250 μv
Output Impedance:	DC, < 2.5 milliohms; ac < 5 milliohms in series with 4 μh
Size:	19" x 5¼" x 12"; 34 lbs.
Price:	$525.00

721A, 0 to 30 v, 150 ma output, versatile, only $145.00!

This ultra compact 4 pounds of power supply gives you easiest possible output voltage monitoring, with a large, easy-to-read meter, plus a four-step current limiter for positive overload protection. Several 721's may be operated in parallel or cascaded for extra flexibility.

SPECIFICATIONS

Regulated Output:	0 to 30 v dc; 0 to 150 ma
Load Regulation:	< 0.3% or 30 mv (whichever is greater) no load to full load
Line Regulation:	< ± 0.3% or 15 mv (whichever is greater) for ± 10% line voltage change
Noise and Ripple:	< 150 μv rms
Output Impedance:	< 0.2 ohms in series with 30 μh
Size:	7" x 4⅜" x 5¼"; 4 lbs.
Price:	$145.00

SUPPLIES BEST FITS YOUR NEEDS?

on your bench, and hp offers the world's most varied stable laboratory power supplies! From high voltage-low hp is ready to meet your requirement:

NEW!
hp 726AR, 2 amps, 45 v output. Transistorized, programmable!

This newest member of the hp transistorized power supply family provides remote programming plus the same high regulation, stable output over a wide range of line and load conditions as other instruments in the hp 720 Series. Model 726AR is especially useful for applications requiring accurate, repeatable voltages, such as component or production testing. A continuously variable current limiter protects circuits under test from accidental overload-damage. Remote sensing feature.

SPECIFICATIONS

Regulated Output:	0 to 45 v dc; 0 to 2 amps dc
Remote Programming:	External resistance can control output voltage at rate of 100 ohms/volt
Load Regulation:	< 5 mv change for 0 to 2 amps change
Line Regulation:	< 2.5 mv change for ± 10% line voltage change
Noise and Ripple:	< 250 μv
Output Impedance:	DC, < 2.5 milliohms; ac < 5 milliohms in series with 4 μh
Size:	19" x 5¼" x 12"; 34 lbs.
Price:	$500.00

PLUS THESE LAB AND FIELD-PROVED VACUUM TUBE POWER SUPPLIES

for high voltage-low current applications:

hp 711A Laboratory Power Supply	DC output 0 to 500 v, 100 ma max; ac output 6.3 v, 6 amps, or 12.6 v, 3 amps. DC regulation 0.5%.	Inexpensive, versatile high voltage, low current power supply. Metered voltage and current. hp 711A, $250.00 (cabinet); hp 711AR, $255.00 (rack mount).
hp 712B Power Supply	DC output 0 to 500 v, 200 ma max; bias supply 0 to —150 v, 5 ma max; ac output, 6.3 v, 10 amps max. Regulation 0.01% at 500 v.	High quality, high voltage supply; particularly good transient response, regulation and stability. hp 712B, $390.00 (cabinet); 712BR, $375.00 (rack mount).
hp 715A Klystron Power Supply	Beam supply —230 v to —400 v, 40 ma max; reflector supply 0 to —900 v below beam supply, 10 μa max; ac output 6.3 v, 1.3 amps. Modulation capabilities.	Klystron supply, inexpensive general purpose instrument. hp 715A, $325.00 (cabinet).

HEWLETT-PACKARD COMPANY
1067B Page Mill Road Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000
Sales representatives in all principal areas

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

Letters to the Editor

Lady's Age No Secret

Editor, ELECTRONIC INDUSTRIES:

On page 50 of your April 1961 issue, you carried an item concerning an electronic device which will tell a lady's height, going on to say that the next step might be an electronic computer to tell a lady's age.

For your information I am enclosing a picture of our digital age computer which I thought might be of interest to you in this connection.

Hamlin Welling
Director of Public Relations
Delco Radio Division
General Motors Corporation
Kokomo, Ind.

RFI Series

Editor, ELECTRONIC INDUSTRIES:

I have followed with great interest your articles on "Radio Frequency Interference." An education in this field is imperative for all users of electronic equipment such as my employer.

Since I treasure my copy so greatly, I would appreciate a reprint of the article entitled "Instrumentation For Radio Interference Measurements" so that I may circulate it through interested sections of Sikorsky Aircraft.

May I take this opportunity to thank you for the wonderful service you provide all engineers by placing before them a most interesting and up to date magazine.

Murray A. Ziller
Elect. Test Engr.
Sikorsky Aircraft
Division of United Aircraft Corp.
Stratford, Conn.

Missile Nomenclature

Editor, ELECTRONIC INDUSTRIES:

In your article appearing in the April edition of ELECTRONIC INDUSTRIES concerning the Air Force Blue Scout Program, you refer to the XRM-90 as the Blue Scout 11. The correct nomenclature is Blue Scout II (Roman numerals).

Robert H. Katzive
1st Lt., USAF
Special Projects Division
Research Directorate
Air Force Special Weapons Center
Kirtland Air Force Base, N. Mex.

Congratulations!

Editor, ELECTRONIC INDUSTRIES:

Congratulations on your service to the electronic industries in presenting a magazine with such timely articles expressed in clear literary style. Mention must be made also of the calibre

Letters to the Editor

of your advertising which expresses in large measure the dynamism of our industry. They are above all else, informative.

I would appreciate a copy of the article by Jerome Kraus, entitled "Electron Tubes & Semiconductors—What's Ahead?" Again, congratulations and wishes for continued success.

Francis X. Doran
Sales Analyst

CBS Electronics
Chelmsford St.
Lowell, Mass.

Writing—The Newest Skill!

Editor, ELECTRONIC INDUSTRIES:

May we have two hundred (200) copies of the reprint of the article "Writing—Newest Engineering Skill" from the March, 1961 issue of ELECTRONICS INDUSTRIES? A former student brought me the article he had taken from the magazine. Among his comments were, "this is a good abstract of the course you taught us" and "I think some of your present students would be favorably impressed by an article printed in this magazine and understand the importance of writing in the engineering field."

I agree with him. I would also like to use it as introductory material for an overview of the work that follows in the course. It is so logical, well organized, simply presented and yet includes all the essential considerations for good writing.

S. James Risler
Assistant Professor of English
Northrop Institute of Technology
1155 W. Arbor Vitae St.
Inglewood 1, Calif.

Secretaries & Efficiency

Editor, ELECTRONIC INDUSTRIES:

Tsk Tsk Tsk. Your formula for scientific productivity (TELE-TIPS, March '61, p. 62) is sadly awry. You should have figured on *total* productivity, not on the *per-scientist* productivity. Then the formula will become:

$$\text{TOTAL PRODUCTIVITY} = \frac{(K) \times (\text{secretaries}) \times (\text{ave. typing speed})}{\text{number of scientists}} \times (\text{number of scientists})$$

. . . . which obviously reduces to a value "K," times the number of secretaries, times the average typing speed.

The error which surprises me is not the algebraic formulation of the problem, but the omission of "K." The importance of "K" is un-questioned in

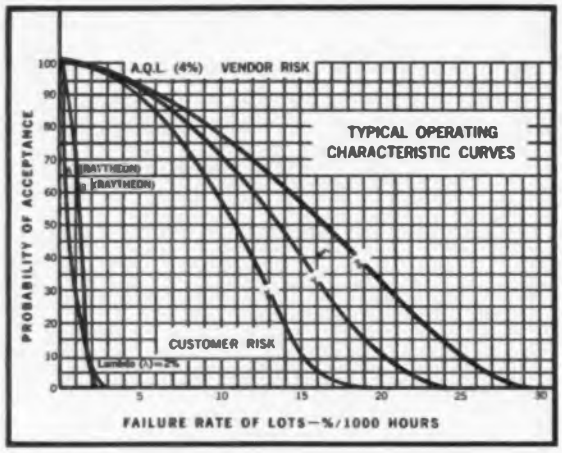
(*Continued on page* 50)

How Raytheon can offer you 10 times better Semiconductor Reliability Assurance

By: R. E. PRATT
Reliability Engineering Manager
Semiconductor Division
Raytheon Company

Most of the commonly used quality control procedures for semiconductors follow MIL Std. 105 and normally result in a wide spread of customer risk, directly dependent on the quantities purchased. (See curves X, Y, and Z below for risk points.) Now, Raytheon offers reliability protection (under MIL-S-19500B, Method B — defining the Lambda [λ] concept), which *specifically limits* customer risk. This means that for the *first time*, you, the customer, can specify reliability assurance at a fixed confidence level, to a fixed low value, in terms of a lambda number.

To explain further, reliability *assurance* is generated by the manufacturer's life test procedures. These life test procedures, or plans, are best described by operating characteristic curves (see below), which describe the ability of each particular plan to discriminate between good and unacceptable product.



Who Takes The Risk?

Under most current procedures, the A.Q.L. (Acceptable Quality Level) and Lot Size determine the operating characteristic curves. Typical of such curves are X, Y, and Z. Note how the customer risk point shifts.

In contrast, curves A and B are typical of the new plan now in operation at Raytheon. Note that not only is the customer risk point fixed, but fixed at industry's lowest specified failure rate.

The first transistor types offered by Raytheon incorporating this new method are the Raytheon 2N404 and Raytheon 2N428 germanium PNP switching transistors. These products, now available in quantity, carry a reliability assurance of lambda (λ) = 2%/1000 hours; equivalent to 0.02 failures/1000 hours.

Here's The Difference

The essential difference is that a reliability specification, under the older system, carried implied customer risk failure rates varying from 15 to 25%/1000 hours, depending on lot size. The lambda (λ) = 2%/1000 hours quality assurance (customer risk failure rate), now offered by Raytheon, averages a 10 fold reduction in failure rate. Stated positively, you can be 10 times more sure of getting good product. A truly important advance in product quality.

Ask your local Raytheon sales engineer about this program.

A new nomograph, relating lambda (λ) to sample size and accept number, as well as process average requirement, is now available. For this, along with the paper "A.Q.L. — What Is It?", by J. M. Gilbey, write or call your local Raytheon Semiconductor Sales Office.

RAYTHEON COMPANY

SEMICONDUCTOR DIVISION

RAYTHEON

SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS • CIRCUIT-PAKS

BALTIMORE, MD., SOuthfield 1-0450 • BOSTON, MASS., Hillcrest 4-6700 • CHICAGO, ILL., NAtional 5-4000 • DALLAS, TEXAS, LAkeside 6-7921 • DAYTON, OHIO, BAldwin 3-8178
DETROIT, MICH., TRinity 3-5330 • ENGLEWOOD CLIFFS, N. J., LOwell 7-4911 (Manhattan, Wisconsin 7-6400) • LOS ANGELES, CAL., PLymouth 7-3151 • ORLANDO, FLA., GArden 3-0518
PHILADELPHIA, PA., (Haddonfield, N.J.), HAzel 8-1272 • SAN FRANCISCO, CAL., (Redwood City), EMerson 9-5566 • SYRACUSE, N.Y., HOward 3-9141 • CANADA: Waterloo, Ont., SHerwood 5-6831
GOVERNMENT RELATIONS: Washington, D. C., METropolitan 8-5205

CENTRALAB CERAMIC TRIMMER CAPACITORS THAT MEET MIL-C-81A

NEWEST in the most extensive line in the industry

825 SERIES ACTUAL SIZE

Rated at 600 VDCW, 1500 VDCT, these units are well within MIL specifications for change in capacity under temperature and vibration extremes. Available in NPO, N300, N500 and N650 temperature coefficients in all standard capacity ranges.

TEMPERATURE CHARACTERISTIC		CAPACITANCE RANGE (MMF)	
CRL	MIL LETTER	CRL	MIL NUMBER
NPO	A	1.5-7	070
N300	B	3-12	120
N500	C	3-13	130
N650	D	5-20	200
		4.5-25	250
		4-30	300
		7-45	450

MICRO-MINIATURE ACTUAL SIZE

Rated at 100 VDCW, 250 VDCT, this unit measures only 0.201″ in diameter and can be supplied on a ceramic base plate, to your specifications, as small as 0.25″ square, plus leads or mounting. It is available in the following ranges: 1.5 to 5 mmf, 3 to 10 mmf, and 7.5 to 25 mmf.

For detailed information on these and many other trimmer and special ceramic capacitors, write for Engineering Bulletin Group "C."

Centralab

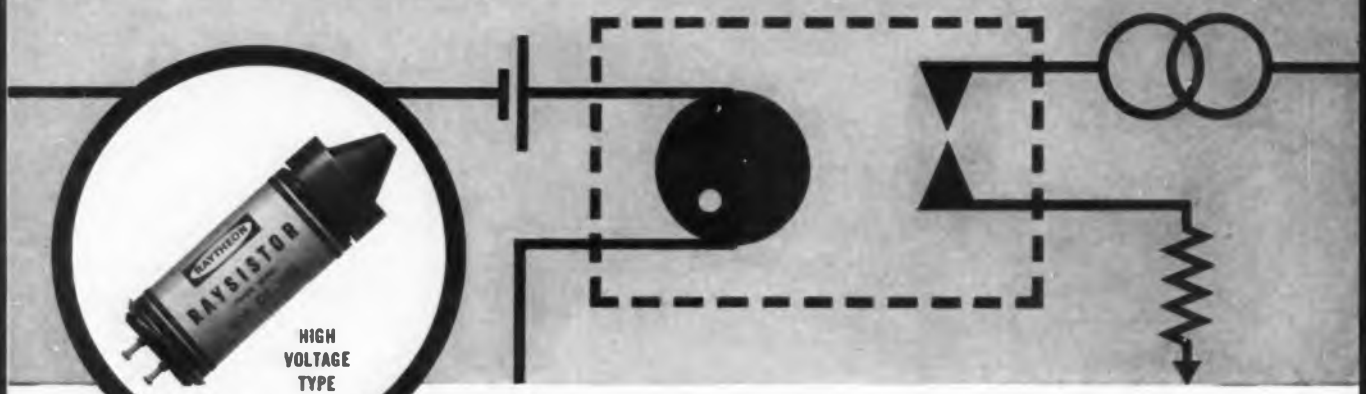
D-6118

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

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

RAYTHEON RAYSISTORS*

offer outstanding advantages in 5 important applications



Raytheon Raysistors enable improved circuit designs for switching, controlling, chopping and commutating. This electro-optical device can turn signals on and off with virtual isolation from switching transients and carriers to provide high signal-to-noise ratio, wide dynamic range, and long life. Here are 5 applications in which Raysistors can be used for improved operation:

1. RELAY: In place of a relay or switch it can provide long life with no contact wear or pitting.

2. POTENTIOMETER: As a potentiometer it can control an AC circuit with a DC signal or vice versa with no contact noise.

3. CHOPPER: Isolation of Raysistor elements assures low noise operation.

4. COMMUTATOR: Freedom from switching transients makes it ideal for low-level signal commutation.

5. HIGH VOLTAGE CONTROL: Signal to control insulation of up to 25,000 volts assures Raysistor's efficiency in controlling high voltage circuits.

For complete technical data and design assistance please write: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Mass.

*TRADEMARK

For Small Order or Prototype Requirements See Your Local Franchised Raytheon Distributor

TYPICAL RAYSISTOR OPERATING CHARACTERISTICS

Control Terminals:	CK-1101	CK-1102	CK-1103	CK-1104	CK-1105
Control Type	Neon	Incandescent	Incandescent	Incandescent	Neon
Voltage Range (V DC or Peak)	120 min	0-1.1	0-5	0-24	120 min
Current Range (mA)	0.5-3	0-55	0-180	0-40	0.5-3
Signal Terminals					
On Resistance (ohms)	600	350	40	70	500
Off Resistance (ohms)	5×10^7	1.5×10^7	1×10^7	1×10^7	4×10^7
Power Dissipation (milliwatts max.)	75	75	75	75	350
Switch On Time (seconds)	.001	.050	.055	.028	.020
Switch Off Time (seconds)	.070	.015	.300	.130	10
Max. Signal Voltage (V DC or Peak)	60	60	60	60	60
Shunt Capacitance (AC $\mu\mu$f)	4.0	4.0	4.0	4.0	—
Insulation, Signal from Control (Volts)	—	—	—	—	25,000

RAYTHEON

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

Circle 33 on Inquiry Card

Where even a fingerprint can cause trouble, ultrasonic cleaning makes the crucial difference...

and in ultrasonic cleaners—

GENESOLV® D FLUOROCARBON SOLVENT

can make the clean difference!

Ultrasonic cleaning is only as good as the solvent you use! In critical precision guidance and electronic components, foreign matter 1/40th the diameter of a human hair can cause malfunction. Fingerprints, water marks, specks of dust, lint, epidermis and many other contaminants are potential trouble makers. Your ultrasonic cleaning material must itself be super clean . . . and effective against a wide range of contaminants, while non-injurious to the parent material.

GENESOLV D Fluorocarbon Solvent offers the exceptional purity you need . . . plus these other specific advantages in ultrasonic cleaning operations:

- ✔ *extremely low undissolved and dissolved residue*
- ✔ *selectivity*
- ✔ *low toxicity*
- ✔ *nonflammability*
- ✔ *low surface tension (increased wettability, with minimum dragout)*
- ✔ *quick drying*

Find out now about GENESOLV D's special effectiveness. Our Technical Service constantly is developing new data, and would be pleased to work with you on your cleaning problems. Write or phone your nearest General Chemical Office.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N.Y.

Letters to the Editor

(*Continued from page 45*)

any professional field. I refer, of course, to "K," the coefficient of pulchritude. It is a well-known fact that doubling the coefficient of pulchritude of the secretaries you have will improve working conditions much more than will merely doubling the number of secretaries. In fact, with a sufficiently high coefficient of pulchritude, the typing speed becomes an unimportant item in the formula, and may be ignored.

Hector E. French
Chief of Engineering Publications

Sanborn Company
175 Wyman St.
Waltham 54, Mass.

Western Electric Relays

Editor, ELECTRONIC INDUSTRIES:

Your April, 1961 issue of ELECTRONIC INDUSTRIES magazine carried an interesting article by Lawrence Prado, Chief Engineer of WPEP, Taunton, Mass., under "Cues for Broadcasters" concerning the use of a Western Electric KS-7340 Relay Set. This Relay Set is placed across the incoming telephone line and uses the ringing current to operate a relay which in turn applies 110 volts A.C. to several lamps. The arrangement provides for a more noticeable visual alarm for incoming calls than the usual beehive lamp or other small indicator.

Please be advised that the KS-7340 Relay Set has been replaced by the KS-16626 Relay Set. Of the five list numbers available, I believe that Lists 1, 2 and 3 would be of most interest. List 1 provides a ringing relay connected in series with an 0.5 microfarad capacitor. A connecting block is provided for terminating the telephone line. The relay contacts will carry a load of 5 amperes. List 2 is the same as List 1 except that a switch is connected in series with the relay winding to provide manual disconnect. List 3 is the same as List 1 except that a latch has been provided to mechanically lock up the relay armature when the relay is contacted by signaling current. A release button is provided in the base to manually release the locked system.

I hope that this information may prove helpful to others who plan to use the system described by Mr. Prado.

Richard A. Genaille
Comm. Systems Planning Engineer

Western Electric Company
110 W. Third St.
Winston-Salem, N. C.

ELECTRON TUBE NEWS...from SYLVANIA

NEW SYLVANIA

6146A

RF amplifier output, Class C service — 70W (ICAS) up to 60MC, 35W (ICAS) up to 175MC.

delivers 45W output* with heater-supply as low as 5 Volts

New Sylvania-6883A (12.6V type), 6159A (26.5V type) maintain 45W power at reduced Ef of 10V and 21V, respectively

From Sylvania comes the first major performance improvement to the popular 6146 and associated family since their introduction 7 years ago. The new, Sylvania-originated 6146A, 6883A, 6159A eliminate communications fade-out caused by decreased heater voltage supplies. Designed for use as an AF power amplifier and modulator, RF amplifier and oscillator, they offer the same excellent output capabilities (at normal heater ratings) and reliability that characterize their prototypes.

At Sylvania even established types undergo intensive and continuous field examination to incorporate up-to-the-minute design requirements. In fact, it was in just this way that the well-known line of Sylvania Gold Brand premium tube types was originated. All are specifically designed to fill critical application requirements—effectively, efficiently, reliably.

If *your* industrial or military design demands specialized tube types, call on the creative engineering and production capabilities of Sylvania. Your Sylvania Sales Engineer will be pleased to work with you. For tech data on specific types, such as the new Sylvania-6146A, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

*Minimum output limit for an individual tube (CCS) measured in a single-tube self-excited oscillator circuit. Conditions: plate voltage – 600Vdc; grid #2 voltage – 180Vdc; grid #1 resistor – 30,000 ohms; plate current – 100 to 112mA; grid #1 current–2 to 2.5 mAdc; frequency–15MC.

MICROWAVE DEVICE NEWS from SYLVANIA

20 KW to 120 KW
peak power output

with Sylvania Ka Band Magnetrons

20KW

Sylvania Ka Band Magnetrons offer a remarkable range of powers, fill virtually all your Ka band requirements. They include extremely compact types with exceptional power-to-weight ratios. All are fixed-frequency types for pulsed operation, utilize stabilized magnets, and exhibit outstanding reliability and longevity.

SYLVANIA-5789, first commercially available U. S. type for Ka band, uses 22-vane "rising sun" anode, and improved dispenser-type cathode. With hermetically sealed input and pressurized output, it is highly adaptable to high altitude operation.

SYLVANIA-6799 features 120KW peak power output and is a proven high-power millimeter wave source. It is available for use with longer pulses and higher duty cycles at slightly reduced power.

SYLVANIA M-4155A, *ruggedized* version of the 5789, features compact size and weight of only 9 lbs., improved heat dissipation and excellent stability. It utilizes a special cone-shaped cathode support and "building block" mounting arrangement for added mechanical strength. M-4155A possesses both long- and short-pulse capabilities.

SYLVANIA XM-4064, *ruggedized* magnetron, offers exceptional stability under severe environmental conditions. Only 9 lbs. in weight, it provides peak power output of 70KW for a remarkably good power-to-weight ratio.

SYLVANIA XM-4158, *ruggedized* magnetron, provides 120KW peak power output. Weight is only 27 lbs. It uses E type magnets for a uniform, flat surface configuration that can be used as a structural part of the chassis. XM-4158 is compatible with either long- or short-pulse operation.

SYLVANIA XM-4218, *ruggedized* tube, provides a power-to-weight ratio of 8:1 making it especially suited for portable, field-type radar. It uses metal-to-ceramic seals, ceramic cathode capsule, cantilever cathode support. The tube withstands 50g shock, 10g vibration tests. XM-4218 provides a lower pushing factor than tubes of comparable performance. Weight is only 4 lb.

SYLVANIA XM-4206 is a *ruggedized*, compact tube with encapsulated cathode. Only 10.5 lbs., it provides 40KW peak power output.

SYLVANIA Ka BAND MAGNETRONS

	Frequency (KMC)	Peak Power Output (KW)	Max. Duty Cycle	Max. Pulse Width (μsec)
5789	34.512 – 35.208	40	.0006	1.0
6799	34.512 – 35.208	120	.0005	1.0
M-4155A	34.512 – 35.208	40	.0006	1.0
XM-4064	34.512 – 35.208	70	.0008	1.0
XM-4158	34.512 – 35.208	120	.0008	1.0
XM-4218	34.512 – 35.207	32	.0006	0.4
XM-4206	34.7 – 35.0	40	.0006	1.1

Investigate the design advantages of Sylvania Ka band magnetrons *and* associated Ka band TR tubes. Contact your Sylvania Sales Engineer for complete information. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. MDO-D, 1100 Main St., Buffalo 9, N. Y.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

P-537-3

Tele-Tips

BRAIN AND BRAWN. Higher academic achievements and increased athletic activity go hand-in-hand. A survey of 2,400 engineers and scientists revealed that, in number of varsity letters awarded, 2 out of 10 went to men with B.S. degrees; 3 out of 10 went to holders of M.S. degrees; and 6 out of 10 went to Ph.D.'s.

THE HIGHER THE SALARY of the individual, the more he earned toward expenses while in college. That same survey turns up the fact that those in the $7,000 median group earned 42% of their expenses: the $8,500 group earned 45% and the $10,000-and-over men earned 52% of their expenses in college.

"ONE REASON the dollar won't buy what it used to is that people don't want to do as much for a dollar as they used to."

CLOSED CIRCUIT TV is being employed in a Brooklyn, N. Y., apartment house to allow tenants to identify visitors at outside main and service building entrances before being admitted.

UNIVAC I, the world's first commercial electronic computer system, has now completed 10 years of operation at the Bureau of the Census. First used during the final stages of the 1950 Census tabulations, it has been in almost constant use, usually 24 hrs. a day and 7 days a week since its installation.

ELECTRONIC LANGUAGE laboratories — classrooms equipped with semi-isolation booths, housing recording equipment with playback and teacher-pupil intercom facilities—now number more than 2,500. In 1958 the U. S. had only 64. More than $21 million—half of it in Federal funds—has been made available to improve the teaching of modern foreign languages in public elementary and secondary schools since the passage of the National Defense Education Act two years ago.

(*Continued on page* 54)

Tele-Tips

(*Continued from page 53*)

ELECTRONIC TECHNIQUES of eavesdropping are so refined that Washington legislators are questioning whether the old common law concepts of trespass are still adequate. Sen. Kenneth B. Keating (R., N. Y.) feels that electronic eavesdropping is comparable to searches and seizures and that the public needs protection.

POWER SYSTEM TEAM of fuel cells and electric motors offers greater potential than any conventional power plants in meeting future requirements of tanks, half-tracks and other military vehicles. This is the conclusion of a study by the Army.

A 1,428 FT. TV TOWER, owned by Dallas, Tex. stations WFAA-TV and KRLD-TV, is being used as a meteorological test station by the Air Force. Principal object of the project is to investigate a "low-level jet wind," reportedly moving at 50 to 60 mph, at heights of 1,000 to 1,500 ft. above the earth.

RADIO WILL BE THE ONLY communication on the Moon. Since it has no atmosphere there will be nothing to convey sound waves, hence no conversation. And even radio communication will be limited; the "horizon" on the Moon will be only three miles away, so that will be pretty much the limits of radio as well.

ENGINEERS ARE COFFEE DRINKERS. Milgo Electronics, Miami, Fla. last year bought upwards of $6,000 worth of coffee for its 265 employees. The firm employs a full-time coffee chef to keep their people well supplied.

LITTLE DELAWARE leads the country again in 1960 in the number of patents issued per capita. For the U. S. as a whole there was one patent issued for every 4,273 persons, down from 1 per 3,808 persons in 1959. In 1960, in the State of Delaware, one patent was issued to every 1,209 persons. New Jersey, Connecticut and Illinois rank second, third and fourth respectively.

NEW TR GLASS

WITH A

GRIP LIKE A VISE

now available on many FUSITE TERMINALS

Never before has a glass been developed that is so compatible for use with 52% nickel alloy leads.

The result is a compression between the glass and pins so tight that twisting and bending of the pins to the breaking point will not cause rupture or leakage. (Determined by Veeco Leak Detector with sensitivity at 10^{-10} std. cc/sec.) Thermal shock is excellent with this new TR-Glass. Salt spray resistance exceeds 100 hours.

Every performance feature is well in excess of Mil Specs. The use of TR-Glass may be considered for all types of Fusite solid glass headers as well as many other style terminals.

Samples on request. Write Fusite, Department G-3

Fusite Corporation, Cincinnati, O.
Woodford Mfg. Co., Versailles, Ky.
Fusite N. V., Konigweg 16, Almelo, Holland
Fusite GmbH, Dieselstrasse 5 Karlsruhe, W. Germany

THE **FUSITE** CORPORATION
6000 FERNVIEW AVENUE,
CINCINNATI 12, OHIO

Circle 52 on Inquiry Card

The Bell System's new desk-top telephone plugs-in with AMPHENOL Micro RIBBON® CONNECTORS

Bell Telephone Laboratories designed, and Western Electric Company built this desk-top telephone—a compact, modern and flexible communications tool. And to speed installation as well as future servicing and rearrangement of lines, B.T.L. adapted for its use AMPHENOL'S quick-disconnect Micro-Ribbons. These miniature connectors have an improved "ribbon" contact that allows easy insertion and extraction even in blind entrances. Contacts are working, flexing members—self-wiping and self-cleaning. AMPHENOL Micro-Ribbons used on the new instrument have heavier gold-plating on the contacts, and special right angle housings. To facilitate factory assembly and wiring Western Electric requested a higher rear insert contact barrier and reversed terminal pockets for soldering to the connectors.

Micro-Ribbons are also being used in advanced electronic equipments for missile and satellite applications. In military or commercial applications, they have functioned with outstanding reliability.

Standard Micro-Ribbons are available with 14, 24, 36 and 50 contacts in rack & panel, cable-to-cable and cable-to-chassis constructions. Dielectric material is diallyl phthalate, contacts are gold plated. Write for catalog!

AMPHENOL CONNECTOR DIVISION

1830 South 54th Avenue, Chicago 50, Illinois • Amphenol-Borg Electronics Corporation

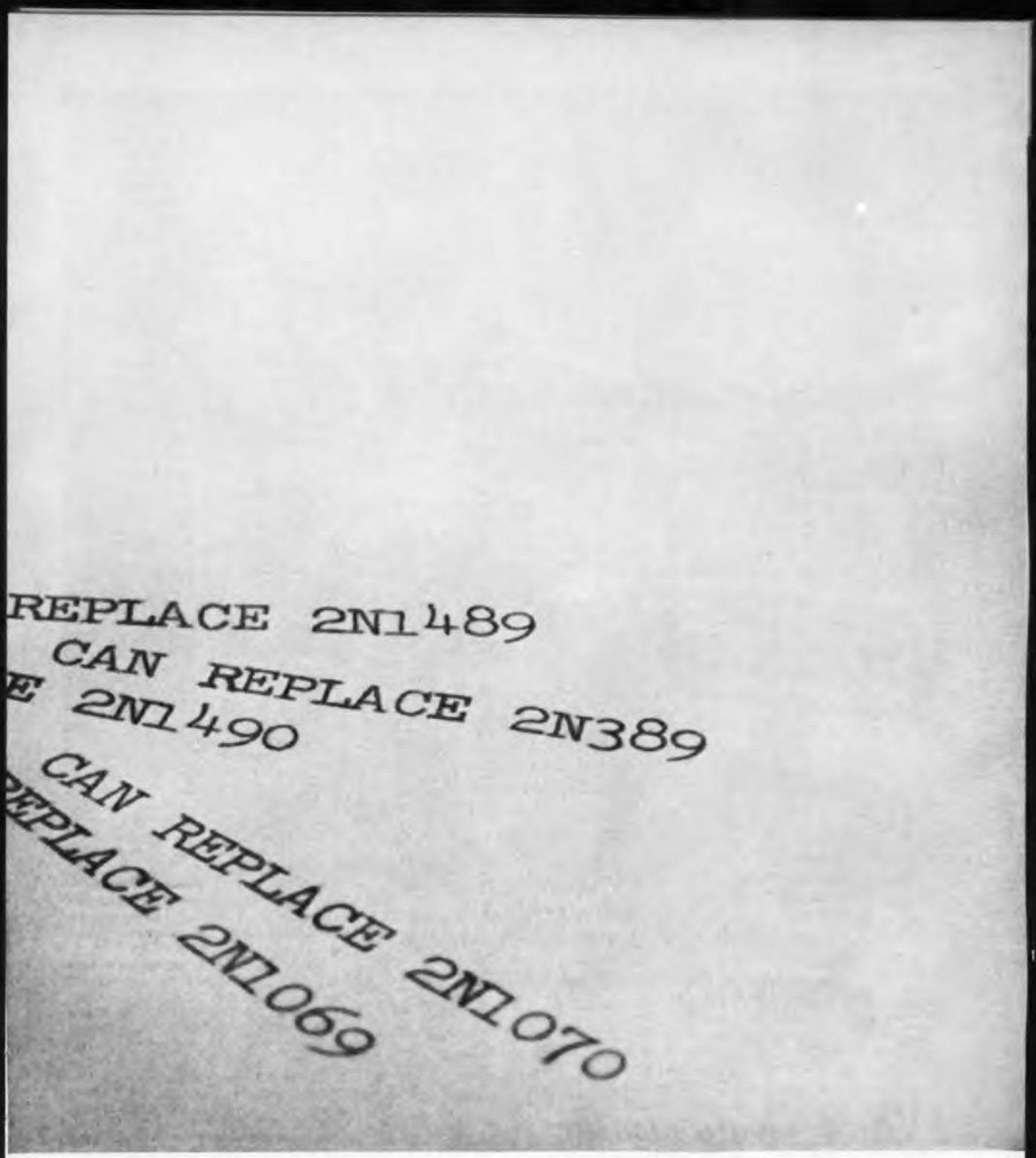
Circle 53 on Inquiry Card

greater derating margin for higher reliability... at lower cost than lower rated types

Westinghouse 2N1015 and 2N1016 transistors— Circuits which use power transistors can be upgraded in reliability by changing to the Westinghouse 2N1015-2N1016 series. The low saturation resistance and high dissipation rating (150 watts) of these transistors mean cooler operation—more safety factor in service. In fact, the 2N1015-2N1016 series offers twice the derating margin you can get in competitive types. Their high voltage ratings—up to 200 volts V_{CE}—also mean an end to series connections of lower rated types. Yet all this is yours at less cost than you are now paying.

In addition to these many circuit advantages, the 2N1015-2N1016 transistors give you the reliability assurance of

Circle 54 on Inquiry Card



True Voltage Ratings verified by 100% Power Testing under full operating conditions. You also get the advantages of reduced inventory, and the convenience of single-source purchasing. Next time you buy transistors in the 2N1015-2N1016 family make sure they're 100% power tested. You can be sure . . . if it's Westinghouse. For complete information, write or call: Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Penna.

SC-1042

Westinghouse

For "off the shelf" delivery, order from these Westinghouse Distributors:

EASTERN

ACK SEMICONDUCTOR, INC. Birmingham 5, Ala./FA 2-1588
CAMERADIO Pittsburgh, Pa./EX 1-4000
CRAMER ELECTRONICS, INC. Boston, Mass./CO 7-4700
ELECTRONIC WHOLESALERS, INC. Melbourne, Florida/PA 3-1441
GENERAL RADIO SUPPLY CO., INC. Camden, N. J./WO 4-8560
GENESEE RADIO PARTS CO. Buffalo, N. Y./DE 9661
HANN-ELLERT ELECTRONICS, INC. Baltimore, Md./TU 9-4242
MILGRAY ELECTRONICS New York, N. Y./RE 2-4400
RADIO & ELECTRONIC PARTS CORP. Cleveland, Ohio/UT 1-6060
SCHWEBER ELECTRONICS Long Island, N. Y./PI 6-5520 Silver Spring, Md./JU 5-7023

MIDWESTERN

ELECTRONIC COMPONENTS FOR INDUSTRY CO. St. Louis, Mo./WO 2-9917
HALLMARK INSTRUMENTS CORP. Dallas, Texas/RI 7-9333
INTER-STATE RADIO & SUPPLY CO. Denver 4, Colo./TA 5-8257
LENERT CO. Houston, Texas/CA 4-2663
RADIO DISTRIBUTING CO. Indianapolis, Ind./ME 7-1571
SEMICONDUCTOR SPECIALISTS, INC. Chicago, Ill./RA 2-9880
S. STERLING CO. Detroit, Mich./BR 3-2900
UNITED RADIO, INC. Cincinnati, Ohio/MA 1-6530

WESTERN

ELMAR ELECTRONICS Oakland, Calif./TE 4-3311
HAMILTON ELECTRO SALES Los Angeles, Calif./DR 2-9154
NEWARK ELECTRONICS CO. Inglewood, Calif./OR 4-9440

Personals

Richard P. Gifford, Manager of the Communication Products Dept. of General Electric Co., Lynchburg, Va., has been appointed Member of the Joint Technical Advisory Committee (JTAC) by the Committee's sponsors, the EIA and the IRE.

Gerald E. (Jerry) Hughes — appointed Head of Applications Engineering, Micromodular Components Div., Ling-Temco Electronics, Inc., Anaheim, Calif.

Dr. Irvin H. Solt, Jr.—to Head Microwave Physics Section, Fairchild Semiconductor Corp., Mountain View, Calif.

Dr. Paul Kruger—appointed Manager of the Nuclear Projects Dept., Hazelton-Nuclear Science Corp.

Dr. P. Kruger

R. J. Brown

Robert J. Brown — appointed General Manager of the Heavy Military Electronics Dept., General Electric Co., Syracuse, N. Y.

Ernest M. Whitley—to the post of Chief Mechanical Engineer, Shockley Transistor, unit of Clevite Transistor, Palo Alto, Calif.

William C. Grimes—appointed Sr. Field Service Engineer, Scientific and Process Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.

Kenneth R. Osborn—to the post of Director of Industrial Development, Allied Chemical Corp., General Chemical Div., New York, N. Y.

A. J. Bielski—appointed Manager of Magnetic Drums Group, Magne-Head Div., General Instruments Corp.

Arnold S. Greenhut—to the new post of Management Engineer, Bulova Research & Development Laboratories, Woodside, L. I., N. Y.

Philip C. Ross—to the new post of Engineering Manager, Switch Devices Section, Electro-Tec Corp., So. Hackensack, N. J.

Henri T. Pichal—appointed Staff Engineer, Trak Microwave Corp., Tampa, Fla.

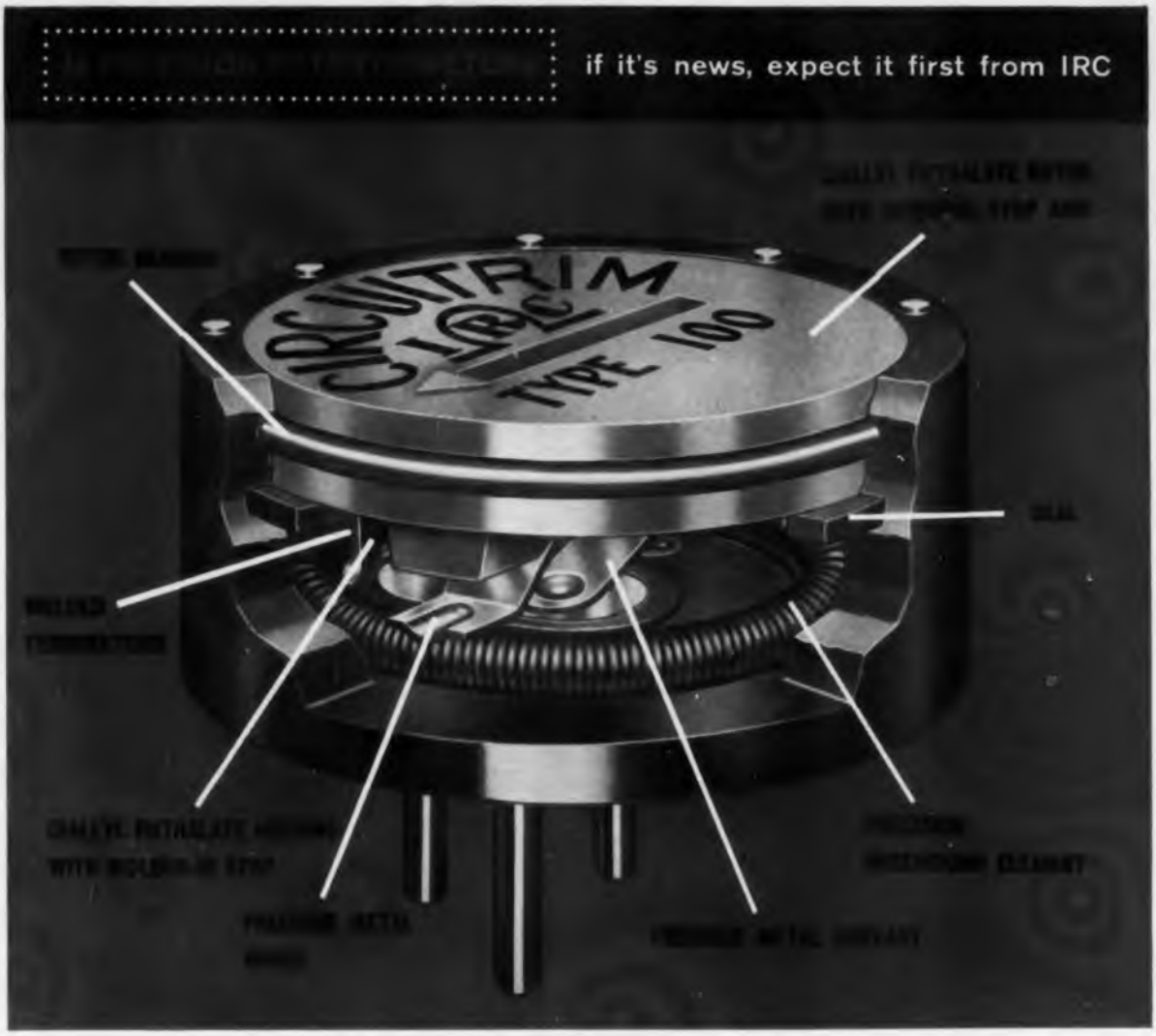
A. L. Hammerschmidt — appointed Chief Engineer, Engineering Dept., Radio Corp. of America's Moorestown, N. J., Missile and Surface Radar Div.

Ramon San Vicenta — appointed Chief Engineer for Glass Diodes, International Rectifier Corp., El Segundo, Calif.

International Resistance Co., Phila., Pa., announces the appointments of

(*Continued on page* 64)

if it's news, expect it first from IRC



EXPOSED...a new simplified trimmer design increased reliability...added economy

The new IRC ½" round Circuitrim trimmer with its unique mechanical design (depicted above) simplifies the complex mechanical linkage used for adjustment in most trimmers making it more reliable and less costly. This round trimmer design employs the same fine electrical assembly found in IRC's popular square trimmer. Available in twelve standard ranges from 10 ohms to 50K ohms, 1 watt. Higher power rating available.

Set it and forget it is the paramount feature of IRC's new square trimmer, made possible by an exclusive self-locking, antibacklash spiroid drive gear. Square Circuitrim has superior moisture, shock and vibration characteristics, and is interchangeable with earlier designs. Teflon leads and seals standard. Printed circuit terminals available. 10 ohms to 50K ohms, 1 watt. Write for technical bulletins. International Resistance Company, 401 N. Broad St., Philadelphia 8, Pa.

COMPLETE LINE OF PRECISION POTENTIOMETERS • STOCKED BY IRC MAJOR INDUSTRIAL DISTRIBUTORS

Standard Single and Multi-turn • Moisture Sealed and High Temperature • Hermetically Sealed • Servo Potentiometers • REVODEX 10-turn Dials

IRC

Leading supplier to manufacturers of electronic equipment

FREQ STDS.

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.

TYPE 2007 TYPE 15

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.

You are invited to submit any problems within the area of our activities for study by our engineering staff.

TYPE K-5A FREQUENCY STANDARD

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:
R-25T and R-25V ± .002% (15° to 35°C)
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.

ATP

AMERICAN TIME PRODUCTS, INC.

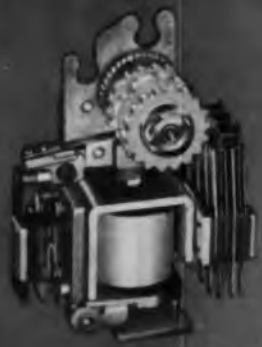
61-20 Woodside Ave., Woodside 77, L.I., N. Y.

SPRING-DRIVEN

TYPE 210
Up to twelve 10-point levels
or four 30-point levels

TYPE 211
Up to twelve 11-point levels
or four 33-point levels

CAM-OPERATED



TYPE 200
Up to eight cams with 30, 32
or 36 teeth ratchets

DIRECT-DRIVE

Up to sixteen 20-point levels
or twelve 40-point levels

Up to sixteen 26-point levels
or twelve 52-point levels

Up to three 10-point levels

Let Clare put the exactly right stepping switch in your design

Designers who count on CLARE stepping switches as components for complex counting, totalizing and sequence-control equipment know that from the wide CLARE line they can select the exact switch their application requires. If necessary, CLARE engineering will provide special switch designs.

CLARE stepping switches are available as spring-driven, cam-operated or direct-drive switches with capacities from 10 to 52 points. All may be hermetically sealed in nitrogen or oil, or provided with dust covers.

All CLARE stepping switches are well known for their long life, high capacity and minimum maintenance through millions of precise stepping operations. For complete information write for Catalog 202.

C. P. CLARE & CO., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ont. Cable address: CLARELAY.

DAP* INSULATION STANDARD ON SPRING-DRIVEN SWITCHES

FOR—

- High insulation resistance
- Good arc resistance
- Stable insulation resistance
- Strength and stability
- Low moisture absorption

*diallyl phthalate

C. P. CLARE & CO.

Relays and related control components

Circle 58 on Inquiry Card

Personals

(*Continued from page* 60)

James C. Alemanni and **Donald E. Kaplan** to the Engineering Staff.

Dr. Harold R. Raemer—appointed Physics Specialist, Applied Research Laboratory, Sylvania Electric Products Inc., Waltham, Mass.

Robert Just — named Chief Industrial Engineer, Indiana Steel Products Div., Indiana General Corp., Valparaiso, Ind.

Donald G. Fink — appointed Vice-President for Research, Philco Corp., Blue Bell, Pa.

Robert E. Learned — promoted to Production Manager for Diodes at Motorola's Semiconductor Products Div., Phoenix, Ariz.

R. E. Learned

E. C. Thompson

E. C. Thompson — appointed Program Manager for the Univac Real-Time System, Remington Rand Univac Div., Sperry Rand Corp., Univac Park, St. Paul, Minn.

Eugene Michaels—appointed Project Engineer and **Ed Cook** appointed Test Equipment Engineer at the California Facility of Technology Instrument Corp., Newbury Park, Calif.

Dr. Peter A. Rizzi — has become President and Head Engineer of Microwave Technology, Inc., Waltham, Mass.

