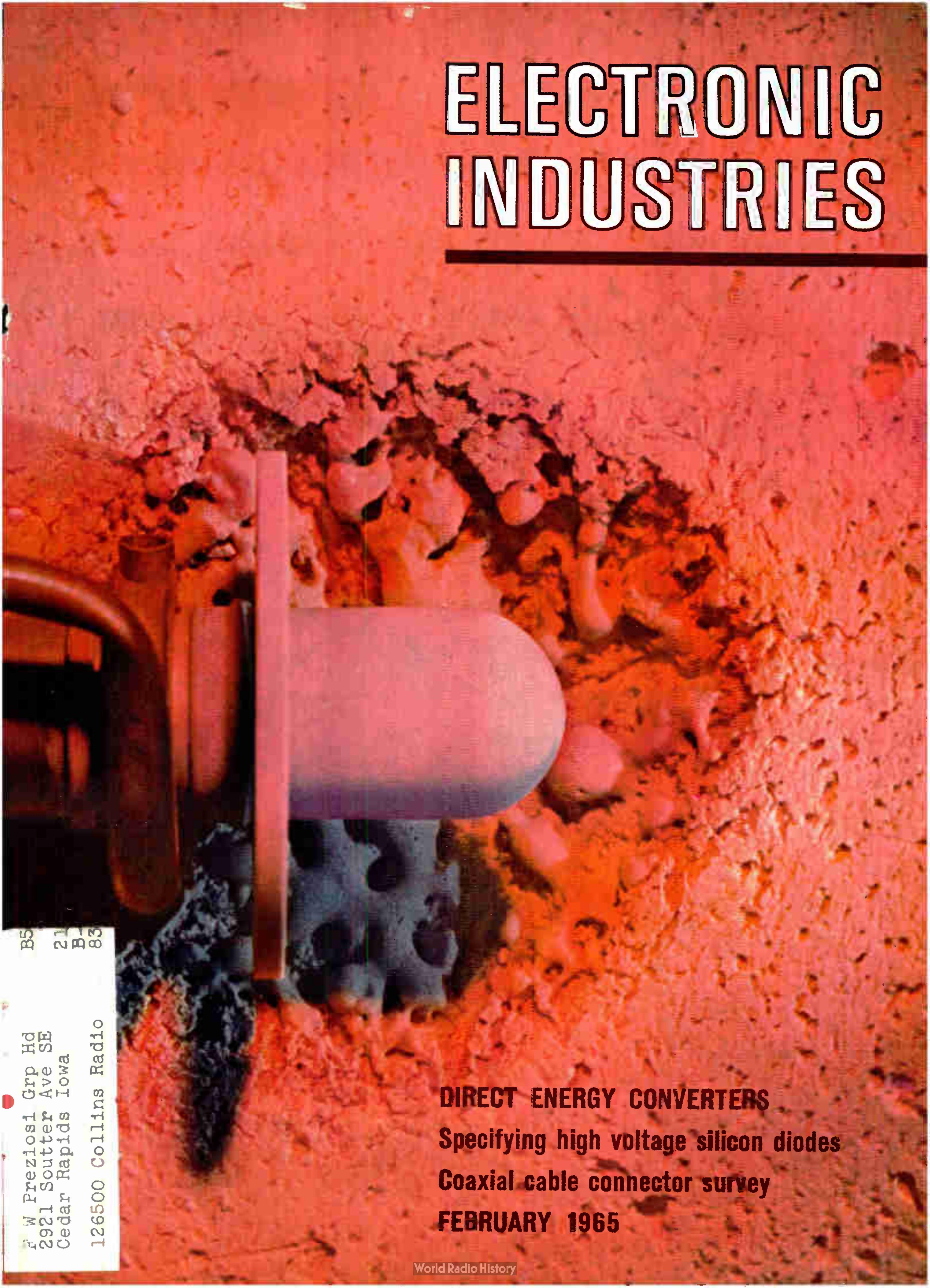
ELECTRONIC INDUSTRIES



DIRECT ENERGY CONVERTERS

Specifying high voltage silicon diodes

Coaxial cable connector survey

FEBRUARY 1965

F W Preziosi Grp Hd
2921 Soutter Ave SE
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126500 Collins Radio
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World Radio History

Call our hand on reliability*

We'll start the showdown with a pair of wire-wound resistors. Our ARS is the world's most reliable power wirewound resistor. Our AGS will soon take this title as a result of testing in the Advanced Minuteman Program. Examine this chart. Note that in the AGS, we're building more reliability into a *smaller* resistor which has a *higher* power rating than the ARS. And we're doing it under more stringent test requirements. No one but Dale produces such a high degree of proven reliability in precision power resistors. Most of our customers don't need it. But they assume that what we've learned about reliability gives our standard parts an edge in quality and performance. They're right.

ARS & AGS RESISTOR DATA

	ARS	AGS
Unit Test Hours:	788,000,000 equivalent unit hours.	323,000,000 equivalent unit hours.
Operating Conditions:	50% rated power, 25°C ambient.	50 % rated power, 25°C ambient.
Failure Rate:	.00045% per 1,000 hours (60% confidence level.) **Failure definition:** Δ R > 0.5%.	.0001% per 1,000 hours (60% confidence level is goal of new program.) **Failure definition:** Δ R > 0.5%.
Specifications:	ARS available in 3 models, rated at 2, 5 and 10 watts in a resistance range from .1Ω to 40K Ω. Standard tolerance 1%.	AGS available in 4 models, rated at 1, 2.25, 4 and 7 watts in a resistance range from .1Ω to 12.4K Ω. Standard tolerance 1%.
Mil. Spec.:	Meets MIL-R-38101 and MIL-R-26, and the new established reliability spec. MIL-R-39007.	Meets MIL-R-38101 and MIL-R-26, and the new established reliability spec. MIL-R-39007.
Comparative Size:	ARS-2 (2 watts) .812" long x .187" dia.	AGS-3 (2¼ watts) .400" long x .078" dia.

* Write for • Detailed Test Reports on ARS & AGS Testing • All-new Resistor Catalog A

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1304 28th Avenue, Columbus, Nebraska
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Circle 98 on Inquiry Card

World Radio History

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART Magazine

Why So Slow With Direct Energy Conversion?

WHY IS IT TAKING SO LONG to develop the new types of power sources?

We must ask this question when we see how little has been done in this field over the past ten years.

True, some progress has been made. A decade ago, all new direct energy conversion schemes were either on the drafting board or laboratory curiosities. Today, a few supplies have reached limited production for space vehicles and for sophisticated "toys." But that's about all! Is it enough? We think not.

It is common knowledge that batteries have severe limitations as power sources for microminiature electronic equipment. They have limited life, don't store well, are poor sources at low temperatures. A-c supplies are heavy and bulky and highly inefficient, generating heat that must be dissipated to prevent damage to circuit components. And, they must be "plugged in" to some other source of energy and are thus only conversion devices—not true power sources.

Almost a decade ago, Westinghouse demonstrated in the laboratory the feasibility of a number of new direct energy conversion schemes. Among these were magnetohydrodynamics (MHD), fuel cells, thermoelectrics, thermionics and solar cells. New, ten years later, only solar cells are commercially available. The other devices are still laboratory curiosities or in limited use for powering space vehicles and equipment.

Yet, during the same period of time, look what has happened in semiconductor technology, in integrated circuits, in electronic circuit packaging, in television, in computer technology! All of these areas have had an almost complete evolution from laboratory to production.

The irony of it all is that when we look to improve the design of computers, semiconductor circuits, integrated circuits and portable TV sets, existing power sources constitute the principal limiting factor. And, it looks like nothing significant is being done about it.