Ian F. Thomson—appointed Manager of Components Assembly at Non-Linear Systems, Inc., Del Mar, Calif.

L. D. Brown—named Chief Engineer for Aerotest Laboratories, Inc., Deer Park, L. I., N. Y.

Dr. Meyer Gilden — appointed Sr. Engineer, Electron Tube and Device Div., Microwave Associates, Inc., Burlington, Mass.

Charles R. Covey—appointed Manager of Manufacturing for Texas Research & Electronic Corp., Dallas, Tex.

Price D. Wickersham—named Manager, Systems Engineering Div., Dit-Mco, Inc., Kansas City, Mo.

Dr. Raymond DuHamel—appointed Sr. Staff Scientist, Radar Laboratory, Ground Systems Group, Hughes Aircraft Co., Fullerton, Calif.

William T. Engel—appointed Chief Engineer, Engineering & Design Dept., Kahle Engineering Co., Union City, N. J.

GENERAL ELECTRIC INDUCTROL® VOLTAGE REGULATORS...

Where reliable voltage control is a MUST

Atlas, BMEWS, Bomarc, Corporal, Minuteman, Nike-Hercules, Nike-Zeus, Tartar—here, reliability may mean survival . . . and dependable voltage control is a *must*. That's one reason why General Electric Inductrol voltage regulators are an integral part of *all* these systems.

This reliability can be vitally important to *your* application, too . . . whatever your voltage control requirements. Reliability is inherent in the simple induction principle of this advanced regulator design. There are no tubes to replace, no sliding brushes to wear out, no associated d-c power supply to maintain.

For full information, see your nearby G-E Sales Engineer. Or write for GEC-1450 to General Electric Co., Section 457-05, Schenectady 5, N. Y. *Voltage Regulator Products Section, Pittsfield, Mass.*

INDUCTROL REGULATOR FEATURES:

- Automatic ±1% control accuracy
- Stepless, drift-free control
- 100% overload capacity up to 1 hour
- 97 to over 99% efficiency
- Lead, power-factor and frequency compensated
- No harmful waveform distortion
- Rugged, compact construction

GENERAL ELECTRIC

Circle 60 on Inquiry Card

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contract awarded by government agencies in April, 1961.

Amplifiers	1,117,297
Analyzer, vibration	461,307
Antenna systems	184,091
Antennas	241,755
Battery, dry	1,326,201
Battery, storage	136,883
Battery, thermal	32,109
Beacon, radar	85,294
Cable assembly	333,675
Cable, instrumentation	35,750
Cable, telephone	100,888
Calibrator	216,025
Capacitors	65,761
Coder-decoder	100,301
Connectors	135,367
Control, intercom power supply	97,550
Converter, frequency	40,229
Dynamotor	70,320
Filter, RF	37,500
Gyros, vertical	49,809
Headset-handset	796,025
Inverters	33,696
Key, telegraph	25,276
Loudspeaker	33,327
Measuring system	110,812
Meter, frequency	657,428
Microphone	147,816
Oscillator subassembly	51,766
Oscilloscopes	1,619,004
Planner, computer	300,000
Power supply	64,978
Radar	36,325,842
Radar trainers	200,068
Radiacmeter	29,305
Radio set	779,952
Radiosonde sets	67,688
Radomes	47,368
Receiver	3,362,723
Recorder	136,907
Recorder/reproducer system, tape	75,696
Recording set, magnetic instrument	230,775
Rectifier, power supply	80,457
Relay	20,853
Resistors	32,181
Resistors, variable	128,965
Semiconductor device	37,410
Signal generator	546,763
Switch, pressure	93,713
Switchboard, FC underwater battery	100,742
Switches	93,000
Tape, magnetic	123,500
Telemetry equipment	27,154
Telemetry ground station, mobile	117,417
Telephone set	928,653
Terminal sets, telegraph	218,700
Test set	383,055
Testers	33,580
Towers, radar	609,302
Transceivers	536,356
Transducers	99,960
Transformers & coils	27,773
Transmission line system, coaxial	64,808
Transmitting head, single sideband	423,524
Transmitters	2,083,781
Tube, electron	2,771,365
Tube, magnetron	1,322,106
Tuner, RF	26,085
TV system, entrapment	92,377
X-Ray equipment	187,830

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in May 1961.

Accelerometers	64,246
Alarms, radiobeacon monitor	41,066
Altimeters	95,134
Amplifiers	479,030
Antenna equipment	740,957
Audio multiplex units	35,637
Batteries	3,163,038
Beacon, radar	54,498
Cable assembly	66,616
Cable, coaxial	32,830
Cable, control	34,959
Cable, telephone	697,747
Calibrator, radiac	55,411
Capacitor	166,484
Circuit analyzer	34,490
Communication equipment	834,691
Comparator	456,571
Computers	1,010,480
Connectors	55,959
Control equipment	269,122
Controls	471,365
Counters	28,352
Converters	299,503
Crystal units	52,290
Data processing sets	3,000,000
Data recorder, magnetic tape	29,730
Detection system	70,000
Direction finding set	74,791
Frequency changer, automatic	41,065
Frequency divider & clock	104,139
Ground readout equipment	66,000
Gyroscope	236,213
Headset-handset	506,363
Indicators	296,020
Intercom equipment	89,090
Loudspeakers	245,825
Magnetic tape	74,107
Meters	3,111,593
Microphone	1,047,800
Motors	66,484
Oscillator, modulator	550,215
Oscillograph	88,383
Oscilloscopes	205,168
Power supplies	234,420
Pulse networks	116,344
Radar	5,463,357
Radiacmeter	72,754
Radio set	1,397,532
Radiosonde set	1,008,990
Receivers	567,683
Receiving system	1,578,842
Recorder/reproducer	1,859,330
Recorder tape	1,168,700
Rectifiers	81,359
Regulator, voltage	29,162
Relay armatures	125,459
Relays	144,230
Resistors	130,764
Resistors, variable	382,038
Semiconductor devices	28,575
Semiconductors	105,400
Signal generator	218,707
Simulator sets	1,000,000
Sonar equipment	112,348
Spectrometry system	52,327
Switchboards	98,440
Switching system	191,500
Switches	287,012
Synchroscope	43,290
Tape handler, digital, magnetic	30,578
Telegraph distortion measuring set	85,143
Telephone equipment	238,549
Teletypewriter equipment	760,318
Terminal, telegraph	466,825
Terminal, telephone	754,615
Test equipment	93,409
Test sets	382,986
Testers	168,556
Timers	114,989
Towers	616,394
Trainers	2,389,283
Transceivers	969,015
Transducers	338,588
Transmitters	1,734,978
Transponders	294,849
Tube, electron	4,073,809
Tube, klystron	98,195
TV equipment	71,123
Waveguide equipment	136,652
X-Ray equipment	164,425

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Sintered metal gears, cams, special purpose filters and structural members from iron, nickel, stainless steel, brass and copper alloys are produced by Mueller for practically every segment of American industry. Whatever your product requirements are, the Mueller Sintered Metal Products Division is completely equipped to supply you with precision parts to exact specifications at substantial savings. In addition, the engineering staff, machining and finishing facilities of Mueller Brass Co. are an important plus value when you

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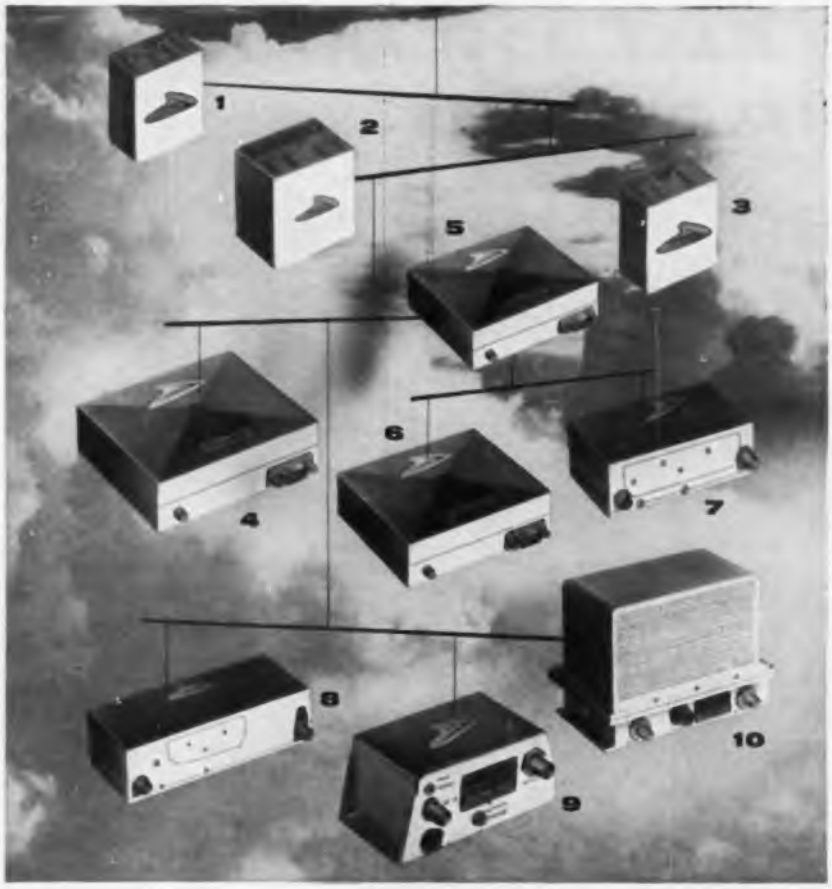

1 1270 high performance, high level VCO, 2 cubic inches volume.

2 1274±5 millivolt floating input VCO for grounded and ungrounded differential signals—4½ cubic inches.

3 1170 wideband amplifier for use with 1270 and 1274 subcarrier oscillators.

4 1053 1 watt all-transistor FM transmitter (silicon) 100° C. 350 ma at 28 vdc; 20 cubic inches, 17 ounces, unlimited altitude.

5 1055 2 watt all-transistor FM transmitter (germanium) 60° C; case same as 1053.

6 1051 FM transmitter, 3 watts, tubed output stage; case same as 1053.

7 1008 compact 2 watt tubed FM transmitter.

8 1009 12 watt FM transmitter, unlimited altitude.

9 1114 15 watt RF power amplifier.

10 1090A frequency converter . . . 8 watt RF output at 2200-2300 mc; unlimited altitude.

Before you buy...count to ten

TELE-DYNAMICS' BIG 10

ALL NEW TELEMETRY COMPONENTS

Here's a complete new line of transistorized telemetry components for all aerospace applications —**TELE-DYNAMICS' BIG 10.** These new units—the latest in FM telemetry—are light in weight, compact in size, low in cost—high in electrical performance, in environmental characteristics and in reliability.

The new oscillators—1270 high level and 1274 low level—provide mechanical interchangeability as well as outstanding electrical and environmental characteristics. The transistorized transmitters provide 1 or 2 watt true FM output with maximum efficiency in size, weight and power consumption. The tubed transmitters (1008·1009), amplifier (1114) and 2200mc converter provide the maximum performance compatible with the state of the vacuum tube art. All of the units are capable of being easily combined into various custom systems.

These units are representative of Tele-Dynamics' latest creative effort in the complete telemetry field. Whether it's one oscillator, a complete transmitting system or a complete data system—count to 10 and then call Tele-Dynamics.

TELE-DYNAMICS
DIVISION
AMERICAN BOSCH ARMA CORPORATION

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FM and analog testing, RF or closed circuit data storage with Mincom reliability—all in the day's work for this superb, all-purpose general instrumentation system: the Mincom G-100 Magnetic Tape Recorder/Reproducer. Direct response is 200 cps to 300 kc at 60 ips. FM response at 60 ips is dc to 20 kc (broadband), dc to 10 kc (standard). Fourteen tracks in one rack. All-transistored card system record/reproduce modules, interchangeable for FM or analog. Greater dynamic range, built-in calibration, lower power requirements. Interested? Write for complete specifications.

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MINCOM DIVISION MINNESOTA MINING AND MANUFACTURING COMPANY

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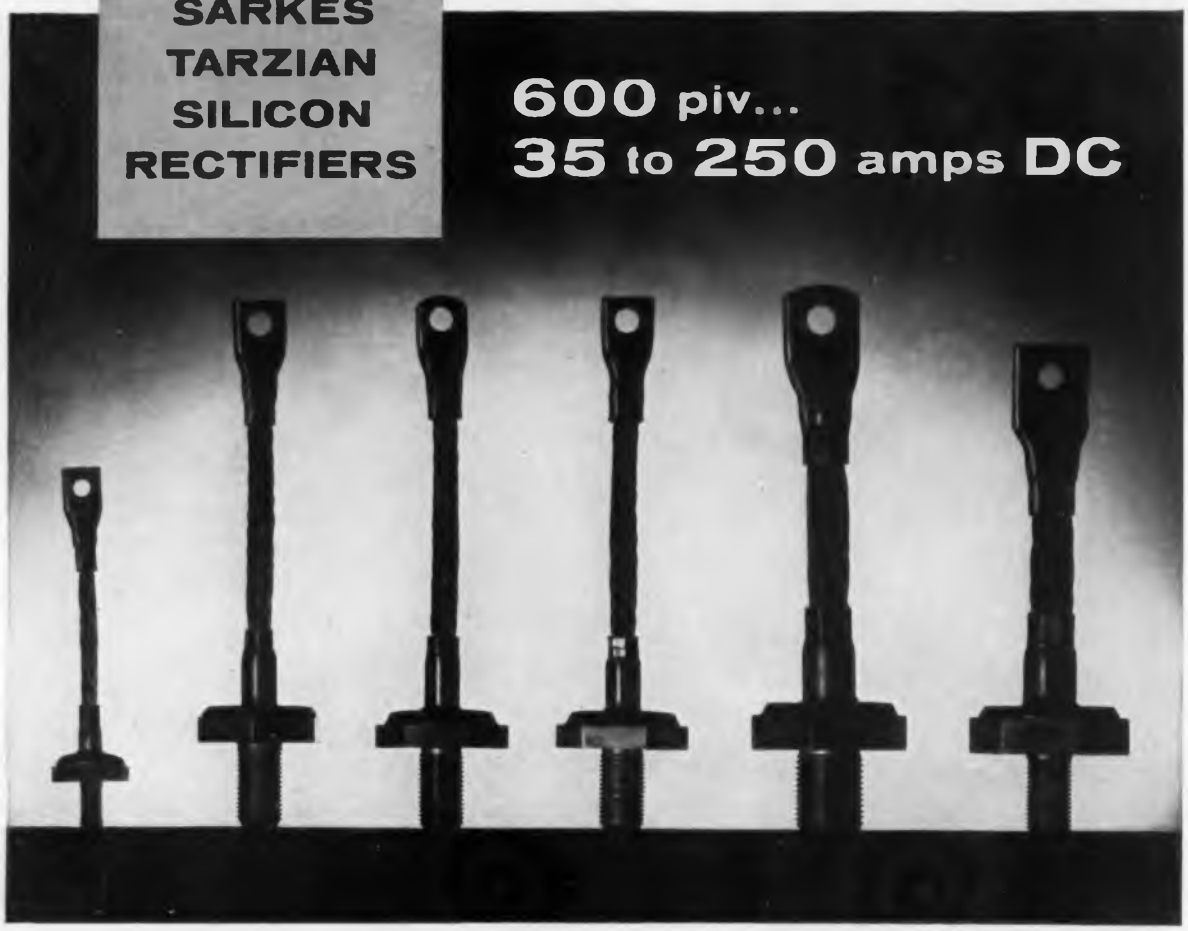
Circle 63 on Inquiry Card

SARKES TARZIAN SILICON RECTIFIERS

600 piv... 35 to 250 amps DC



Tarzian Type*	Amps DC (100°C)	peak inverse volts	Max. RMS volts	Max. forward voltage drop	Max. reverse current	Max. amps	
						recurrent peak	surge 4MS
60S3	35	600	420	1.3	20 ma	210	350
60T3	50	600	420	1.2	25 ma	300	500
60V3	100	600	420	1.2	60 ma	900	1500
60W3	150	600	420	1.2	60 ma	900	1500
60X3	200	600	420	1.2	60 ma	1200	2000
60Y3	250	600	420	1.2	60 ma	1500	2500

*Add N for negative, P for positive, base polarity

Other 600 piv Tarzian silicon rectifiers are available in 0.5, 0.75, 1.5, 2, 10, 12, and 20 ampere units.

These husky units meet new high current needs. They all are characterized by extremely low current density for maximum reliability and operating life, thanks to oversize junctions—the largest available. The 250-amp 60Y3, for example, has a junction diameter of over an inch. This is nearly twice the area of similar ratings on the market. Prices are realistic.

Complete engineering service on rectifier applications is available without charge.

Send for new free Tarzian catalog (No. 61CC-1).

SARKES TARZIAN, INC.

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

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

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

NEW 20-AMP Variable Transformer

VT20B—
IN BASIC ENCLOSURE

OHMITE SERIES VT20

SHOWN ⅔ ACTUAL SIZE

FEATURES

A Base has elongated mounting holes and other features which give the VT20 universal mounting capabilities. Can be used as a *direct replacement for other popular transformers* of comparable size.

B Radiator plate is counterbalanced in conjunction with the brush assembly for smooth operation and stability under vibration.

A B Unusually fast heat dissipation results from carefully designed base and radiator plates.

C Adjustable shaft extends from either end of the transformer as required for panel or horizontal surface mounting. *Unique, collet-type lock permits repositioning without scoring or defacing the shaft.*

D Extra large brush assembly gives a big margin of heat dissipation . . . is accurately counterbalanced by radiator plate design.

E Terminal panel allows quick arrangement of *clockwise or counterclockwise* increase of voltage for "line" (120 V) or "overvoltage" (140 V) maximum output.

VT20 VARIABLE TRANSFORMERS CURRENTLY STOCKED

Cat. No.	Input (Sing. Ph.) Volts	cps	Output Volts	Amps	Rot. Ang.
VT20 VT20B	120	50-400	0-120/140	20	317°

WRITE FOR BULLETIN 165

OHMITE MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois

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

OHMITE

Circle 65 on Inquiry Card

Books

Computer Logic

By Ivan Flores. Published 1960 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 452 pages. Price $12.00.

Exactly how a computer is put together and how it works is described and illustrated with block diagrams. The author emphasizes the organization and functional interrelation of fundamental units and discusses these relationships from the viewpoint of operational necessity rather than mathematical logic, Boolean algebra or circuit theory.

Sequential Decoding

By John M. Wozencraft and Barney Reiffen. Published 1961 by The Technology Press, Mass. Inst. of Technology and John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y. 74 pages. Price $3.75.

This book considers the electrical communications problem of coding and decoding from a probabilistic point of view. It presents a data-communication procedure for which the average computational complexity grows only algebraically with delay.

The decoding scheme, called sequential decoding, is considered in detail with respect to the binary symmetric channel. Its extension to more general channels is discussed briefly.

An Introduction to the Theory & Practice of Transistors

By J. R. Tillman & F. F. Roberts. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 340 pages. Price $8.00.

The basic physical theory of semiconductors and of the transistor is presented in terms that should be more than usually comprehensible to electronic engineers and experimental physicists. An analysis is made of a practical three-dimensional model of a transistor which gives a realistic account of its electrical properties. The preparation of the two key semiconductors is described. A critical survey of the electrical characteristics of the semiconductor diodes and transistors is made. It is shown how circuits can be quantitatively designed around them in the fields of amplification, oscillation, switching, logic and waveform generation.

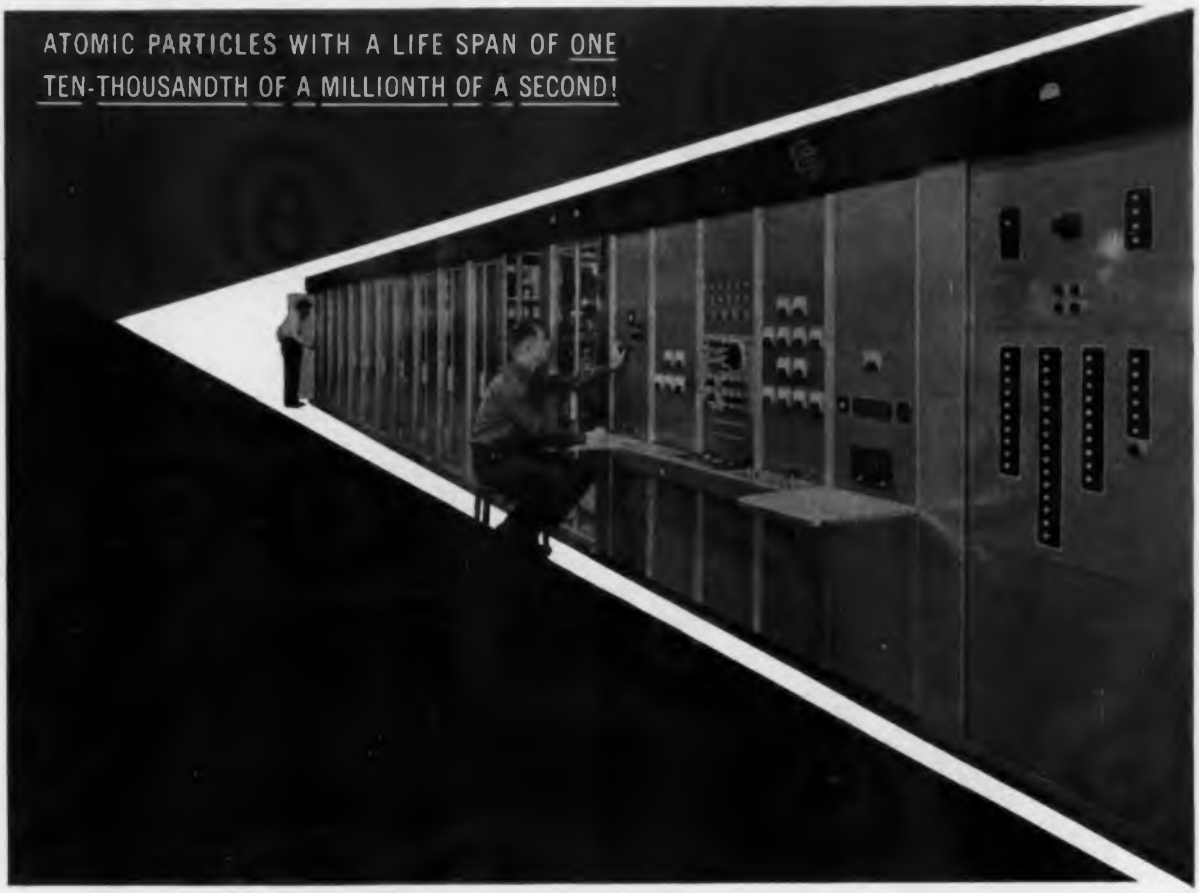
Iterative Arrays of Logical Circuits

By F. C. Hennie III. Published 1961 by The Technology Press, Mass. Inst. of Technology and John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y. 242 pages. Price $4.95.

This book examines the behavior of one and two-dimensional iterative networks. It is written for persons working in the communications sciences, and is especially pertinent to the areas of information processing, switching theory, and computer design.

(Continued on page 76)

space age research



Continental Electronics, specialist in super power electronics equipment, is building the radio frequency driver system for the linear accelerator injector for the proton synchrotron now under construction for the Argonne National Laboratory. This driver system will have a peak power of 5 megawatts, with an average power of 25 kilowatts, operating at a frequency of 200 megacycles with a 500 micro-second pulse.

When completed, the Argonne proton synchrotron will accelerate protons to an energy of 12.5 billion electron volts, enabling scientists conducting atomic research to experiment with known phenomena and discover new phenomena that occur when protons of high energy collide with other protons at rest. This collision usually results in the production of rare, short-lived particles; some with a life span of one ten-thousandth of a millionth of a second!

To achieve the high energy required to produce these rare atomic phenomena, protons from a conventional ion source are first accelerated to 750,000 electron volts with a conventional high voltage supply. They are then increased to 50 million electron volts by passing through the linear accelerator, reaching final energy of 12.5 billion electron volts in the synchrotron.

Continental Electronics is proud to be a contributor to the Argonne National Laboratory's atomic research program which is dedicated to increasing scientific understanding of atomic energy.

Continental Electronics MANUFACTURING COMPANY

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DESIGNERS AND BUILDERS OF THE WORLD'S MOST POWERFUL RADIO TRANSMITTERS

NEW BORG MICROPOT® 2400 SERIES POTENTIOMETERS

★ 100 Ohms to 200K Ohms Resistance . . .

★ Meet Full Range of Military Specifications . . .

4 NEW SINGLE-TURNS

Feel the fine construction by turning the shaft . . . action is smooth, continuous . . . a feel of jeweled precision. See the extra strong design in the one-piece aluminum housing and front bearing mount. Note the rear covers fit precisely into machined shoulders to seal out dirt, vapors, corrosive atmospheres according to applicable mil specs.

Color-coded terminals are gold-plated for perfect solderability, corrosion-free shelf life. Element ends and terminals are welded to prevent loosening during application. All models are wirewound and linear. Standard bushing mounts have life-time lubricated sleeve bearings; standard servo mounts have two precision ball bearings. Precious metal contact and collector surfaces minimize noise, contact resistance and thermal effects over a long, trouble-free life. Complete data is yours by return mail.

REFERENCE-ACTION DATA

SPECIFICATIONS	2440 Series	2460 Series	2480 Series	2490 Series
Standard Resistance Range (ohms)*	500 to 50K	500 to 100K	100 to 125K	100 to 200K
Resistance Tolerance	±5% to 10K ±3% over 10K	±5% to 5K ±3% over 5K	±5% to 5K ±3% over 5K	±5% to 5K ±3% over 5K
Temperature Range (°C)	−55 to +125	−55 to +125	−55 to +125	−55 to +125
Power Rating (watts)	3	4	5	6
Standard Linearity Tolerance (%)	±.5	±.5	±.5	±.5
Data Sheet	BED-A186	BED-A189	BED-A190	BED-A191

*Other resistances available.

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GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

NEVER BEFORE POSSIBLE...ultra-fast silicon diodes that combine 2 nanosec speed, 100 mA conductance, .025 μA leakage and 2 pf capacitance

The new General Instrument 'SP' series offers a combination of electrical characteristics never before possible in ultra-fast switching silicon diodes. The complete line, including the popular IN914, IN916 and IN903 series, are immediately available in production quantities. They all feature nanosecond switching speeds, coupled with either high conductance, low leakage current or low capacitance. Check the chart. Then call the General Instrument sales office or franchised distributor nearest you for complete specs. Or write today to General Instrument Semiconductor Division, 65 Gouverneur Street, Newark 4, New Jersey.

TYPE	Breakdown ① Voltage (BV)	Maximum Reverse Current (μA) 25°C	150°C	Test Voltage ②	Forward Current (Min. mA @ 1V)	Reverse Recovery Max. (mμsec) ③	Capacitance at V_R=0 (pf) ④	Rectification ⑤ Efficiency
SP100	75	0.1	100	50	10	2	2	45%
SP101	30	.025	50	20	100	2	2	45%
SP106	125	.025	50	100	100	2	2	45%
IN914A	100	.025	50	20⑥	20	4	4	45%
IN916A	100	.025	50	20⑥	20	4	2	45%

① Breakdown Voltage at 100 μA. ② Voltage at which Reverse Current measurements were taken. ③ Switching I_F= 10 mA to V_R=6.0 V R_L=100 ohms recovery to 1 mA. ④ Measured at 1 megacycle. ⑤ Measured at 100 megacycles using MIL-STD-19500 test circuit. ⑥ Reverse leakage when measured at −75 Volts and 25°C shall not exceed 5 μA.

ACTUAL SIZE

GENERAL INSTRUMENT CORPORATION

Books

(*Continued from page 72*)

High Fidelity Sound Engineering

By Norman H. Crowhurst. Published 1961 by Pitman Publishing Corp., 2 West 45th Street, New York 36, N. Y. 328 pages. Price $10.00.

This book provides the reader with basic concepts and design procedures of proved and lasting practical value. The material comes from a hitherto unpublished library of design data and information built up from the author's day-to-day work as engineering consultant, writer and teacher. It provides a complete ready reference for active design work, assuming only a knowledge of electrical fundamentals.

BOOKS RECEIVED

The Missile Industry—In Defense and the Exploration of Space

A series of lectures before the New York Society of Security Analysts by the Martin Co. and United Aircraft Corp. Published 1961 by the Martin Company, Baltimore, Maryland. 95 pages. Paperbound.

Ceramics

By P. William Lee. Published 1961 by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y. 210 pages. Price $5.95.

Scientific Thinking and Scientific Writing

By Martin S. Peterson. Published 1961 by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y. 214 pages. Price $6.95.

Frequency Modulation Theory-Application to Microwave Links

By J. Fagot and Ph. Magne. Published 1961 by Pergamon Press, Inc., 122 East 55th Street, New York 22, N. Y. 500 pages. Price $12.50.

Proceedings 1961 Electronic Components Conference San Francisco, Calif.

Sponsored by AIEE, 33 W. 39th St., New York 18, N. Y.; EIA, 11 W. 42nd St., New York 36, N. Y.; IRE 1 E. 79th St., New York 21, N. Y.; and WEMA, 1435 S. La Cienega Blvd., Los Angeles 35, Calif. Paperbound.

Transistors

Published 1961 by Gernsback Library, Inc., 154 West 14th St., New York 11, N. Y. 95 pages, paperbound. Price $1.95.

Solid State Physical Electronics

By Aldert Von Der Ziel. Published 1957 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 604 pages. Price $9.75.

Radio & TV Alignment Handbook

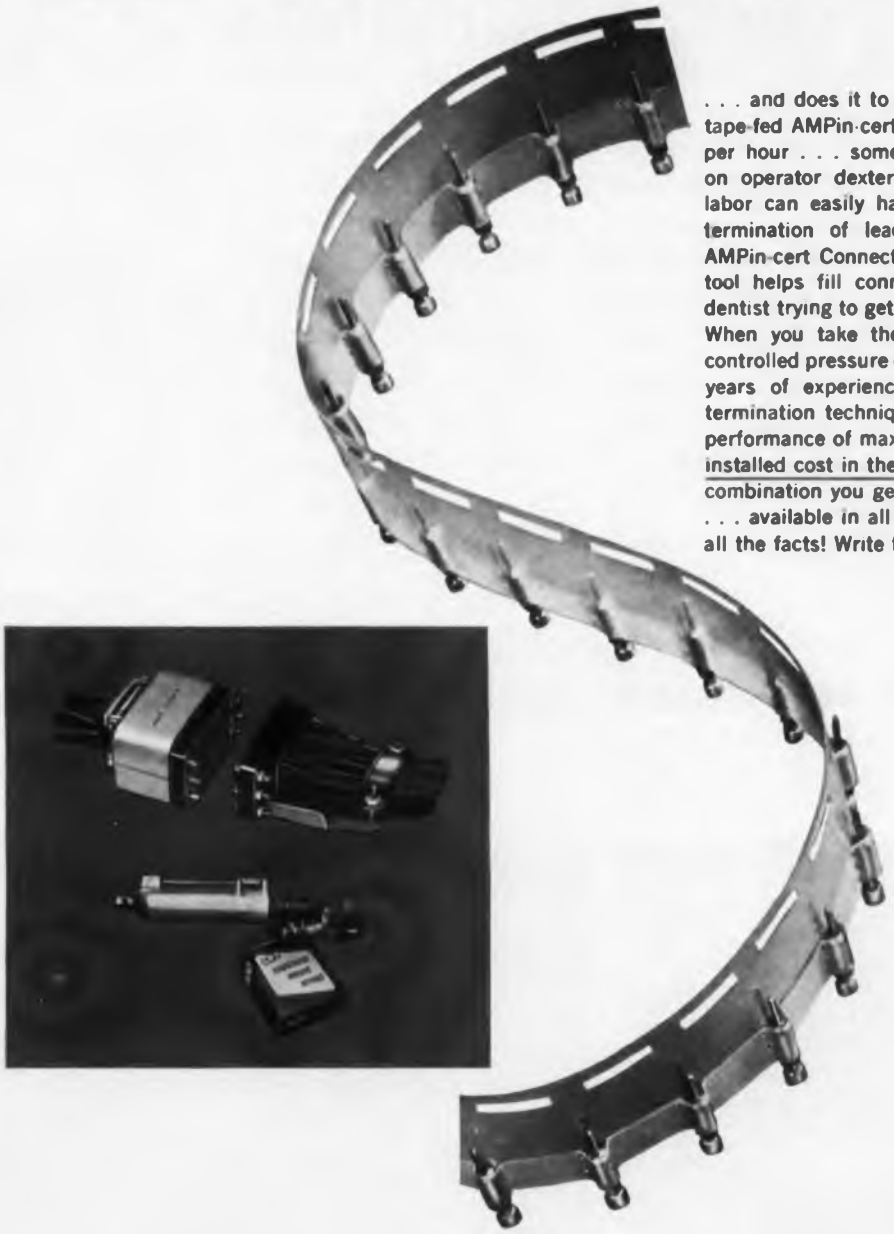
By W. J. Smith. Published 1961 by Howard W. Sams & Co., Inc., 2201 E. 46th St., Indianapolis 6, Indiana. 160 pages. Price $2.95.

1961 Registry of Transportation Radio Systems

Edited by E. V. Sleeper. Published 1961 by Communication Engineering Book Co., Radio Hill, Monterey, Mass. 88 pages. Price $4.00.

(*Continued on page 82*)

THIS TAPE PLAYS BACK THE SOUND OF MONEY...



. . . and does it to the tune of more than 1,600 tape-fed AMPin-cert Pin and Socket terminations per hour . . . sometimes even more, depending on operator dexterity! Lower cost, semi-skilled labor can easily handle not only the automatic termination of leads but also the loading of AMPin-cert Connector blocks. A simple insertion tool helps fill connector cavities faster than a dentist trying to get away for an afternoon of golf. When you take these advantages and add the controlled pressure crimp backed by AMP's twenty years of experience in the field of solderless termination techniques . . . you have connector performance of maximum reliability at the lowest installed cost in the industry. This is the winning combination you get with AMPin-cert Connectors . . . available in all sizes and configurations. Get all the facts! Write today!

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The Important Difference In Digital Voltmeters...

Check the design and construction features pictured here. These are the subtle marks of quality that exemplify the engineering leadership of NLS . . . the *important difference* between NLS digital voltmeters and those of other manufacturers. These are the engineering innovations that assure accuracy and rugged reliability . . . that minimize maintenance and downtime . . . that add to the long-term efficiency and usefulness of NLS instruments. Yes, there's more to a digital voltmeter than meets the eye . . . so look behind the front panel and beyond the specification sheet before you buy! Call on your NLS representative to demonstrate the instrument of your choice . . . to show what engineering leadership means to you in digital voltmeter performance and usefulness. Write today for the NLS catalog that describes the world's most complete line of digital voltmeters . . . by purpose, by price!

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR, CALIFORNIA

1 **PLUG-IN MODULAR CONSTRUCTION** *simplifies servicing, drastically reduces maintenance costs, keeps instruments on the job. More than 99% of the components of the NLS V44, Series 20 and Series 30 instruments are mounted on plug-in modules.*

2 **SNAP-OUT READOUT,** *exclusive on all NLS digital instruments, permits 20-second bulb replacement through front panel without tools. Precisely engraved readout numerals can be read all day from close up or far away without eye fatigue.*

3 **COMPACT DESIGN** — *illustrated by the 5¼"-high NLS 484 DVM, complete with recording controls – is one of the more obvious clues to superior engineering. Even the lowest cost NLS instruments are more compact with fewer cables and connections. Result: greater reliability.*

4 **"NO-NEEDLESS-NINES" LOGIC** *in Series 30 results from a new concept in transistor logic which eliminates unnecessary, time-consuming cycling of stepping switches through their 9's and 0's positions. This increases accuracy, speed, reliability and usefulness, particularly in systems applications.*

5 **PLUG-IN STEPPING SWITCHES** — *exclusive with NLS — are standard even on lowest cost Industrial models. Results: switch replacement is a one-minute cinch instead of a half-day chore — troubleshooting is as easy as shifting switches and noting changes in the readout.*

6 **PLUG-IN ACCESSORIES** *can be mated in minutes with an NLS digital voltmeter to form hundreds of combinations. These include AC/DC converters, preamplifiers, input scanners, and virtually every type of data recorder.*

7 **"NO POTS AT ALL" STABILITY** *of the NLS V44 DVM is checked by the "boil in oil" test at 158°F. This feature eliminates all trimming of decade and amplifier circuits.*

8 **PLUG-IN OIL-BATH STEPPING SWITCHES** *in Series 30 instruments outlast dry switches by a factor of five . . . completely eliminate periodic disassembly for manual lubrication of switches.*

Circle 72 on Inquiry Card

NOW! NEW STANDARDS OF FREQUENCY STABILITY, SPECTRAL PURITY WITH NEW hp 104AR QUARTZ OSCILLATOR

Long term stability: 5 parts in 10^{10}/day
Typical short term stability*: 1 part in 10^{10}
Spectral purity: 2 cps typical bandwidth at X-Band

*averaged over one second intervals and under reasonably constant environmental conditions.

hp 724BR/725AR Standby Power Supplies

These standby power supplies are completely automatic, assure continued operation of frequency and time standard systems in the event of ac line power failure. Standby batteries floating across supply outputs, instantly assume load, without switching, in case of ac failure. Battery recharged automatically after ac line power is restored. hp 724BR battery operates 103/104AR, 113BR up to 48 hours. hp 725AR battery operates 103/104AR, 113BR at least 6 hours. hp 724BR, 75 lbs., $850.; hp 725AR, 20 lbs., $425.

Precision instruments for "Building Block" frequency/time standard systems allow comparison with HF, VLF standard broadcasts.

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

The accuracy, stability and spectral purity you need for communication, navigation, missile guidance, satellite tracking and other advanced frequency/time standard applications are yours now with the new hp 104AR Quartz Oscillator.

Model 104AR provides a 5 MC output of extreme spectral purity that retains the stability of the 1 MC oscillator. Spectra only a few cycles wide may be obtained in the X-Band region by multiplication of the 5 MC output. Model 104AR also provides 1 MC and 100 KC sinusoidal output signals, plus a separate 100 KC output for driving hp 113BR Frequency Divider and Clock in frequency and time comparison measurements and time signal generation. The 113BR, which permits greater absolute accuracy from frequency or time standards and is suitable for HF or VLF comparisons, is described below.

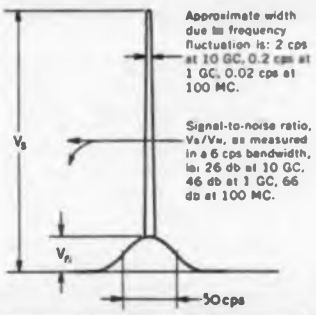
Continuous operation of hp 104AR and hp 113BR is assured with hp 724BR/725AR Standby Power Supplies (also described below). Models 724BR/725AR provide power for the oscillator and frequency divider, and incorporate batteries to insure operation of the system in case of ac power failure. These instruments, plus a comparison device and a receiver, provide a compact, lightweight, rugged, stable and accurate primary frequency and time standard system.

The new hp 104AR Quartz Oscillator, which is completely transistorized, employs a proportionally-controlled double oven which houses the crystal and all critical frequency-determining elements. Crystal dissipation level is kept constant at less than 1/4 μw by AGC action. Frequency changes due to variations in supply voltage and load impedance are virtually eliminated as a result of internal voltage regulation and excellent buffering.

SPECIFICATIONS, hp 104AR

Overall Stability:	Long term: 5 parts in 10^{10}/day. Short term: Better than 5 parts in 10^{10} averaged over 1 sec. intervals. (Includes effects of temperature, supply voltage and load impedance.)
Output Frequencies:	5 MC, 1 MC, 100 KC, 1 v rms into 50 ohms, 100 KC for driving hp 113AR/BR.
Harmonic Distortion:	At least 40 db below rated output.
Non-harmonically Related Output:	At least 80 below rated output.
Output Terminals:	5 MC, 1 MC, 100 KC, front and rear BNC connectors.
Frequency Adjustments:	Coarse: Screwdriver adjustment with range of approx 1 part in 10^8. Fine: Front panel screwdriver control with range of approx. 600 parts in 10^{10}. Digital indicator calibrated directly in parts in 10^{10}.
Monitor Meter:	Ruggedized front-panel meter and associated selector switch monitors the SUPPLY voltage, BIAS, OSC current, INNER OVEN current, OUTER OVEN current, 1 MC output, 100 KC output.
Temperature Range:	0 to 50° C.
Size:	19" x 5¼" x 14" deep behind panel. Approx. 20 lbs.
Price:	hp 104AR, $3,250.00

Typical Spectral Purity, hp 104AR



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Books

(*Continued from page 76*)

Basic Mathematics for Electronics, Second Edition

By Nelson M. Cooke. Published 1960 by McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y. 679 pages. Price $10.75.

Experimental Correlograms and Fourier Transforms

By N. F. Barber. Published 1961 by Pergamon Press, 122 East 55th Street, New York 22, N. Y. 180 pages. Price $7.50. This is volume 4 of the series "International Tracts in Computer Science and Technology and Their Application."

A Guide to Technical Literature Production

By E. Clarke. Published 1961 by TW Publishers, Box 152, River Forest, Ill. 192 pages. Price $3.00.

Advances in Electron Tube Techniques

By D. Slater. Published 1961 by Pergamon Press, Inc., 122 East 55th St., New York 22, N. Y. 242 pages. Price $15.00.

Your Future in Electronic Engineering

By Sol Levine. Published 1961 by Richards Rosen Press, 13 East 22nd Street, New York 10, N. Y. 160 pages. Price $2.95.

Electronic Drafting Handbook

By N. M. Raskhodoff. Published 1961 by the Macmillan Co., 60 Fifth Ave., New York 11, N. Y. 402 pages. Price $14.75.

Silicon Zener Diode and Rectifier Handbook, 2nd Edition

By the Applications Engineering Department of Motorola's Semiconductor Products Division, 5005 E. McDowell, Phoenix, Arizona. 182 pages. Price $2.00.

Annual Review in Automatic Programming, Vol. II

By Richard Goodman. Published 1961 by Pergamon Press, Inc., 122 East 55th Street, New York 22, N. Y. 250 pages. Price $12.00.

TV Tube Symptoms & Troubles

By R. G. Middleton. Published 1961 by Howard W. Sams & Co., Inc., 2201 E. 46th St., Indianapolis 6, Indiana. 96 pages. Price $1.50.

Hi-Fi Stereo Handbook

By W. F. Boyce. Published 1961 by Howard W. Sams & Co., Inc., 2201 E 46th St., Indianapolis 6, Indiana. 288 pages. Price $3.95.

Rare Metals Handbook, 2nd Edition

Edited by Clifford A. Hampel. Copyright 1961 by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N. Y. 715 pages. Price $20.00.

Transistor Substitution Handbook

By the H. W. Sams Engineering Staff. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 95 pages, paperbound. Price $1.50.

ABC's of Computers

By Allan Lytel. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 128 pages, paperbound. Price $1.95.

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EI's 10th ANNUAL WESTERN ISSUE

Reliability Doesn't Cost—IT PAYS!

This article points out the type of "thinking" required by the Congress and military in allocating funds for reliable equipment, and selecting the right company to handle the contract. The thinking has been for the low bidder to get the contract—regardless, in most cases, of this company's integrity, ability, or past performance. Usually this low bidder, by renegotiating, winds up charging more money than one of the higher bidders that would do a good job. And even then this company does not achieve the desired level of reliability.

For the manufacturers we point out what steps they should take to achieve a more reliable product. Many companies are bidding on a contract just to be a low bidder, without regard for producing an excellent product. If the manufacturers would band together and hold out for better written contracts and procurement practices, then they would be bidding on equal footing. Unfortunately, in many cases the reliability level is whatever the bidder interprets it to be. Hence, the wide range in bid pricing.

KILOMEGACYCLE OSCILLOSCOPES

Traveling-wave oscilloscopes are the only devices available for viewing non-recurring events at high frequencies. They continue to hold their own even with the newer sampling scopes in viewing recurring events at frequencies above 1KMC. The steps leading to the development and the present status of the above two scope types are described.

PRACTICAL APPROACH TO LOW NOISE TRANSISTOR AMPLIFIERS

Noise is any unwanted signal present in an amplifier. Usually, it is a combination of external noise, noise in the signal source, and internal noise. We are concerned with the last one. More specifically with specifying (predicting) noise performance. Two approaches are possible: first, mathematically; second, empirically. This article uses the latter. The required design information can be obtained by applying tests to the external terminals of the transistor.

APPLICATION OF DIGITAL COMPUTERS TO COMPUTATION OF DIELECTRIC CONSTANTS AND LOSS TANGENTS

Graphical analysis is nice but numerical presentations afford less chance of error. This article presents a Fortran (Formula Translation) program which uses the readily available subroutines of a digital computer to compute the dielectric constant and loss tangent of a substance at microwave frequencies. Twenty-eight parameters per case are submitted to the computer; values of 4 variables are printed out for each case. Speed: 0.6 minute for 22 cases.

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By GEORGE W. OGAR
Associate Professor of Electrical Engineering
Institute of Technology, Air University
USAF, Wright-Patterson AFB, Ohio

Putting Diode Modulators to Work

Diode modulators are good basic building blocks. They can easily implement many useful electronic functions. This tutorial article analyzes various applications—wide-band phase shifters, SSB systems, stereo systems—and proves that the outputs are what they are claimed to be.

MANY functions can be implemented by using diode-bridge modulators as basic building blocks, Fig. 1.

A control signal e_c has a frequency which is usually higher than that of e_s. But, sometimes the frequencies are equal. The output signal frequency is e_o. The cw control signal e_c drives all 4 diodes into full conduction as soon as e_c crosses the zero axis in the positive-going direction.