A state-of-the-art piece on the subject of new power sources appears on p. 36 in this issue by an RCA scientist. Yet, David Sarnoff, in his reported remarks to stockholders recently, emphasized several glamorous areas of work at RCA without mentioning this important field. But, it is a field where work should be concentrated if other devices are to achieve full potential

We can't begin to guess at the vast number of possible applications for new direct energy converters. Our crystal ball could suggest many. But, you who are our readers— who are on the firing line to deliver a better product in smaller space, with less weight, at lower cost, and to last a "lifetime" —can put together a much more practical list of specifics.

What we hope is that you will put your "wheels" to work when you read Mr. Rappaport's article. We want you to come up with these specifics—applications that will place such requirements on power sources that they will stimulate RCA, Westinghouse, General Electric and others now engaged in limited research and development of energy sources, to step up their development programs.

Think, for instance, of what could be tremendous new markets for portable power in the underdeveloped countries of the world as well as at home for marine applications and rural development. Think of all the potential applications in portable appliances of all kinds. It seems to us that companies should, in the future, allocate a higher percentage of their research and development funds for just such studies.

Here is a challenge for electronic engineers and engineering managements. Some good profits are in the offing for those with foresight and ingenuity in the field of direct energy power sources.

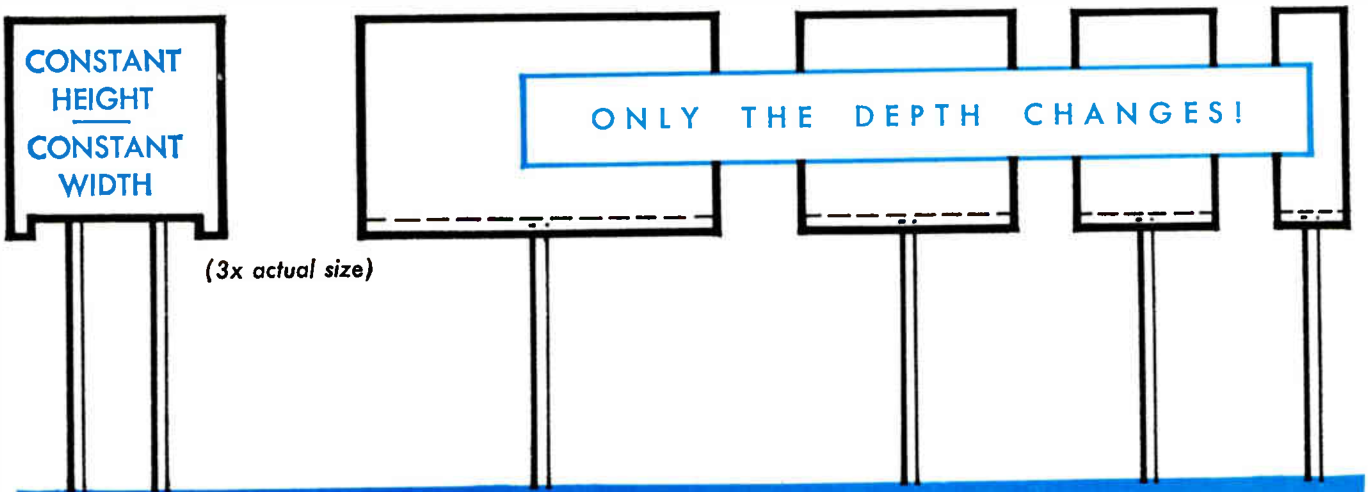
Why are we waiting?

Bernard F. Osbahr

World Radio History

New from Sprague!

A MOLDED SOLID TANTALUM CAPACITOR THAT MAKES SENSE



TYPE 190D RECTANGULAR TANTALEX® CAPACITORS

Especially qualified for applications such as printed circuits, where board space is at a premium and must be fully utilized.

- Only the depth changes from case to case—face area remains constant, making Type 190D Capacitors extremely well-suited for automatic insertion.
- Carefully selected height (0.350") corresponds with most acceptable maximum height in normal printed board spacing.
- Uniform width (0.375") permits neat, space-saving alignment on wiring board.
- Present lead spacing based on popular 0.100" printed board grid. In anticipation of the 0.125" grid, Type 190D Capacitors will also be available with new lead spacing when required by future circuit designs.
- Encapsulated in tough molded case with excellent dielectric properties, Type 190D Capacitors fully meet environmental test requirements of Specification MIL-C-26655A.
- Capacitance values from .01μF to 330μF—voltage range, 6 to 50 vdc.
- Stand-off feet at base of capacitors permit complete circulation of air, preventing moisture and solvent traps.
- Unlike many solid tantalums, these new capacitors exhibit the low impedance at high frequencies desired for high-speed computer applications.
- Low dissipation factor (high Q) permits higher ripple currents.

For complete technical data write for Engineering Bulletin 3531 to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE COMPONENTS

CAPACITORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
TRANSISTORS	INTERFERENCE FILTERS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	BOBBIN and TAPE WOUND MAGNETIC CORES
INTEGRATED CIRCUITS	TOROIDAL INDUCTORS	SILICON RECTIFIER GATE CONTROLS
THIN-FILM MICROCIRCUITS	ELECTRIC WAVE FILTERS	FUNCTIONAL DIGITAL CIRCUITS

4SC-176-63R2

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World Radio History

February 1965, Vol. 24, No. 2

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine

STATE-OF-THE-ART FEATURES:

DESIGN/DEVELOPMENT:

MEASUREMENT/TEST:

PROFESSIONAL GUIDELINES:

WHAT'S NEW

DEPARTMENTS

COVER

When we took this picture back in December 1964 at RCA's Lancaster plant, a Model A1192 thermionic converter such as the one shown had been operating continuously for 738 hrs., at temperatures of 1200°C, and generating lw/cm². It subsequently reached 1,000 hrs. and the test was ended. For this unique background, Designer Mike Louridas used a piece of well-worn low temperature fire brick. More information on direct energy conversion will be found in the article "State-of-the-Art in Electrical Energy Sources" beginning on page 36.

*STATE-OF-THE-ART: up-to-the-moment capability in each area of electronic technology

BPA

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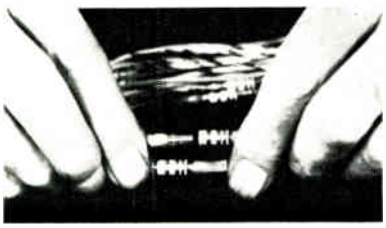
World Radio History

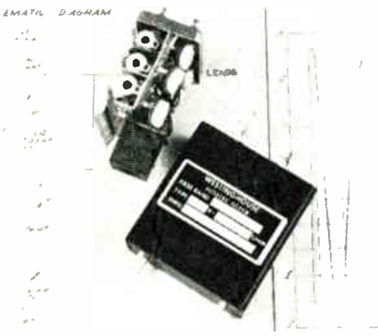
ELECTRONIC INDUSTRIES

HIGHLIGHTS

Electrical Energy Sources



Coaxial Cable Connectors



All-Pass Networks

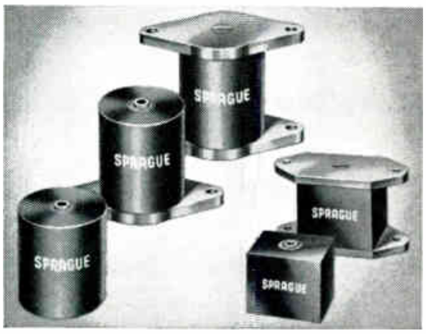
Making Meaningful Measurements

Portable Scope

• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department, 56th & Chestnut Streets, Philadelphia, Pa. 19139

World Radio History

New Cast Mica Capacitors Provide Major Change in High Power Mica Design



The first major change in high power transmitter-type Mica capacitors in over 25 years has resulted in a modern, miniaturized mica capacitor with liberal new design possibilities.

Designed and developed by the Sprague Electric Company, Cast Mica Capacitors are approximately 30% smaller in size and weight than old-fashioned, bulky, potted assemblies.

Encapsulated in high-temperature epoxy resin by a patented process, these unique capacitors will operate at temperatures to 125 C *without derating*—greatly in excess of the 70 C or 85 C limits of conventional capacitors. This exclusive construction also provides superior thermal conductivity—far better than with porcelain—enabling these capacitors to carry higher r-f currents.

Unlike older units with fragile insulating housings, Sprague Cast Mica Capacitors are rugged. Their tough epoxy resin encapsulation, with improved hermeticseals, eliminates use of potting waxes which tend to melt and cause damage to electron tubes and other components.

Sprague Cast Mica Capacitors, designed not only to meet but exceed MIL Specifications, are made in both the familiar cylindrical as well as a new rectangular shape, with female threaded terminals on opposite ends.

Although smaller in size than conventional capacitors, Cast Micas can be procured—for interchangeability—with one or two aluminum plates having the same center-to-center mounting holes as standard types. Where space is critical, they may also be mounted or stacked without plates by means of dual-ended headless screws.

For application engineering assistance write to Mica Capacitor Section, Field Engineering Dept. For complete technical data write for Engineering Bulletins 1230 and 1240 to Technical Literature Service, Sprague Electric Co., 233 Marshall St., North Adams, Massachusetts.

45C-142-63

Circle 68 on Inquiry Card

6 Reasons Why SPRAGUE is a Major Resistor Supplier

FILMISTOR® PRECISION FILM RESISTORS

metal-film, molded case

Distinct limited temperature coefficients and low tolerances to meet exacting application requirements. Rugged end cap construction for long-term stability and reliability. Superior resistance to humidity and mechanical damage. Surpass MIL-R-10509E requirements. Send for Bulletin 7025B.

deposited-carbon, molded case

Approach precision wirewounds in reliability and stability, yet are smaller in size and have lower self-inductance. Low, controlled temperature coefficient. Dense molded case provides outstanding humidity protection. Send for Bulletin 7000A.

deposited-carbon, conformal coated

Full rated load operation at 70 C with no wattage derating. Assured uprated loads at lower operating temperatures. Ideal for circuitry where small size, humidity resistance, and close tolerance (±1%) are required. Send for Bulletin 7005A.

Circle 61 on Inquiry Card

ACRASIL® PRECISION/POWER WIREWOUND RESISTORS

silicone-encapsulated

Combine the best features of both precision and power wirewound types. Resistance tolerances to ±0.05%. Unusually tough encapsulation protects against shock, vibration, moisture, fungus. Meet MIL-R-26C requirements. Smaller than conventional wirewounds, yet greater in stability. Send for Bulletin 7450.

Circle 62 on Inquiry Card

BLUE JACKET® VITREOUS ENAMEL POWER WIREWOUND RESISTORS

All-welded end cap construction with special vitreous coating for long-term dependability. Axial-lead style for conventional wiring or on printed boards. Tab terminals for higher wattage applications. Meet MIL-R-26C requirements. Send for Bulletins 7400B, 7410D, 7411A.

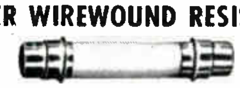
Circle 63 on Inquiry Card

KOOLOHM® CERAMIC-SHELL POWER WIREWOUND RESISTORS

Exclusive ceramic-insulated resistance wire permits "short-proof" multilayer windings for higher resistance values. Standard and non-inductive designs. Non-porous ceramic shell for moisture protection and electrical insulation. Axial-lead, axial-tab, and radial-tab styles. Send for Bulletins 7300B, 7305, 7310.

Circle 64 on Inquiry Card

GLASS-JACKETED POWER WIREWOUND RESISTORS



Ferrule terminals soldered to metallized ends of glass casing, for true hermetic seal. Virtually failure-proof, even in extremely corrosive industrial and salt atmosphere. Standard and non-inductive windings. External meter-multiplier types also available. Send for Bulletins 7350, 7420, 7421.

Circle 65 on Inquiry Card

STACKOHM® POWER WIREWOUND RESISTORS

Flat silhouette permits stacking of resistor banks in close quarters. Aluminum thru-bar simplifies mounting and conducts heat from resistance element. Vitreous enamel protective coating. Meet MIL-R-26C performance requirements. Send for Bulletin 7430.

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For complete technical data, write for engineering bulletins on the resistors in which you are interested to: Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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4 SR-166-63 R2

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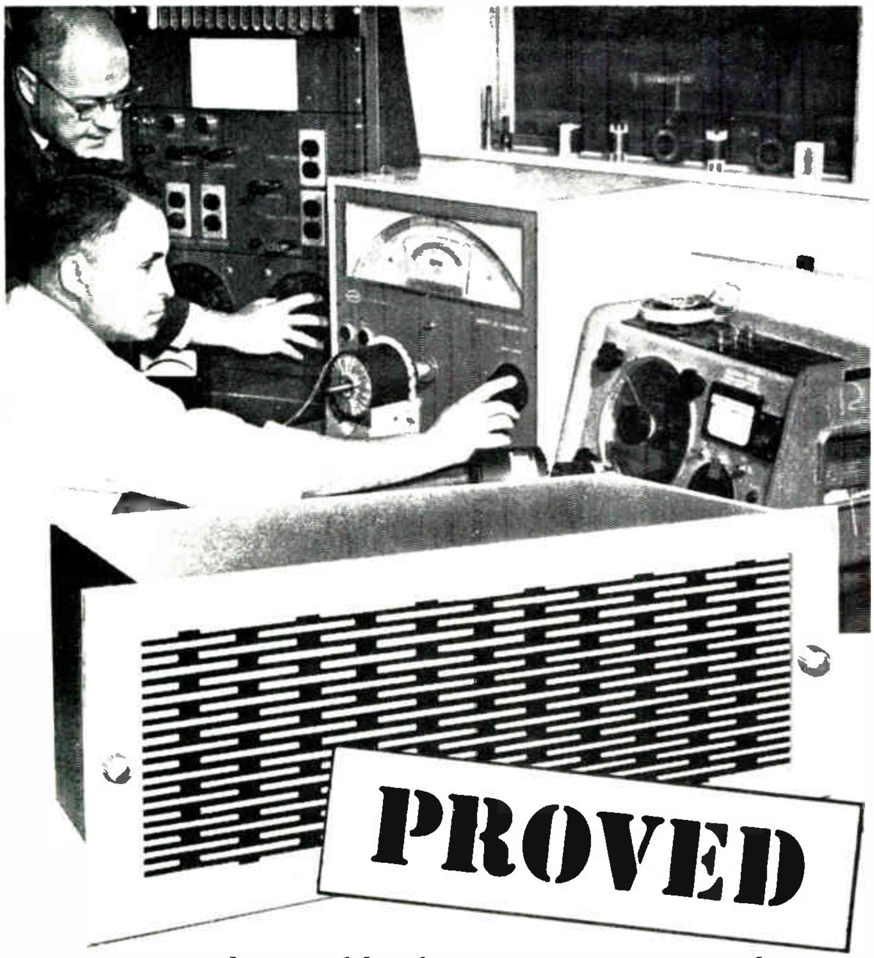

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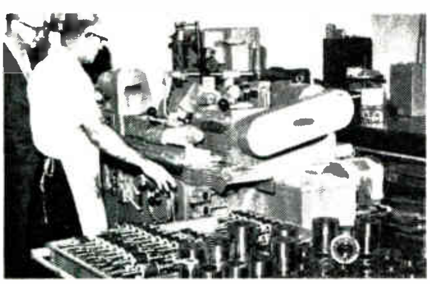