On the other hand, e_c cuts off the 4 diodes completely when it crosses the zero axis in the negative-going direction. The effect at e_o is the same as if e_s were multiplied by a square wave $S(t)$ of frequency ω_c; that is,

$$e_o(t) = e_s(t)\, S(t)$$

where,

$$S(t) = \frac{1}{2} + \sum_{n=1}^{\infty} \frac{\sin \frac{n\pi}{2}}{\frac{n\pi}{2}} \cos n\omega_c t.$$

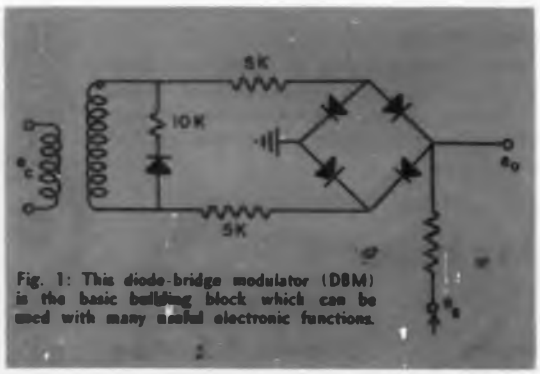


Fig. 1: This diode-bridge modulator (DBM) is the basic building block which can be used with many useful electronic functions.

If $e_s(t) = E_s \cos(\omega_s t + \phi_s)$, then it follows that

$$e_o(t) = E_s \cos(\omega_s t + \phi_s)\left[\frac{1}{2} + \sum_{n=1}^{\infty} \frac{\sin \frac{n\pi}{2}}{\frac{n\pi}{2}} \cos n\omega_c t\right]$$

The signal $e_o(t)$ can then be applied to a band-pass filter centered at ω_c so that only the $n = 1$ component passes through to the output of the filter. The output can be expressed as

$$e'_o(t) = \frac{2E_s}{\pi} \cos(\omega_s t + \phi_s) \cos \omega_c t$$

$$= \frac{E_s}{\pi}\left([\cos(\omega_c + \omega_s)t + \phi_s] + \cos[(\omega_c - \omega_s)t - \phi_s] \right)$$

The output of the basic building block (DBM) consists of the original signal frequency and pairs of side-bands, centered around harmonics of the control frequency f_c, Fig. 2.

A 90° Wide-Band Phase Shifter

To build a 90° wide-band phase shifter, operating throughout the entire audio band, we can use the block diagram of Fig. 3.

In Fig. 3,

$$e_o(t) = \sum_{k=1}^{n} a_{sk} \cos(\omega_{sk} t + \phi_{sk})$$

$$e'_o(t) = \sum_{k=1}^{n} a_{sk} \cos\left(\omega_{sk} t + \phi_{sk} - \frac{\pi}{2}\right)$$

$$= \sum_{k=1}^{n} a_{sk} \sin(\omega_{sk} t + \phi_{sk})$$

Fig. 4 expands this wide-band phase shifter.

To verify that $e_s(t)$ and $e_s'(t)$ are truly 90° out of phase for each signal frequency, take any one component of $e_s(t)$ and follow it through to the 2 outputs. Perform the indicated operations of modulation and filtering as you do. This would proceed as follows:

$$e_{sI}(t) = E_s \cos(\omega_s t + \phi_s)$$

$$e_{cI}(t) = \cos \omega_c t$$

$$e_{oI}(t) = \left[E_s \cos(\omega_s t + \phi_s)\right]\left[\frac{1}{2} + \sum_{n=1}^{\infty} \frac{\sin \frac{n\pi}{2}}{\frac{n\pi}{2}} \cos n\,\omega_c t\right].$$

Of the 2 frequencies corresponding to $n = 1$, only the upper one is passed by the filter, so that

$$e'_{oI}(t) = \frac{E_s}{\pi} \cos\left[(\omega_c + \omega_s)\, t + \phi_s\right].$$

Then $e_o'_I(t)$ becomes the signal input for both DBM II and DBM III. The control inputs are the cw voltages at f_c phase-shifted 90° from each other. This then can be written

$$e_{oII}(t) = \frac{E_s}{\pi} \cos\left[(\omega_c + \omega_s)\, t + \phi_s\right]$$

$$\left[\frac{1}{2} + \sum_{n=1}^{\infty} \frac{\sin \frac{n\pi}{2}}{\frac{n\pi}{2}} \cos n\,\omega_c t\right].$$

The 2 frequencies corresponding to $n = 1$ are

$$\frac{E_s}{\pi}\left[\cos(\omega_c + \omega_s)\, t + \phi_s\right]\left(\frac{\sin \frac{\pi}{2}}{\frac{\pi}{2}} \cos \omega_c t\right) =$$

$$\frac{E_s}{\pi^2}\left(\cos\left[(2\omega_c + \omega_s)\, t + \phi_s\right] + \cos(\omega_s t + \phi_s)\right)$$

Of these 2 frequencies, only the lower one is passed by Filter II. Therefore,

$$e'_{oII}(t) = e_s(t) = \frac{E_s}{\pi^2} \cos(\omega_s t + \phi_s)$$

In the same way, we can write that

$$e_{oIII}(t) = e_{sIII}(t)\, S_{III}(t) = \frac{E_s}{\pi} \cos\left[(\omega_c + \omega_s)\, t + \phi_s\right]$$

$$\left[\frac{1}{2} + \sum_{n=1}^{\infty} \frac{\sin \frac{n\pi}{2}}{\frac{n\pi}{2}} \cos n\left(\omega_c t - \frac{\pi}{2}\right)\right]$$

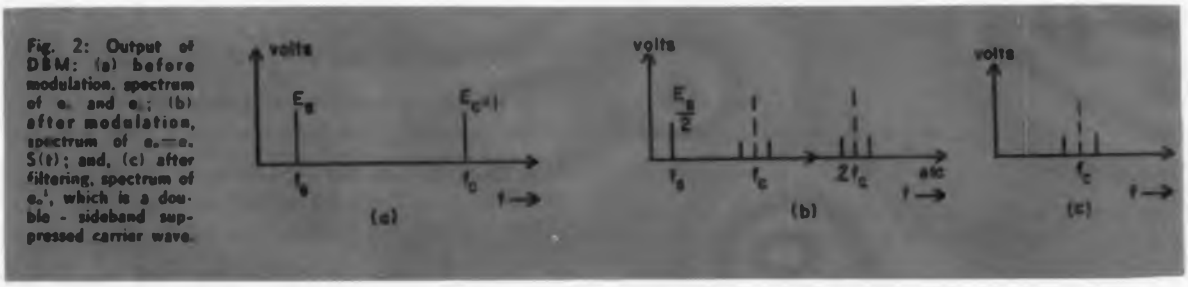


Fig. 2: Output of DBM: (a) before modulation, spectrum of e_s and e_c; (b) after modulation, spectrum of $e_s \cdot e_c$ $S(t)$; and, (c) after filtering, spectrum of e_o', which is a double-sideband suppressed carrier wave.

The 2 frequencies corresponding to $n = 1$ are included in the term

$$\frac{2E_s}{\pi^2} \cos\left[(\omega_c + \omega_s)\, t + \phi_s\right] \sin \omega_c t$$

which equals

$$\frac{E_s}{\pi^2}\left(\sin\left[(2\omega_c + \omega_s)\, t + \phi_s\right] - \sin(\omega_c t + \phi_s)\right)$$

Of these 2 frequencies, only the lower one is passed by the Filter III.

Therefore,

$$e'_{oIII} = e'_s(t) = -\frac{E_s}{\pi^2} \sin(\omega_s t + \phi_s)$$

Fig. 4: The two outputs are 90° out of phase for the entire range of frequencies.

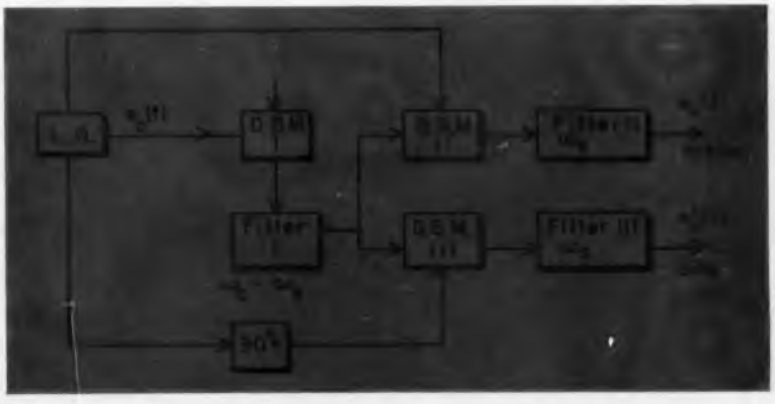
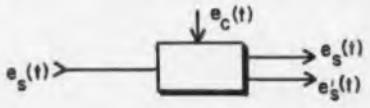


Fig. 3: A 90° wide-band phase shifter for the entire audio range can use this diagram.



Diode Modulators
(Continued)

Fig. 5: One system for generating an SSB signal filters out the undesired sideband.

It is evident that $e_s'(t)$ and $e_s''(t)$ are 90° out of phase with each other (ω_s could be any frequency in the audio band).

Single-Sideband Systems

One system for generating a single-sideband signal is based on filtering out the undesired sideband. Fig. 5 is an expansion of the system.

The output of the first diode bridge modulator is applied to a filter which passes only the lower sideband. This lower sideband of e_{c1} then becomes the signal input to the second diode-bridge modulator. The double-sideband signal is filtered so that only the lower sideband is passed to the next diode bridge. The analysis proceeds as follows:

$$e_{o1} = e_s S_1(t) = E_s \cos(\omega_s t + \phi_s) \left[\frac{1}{2} + \sum_{n=1}^{\infty} \frac{\sin \frac{n\pi}{2}}{\frac{n\pi}{2}} \cos n\omega_{c1} t\right]$$

$$e_{o1} = k_1 \frac{E_s}{\pi} \cos\left[(\omega_{c1} + \omega_s) t + \phi_s\right] + \frac{E_s}{\pi} \cos\left[(\omega_{c1} - \omega_s) t - \phi_s\right]$$

where k_1 expresses the attenuation of the filter of the upper side-band.

$$e_{o11} = e_{o11} S_2(t) = \frac{k_1 E_s}{\pi} \cos\left[(\omega_{c1} + \omega_s) t + \phi_s\right] S_2(t) + \frac{E_s}{\pi} \cos\left[(\omega_{c1} - \omega_s) t - \phi_s\right] S_2(t)$$ and so forth.

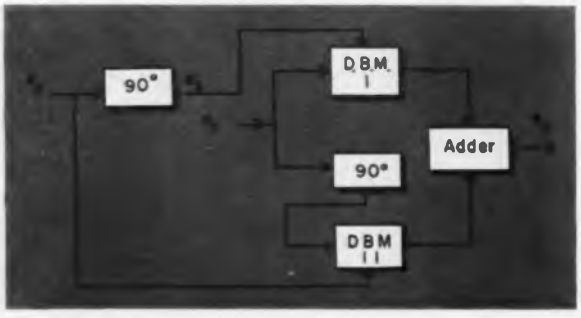
Ideally, the output of the system can be expressed as

$$e_o = \frac{E_s}{\pi^2} \cos\left[\omega_{c2} t - \omega_{c2} t - \omega_{c1} t - \omega_s t - \phi_s\right]$$

Second System

A second system for generating a single-sideband wave is based on the use of a wide-band 90° phase shifter. It proceeds as shown in Fig. 6.

Fig. 6: Another system for SSB signals uses a 90° phase-shifter.



The analysis is as follows:

$$e_{o1(mod)} = e'_s S(t) = \frac{2E_s}{\pi} \sin(\omega_s t + \phi_s) \sin \omega_c t = \frac{E_s}{\pi} \cos\left[(\omega_c - \omega_s) t - \phi_s\right] - \frac{E_s}{\pi} \cos\left[(\omega_c + \omega_s) t + \phi_s\right]$$

$$e_{o11(mod)} = e_s S\left(t - \frac{T}{4}\right) = \frac{2E_s}{\pi} \cos(\omega_s t + \phi_s) \cos \omega_c t = \frac{E_s}{\pi} \cos\left[(\omega_c - \omega_s) t - \phi_s\right] + \frac{E_s}{\pi} \cos\left[(\omega_c + \omega_s) t + \phi_s\right]$$

$$e_o = e_{o1(mod)} + e_{o11(mod)} = \frac{2E_s}{\pi} \cos\left[(\omega_c - \omega_s) t - \phi_s\right]$$

$\therefore e_o$ is a lower side-band signal.

Third System

A third system for generating a single-sideband signal employs 2 sets of modulators, Fig. 7.

The analysis can follow these steps:

$$e_{o1(mod)} = \frac{2E_s}{\pi} \cos(\omega_s t + \phi_s) \cos \omega_{c1} t = \frac{E_s}{\pi} \cos\left[(\omega_{c1} - \omega_s) t - \phi_s\right] + \frac{E_s}{\pi} \cos\left[(\omega_{c1} + \omega_s) t + \phi_s\right]$$

At the output of the low-pass filter, this becomes simply,

$$e'_{o1} = \frac{E_s}{\pi} \cos\left[(\omega_{c1} - \omega_s) t - \phi_s\right]$$

In the same way,

$$e_{o11(mod)} = \frac{2E_s}{\pi} \cos(\omega_s t + \phi_s) \sin \omega_{c1} t = \frac{E_s}{\pi} \sin\left[(\omega_{c1} + \omega_s) t + \phi_s\right] + \frac{E_s}{\pi} \sin\left[(\omega_{c1} - \omega_s) t - \phi_s\right]$$

At the output of the low-pass filter, this becomes,

$$e'_{o11} = \frac{E_s}{\pi} \sin\left[(\omega_{c1} - \omega_s) t - \phi_s\right]$$

The output of DBM_{III} can be written

$$e_{o111(mod)} = \frac{2E_s}{\pi^2} \cos\left[(\omega_{c1} - \omega_s) t - \phi_s\right] \cos \omega_{c2} t = \frac{E_s}{\pi^2} \cos\left(\omega_{c2} t - \left[(\omega_{c1} - \omega_s) t - \phi_s\right]\right) + \frac{E_s}{\pi^2} \cos\left(\omega_{c2} t + \left[(\omega_{c1} - \omega_s) t - \phi_s\right]\right)$$

The output of DBM_{IV} can be written

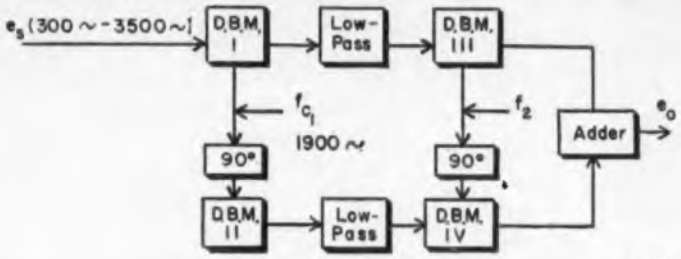
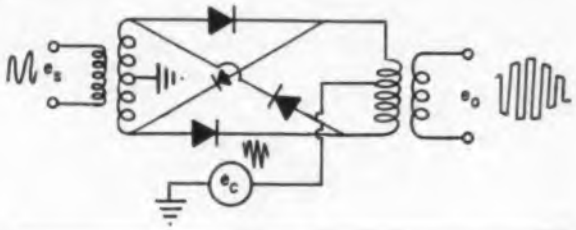


Fig. 7: A third SSB system uses two modulators.

Fig. 8: Building block could take this form for the SSB circuit arrangement shown in Fig. 7.



$$e_{oIV(\omega_{c1})} = \frac{2E_s}{\pi} \sin \left[(\omega_{c1} - \omega_s)\, t - \phi_s \right] \sin \omega_{c1}\, t$$

$$= \frac{E_s}{\pi^2} \cos \left(\omega_{c2}\, t - \left[(\omega_{c1} - \omega_s)\, t - \phi_s \right] \right)$$

$$- \frac{E_s}{\pi^2} \cos \left(\omega_{c2}\, t + \left[(\omega_{c1} - \omega_s)\, t - \phi_s \right] \right)$$

$$e_o = e_{oIII} + e_{oIV}$$

$$= \frac{2E_s}{\pi^2} \cos \left(\omega_{c2}\, t - \left[(\omega_{c1} - \omega_s)\, t - \phi_s \right] \right)$$

which is, of course, a single-sideband signal referred to a carrier frequency $\omega_{c2} - \omega_{c1}$. Note that the two quadrature channels contain, at the outputs of the 2 low-pass filters within a band 1900 cps wide, all the information that was in the original audio signal e_s (300-3500 cps).

In this system, the diode-bridge modulators should be connected so that there will be no original audio in the modulation products of the first 2 modulators. In this case the building block could take the form of Fig. 8. For this system

$$e_o = e_s\, S\,(t)$$

where

$$S\,(t) = \sum_{n=1}^{\infty} \frac{\sin \frac{n\pi}{2}}{\frac{n\pi}{2}} \cos n\, \omega_c\, t,$$

i.e., $S(t)$ has no dc component.

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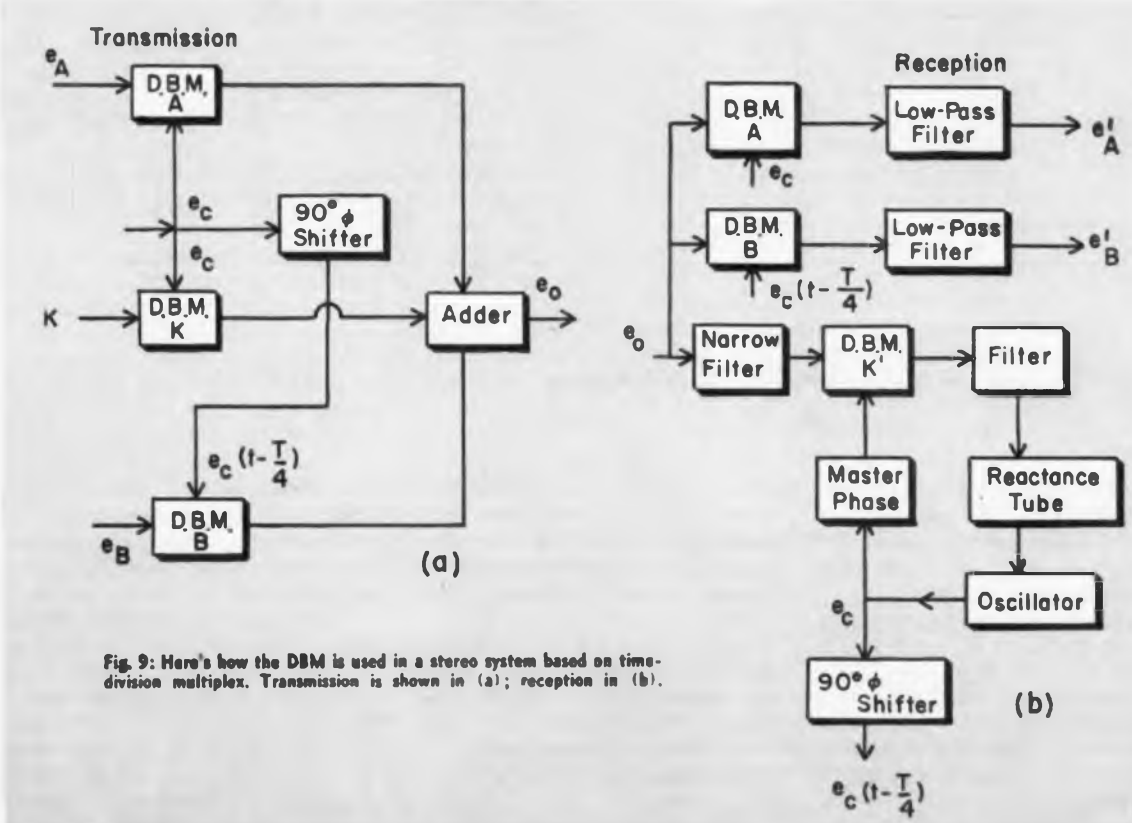


Fig. 9: Here's how the DBM is used in a stereo system based on time-division multiplex. Transmission is shown in (a); reception in (b).

Diode Modulators *(Concluded)*

Stereo Broadcasting and Reception

A stereo system based on time-division multiplex can be instrumented as in Fig. 9 where the A and B channels refer to the right hand signal and the left hand signal, respectively.

(Note that e_o could either frequency modulate or amplitude modulate another carrier, but this step is omitted here.)

$e_{oA} = e_A\, S(t)$ where $S(t)$ is a square wave of frequency f_c which is at least twice as great as the highest frequency contained in e_A or e_B.

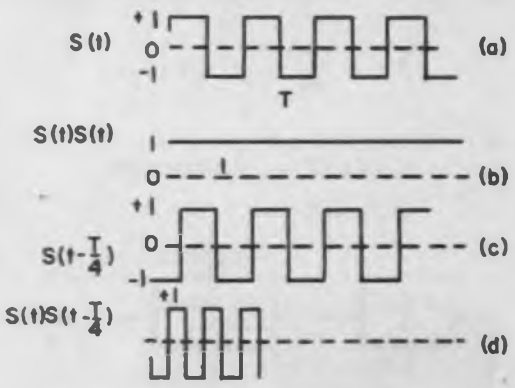
$$e_{oB} = e_B\, S\left(t - \frac{T}{4}\right)$$

$$e_{oK} = K\, S(t)$$

and

$$e_o = e_A\, S(t) + e_B\, S\left(t - \frac{T}{4}\right) + K\, S(t)$$

Fig. 10: This build-up of terms shows that the analysis of time-division multiplex is simpler than frequency division because it uses the easily variable relations.



$$e'_A = e'_{oA} = e_A\, S(t)\, S(t) + e_B\, S(t)\, S\left(t - \frac{T}{4}\right) = e_A(t)$$

since $S(t)\, S(t) = 1$

and $S(t)\, S\left(t - \frac{T}{4}\right) = 0 +$ Components of double f_c and higher. (Note that the components of double f_c and higher are eliminated by the low-pass filters.)

Since $e_A' = e_A$, the A signal has been recovered. In the same way, it follows that

$$e'_B = e'_{oB} = e_o\, S\left(t - \frac{T}{4}\right)$$

$$= \left[e_A\, S(t) + e_B\, S\left(t - \frac{T}{4}\right) + K\, S(t)\right] S\left(t - \frac{T}{4}\right)$$

$$e'_B = e_A\, S(t)\, S\left(t - \frac{T}{4}\right) + e_B\, S\left(t - \frac{T}{4}\right) S\left(t - \frac{T}{4}\right) + K\, S(t)\, S\left(t - \frac{T}{4}\right).$$

But $e_A\, S(t)\, S\left(t - \frac{T}{4}\right)$ and $K\, S(t)\, S\left(t - \frac{T}{4}\right) = 0$

and $S\left(t - \frac{T}{4}\right) S\left(t - \frac{T}{4}\right) = 1$

Therefore, the result is that $e_B' = e_B$ and we have recovered the B signal. In a sense, the analysis of time division multiplex is simpler than frequency-division since it makes use of the easily variable relations that

$$S(t)\, S(t) = S\left(t - \frac{T}{4}\right) S\left(t - \frac{T}{4}\right) = 1$$

and $S(t)\, S\left(t - \frac{T}{4}\right) = 0.$

This can be seen by building these terms as in Fig. 10.

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2. Coffman, Barton C., "Spectrum Analysis of Time Division Stereo," *Electronic Industries*, Sep. 1960 issue, pp 228-233.

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Air Traffic Control System

HAZELTINE CORP., under contract to the Federal Aviation Agency, is developing a system designed to expedite air traffic control and increase air safety.

Scheduled to be delivered to FAA in the fall, it is known as TV Marker Handoff Equipment. The equipment will be installed and evaluated at the FAA's test center near Atlantic City, N. J. Basically, it allows one radar controller to place an identifying marker over a particular radar target. Coordinates of this target are translated to controllers of adjacent sectors in a manner that identifies the same target, but on a different radar indicator, or on a different radar system.

Each handoff has two numerical characters associated with it which are written directly on the radar display. These tell the radar operators which adjacent sector or neighboring facility is initiating the handoff.

Generally, markers are applied to scan converted TV displays, but methods of transferring radar coordinates to more conventional dark-tube radar indicators are being studied.

According to a Hazeltine official, the system should have application at every high-density traffic hub, and will greatly facilitate radar handoffs between controllers and facilities. Work on the equipment is now under way at Hazeltine Technical Development Center, Inc., at Indianapolis, Ind.

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For Low Level Circuits . . . . .

Connector Design Considerations

Today, with low level transistorized circuits and unitized construction, many connector contacts are used. These contacts must give reliable performance without being overdesigned—or costly. The design considerations presented here should enable the engineer to cope with the problem successfully.

MODERN complex electronic equipment depends upon unitized construction, for easy assembly and maintenance. This has resulted in equipment operation depending on a quantity of contacts that would challenge the imagination of the uninitiated. This quantity, plus the growing use of low level transistorized circuits, has created contact reliability problems that did not exist a few years back. To cope with this situation, new design concepts have developed. This includes the increased use of precious metals, bifurcated contacts, methods of protection against dirt contamination and physical damage.

A basic knowledge of contact operation will enable engineers to make a better selection for a specific application, and will also serve as an invaluable aid when maximum reliability and wear must be designed into a connector for a specific application.

Principles of Contact Operation

A. Conduction—Electrical conduction between two surfaces depends on pure metallic contact between the two areas. This can be obtained by either of two or a combination of these methods:

1. As a result of metal deformation under contact pressure. This results in rupturing the tarnish film (or other contamination) resulting in metallic contact.

2. Coherer action which depends on a field potential buildup sufficiently high to allow the voltage to puncture the film. The resulting arc forms minute bridges of molten metal—thus, completing the contact. Regardless of the type, shape, or metal involved in a contact, the successful completion of the contact will depend on the establishing of bare metallic spots through either, or a combination of these two actions[1].

B. Contact Resistance—The resistance of a contact is actually the sum of two parameters involved, constriction resistance plus any film resistance that remains between the two surfaces. Constriction resistance is the term applied to the narrowing effect of the current flow through the contact because the flow is constricted to the small metallic spots which, in effect, are only a very small percentage of the surface that appears to be in contact. The total resistance can then be expressed $R_t = R_f + R_{c_1} + R_{c_2}$ where

R_t = Total Resistance
R_f = Film Resistance
R_{c_1} = Constriction Resistance of one contact half
R_{c_2} = Constriction Resistance of other contact half.

In many practical contact applications the film resistance will be negligible because of high contact pressure, good coherer action, or the choice of a metal having either a very thin film, or a film which may be

[1] Tunnel effects on monomoleculaur films could be a factor in some instances.

REFERENCE PAGES
The pages in this section are perforated for easy removal and retention as valuable reference material.
SOMETHING NEW HAS BEEN ADDED
An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed in standard three-hole notebooks or folders.

a good conductor. The contact resistance in this case is the total constriction resistance of the two surfaces involved.

C. Contact Surface—The contact surface (Fig. 1) must be broken into three areas to effectively analyze the problems involved. What appears to be the total surface (Sa) actually is the apparent surface. The actual load bearing surface (S_L) is, in practical applications, considerably less, regardless of the finishing efforts made in an attempt to gain a load bearing surface as near equal to ideal as possible. The actual conducting surface (Sc), in turn, is considerably less than S_L, whose total area is equal to pure metallic spots (Sc) plus the multi-molecular film areas which were not disturbed by either the bearing pressure or coherer action.

D. Contact Load—Contact load (P) is the total force applied to the contact. This is often, in error, referred to as the contact pressure.

E. Contact Pressure—Contact pressure (Pc) is a function of the contact load and the bearing surface or $P_c = \frac{P}{S_L}$. Where sufficient contact load is available, Pc is limited by the hardness of the material; the metal deforming under pressure until the increased bearing surface decreases the pressure to a value approaching the hardness of the contact material.

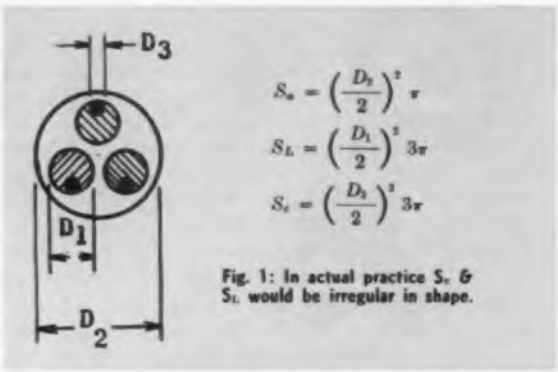


Fig. 1: In actual practice S_c & S_L would be irregular in shape.

F. Ideal Contact: In any design an ideal concept is useful so that the final design will be the best possible compromise of the parameters involved. In this case an ideal contact would have the following characteristics:

1. The two surfaces would be tarnish free, and remain that way.
2. The contact load would be sufficient so that the contact surface (Sc) would approach the apparent surface as a limit.
3. The metals used would have infinite conductance, so that the constriction resistance would be zero.
4. The coefficient of friction of the contact material would be zero so that the life would be infinite insofar as abrasion is concerned.
5. The contacts would have complete protection against organic and inorganic contamination.
6. Physical damage due to either mating or external forces would be impossible.
7. The mechanical aspects would have design safety factors to insure infinite life without deterioration.

Design Parameters

A well designed contact involves the consideration of all factors balancing the design so that the ideal is approached in each respect as much as the end use dictates. This, as in all designs, means emphasizing the features needed at the expense of another. This may be dictated by cost in some cases, or by the state of manufacturing art in others. In any event, the final result is of necessity a compromise which requires a basic knowledge of contact principles if an optimum design is to be reached.

A. Contact Shape—This is determined by a number of factors including manufacturing technique, end use, space, wear, operating force and available materials. This accumulation of variables makes it difficult to make specific recommendations in this respect. There are, however, basic considerations that should be followed regardless of the fundamental design.

1. The leading edges of the mating parts should be shaped so that a minimum of wear and gouging occurs during entry or mating.
2. The overall shape should result in maximum protection against contamination which can occur either during mating, or can collect at any time.
3. The contact wear surfaces of the mating parts should be proportioned so that optimum wear to the two parts results. This is often difficult to obtain because of the difference in area burnished between the mating parts. In order to compensate for this inequality and gain the required wear, it may be necessary to either use a harder type material or a plating thicker than that used in the mating part. Unfortunately, this does not result in equal burnishing to the two mating surfaces. In some applications, where several or more units may be used with a common mating part, inequal wear is desired; and the design problem will be to proportion the wear to favor the common part.

B. Bearing Pressure—To insure a positive contact, a high bearing pressure is required. This can be done by making the area as small as the electrical load will permit, and increasing the contact load to a value as high as the stress limitations of the material will allow. The advantages from a reliability standpoint by making the contact area as small as possible should not be minimized, and are a result of the following factors:

1. The resultant high pressure per unit area will be more effective in rupturing the tarnish so that it is not necessary to rely on coherer action to complete the contact.
2. The small area means less space for dirt, and other contamination to lodge on the contact.
3. The greater pressure increases the probability of the contact surface cutting through foreign insulating particles in the event of their lodging on the contact surface.
4. The possibility of obtaining a gas tight contact is increased, which is essential to prevent breathing with resultant tarnishing.

The factor limiting the bearing pressure will be the

accelerated wear, or possible gouging if carried too far. and the total contact load available, which in the case of a multiple pin may be insertion or withdrawal force limitations. Accelerated wear can be compensated, within limits, by increasing the plating depth. with the use of overlay material, or by the use of a harder alloy such as Selrex in place of pure gold. In many cases a greater load can be obtained with the use of some sort of mechanical advantage to operate the connector or device. Changing the contact shape to lower insertion force, without sacrificing bearing pressure, in many cases is possible. The friction coefficient of metal combination is another factor which should be considered.

Contact Damage

Damage to a connector can be caused by any one or a combination of the following ways:

1. During mating of the connectors
2. Improper use of test prods by maintenance personnel
3. In storage or in handling

The final design should consider all these factors, and all possible steps taken to minimize the possibility of damage occuring due to any of the three causes. The most frequent offender—connector mating, can be minimized by considering the following:

1. Use of properly placed guide pins to assure pin alignment.
2. Allow adequate contact float to assure alignment without binding during insertion.
3. Female contact design should have sufficient flare and taper to guide the male pin into position.
4. Shape and dimension of the female contact and the block receptacle should be such that the possibility of damage caused by the male pin becoming wedged between the contact receptacle and block is minimized.

An effective method of protecting against both damage in mating and test prod damage is use of a closed entry receptacle as shown in Fig. 2.

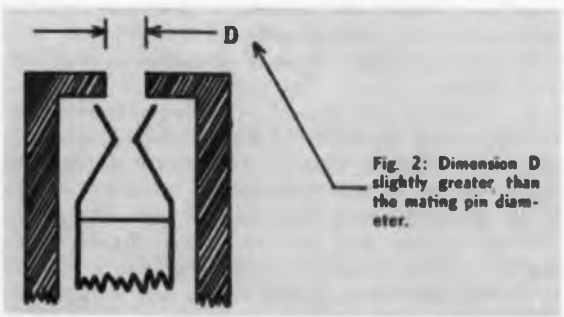


Fig. 2: Dimension D slightly greater than the mating pin diameter.

The third offender, handling and storage, pertains largely to the male part. This is because it is not only more apt to be handled. but usually has a pin protruding into space with no physical protection and with mechanical strength sufficient to withstand only a minor jar without bending.

There are several approaches that can be used. A protective shell having a heighth equal or slightly more than the male pin can be made an integral part of the male half. Over-design the pin from a mechanical standpoint. This means a pin with a low length of diameter ratio made of a material having a high tensile strength. An effective measure is to place an inexpensive protective cap over the pins during storage and handling.

Contact Plating

Since the basis of contact operation depends on metallic spots obtained through either mechanically or electrically rupturing a tarnish film (or other form of contamination), plating contributes a very significant part in contact design. An ideal contact surface would have the following characteristics:

1. Tarnish and corrosion free regardless of environmental conditions
2. High conductance so that the constriction resistance will be low
3. Relatively soft so that a high ratio of metallic spots to apparent area can be obtained. This softness may also contribute to reliability in that minute insulating particles which would normally separate a harder material will actually become imbedded, thus allowing metallic contact
4. Low coefficient of friction so that long life and low insertion and withdrawal force can be obtained
5. High degree of density so that the possibility of base metal diffusion is minimized

Studying these requirements reveal, at least to some extent, why gold has become popular where low level inactive contacts are required. Its inherent characteristics approach the ideal in virtually every requirement, and the hazards involved in its use basically are a result of the methods used to combat its initial high cost. These cost saving methods in many cases are certainly effective. However, it is well to keep in mind the problems that can result in specifying their use.

The use of a gold flash (less than 10^{-5} inches) over silver is usually substantiated by the statement that in case the gold is worn off, the silver is a good contact material and conduction will continue even though tarnish is present because the sulphides of silver are also a conductor. However, this statement is true only when sufficient voltage is present to break down the tarnish film on the silver, and where low level signals are involved, severe contact problems can result.

Specifying a hard gold alloy to gain increased wear with a thinner plate in many cases can be effective; but, it is well to keep in mind that the hardness gained can reduce the qualities of the gold as a contact material because of the following:

1. The metals usually alloyed decreases the conductance resulting in an increased contact resistance.
2. The harder material requires a greater contact load to cause the metal to plastically deform to the extent required for metallic contact.
3. A grave possibility of the alloy being more susceptible to tarnish and corrosion than 24K gold must be considered.

Use of a buffer plate using a dense material such as nickel, thus lowering the thickness requirements of

the gold plate, is a measure that has been used with various degrees of success. The hazards involved result from over-confidence in the effectiveness of the buffer plate, and as a result the specified thickness is insufficient to take care of the following variable experienced in production.

1. Variations in density experienced in the plating process
2. Problems involved in obtaining and measuring the plating thickness
3. Contamination that can occur in the plating process

There are innumerable metals and metal alloys available for contact surfaces, the characteristics of which are beyond the scope of this article. However, in considering the use of a specific metal, all available data should be obtained with emphasis on its tarnish and corrosion properties, conductance, and degree of hardness.

Methods of Evaluation

The true evaluation of any connector is its performance as used in the end product. Unfortunately, the design or choice of a connector must be made with lead time so that it can be incorporated in a particular piece of equipment. The final evaluation then depends on several years of actual field use to verify that the contact as used is furnishing the degree of reliability demanded by equipment. The ideal qualifying test would consist of many million observations using a circuit voltage and impedance equivalent to equipment conditions under identical environmental surroundings. In the case of relay contacts, this type of test does not present any serious obstacles and will provide valuable information as to the expected reliability. In the case of connectors, a functional life test is difficult if not impossible to duplicate. This is particularly true of low level inactive contacts where neither voltage nor burnishing is available to rupture the tarnish film and obtain a bare metallic contact. In this case a contact resistance test, when properly used and evaluated, can prove to be very valuable. This test becomes more useful when used on a comparison basis under adverse environmental conditions when a choice between two connectors must be made, or to determine the merits of a new design.

A. Contact Resistance Tests—To be informative the circuit voltage must be sufficiently low so that coherer action does not cause breakdown of the tarnish film giving indication of a good contact which is actually a function of the voltage rather than a function of the contact itself, i.e., high bearing pressure or tarnish free plating. Furthermore, the system must be capable of giving usable readings in the low milliohm range so that variations from normal can be detected. A shunt meter type circuit, Fig. 3, has the advantage in this respect in that the voltage across the contact even under open circuit conditions cannot exceed the full scale meter reading. For example, with a 20 mv full scale meter, and R_1 0.020 ohms, a half scale meter reading will equal 0.020 ohms, and at the low end 1 mv deflection will equal 1 mili-ohm. Substituting a micro-voltmeter in place of the milivoltmeter, makes possible checking contacts under very low level operating conditions.

The disadvantage of this method is that the contact under test must be connected as directly as possible across R_1 and a means of connection used so that their contact resistance is small compared to the contact under test. The fixed parameters can, of course, be calculated and subtracted from the reading so that the result is the true contact resistance.

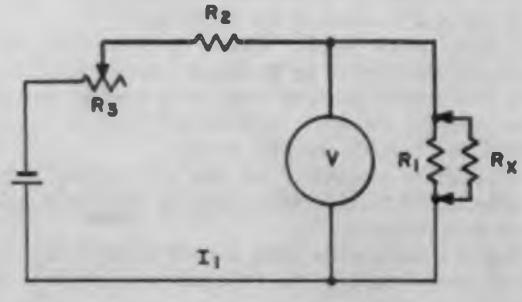
Medium level circuits (not over 10 volts) can be simulated with the volt-ammeter method providing a reasonable ratio of test to working voltage is maintained. It should be kept in mind that the greater the ratio mentioned the more rigid the test will be. This is true because the film breakdown due to coherer action does not necessarily result in a contact resistance of the same magnitude as that obtained with simple metallic action. The final resistance obtained after initial breakdown will depend on the current flow, and degree of tarnish, or corrosive film. A minimum of 5:1 is suggested, and if possible 10:1, or a 1 v. maximum test voltage for a connector used with 10 v. circuit.

B. Analyzing Results—An indication of the expected reliability will be given by the variations in contact resistance obtained. This can be better understood by analyzing the factors which make up contact resistance. Since the total resistance is the sum of the constriction and film resistance, any change which will affect these parameters will show up as variations in contact resistance. If the design and construction is such that sufficient bearing pressure is obtained to rupture the tarnish film, and obtain bare metallic spots, and to assure that these spots are maintained in spite of environmental conditions, manufacturing tolerances, variations in mating, and with aging, the contact resistance will be unchanged when measured under these conditions. An example is shown in Fig. 4.

In this case the results show that the bearing pressure is insufficient to consistently rupture the tarnish film presented by the nickel thus causing wide variations in contact resistance. Substituting gold not only lowers the resistance, but results in a large improvement in uniformity indicating a gain in

Fig. 3: Circuit for low level contact resistance tests.

R_x = Resistance of contact under test with R_1 high compared to R_1 (minimum ratio of 20 to 1 is suggested) adjust R_3 for full scale deflection with R_x out. Assuming I_1 is essentially the same when R_x is inserted then $R_x = \frac{V}{I - \frac{V}{R}}$



reliability is to be expected. This is confirmed by a functional test involving sufficient data to give a reliable answer. Fig. 5, shows a ratio of improvement approximately six to one by the use of a material requiring less bearing pressure to rupture the film. Continuing the study and plotting the gold silver on a larger scale shows a variation from 1.4 to 2.3 milliohms. An ideal design would result in sufficient bearing pressure so that these variations would be completely eliminated and would remain so under operating environmental conditions throughout the life of the equipment. Assuming that this were possible, 100% reliability would result.

Summary

The objective of reliable contact design should be to insure that the contact surface is initially metallic, and that it remains so throughout the required life of the contact. In attaining this goal the obstacles which must be overcome through good design procedure are:

1. Tarnish and corrosion which must be eliminated.
2. Foreign contamination.
3. Loss of contact pressure.
4. Deterioration of contact surface.

The objective of contact evaluation is to insure that the design goal has been reached. An effective method of accomplishing this should include the following:

1. Use a sufficient number of observations, on a sufficient quantity of samples so that the results can be statistically analyzed.
2. The circuit voltage must be low enough so that variations in film and constriction resistance is not obscured by completing of the contact through coherer action.
3. Subject the samples to accelerated environmental tests to insure harmful deterioration will not cause premature failure.
4. Use sensitive and sufficiently accurate equipment so that variations can be detected.

Acknowledgments

To J. P. Murphy, supervising engineer, Remington Rand Univac, Division of Sperry Rand Corporation, for the mechanical design of the automated contact testing equipment.

D. W. Weidendach, department manager, Remington Rand Univac, Division of Sperry Rand Corporation, for his many helpful suggestions.

Dr. Ralph Andes, supervisor of Materials and Process Laboratory, Remington Rand Univac, Division of Sperry Rand Corporation, for the excellent work done by his group.

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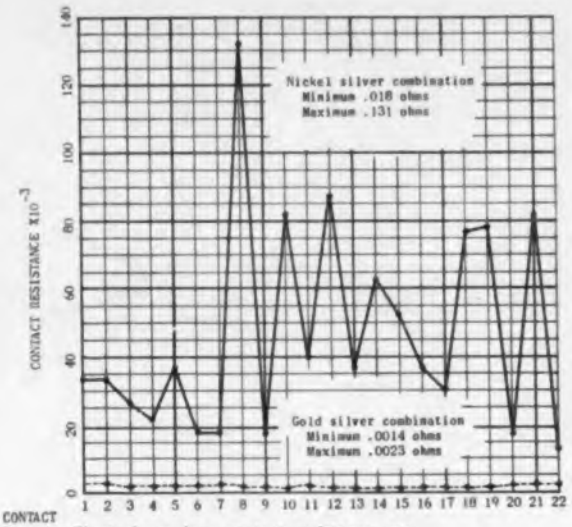
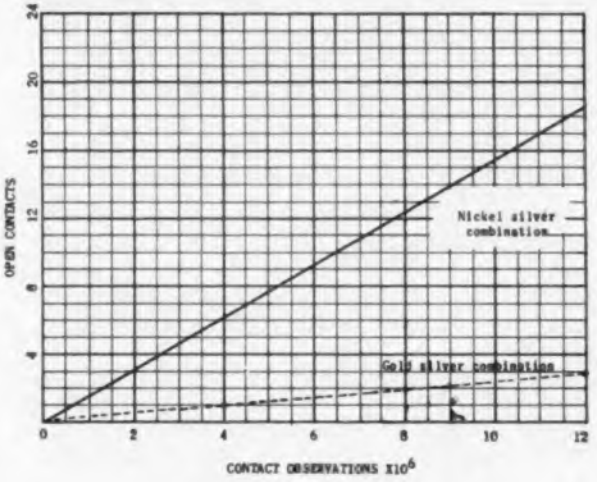


Fig. 4: Chart shows how contact resistance can be lowered and variations reduced by substitution of gold in place of nickel on one contact part.

Fig. 5: Chart shows performance improvement obtained by substituting gold for nickel in contact combinations.



"Some Practical Considerations in the Design and Testing of Semi-Permanent Metallic Contacts for Use at Low Voltages," by Alan Fairweather and E. J. Frost (Post Office Research Station, Dollis Hill, London N.W.2., England).

Paper presented to the Third Electronic Industries Association Conference on Reliable Electrical Connections held in Dallas, Texas, December 2nd, 3rd, and 4th, 1958.

New Plastic Cover

A REINFORCED plastic cover has been selected by the Monroe Calculating Machine Co. for its new Monrobot Mark XI general purpose computer. The selection has eliminated many assembling difficulties usually found in metal castings.

Developed and molded by Firmaline Products of Crompton & Knowles, Midland Park, N. J., the material is made from a special formula consisting of polyester resin reinforced with fibre glass. It has high impact resistant characteristics. It is resilient and can be made so that anything dropped on it could actually bounce off. Because of low initial costs and other production efficiencies, the covers cost 50% less than aluminum covers. Also, they are 50% lighter in weight than aluminum covers.

Reinforced plastic cover is shown on the Monrobot Mark XI general purpose computer.

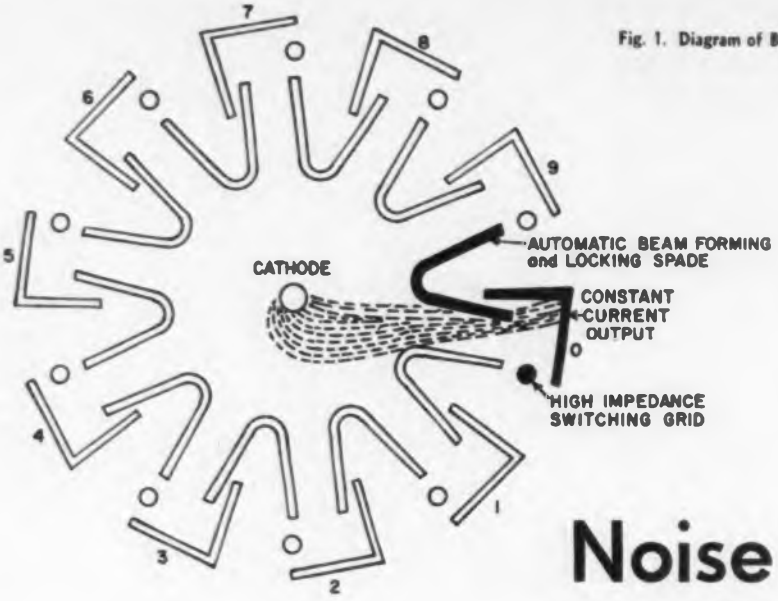


Fig. 1. Diagram of Beam Switching Tube.