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2N1724	TO-61	50 watts	10 MC	80	20 @ 2A
2N2657	TO-5	1.25 watts	20 MC	60	—
2N2658	TO-5	1.25 watts	20 MC	80	—
2N2877	TO-59 (7/16″ DES)	30 watts	30 MC	60	20 @ 1A
2N2878	TO-59 (7/16″ DES)	30 watts	50 MC	60	40 @ 1A
2N2879	TO-59 (7/16″ DES)	30 watts	30 MC	80	20 @ 1A
2N2880	TO-59 (7/16″ DES)	30 watts	50 MC	80	40 @ 1A

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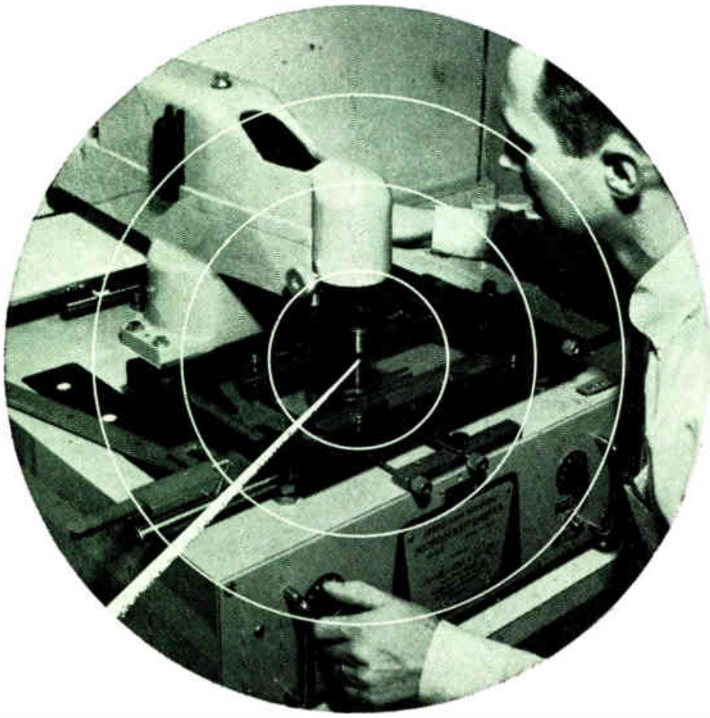
ELECTRONIC INDUSTRIES RADARSCOPE

Developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries



MEASURING SPECTRAL LINE INTENSITIES

V. J. Caruso a spectro chemist in IRC's Research and Development Dept. uses a Microdensitometer to gain quantitative information on trace impurities in semiconductor materials. Photographic slide being measured was obtained from a Jarrel-Ash Mark IV 3.4 meter Ebert Type Grating Spectrograph.

SOUND is being used by two Iowa State University professors to measure atmospheric changes. Sonic instrumentation developed by Dr. R. M. Stewart, Jr., and Dr. R. E. Post, makes use of acoustic energy and a digital computer to measure instantaneous values of temperature and velocity of the atmosphere. Data collected through sonic anemometry research using these and other instruments could possibly be applied to everyday problems. Conceivably, the data could enable TV stations to vary power transmission according to variations in atmospheric conditions, instead of transmitting constantly at the rate needed to meet worst conditions.

A NATIONAL HEADQUARTERS for the newly created National Council on Radiation Protection and Measurements (NCRP) has been opened at 4000 Brandywine St., N.W., Washington, D.C. The council has been chartered by Congress as a non-profit corporation. It is to collect, analyze, develop, and disseminate scientific information and recommendations about radiation measurement and protection against radiation. W. Roger Ney has been named Executive Director.

GaAs MICROWAVE GENERATOR has aroused much interest. An experimental device has been operated at room temperature by IBM researchers. Unlike other microwave generators, no additional resonant circuitry is needed to operate the device. A block of gallium arsenide converts steady dc into fluctuating current in the microwave region. Connecting one side of the block to a matching network transforms the device current into microwave power. It may find use in receivers as a low cost local oscillator. Units have operated in the 4 to 7 GC range.

SELF-CASED CAPACITOR has additional windings of Mylar film which replaces dipped or molded casings. The low-cost unit has been developed by Paktron Div. of Illinois Tool Works for consumer products. They have been cycled from —55° to 125° C. without mechanical or electrical damage. These capacitors weigh about half as much as the same value in a molded or dipped unit.

A RECORD HIGH $30,095,000 has been forecast by NEMA (National Electrical Manufacturers Association) as the value of shipments of all electrical manufactured products in 1965. This forecast is based on a round-up of estimates for the new year by member companies of NEMA. In dollar volume, the 1965 leader is expected to be industrial electronics and communications equipment with predicted industry sales of $9,460,000.

MILLIMETER WAVE region for space communications is the subject of an experiment design study by Raytheon Company for NASA. Experiments will be decided upon to define channel characteristics of two-way earth-to-space links. Higher bandwidths, smaller equipment, and an uncluttered region are hoped for. The study will include specific equipment recommendations and data processing needs for a later one-year propagation data program.

PLATING PROCESS which cleans and coats a surface with a tightly adhering film in one operation has been developed at the Atomic Energy Commission's Sandia Lab. The process involves the deposition of atoms and ions while the substrate is being bombarded with inert gas ions. Substrate surface is cleaned by high energy gas ions, which remove contaminating material. Superior results were obtained with such combinations as copper and gold on molybdenum; aluminum on steel and uranium; and gold and copper on aluminum.

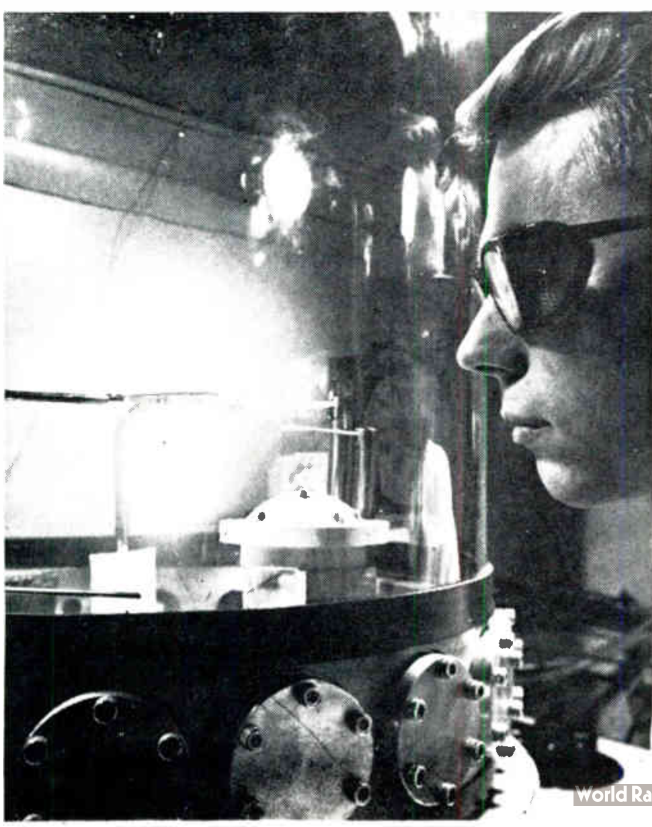
World Radio History

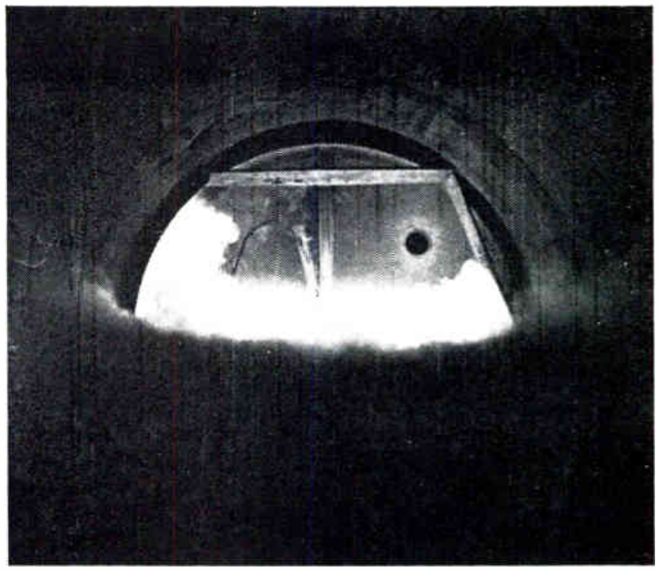
SOLDER BALLS are a large cause of transistor failures in military electronic equipment. Scientific personnel at Fort Monmouth have been doing research to find the cause of transistor failures. They found that balls of about 99% tin are formed when the transistor is exposed to an abnormal transient surge of power. Under shock or vibration these balls break loose and can cause a brief short circuit. This leads to a complete circuit failure. These balls can be formed even during testing of the unit and will not show up in any normal tests. The balls are usually formed in the emitter area. Their conclusions call for other than tin in solders.

RESEARCHERS from Queen Mary College, London University, are using a new radio telescope to study the brighter planets and radio sources in the sky. The telescope operates at wavelengths in the region of 1 mm and uses a 15 ft. dish antenna. Built by The Marconi Co., Ltd., the antenna has been molded in glass fiber reinforced plastic, with a final reflecting surface of sprayed zinc. Final average (RMS) measured accuracy of the entire surface is within five thousandths of an inch of the specified paraboloid. This is an accuracy almost as great as could be achieved by using cast iron or invar. And, it can be done at a fraction of the cost of more conventional methods according to Marconi.

THIN FILM MATERIALS

Metallurgist James A. Seeman views purple glow given off by positively charged argon gas plasma in an experiment with a Honeywell, Inc. ion-sputtering device. Honeywell's Minneapolis aeronautical division is now using ion-sputtering techniques to explore the potential new uses for thin film materials.





ADVANCED COUNTERMEASURES RESEARCH

High temperature chemical reactions at simulated altitudes of over 160,000 ft are shown under study at ITT Research Institute in Chicago. The production of high intensity UV, visible and IR radiation from high energy reactions are aimed at developing countermeasures for future aircraft and space use.

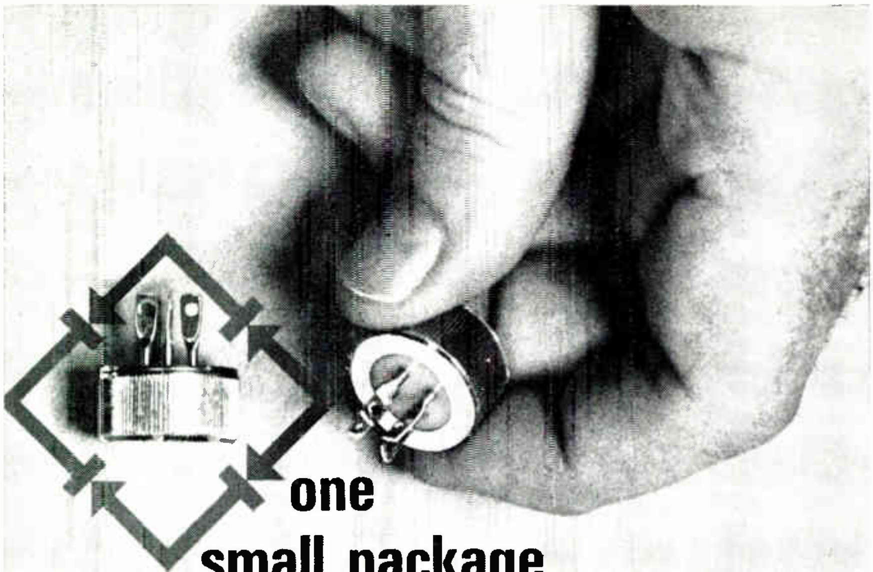
BIOTECHNOLOGY is receiving increased emphasis by Philco scientists. This deals with the application of biological sciences to electronics. One team is investigating the use of electrical potential of the skin to trigger remote mechanical devices. Sensors can intercept a motor command transmitted along the nervous system through electrical impulses generated on the skin. There is the possibility that these impulses could be used with a controller to actuate machines. This would be one step beyond pushbutton control.

ANIMAL LANGUAGES are being analyzed in Germany by Telefunken engineers. Working with zoologists, the engineers are using special amplifiers and sound spectroscopes, and are systematically investigating the language with a view to their usefulness as a communications medium between man and animal.

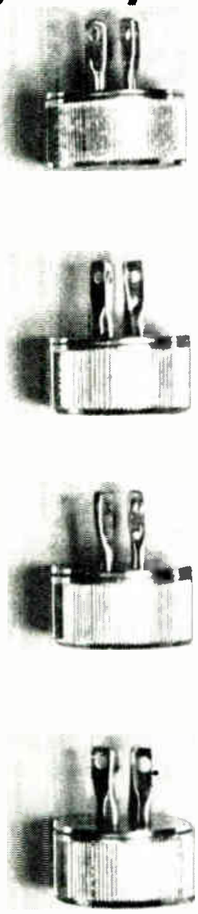
A BROADBAND, GASEOUS CRYSTAL PROTECTOR TUBE has been made. This TR type tube is ignitorless and thus needs no external power source. It was developed at Westinghouse's Electronic Tube Division for protection of crystals in microwave systems. These crystals must be protected from occasional high power signals from either its own or external signals. Suitable breakdown and leakage characteristics were achieved by: use of enough radioactive material placed in the microwave cavity as an electron source. and a magnetic field for reduction of the effective EM field heeded for breakdown. The tube has a VSWR less than 1.40:1 and an insertion loss under 0.50 db from 8.66 to 10.38 GC.

(MORE RADARSCOPE on Page 10)

World Radio History



one
small package
gives you full wave rectification



IBR*

SILICON AVALANCHE
INTEGRATED BRIDGE RECTIFIERS

The Varo IBR* offers commercial and industrial OEM's a reliable, low-cost solution to rectification problems requiring a full wave bridge. The 1N4436 (250 V BV_R min.) and 1N4437 (450 V BV_R min.) are integrated bridge rectifiers in one small package with a circuit-to-case insulation of 2000 V min.
An even greater economy in installation time is achieved through the small sized, single package and versatile mounting techniques.
Decreased PRV safety factors may be used in design considerations due to the SAR* (Silicon Avalanche Rectifier) characteristics that control avalanche voltages and eliminate junction perimeter destruction from transient overvoltages.
Varo's IBR* devices feature 250 V and 450 V min. avalanche voltages, 10 amp DC output current at 100°C (T_C) and 100 amp one-cycle current surge.

Press-fit, single stud and TO-3 mountings are available.

SINGLE
STUD

TO-3

Write today for complete information.

varo inc
SPECIAL PRODUCTS DIVISION
2201 WALNUT ST., GARLAND, TEXAS
AC 214 / BRoadway 6-6141

*TM Varo Inc.

RADARSCOPE

NICHROME RESISTORS are being deposited to very tight tolerances over a passivated active substrate by a technique developed by Raytheon Co. The new process, which forms another type of monolithic integrated circuit, eliminates a common problem of unwanted parasitics. These are unwanted parasitic effects which occur between functions or regions of several types of normal integrated circuits. First circuit to use these resistors is a multiple-input DCTL gate designated RC-401.

COMPONENTS such as solid state tantalum capacitors can now be purchased with a "guaranteed failure rate," according to Union Carbide Corp. This unusual way of expressing reliability is due to the decreasing failure rate with time of their solid tantalum capacitors. An accelerated testing method makes it possible to subject capacitors to millions of hours of simulated operation at rated conditions in a short time. This has led to data that substantiate the guarantee. With this method, the weaklings are first eliminated. Later, healing of minor defects in the dielectric takes place so effectively that the capacitor has no predictable end to its service life.