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Noise Properties

THE Beam Switching Tube (BST) is a cross-field device recently developed by Burroughs for use as a computer element and has been described previously in the literature.[1, 2] Internally the tube consists of the following elements:

(a) filament
(b) cathode
(c) spades
(d) targets
(e) grids

The element configuration, for example, of a JAN type 6700 BST is shown in Fig. 1 with accompanying outline dimensions in Fig. 2. The cross B field is obtained by employing an external permanent magnet in the form of a thin-walled cylinder which fits snugly over the envelope of the tube.

The "spade" elements form and hold the beam to a particular target. The beam may be shifted to other targets by properly changing the grid voltage. For computer operation, the odd, and even numbered grids are connected respectively to appropriate RC time constants to permit a stable rotation of the beam from one target to the next. In this manner, information stored on the individual targets may be read off, or recycled periodically. The operation of this device may therefore be likened to that of an electronic distributor.

The broadband noisy properties of the BST were first discovered experimentally and are somewhat of a disadvantage for computer operation since higher signal levels are necessary to maintain a required S/N ratio. There are, however, applications (e.g., Electronic Countermeasures) where the broadband noise properties of these tubes are very useful. The noisy properties of cross-field devices, such as Magnetrons operating just below the critical value of anode voltage for oscillation, have been known for years but are still not clearly understood.[3] It is the purpose of this paper to report on the experimental findings of the noise properties of the JAN 6700 (as well as the Burroughs Type BD-319, AF-12 and BD-321 Beam Switching Tubes, which were specifically designed for higher noise power output) and to suggest how this device may be used as a gateable source.

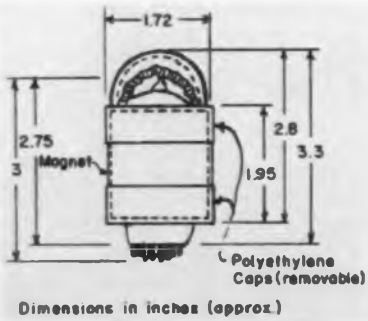


Fig. 2. Dimensions of BST, BD-319.

Experimental Investigation

Of the four types of Beam Switching Tubes indicated above, only the BD-319 and BD-321 were tested in the Sperry Laboratories. The data for the JAN 6700 and AF-12 were supplied by Burroughs.

The first tests were performed using the BD-319 BST. The element configuration for this tube is identical to that of the JAN 6700 shown in Fig. 1. For connection as a noise source the BD-319 was operated in an unconditionally stable mode with two beams permanently formed to targets T_0 and T_3 which geometrically are 180° apart; these electrodes are electrically connected in parallel. Experimentally it was found that by forming two beams a somewhat higher noise power output was realized. It was also found that no more than two beams can be formed at the same time. The BD-319 element connections for noise source operation is indicated in Table 1.

The tube was mounted in a fixture that was carefully constructed to minimize the effects of shunt capacity and lead inductance while B+, B−, and filament leads were choked and bypassed to reduce the effects of RF common coupling.

In computer operations the noise properties of beam switching tubes are somewhat of a disadvantage. In electronic countermeasures, however, these same properties can be put to good use. This article describes how certain tubes, specifically designed for a higher broadband noise output, are employed as a gateable source, saving weight, power and space in ECM systems.

# of Beam Switching Tubes

The substitution method of measurement was used to determine the output noise power density spectrum for both the BD-319 and the BD-321 BST's. The BD-319 was first tested from 30 to 300 MC using a calibrated Rhode & Schwartz receiver, and later the measurements were extended to 500 MC with the aid of an APR-4 receiver. The laboratory setup for testing the BD-319 is shown in Fig. 3. RF broadband noise from the BD-319 is coaxially coupled out of the target circuit and into two step attenuators, a Rhode & Schwartz receiver, and finally to a bolometer and power bridge. By varying the amount of attenuation in the circuit, the noise output may be varied until a convenient reading is obtained on the power meter. The noise source is then removed and replaced by a calibrated VHF signal generator.

The CW output of the generator is adjusted until the same reading is again obtained on the power meter. The two readings are then adjusted equal. The noise power density of the signal is then determined by dividing the reading obtained on the power meter by the effective noise bandwidth of the receiver.[4] The quantity thus obtained must then be increased to take account of the insertion loss of the step attenuators.

Power density tests were conducted with:

(a) the filament voltage as a variable parameter (6 to 9 volts AC), −120 volts on the operative spades, +300 volts on the operative targets and grids, and +280 volts on the non-operating spades and targets.

(b) the operative spade voltages as a variable parameter (−120 to 0), 6.3 volts on the filament, other values the same as in (a).

(c) the non-operating spades and targets adjusted from +280 to 0 volts.

The results of experiment (a) showed that varying the filament voltage from 6 to 9 v. had no significant

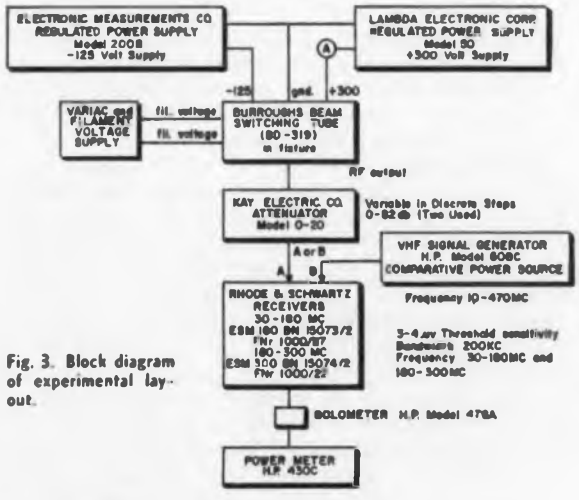
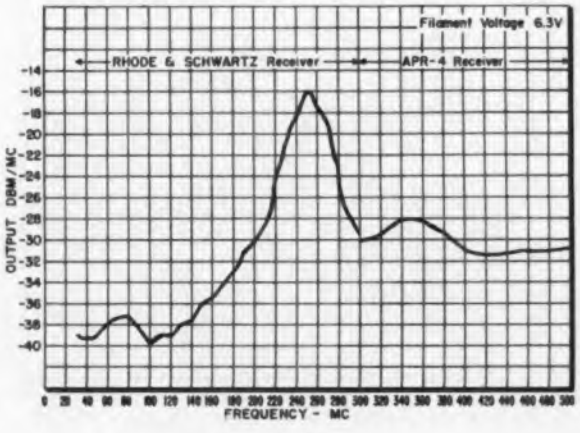


Fig. 3. Block diagram of experimental layout.

Fig. 4. Noise power density for fixed filament voltage.



Beam Switching Tubes *(Continued)*

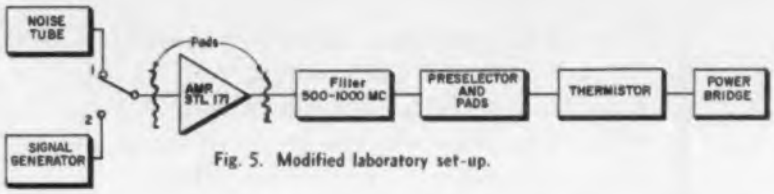


Fig. 5. Modified laboratory set-up.

effect on the noise power output. The noise power density for the conditions stated in (a) and for a fixed filament voltage (E_f = 6.3 v.) is shown in Fig. 4.

Variations in the potential of the operating spades (experiment b) resulted in erratic changes in the noise power output as a function of frequency, and the data could not be correlated with other BD-319 samples.

The last test (experiment c) measured the cut-off characteristics of the noise source. There are no internal provisions in the BST (e.g., a control grid) for gating the device on or off. The substitution experiments indicated that the non-operating spade and target voltages had to be reduced to almost zero volts before the noise output was reduced by 50 db.

In similar fashion, the BD-321 BST was investigated to determine the power density over the frequency range of 500-1000 MC. Although the substitution method was once again used, the laboratory setup was modified as shown in Fig. 5. A Sperry-type STL-171 traveling-wave tube is used to provide sufficient gain to overcome the losses in the various pads, bandpass filter, and tunable preselector.

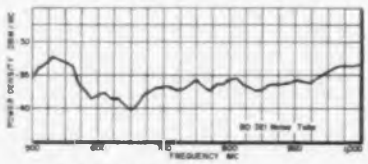
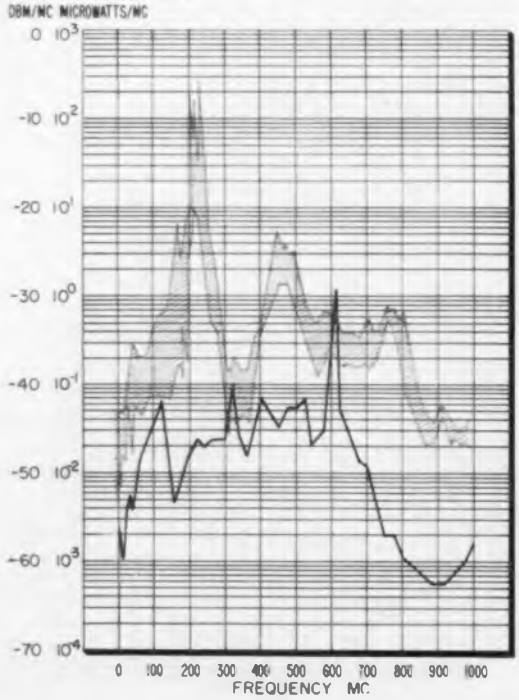


Fig. 6. Curve of power density vs. frequency for BD-321.

Fig. 7. Sample of plots for JAN 6700 and AF-12 BST.



One precaution that must be taken is to ensure that the total power output of the TWT amplifier corresponds to a level within its linear region of operation. If the tube begins to saturate by virtue of its broadband input, its gain for a noise signal will be less than that for the single frequency supplied by the calibrated generator and the readings will be in error.

The voltages on the tube elements were selected for optimum noise output in the 500-1000 MC range and are as follows:

Filament Voltage	6.3 vac
Spade Voltage-operating	−150 v.
Target Voltage-operating	+125 v.
Non-operating Targets and Spades	+250 v.

The curve of power density vs. frequency for the BD-321 is shown in Fig. 6. Similar plots for the JAN 6700 and a sample of six AF-12 Beam Switching Tubes are shown in Fig. 7.

Gating the Beam Switching Tube

It was indicated earlier that the BST does not have a control grid and hence gating must be accomplished by one of two methods. Either the cathode circuit must be opened, interrupting the total beam current (for example, 55 MA for the BD-319), or the non-operating target and spade voltages must be reduced approximately zero volts, requiring a swing of essentially 300 volts. Neither choice is particularly appealing, especially if the switching function must be accomplished within microseconds.

A circuit designed to accomplish this switching function employs one transistor and two subminiature tubes and is shown in Fig. 8. An accompanying list of components is given in Table 2. The operation may be described as follows:

Consider switch S1 to be in position X ready to accept a pulse from a video source. Transistor TR1 is used for amplification and for establishing the proper DC levels. Tube V2 is normally off, while V1 is full on. A current of 6 MA passes through V1 to load resistor R5 and each of the non-operating targets and spades; the non-operating elements draw approximately 4 MA. V1 is full on or zero biased since V2 is off and no current is flowing through R4.

When a 1.25-volt video pulse is applied from a pulse generator at Z, V2 is driven to zero bias and current begins to flow through R4. This current rapidly turns V1 off and at the same time starts discharging the circuit and non-operating target and spade capacities C_d (estimated to be 100 uuf). The current continues to flow from ground through C_d, R4, and V_2 until the voltage across C_d actually changes sign and asymptotically approaches −100 volts. The circuit time constant is given approximately by C_d multiplied by the parallel combination of R4 and R5 (note: r_{p2} is negligible compared with the parallel combination of R4 and R5). Diodes CR1 and CR2, however, prevent the

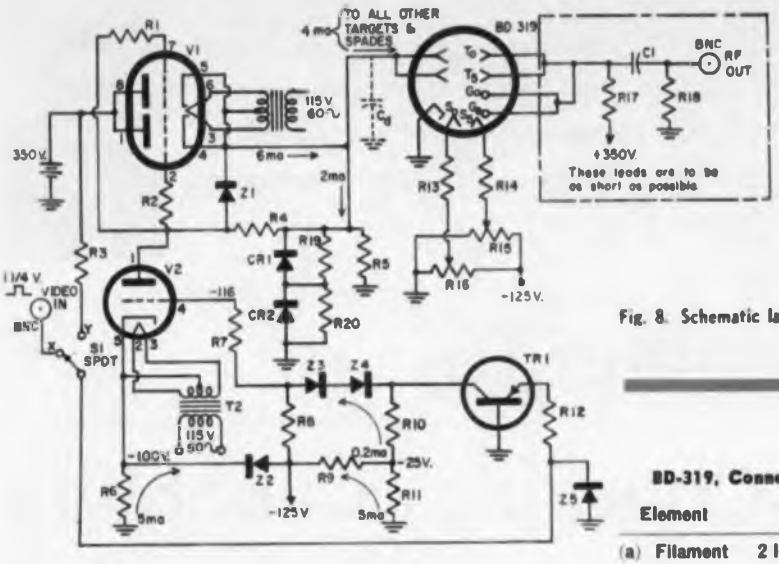


Fig. 8. Schematic layout of BST gating circuit.

voltage across C_d from falling below ground by more than their own forward voltage drop (i.e., 1 volt). At the end of the pulse the cycle reverses with V1 once again turning full-on.

Zener diode Z1 is used to protect V1 at the time of switching from exceeding the permitted safe negative grid to cathode voltage. R1, R2, and R7 are grid stoppers which protect V1 and V2. The IR drop across R4 is chosen to be sufficient to cut V1 off, when a video pulse is applied. The circuit may operate under 0-1 duty cycle conditions while achieving rise and fall times of approximately 10 micro-seconds or less.

Conclusion

The Beam Switching Tube has been shown experimentally to be an excellent random noise source from essentially DC to 1000 MC. Some recent laboratory tests have shown that the tube produces noise at frequencies as high as 3000 MC. Techniques for coupling the noise signal from the tube to a coaxial line, or waveguide structure are currently under investigation.

The author wishes to thank the following members of the Sperry engineering staff for their assistance in the preparation of this paper: Messrs. Charles Brockner and Robert Gould who were responsible for the initiation and planning of the noise tube studies, Mr. Robert Service who conducted the original laboratory tests, and Mr. Lewis Graber who was responsible for noise source testing above 500 MC. Also gratefully acknowledged is the assistance of the Burroughs Corporation engineering staff for providing characteristic curves of the JAN-6700 and the AF-12 Beam Switching Tubes.

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Table 1

BD-319, Connection of Elements for Noise Operation

Element	Connections	Remarks
(a) Filament	2 leads	6–9 volts AC at 0.3 amps
(b) Cathode	common to all elements and grounded	
(c) Spades	S_o, S_9	Connected to a variable negative source, 0 to −100 volts at <1 ma
(d) Targets	S_1, S_2, S_3, S_4 S_5, S_7, S_8, S_9 T_1, T_2, T_3, T_4 T_5, T_7, T_8, T_9	Spades and Targets connected together to +280 volts at <4 ma
(e) Grids	T_6, T_8 G_{even} G_{odd} connected to all even and odd grids	Output Targets and Grids are connected through load impedance to +300 volts at 50 ma: RF output taken from across this impedance.
(f) Magnet	none	Permanent magnet

Table 2

Parts List for Beam Switching Tube Circuitry

Designation	Description	Designation	Description
V1	6111	R1	120 Ω ½ w
V2	5744 WA	R2	120 Ω ½ w
		R3	56 K Ω 2 w
C1	1000 μμf	R4	82 K Ω ½ w
		R5	150 K Ω 1 w
TR1	2N1025	R6	20 K Ω 1 w
		R7	10 K Ω ½ w
CR1	1N629	R8	43 K Ω ½ w
CR2	1N629	R9	20 K Ω 1 w
		R10	1 K Ω ½ w
T1	Filament Transformer Pri. 117v @ 50/60 CPS Sec. 6.3 v CT @ 1a	R11	5.1 K Ω ½ w
		R12	33 Ω ½ w
		R13	1 meg Ω ½ w
		R14	1 meg Ω ½ w
		R15	variable 250 K Ω
T2	Same as T1	R16	variable 250 K Ω
		R17	5 K 15 w
Z1	Z 68	R18	51 Ω ½ w
Z2	Zv 824	R19	10 meg Ω 1 w
Z3	Z 68	R20	10 meg Ω 1 w
Z4	Sv 824	BD319	Beam Switching Tube
Z5	Sv 6	SPDT	Switch

A computer can be programmed to detect its own malfunctions automatically. The development of such a program, used in the Atlas Guidance Computer, is presented.

Missile Computer Has "Self-Checking" Capability

THE Atlas ground guidance computer provides computation for the Atlas guidance system. It is operated and maintained by Air Force personnel.

In designing a large digital computer—such as the Atlas computer—for operation by military field personnel many unique problems are encountered. These problems are becoming more common as the military demands more and more complicated equipment.

We are going to review here the various design considerations that went into the Atlas computer, emphasizing the maintainability aspect that makes it possible for the computer to be operated by minimum-skill personnel.

If personnel of limited training are to maintain equipment as complex as a large digital computer, they should be required to exercise little control and not be required to make decisions. They should be given only limited access to the equipment, performing the repairs on a "replace-maintenance" basis.

Maintenance Philosophy

In preparing the maintenance philosophy, and designing the maintenance procedures and "tools," several objectives and criteria were used.

Fig. 1: The operational console has a minimum of operator controls.

No Major Redesign of Computer Logic—The R&D version of this computer had proven satisfactory and there was no desire to have to debug a new design.

No Major Repackaging—The manufacturing facilities were already tooled to manufacture the R&D model. A change in packaging would increase depot maintenance costs, and require much engineering expense.

Minimum Equipment Degradation—If the testing and maintenance procedures were to degrade the equipment, reliability would be affected and make improved maintenance pointless.

Usable by Unskilled Personnel—All decisions must be automatic, either being made by the computer itself or coming from a simple procedure. The tests must proceed at high speed, be complete, and be finished in a short time. All controls and displays must be centrally located for operation by one man. There must be no use of meters or oscilloscopes which require skill to operate.

Quick Changeover Required—In its operational use, the system must be able to respond to activation on very short notice. The computer must be ready-to-go in time equal to or less than the rest of the system. Thus, a quick changeover from confidence testing to an operational condition is required. Also, it is imperative that any repairs take very little time.

Maintain a High Confidence Level—Success of the weapon system depends on all components having a high confidence level. Once a repair is made, this confidence must be reestablished.

No Access to the "Guts" of the Computer—Experience has shown that probing in the interior of equipment, even by experts, will adversely affect the failure rate.

The Diagnostic Process

The diagnostic process allows an operator, with no special skills, to have the computer diagnose its own troubles. The process exercises various functions and

Fig. 2: The R and D console shown here, was much larger than the operational version.

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checks for their proper operation. If the operation of an exercise is not proper, an error routine is entered. Additional exercises are introduced, allowing decisions to be made about the source of the malfunction. When the location of the error is ascertained, the computer stops, an indicator labelled "diagnostic error" lights, and a number is displayed on the console panel. This number appears as a pattern of lights in the computer test register indicators.

Located on the console panel is a roll chart, similar to those found on tube testers. This roll chart is turned until the number displayed on the left side of the roll chart is identical to the number displayed in the computer test register lights. A list of computer packages appear to the right of this number on the roll chart. The first package on this list is replaced, and that section of the process in which the malfunction was discovered is repeated. In 61.4% of the cases, this replacement cures the trouble. If the process indicates the same failure again, the second package listed is replaced. If the list of packages is exhausted and the error persists, (which happens about once every two years), a mobile maintenance team is called. While waiting for them, the operator replaces all packages according to a predetermined pattern, testing after each replacement. The operator can put the computer back "on the air," unless the trouble is in the backboard wiring.

Maintenance Console—The console needed by the operator, Fig. 1, is greatly reduced from the R&D version, Fig. 2. The barest minimum of controls and indicators permit very little confusion. This minimum is all that is necessary for operator maintenance and operation of the computer.

Diagnostic Process Organization

Simple and basic functions are tested first in the diagnostic process. If there are no failures in these, they may be used in checking the more complicated and the more peripheral ones. Thus, diagnosis is achieved partly by process of elimination and partly by direct observation.

If an error stop occurs somewhere in the middle of the process, it is caused by an error being detected in a specific exercise. Next to this error stop number the roll chart lists the packages which can cause that particular error. This list would be long if possible packages were listed for each error stop. Therefore, the list is compiled by eliminating all functions previously checked. If one of these functions had been incorrectly performed, it would have been caught earlier in the process. Thus, the various sections of the process are written based on the assumption that a sequential type of testing is to be performed. The process is organized in five major sections. They are the preprogram manual procedures, automatic diagnostic program, postprogram manual procedures, diagnostic interconnection test, and guidance simulation.

In general, there are two types of functions which the computer cannot check without operator participation. The first are those which are so basic that without them the computer cannot operate. The second are those for which the computer has no access to the output. The preprogram manual procedures check all of the first and the more basic elements of the second. An example would be the console panel (indicators and controls). This falls into both classes, since it is very basic and since the outputs of indicators are not accessible to the computer.

When the operator has completed the preprogram manual procedures, enough functions have been verified to allow the computer to automatically check itself. The automatic diagnostic program will test for

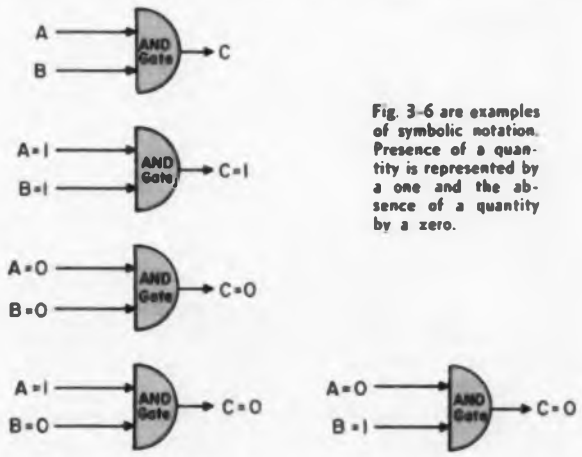


Fig. 3-6 are examples of symbolic notation. Presence of a quantity is represented by a one and the absence of a quantity by a zero.

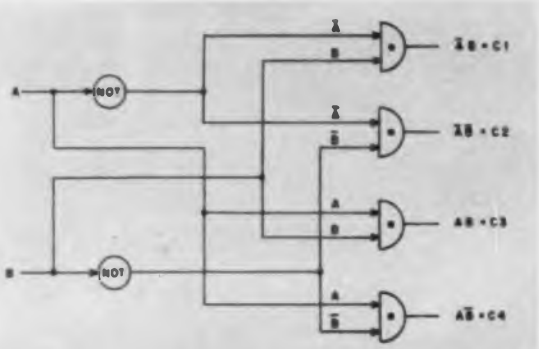


Fig. 7: Four gates are now checked by the same number of combinations which checked one gate in the original example.

Self-Checking Computer

(Continued)

and diagnose malfunctions in any of the remaining basic computer functions. Among the elements tested here are the arithmetic, program, memory, and control units. Also tested are peripheral functions such as the input unit, output unit, real-time synchronization, and the countdown controls.

Several of the peripheral functions are in the class of functions whose outputs are inaccessible to the computer. These are checked in the postprogram manual procedures.

All of the preceding tests are performed on the computer as an independent sub-system. A diagnostic interconnection test was devised to test the connections between the computer and the radio tracking system (radar). It is also an aid to radar maintenance.

As a final step in the diagnostic process, confidence in the computer is established by a successful countdown and guidance simulation. In addition to being performed as a part of the process, the simulation is performed on a routine basis. This is done to check computer adequacy and to assure future performance.

Basic Philosophy

Diagnostic Exercise of Logic—For the purposes of illustration note the Boolean relationship $A \cdot B = C$. This is represented by the "and" gate in Fig. 3. Both the Boolean and the symbolic notations are used to represent a logical combination of A and B to create C if, and only if, both A and B are present. The presence of a quantity will be represented by the statement that the quantity equals one, and the absence by stating that the quantity equals zero. Then either the Boolean expression ($A \cdot B = C$) or the symbolic notation (Fig. 3) may be read as "If $A = 1$ and $B = 1$, then $C = 1$; otherwise $C = 0$."

When testing this "And" Gate, we must first examine C when A and B are both present, as in Fig. 4 to determine that C is present. The next step is to provide for the absence of both A and B and check for the absence of C as in Fig. 5.

To complete the test, A and B are supplied independently and the absence of C is verified, as in Fig. 6. It should be noted that four input combinations were required to test this piece of logic which has two inputs. It has been shown that 2^n combinations of inputs are required to test any piece of purely combination logic having n inputs. When storage elements (e.g. Flip-Flops, delays, etc.) are present, the number of combinations of inputs required is $2^n \times 2^m$ where m is the number of storage elements.

In a complete computer, logical functions occur in large groups. They are packaged so that the inputs to each are not directly accessible to and controllable by the programmer.

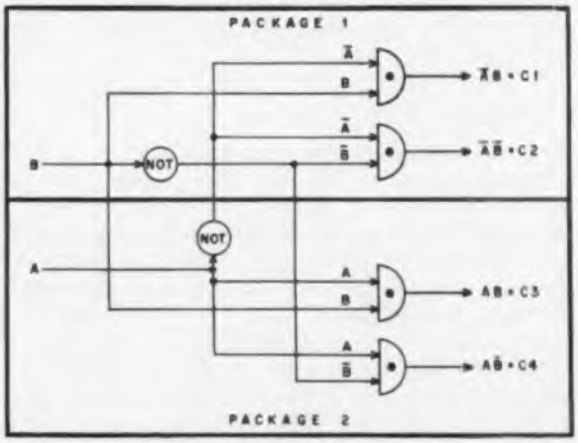
To test the logic by the method illustrated earlier, a complicated set of instructions must be devised to control the A and B of our example and to test the output C. It becomes much more economical of time and effort to test more than one of these elements at once. In the decoder in Fig. 7, the same number of combinations of inputs which checked one gate in the original example will now check four gates.

For efficiency, a group of similar functions is usually checked at the same time. When the distribution of functions among the packages is done on the proper basis, and a remove and replace maintenance philosophy is planned, further efficiency is possible.

If the decoder in Fig. 7 were contained entirely within one package, it would not be necessary to determine which gate was malfunctioning. The test would merely need to determine if any gate was malfunctioning. In this case, a malfunction detected is also a malfunction diagnosed. Package replacement may proceed immediately. However, if the decoder is split between two packages as in Fig. 8, we must test to see which package is malfunctioning. In many cases the gates themselves are (from the point of view of diagnosis) split between packages. One example in the Atlas computer exists where a gate exists simultaneously in eight different packages. In the diagnosis of a malfunction in this gate, the package replacement list must contain eight packages.

The approach to diagnosis considered in the preceding discussion is basically the one used in designing the process for the Atlas computer.

Fig. 8. If the decoder is split between two packages, tests must be performed to see which package is malfunctioning.



Electronic switching is bringing the telephone industry into a new era. Schematics, loaded with recurring component symbols, would be confusing. Here is a basic circuit building block system which aids the designer, packaging engineer, and maintenance personnel by including logic, packaging, and normal state information as well as test points, connectors and waveforms.

Switching Drawings Show Logic

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BOTH electromechanical and electronic switching have developed their own formats for presenting functional circuit information. Neither provides the clarity necessary for proper maintenance of the new telephone switching circuitry.

Therefore, a new approach must be taken in schematic drawings for electronic switching. The objective: facility of design, packaging, reliability and maintainability evaluation and, most important, maintenance.

Fundamental Approach

To design, develop, manufacture, test, install, and maintain a system, the following information is needed:

1. How the system works.
2. How the system is put together.
3. How the system is to be maintained.

These often require many separate diagrams. The object: present as much information as we can on as few drawings—with least complexity.

Electronic switching system circuitry usually appears more complex than electro-mechanical. The many symbols for components make a diagram seem more obscure than one mainly showing switch contacts. To clarify electronic switching system diagrams, we must use a building block approach.

By giving designers a set of building blocks with interconnection rules, and by insisting that the number of blocks be kept to an absolute minimum, circuit uniformity is obtained, even though many persons may help in its design. By the same token, building block clarity aids the designer in seeing the maintenance man's problem.

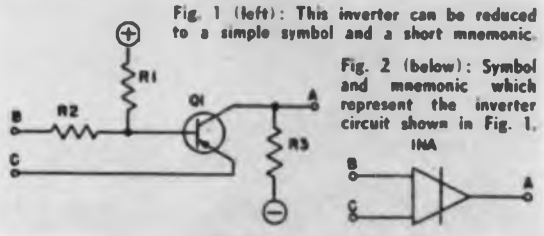


Fig. 1 (left): This inverter can be reduced to a simple symbol and a short mnemonic.

Fig. 2 (below): Symbol and mnemonic which represent the inverter circuit shown in Fig. 1.

Attention can then be directed to providing maintenance aids, e.g., test points, alarm indicators, routing facilities. Once the building blocks are mastered, understanding the overall circuit operation is reduced to a functional analysis.

The maintenance man is concerned primarily with the physical relationship of the blocks in the actual equipment. The presentation of information should provide a clear picture of packaging breakdown and the interconnection of the packages, as well as the circuit logic. This is achieved by the basic circuit approach.

Basic Circuits

The building block approach is based on using a series of basic circuits, e.g., gates, amplifiers, flip-flops, etc. Each basic circuit is carefully designed, tested and analyzed. Performance characteristics and limits of each circuit are precisely stated. This assures that any system composed of these circuits will perform in the specified environment and fulfill the operational requirements with very little need for intermediate breadboarding.

To simplify drawings of the circuits, a symbol and a mnemonic are used. The inverter, Fig. 1, is designated as shown in Fig. 2. To further clarify the circuit functions, the symbol bears very close resemblance to conventional logic symbols. This simplifies circuit logic analysis.

The basic circuit symbols represent distinct combinations of parts that are used together. The circuitry indicates the logical relationship. The packaging engineer can make extremely good use of this fact to break down a system into its modules or packages.[1]

The basic circuits are packaged in groups to retain

their logical inter-relationship. They adhere to a predetermined maintenance concept.

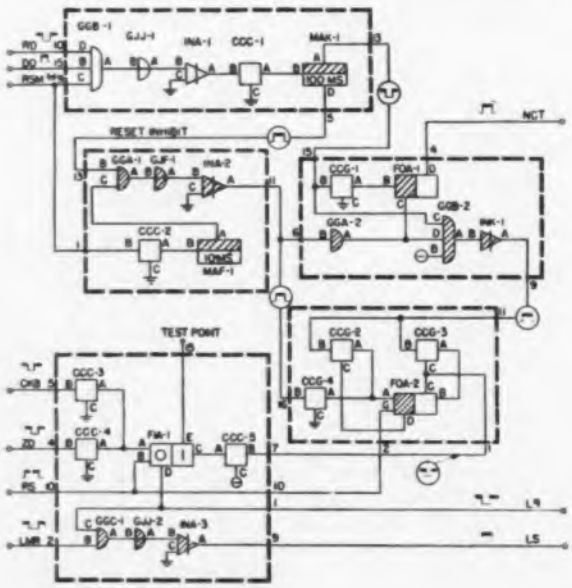
Underlying all phases of design, packaging, and maintenance is the question of system reliability. Each basic circuit is evaluated in terms of its "mean time between failure" (MTBF) at different levels of stress.[2,3] This figure of merit for each circuit is invaluable in determining the system's susceptibility to failure. Thus, it acts as a guide during design. The final design objective is to produce a system with maximum reliability and, therefore, minimum maintenance. The work of the designer and the packaging engineer is reviewed by the reliability and maintainability engineer, who, studies the circuits to assure a satisfactory system effectiveness.

The assessment of the individual component parts makes such reliability measurement more complicated than an assessment of basic circuit reliability. Integration of the basic circuits into operational reliability of sub-systems can be performed efficiently with the aid of the logic schematic.

Logic Schematic (LS) Diagram

A schematic combining the features of a logic diagram, a packaging diagram, and the necessary maintenance information, is shown in Fig. 3. The LS diagram resembles a conventional logic diagram where each logic symbol represents a basic circuit.[4] The basic circuits that are co-related on the same physical package are surrounded by heavy dashed lines. The diagram shows the inputs on the left and the outputs on the right. Connector points for the overall assembly of the group of basic circuits are shown on the left (input) and on the right (output) of the diagram. The connector points of the packages mounting basic circuits are shown inside the relevant boundaries.

Fig. 3: This schematic combines the features of a logic diagram, a packaging diagram, and the necessary maintenance information.



To assist the maintenance man, package connector and test point information for the circuit is shown on the diagram. In addition, associated with each "input-output lead" is a typical waveform picture. The normal state of each basic circuit is indicated by the cross hatching shown within each logical symbol. The cross hatching indicates that the output terminal of the basic circuit is at zero potential.

With the information shown on the LS diagram a maintenance man has the essential information for maintaining a system.

The maintenance man is not the only individual to benefit from the LS diagram. It is definitely an aid in facilitating design and evaluation during development. In fact, the LS diagram is geared to the easy application of reliability-maintainability evaluation and review.[1] By using the basic circuit information with the LS diagram, reliability evaluation can be reduced to a simple computer problem and a constant check of the system reliability maintained. Recognizing that there is an optimum packaging approach which takes into account the individual reliability of the basic circuits, a similar procedure can be set up to evaluate the grouping of circuits in their final package. Such a grouping must be consistent with minimum combinations from a logistic point of view and must consider the logical grouping for maintenance.

Training

Maintenance personnel can be taught the system logic directly from the LS diagram. It presents in a direct manner the exact logic of the circuits. It serves as an instruction aid for training the maintenance man. No special training drawings are necessary since the trainee learns directly from the final circuits he will use in practice. By incorporating many important pieces of information on one diagram, the bulk of information which the trainee must master is minimized and confined to a compact, familiar format.

A replacement type of maintenance is anticipated for electronic switching systems. However, assuming that packages will not be of a throw-away type, other types of maintenance personnel will, no doubt, have to analyze the package circuit operation. The LS diagram permits the maintenance man to understand the circuit to whatever detail is required. If it is primarily at the logic level, no further information is necessary. If it is at the circuit level, reference is made to the basic circuit manual to ascertain the detail component part content of the symbol.

Acknowledgment

The author wishes to thank Messrs. W. P. Karas and J. G. Pearce, both of General Dynamics Corp., Stromberg-Carlson Div., for their comments and suggestions.

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What's New

3-D Stereoscopic Display

Fig. 1: Stereoscopic 3-D radar display device is flanked by 3-D frequency scanning antenna.

A RADAR display which presents a progressive three-dimensional picture of the trails of aircraft under surveillance by an operating radar, has been demonstrated by Hughes Aircraft Co., Fullerton, Calif.

The display, called "Stereoscan" was developed for use in air traffic surveillance and control. Used in connection with Hughes 3-D radar, it provides depth perception enabling the viewer to distinguish between target trails, as well as their range and bearing. Wearing polarized glasses, an operator is able to distinguish differences in altitude between merging targets, which, in a flat or two-dimensional display, would appear to be approaching collision.

"Now an observer is, in effect, able to view in three dimensions, a scaled-down portion of the earth's surface in his region, including the air space above it, and everything within that space," said Dr. Nicholas A. Begovich, under whose direction 3-D radar was developed at Hughes.

In operation, the Tonotrons A and B (Fig. 3) are mounted at right angles to one another. A front surface, half-silvered mirror E is located at 45 degrees relative to the plane of the phosphor of each tube. Faces of both tubes, therefore, appear to coincide with one another when viewed by the observer. Polaroid filters C, D and F cause the information displayed on tube A to be seen only with the left eye while that on tube B is seen only with the right one. In order to obtain the third dimensions (i.e., depth along the viewing axis Z) visual parallax must be introduced into the display of each tube. Changes in this parallax produce corresponding changes in the convergence angle of the eyes and these are mentally interpreted as changes in depth.

Stereoscan was developed with company funds under the direction of George G. Vitt at Hughes' research and development laboratories, Malibu, Cal., Dr. Begovich said.

Fig. 2. At left, observer sees what appear to be two merging "blips," representing aircraft about to collide, on a conventional radar screen. At right, altitude separation of the two aircraft is clearly shown on a 3-D radar display screen.

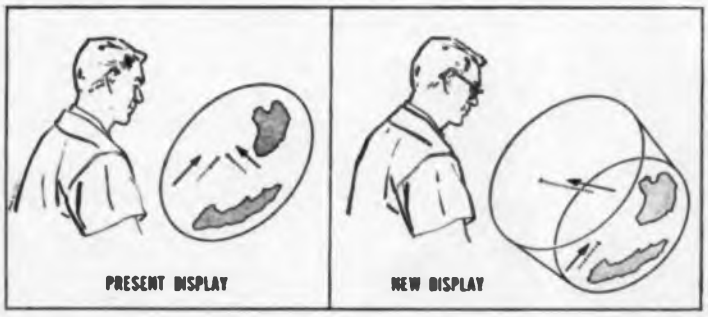
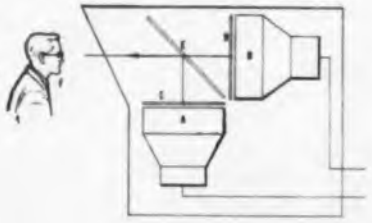


Fig. 3. A&B are 21 inch Tonotron display tubes. C&D are polarizing light filters. E is a transparent, half-silvered mirror. F, the observer, is wearing polarized glasses.



By D. F. CHRISTENSEN
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And M. E. NELSON,
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Improving Reliability

MILITARY and commercial applications are placing increasing reliability demands on electronic equipment. In adverse environment applications, electronic packaging can assure the required levels of high reliability. Here are examples:

Environmental Protection

An embedding compound will protect electronic devices from effects of moisture, salt spray, oils, and fuels.

Thermal Protection

a. From external heat—a material with low thermal conductivity will insulate and protect temperature sensitive parts from thermal degradation.

b. From internal heat—the heat generated by components can be removed by an encapsulant with high thermal conductivity.

Mechanical Protection

A resilient embedding compound will dampen vibration and protect parts from the stress of severe mechanical shock.

Electrical Protection

Elimination of air by potting or embedding assures maximum electrical protection and permits greater miniaturization in circuit design. Corona is also minimized.

Trends in Materials

In past years, designers were forced to choose from a rather narrow range of general purpose products.

Today, the material supplier develops products for specific applications. Such endeavors result in a property compromise. To integrate their developments with the requirements of designers, materials people have been alerted to design, production and repair problems. These include:

Difficulty of Repair

While some resinous encapsulants can be removed, most are so hard and rigid that entire subassemblies are discarded. On the other hand, resilient materials can be cut away to facilitate replacement of damaged components.

D. F. Christensen

M. E. Nelson

Visibility of Components

Recent advances in chemistry have led to trans parent materials with high strength. A transparent compound has several advantages: visual location of a trouble spot; visual checking of component values; and, terminal identification.

Processing

Many casting resins depend upon a chemical reaction for their cure. Often this chemical reaction generates internal heat (exothermic reaction). Depending upon mass and thermal characteristics of the compound, this heat can reach a temperature that will damage embedded components or even impair the casting resin itself. Certain types of room temperature curing silicone rubber require moisture for proper curing. If deep or confined areas are involved, the long set-up time may be intolerable. Sometimes, a complete cure may never be achieved. Catalysts and hardeners used with some classes of encapsulants are toxic chemicals. Body contact may cause dermatitus; and, inhalation for an extended period should be avoided. Vented hoods are sometimes necessary and special ventilated curing ovens are often required.

Variety of Selection

When selecting a packaging material, designers, must weigh one requirement against another. Ease of handling may dictate a choice in one case and thermal endurance in another.

Phenolics may be adequate in low temperature applications where solvent resistance is required. Higher temperature applications may suggest epoxies or polyesters.

Silicones are dictated where best thermal endurance is required; but this is not always the principal reason for selecting a silicone material.

Silicones provide a combination of properties. Some of these are:

(1) Electrical properties unchange over wide temperature and frequency ranges.

(2) Moisture resistance.

Electronic packaging is as old as electronics itself.
But adverse environments and higher reliability,
typical of our missile age, have placed unusual demand on packaging.
Now, new materials and techniques are meeting the challenge.
Here we present complete design information.

Through Packaging

Fig. 1: Test probes can enter this silicone potting material, but because it is not self-supporting, it is restricted to potting.

(3) Corona resistance.
(4) Usable over very wide temperature span.

Equally important to the designer is the variation in types of silicone material. Table I lists many of the useful silicones.

Selection of the best material depends upon the design objective. If the principal objective can be satisfied by more than one material, the secondary design factor or handling characteristics may determine the choice. Considerations in choosing the optimum material include:

Repairability

For ease of repairability, it is necessary
(1) To locate the fault.
(2) To remove the embedding or potting compound.
(3) Replace or repair the defect.
(4) Reseal.

Few materials now used permit easy repair. A few organic resins are somewhat repairable. Removal of a potting compound may be helped by using a solvent; but usually chipping, scraping or stripping is required.

Liquid dielectrics can simply be poured from their containers.

A recent addition to repairable potting compounds is the advent of dry inert fillers. A powder, such as aluminum oxide, is used to surround the components. When repairs are necessary the loose powder is simply poured from its container. However, because air is not excluded, such a system is not recommended where high voltage or altitude is encountered.

Several years ago, room temperature vulcanizing (RTV) silicone rubbers were developed. These RTV's offered users the advantage of parts replacement in embedded assemblies. While readily accomplished, some difficulty was encountered in locating faulty parts due to the opaque nature of most rubber compounds.

Recently, a silicone potting material was developed to make possible visual inspection. This product, Dielectric Gel, not only can be stripped from the area surrounding the faulty part, but being soft and transparent, it allows both visual and instrument inspection of components without any disruption of the potting, Fig. 1. However, since gel is not self-supporting, its use is restricted to potting applications.

Self-supporting, transparent silicone embedding compounds are now available. These materials also offer easy repairability. One of these, Dave Corning Sylgard 182, is an extremely flexible solventless silicone resin. This unique material has a Shore A Scale hardness of 40 and an elongation of approx. 100%, Fig. 2.

Fig. 2: This self-supporting, transparent silicone embedding compound is repairable. Strength is comparable to silicone rubber.

Fig. 3a: All components in circuits encapsulated with the resin illustrated in Fig. 2 are clearly visible. The resin can be cut away from around the defective part with a knife.

Fig. 3b: The defective part is removed and its replacement soldered into the circuit without damaging the resin encapsulant.

Fig. 3c: Freshly prepared encapsulant is poured over the new part. Its low viscosity allows easy and rapid repair.

Fig. 3d: After heating to cure the patch, the circuit is ready for service. An excellent bond forms between the original and new resin—only a thin knit line reveals the repair area.

Packaging *(Continued)*

The repair technique used with the compound is quite simple, Fig. 3.

Assembly Configuration

An assembly configuration may require deep sections of the potting material. Deep section cure can cause problems, e.g., the exothermic heat of some epoxy resins may be excessively high. Also, some RTV silicone rubbers may not cure properly in confined or heavy areas.

Most RTV silicone rubbers require a slight amount of moisture for proper curing. Heavy sections of coating or confined areas exclude the needed moisture and cure is retarded. Similarly, heavy sections retard the escape of minute amounts of volatile curing byproducts. Once trapped, these byproducts may cause reversion of the rubber during subsequent heating.

If an application involves heavy or confined areas or components sensitive to temperature, several new silicone materials should be considered.

With regard to resilient packaging materials, Dielectric Gel is entirely free from problems of reversion. As a matter of fact, this silicone potting compound, can be set up even when totally sealed.

Processing Considerations

There are no known health hazards associated with silicone encapsulants. Hoods or special oven facilities are not necessary since no toxic fumes are evolved during handling or cure.

Working time is another important processing consideration. Silicone products are available with pot life ranging from months to minutes.

Other material considerations that influence processing are viscosity and de-airing. Low viscosity materials will, of course, assure maximum fill around complex components. Similarly, thin compounds are easier to de-air. *(See Table One, Page 109.)*

DEFINITIONS

Electronic Packing . . . coating or surrounding an assembly of electronic components with a dielectric compound.

Encapsulating . . . coating, by dipping, brushing, spreading, or spraying an electronic component or assembly. An encapsulated unit usually retains its original geometry.

Embedding . . . results in complete enclosure of the electronic device. This is usually a free-flowing process in which the compound surrounds and fills all voids throughout the assembly. Molds or forms are usually necessary during processing but are removed after solidification of the compound. Since there is no other protective surface, an embedding compound requires good physical strength.

Potting . . . similar to embedding except that the mold, form or can, becomes an integral part of the completed device. Potting compounds are also free flowing, but do not require the same degree of physical strength as an embedding compound since the can or mold affords outside protection.

Impregnating . . . denotes complete filling of even the smallest voids in a component or closely packed assembly of parts. Low viscosity compounds, usually liquids, are used. The process is frequently accomplished by a vacuum process, where all air is removed before introducing the impregnating material. Typical examples of impregnating are the filling of capacitors or transformer windings.

Complete commercial Interferometer Spectrometer (above)
Hand held field model of Interferometer Spectrometer (right)

Interferometer Spectrometer

USE of infrared spectroscopy has often been limited by inadequate sensitivity. It has been difficult, and frequently impossible, to obtain data on weak sources of radiation. To overcome this, Block Associates, Inc. of Cambridge, Mass., has developed an infrared spectrometer with a gain in sensitivity of more than 1000 over conventional models.