AN R-F GASKET ADHESIVE has been developed by Chomerics, Inc., Plainville, Mass., as a compressible non-wicking adhesive for holding aluminum, stainless steel and monel woven wire gaskets in place. Conductive Resin B-584-208 has been developed to minimize wicking, and where (through misuse) wicking does occur, to permit proper seating. Also, while its cohesive strength is enough to hold a gasket permanently in place, it is low enough to allow removal of both the gasket and the adhesive when necessary.

World Radio History

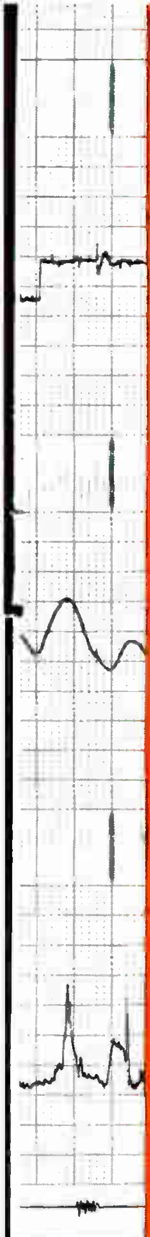
ticklish signals?

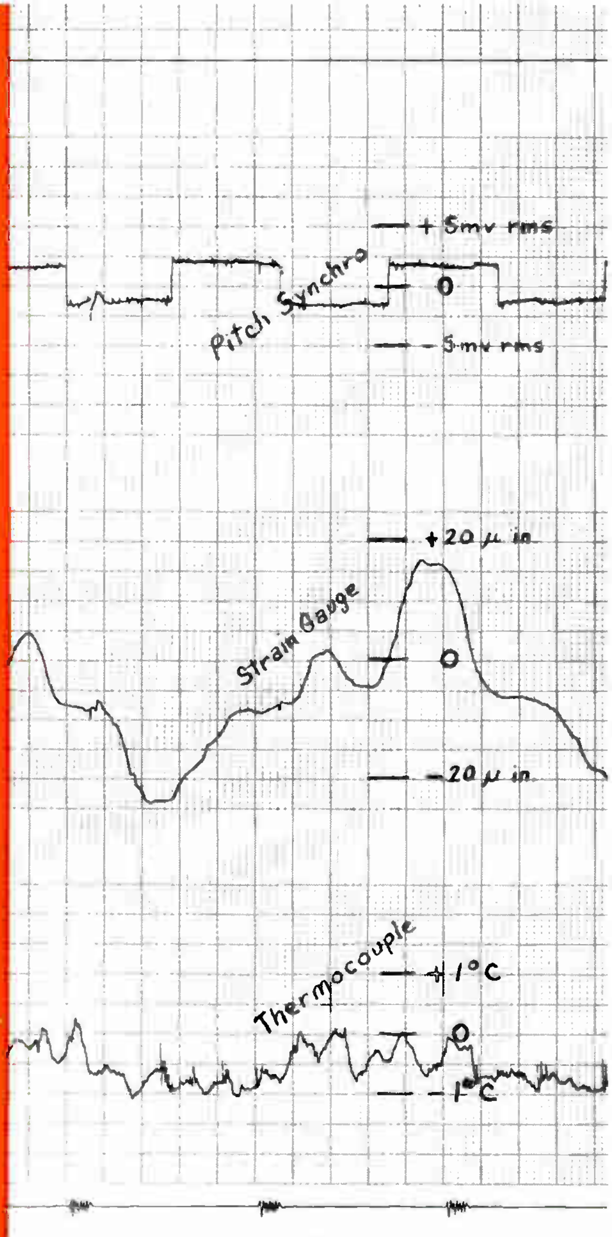
PUT THEM ON PAPER WITH EASE WITH THIS NEW SOLID STATE OSCILLOGRAPH

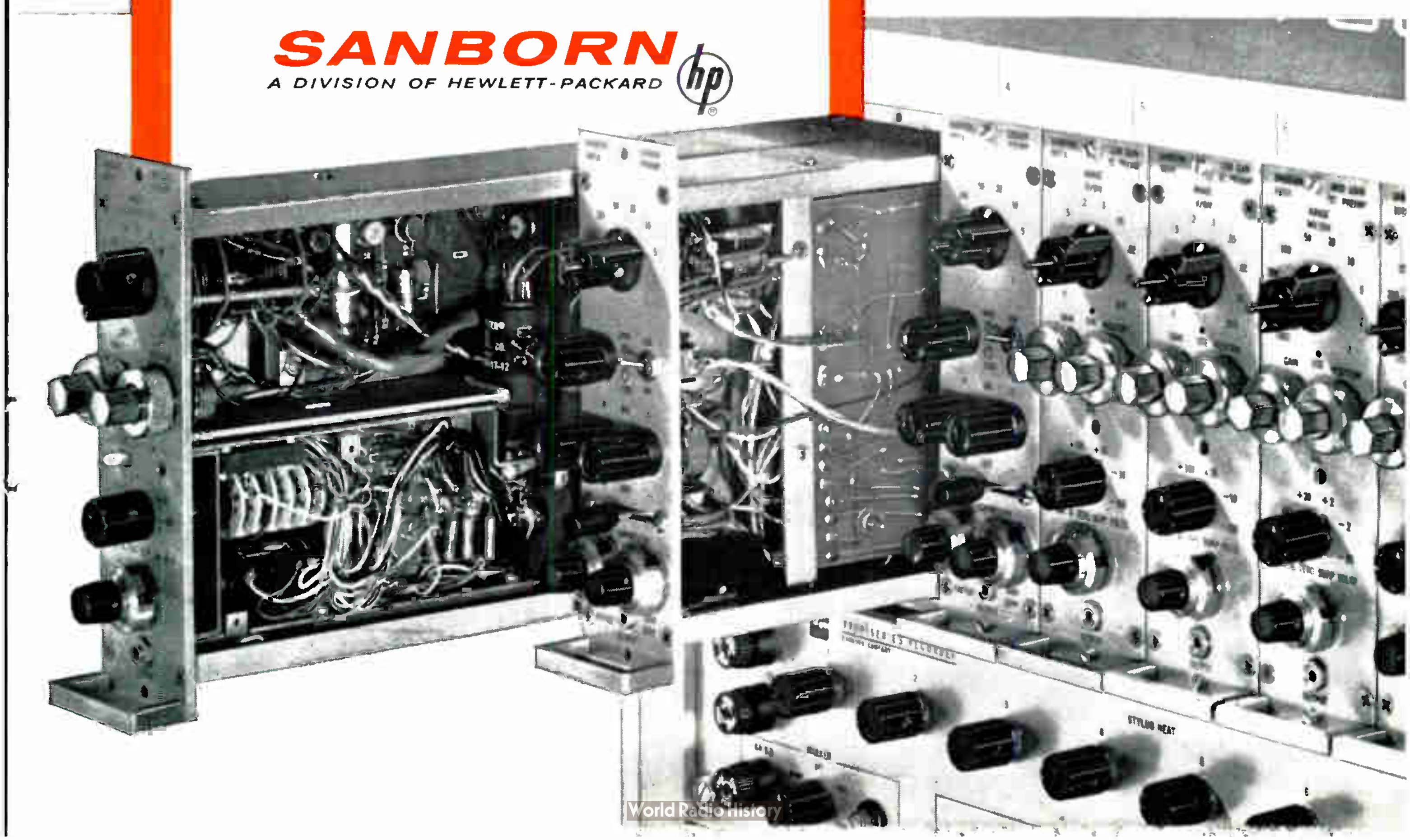
Now you can precisely measure and record a greater variety of AC and DC variables — over wider dynamic ranges and with more signal-conditioning capabilities at your command — with this new Sanborn 7700 Series 6- and 8-channel oscillograph. A choice of highly developed plug-in preamplifiers (eight in 7" x 19" of panel space) gives you recording capabilities such as: 1 μv/div. to 250 volts full scale in a single preamp, which also has multi-range, calibrated zero suppression built in . . . phase-sensitive demodulation of in-phase or 180° out-of-phase floating signals, 60 cps to 40 KC, with calibrated or uncalibrated adjustable phase shifting . . . carrier signal recording from 10 μv/div. and with calibrated zero suppression and cal. factor.

The all-solid-state circuits in this new system also mean cooler operation with less power than tube circuits . . . easy servicing of modular circuits on accessible plug-in cards . . . simpler, smaller power supplies with integral AC excitation . . . and generally improved drift, gain stability, noise and linearity characteristics. Combine these advantages with the proven and widely-used Sanborn *heated stylus*-Permapaper® recording method: true rectangular coordinate writing with *higher* resolution at slow chart speeds, *no* spills or smears, *greater* environmental immunity, *no* priming or constant attention needed. Call your HP field engineering office for complete specs — or write Sanborn Company, Industrial Division, Waltham, Mass. 02154

SANBORN
A DIVISION OF HEWLETT-PACKARD







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AT LAST...

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AMPHENOL slashes prices

Compare these coaxial connector prices*—

UG-88/U	Plug	.30
UG-88C/U	Plug	.32
UG-88E/U	Plug	.37
UG-89/U	Jack	.39
CW-159/U	Male Cap	.31
UG-260/U	Plug	.31
UG-260D/U	Plug	.37
UG-290A/U	Panel Receptacle	.34
UG-657/U	Bulkhead Receptacle	.46
UG-1094/U	Bulkhead Receptacle	.30

Same built-in Amphenol quality. Off-shelf delivery from 100 Amphenol Industrial Distributors or direct from factory through your local Amphenol man. Amphenol RF Division, 33 East Franklin Street, Room 25, Danbury, Connecticut 06813.

*** In 2500-piece quantities. Call your Amphenol man to get lower prices for higher quantities.**

Amphenol® RF DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION

Specify Amphenol . . . the leading name in cable, connectors, RF switches, potentiometers, microelectronics

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With FAIRCON potentiometers

the only difference is quality & price

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If it's trimmers, multi-turns or turns counting dials you need ...ARCO's fully stocked regional headquarters in New York, Dallas and Los Angeles can deliver FAIRCON potentiometers anywhere in the U. S.—**overnight** if you need it.

FAIRCON potentiometers give you MIL spec precision at industrial prices...backed by guaranteed FAIRCHILD quality.

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COMING EVENTS

February

Feb. 17-19: Int'l Solid-State Circuits Conf., IEEE, G-CT, Univ. of Pa.; Sheraton Hotel & Univ. of Pa., Phila., Pa.

Feb. 22-26: Western Metal & Tool Exp. & Conf., ASM; Great Western Exhibit Ctr. & Biltmore Hotel, Los Angeles, Calif.

March

Mar. 1-5: 21st Annual Tech. Conf. (ANTEC), Soc. of Plastics Engineers, SPE; Statler-Hilton, Boston, Mass.

Mar. 10-12: Particle Acceleration Conf., APS, IEEE, NBS, AEC; Shoreham Hotel, Washington, D. C.

Mar. 21-24: 19th Annual Broadcast Eng. Conf., NAB; Sheraton-Park & Shoreham Hotels, Washington, D. C.

Mar. 31-Apr. 2: 7th Annual Electron Beam Symp., Alloyd Corp.; Penn State Univ., University Park, Pa.

April

Apr. 6-8: Railroad Conf., IEEE, ASME; Penn-Sheraton Hotel, Pittsburgh, Pa.

Apr. 13-15: Nat'l Telemetering Conf., IEEE, AIAA—ISA; Shamrock Hilton, Houston, Tex.

Apr. 14-15: Electronics & Instrumentation Conf. & Exhibit, IEEE & ISA; Cincinnati Garden, Cincinnati, Ohio.

Apr. 19-21: 3rd Nat'l ISA Biomedical Sciences Inst. Symp., ISA; Statler-Hilton Hotel, Dallas, Tex.

'65 Highlights

IEEE Int'l Conv., Mar. 22-25; Coliseum, New York Hilton, New York, N. Y.

WESCON, Western Electronic Show & Conv., Aug. 24-27, IEEE, WEMA; Cow Palace, San Francisco, Calif.

Nat'l Electronics Conf., Oct. 25-27; McCormick Place, Chicago, Ill.

NEREM, Northeast Research & Eng. Mtg., Nov. 3-5, IEEE; Boston, Mass.

Apr. 20-22: Symp. on System Theory, IEEE, USDRA, SIAM; Polytechnic Inst. of Brooklyn, Brooklyn, N. Y.

Apr. 20-22: 19th Annual Freq. Control Symp., Army Electronics Labs.; Atlantic City, N. J.

Apr. 21-23: Southwestern IEEE Conf. & Elect. Show, IEEE; Dallas Memorial Auditorium, Dallas, Texas.

Apr. 21-23: Int'l Nonlinear Magnetics Conf., IEEE; Sheraton Park Hotel, Washington, D. C.

Apr. 27-29: American Power Conf., IEEE; Sherman Hotel, Chicago, Ill.

May

May 4-6: 5th Annual Packaging Ind. Conf., IEEE; Milwaukee Inn, Milwaukee, Wisc.

May 5-7: Microwave Theory & Tech. Symp., IEEE; Americana Motor Hotel, Atlanta, Ga.

. . . is worth up to four straight hours of data logging in the bush—on a geological survey. In a laboratory—on a biomedical research project. Anywhere! The remarkable new KRS DATA-STACT™ MD-2 fits any need for a portable recorder with big tape capacity. This trim 20-pounder covers a range of DC to 100 kc, handles up to four channels, and gives you bigger performance features in a smaller package than any other portable tape recorder available today.

1200 FEET OF CONTINUOUS-LOOP TAPE! The handy size MD-2 recorder uses one KRS STACTape™ Cartridge—the precision magnetic tape cartridge that holds up to 1200 feet of ¼" tape in an endless-loop roll, and incorporates unique reversing and fast-forward features. Models are available in all standard tape speeds from $1\frac{5}{16}$ to 30 ips.

WOW? FLUTTER? Extremely low, even at low tape speeds. Classically simple design eliminates all mechanical adjustments—you concentrate on your work, not the machine. Complete with solid-state standard instrumentation electronics (FM or Direct), MD-2 recorders sell in the price range of $850 to $2500.

™ Trademarks of KRS Electronics

For complete data on the new KRS DATA-STACT MD-2 Cartridge Instrumentation Recorder, send for Instrumentation Division Bulletin MD-2.

KRS ELECTRONICS

KRS Electronics, 2370 Charleston, Mountain View, California

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WE WERE WRONG!

A few months ago we introduced a new kind of miniature soldering iron.

We called it the "Little Dandy", and we thought its biggest selling point would be its $6.00 list price.