The techniques of interference spectroscopy have been developed and reduced to practical instruments. The interferometer spectrometer evolved from this development work attains its increased sensitivity by making more efficient use of the measuring time, examining all wavelengths simultaneously and by requiring no narrow entrance slit as in the conventional instruments.

The interferometer spectrometer is light in weight, small in size, and has high reliability due to only one moving element. It is capable of using two different detectors to simultaneously cover a broad spectral region in one output channel. There are no problems with any overlap of wavelengths or spectral orders. Broad spectral regions can be handled conveniently. As no slits are used, it is not necessary to trade off resolution for signal strength. Also, it can be used with a variety of foreoptics systems to provide any desired field of view.

Table 1

Silicone Electronic Packaging Materials

Use	Applicable Silicone Product	Important Features
Encapsulating	RTV Silicone Rubber	Adaptable to easy processing (many available types)
	Heat Curing Silicone Rubber	Long working time
Embedding	All Encapsulants, Plus	
	Rigid Filled Solventless Silicone Resin	Thermal endurance—strength
	Flexible Solventless Silicone Resin	Transparent—flexible—strong
	RTV Silicone Rubber (Deep Section Cure)	No reversion—may be heat cured
	Silicone Rubber or Resin Foam	Thermal insulator—very low dielectric constant
Potting	All Encapsulants and Embedding Compounds, Plus	
	Silicone Gel	Clear—flexible—extraordinary electrical properties
	Silicone Grease-like Compounds	Wide range of uses—very water repellent
	Silicone Liquids	Very low dielectric losses
Impregnating	Rigid Solventless Silicone Resin	Thermal endurance—low viscosity
	Flexible Solventless Silicone Resin	Flexible—strong
	Silicone Gel	High electric strength—low viscosity
	Silicone Liquids	Very low electrical losses

Printed Circuit Technique

A FAST and accurate method of preparing artwork for printed circuit boards is being used at Eastern Industries, East Norwalk, Conn. The new method, developed by Keuffel & Esser Co., Hoboken, N. J., features the use of a dimensionally stable Polyester based film having an actinically opaque, but visually transparent peelable surface and a set of specially-patterned cutting tools.

The method, called CUT'N'STRIP, provides tracks of uniform width with exceptionally sharp edges. This permits designers to lay out a printed circuit diagram in a manner that reduces wires to a pattern which can be placed on one or more

(*Continued on page* 171)

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For the practical engineer...

Designing a Common-Emitter

BLOCKING oscillators (BO) are commonly used as pulse generators. Lately, transistors have been used as their active elements.

The pulse duration of transistor BO's has been evaluated with emphasis on a common-base circuit[1]; but, the common-emitter circuit has many advantages.

Let's look at the common-emitter circuit with predictable pulse duration. We'll analyze it and see where to use it. Since silicon transistors have such an effect on loading, we'll dwell on them. Our analysis will be direct; so, we will neglect transition periods.

Essential Components

A transistor BO has three essential components: transistor, transformer, and resistor. Two elementary common-emitter circuits, with base timing or with emitter timing, can be made, Figs. 1 and 2. A simple and reasonably accurate analysis for the pulse duration produced by these circuits is possible if the following assumptions are made:

(1) The transistor can be represented by a short circuit from collector to emitter and from base to emitter when the transistor is in the saturated region, and by an open circuit between the three terminals when it is in the cutoff region. The transition from cutoff to saturation takes place extremely rapidly and, during this time, the collector current i_c and the base current i_b are

$$i_c = H_{fe}\, i_b$$

where H_{fe} is the large-signal-common-emitter current gain in the active region (assumed constant).

(2) The transformer has no parasitic capacity or leakage inductance, since these primarily affect the transition interval. It is represented by an ideal transformer of turns ratio n and primary inductance L.

In the base-timed BO, Fig. 1, the full supply voltage appears across the primary of the transformer after the circuit is triggered from an external source. This induces a transformer secondary voltage and a current

$$i_b = \frac{V_{cc}}{n\, R_b} \qquad (1)$$

flows. The collector current is the sum of the increasing transformer magnetizing current and the reflected constant base current,

$$i_c = \frac{V_{cc}}{L}\, t + \frac{V_{cc}}{n^2\, R_b} \qquad (2)$$

The pulse ends when

$$i_c = H_{fe}\, i_b$$

giving for the pulse duration:

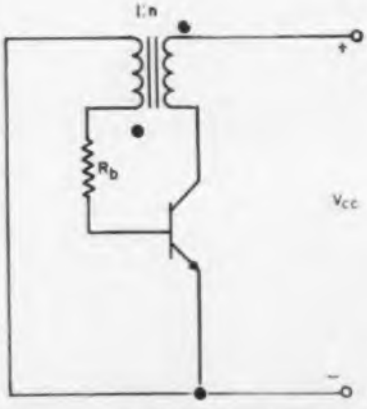


Fig. 1: Elementary common-emitter blocking oscillator with base timing.

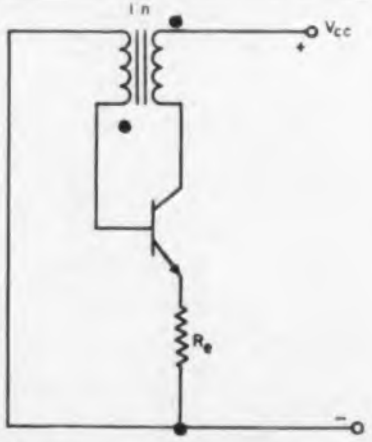


Fig. 2: The common-emitter blocking oscillator with emitter timing.

A common-emitter blocking oscillator pulse generator may use either base or emitter circuit timing. This article discusses the design, calculates pulse durations, and shows why emitter-circuit timing is less dependent on the transistor current gain.

Blocking Oscillator

$$T = \frac{L}{n R_b}\left(H_{fe} - \frac{1}{n}\right) \approx \frac{H_{fe} L}{n R_b}. \tag{3}$$

The duration of the pulse produced by this circuit depends upon H_{fe} in a nearly linear manner. A spread of four to one in H_{fe}, among transistors, is not uncommon. Therefore, the base-timing circuit is satisfactory for only the crudest of timing operations.

Much less depends on H_{fe} if the timing resistor is moved to the emitter circuit, Fig. 2. After the circuit is triggered from an external source, the equivalent circuit, Fig. 3, applies. The voltage across the emitter resistor is constant and an emitter current

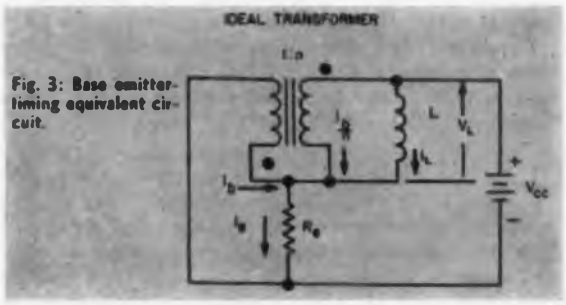


Fig. 3: Base emitter-timing equivalent circuit.

$$i_e = \frac{V_{cc}}{(n+1) R_e} \tag{4}$$

flows. The emitter current is composed of the sum of the saturated transistor base and collector currents. The collector current is composed of the reflected base current and the transformer magnetizing current, i.e.,

$$i_c = \frac{i_b}{n} + i_L. \tag{5}$$

Combining Eqs. (4) and (5) and inserting the magnetizing current

$$i_L = \frac{n V_{cc} t}{(n+1) L} \tag{6}$$

yields

$$i_b = \frac{n V_{cc}}{(n+1)^2}\left[\frac{1}{R_e} - \frac{nt}{L}\right] \tag{7}$$

$$i_c = \frac{n V_{cc}}{(n+1)^2}\left[\frac{1}{n R_e} + \frac{nt}{L}\right] \tag{8}$$

The pulse ends when the base current has decayed enough and the collector current has built up enough to pull the transistor out of saturation. Then $i_c = H_{fe}\, i_b$, and the resulting pulse width is

$$T = \frac{L}{n^2 R_e}\left[\frac{n H_{fe} - 1}{H_{fe} + 1}\right] \tag{9}$$

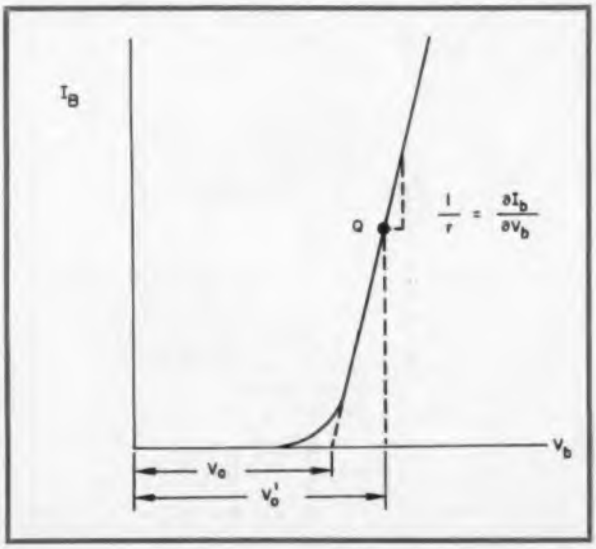
and, because in most cases $H_{fe} \gg 1$,

$$T = \frac{L}{n R_e} \tag{9a}$$

and the pulse duration is seen to be essentially independent of transistor current gain.

A short cut results, if we assume at the start that transistor current gain is very high. The collector current then consists of the transformer magnetizing current only, since the reflected base current may now be neglected. Under our assumption of negligible base current, the transistor pulls out of saturation and the BO pulse ends when the collector and emitter current are equal; and, Eq. (9a) is obtained directly. The short cut permits rapid computation of the pulse duration of a BO having a complex emitter load. For example, a bias source, trigger source, or temperature compensating element.

Fig. 4: Characteristics of a typical medium-power silicon transistor.



Blocking Oscillator *(Concluded)*

The three-way short-circuit approximation of a saturated transistor is excellent when germanium transistors are used, but is often inadequate for silicon transistors. The base-emitter characteristics of a typical silicon transistor, as used in a BO, are indicated in Figs. 4 and 5. The term V_o is typically 0.5 volts and r is typically 50 ohms. Usually, this is a significant part of the total base-ground voltage,

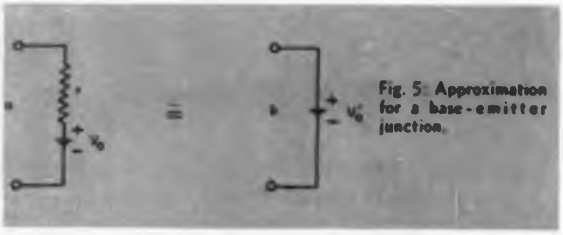


Fig. 5: Approximation for a base-emitter junction.

Fig. 2, and introduces errors into the pulse duration calculation; therefore, a correction for the transistor input characteristics is desirable. A standard technique for making this correction is to use the representation of Fig. 4. However, when a similar equivalent is included for the saturated collector junction, the analysis becomes unwieldly and the equations obtained are not direct. Reasonable accuracy is retained and a greatly simplified analysis results if r is neglected. The base-emitter "battery" is taken as the drop at the anticipated average base current, Fig. 5. A similar argument is used for computing the saturated collector-emitter voltage. It, too, is assumed constant.

Using the constant-drop approximation and going through a similar, although slightly more complicated in detail, derivation, the duration of the pulse produced by the silicon transistor BO is

$$T = \left(\frac{L}{n^2 R_e}\right)\left(\frac{n H_{fe} - 1}{H_{fe} + 1}\right)\left(\frac{1 - nk}{1 + k}\right) \qquad (10)$$

where

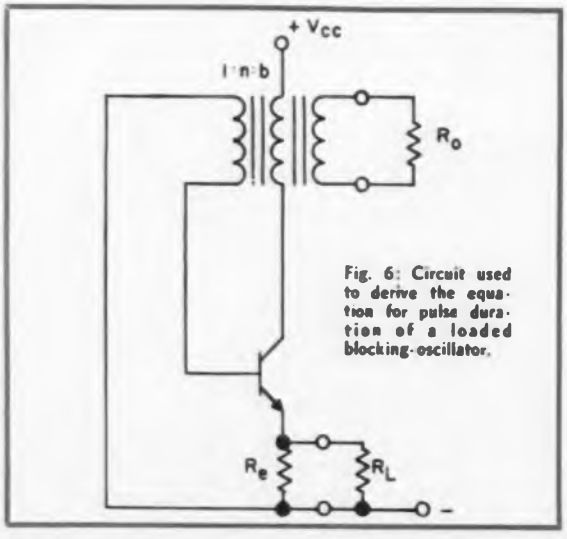


Fig. 6: Circuit used to derive the equation for pulse duration of a loaded blocking-oscillator.

$k = V_{be}/(V_{cc} - V_{ce})$

V_{be} = base-emitter voltage

V_{ce} = collector-emitter voltage.

Eq. (10) gives a prediction of the pulse duration, seldom in error by more than 10%.

Pulse Power

Frequently, a BO is required to supply a significant amount of pulse power. In many cases, at least to a first approximation, the load can be considered a resistor. To derive an equation for the pulse duration of a loaded BO, load resistors are assumed to be connected, as shown in Fig. 6:

(1) Third winding load resistor R_o on the BO transformer.

(2) Emitter load resistor R_L in shunt with the emitter resistor.

The pulse duration for these two cases of resistive loading is

$$T = \frac{L}{n^2}\left(\frac{n H_{fe} - 1}{H_{fe} + 1}\right)\left(\frac{1}{R_e} + \frac{1}{R_L}\right)\left(\frac{1 + nk}{1 - k}\right) - \frac{b^2 L}{N^2 R_e} \qquad (11)$$

where

$k = V_{be} / (V_{cc} - V_{ce})$.

It is convenient to consider collector and emitter loading separately. If the effects of base-emitter and collector-emitter voltage drops are neglected, the equations are greatly simplified but still have useful accuracy. For a load connected through a third transformer winding when H_{fe} is very large

$$T = \frac{L}{n}\left(\frac{1}{R_e} - \frac{P_o (n + 1)^2}{N V_{cc}^2}\right) \qquad (12)$$

where P_o is the power dissipated in the load resistor.

A pulse duration sensitivity to loading parameter is defined as

$$s_e = \frac{\delta T}{P_o} = \frac{L (n + 1)^2}{n^2 V_{cc}^2}. \qquad (13)$$

If the load is in the emitter circuit only,

$$T = \frac{L}{n}\left(\frac{1}{R_e} + \frac{P_e (n + 1)^2}{V_{cc}^2}\right) \qquad (14)$$

where P_e is power dissipated by the emitter shunt load. The sensitivity to loading is

$$s_e = \frac{\delta T}{\delta P_e} = \frac{L (n + 1)^2}{n V_{cc}^2}. \qquad (15)$$

Dividing Eq. (15) by Eq. (13) yields

$$s_e = -n s_o.$$

Eq. (16) reveals that if $n<1$, emitter loading produces less variation in pulse duration with load variations than third-winding loading, and conversely for $n>1$.

Experience has shown $\frac{1}{4} < n \leqslant 1$ to produce most satisfactory BO operation with regard to use time and insensitivity to base-emitter voltage variations. Therefore, in most applications of simple resistive loading, emitter loading is preferred. Very often the base emitter junction of a second transistor, or a controlled rectifier, is used as a load. These are characterized by

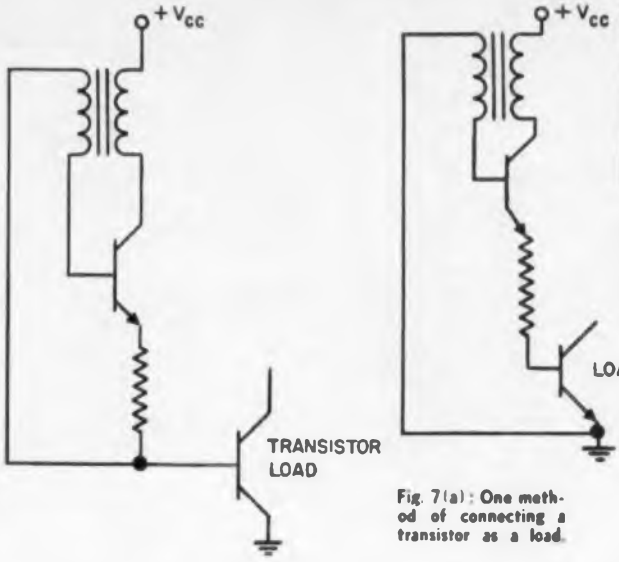


Fig. 7(a): One method of connecting a transistor as a load.

Fig. 7(b) The preferred method of connecting a transistor as a load.

their "clamp" voltages. Two methods of connecting a clamping load are indicated in Fig. 7.

The two methods differ only in the point to which the BO transformer is returned. The transformer is either returned to ground, Fig. 7a; or, to the base of the second transistor, connecting the BO and load in series, Fig. 7b. If the transformer is returned to ground, the pulse duration is as derived in Eq. (12).

$$T = \frac{L}{n^2 R_e}\left(\frac{n H_{fe} - 1}{H_{fe} + 1}\right)\left(\frac{1 - nk}{1 + k} - \frac{(n + 1) V_{b2}}{1 + k}\right) \quad (17)$$

where V_{b2} is the base-emitter voltage of the driven transistor.

If the driven transistor is connected in series with the BO, the pulse duration is

$$T = \frac{L}{n^2 R_e}\left(\frac{n H_{fe} - 1}{H_{fe} + 1}\right)\left(\frac{1 - nk'}{1 + k'}\right) \quad (18)$$

where

$$k' = V_{b2}/V_{cc} - V_{ce} \doteq V_{b2}.$$

Pulse-Duration Stability

Pulse-duration stability is better when the transformer is returned to the base of the driven transistor. The pulse duration is less dependent upon the input characteristics of the driven transistor than it is when the transformer is returned to ground. This is because the base-emitter voltage of the driven transistor appears in the numerator of Eq. (17) and in the denominator of Eq. (18).

This comes about because in Fig. 7a the emitter current is affected by variations in the clamp (base-emitter) voltage of the load; and, in Fig. 7b, variations in load clamp voltage are the same as supply voltage variations which have small effect on pulse duration. However, the BO current (the transistor collector current) is not constant, but increases linearly during the pulse as indicated in Eq. (8).

A BO delay generator of good pulse-duration stability is shown in Fig. 8. The transformer is wound on a molybdenum permalloy powder core to minimize inductance variations with temperature variations. A small capacitor in the emitter circuit speeds up the pulse rise during turn-on. The 47-kilohm resistor from V_{cc} to the emitter provides bias to prevent the BO from "free-running" on junction leakage. A por-

Fig. 8: This circuit is an example of a blocking-oscillator delay generator of good pulse-duration stability.

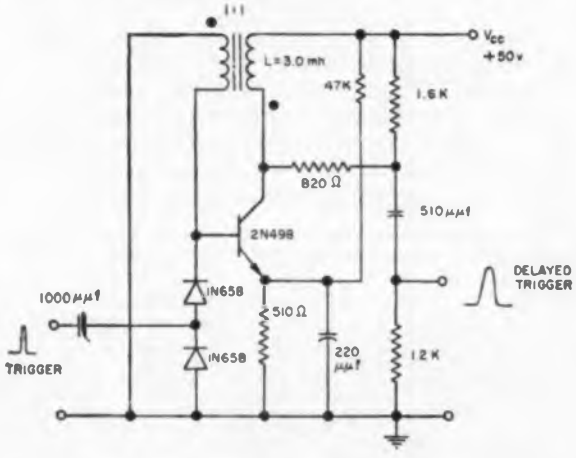


Table 1

Delay-Generator Pulse Duration Versus Temperature

Ambient Temperature (°C)	Delay	Change from 25°C Delay (percent)
+100	6.3	+6.8
+ 25	5.9	—
− 55	5.4	−8.5

Table 2

Series-Loaded Blocking Oscillator Pulse Duration Versus Temperature

Temperature (°C)	Rise	Fall	Width
+100	0.9	1.0	8.0
+ 25	0.8	1.0	8.0
− 55	0.6	0.9	8.0

Blocking Oscillator *(Concluded)*

tion of the collector voltage swing is passed through an R-C differentiator (1.2 kilohms and 510 μμf). A positive pulse is produced at the end of the BO pulse. The quasi-differentiated output has approximately a 0.5- μsec rise time and has 2 μsec between half-amplitude points.

This pulse may be sharpened by using a faster transistor—not available when this circuit was originally designed—or a faster transformer core. The faster transformer provides a commensurate decrease in pulse duration stability because of inductance variations with temperature.

Significant Measurements

The significant measurements of circuit performance are given in Table 1. The transformer trigger is a 5-volt, 1- μsec fast rise pulse for the test. The delay is measured from the 50% point of the input trigger to the corresponding point of the delayed trigger (positive output pulse), on an oscilloscope. The delay varies by less than ±2% for a supply voltage variation of ±20%. A series-loaded BO of good pulse-duration stability used for driving ferrite memory cores is shown in Fig. 9. The circuit generates approximately a 1.5-amp pulse, although pulse amplitudes up to 2.5 amps (16 ohm load) have been readily obtained. The transformer is wound on a molybdenum permalloy powder core. The collector winding inductance is 0.525 mh. R4 is the emitter timing resistor. The collector current increases during the pulse and the current builds up in L1 during the pulse, at a rate that makes the base current of Q2 nearly constant. Resistor R3 and diode D3, following the pulse, dissipate the energy stored in L1.

The base of Q2 goes about 5 volts negative following the pulse, which helps to reduce minority carrier storage in the 2N389 power transistor. The energy stored in T1 is dissipated after the pulse by D1 and D2 in series. Resistor R1 and capacitors C1 and C2, along with diode D2, form a trigger pulse "steering" network. L1 has about 17 ohms dc resistance which

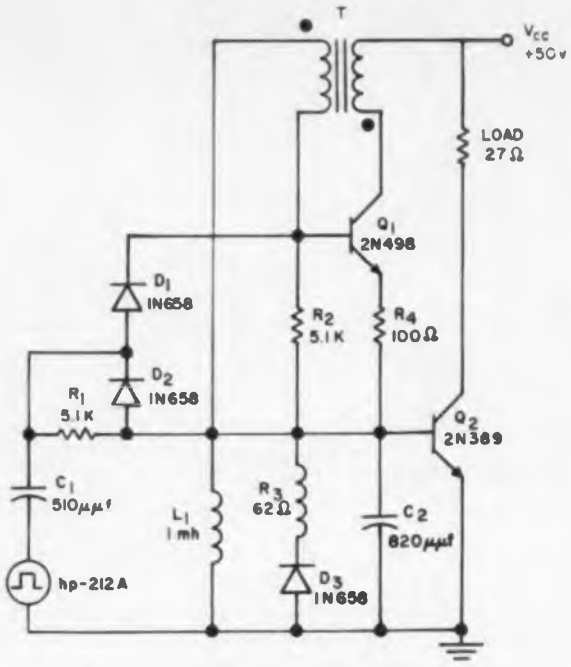


Fig. 9: This blocking-oscillator drives ferrite memory cores.

maintains the leakage current in Q2 at a reasonable value over the entire temperature range. The significant measurements of circuit performance obtained in the laboratory are given in Table 2. The trigger pulse was obtained from a pulse generator. Rise and fall times are measured from the 10 to 90% points and the width between the 50% points. The output is taken from the collector of Q2 (2N389) to ground. All measurements are made with an oscilloscope. Circuit performance has very low dependence upon supply voltage.

References

1. Hamilton, D. J., "A Transistor Pulse Generator for Digital Systems," *I.R.E. Transactions on Electronic Computers*, Sept 1958.

2. Lockheed Missiles and Space Division, "A Common Emitter Blocking Oscillator of Stable Pulse Duration," by J. J. Rolfe, LMSD-601931, Sunnyvale, California, Feb. 1959.

Three Stage Amplifier

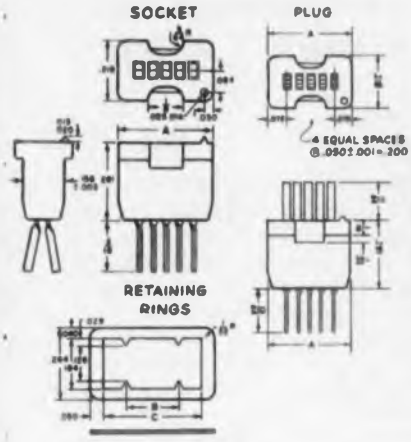
Six SX-200 amplifier units are shown mounted on a printed circuit board. Volume reduction achieved through the SX-200 microcircuitry is approximately ten to one.

MICROMINIATURE three stage amplifier SX-200 made by Lear Inc. performs basic functions in control, communication and data handling. It is capable of operating from an input power source of 15 to 48 volts DC and with a maximum undistorted gain of over 300.

Vacuum deposited techniques were used to achieve the densely packaged assembly. Package configuration consists of both active and passive circuity elements and is protected by an enclosure of epoxy resin. This method of circuitry fabrication assures greater reliability through the elimination of factors that cause present day equipment failure.

Total weight of the amplifier is 2.6 grams with its dimensions being 0.5 x 0.5 x 0.3 inches or a volume of 0.075 cubic inches.

NEW FROM CINCH.



Low-Cost SUBMINIATURE PLUGS and SOCKETS

for low-current circuits

ACTUAL SIZE

for interconnecting low current circuits where miniaturization is important... electrical ratings conform to EIA standards

DIMENSIONS

No. of Contacts	A	B	C
3	.350 ± .003	.194	.360
4	.350 ± .003	.194	.360
5	.350 ± .003	.194	.360
6	.400 ± .003	.244	.410
7	.450 ± .003	.294	.460

NOMENCLATURE

PLUG	RECEPTACLE	RETAINING RINGS
3 contacts 204-92-03-047	131-13-12-095	441-00-11-082(105)
4 contacts 204-92-04-048	131-14-12-096	441-00-11-082(105)
5 contacts 204-92-05-049	131-15-12-097	441-00-11-082(105)
6 contacts 204-92-06-050	131-16-12-098	441-00-11-083(105)
7 contacts 204-92-07-046	131-17-12-099	441-00-11-084(105)

Molded of low-loss, mica filled phenolic insulation (type MFE per MIL-4-14E) with beryllium copper contacts, .00003 Min. Sel-rex gold plated. Available also, with glass-filled Diallyl Phthalate insulation (type SDG per MIL-M-18794).

May be swaged into metal chassis, cemented into Bakelite chassis, mounted with retaining ring or potted.

ELECTRICAL RATINGS

Maximum Rated Voltage AC-RMS
- Contact to contact ..... 300 volts
- Contact to ground ..... 500 volts

Capacitance
- Measured from one contact to all other conducting parts ..... 1.5 m.m.f. (Max.)

Insulation loss factor
- Maximum ..... 0.50 Dry

Insulation Resistance
- Measured from one contact to all other conducting parts ..... 50,000 Megohms (Min.)

ContactResistance 0.50 Ohms (Max.)

Safe Operating Temperature
- Maximum ..... 80 C

Initial Insertion and Extraction Force
- 3 contact (Max.) ..... 6 lbs.
- 4 contact (Max.) ..... 7 lbs.
- 5 contact (Max.) ..... 8 lbs.
- 6 contact (Max.) ..... 9 lbs.
- 7 contact (Max.) ..... 10 lbs.

Individual Contact Retension Force
- Minimum Gauge Weight ..... ½ ounce

WRITE FOR FULL INFORMATION TODAY! Complete engineering data and detailed specifications on this line of low cost plugs and sockets is available. Yours for the asking, or phone NE 2-2000.

Circle 14 on Inquiry Card

Cinch ELECTRONIC COMPONENTS

CINCH MANUFACTURING COMPANY

1026 South Homan Avenue, Chicago 24, Illinois

Division of United-Carr Fastener Corporation. Boston. Massachusetts

ELECTRONIC ASSEMBLIES DOT

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California, and St. Louis, Missouri

WASHINGTON News Letter

JOINT SYSTEM—A joint venture satellite communications system, owned entirely by international communications common carriers, was viewed by the FCC as the structure best suited to promote development in this field. The Commission, in a report, delineated this initial determination in connection with its inquiry into the regulatory and policy aspects of space communications. The FCC stated that a joint undertaking by the existing companies engaged in international telephone and telegraph communications "is deserving of consideration and exploration as an effective means of promoting the orderly development and effectuation of such a system."

NOT BENEFICIAL—In its pronouncement, the FCC states that it failed to see why ownership participation by the aerospace and communications equipment industries "will be beneficial or necessary to the establishment of a satellite communications system to be used by the common carrier industry." The Commission expressed the view that such participation could well result in encumbering the space system with complicated and costly corporate relationships, disrupting operational patterns that have been established in the international common carrier industry, and impeding effective regulation of the rates and services of the industry.

STEPS BY NASA—The National Aeronautics & Space Administration received a boost from Presirent Kennedy. In a personally delivered message to Congress on "urgent national needs," he made a recommendation for an additional $50,000,000 to expedite development of a satellite communications system.

At the same time NASA Administrator James E. Webb formally announced that NASA is negotiating with the American Telephone & Telegraph Co. for the most rapid possible development of AT&T's plan for experimental and development flights of satellites built at its own expense. Mr. Webb also cited the selection of the Radio Corp. of America to conduct the Project Relay tests.

FCC PLAN DOOMED—The FCC reorganization plan as proposed by President Kennedy, to go into effect June 26, was doomed by the House. The plan would give Commission Chairman Newton N. Minow broader authority over FCC personnel and work assignments. In the Senate, Commerce Communications subcommittee chairman John O. Pastore (D., R. I.) has proposed the establishment of an area of reorganization which could be produced through legislation and would meet relatively little opposition.

FOREIGN CONSULTATION—The Interdepartment Radio Advisory Committee recommended to the FCC that "a major effort" be made "to arrange for advance consultations with foreign governments to acquaint them with U. S. thinking" on space communications. The IRAC program which was adopted verbatim by the FCC is to be the basis of discussion by U. S. representatives with other countries. Its purpose is to serve as the vehicle by which the ideas and reactions of other countries in connection with the projected 1963 international Radio Administrative Conference on space communication at Geneva, Switzerland, can be obtained.

COHERENT LIGHT UNVEILING—A highlight of the 15th annual convention of the Armed Forces Communications & Electronics Association in Washington was the use of "coherent light" in an opening demonstration. The AFCEA president triggered the unfurling of an American flag and the cutting of the ceremonial ribbon using Bell Laboratories' equipment. The coherent light beams used two different types of optical masers. The ruby maser produced a burst of coherent light to trigger the opening display and background music was transmitted over a coherent light beam provided by a simulated display of the continuously operated gas maser.

NEW HIGH FOR INDUSTRY—A new production record of $10 billion or more as compared to $9.75 billion last year is indicated for the electronics industry in 1961, according to a forecast by Electronics Industries Association President L. Berkley Davis who is also General Electric Co. Vice President. Defense expenditures for electronics equipment and research will exceed $5 billion or ten times the 1950 figure and almost twice the industry's total electronic sales that year. Computing and data processing equipment, and satellite communications systems loom as tremendous expansion areas.

National Press Building
Washington 4

ROLAND C. DAVIES

ACCORDING TO EIA'S Small Business Committee, small manufacturers are "in the most vulnerable position with respect to the impact of increased electronic imports." Committee chairman C. J. Harrison of Rixon Electronics, Inc., emphasized that the electronics industry "includes thousands of small manufacturers producing 'bits and pieces' for assembly in many and varied complex electronic equipments." "The electronics industry, by its very nature, is a prime target of foreign competition," Mr. Harrison said.

PIONEERING

AT BELL TELEPHONE LABORATORIES

In such an open field as this Dr. Karl Jansky of Bell Laboratories opened the way to radio astronomy. His search for a mysterious source of radio noise led him—and us—to the stars for our answer.

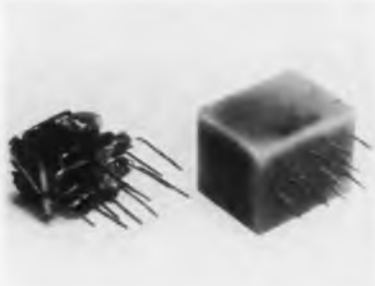
Today Bell scientists continue their pioneering in many fields—among them the transmission of human voices on beams of coherent light. Bell Laboratories' revolutionary Optical Maser foreshadows the use of light as a whole new medium of telephone, TV and data communications.

These are but two of the many fundamental advances which have come from breaking fresh ground at the world center of communications research and development.

New Products . . . for the Electronic Industries

DIGITAL CIRCUIT MODULE

DM 200 designed for logic and control functions.



The module is a (200 KC) digital circuit with an operating temp. of −60°C to +71°C. Combination of two 5 input and gates plus transient coupling allows the circuit to function as a shift register stage, counting stage or static storage unit. A complete line of digital logic circuits (gates, multivibrators, drivers, etc.) is available "off-the-shelf." It will meet or exceed the environmental requirements of Mil-E-5272D(ASG). Delco Radio Div., General Motors Corp., 700 E. Firmin, Kokomo, Ind.

Circle 213 on Inquiry Card

TRIMMER CAPACITOR

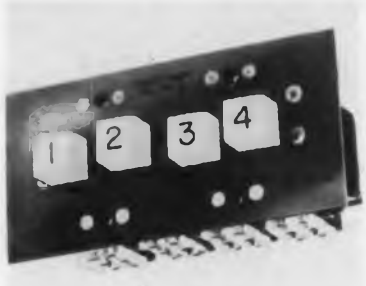
Tiny unit for miniaturized communications or instrumentation equipment.

Mini-Trimmer® model, equipped with 1 wire lead and 1 tab lead, made in 4 models with capacitance ranges as broad as 1 to 18 pf. Featuring fixed cavity tuning and a linear tuning curve, the new type makes posisible sturdy, 2 terminal mounting for printed circuit boards or for custom applications. Combination of glass and hardware provides low inductance at high freqs., thermal stability and ruggedness. Electronic Components Div., Corning Glass Works, Corning, N. Y.

Circle 215 on Inquiry Card

INTERLOCKING SWITCH

Interlock permits only 1 station to be committed at any time.



Actuating any of the 4 push button causes the previously depressed button to return to normal position. Combination of over center action station button and interlock inclusion prevents the "all station up" configuration. Electrical rating is 5 a @ 125/250 vac; 5 a (Res) @ 30 vdc; 2.5 a (Ind) @ 30 vdc. Pushbuttons individually illuminated with standard MS 25237 type lamps replaceable from the front. Control Switch Div., Controls Co. of America, 4218 W. Lake St., Chicago 24, Ill.

Circle 217 on Inquiry Card

L-V DC POWER SUPPLIES

Model PS 120 is for use in transistorized circuits.

Miniature solid state power supply unit has an input of 105-135 vac, output is 0-10 vdc, current 0-1 a. Regulation is 0.002% for 10% line voltage change and 0-200 ma load current. Ripple, 1 mv, RMS at 1 a max. Weight is 7 lbs.; size, 8⅜ x 10⅛ x 8 in. Unit is bench type, rack mounting available if desired. It will withstand shock and stress and operate in continuous high temp. to 100°C. Performance in accordance with mil. specs. Dynex Industries, Inc., 123 Eileen Way, Syosset, N. Y.

Circle 214 on Inquiry Card

SPECTROMETER SYSTEM

Model A-60 analyses organic compounds.

The Analytical NMR Spectrometer System is sensitive to the hydrogen nucleus at an operating freq. of 60 MC and a magnetic field strength of 14,092 gauss. Typical volume of a liquid sample is 0.2 to 0.4 cc. (cylindrical). Instrument can resolve 2 lines separated by 1 part in 10^8 and has sensitivity sufficient for a wide range of analytical problems. Power is 208-230 v., 1φ, at 50 or 60 CPS (as specified). Instrument Div., Varian Associates, 611 Hansen Way, Palo Alto, Calif.

Circle 216 on Inquiry Card

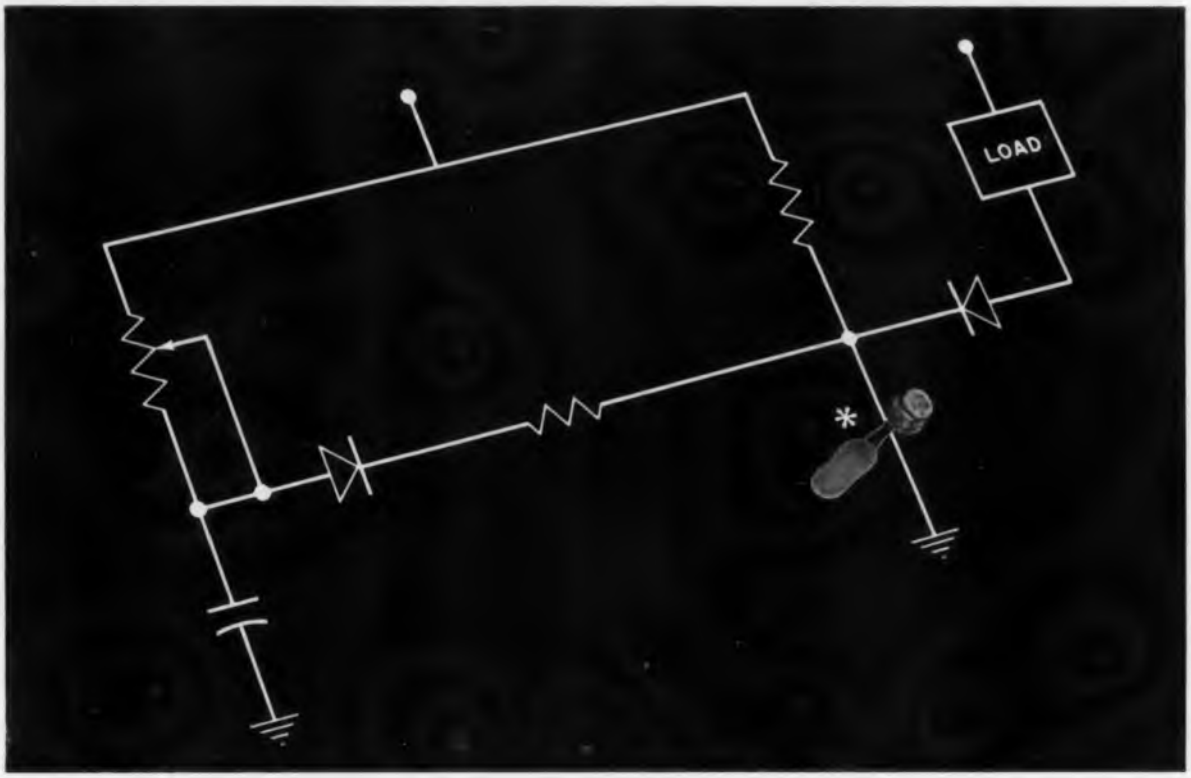
BAYONET-LOCK CONNECTOR

Featuring contacts to Mil-C-26636 and bayonet-lock coupling mechanism.

DTK series, miniature-environmental connectors, also mate with existing MS 3110 and 3116 connectors. Features include: color keyed index grooves for grope-free engagement and alignment; 7 point lock indication for both visual and blind mating inspection; silicone inserts for higher operating temps. and a complete inter-facial seal. Mil-C-26636 contacts are crimp-type, insertable and removable. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 218 on Inquiry Card

WAIT A MINUTE... or a μSECOND



SHOCKLEY 4-LAYER DIODE gives minutes or μs time delays with a single circuit.*

A wide variety of time delays from fractions of a microsecond to several minutes have been made possible by the Shockley 4-layer diode. Now you have the advantages of solid state circuitry for a wide range of industrial and military time delay or time cycle applications.

You'll see in the schematic drawing above that only one active element is needed in this circuit: the Shockley 4-layer diode. The Type AD shown will carry 300 ma continuously. Higher power diodes are available. Contact bounce and chatter are entirely eliminated since mechanical devices are no longer necessary.

If you are developing a circuit where a variable time delay is needed (to energize relays, to activate a power supply or to obtain timing pulses), contact our local engineering sales representative for details, or write to Shockley Transistor, Palo Alto.

Shockley TRANSISTOR
UNIT OF CLEVITE TRANSISTOR
STANFORD INDUSTRIAL PARK, PALO ALTO, CALIF.

CLEVITE CORPORATION

New Products . . . for the Electronic Industries

COOLING DEVICE

Gold Seal Muffin® offers extended reliability at same price.

It measures the same as the former Muffin basic configuration providing interchangeable mounting. Output capacity is 100 cfm at free delivery. It operates on 115 v., 60 CPS, 1 ϕ. Available as a skeleton, venturi, or grilled fan. Incorporated new rigid leads between motor and redesigned terminals, both fabricated as integral parts of the housing eliminate internal electrical breakdown. New bearing design results in smooth, quiet, long life. Rotron Mfg. Co., Inc., Woodstock, N. Y.

Circle 219 on Inquiry Card

100 mc COUNTER-TIMER

Solid state unit is for automatic programming of control functions.

The Model 728B measures and displays freqs. directly without heterodyning techniques from dc to 100 MC, measures time intervals and periods to 10^{-6} sec. and counts at rates to 100 MC with self-contained time base. The universal counter-timer consists of 3 input channels, a special decade count-down time base which eliminates the need for divider adjustment, and a series of plug-in transistorized decade counting units. Computer Measurements Co., 12970 Bradley Ave., Sylmar, Calif.

Circle 221 on Inquiry Card

CONTROL TIMERS

Long-life, reliable timers adjust manually from 5 sec. to 5 hrs.

Designed for industrial applications, Series 41500 adjustable interval timer has a precision snap-action SPDT switch. Designed to operate either as a time delay mechanism or as a straight interval timer. Models are available with 1 to 4 switches in the same package size, rated life in the standard version is 40,000 CPS at 15 a, 115 v. 60 CPS. It measures 3 in. sq. x 1 57/64 in. deep; timer has shaft extension of ¼ in. dia x ⅞ in. long. The A. W. Haydon Co., Waterbury, Conn.

Circle 223 on Inquiry Card

VARIABLE TRANSFORMERS

Two series of transformers are UL® approved.

Approved are the Series VT4 units and Series VT8 units. Series VT4 units are rated 3.5 a nominal with overvoltage feature: 4.75 a without overvoltage. Series VT8 units are rated 7.5 a nominal with overvoltage: 10.00 a without overvoltage. The approval applies to uncased, cased, and various ganged assemblies in these models. Transformers feature mounting versatility and are mechanically and electrically interchangeable with other popular brands. Ohmite Mfg. Co., 3682 Howard St., Skokie, Ill.

Circle 220 on Inquiry Card

SENSITIVE RELAY

Low-cost, high-sensitivity for industrial, commercial and military use.

"4325 Series" line available with coil impedances to 5 K Ω for the 50 mw unit, providing a pull-in at 3.2 ma and a drop-out at above 0.5 ma. To be plugged into a printed circuit board or screwed to frames to allow for soldered leads. Each type is available with a choice of 3 contacts: SPDT, SP (NO) and SP (NC). Contact rating: 1 a 28 vdc or 120 vac, non-inductive. Dimensions: 1.3 x 1.2 x 1.2 in.; weight: 1.1 oz. The Lionel Corp., Electronics Div., Hoffman Place, Hillside, N. J.

Circle 222 on Inquiry Card

METERS

"M" Series in 4 case sizes offers longer scale length.

Four sizes offered in transparent and black molded plastic: 220-M, scale length 2.5 in.; 320-M, scale length 3.34 in.; 420-M, scale length 4.5 in.; and 820-M, scale length 7 in. "M" Series have 3-way terminals permitting use of time-saving push-on solderless connectors; or conventional solder terminals; or conventional wrap-around (binding head screws). Have Triplett-Bar-Ring® self-shielded movements with Alnico magnets. Triplett Electrical Instrument Co., Bluffton, Ohio.

Circle 224 on Inquiry Card

ENGINEERING NEWS - #10

LIGHTED PUSHBUTTON SWITCHES

CHECKED Fred	ENGR. W.E.M.	CONTROL SWITCH DIVISION

These five models indicate only a part of the full line of SWITCHLITES made by Control Switch Division. These units combine both switch and indicator light in a single rugged, compact assembly. They are available with momentary, push-push, or push-pull snap-action, having a positive feel. There are eight basic case styles, 20 circuit arrangements. Switch ratings from 2 to 20 amps, ind. or 10 to 20 amps, res. at 28 VDC—depending on switch type, circuit, and required operating life. Switchlites use a midget flange base MS25237 lamp, 6, 14 or 28 volts. Choose from five styles of plastic pushbuttons in standard transparent and translucent colors.

A3311
Momentary, N.O. or N.C. (A3312)

A3298
Momentary, SPDT

In other words, almost any requirement you may have for a compact lighted pushbutton is available in a standard SWITCHLITE from Control Switch Division. For more technical data write for free literature.

J6230
Push-Push, SPDT

WC1501
Momentary, DPDT. Moisture-proof

TWINLITE . . . lights in 2 colors

Here is a low-cost lighted pushbutton containing two lamps which may be individually circuited. Plastic lens is 1" x .740", and comes in one solid color, two-color split, engraved or with a nameplate slot. Select double-pole or triple-pole switching with push-push, momentary, or solenoid-hold action. TWINLITE mounts individually with barriers, in rows, or a matrix.

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.

CONTROLS COMPANY OF AMERICA

CONTROL SWITCH DIVISION

4244 West Lake Street • Chicago 24, Illinois
TELEPHONE: VAn Buren 6-3100 • TWX CG-1408

Circle 80 on Inquiry Card

New Products . . . for the Electronic Industries

LOW POWER RECTIFIERS

For use in magnetic amplifiers, precision metering and test equipment.

Series 1N536 low power silicon rectifiers available in ratings to 750 ma max. forward current and range in PIV from 50 to 1000 v. Suitable for operation in ambient temps. from −65 to +165°C without external heat sinks. Each cell is in a hermetically sealed case designed for rugged construction and long life, and may be mounted in any position. Axial leads are flexible and tinned for easy soldering. Westinghouse Semiconductor Dept., Westinghouse Corp., Youngwood, Pa.

Circle 225 on Inquiry Card

MICROWAVE OSCILLATORS

Triode Cavity Oscillators cover freq. range of 2500 to 3900 MC.

Another standard model CW oscillator utilizing the GL-7391 tube covers from 5400 to 5900 MC. Standard oscillators feature a single freq. tuning control and power output adjustment normally preset to provide the min. power over entire freq. range. Operate from a 200 v. plate power supply and can draw up to the max. current specified by the electron tube manufacturer. Designed to provide max. performance under extreme environmental conditions. Waveline Inc., Caldwell, N. J.

Circle 227 on Inquiry Card

MINIATURE LIMIT STOP

Servo-mounted units is continuously variable from 0-42 turns.

External adjustment control permits stop range to be varied without disassembling or removing unit from mount. Torque rating of 40 oz. in. with max. starting torque of 0.04 oz. in. Shielded stainless steel ball bearings at both shaft ends. Shaft, and all wear parts, fabricated of corrosion resistance passivated stainless steel. Complete assembly measures 2 in. in length and less than 1 in. in dia. weighs under 2 oz. Components Marketing Div., Reeves Instrument Corp., Garden City, N. Y.

Circle 229 on Inquiry Card

AIRBORNE AMPLIFIER LINE

Units for use with transducers in missile environments.

With high input, low output impedances and broad freq. response, these amplifiers have high gain stability over wide range of temps. and power supply voltage variations. Offer continuously variable gain adjustments over a range of at least 20:1. Two models can operate into coax. cable up to 3000 ft. long. For use with piezoelectric accelerometers, pressure gauges and high intensity microphones. Gulton Instrumentation Div., Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Circle 226 on Inquiry Card

MINIATURE ARRESTOR

Miniature multiple-stroke arrestor weighs less than 2 oz.

Body of the arrestor is 1 x ⅞ in. Overall length is 1½ in. Applications are: as a lightning arrestor on fixed station, high and low freq. antennas, both transmitting and receiving; high and low freq. receiving antennas on boats and aircraft; and as a voltage surge limiting device where large currents will be shunted. Shunt capacitance is 3.5 μf. Arc-over voltage is factory adjustable from 500-5,000 vdc. Ambient temp. range from −55° to +150°C. Dale Electronics, Inc., Columbus, Nebr.

Circle 228 on Inquiry Card

PRESSURE TRANSDUCER

Designed for industrial and missile applications.

Type 4-350's over-pressure performance is specified as 10 times the rated pressure or 10,000 psi (whichever is less) and when applied for 3 min. will not cause a zero set to exceed 1.0% of full range output. Features sensitivity of 50 mv, low residual unbalance, and a combined figure of ±0.35% for linearity and hysteresis. The operable temp. range is −320°F to +300°F. Consolidated Electrodynamics Corp., sub. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

Circle 230 on Inquiry Card

2 NEW SOLID STATE

TRUE FM TELEMETRY TRANSMITTERS

from

Dorsett Electronics

Actual Size

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

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.

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.

DORSETT ELECTRONICS, INC.

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

Circle 81 on Inquiry Card

New Tech Data for Engineers

High Temp. Coaxial Cable

Times Wire & Cable Div., The International Silver Co., Wallingford, Conn., has information available on seven new versions of miniature high temp. coaxial cable construction just included in Mil-C-17C. RG-178 B/U, RG-179 B/U and RG-180 B/U are now available with FEP jackets which permit higher operating temps. RG-187 A/U, RG-188 A/U, RG-195 A/U and RG-196 A/U are also available with annealed center conductors (8% min. elongation) permitting greater tensile loads to be applied.

Circle 160 on Inquiry Card

Portable Power Source

Completely self-contained and capable of providing from 300 to 600 w. of CW or modulated r-f microwave power in freq. ranges from 350 MC to 10.5 GC. Model L-3653 is for high power testing of microwave components and systems and as the r-f driver for high power microwave amplifier tubes. Litton Industries, Electron Tube Div., 960 Industrial Rd., San Carlos, Calif.

Circle 161 on Inquiry Card

Holding Magnet

Engineering bulletin explains a simplified method for designing holding magnets and assemblies. Twenty-four basic designs for holding magnets and their performance characteristics are included in the bulletin. Bulletin entitled, "Shortcut for Holding-Magnet Design," contains complete data for Alnico® and Indox® permanent magnets. Indiana Steel Products Div., Indiana General Corp., Valparaiso, Ind.

Circle 162 on Inquiry Card

Printed Circuits

Engineering data is available on printed circuit boards and photopunching. Information describes features of printed circuit boards produced and discusses applications, tolerances, and cost advantages of producing precision metal parts by photopunching rather than conventional metalworking processes. Electrodynamic Instrument Corp., 1841 Old Spanish Trail, Houston 25, Tex.

Circle 163 on Inquiry Card

Plating Process

An 8-page, illustrated booklet describes equipment, application techniques, and plating jobs performed with the Dalic® Process, a method of electroplating localized areas of a workpiece quickly without using immersion tanks. Plating operations may be carried out wherever ordinary a.c. power is available. Sifco Metachemical, Inc., 935 E. 63rd St., Cleveland 3, Ohio.

Circle 164 on Inquiry Card

Ceramic Tubes

Complete compilation of information on ceramic receiving tubes is contained in 2 new volumes from General Electric's Receiving Tube Dept., Owensboro, Ky. Bulletin ETD-2713, 213 pages, contains full tech. data on G-E's entire line of 20 registered and 15 developmental ceramic tube types. Graphs, diagrams, illustrations, a tube selection chart and typical socket data are included. Bulletin ETD-2134, 52 pages, contains extensive application information as well as data on design, materials, manufacturing UHF-VHF performance, and reliability, of small ceramic receiving tubes.

Circle 165 on Inquiry Card

Radiation Meters

New 16-page catalog on nuclear radiation survey meters and dosimeters is available from The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio. Each model in the line is illustrated and described in detail. Ranges, uses, performance figures, ratings, dimensions and other pertinent data are included.

Circle 166 on Inquiry Card

Phasemeter

Tech information is available on a new precision phasemeter, Model 1010. Instruments feature 0.1° absolute accuracy over the entire 0-360° phase range without ambiguity. Direct reading of phase difference over freq. range of 30 to 20,000 CPS. Designed for testing of polyphase systems, feedback amplifiers, filters, transformers and phase shifting networks. Maxson Electronics Corp., 475 10th Ave., New York 18, N. Y.

Circle 167 on Inquiry Card

Semiconductor Process

A 12-page full-color brochure describes in detail the technology of the planar process whereby semiconductor devices have as their major feature a surface junction protective oxide. Brochure deals with the reliability, performance, cost and adaptability of planar devices and gives tech. information dealing with performance parameters and electrical specs. Fairchild Semiconductor Corp., 545 Whisman Rd., Mountain View, Calif.

Circle 168 on Inquiry Card

Microwave Capabilities

Special Products of the Microwave Div. of FXR, Inc., 25-26 50th St., Woodside 77, N. Y., are displayed in a brochure. Among the special Products illustrated and described in capsule form are a radar test for missiles, high power rotary joint, stripline power divider, resistive loop directional coupler, three port switch, and audio function generator.

Circle 169 on Inquiry Card

Photo-Duo-Diode

Texas Instruments Incorporated, Semiconductor-Components Div., P.O. Box 5012, Dallas 22, Tex., has tech. information on photo - duo - diode theory, measurement of parameters, and operation. Schematics, charts and graphs are included.

Circle 170 on Inquiry Card

Transistor Data

Operational characteristics of radio and TV transistors are explained in detail in a special transistor data chart available from Philco Corp., Electronic Education Dept., Consumer Products Div., Tioga & C Sts., Phila. 34, Pa. The chart provides information pertaining to the recently developed improved transistors which may replace older and less effective ones.

Circle 171 on Inquiry Card

Instrument Catalog

Marconi Instruments, 111 Cedar Lane, Englewood, N. J., has a short form catalog which lists their complete line of signal generators, FM, AM, sweep, FM deviation meters, Bridges, L C & R, Q meters and accessories.

Circle 172 on Inquiry Card

Test Equipment

The Triplett Electrical Instrument Co., Bluffton, Ohio, has available test equipment catalog No. 42-T, covering their complete line of volt-ohm-milliammeters, combination V-O-M and VTVM's, signal generators, sweep generators, transistor testers, and their 5 in. oscilloscope Model 3441-A.

Circle 173 on Inquiry Card

High Voltage Testing

A complete engineering application analysis, entitled "High-Voltage Testing: It Can Be Nondestructive" is available from Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill. The bulletin details the causes of insulation breakdown, the minimizing of destructiveness by current limiting and many other pertinent aspects of insulation testing. Bulletin 5-15.4.

Circle 174 on Inquiry Card

Flame-Retardant Laminate

Tech. information is available on the properties of Fireban® 600 and 600 E, glass-base, epoxy-resin laminated self-extinguishing plastics. Material is available in sheets and can also be supplied with copper cladding for printed circuits. NEMA equivalent is FR-4. Taylor Fibre Co., Norristown, Pa.

Circle 175 on Inquiry Card

Direct Reading Microwave Wavemeters

Proven in Performance and Reliability .01% Accuracy

Covering a frequency range of 500 mc to 18 gc with .01% maximum error, Frequency Standards' precision-engineered wavemeters combine greater accuracy of readout with a broader frequency range in both absorption and transmission types. Each unit provides direct readout **without chart** and is individually calibrated and temperature compensated for a high degree of accuracy and stability. Higher accuracies can be obtained depending on other limitations.

Frequency Standards, America's foremost center for new ideas in microwave technology, produces this precision wavemeter in absorption, termination, and RF transmission styles both for laboratory and operational applications. For outdoor use a direct reading model is furnished in a ruggedized waterproof carrying case. **Delivery within 10 days** • For information on the complete line of wavemeters, write for catalog P-26102.

Certified: All wavemeters are calibrated against standards originating with the U. S. National Bureau of Standards.

DEPT. KW

FREQUENCY STANDARDS

A DIVISION OF HARVARD INDUSTRIES, INC.
BOX 504 • ASBURY PARK, N. J. • PROSPECT 4-0500

Center for Microwave Components: Wavemeters • Reference Cavities • Signal Sources • High Power Filters • Discriminators • Antenna Couplers • Diplexers • Duplexers • Directional Couplers • Antennas • Cavities

New Tech Data for Engineers

Commercial Glasses

Bulletin B-83, available from Corning Glass Works, Corning, N. Y., has expanded data on corrosion resistance and thermal expansion of 32 commercial glasses. The brochure, "Properties of Selected Commercial Glasses," also contains the information on the new commercial code system showing resistance of each glass to weather, water and acid.

Circle 176 on Inquiry Card

Potentiometers

Latest in the line of multi-turn potentiometers are described in a bulletin from International Resistance Co., 401 N. Broad St., Phila. 8, Pa. The miniature ⅞ in. dia. units are for either bushing or servo mount. Resistance range is 25Ω to 250 KΩ. Resistance tolerance is ±5%, and linearity tolerance is ±0.5%. Bulletin AE26.

Circle 177 on Inquiry Card

Solid State Control

A 6 page article on "Solid-State Control of Microwaves" is available from Microwave Associates, Inc., Electron Tube & Device Div., Burlington, Mass. Paper discusses the applications of semiconductor diode devices which use varactors in microwave switching, phase-shifting, duplexing and limiting. Summarizes typical performance capabilities of solid-state control devices which are now commercially available.

Circle 178 on Inquiry Card

Magnetic Core Tester

Tech. Bulletin 60-L describes Model 1300 Magnet Core Tester, a high speed, multiple output pulse generator that provides programmed high amplitude current or voltage pulses for laboratory research and development, computer circuits and systems. Bulletin contains a full description, block diagram, waveforms, and timing charts. Rese Engineering, Inc., A and Courtland Sts., Phila. 20, Pa.

Circle 179 on Inquiry Card

Time Controls

Haydon Div. of General Time Corp., Torrington, Conn., has available a basic instruction manual on time controls. The manual concentrating on practical information, starts with elementary explanation of time controls and circuitry and progresses to complex application diagrams. Intended as a beginning text for rapid understanding of basic time control principles and applications. Title, "Basic Timing Instruction Manual."

Circle 180 on Inquiry Card

Infrared Equipment

Fostoria Corp., Fostoria, Ohio, has tech. information available on their high intensity electrical radiant energy equipment. Information is included on their furnaces with temps. to 3000°F and ovens featuring instant heat, immediate shut-off, compact design, long equipment life, versatility and low maintenance.

Circle 181 on Inquiry Card

Modular Power Supplies

Quan - Tech Laboratories, Inc., Boonton, N. J., has available a technical flyer describing 3 versions of the new Seriex 170 modular, regulated power supplies. Compact units are fully transistorized. Included are dimensional drawings, electrical specs., weight and price.

Circle 182 on Inquiry Card

Language System

Porta - Control® Electronic Language Lab System is covered in a tech. bulletin available from Robert H. Redfield, Inc., 1020 S. Wabash Ave., Chicago 5, Ill. Model PC1 may be used for music appreciation classes, stenographic and business education training, science demonstrations and experiments. The system provides phonograph, multiple channel tape record and playback plus multiple channel student monitored practice.

Circle 183 on Inquiry Card

Thyratron Tube

Tech. information is available on a 3.2 a d.c. thyratron, NL-734/5544 which is designed for welding control, motor control and other industrial applications. Inert gas-filled tube is for operation within wide temp. limits. National Electronics, Inc., Geneva, Ill.

Circle 184 on Inquiry Card

Traveling Wave Tubes

Huggins Laboratories, Inc., 999 E. Arques Ave., Sunnyvale, Calif., is offering a catalog which covers their line of backward wave amplifiers, forward wave amplifiers, backward wave oscillators, and special purpose tubes.

Circle 185 on Inquiry Card

Size 5 Motor-Generator

Tech. information is available which describes Beckman Size 5 Motor-Generator, Model 9005-1102-0. Weighing 1.1 oz., and measuring 1.565 in. in length, the Size 5 component is completely detailed on this spec. sheet. Helipot Div. of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

Circle 186 on Inquiry Card

Plastic Capabilities

A 16-page catalog lists products and capabilities for advanced military and industrial applications. It covers firm's line of laminated plastics, printed circuit boards, flexible insulation, molded plastics, vulcanized fibre and mica products. Catalog A-61. Continental-Diamond Fibre Corp., Newark, Del.

Circle 187 on Inquiry Card

High Altitude Chart

The Garrett Corp., AiResearch Mfg. Div., Los Angeles 45, Calif., has available a High Altitude Chart. Chart includes information on specific weight, pressure, altitude, acceleration of gravity, and molecular weight up to altitudes of 2 million ft. Also offered is an Atmosphere Chart which presents the latest recognized standard values of temp., pressure and specific weight of the air for altitudes up to 100,000 ft. Includes information records from mountain heights to height of orbiting satellites.

Circle 188 on Inquiry Card

Nuclear Space Chart

Tracerlab Inc., 1601 Trapelo Rd., Waltham 54, Mass., has available a colorful wall chart depicting the distribution of ionizing radiation in outer space. The 25 x 38 in. document maps out the zones of ionizing radiation from the face of the earth to outer space. Cost $1.00.

Circle 189 on Inquiry Card

Semiconductor Nomograph

Semiconductor users can now quickly compute the acceptance number of any given sampling plan with a reliability nomograph from Raytheon Co., Semiconductor Div., 215 First Ave., Needham, Mass. Printed on sturdy card stock, the nomograph contains scales and tables with complete instructions on how they work, and a glossary of terms.

Circle 190 on Inquiry Card

Standard Systems

Comprehensive manual of freq. and time standard systems is available in Application Note No. 52 from Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. The textural portion of this 56-page manual is divided into 4 main sections. The first section contains a general discussion of such problems as freq. and time control, radio propagation, time scales, etc. The second, third and fourth contain detailed consideration of system operation, freq. determination, and time determination. Sixteen illustrations and 6 tables are included.

Circle 191 on Inquiry Card

Proved in performance

THE TUNG-SOL LINE OF HIGH-POWER GERMANIUM TRANSISTORS

■ WIDELY INTERCHANGEABLE ■ MORE FLEXIBLE IN APPLICATION ■ UNIFORMLY RELIABLE

For several years Tung-Sol has been manufacturing high-power germanium transistors to the industry's most exacting standards of electrical and mechanical reliability.

They have proved themselves efficient and fully reliable in countless installations, providing rugged, long-life performance for equipment in commercial and military use.

As further proof of peak performance, the fact may be cited that Tung-Sol's complete line of high-power transistors includes the JAN 2N174 and USA 2N1358, fully inspected and guaranteed to their respective MIL specifications.

The Tung-Sol line offers widest applicability in high-power amplifiers. DC-to-AC converters, DC-to-AC inverters, regulated power supplies, motor controls, servo amplifiers, relay drivers and high-power switches.

Designed for wide interchangeability, they may be specified for new, improved equipment. Their features of vacuum-tight, copper-to-copper "Cold-Welded" sealing increase design flexibility and make them more reliable. Stud-mounted, single-end construction, with solid-lug terminals, simplifies installation in all chassis and allows sufficient heat-sink design.

Ask your Tung-Sol representative for full technical details, or write: Tung-Sol Electric Inc., Newark 4, N.J. TWX:NK 193.

TUNG-SOL HIGH-POWER GERMANIUM TRANSISTORS

	MAXIMUM RATINGS (25°C)				TYPICAL VALUES (25°C)			
TYPE	V_{CE} Volts	V_{CB} Volts	I_C A	T_J °C	MAX. I_{CBO} Ma	h_{FE}	$f_{\alpha b}$ kc	MAX. T_R °C/W
2N173	-60	-60	15	100	8	52	10	.8
2N174*	-70	-80	15	100	8	87	10	.6
2N174A	-70	-80	15	100	8	87	10	.6
2N277	-40	-40	15	100	8	52	10	.8
2N278	-45	-50	15	100	8	52	10	.8
2N441	-40	-40	15	100	8	30	10	.6
2N442	-45	-50	15	100	8	30	10	.8
2N443	-60	-60	15	100	8	30	10	.8
2N1099	-70	-80	15	100	8	52	10	.8
2N1100	-80	-100	15	100	8	87	10	.8
2N1358*	-70	-80	15	100	8	87	10	.6
2N1412	-80	-100	15	100	8	87	10	.6
2N1970	-80 (1)	-100	15	100	4	29	10	.8

(1) BV_{CEO}

TECHNICAL ASSISTANCE IS AVAILABLE THROUGH THE FOLLOWING SALES OFFICES: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. In Canada: Abbey Electronics, Toronto, Ont.

*Also available in military versions.

TUNG-SOL

Circle 83 on Inquiry Card

New Tech Data for Engineers

Potentiometers

Bourns, Inc., Trimpot Div., 6135 Magnolia Ave., Riverside, Calif., is offering tech. data on their line of Trimpot® potentiometers. Included are dimensional drawings and photographs.

Circle 192 on Inquiry Card

Fractional H.P. Motors

Howard Industries, Inc., 1760 State St., Racine, Wis. offers tech data on fractional horsepower motors with ratings from 1/2000 to 1 H.P. Catalog contains information on motor parts sets, motor blowers and gear reduction units.

Circle 193 on Inquiry Card

Silicon Rectifiers

Complete tech. information is contained in a 6-page short form data folder on Bradley, JEDEC Type Silicon Rectifiers. Also included are dimensional drawings. Bradley Semiconductor Corp., 275 Welton St., New Haven 11, Conn.

Circle 194 on Inquiry Card

Shock Testers

Consolidated Vacuum Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y., has tech. information available on their HYGE® Shock Testers. Information includes operating principles, graphs, photographs, charts and dimensional drawings.

Circle 195 on Inquiry Card

Semiconductor Catalog

Transitron Electronic Corp., 168-182 Albion St., Wakefield, Mass., has available a 12-page catalog containing information on their line of transistors, diodes, rectifiers, controlled rectifiers, switches, regulators, capacitors, and encapsulations.

Circle 196 on Inquiry Card

Antenna

Ground plane antenna Model 10-2 has a freq. range from 70 to 300 MC. Constructed of corrosion resistant materials throughout and suited to severe environmental applications. Plas-Tron Corp., 815 S.W. Viewmont Drive, Portland 1, Ore.

Circle 197 on Inquiry Card

Solder Terminals

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass., has a wall chart which covers their complete line of solder terminals. Included on the chart are dimensional drawings, photographs, and information concerning a solder terminal kit.

Circle 198 on Inquiry Card

Voltmeter

A 4-page illustrated brochure describes Model 317 Voltmeter which measures from 300 μv up to 300 v. at freqs. from 10 CPS to 11 MC. Ballantine Laboratories, Boonton, N. J.

Circle 199 on Inquiry Card

Pulse Modulator

Ling-Temco Electronics, Inc., Ling Electronics Div., 1515 S. Manchester Ave., Anaheim, Calif., has tech. information available on; Pulse Generator, Model PM-87, Electronic Vibration Power Generator, Model RP 3/4C; and Model 300 Shaker with a force rating of 5000 lbs.

Circle 200 on Inquiry Card

Snaps in – Stays in

There's muscle in that Deutsch snap-in contact...enough to withstand 25 pounds pull. Each pin and socket in the DS miniature electrical connector is locked in place by a patented spring mechanism that can only be released by specially designed tools. Add to this a crimp that is strong as AN 478 wire itself, and you have the completely reliable DS snap-in type connector. What's more... crimping, inserting, and removing contacts is a quick and easy operation with Deutsch designed tools...even in the hands of unskilled operators. The DS series also features the Deutsch ball-lock coupling mechanism which operates in the direction of plug travel...just push to connect and pull to disconnect. With environmental performance that meets or exceeds MIL-C-26482, plus a wide range of shell sizes and contact arrangements, this connector will satisfy your toughest design requirements with ease.*

DEUTSCH

Electronic Components Division • Municipal Airport • Banning, California

ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

*For complete information contact your Deutschman or write for Data File A-7.

Tech Data

for Engineers

Silicon Diodes

A brochure listing the characteristics of 86 conventional glass silicon diodes is available from Computer Diode Corp., 250 Garibaldi Ave., Lodi, N. J. Catalog D-100 contains information on hermetically encapsulate diodes now in stock. They comprise 35 general purpose silicon types and 51 silicon computer diode types.

Circle 201 on Inquiry Card

Wire Enameling Ovens

Bulletin GED-4329 describes General Electric Co.'s new controlled convection wire enameling ovens for high-quality magnet wire enameling at twice the speed previously obtainable. Information also includes spec. chart and picture of control panel. General Electric Co., Schenectady 5, N. Y.

Circle 202 on Inquiry Card

Logic Module

BIP-500 one of the BIPCO™ modules is a binary coded decimal-to-decimal diode converter which uses 40 silicon diodes in matrix logic. Photographs, drawings and circuit diagrams of the BIP-500 are featured. Burroughs Corp., Electronic Components Div., P.O. Box 1226, Plainfield, N. J.

Circle 203 on Inquiry Card

Switch Catalog

Clarostat Mfg. Co., Inc., Dover, N. H. has available a catalog on their line of switches. Catalog includes dimensional drawings, specs, and photos on 4 types of switches. Included are AE and BE rotary types, BHM miniaturized types, regular or encapsulated, and AG push-pull types.

Circle 204 on Inquiry Card

Recording Camera

Pamphlet gives detailed presentation of Tektronix new C-12 camera which offers new convenience in undistorted viewing and direct recording of oscilloscope traces. C-12 features include one-hand portability, lift-on mounting, swing-away hinging, comfortable viewing with or without glasses. It uses Polaroid or conventional film. Tektronix, Inc., P.O. Box 500, Beaverton, Ore.

Circle 205 on Inquiry Card

Nut-Bolt Fastening

Tech. information is available from Standard Pressed Steel Co., Box 899, Jenkintown, Pa. It reviews a new self-aligning locknut, SPS SA 16, that compensates for out-of-squareness conditions as great as 8°. Diagrams illustrate the action of the 2-part nut in restoring perpendicularity, that is, eliminating destructive bending of bolts in cases of surface misalignment.

Circle 206 on Inquiry Card

Circle 87 on Inquiry Card

FASTEST, EASIEST WAY YET DEVISED TO MEASURE POWER,

10 MW to 10 Watts, DC to 12.4 GC!

434A Calorimetric Power Meter

Just connect, then read power
Direct reading in watts, DBW
Only two operating controls
No external terminations or equipment

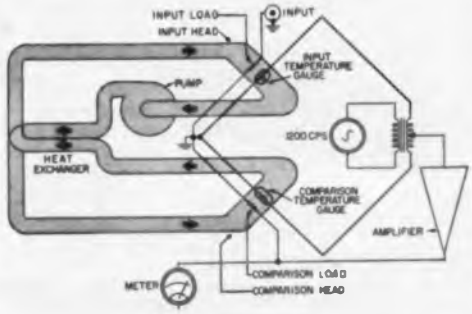
Fast reading—5 sec. response max.
Measure cw or pulsed power
Compact, self-contained
Internal 1% calibrator

hp 434A makes it just this simple: connect your power source to the front-panel input terminal . . . then read power directly in watts and DBW, 7 ranges, full-scale readings 10 mw to 10 watts average, 1 KW peak!

The hp 434A is a self-contained, high-precision instrument, yet it operates with only two simple front-panel controls—range switch and zero set. No other adjustments are needed to measure power at any frequency, dc to 12.4 GC. And the compact 434A requires no thermistor, barretter, external terminations or plumbing of any kind! Thus it is ideally suited for use by non-technical personnel to measure AM power, pulsed power, cw, video and dc power. An internal calibrator ensures that the 434A operates always at peak performance.

Fast response—high stability

hp 434A provides a full scale response time of 5 seconds or less, by means of a self-balancing bridge and a high-efficiency heat transfer system using an oil stream (see diagram). This fast reaction, a fraction of the response time needed by ordinary calorimeters, means the 434A quickly follows small changes in input tuning circuits. Further, the 434A achieves a new high in stability through the use of twin power-sensitive elements in a single oil stream, a design which makes the accuracy independent of changes in oil flow rate and temperature.



BRIEF SPECIFICATIONS

Input Power Range: 7 ranges; full-scale readings 0.01 to 10 watts, with continuous readings —30 to 10 DBW; may be extended upward with attenuators or directional couplers. Peak input power: 1 KW maximum.

Frequency Range: DC to 12.4 GC.

DC Input Impedance: 50 ohms ± 10%, at type N input jack.

Input SWR: Less than 1.5 full range; less than 1.3 to 5 GC.

Meter Response (full scale): Less than 5 seconds.

Accuracy: Within 5% of full scale. Can be increased through appropriate techniques.

Price: $1,600.00 (cabinet); $1,585.00 (rack mount).

HEWLETT-PACKARD COMPANY
1083B 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

7174

Circle 88 on Inquiry Card

New Tech Data for Engineers

CRT Booklet

A new tech. booklet on industrial and military cathode ray tubes is available from Sylvania Electric Products Inc., sub. of General Telephone & Electronics Corp., 1100 Main St., Buffalo, N. Y. The 12-page brochure contains physical dimensions, electrical characteristics, and line width specs. on over 200 CRT types including oscilloscopes, video recorders, flying spot scanners, industrial monitors, and receiver check tubes.

Circle 207 on Inquiry Card

Telemetry Systems

Technology Instrument Corp. of Acton, Space Instrumentation Div., 533 Main St., Acton, Mass., has available a descriptive brochure on silent switching with TIC Rotoflex® Commutator. Designed for rocket and satellite telemetry systems, the unit has in a number of cases made it possible to eliminate amplification stages prior to commutation. Noise level is guaranteed less than 10 mv.

Circle 208 on Inquiry Card

Diodes

"Introduction to the Shockley 4-layer Diode" a 6-page folder is available from Shockley Transistor, unit of Clevite Transistors, Stanford Industrial Park, Palo Alto, Calif. The folder gives a working introduction to the operation and application of the Shockley pnpn, 2 terminal, silicon switch. Basic circuit application schematics are included.

Circle 209 on Inquiry Card

Relays

Complete data with circuit diagrams, chassis layouts and socket guide for its line of military and commercial T154 "Cradle" relays is available from Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y. Open, dust cover and hermetically sealed types with plug in, printed circuit and hook-type solder terminals for the T154 cradle relays are described for 12 mounting variations with contacts up to 6 PDT.

Circle 210 on Inquiry Card

Oscillographs

Revised Product Digest No. 160 contains pictures and brief descriptions of Midwestern Instruments' complete line of products. General performance information is contained on both wet-process and direct-readout oscillographs, galvanometers, bridge balance units and galvanometer amplifiers. Midwestern Instruments, Inc., P. O. Box 7509, Tulsa 18, Okla.

Circle 211 on Inquiry Card

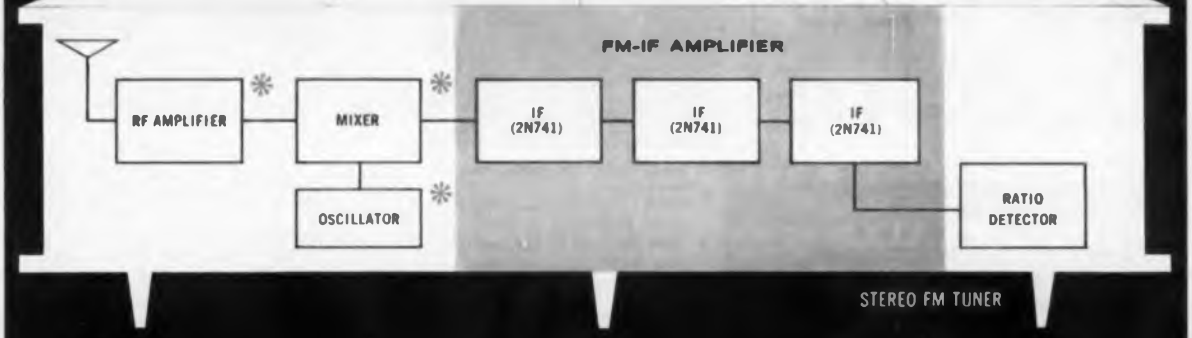
Catalog and Handbook

A new dc power supply handbook and catalog is now available to engineers in dc power design or procurement. This 24-page manual includes a step-by-step procedure, designed for engineers who wish to calculate packaging dimensions for multiple dc outputs. The catalog details over 200 power supplies. Dressen-Barnes Electronics Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Circle 212 on Inquiry Card

LOW-COST MOTOROLA MESA TRANSISTORS NOW AVAILABLE...

FOR
FM-STEREO
APPLICATIONS



2N741 PERFORMANCE: 30db gain at 10.7 mc

Motorola 2N741 Mesa transistors provide excellent performance characteristics for FM-IF applications . . . characteristics which enable designers to obtain transistor reliability at new low cost. For example — three Motorola 2N741 Mesas will provide 90 db gain and offer good dissipation reserve for high-quality FM-IF stereo tuner applications, as shown in the block diagram. The excellent performance with low supply voltage of Motorola's 2N741 is also an advantage in battery-operated portable equipment. It is an ideal transistor for video amplifiers and medium-power oscillators.

In addition to the 2N741, Motorola supplies a wide range of Mesa transistors for amplifier applications to 1000 mc . . . all with the remarkable level of reliability that has resulted in their selection for the most critical missile/space programs.

MOTOROLA 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	26 db @ 70 mc	55 mW @ 70 mc	TO-17
2N741	15	15	300	22 db @ 30 mc	200 mW @ 30 mc	TO-18
2N741A	20	20	300	22 db @ 30 mc	250 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 amplifier Mesa transistors are available from your Motorola Semiconductor Distributor.

New Low-Cost 100 MC Communication Series To Be Announced Soon! For complete pre-announcement information on this new Motorola Mesa series — and for data on the 2N741 as an IF amplifier — write to Motorola Semiconductor Products Inc., Technical Information Center, 5005 East McDowell, Phoenix 8, Arizona.

LOOK TO MOTOROLA FOR ALL YOUR SEMICONDUCTOR REQUIREMENTS

Power Transistors/Mesa Switching & Amplifier Transistors
Milliwatt Transistors/Silicon Rectifiers/Zener Diodes

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Semiconductor Products Inc.
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5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

Circle 91 on Inquiry Card

New Products

SIZE 5 SERVO MOTOR

Size 5 servo for use under varying environmental conditions.

Type 5351-01 is only 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. Rated voltage at 400 CPS is 26 v. (can be available in 18 v. or 33 v.). Effective resistance at stall 400Ω. Corrosion resistant materials are used throughout. John Oster Mfg. Co., Avionic Div., Racine, Wis.

Circle 231 on Inquiry Card

COUNTER

Features high input impedance and latched display.

Model M 1154 is a transistorized digital frequency and time interval meter. The latching system retains the display of the previous count during the time a new count is being made. Unknown freqs. between 0.1 CPS and 120 KC measured using count periods of 0.1, 1 or 10 seconds. Features; input impedance, 10 meg; single knob function/range switch; and provision for remote read-out or print-out. Application: time interval or period measurement to 10,000 units. Southern Instruments Ltd., Instrumentation Div., Frimley Rd., Camberley, Surrey, England.

Circle 232 on Inquiry Card

85%* smaller lighter

*compared with electrical counterparts in TO-5 package.

SYLVANIA PANCAKE TRANSISTORS

Increased packaging density! Mil-min .100" lead-to-lead spacing!

Now available in • Epitaxial Germanium Mesa • Epitaxial Silicon Mesa
Germanium Alloy-Junction • Germanium Drift-Field

.100" lead-to-lead spacing for automatic and direct insertion in Mil-standard 275A printed circuit without reforming leads • mechanically indexed for positive and permanent lead identification • eliminate solder bridging problems • .070" max. case height • .255" max. case diameter • power dissipation in free air: 300 mw for Mesa, 100 mw for Alloy and Drift-Field units • max. junction temperature: 100°C for Germanium and 175°C for Silicon • meet all environmental tests in accordance with Mil-S-19500B • hermetic seal reliability (leak rate lower than 1×10^{-7} cc/sec. verified by Radiflo equipment) • withstand 200 p.s.i.g. pressure.

Sylvania originated the "Pancake" package to provide a practicable solution to a vital engineering challenge—end-product miniaturization with high operational reliability. The tabulation of 15 types is a clear indicator of the industry's acceptance of the "Pancake" package.

If you are working with microminiaturization to improve "payload factors" or to enable "redundancy for reliability," call in your Sylvania Sales Engineer now, to help you determine the best device for your specific requirements. He or your Sylvania franchised Semiconductor Distributor can provide you with "Pancake" transistors—*fast!* For tech data on specific types, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 197, Woburn, Mass.

"Pancake" types now available for space-saving circuitry

Sylvania "Pancake" Transistors		Electrically Similar Type
GERMANIUM ALLOY-JUNCTION		
		(TO-5 Package)
2N1684	PNP	2N404
2N1685	NPN	2N388
2N1779	NPN	2N377
2N1780	NPN	2N385
2N1781	NPN	2N1606
2N1782	PNP	2N396
2N1783	PNP	2N414
2N1784	PNP	2N428
GERMANIUM EPITAXIAL MESA		
		(TO-18 Package)
2N1960	PNP	2N781
2N1961	PNP	2N782
SILICON EPITAXIAL MESA		
		(TO-18 Package)
2N1962	NPN	2N783
2N1963	NPN	2N784
		(TO-5 Package)
2N1964	NPN	2N1958
2N1965	NPN	2N1959
DRIFT-FIELD		
		(TO-33 Package)
2N1699	PNP	2N1225

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

New Products

THERMOSTATS

For use wherever moisture, fumes or dust are a problem.

Known as Type GP Stevens Commercial Thermostats, they are enclosed in a polypropylene boot filled with epoxy resin. The bimetal disc thermal element in close proximity to aluminum or tin-plated brass sensor cap providing rapid response to temp. changes. Rated for 100 KC up to a max. operating temp. of 176°F. Uses include pilot duty and temp. protection in refrigerators, freezers, liquid coolers and industrial apparatus. Stevens Mfg. Co., Inc., P. O. Box 1007, Mansfield, Ohio.

Circle 233 on Inquiry Card

SILICON COMPUTER DIODE

Construction features direct fusion of hard glass to junction.

Six high speed diffused silicon mesa computer diodes (MA-4303 through MA-4308) with all-glass microminiature packaging meet environmental specs of Mil-S-19500B. These Micro Glass® diodes have switching speeds of 2 μsec. MA-4303 and MA-4304 rated 10.0 ma at 1.0 v. forward and 0.025 ma at −40 v. reverse. MA-4307 and MA-4308 rated at 30 ma at 1.0 v. forward and 0.050 ma at −75 v. reverse. Sizes: 0.06 x 0.125 and 0.06 x 0.09. Diodes have junction temp. of 200°C and an operating temp. range −61°C to +200°C. Microwave Associates, Inc., Burlington, Mass.

Circle 234 on Inquiry Card

GEC INDUSTRIAL R. F. GENERATORS

GEC VIDICONS

GEC SCAN CONVERSION TUBES

GEC SCAN CONVERTERS

ADVANCED

ELECTRONIC DEVELOPMENTS FROM G E C

ELECTRONIC TUBES . . .

Vidicons with unsurpassed light sensitivity and low lag responding to all parts of the spectrum including near and far infrared.

FEATURES:

- 1 in. and larger sizes
- Electrostatic and magnetic focus and deflection
- Low power heaters
- Patented internal construction allows operation in any position

Scan Conversion Tubes provide controllable storage of input signal with simultaneous reading and writing.

GEC's Capability includes the design and development of a wide range of *pickup, conversion* and *display tubes.*

SCAN CONVERSION SYSTEMS . . .

Transistorized Scan Converters convert from any scanning format into another. One basic unit uses plug-in functional modules to provide required conversion. Modules presently available are: TV Control, PPI Control, and Slow Scan Control.

FEATURES:

- Translation of video information from one scanning mode to another
- Storage and Integration of video information
- Time-Coordinate Transformation providing expansion or reduction of bandwidth
- Rack-mounted requiring 36¾ in. of panel space
- Power consumption only 1.5 amp at 115 Vac, 60 cps
- No external power supplies are needed

GEC Monoscope Cameras, Radar Target Simulators and other system equipment are available for operating scan conversion systems.

INDUSTRIAL R. F. GENERATORS . . .

Induction and dielectric heating R. F. Generators are available in the very highest powers. GEC's extensive radio-frequency engineering is available to assist customers in special applications of R. F. Generators.

For additional information about your specific R & D needs, contact . . .

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G E C **GENERAL ELECTRODYNAMICS CORPORATION**

4430 FOREST LANE • GARLAND, TEXAS • BROADWAY 6-1161

New Products

SHAFT ADAPTERS

Converts odd shafts to use ¼ in. standard bore gears or couplings.

Machined from #303 stainless steel, with clear passivate finish, the 2-piece adapters provide a 0.2497 (+0.000 −0.002) standard shaft on tapered shaft motors, such as Diehl FPE-25 and FPE-49, and Bureau of Ordnance type rotating components, such as synchros, resolvers and tachometer generators. PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.

Circle 235 on Inquiry Card

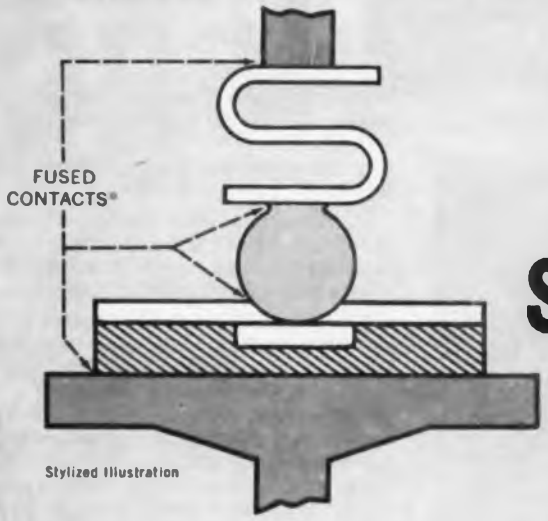
DETECTOR

Integrates incident energy and reads total field strength on meter.

Designed for hand-carrying or to stand and operate unsupported, it has a strong plastic housing, one knob operation without freq. range switching. Model B86B1 operates over a freq. range from 400 MC to 10 GC has a single integral antenna and utilizes standard, large-capacity mercury batteries. Providing a rapid and simplified means for monitoring power density over its wide band, the instrument responds to all planes of polarization. Sperry Microwave Electronics Co., Clearwater, Fla.

Circle 236 on Inquiry Card

COST/ PERFORMANCE/AVAILABILITY



Stylized Illustration

SILICON PLANAR DIODES

OFFER SIGNIFICANT BUYING ADVANTAGES

COST SAVINGS! High yields produced by Fairchild's Planar process mean reduced manufacturing costs. Result: Major savings for you because of extremely low reject rates. Fairchild's computer and general purpose diodes are priced for your cost savings.

PERFORMANCE BONUS! Planar diffusion techniques make possible combinations of parameters for highest performance in Fairchild diodes. The "self-protective" Planar manufacturing technique provides an integral oxide coating from start to finish, and surface passivation for life. All internal contacts are fused, enabling the structure to withstand as much as 30,000 g's impact without mechanical or electrical degradation.

ON-SCHEDULE AVAILABILITY! Process and production control made possible by Planar diffusion results in easy high volume production. For you, this means immediate availability of standard units and on-schedule delivery of your specification devices and assemblies.

OVER 400 TYPES! Write for your free copy of the Fairchild Silicon Planar Diode Catalog... over 400 1N and FD types to established standard and military specifications.

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SEMICONDUCTOR

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DIODE PLANT: 4300 REDWOOD HIGHWAY, SAN RAFAEL, CALIF. • GREENFIELD 9-8000 • TWX: SRF 26
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

Circle 96 on Inquiry Card

Extra quality at no extra cost with Bendix Semiconductors

Bendix Bulletin

POWER-SWITCHING TRANSISTORS THAT CARRY PROVED RATINGS

Established parameter limits give engineers new reliable design base

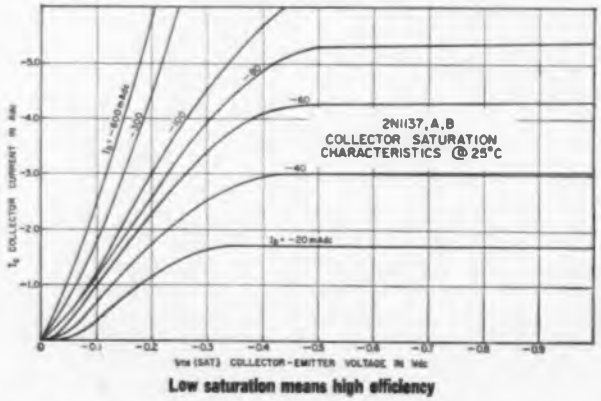
100% specification testing assures transistor rating.

To help engineers achieve maximum circuit design reliability, Bendix series 2N1136 and 2N1137 power-switching transistors now come *with absolutely defined and tested maximum performance ratings.*

Electrical specifications are substantiated by actual dynamic tests which include both open base and shorted base breakdown voltage tests at high current.

This valuable testing is conducted at our new Holmdel, New Jersey, facility, devoted exclusively to semiconductor production. Here, also, our improved transistor processing reduces leakage currents, increases current gain linearity, increases transistor power rating by reducing thermal resistance, and controls high temperature (85°C.) ICBO to a maximum of 10 mAdc.

These 2N1136 and 2N1137 germanium PNP power transistors switch up to 400 watts as drivers for relays, relay replacements, solenoids, magnetic clutches, and have many other high current applications in DC-DC converter and DC-AC inverter circuits. Write for complete information on these series, and others in our complete line of Semiconductors.



Low saturation means high efficiency

ABSOLUTE MAXIMUM RATINGS						CURRENT GAIN	
Type No.	Vcbo Vdc	Vceo Vdc	Vceo Vdc	Ic Adc	Tj °C.	hFE	@ Ic
2N1136	60	40	30	6	100	50-100	3 Adc
2N1136A	90	70	55	6	100	50-100	3
2N1136B	100	80	65	6	100	50-100	3
2N1137	60	40	30	6	100	75-150	3 Adc
2N1137A	90	70	55	6	100	75-150	3
2N1137B	100	80	65	6	100	75-150	3

The Bendix Corporation

Bendix Semiconductor Division
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West Coast Office: 117 E. Providencia Ave., Burbank, Calif.—Phone: Victoria 9-3961—TWX BRB 9808 • Canadian Affiliate: Computing Devices of Canada, P.O. Box 508, Ottawa 4, Ont.
Export Office: Bendix International, 205 E. 42nd Street, New York 17, N. Y.—Phone: MUrray Hill 3-1100—TWX NY 1-4800.
Stocking Distributors—Contact nearest sales office for name of local distributor.

New Products

RESISTORS

Components designed for close tolerance applications.

Molded metal-film resistors give low, controlled temp. coeff. and long-time stability. They are well-suited for matching in precision voltage dividers as well as test equipment, digital circuitry, and other applications requiring closely controlled performance characteristics. They meet all requirements of Mil-R-10509C. Sprague Electric Co., 233 Marshall St., N. Adams, Mass.

Circle 237 on Inquiry Card

MINIATURE OSCILLOSCOPE

Small scope for training, service, and light industrial use.

The Primer-Scope®, Mark I, is small and versatile, in the low price range. Weighing under 6 lbs., favors its inclusion in heavy service kits. Its size is 7¼ x 3½ x 11¼ in. The main scope component is a special 3 in. Rayonic® CRT, incorporating an integral magnetic shield to prevent stray or spurious pickups. Accelerating potential is approx. 840 v. Trace is bright and sharp. An instruction manual is included. Waterman Products Co., 2445 Emerald St., Phila. 25, Pa.

Circle 238 on Inquiry Card

New Products

PREAMPLIFIER

Dual trace preamplifier is for Memo-Scope® Oscilloscope Model 105.

It employs a blanked writing beam during switching time when operated in the chopped mode. It can provide chopped displays of both Memo-Scope channels simultaneously, alternate displays of both channels or single operation of either channel. The unit has a pass band of dc to 10 MC, a chopping rate of 270 KC and a sensitivity of 0.05 v./div. Hughes Aircraft Co., Industrial Systems Div., P. O. Box 90904, Airport Station, Los Angeles 45, Calif.

Circle 239 on Inquiry Card

POWER SUPPLY

Type 132 powers an internal amplifier and one "letter-series" plug-in.

Electronically-regulated power supply provides an easily-portable housing for any Tektronix A-to-Z plug-in unit, enabling the plug-ins to be used with or without an oscilloscope. Internal amplifier of the Type 132 has a freq. response of dc to 22 MC, rise-time of 15 nsec., noise level less than 0.5 mv, peak-to-peak (referred to internal amplifier input). Front-panel terminals permit push-pull or single-ended + or — input. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 240 on Inquiry Card

New Products

REGULATED POWER SUPPLY

Convection cooled 20 a, 0-34 vdc unit is transistorized.

LA Series models have line regulation better than 0.05% or 8 mv, whichever is greater, for input variations from 100-130 vac. Load regulation is better than 0.10% or 15 mv, whichever is greater, for load variations from zero to full load. Swing-open backs permit easy servicing in rack, all major component terminals are accessible from the rear. Rated for continuous operation at 50°C ambient, Lambda Electronics Corp., 515 Broad Hollow Rd., Huntington, L. I., N. Y.

Circle 241 on Inquiry Card

AIRBORNE BLOWER

Needs no pressure sensing or speed regulating switches.

Vaneaxial blower, VAX-4.5, designed for delivery of 140 cfm or air against a static pressure of 5 in. of water at 25,000 ft., sea level output is 77 cfm of air against 5 in. of water. Motor is wound for 200 vac, 400 cps, 3 ϕ; other power requirements can be met, including dc and universal ac/dc. VAX-4.5 is 4 11/16 in. in dia. by 3⅛ in. long and weighs 5½ lbs. Unit rated for 1000 hr. life at 110°C ambient. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 242 on Inquiry Card

New Products

TEST JACK

Printed circuit test jack used in tight spaces.

Designed for use in computers and other equipment, the jacks permit circuit testing without removing adjoining boards and without the need for right angle test prod adapters. All materials meet military specs. Units feature Raytheon's damage-proof beryllium copper spring pin contact and nylon body available in natural and 8 colors/MS 16108. Contact and brass terminals have double gold plating over silver plate for positive electrical contact. Industrial Components Div., Raytheon Co., 55 Chapel St., Newton 58, Mass.

Circle 244 on Inquiry Card

STEREO HEADSET

Stereo Dyna-Twin® provides comfortable, high-fidelity listening.

It is also well suited to recording laboratories, record shops and for private practice on such electronic instruments as organs. Max. sensitivity is better than 90 db. SPL for 1 mw. input, achieved with a self-supporting voice coil, has a freq. response of 30 to 15,000 CPS. It has an impedance of 8Ω. Headset consists of a Mylar® diaphragm, Tenite® cups, and one piece stainless steel construction. Communications Accessories Div., Telex, Inc., 1633 Eustis St., St. Paul 1, Minn.

Circle 245 on Inquiry Card

Die Stamp Circuits

DIE stamped circuits are rapidly gaining acceptance for a wide variety of products requiring mass produced electronic and electrical circuitry. Produced by Dytronics, Inc., Rochester, Mich., they are made by die cutting the conductor pattern from metal foil coated on one side with a thermo responsive adhesive and simultaneously binding the circuit to the insulating base material under heat and pressure. Principal cost is that of making the die, hence the larger the quantity required of an identical board, the greater the saving. In general, an order for 25,000 or more circuit boards can be produced at less cost by die stamping them than by etching.

Mechanically produced, circuit configurations are uniform and can be maintained indefinitely. Thus, in designing the circuit, virtually no allowance need be made for variations in circuit patterns. Also, this characteristic uniformity saves inspection costs in the user's plant. Statistical control methods rather than 100% inspection can be used.

Since the circuits are produced by a dry process with no excess metal to remove by chemical etching, degradation of the base material by chemicals or moisture need be considered only in relation to the environment of the end product in which the circuit board will be used, not to the method of producing the board. Unique base materials such as vulcanized fibre, thermosetting and thermoplastic molded materials, compressed paper and wood products may easily be used.

The same pilot holes are used for piercing and blanking operations on the circuit board as for the die stamping cycle which produces the conductor pattern. This assures extremely accurate registration between the conductor pattern and all piercings.

Advantages of printed circuitry are extended to applications where current loads were once thought too heavy for this type of circuit. This is due to the fact that they may be designed to carry more than 40 amperes, compared with the usual limit of 20 amperes for etched circuits.

Die stamp circuits with a minimum bond strength of 10 lb./in. of width can be consistently supplied at standard cost. Higher bond strength can usually be provided to meet specific requirements.

Various sizes and shapes of die stamped circuits are illustrated. Produced by a dry process, there is no excess metal to remove by chemical etching.

New Products

SIGNAL SOURCE

Electronically tuned for use in 10 KC to 400 KC freq. spec.

These packaged units, called the SO series produce a signal whose freq. is controlled by applying either a current or voltage, eliminating manual tuning requirements. In a typical vacuum-tube, single-band unit, a change in freq. of 5 to 1 is produced by applying a control current between 0 and 70 ma over the 10 KC to 200 MC range. Units require an extended power source of 150 v. at 30 ma and 6.3 vac at 0.4 a. Increductor Magnetics Dept., Trak Electronics Co., Inc., Wilton, Conn.

Circle 246 on Inquiry Card

GLASS DIODES

Feature 300 ma rating, low leakage and low cost.

Subminiature mesa diffused junction general purpose glass diodes, designated types 3G05 through 3G30, the 7 types of the new series have peak reverse voltage ratings ranging from 50 to 300 v. Applications include relay circuits for both dc operation of an ac relay and arc suppression, and power supplies where a low cost, subminiature rectifier is called for. Operating temp. range from −55°C to +150°C. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle 247 on Inquiry Card

New Products

PHOTOVOLTAIC DETECTOR

TO-18 cased gallium arsenide detector for celestial navigation.

GAU-401, provides high sensitivity for both visible and near-infrared radiation detection. Designed for the 0.4 to 0.9 micron region, it has a peak sensitivity at 0.85 microns. Operation up to 120° shows no loss in detector sensitivity. The device exhibits virtually no microphonism and can withstand radiative overloads without permanent damage. Cell areas from 0.2 to 4.0 mm² can be provided. Philco Corp., Lansdale Div., Lansdale, Pa.

Circle 248 on Inquiry Card

COMPACT MICROPHONE

Sonodyne® II features variable freq. response.

This allows the user to tailor the microphone to the application. Model 540S, has a high output dynamic element, a freq. response of 60-10,000 CPS dual impedance and an on-off switch. Unit suitable for "difficult" public address installations and home recording activities. Unit is said to be the only microphone of its kind with the capability for adjustment of both high and low end freq. response independently or together. Shure Bros., Inc., 222 Hartrey Ave. Evanston, Ill.

Circle 249 on Inquiry Card

ASK ASI!

A new 30′ mesh surface antenna from Antenna Systems

This newly designed parabola (Model 101) has a lot to recommend it. For instance:

Versatility — the 101 is suitable for radio astronomy, tropospheric scatter, tracking radar, and experimental test stations. Its f/d ratio of 0.417 adapts to a wide variety of feed systems.

Ruggedness — it can operate under 150 mph winds and 4″ of ice.

Easy assembly — its expanded, reinforced aluminum mesh panels are fully interchangeable. It can be either top — or side-mounted on a tower with azimuth and elevation adjustments, or on el-az or equatorial pedestals, self-contained trailer tower mounts, or other types.

Accuracy — overall static surface tolerance is better than ±0.25. And, if higher accuracy is required, ASI can equip the 101 with solid surface panels which will permit its use at frequencies above 10,000 megacycles.

Unfortunately, we can't mail you the Model 101 for a free trial — but we can send you complete information. Matter of fact, we can help you with any antenna problems you may have. Just write:

ANTENNA SYSTEMS INC.
HINGHAM, MASSACHUSETTS

FOR ANSWERS TO PROBLEMS IN THE DESIGN, FABRICATION AND INSTALLATION OF ANTENNA SYSTEMS, ASK ASI!

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Circle the item number, fill in your name, title, company; detach and mail.

Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

Please send me further information on the items I have circled above.

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CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

A

117 Airpax Incorporated—Low-level magnetic amplifiers

2 Allied & Westlake Co. The—Mercury wetted contact relay

27 Allen-Bradley Co.—Ferrites

24 Allied Chemical Div. General Chemical—Fluorocarbon solvent

102 Alpha Wire Corporation — Shrinkable tubing

62 American Bosch Arma Corp. Tele-Dynamics Division — Telemetry components

[illegible] American Electrical Heater Co.—Transformer type electric soldering iron

130 American Machine & Foundry Co.—Precision meters

57 American Time Products, Inc.—Frequency standards

7 AMP Incorporated—Coaxial connectors

71 AMP Incorporated—Solderless connectors

34 Amphenol Connector Division, Amphenol-Borg Electronics Corp.—Quick-disconnect miniature connectors

65 Borg Equipment Division, Amphenol-Borg Electronics Corp.—Wirewound potentiometers

12 RF Products, Div. Amphenol-Borg Electronics Corp.—Coaxial switches

76 Armco Division—Magnetic alloys

100 Antenna Systems, Inc.—30' mesh surface antenna

17 Arnold Engineering Co.—Iron powder cores

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142 Bendix Corporation, Pioneer Central Division—Sonic energy cleaning

[illegible] Bourns, Incorporated—Trimmer potentiometers

[illegible] Bruno-New York Industries Corp.—"Pig-tailoring" machine

115 Bulova Electronics Div.—D C reference source

9 Bussmann Mfg. Division, McGraw-Edison Co.—Indicating fuses

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8 Clevite Transistor—Power transistors

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67 Continental Electronics Co.—Radio frequency driver system for proton synchrotron

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112 Delco Radio—Germanium power transistors

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55 Exact Electronics, Inc.—Waveform synthesizer

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43 Grayhill, Incorporated—Test posts

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H

68 Hewlett-Packard Company — Calorimetric power meter

73 Hewlett-Packard Company—Frequency/time standard systems

28 Hewlett-Packard Company—Power supplies

15 Hughes Aircraft Company, Semiconductor Division—Switching diodes

PROFESSIONAL ENGINEERING OPPORTUNITIES

Circle number of company on card at right from whom you desire further information.

801 Radio Corporation of America—Professional Employment

111 Hughes Aircraft Company, Vacuum Tube Products Division—Voltage regulated welders

I

132 Ideal Industries, Inc. — Hand-held wire strippers

90 Industrial Electronic Engineers, Inc.—Digital readout device

70 Inland Motor Corporation of Virginia, Subs. of Kollmorgen Corp.—DC torque motors

66 International Resistance Corporation—Trimmer potentiometers

J

73 Jennings Radio Mfg. Corp.—Vacuum relay

125 Johnson Co., E. F.—Tube sockets

137 Jones Division, Howard B., Cinch Mfg. Co.—Plugs and sockets

K

119 Klein & Sons, Mathias—Electronic pliers

L

87 Lenz Electric Manufacturing Co.—Double channel audio cable

M

121 Masterite Industries Division of Houston Fearless Corp.—Component holders

147 Metals & Controls Inc., A Corp. Div. of Texas Instruments Incorporated—Silver electroplated strip

24 Microwave Associates Inc. — Epitaxial silicon varactors

63 Minicom Division Minnesota Mining and Manufacturing Co. — Instrumentation recorder-reproducer

91 Motorola Semiconductor Products Inc.—Mesa transistors

61 Mueller Brass Co.—Design and manufacture of metal products

N

72 Non-Linear Systems, Inc.—Digital voltmeters

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 173 of this issue.

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PROFESSIONAL ENGINEERING OPPORTUNITIES

Please send me further information on the engineering position I have circled below.

801	806	811	816	821
802	807	812	817	822
803	808	813	818	823
804	809	814	819	824
805	810	815	820	825

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31 Nytheifer Winding Laboratories, Inc.—High impedance transformer

124 Nuclear Measurements Corp. — Nuclear instrumentation

O

68 Ohmite Manufacturing Company—Variable transformers

103 Omtronics Manufacturing Inc.—Miniature precision power resistors

P

13 Packard Bell Electronics—Dual gun oscilloscope

92 Panoramic Electronics, Inc. — Sweep Generator

145 Philbrick Researches, Inc., George A.—Solid-state power supply

143 Philbrick Researches, Inc., George A.—Solid-state amplifier

11 Philco Lansdale Division — Germanium switching transistors

10 Potter Instrument Company, Inc.—High density recording systems

5 Precision Instrument Company — Telemetry sub-carrier discriminator

R

1 Radio Materials Company—Ceramic disc capacitors

10 Rayclad Tubes Incorporated — Heat-shrinkable boots

83 Raytheon Company, Industrial Components Div.—High voltage control unit

131 Raytheon Company, Industrial Components Division—Spectrum Analyser

30 Raytheon Company, Semiconductor Division—Semiconductors

128 Reeves Soundcraft Corporation — Magnetic tape test equipment

51 Rotron Mfg. Co., Inc.—Fans

S

23 Sanders Associates, Inc. — Miniature blower

64 Sarkes Tarzian, Inc.—Silicon rectifiers

141 Sekonic Inc.—Meters of all types

79 Shockley Transistor, Unit of Clevite Transistor—4-Layer diode

124 Shure Brothers, Inc. — Communications Microphone

120 Sonotone Corp.—Electronic tubes Transistors

133 Sperry Semiconductor — Silicon Mesa Transistors

78 Sprague Electric—Pulse transformer

2 Sprague Electric—Decade counters

6 Sprague Electric—Metal film resistors

126 Stewart Engineering Company—Backward wave oscillator tubes

101 Stromberg-Carlson — Telephone type components

106 Systems Incorporated — Crystal filters and discriminators

T

59 Taylor Fibre—Glass base laminates

18 Tektronix, Inc. — Oscilloscope with plug-in units

16 Texas Instruments, Inc.—Silicon transistors

104 Tinsley Laboratories, Inc. — Corning Glass color filters

99 Toledo Edison Company — Industrial plant sites

107 Transistor Electronics Corporation—Indicator lights

127 Transvision—Television kits

88 Tung-Sol — High-power germanium transistors

114 Turbo Machine Company—Miniaturized waveguides

V

19 Victoreen—Vacuum tubes

W

93 Waveline Inc.—Microwave instruments & components

116 Western Rubber Co.—Lathe-Cut rubber parts

129 Western Sky Industries — One piece nylon grommets

84 Westinghouse—Power transistors

35 White, S. S.—Air abrasive unit

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MICROMINIATURE MODULE MAKERS!

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The better way's by welding -- the better welder's by Hughes.

Are you reaching for maximum reliability? These manufacturers are. They recognize that only by use of voltage-regulated welders can they achieve the full reliability that welded packaging offers. That's why they've chosen Hughes.

When your microminiaturization problems involve high-density packaging of heat sensitive components, you will find that the better way is by welding—and the best results come from Hughes voltage regulated welders.

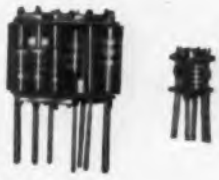
Write or wire today for full information on the complete line of HUGHES electronic welding equipment: **HUGHES, Vacuum Tube Products Division,** 2020 Short Street, Oceanside, California. For export information, write: HUGHES INTERNATIONAL, Culver City, California.

CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
VACUUM TUBE PRODUCTS DIVISION

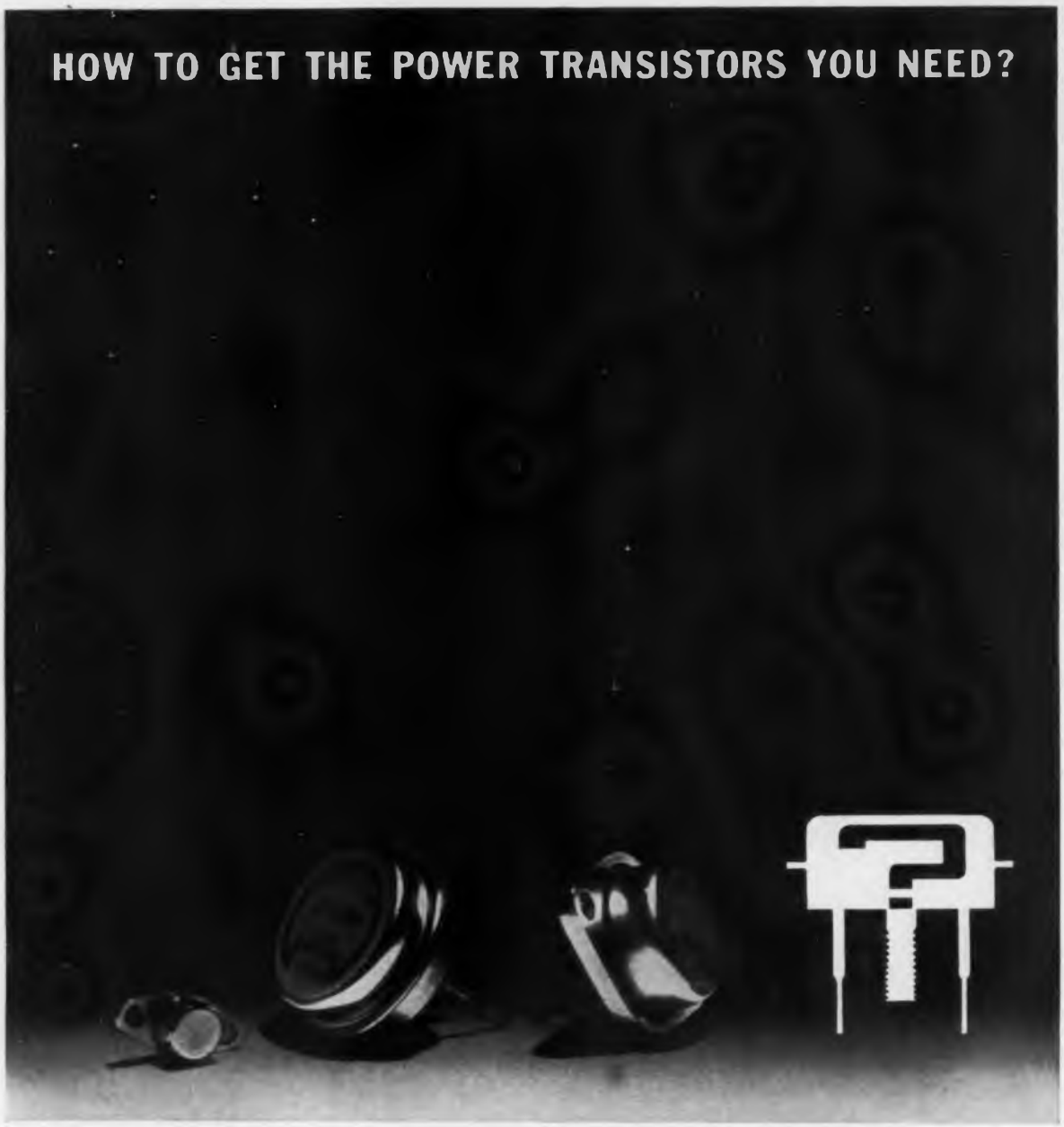
Military Products Group engineers at Minneapolis-Honeywell, St. Petersburg, Florida, use welding for maximum density—encapsulation for maximum strength—to achieve uniform, reliable results in the production of rugged but inexpensive modules. Shown above is Minneapolis-Honeywell module using build-on welded technique.



The Cubic Corporation, San Diego, California, welds presently available, standard components to achieve flexible design of computer logic modules. (above left) 10 mc flip-flop circuit using conventional components, wafer board point-to-point assembly. (right) NAND gate produced to fit TO-5 transistor case using micro components, insulative wafers, point-to-point wiring.

Design engineers at Texas Instruments, Incorporated, Dallas, Texas, face difficult microminiaturization problems. They find that electronic welding produces inexpensive, lightweight, shockproof modules of outstanding reliability. Shown above are modules employing point-to-point welded wiring. (left) Set and reset generator; (right) Oscillator amplifier, dual controlled.

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.

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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

New Products

TRANSDUCER

Sonic Energy Cleaning systems feature a lifetime guarantee.

Omnimite®, a magnetostrictive transducer, metallically bonded to a ¼ in. thick 316-L stainless steel diaphragm is used in this new series of sonic cleaners. Every Bendix Omnimite transducer diaphragm assembly is guaranteed unconditionally not to break, crack, depolarize, deteriorate, become detached or in any way cease to function for the lifetime of the cleaning unit. The Bendix Corp., Pioneer-Central Div., Sonic Energy Products, Davenport, Iowa.

Circle 250 on Inquiry Card

FIELD INTENSITY RECEIVER

Mobile, transistorized, calibrated unit covers the 1 to 10 GC range.

Entire complement of equipment consists of a basic unit, 4 interchangeable r-f tuning units, an impulse calibrator, 5 antennas, and a tripod. Model CFI is designed to perform the tests prescribed by the latest mil. specs covering r-f leakage and interference in electronic and associated equipment. The instrument has single-knob Unidial® tuning; 3 impulse bandwidths; 1 MC, 5 MC, and 8 MC; and an accurate, direct-reading freq. dial. Polarad Electronics Corp., 43-20 34th St., Long Island City, N. Y.

Circle 251 on Inquiry Card

New Products

DIGITAL DELAY GENERATOR

Uses: radar simulator, secondary freq. standard or freq. divider.

Digital Delay Generators are designed for accuracy and precision in generating and measuring time intervals in electronic component testing. Digital circuitry and crystal controlled stability of 1 part in 1 million permit accuracy of better than ±0.003 μsec in 1,000 μsec. Continuous calibration is unnecessary with digital circuitry. Convenient decimal input permits economy in laboratory set-up time. Electronic Designs, 2311 Farrington St., Dallas 7, Tex.

Circle 252 on Inquiry Card

VOLTAGE SENSING RELAY

Adjustable unit operates contacts at pre-determined level.

The device features an input impedance of greater than 100 KΩ, a differential between pull-in and drop-out of less than 1%, switching accuracy of ±5% over the temp. range, and adjustability over broad voltage ranges. Available in various contact configurations and ratings, the units are normally hermetically sealed; can be provided to sense either ac or dc voltages, and use either ac or dc auxiliary power depending on type required. HI-G, Inc., Bradley Field, Windsor Locks, Conn.

Circle 253 on Inquiry Card

How to shrink a filter!

Magnetics Inc. "120" solves the problem of core size vs. inductance in miniaturized circuits

Trying to squeeze high core inductance into a small space for use in miniaturized resonance, filter, audio, or carrier frequency circuits usually ends in a compromise. You either force more out of a smaller core, or you use a larger one. Not so, however, if you're familiar with the Magnetics Inc. "120."

This molybdenum permalloy core has a .655 inch outer diameter—is just between the .500 and the .800 inch core you may be using. What makes this little fellow unique is its inductance per 1,000 turns . . . higher than either of its neighbors, whether 60, 125 or 160 permeabilities.

Note, too, that like all Magnetics Inc. powder cores, the "120" is performance-proved and rated within realistic inductance limits. All permeabilities are available from stock now. What's more, the 125 permeability core is inductance stabilized within $\pm 0.1\%$ from 0° to 55°C.

More information on this and other cores in the Magnetics Inc. line is contained in design bulletin PC-203 R. It's yours by writing *Magnetics Inc., Department EI-91, Butler, Pennsylvania.*

MAGNETICS inc.

New Products

CONTROLLED RECTIFIERS

For use in power supplies, motor controls and inverters.

The TI-150 Series of 25 a diffused silicon controlled rectifiers eliminate using low-current SCR's in parallel to handle high-current applications. Packaged in TI's new SCR stud package with an average rectified forward current of 25 a at 100°C, it carries a max. dc current of 35 a at 95°C. Rated breakover voltages, both forward and reverse, for the series are 50, 100, 200, 300 and 400 v. Texas Instruments Incorporated, P. O. Box 5012, Dallas 22, Tex.

Circle 254 on Inquiry Card

IN-CIRCUIT TESTER

Measures in-circuit parameters of transistors and diodes.

Instrument will measure ac Beta, in or out of circuit, with an accuracy of 5% with impedances as low as 25Ω. Tester uses patent-applied-for method of neutralizing circuit impedance before tests to prevent inaccuracies. The fully transistorized, battery operated tester has 3 I_{cbo} ranges: 0-5 μa, 0-500 μa and 0-5 ma. I_c ranges are 0-1 ma, 0-10 ma, 0-100 ma. Collector voltage is variable to 4.5 v. in 3 steps and collector current is variable, 0-100 ma. The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

Circle 255 on Inquiry Card

Special Pliers for the Highly Specialized Electronics Field

When the early transmission lines were strung in this country a century ago, it was Klein Pliers in the hands of linemen that helped do the job.

Klein has kept pace with the development of the electrical field, meeting each new challenge with tools specially designed to do the wiring job better . . . more economically.

Shown here are a few of the many highly specialized Klein Pliers carried in stock to meet the needs of electrical and electronics manufacturers.

You will find your assemblies go together more smoothly and wiring is done more rapidly when the right Klein Plier is used.

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Company_____

Address_____

City_____ State_____

Circle 119 on Inquiry Card

New Products

FEEDTHROUGH TERMINAL

Miniature unit with pigtail lead saves construction time.

Sealectro Press-Fit® Type FT-M-9 has a standard pin lug on the opposite end from the pigtail lead. The pigtail lead is 1½ in. long, but may be specified in other lengths. The lead allows bending to other terminations for point-to-point wiring. It is especially adaptable to printed wiring boards and computer assemblies. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N. Y.

Circle 256 on Inquiry Card

POTENTIOMETER

Single-turn Micropot's® have standard range from 100 to 200 KΩ.

The 2490 Series is 3 in. in dia. and 1 in. long. Resistance element is wirewound featuring certified resistance alloys wound on thermosetting cards. Max. power rating is 6 w at 40°C. Gangable up to 8 units on a shaft, will withstand temps. up to 125°C. Servo, bushing or tapped-hole mounts are available. Terminals are gold-plated for improved solderability and are color-coded for position and function identification. Borg Equipment Div., Amphenol-Borg Electronics Corp., 120 So. Main St., Janesville, Wis.

Circle 257 on Inquiry Card

PROGRESS IN MICROWAVES

New General Electric VTM's and TWT's . . .

ADVANCE S- AND X-BAND TRANSMITTER CAPABILITIES

Provide Higher Power in Lighter, Smaller Tubes

Four new General Electric power tubes—two voltage-tunable magnetrons and two traveling-wave tubes—have been designed to advance transmitter capabilities in S- and X-bands. All provide higher power in smaller, lighter, more compact packages for missile and airborne transmitter applications.

HIGH EFFICIENCY, LIGHT WEIGHT VTM's

Designed primarily for space applications, the Z-5428 voltage-tunable magnetron achieves an efficiency of 35 percent in a tube weighing only 4.5 pounds. Moreover, it operates under severe shock and vibration conditions with only radiation cooling. Tests show the Z-5428 meets shock requirements of 40 G's for 11 milliseconds and vibration requirements of 5 to 25 cps at one quarter-inch double amplitude; and from 25 to 2000 cycles at 10 G's.

Equally efficient and compact, the Z-5424 provides high power (50 W min.) in an exceptionally light (4.5 pounds) VTM. And like the Z-5428, it is a complete r-f power package requiring only input and r-f output power connections.

Both VTM's can be linearally voltage-tuned without mechanical adjustment.

HIGH-POWER, COMPACT TWT's

The two new high-power traveling-wave tubes are designed to operate in series, one as the driver and one as the final amplifier in a pulsed high-power chain for X-band radar applications. They are compact, of metal-ceramic construction, and incorporate an advanced focusing system utilizing periodic permanent magnets requiring no temperature stabilization. The Z-3090 driver tube weighs only 15 pounds while the Z-3091 amplifier tube weighs 42 pounds with electrical connectors. Both tubes are ruggedized for airborne applications and can be mounted in any position.

These TWT's, as well as the new VTM's, are now available in sample quantities. Delivery in 90 to 120 days.

265-06

FREQUENCY RANGES AVAILABLE*

VTM's OSCILLATOR SERVICE

Frequency (KMC)	P_0 (Min. CW)
2.2 – 2.3	10 W
2.5 – 3.5	10 W
2.9 – 3.2	50 W
5.17 – 5.42	10 W

TWT's AMPLIFIER SERVICE

Frequency (KMC)	P_0 (Min. Peak)
5.4 – 5.9	25 KW
8.5 – 9.6	5 KW
8.5 – 9.6	50 KW
8.5 – 9.6	250 KW

**These tubes can be scaled to meet specific frequency and power requirements.*

TO ORDER, or obtain more information, contact your nearest Power Tube Sales office (telephone numbers listed below).

POWER TUBE DEPARTMENT

GENERAL ELECTRIC

TELEPHONE TODAY—Syracuse, OL 2-5102 . . . New York City, WI 7-4065 . . . Clifton, N. J., GR 3-6387 . . . Washington, D. C., EX 3-3600 . . . Chicago, SP 7-1600 . . . Dayton, BA 3-7151 . . . Orlando, Fla., GA 4-6280 . . . Los Angeles, GR 9-7765

Circle 122 on Inquiry Card

Z-5424: 50 percent efficiency—2900 to 3200 mc.

Z-5428: Designed for space—2200 to 2300 mc.

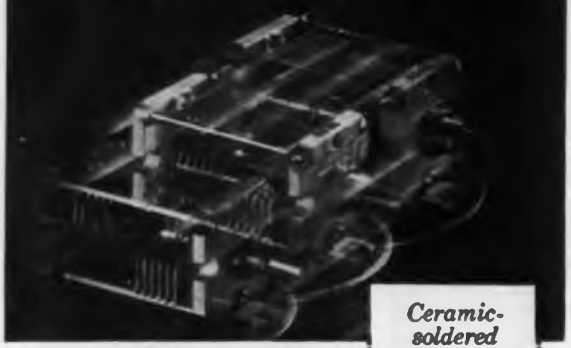
Z-3091: Periodic permanent-magnet focus high-power traveling-wave tube

LOOK TO G-E POWER TUBE DEPARTMENT FOR:

- Ignitrons
- Hydrogen Thyratrons
- Magnetrons
- Metal-ceramic Tetrodes
- High-power Duplexers
- Klystrons
- Thermionic Converters
- Traveling-wave Tubes
- Harmonic Filters

THESE RUGGED JOHNSON VARIABLES WITHSTAND TERRIFIC

VIBRATION and SHOCK!



Ceramic-soldered for greater strength!

Parts can't break loose... capacity can't fluctuate!

Set your frequency... these tough Johnson "L" variables will hold it—even under severe conditions of shock and vibration! Designed to provide outstanding strength, rigidity and operating stability—rotor bearings and stator support rods are actually soldered directly to the heavy .3/16" thick steatite ceramic end frames. Parts can't break loose... capacity can't fluctuate!

Specially designed split-sleeve tension bearing and silver-plated beryllium copper contact provide constant torque and smooth capacity variation. Plating is heavy nickel—plate spacing .020", .060" and .080" spacing as well as special platings, shaft lengths and terminal locations in production quantities.

A complete variable capacitor line . . . from tiny sub-miniatures to large heavy duty types!

From the tiny Type "U" sub-miniature, which requires less than 0.2 sq. in. for chassis or panel mounting—to the rugged heavy-duty "C" and "D" types . . . the Johnson variable capacitor line is designed for more capacity in less space—offers you one of the widest standard capacitor lines in the industry! For detailed specifications on all Johnson variable capacitors, write for your free copy of our newest components catalog, described below.

New Catalog

Write today for our newest electronic components catalog—complete specifications, engineering prints and current prices on:

• CAPACITORS • TUBE SOCKETS • CONNECTORS • PILOT LIGHTS
• INSULATORS • KNOBS, DIALS • INDUCTORS • HARDWARE

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New SHURE "TEN-FOUR" MICROPHONE, with exclusive Armo-Dur housing, and another microphone with standard die-cast metal housing were dragged for miles on a test drive over all kinds of pavements at speeds to 30 mph. In a matter of minutes, it was subjected to greater punishment than a lifetime of severest mishandling *and here's the result:*

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Tele-Tech's
ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • JULY 1961

SYSTEMS—WISE . . .

▸ **Melpar, Inc., has developed under Air Force contract a speech compression system based on formant tracking and capable of communicating speech in a total bandwidth of 150 CPS. When digitized compressed speech signal can be transmitted at a rate of 1000 bits/sec. System is for spectrum conservation, coded communication and long-range communication for manned space craft.**

POWER IN SPACE

Artist's conception of polar thermoelectric power generator on a space vehicle near Mars. Solar power plant composed of 1/10 in. thick thermoelectric panels joined to form energy - collecting sheet facing sun. Panels convert light energy into auxiliary electric power. General Atomic Div., General Dynamics Corp.

▸ RACEP (Random Access and Correlation for Extended Performance) is the equivalent of a private radio telephone system. It operates like an ordinary telephone system but without wires or central switchboards. Modulation techniques to carry voices in the form of quick pulses of radio energy are used on a single freq. band simultaneously between persons and locations. Only receivers pre-set for the proper code of a specific conversation can receive and reconstruct its fragments into a normal flow of speech. Range for prototypes 15 mi. The Martin Co., Orlando Div.

▸ **Heart of the Bendix control system in the B-58 Hustler, "The Spirit of St. Louis III," in setting new Transatlantic speed record, was a computer. The control system begins in the nose, picking up data concerning air speed, air density, temperature, aircraft attitude and other information. This information is fed to a central air data computer which then translates the pilot's control-column movements into the right amount of actual control-surface motion.**

▸ **IBM, Data Processing Div., together with Pratt & Whitney, United Aircraft Corp. and AIAA, has unveiled AUTOPROMT (AUTOmatic PROgramming of Machine Tools). This new computer language describes the shape of an object, taking the dimensions directly from blueprints. The relation of surfaces, rather than each path the tool must follow, is described. The part description is punched into cards and fed into a computer. The computer then selects and generates tool travel instructions. AUTOPROMT programming manuals and operating instructions are available from IBM without charge.**

▸ **Electronic converter for use in the programming of missiles has been created for the SAC by the Digitronics Corp. The converter is solid state and bi-directional and converts magnetic tape to punched paper tape at a speed of 300 characters/sec., 3,000 words/min. It will be used to prepare trajectory instructions for the Minuteman, Atlas and Titan missiles.**

▸ Coast-to-coast data processing system supplied to United Air Lines by The Teleregister Corp., provides reservation data for a thousand ticket agent locations throughout the U. S. It operates at over 1,300 words/min. System is interconnected by 12,000 miles of leased circuits. Inquiries from passenger stations on main loops receive answers in an average time of 1 sec. On tributary lines, tapped to the loops at certain points, the process takes 5½ sec. Entire high speed system checks itself regularly every second.

▸ **Three new air-transportable centrals providing the U. S. Army with unlimited communications in limited wars have been developed by Adler Electronics. The AN/TSC-18, AN/TSC-19 and AN/TSC-20 can be transported to any world trouble spot and erected in hours for telephone and teletypewriter contact with the Pentagon. Their ranges are 7,500, 5,000 and 2,500 miles respectively. They are compatible with STARCOM, the Army's global communications network. The systems are SSB.**

▸ General Electric Co. will supply a solid-state automated mailbag handling system for the Louisville and Nashville Railroad Co. The system, to sort as many as 2400 mailbags an hour, will be installed at Union Station, Nashville, Tenn. It includes equipment to convey, store, sort, and automatically deliver mailbags to any of 30 loading chutes, as well as automatic car-loading equipment for dispatching of the sorted bags.

BREATH-TAKING EXPERIENCE

Part of a new instrumentation system, by Minneapolis - Honeywell's Heiland Div., the experimental device pictured is for post-operative monitoring of respiration. The complete system, expected to be introduced later this year, would make it possible to automatically monitor and record patient pulse rate, blood pressure, respiration and temp. in hospital recovery rooms.

Automobile ignition systems must operate under unfavorable conditions such as over or under voltage, high switching frequencies, and environmental extremes. New systems using semiconductors are being designed and built which will overcome these problems as well as others that plague today's conventional systems.

From Overseas . . . .

Electronic Ignition Systems

By DR. A. V. J. MARTIN
Director
Electronique Automatisme
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Paris 9, France

THE idea of applying electronic techniques in the automobile industry is not new. One of the first concepts was probably that of electronic ignition systems. A large number of troubles, with the usual automobile, originate in the ignition system, which must perform properly under unfavorable conditions of overvoltage, overintensity, high switching frequency and temperature extremes.

That there is large room for improvement is only too common knowledge. However, most ideas based on electronics did not reach practical application until the advent of semiconductors, with their characteristic ruggedness, small size, and also the possibility of working directly off the standard battery voltage. Besides ignition, there are of course a number of domains wide open to electronics in the automobile industry. Let us cite for example voltage and current stabilization, automatization of numerous functions, and various applications of photoelectric cells.

For the reasons already stated, and painfully evident every time an automobile mechanic presents his bill, ignition is at the forefront of automobile industry thinking. A number of electronic systems are being developed or even have left the laboratory stage to reach industrial production.

Electronic Ignition Systems

In the classical ignition system, the primary switch is put to hard work because of the large current and the high switching frequency. Contacts bounce, become pitted and deteriorate, and periodical inspection and maintenance has become a necessity.

A basic idea is to use the current amplifying properties of a transistor. The primary switch is placed in the base circuit (Fig. 1) and controls a power transistor. The ignition coil primary winding is fed by the collector. In this way, there is only a small current flowing through the mechanical switch, with resulting improvement. The problem has been only displaced however, because now it is the transistor which is doing the hard work. Although the basic circuit could work with a suitable transistor, matters can be improved by more sophisticated circuits, such

Fig. 1: Adding a transistor to the basic ignition system will prevent point burning.

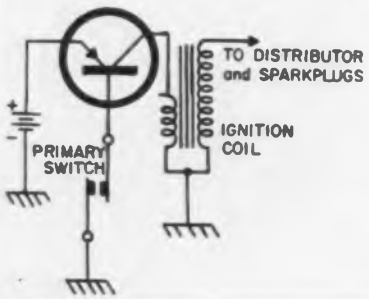
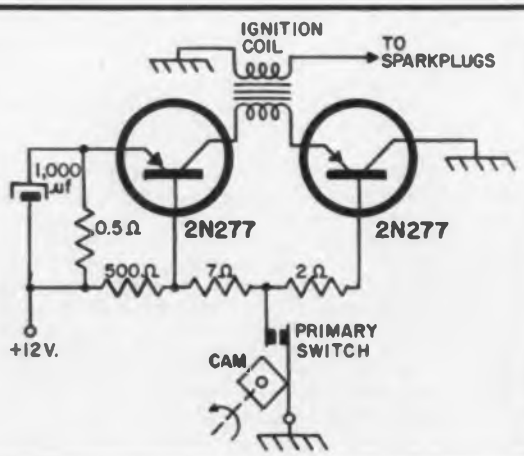


Fig. 2: With two transistors the working load is divided. This increases transistor life.



Designs

as the commercial Ducellier unit represented in Fig. 2.

In this diagram, the mechanical switch, cam-driven by the engine as usual, controls a pair of 2N277 power transistors. These transistors are series connected with the primary winding of the ignition coil and are fed by the battery. The secondary, or high-voltage, winding of the ignition coil feeds the spark-plugs through a high-voltage distributor as usual.

The fact that the transistors are series-connected eases matters somewhat, since each unit is submitted to only half of the overvoltage. Notice that the capacitor usually connected across the primary switch has to be disconnected in this circuit. The same advantages accrue as before, the main one being that the primary switch has only to control the small base current.

An improved circuit is shown in Fig. 3. It is again a commercial product by Ducellier. This time, the system is purely electronic, since even the mechanical primary switch has disappeared. The top half of the circuit resembles the preceding arrangement. The main improvement results from the addition of a high-voltage crystal diode, inserted in the transistor return circuit, and whose function is to eliminate the overvoltages produced during opening of the circuit.

The remainder of the circuit is new. It consists of an electromechanical trigger unit which replaces the primary switch. This unit is essentially made of a coil, across which pulses are produced by the rotation of a star magnet driven by the engine. These pulses are not powerful enough to control directly the pair of power transistors. They are amplified by a transistor driver using a medium power transistor.

This arrangement offers several advantages. Elimination of the classical primary switch does away with all of the contact problems. The triggering is accurate and can be time controlled by very simple means. It can also be automatically controlled with ease. The spark produced across the spark plugs is always satisfactory, because it is largely independent of the engine speed and even of battery voltage, including the voltage drop due to the starter. Moreover, the circuit is practically immune to

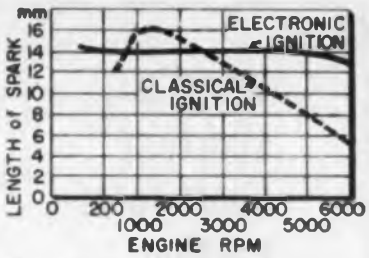


Fig. 4: Graphs illustrate the difference between the two types of ignition systems.

environment, and particularly to heat or humidity. All transistors work only as on-off switches.

Fig. 4 illustrates the difference in performance between a classical and an electronic ignition system. To allow practical comparison on a basis somewhat akin to actual working conditions, which has been measured is the maximum length of the spark produced in free air, as a function of engine speed. This length is shown in millimeters on the ordinate scale, while the abcissa scale carries the engine RPM. The difference is striking. Classical ignition shows a pronounced peak around 1200 RPM, after which the curve goes down, almost linearly. Electronic ignition produces an almost horizontal curve.

Electronic Speed Meter

The classical engine speed- or RPM-meter is coupled to the shaft through some sort of flexible mechnical link, which is again a common source of trouble. It can be replaced by an electronic system, such as the one proposed in Fig. 5. Pulse signals appear across the cam-driven ignition primary switch. They are applied, through

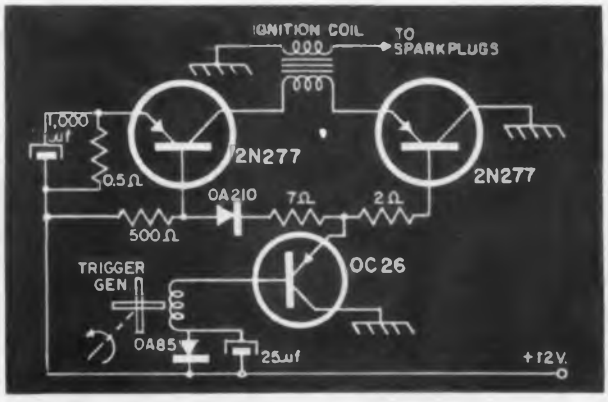
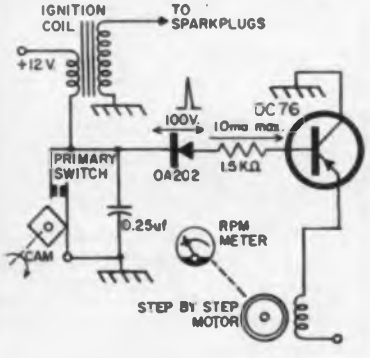


Fig. 3: The ignition system is purely electronic since the breaker points have been eliminated.

Fig. 5: Drawing illustrates a method of incorporating a speed meter into a conventional type of ignition system.



Ignition Systems

(Concluded)

a rectifying diode and a limiting resistor, to the base of a transistor. Amplified signals are available in the low-impedance emitter circuit. They are used to drive a remote RPM-meter of some kind. In the circuit shown, a step-by-step Retem motor is used to this effect, with direct display of the rotation speed. The diode is a high-voltage silicon type, and the transistor is a power type suited to the motor it drives.

Of course, the very same arrangement can be used as a speed meter. In this case, control pulses are obtained after the gearbox. This can be done in a number of ways, for example with a cam-driven switch, or again with an electromechanical trigger generator similar to the one used in Fig. 3.

A simpler and more rugged arrangement is represented in Fig. 6. It could also be adapted to engine speed metering. A small step-by-step motor is mechanically linked to the shaft and is used as a generator. The pulse it produces drive another remote motor, which actuates the speed display.

Automatic Speed Regulation

The preceding system can be modified to ensure automatic speed limitation. In this variant, a speed dial is installed on the dashboard, with a manually adjustable pointer. Assume the pointer is set at 60 MPH. The driver, stepping on the accelerator, increases the speed until it exceeds 60 MPH. At this moment, the electronic system is triggered and cuts the link between the accelerator pedal and the carburetor. The speed limit can not be exceeded, and the possibilities of the system will be better understood when it is realized that

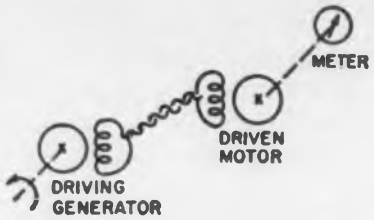


Fig. 6: A simple electrical speed meter.

mounting the controls on the dashboard is in no way necessary. The control can be set anywhere out of reach, or even be made tamper-proof.

Fig. 7 shows, in simplified form, how the speed limiter works. A small alternator, or a step-by-step motor used as a generator, is mechanically driven by the shaft at the output of the gear box. It can provide speed metering as indicated before and as shown on the diagram. For speed limiting, use is made of the fact that the signal has a frequency which is proportional to speed. The pulses are rectified and integrated, so that the resulting dc level represents speed. A variable series resistor adjusts this dc level and constitutes the speed control mentioned previously. The dc level controls the base of a power transistor, and it will be noticed that a Zener diode or a thermistance is used to ensure precise triggering of the transistor.

When the transistor is conducting, its collector current flows through the exciting coil of an electromechanical clutch, coupling the accelerator pedal to the carburetor control. The arrangement is such that when the generator signal frequency exceeds the preset limit, the coupling opens and the speed can not be increased any more. Exact circuit details are somewhat more sophisticated, but Fig. 7 gives a good idea of the system.

For the European transistors indicated, approximate equivalents are 2N257 for OC 26 and 2N188 for OC 76.

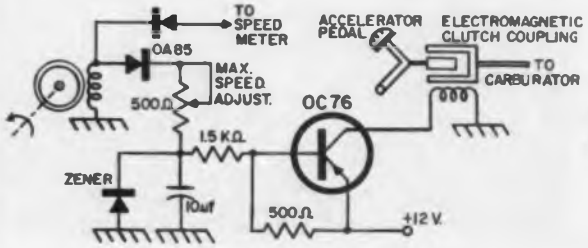


Fig. 7: A simplified drawing of how an automatic speed limiter would work.

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Proc. AIRE. Proceedings of the Institution of Radio Engineers

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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 Uberragung
El Rund. Elektronische Rundschau
Freq. Frequenz
Hochfrem. Hochfrequenz-technik und Electroakustik
Nach. Z. Nachrichtentechnische Zeitschrift
Rt. Regelungstechnik
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechniczne

USSR

Avto. i Tel. Avtomatika I Telemekhanika
Radio. Radio
Radiotek. Radiotekhnika I Elektronika
Rad. i Elek. Radiotsennika I Elektronika
Iz. Acad. Bulletin of Academy of Sciences USSR

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ANTENNAS, PROPAGATION

Phase Center of Antennas. A. R. Volpert. "Radiotek" 16, No. 3, 1961. 10 pp. An analytic form of the phase diagram in which the antennae have a phase center is established. Properties of antennae without phase centers are analyzed. (U.S.S.R.)

Considerations of Topological Characteristics of the Array Factor in the Projection of Four-Element Cophased Arrays with a Reduced Level of Spurious Radiation. V. I. Beketov. "Radiotek" 16, No. 3, 1961. 9 pp. This is a method to reduce the level of spurious radiation in four-element cophased arrays. It is based on the consideration of topological characteristics of the array factor. Results are given of the measurements of the relative gain factor of a typical antenna. (U.S.S.R.)

GENERAL

A Crystal Filter of Increased Bandwidth and its Synthesis. W. Herzog. "Nach. Z." March 1961. 5 pp. A calculation of a filter with a symmetrical attenuation curve on the basis of two given attenuation values is carried out. (Germany.)

New Thermionic Ionization Gauge. N. A. Forescu. "Vide." Jan.-Feb. 1961. 8 pp. A new design of ionization gauge is described in which the two electrodes acting as electron emitter and ion collector, respectively, are placed inside the positive grid having the form of a helical coil. (France.)

Barkhausen Oscillations in Ionization Gauges. J. Pierre. "Vide." Jan.-Feb. 1961. 5 pp. It was often noticed that, under particular conditions, very high frequency oscillations took place in ionization gauges of the triode type. This phenomenon is unwanted, as, on one hand it changes the gauge sensitivity, and, on the other hand, supply leaks disturb its operation. The present paper is directed to the analysis of this phenomenon and to subsequent means to avoid unwanted oscillations. (France.)

Commercial High Vacuum Short-Path Distillation. K. Lohwater and H. Eckstein. "Vide." Jan.-Feb. 1961. 10 pp. The classic examples of commercial molecular distillation mentioned in the literature are the concentration of vitamin esters from fish liver oils, and the production of high purity monoglucerides of fatty acids. (France.)

How Canada's Electronic Industries Association is Meeting Industry Problems. W. S. Kendall. "El. & Comm." April 1961. 4 pp. The article reveals some of the behind-the-scenes activity of the part EIA is playing in Canada's industrial growth. (Canada.)

Applications of Electroluminescence. M. Vingert. "El. et Auto." May 1961. 6 pp. This article recalls the design of an electroluminescent lamp and its main characteristics. Some typical examples of application are described. (France.)

Analytical Solutions for Linear Equations Describing One Class of Variable Parameter Dynamic System. C. G. Litovchenko. "Avto. i Tel." April 1961. 9 pp. With the help of operational calculation the solution in general form is obtained for linear equations with linearly changing coefficients. (U.S.S.R.)

Problems of Non-Linear Filtration. I. I. A. Bolshakov & V. G. Repin. "Avto. i Tel." April 1961. 13 pp. A problem of filtration of a random process (parameter) from its non-additive mixture with another random process (parameter carrier signal) with some assumption for both random processes is solved. (U.S.S.R.)

Amplification of Low-Power Periodic Signals. B. A. Mamyrin. "Radiotek" 16, No. 3, 1961. 7 pp. A method is analyzed for amplifying low-power wide-band periodic signals with a possibility of observing their form at the output. (U.S.S.R.)

Residual Magnetization Distribution Along the Thickness of Magnetic Recording Tape. V. A. Geranin. "Radiotek" 16, No. 3, 1961. 6 pp. An attempt is made to establish the law of distribution of the residual magnetization along the thickness of the magnetic recording carrier, which is in the form of a magneto-dielectric powder tape, with signals recorded with a standard ring-type head and high-frequency magnetisation. (U.S.S.R.)

An Additional Method for Optimal Treatment of a Received Signal in the Presence of Noise. F. P. Tarassenko. "Radiotek" 16, No. 2, 1961. 6 pp. It is shown that there exists at least one additional method to demodulate AM signals. From the informative standpoint, this method is as effective as synchronous detection. (U.S.S.R.)

MATERIALS

Ferrite Cores for High Speed Stores and Their Operational Properties. C. Heck, J. Weber. "Nach. Z." April 1961. 7 pp. After a summary of the ferrite materials suitable for stores and the methods of manufacturing ferrite cores follows a comparison between the mechanical and electrical requirements and the measured properties. The effects of amplitude and rise time of the reading pulse as well as temperature fluctuations and asymetries on the signal voltages are discussed with the aid of measured values. (Germany.)

Special Piezomagnetic Ferrites in Band Filters and Supersonic Cleaners. C. M. Van der Burgt. "El Rund." March 1961. 4 pp. Properties and characteristics of various piezomagnetic materials (Ferroxcube 7A1, 7A2 and 8B) are discussed. Two fields of application (band filters and supersonic cleaners) are discussed in greater detail. (Germany.)

Components and Type Series of Magnetic Amplifiers. Peter Kratz and Alfred Long. "AEG Prog." #1, 1961. 12 pp. The suitability of different forms of transductor cores is discussed. In addition to magnetic characteristics, constructional questions are considered, design data and examples being given. (Germany, in English.)

Properties and Applications of Indium Antimonide. R. E. J. King and B. E. Bartlett. "Phil. Tech." #7, 1961. 9 pp. In this article the preparation of InSb crystals and the construction and performance of photocells based on InSb are described. (Netherlands, in English.)

MEASURE & TESTING

The Detection of Seasonal Delay Fluctuations of Waves in the 100 kc/s Band by Means of an Evaluation of Observations Collected Over Many Years from the German Decca-Chain. W. Feyer. "Nach. A." April 1961. 14 pp. Since 1952 many observations within the coverage of the German Decca chain have been made at various daytimes and seasons on the propagation of the radiated frequencies in the 100 kc/s band. In the present paper the curves are subjected to a critical investigation in respect of transients depending on the daytime and in respect of fluctuations over longer periods. (Germany.)

Calculation of the Static Operating Conditions of a Two-Transistor Trigger Circuit. N. M. Ashimoff. "Radiotek" 16, No. 3, 1961. 9 pp. A method to calculate trigger circuit parameters is presented based on the presence of four static operating conditions. Data obtained theoretically and experimentally are compared. (U.S.S.R.)

An Electronic Distance Measurement System for Accurate Survey. M. R. Ramsay. Jan. 1961. 4 pp. This paper gives an explanation of the principles and operation of the Tellurometer, a recent invention. (Australia.)

Test Results of Standard 1.18/4.43 mm Coaxial Pairs in the Marseille-Toulon Cable Link. R. Belus and M. Trouble. "Cab. Trans." April 1961. 17 pp. The Marseille-Toulon cable includes five small diameter standard coaxial pairs surrounded by 38 double-twisted 0.9 mm quads in two layers. Intermediate repeaters with a 6 km spacing divide the cable length into 11 amplification sections. The paper gives measurement results obtained from all the 11 sections, relating to impedance, impedance deviation, crosstalk and attenuation. (France.)

An Approximate Determination of the Distribution Function of a Normal Process at the Output of a Typical Section of an R-F Circuit. V. S. Borodin. "Radiotek" 16, No. 2, 1961. 6 pp. An approximate expression is found for the differential distribution function of instantaneous values of a normal random process with an unlimited spectrum (white noise) at the output of a typical R-F section. (U.S.S.R.)

An Evaluation of the Effectiveness of Methods to Accumulate Data in the Process of Determining the Time Position of Weak Pulse Signals. B. N. Mityasheff. "Radiotek" 16, No. 2, 1961. 9 pp. An effectiveness evaluation of methods to accumulate data in the process of determining the time position of a group of weak pulse signals with coherent and incoherent high frequency content is performed. (U.S.S.R.)

A New Method for Calculating the Signal Distortion in High Frequency Cables. K. Rihaczek and H. Worner. "Nach. Z." March 1961. 6 pp. A method for a power series representation for the transmission factor of its approximation by polynomials is described in detail. Two examples are given for the application of this method in the case of a carrier-frequency pulse transmission. (Germany.)

TRANSMISSION

Theory of Waveguides and Cavities—3: Perturbation Theory and its Applications. R. A. Waldron. "El. Tech." May 1961. 6 pp. The basis, applications, and limitations of perturbation theory are discussed in relation to waveguides and cavities. (England.)

The Standard Frequency Transmission of the German Federal Post Office. J. Bastelberger. "Nach. Z." Feb. 1961. 10 pp. An introductory summary of the principles of the generation of standard frequencies is followed by a description of the units and measurement methods used in the standard frequency equipment installed at the Central Bureau of Telecommunications of the German Federal Post Office. (Germany.)

Long-Distance Waveguide Transmission. R. Hamer. Part I. "Elec. Eng." April 1961. 8 pp. The feasibility of long-distance circular waveguide (H_{01}-wave) transmission using frequency modulation is examined on the assumptions that a special waveguide structure is provided and that waveguide imperfections are random. (England.)

Waveguide Equipment for 2 mm Microwaves II. Measuring Set-ups. C. W. van Es, et al. "Phil. Tech." #6, 1961. 9 pp. In Part I of this article, a review was given of the equipment developed by Philips for 2 mm microwaves. Part II contains a description of some measuring set-ups in which the use of the components discussed are considered in more detail; some components which were not considered in Part I are also described. (Netherlands, in English.)

New Distortion Criterion—Part 1: Audience Reaction to Non-Linearity Distortion. E. R. Wigan. "El. Tech." April 1961. 10 pp. Summary: In any sound-transmission system nonlinearity distortion is always present to some extent. Part I: Experiments are described which separate out those features of the distorted sounds which are responsible for the audience reporting that they are unpleasant to listen to. (England.)

The Theory of Waveguides and Cavities—2: Examples of Waveguides and Discussion of Special Points. R. A. Waldron. "El. Tech." April 1961. 8 pp. The general approach described in the first article of this series is applied to two examples, the guide consisting of a metal tube of circular cross-section enclosing air, and the coaxial line, taking the one material to be a general dielectric instead of a perfect conductor. (England.)

Carrying Capacity of an Elliptical Waveguide for a E_{11} Type Wave. V. Y. Smorgonsky. "Radiotek" 16, No. 4, 1961. 3 pp. The author analyzes the relative intensity distribution of the lateral and longitudinal electric field components at the cross-section of an elliptical waveguide. The carrying capacity is determined on the basis of power considerations. The change in the carrying capacity is evaluated as a round waveguide is deformed into an elliptical waveguide. (U.S.S.R.)

Certain Aspects to Increase the Effectiveness of the Wireless Electromagnetic Energy Transmission. A. M. Pokras. "Radiotek" 16, No. 2, 1961. 6 pp. An analysis is conducted of a wireless transmission system with ellipsoidal mirrors. Graphs are obtained for the determination of the efficiency of this line. Advantages of such a line with ellipsoidal mirrors are considered and also compared to lines with parabolic mirrors. (U.S.S.R.)

A Rhythmic Time Division Multiplex for the Transmission of Five Telemetering Data Channels Over a Single Telegraph Channel. Peter Buck. "Freq." March 1961. 5 pp. A time-division multiplex system is described, which allows the simultaneous transmission of five telemetering data over a single telegraph channel. (Germany.)

CUES for Broadcasters

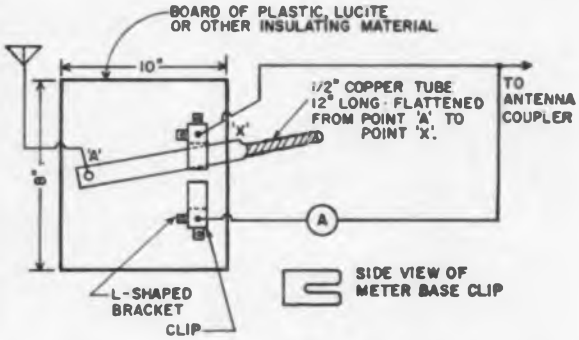
Antenna Meter Protective Switch

CHARLES T. SMITH, Ch. Eng.

KBTA, Batesville, Ark.

With a piece of insulating board about 8 by 10 inches, a few bolts and nuts, 12 inches of ½ inch copper tubing, and the clips from an old meter base from a kilowatt meter as used by power companies, a serviceable and inexpensive switch to remove the antenna base current meter from the circuit, can be constructed.

The accompanying drawing shows placement of parts. The local power company gave us the clips from a discarded meter base. The copper tube cost 50¢, and other material came out of the "junk" box. The tube



Antenna meter switch can be made from "junk box" parts.

is flattened from swivel point "A" far enough to fit into clips easily but firmly. The clips are spaced close enough for a "make-before-break" condition. The handle can be insulated with a knob or you can just wrap it with three or four plies of plastic electricians tape like we did. We are using it with a kw operation and it has been in use for more than a year.

Low Priced Echo Chamber

WILLIAM J. KIEWEL, Mgr.

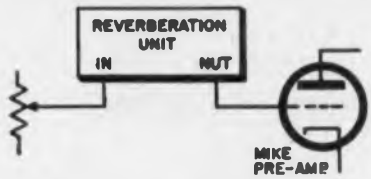
KROX, Crookston, Minn.

Reverberation units made to be used in Hi-Fi sets are now on the market. They include the mechanical delay unit used in Hammond organs and can be used as an echo chamber on any console without any conversion.

At our station we simply put the entire unit, which has an input and output at high impedence, in series with the grid lead to one of the mike input tubes. A switch can be added to put the unit in or out of the circuit, although we keep this one mike input exclusively for echo. No other inputs on the console are affected. The amount of echo is controllable.

There is some loss in the reverberation unit which can be compensated for by riding the mike gain control a little higher. Although some hiss may be pro-

duced by the high gain, it is not objectionable using echo. The unit we use is a Sergent-Rayment SR-202 but Knight also makes one. Both sell for under $50.00.



A switch can be added to the circuit to cut-out the reverberation unit.

Interesting variations can be produced by installing the unit just before the master gain control, which gives echo on records and all inputs. It is also interesting to use a regular mike input and the echo input at the same time.

Care should be taken to mount the mechanical delay section on a solid wall because it picks up mechanical vibrations quite easily.

$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double spaced text is requested. Our usual rate will be paid for material used.

Printed Circuits

(*Continued from page* 109)

flat surfaces, and eliminates as many crossovers as possible. A touch-up fluid by K&E permits the repair of delicate areas without the loss of accuracy.

Fig. 1. Draftsman J. Saude uses parallel line cutter to incise circuit path on STABILENE CUT'N STRIP film. This tool permits precision cutting of parallel lines.

Fig. 2. Mr. Saude peels out circuit path by lifting one edge of film in the outlined area and pulling it from sheet.

Fig. 3. Master is corrected using specially prepared touch-up fluid.

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

Circle 133 on Inquiry Card

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!

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

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

"Shortage of Engineers Approaching Crisis"

Business management magazine "Dun's Review and Modern Industry," predicts that industry will be hobbled by another severe shortage of engineers. "Few businessmen, in fact, are even aware of the fast approaching crisis," they report.

All companies won't be hit equally hard by the shortage. Some companies with glamorous products such as missiles and satellites may succeed in drawing all the engineers needed.

The number of freshmen entering engineering colleges has dropped sharply in the past three years, which will account for the predicted future scramble. Even if a business recovery should spark a reversal of the trend this September, the upturn in enrollments wouldn't have much effect for four or five years—the time it takes a student to graduate.

Technological progress and Russian pressure are creating new, more complex jobs for engineers. Even now, industry leaders report difficulty in filling many specialized technical openings. Salary competition for graduating engineers continues brisk.

Dun's Review sees much of the coming shortage the result of past industry shortsightedness. A few years back, government contract cancellations were reflected in wholesale firings of engineers—a panic action which caused youngsters entering college to shy away from the profession.

Honorary Member of AIEE

Dr. Allen B. DuMont has been named an honorary member of the American Institute of Electrical Engineers. It is the highest honor awarded by that society. Dr. DuMont is only the 48th person to be made an honorary member of the Institute since it was organized in 1884.

WEMA SCHOLARSHIP

H. P. Hayes, Dean of Engineering at Calif. State Polytechnic College, San Luis Obispo, Calif., presents Linda R. Miller a freshman Cal Poly coed, the first Western Electronic Manufacturer's Association scholarship awarded to an electronic engineering coed in the 60 year history of Cal Poly. A. J. Clement of Diodes, Inc. in Los Angeles, representing the WEMA looks on.

Expanding Overseas Market a Challenge

Overseas markets for American products are at a higher level than at any other time in history according to Ray W. Macdonald, Vice President in charge of International Division of Burroughs Corp.

Macdonald said that the economies of peoples outside North America are progressing at an astonishing rate and have surpassed all previous records. The ultimate result of this progress is the creation of an international market with a sales potential for U. S. industry two to four times the size of the present North American market, he said. American businessmen must reorient their thinking to this changing market, he asserted, if they hope to compete and stay alive.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 151.

Space Market Prediction Made by Space Executive

Growth of the space market in the 60's will double the skyrocketing growth of the electronics market of the 50's, according to G.E. space expert A. W. Robinson.

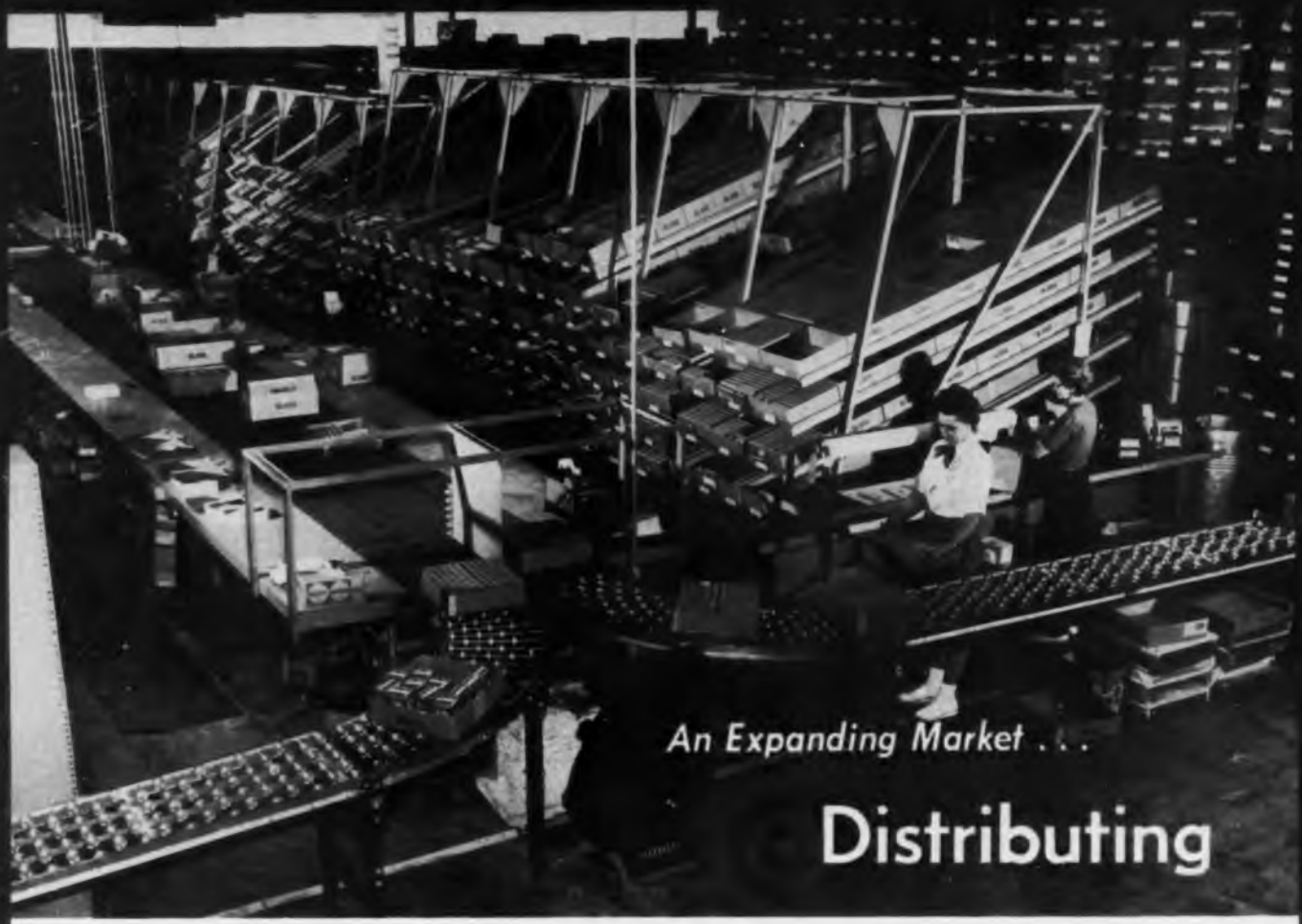
Mr. Robinson said that the space market will increase from one billion dollars per year in 1960 to eight billion dollars per year in 1970. The electronics industry experienced only a four-to-one growth rate during the last decade.

Government foresight, business courage and engineering imagination, he said, are the principle forces behind the growth of the space market. He explained that his company is already conducting government sponsored studies for five multi-manned space missions in which performance of the space vehicle will be improved by integrating the human intelligence and physical reaction of future astronauts with vehicle design.

He added that space will have a major impact on our economy in this decade as a new frontier for exploration, as a key instrument of national policy and as a source of opportunities for economic development.

Ford Foundation Grant

Cornell University has received a $4,350,000 grant from the Ford Foundation to further strengthen graduate study and research in the College of Engineering. The grant will contribute toward the endowment of 11 professorships. It will help provide graduate fellowships and loan assistance, additional facilities for study and research, and will make other funds available for special purposes in the College of Engineering. A period of 10 to 15 years will be covered by the grant.



An Expanding Market . . .

Distributing

THE industrial market for electronic parts distributors may be defined as those users of electronic equipment and accessories who use that equipment for manufacturing, process control, communications or services. This is as opposed to the dealer market, which is classified as the consumer-user of entertainment or other home electronic devices maintained by a retail service dealer.

Included in the broad industrial market are these basic categories of customers:

1. Broadcast Stations — Television, AM and FM transmitters and studio equipment.

2. Communication Users—Fixed and mobile communication users such as industrial concerns, airlines, state and local police and fire departments, utility customers and industrial concerns using microwave transmitter devices for processing or operating controls.

3. Industrial Control Devices—Industrial concerns such as metal fabricators, chemical industry, electrical concerns, newspapers, the paper industry and many others who use speed control devices, electronic heating, welding control and other devices which use electronic circuitry in the control of manufacturing equipment.

J. A. Hickey

The miscellaneous category covers a broad spectrum of electronic applications such as laboratories, colleges and universities, hospitals and other institutions where electronic devices may be used for security, communications, data processing or any one of a number of purposes using electronics functionally.

Size of the Market

Due to the variety of applications in the industrial market as described above and the broad dispersion of devices which employ electronic circuits, specific market sizes are not as clearly defined as they are in the home entertainment field. However, each of the broad categories described above can be quantitatively defined with varying degrees of accuracy, depending on the ability of either a manufacturer or a distributor to list the specific location and type of equipment being measured. For example, the broadcast industry is known in terms of the total number of operating facilities and the use by transmitter of the perishable components used in such equipment. In the other extreme, the miscellaneous category is not so easily defined due to the myriad of applications involved and the broad dispersion geographically.

In 1961 products sold by distributors to the industrial categories outlined above should exceed $450,000,000 and may reach $550,000,000 due to the rapid growth of new applications in these categories for electronic devices. It is difficult for anyone to accurately define the size of this dynamic market.

However, we do know that the industrial segment

Left: Shown is a high-speed warehouse setup for filling distributor orders.

By JOHN A. HICKEY

Industrial Products Mgr.
Distributor Products Div.
Raytheon Company
Lexington 73, Mass.

Airlines, business and private aircraft are a distributor market that should be given strong consideration.

Once the industrial market was served exclusively by the manufacturers. Now most market their products through distributors. Knowledge of how the manufacturer and distributor both should function means a better relationship and greater profits.

Industrial Electronic Parts

of our business is greater than the entire distributor market for electronic components ten years ago.

In a recent study one major airline provided statistics, by type, of electronic products used in 1958 and 1959. This particular airline was involved in a transition from propeller driven aircraft to jets. Their 1959 usage was estimated at over $250,000 for both airborne and ground-based electronic devices. To give you an idea of the product scope covered in this usage, they used the following basic product categories to make up this total dollar figure:

1. Reliable receiving tubes
2. Entertainment receiving tubes
3. Magnetrons
4. Bright radar tubes—cathode ray
5. Semiconductors
6. Power tubes
7. Mechanical hardware

In addition to the above categories they estimated additional substantial purchases of accessory devices which amount to well over an additional $200,000. Since this airline was one of the five major domestic airlines, a distributor can determine the potential of any such account which may be within his trading area. This is but one example indicating the potential development of specialized distribution in an industry which can provide such a total volume. When you consider that this does not include business or private aircraft, you can readily determine the potential market which is represented in this end use category. It is estimated by the F.A.A. that in 1965 the domestic fleet of commercial aircraft will be around 2,000. The business and private aircraft fleet will reach an estimated 75,000.

As another example, the industrial control market should reach $250,000,000 in sales of end equipment in 1961 and should represent a market of more than $7,000,000 in terms of tubes and components required for maintenance.

Purpose of Industrial Distribution

The industrial electronic components distributor was developed to provide time and place utility of product required for these purposes:

A. Maintenance of existing operating equipment
B. Small quantity requirements for research and development and small quantity OEM needs

This need did not exist when the number of such customers was small in number. Then application engineers from any manufacturer could participate directly in the sale of his product to both users and OEM accounts. Most distributors will recall that the entire broadcast industry used to be served on a direct basis by tube manufacturers. It wasn't until the number of broadcast outlets reached its present combined total of over 4,300 AM, FM and TV transmitters that the principle of serving this class of customer through distribution was established. Similarly, it has been only within the last two years that manu-

Parts Distribution *(Continued)*

facturers have found for the same reason that accounts previously handled directly as OEM accounts could be handled more effectively by distributors. The significance of this is indicated by the $450,000,000 market which now is not only the privilege of the distributor to serve, but also his responsibility to serve.

How can a program be developed in the light of these market characteristics by:

A. The manufacturer
B. The distributor

Manufacturer's Program

The manufacturer must first develop a definition of his own objectives in serving each of the basic market categories. He must then establish price structure, terms and conditions of sale which are compatible with the distribution system.

After the manufacturer has established his terms and conditions of sale, which recognizes the handling of OEM accounts as well as the normal maintenance business, a distribution policy, which can be clearly defined, should be established. This should clearly reflect the functional support which the manufacturer requests in terms of market coverage by class of customer and the method by which the manufacturer expects his franchised distribution to approach the market.

One of the key elements in such a program should be the clear definition of cutoff points beyond which the manufacturer expects to serve OEM accounts directly, or beyond which it is not economical for the distributor to participate on a normal basis.

Such points have been established in manufacturers' programs and will, undoubtedly, be extended to higher volume breaks as the distribution system itself justifies the contribution which it is making and can make to the end customer.

Heat induction equipment, such as this, and many other manufacturing devices require a variety of replacement parts.

Distributor Program

Based on the programs which manufacturers develop for the industrial market, the distributor must, after selecting those programs which he feels will best lend themselves to his own objectives in the industrial market, organize his activities and business structure to provide for the implementation of both the manufacturer's program and his own.

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

Based on the size of the market and depending on the share of the total industrial market represented by the distributor trading area, enough specialized and concentrated effort is essential to establish an industrial distribution reputation. In many cases, distributors have developed stocks which they consider adequate to serve the industrial market without proper regard for the type of sales personnel and administrative backup necessary to support a continuous effort in this field. Most successful industrial distributors have developed an organization within their over-all organization to concentrate on serving this market. Some of the basic steps necessary are based on these business functions:

1. Survey the Industrial Market—This should be done through a specific listing of all known industrial accounts in the area, plus a listing of the product groups which normally are required for these users.

2. Develop both an internal and external organization structure based on the present size of the market and its potential during the next three to four years. Assign specific outside sales personnel by account with corresponding internal personnel assignments to support the outside activities.

3. Set up specific inventories by type of product based on the real needs of your industrial market.

4. Develop promotional and advertising campaigns to publicize your activities.

5. Use manufacturers' personnel and published material for product symposiums directed towards specific customer groups. For example, conduct broadcast symposiums for the engineers from all stations within your market. Conduct maintenance seminars for manufacturing customers using electronic controls, induction or dielectric heating or other devices requiring maintenance.

In serving the industrial market, the normal points of buying influence are both the buyer himself and the engineering personnel specifying product. Each of these points are of equal significance in determining your success in supplying the needs of the market. Whether your customer is being served as an original equipment manufacturer or for maintenance, the same principle applies.

(Continued on Page 178)

Industry News

Dr. Allen B. DuMont—named an Honorary Member of the AIEE, highest honor awarded by that society. Dr. DuMont is the 48th eminent person made honorary member of the Institute since 1884.

Dr. Walter K. Volkers — elected President, Director and Chief Executive of Lionel Electronic Laboratories, div. Lionel Corp., Brooklyn, N. Y.

Thomas J. Watson, Jr., Chief Executive Officer, International Business Machines Corp., New York, N. Y., has been elected Chairman of the Board.

T. J. Watson, Jr.

W. H. Moore

William H. Moore — named Staff Vice President, Military Products Div., Electronic Industries Assoc.

Non-Linear Systems, Inc., Del Mar, Calif., announces the appointments of **Robert A. Cordner**, Supervisor of Materials; **Stuart H. Zuck**, district Sales Manager, Southern California.

Donald E. Young—elected Assistant Vice President - General, Burroughs Corp., Detroit, Mich.

Hughes Aircraft Co., Culver City, Calif., announces the appointments of **John E. Locke**, Manager of Diode Operations, Semiconductor Div. and **Herbert S. Evander**, Manager of Transistor Products, Semiconductor Div., Newport Beach, Calif.

Gene E. Lewis—appointed Manager of Marketing and Engineering, General Electric Co.'s High Voltage Special Transformer Section, Holyoke, Mass.

Albert L. Williams—elected President, International Business Machines Corp., New York, N. Y.

Frank L. Roberts—appointed Vice President and Assistant to the President of Sperry Gyroscope Co., div. Sperry Rand Corp., Great Neck, N. Y.

Samuel F. Commons — appointed Manager Plant Engineering, Brown Instrument Div., Minneapolis-Honeywell Regulator Co.

William L. Moorhead—named Products Manager for ac capacitor sales, Sprague Electric Co., North Adams, Mass.

Parts Distribution *(Concluded)*

Training

In view of the relative newness of the industrial market as a major segment of an electronic parts distributor's business, it is extremely important that every available training device be used. These are a few methods which can be made a part of a continuous program to make the distributor personnel more productive for their organization and more useful to the end customer:

The number of radio and TV stations in existence has changed the old pattern of the manufacturer dealing directly with each station for supplying replacement parts.

a. Frequent visits to supplier's plants. These should not be restricted to the distributor principal, but should include his sales manager and key inside and outside sales personnel. Instead of waiting for the manufacturer who is supplying you to invite you and your organization, ask him for such a meeting.

b. Written training programs — As an example, Raytheon is providing a continuous program directed towards training industrial personnel on specific markets which they may serve in their area. Such programs can be supplemented by distributors' own sales meetings to discuss the application of such knowledge to their own business problems.

c. Periodic customer surveys—In view of the rapidly changing characteristics of the industrial market, it is important to audit customer requirements and competitive practices. From such a survey distributors can determine customer requirements and reflect their requirements in the constant change in service necessary to keep abreast of the real needs of their customers.

A pattern of success in the industrial market is being established in many parts of the country. If an electronic parts distributor wishes to enter this field or establish a better position for himself, he can readily determine from the limited number of successful industrial distributors what formula has been successfully applied. From these cases specific principles will evolve. And they certainly can apply to each distributor's business and may eliminate unnecessary errors in either judgment or practice.

One of the most serious problems which a distributor faces in establishing a position is the creation of inventories which are adequate for the market, but which do not represent idle inventory.

Inventory Control

Inventory control as a distributor problem has become a much more serious operating factor with the development of the industrial market. Most distributors are familiar with the large stocking requirements for product lines which were not even a part of their inventory four or five years ago. Since the supply of the growth capital from profits has not noticeably improved, the only alternative is to use devices which will provide for turnover which is attainable in the dealer products business. Since this is a new field, without the statistical product turnover information, it is essential that distributors develop a mechanical playback of sales activity quickly to minimize investment in dead inventory. My suggestion is to approach this problem from two directions:

1. Use salesmen to develop specific market requirement data by customer.

2. Set up automatic replenishment systems with manufacturers which will reflect actual market activity.

The probability of turnover in the maintenance market, which includes broadcast, communication and industrial users, is fairly well defined. The balance of the market, which may be categorized as the small OEM or laboratory requirement, can probably never be as closely defined, but can be improved through the simple device of developing requirement estimates from each of these customers.

A frequent review of items which are not turning over should be made to either make sure that potential customers are being solicited or to determine that there is not a market for such products. Most manufacturers are glad to replace such products with items which do more in the distributor's area.

Conclusion

In summary, we can conclude that we are looking at a market of approximately $450,000,000 in 1961. It is essential that a distributor participating in this market organize his business, both with regard to procedure and personnel, to serve the needs of this market as it differs from other markets.

There is no substitute for specific knowledge of existing and potential customer characteristics in one's trading area. A part of each of your outside salesmen's time should be devoted to "smokestack calls" to expose new potential in the area. Distributors should train men and train themselves to develop market orientation to the basic customer categories outlined previously. The distributor who is sensitive to these changes will easily adjust himself to both new markets and new potentials in known markets. Don't forget that electronics is now a part of the business scene in accounting, data processing, in manufacturing of all types, and in all of the service industries. Awareness to customer scope must be continuously enlarged to fit these new areas.

Industry News

Robert E. Johnson—to the post of Vice President and Sales Manager, Shallcross Mfg. Co., Selma, N. C.

Henry J. Pannel, Jr.—promoted to Sales Manager for Kintel Div., Cohu Electronics, Inc., San Diego, Calif.

George F. Houlroyd—elected Vice President - Manufacturing, Foto-Video Electronics, Inc., Cedar Grove, N. J.

Dean Johansen—promoted to Head of Materiel, and **Earl A. Melander** appointed Business Manager, Engineered Electronics Co., Santa Ana, Calif.

Louis H. Aricson—named Chief Executive Officer, Weston Instruments Div., Daystrom, Inc., Murray Hill, N. J.

Even T. Collinsworth, Jr.—elected President and Chief Administrative Officer, Fansteel Metallurgical Corp., North Chicago, Ill.

E. T. Collinsworth, Jr.

H. E. Rice

H. Edward Rice—named Vice President-Operations, Philco Corp.'s Government & Industrial Group, Phila., Pa.

Donald G. McDonald—named Vice President-Engineering, Sola Electric Co., Div. Basic Products Corp., Elk Grove Village, Ill.

RCA Sales Corp., announces the following appointments: **B. S. Durant** elected Vice President—Product Planning and Development; and **Justin L. Albers** named Vice President—Distributor Operation Services.

Robert Merrick—promoted to Advertising and Sales Promotion Coordinator, Diode Facility, Fairchild Semiconductor Corp., San Rafael, Calif.

Dr. Walter Duchinsky—has joined the Lionel Corp. as Director of Research & Development Planning.

Thomas J. Payne, Treasurer—elected Vice President and Treasurer, J. Bishop & Co., Platinum Works, Malvern, Pa.

"Wire & Cable" Chart

On this chart, which appeared on page 61 in ELECTRONIC INDUSTRIES' All-Reference Issue, June 1961, the source was inadvertently omitted. The data should have been credited to Hudson Wire Co., Ossining, N. Y.

why compromise

your specifications to use a "stock item" meter when SEKONIC can give you exactly what you need at "stock item" economy prices?

It costs you nothing to get the facts about Sekonic's "Made-to-your-order" meter facilities . . . and the economies involved can be substantial.

Sekonic Meters are now being purchased by major meter users (names upon request) who require large quantities on tight delivery schedules. From simple A-C amperages and D-C voltages to complex, acceleration-proof radiation counters, Sekonic's experience in the fulfillment of specific meter requirements may be of considerable help to you.

Unique component and assembly quality control procedures assure you of an unsurpassed in-use reliability.

Specifications with your delivery requirements will receive immediate attention.

Write for your FREE copy of "Sekonic Meters . . . A Story of Precision."

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Sonic Energy Cleaning Systems

REDUCED INITIAL COST
25% less cost

LESS FLOOR SPACE
up to 40% less

MAXIMUM RELIABILITY
proven design—field tested

IMPROVED EFFICIENCY
compact power generation

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on new Omnimite® transducer

SYSTEM INTEGRATION
improved filter, rinse & dryer

RESTYLED CABINETS
for maximum adaptability

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Please send complete information on your new Sonic Energy Cleaning line, including compact Uni-Son® models.

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News of Mfrs' Representatives

ERA Adds Dir. of Ed.

Accelerating its educational activities, ERA adds a new Director of Education, **Robert J. Morgan.** The new Director will work under ERA's Exec. Dir. William C. Weber, Jr. His duties include: operation of the four BMI's; coordinate business session portions of the Annual Conv. & Management Conf.; develop educational programs for local chapters; and coordinate the manufacturer-representative workshops.

ERA Testimony on S.B. Tax Credit & Expense Accounts

Henry Lavin, Meriden, Connecticut, representative, before the Ways & Means Comm. of the U. S. House of Representatives, gave ERA views on President Kennedy's tax message. He urged Congressmen to provide some form of a tax credit to representatives who plough back part of their earnings into modern office equipment and other physical assets. On expense accounts, he advised, representatives would prefer, as an alternate to any flat dollar amount limitation (particularly on a per diem basis), "to see the restrictions on the types of deductions tightened," if such a limitation is necessary.

Computer Measurements Co., Sylmar, Calif., announced the appointment of **Atlas Instrument Corp., Ltd.,** Toronto, Ont., to cover Canada.

Dan R. Bittan announces the appointment of **Dan Leib** as Sales Engineer for the D. R. Bittan Co. Inc., Valley Stream, L. I., N. Y., to cover Northern New Jersey.

Polyphase Instrument Co., Bridgeport, Pa., announces the appointment of **Lowry Dietrich Co.,** Cleveland, Ohio, as representatives in the states of West Virginia, Kentucky, Ohio, and Western Pennsylvania.

North Electric Co., Component Products Div., Galion, Ohio, has made the following representative appointments: **Electro-Ser Co.,** Minneapolis, to cover Minnesota, the Dakotas, and Western Wisconsin; **Engineering Services Co.,** St. Louis, Mo., for Missouri, Kansas, Iowa, Nebraska and southern Illinois; and the **E. F. Aymond Co.,** to extend their coverage to include Arkansas, Louisiana, Mississippi and Western Tennessee.

ESC Electronics Corp., Palisades Park, N. J., announces the appointment of two West Coast representatives. For Southern California, **Shephard-Winters Co.,** No. Hollywood, Calif., and for Northern California, **William J. Purdy Co.,** San Francisco, Calif.

ELECTRONIC INDUSTRIES Advertisers—July 1961

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INFRASONIC VOLTMETER

0.01 cps to 30 kc

This peak to peak vtvm has been designed to make accurate measurements from 30 kc down to 0.05 cps, or even to 0.01 cps with corrections. Square waves may be measured with the stated accuracy to 0.5 cps. Accuracy is **better than 3 percent of reading regardless of voltage or frequency.** Provision is made for speeding up measurements that might be delayed by severe overload or by a dc component on the input signal, or by a reduction of the voltage being measured. This instrument may be used for measurements of peak to peak voltages in such applications as automatic control systems involving low frequency servomechanisms, and in fields where infrasonic frequencies down to 0.01 cps are encountered, or in measuring voltages at very low frequencies at the output of signal generators. Flutter down to 0.05 cps is virtually eliminated, and is very small at 0.01 cps. Power line transients have negligible effect.

Price: $330.

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SPECIFICATIONS

Voltage Range..... 20 mV-200 V peak-to-peak

Frequency Range..... 0.05 cps-30 kc (Down to .01 cps with correction)

Accuracy..... 3% ENTIRE RANGE AT ANY POINT ON SCALE

Input Impedance..... 10 MΩ shunted by 17 pF or 40 pF

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Boonton, New Jersey

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From Receiving to Assembly in One Operation!

- Eliminates batch plating after stamping or blanking.
- Available in strip form . . . widths from .020" to 5½" . . . with thickness capacity ranging from .002" to .080" . . . priced to sell!
- Rigid quality control. . . complete facilities for plating, rolling, slitting or annealing . . . to suit your most exacting specifications.
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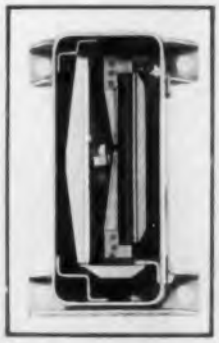

SPECIFICATIONS

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.

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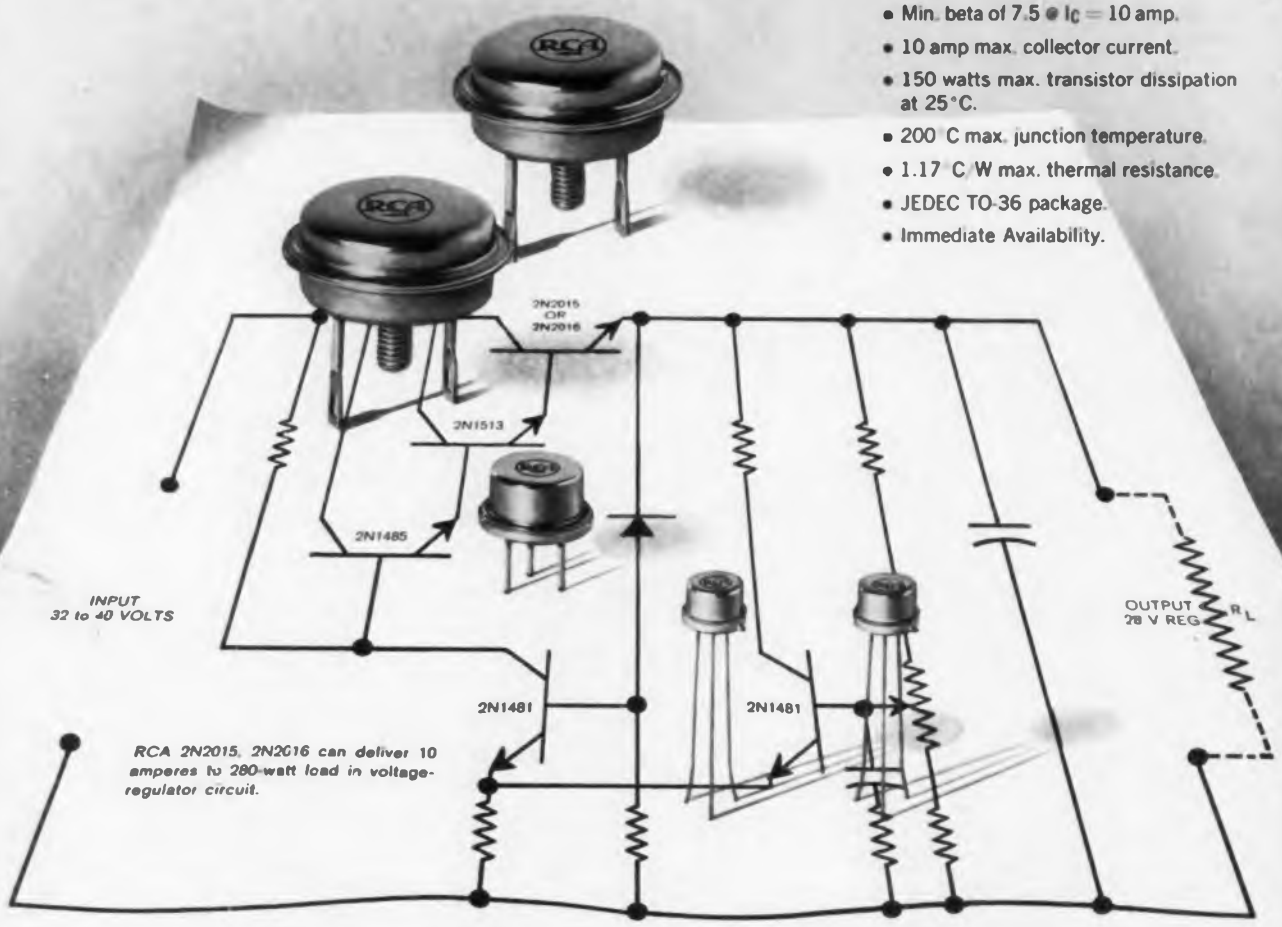

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Check these superior ratings against those of the germanium types you are now using:

Type	Dissipation @ 25°C Watts	I_C Amp	V_{CEX} Volts	$V_{CEO(sus.)}$ Volts	Typical h_{fe} @ I_C	Constr.	JEDEC Package
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2N2015	150	10	100	50	25	NPN	TO-36

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