But here's what production-soldering men are telling us: *"the low original cost is important, but . . .*

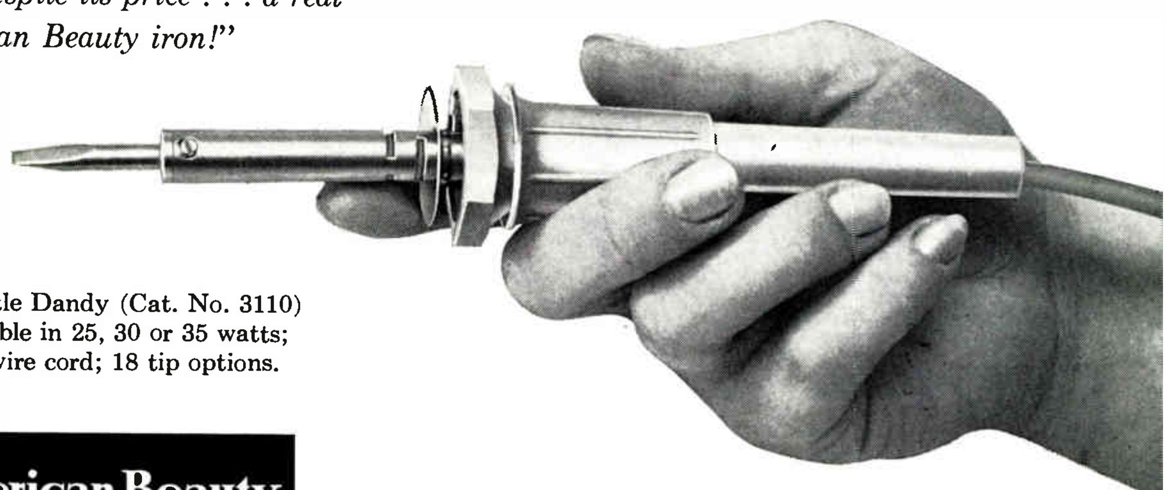
". . . life of the heating element frankly amazed us."

". . . the girls like it best, probably because of the balance and cool handle."

". . . none of the breakage we were experiencing when our irons had ceramic insulators."

". . . all service so far is done right on the line . . . no crib time."

". . . despite its price . . . a real American Beauty iron!"



The Little Dandy (Cat. No. 3110) is available in 25, 30 or 35 watts; 2- or 3-wire cord; 18 tip options.

American Beauty

American Beauty Division • American Electrical Heater Company • Detroit, Michigan 48202

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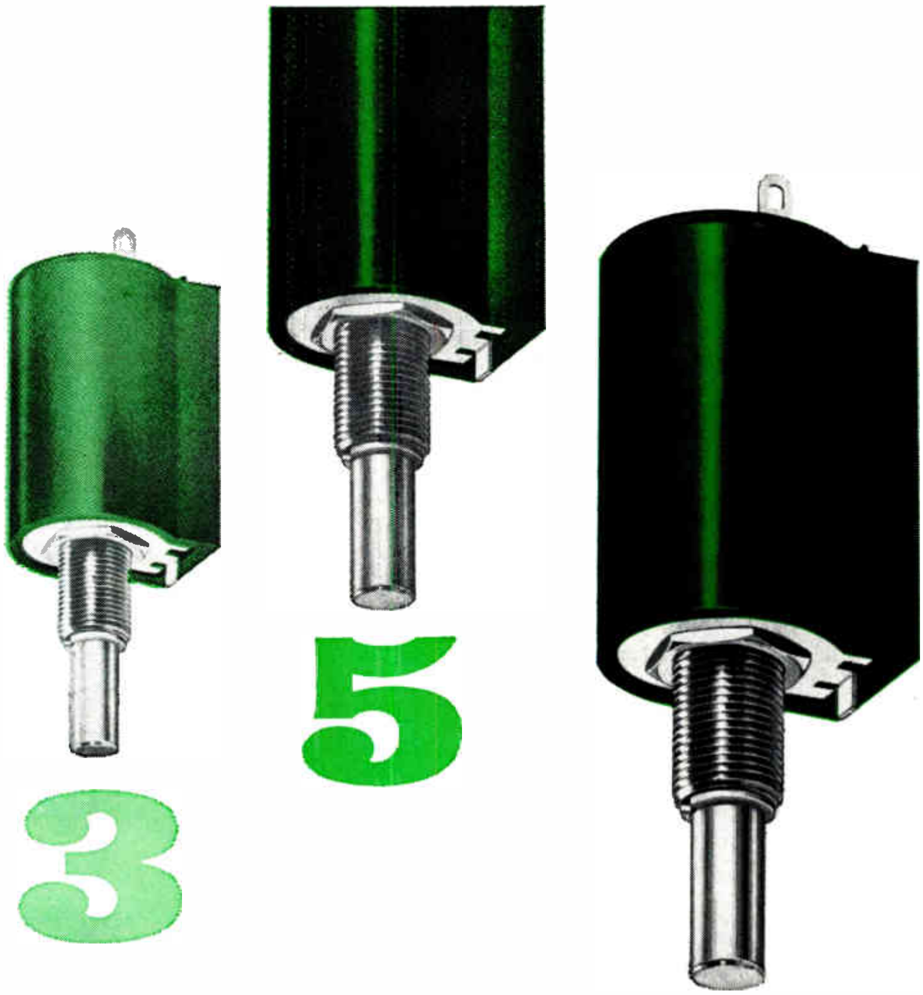

OR 10 TURN

PRECISION POTENTIOMETERS FOR AS LITTLE AS $5[00] EACH

series 62 multi-turn precision potentiometers will fill the bill for all your requirements in industrial and instrument applications . . . and the price is right! Check these outstanding features for a typical 10-turn model: ■ Absolute linearity—±0.25% ■ Resistance Tolerance—±5% ■ Power Rating—2 watts @ 25°C ■ Dielectric Strength—1000 V. rms for 1 minute at atmospheric pressure. Add to this, your choice of number of turns up to 10 and you've truly got top performance at lowest cost. Send today for complete details. . . .

CLAROSTAT

MFG. CO., INC. DOVER, NEW HAMPSHIRE

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World Radio History

WASHINGTON TRENDS

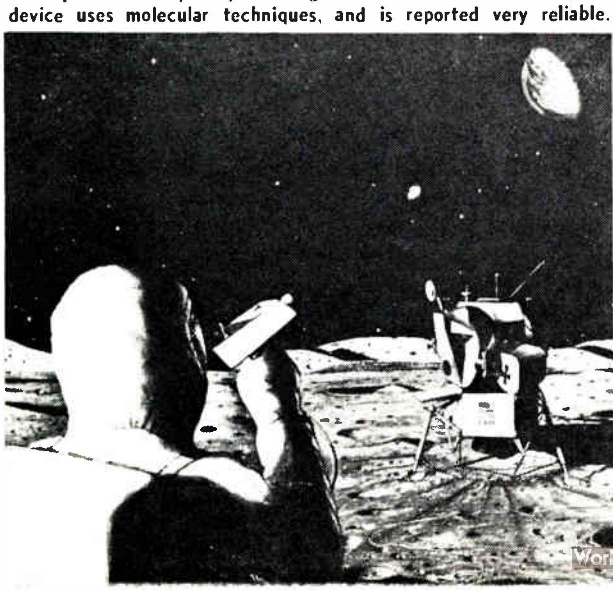
ANTI-MISSILES, YES OR NO?—Defense Secretary McNamara will soon have to decide whether to go ahead with a massive U. S. missile defense system. If the 30-billion-dollar project is approved, a substantial boost in defense electronic contracts will follow. The system will include long-range and short-range radar, plus components for Nike X anti-missile missiles and supporting equipment. The project, reportedly, is in favorable light in the Executive Branch. Certain Air Force Generals are not happy about the project. They want an advance bomber to replace the aging B-52. They also say that the missile project would not be ready and operable before 1972.

COMPUTERS OPEN NEW JOBS—Computers can cause problems as well as solve them, warns the Labor Department. Experts predict that demand for technical data support personnel in the communications equipment industry will jump by 50% by 1970. As computers create new jobs, finding qualified people will be the problem. Jobs will include information center workers and technical writers.

AWARDS UNDER FIRE—Congressmen are criticizing aerospace and defense contract award methods. They insist that only 5% of $2 billion in 1963 NASA procurement was let under formal advertised bidding. A subcommittee of the House Committee on Science and Astronautics reports that 75.7% of grant and contract funds are kept in-house by prime contractors. It had been believed generally that some 50% of prime contracts were distributed geographically by sub-contracts.

LUNAR TV CAMERA

Artist's concept of tiny TV camera (astronaut's hand) which will take TV pictures of astronauts and lunar scenery for immediate "live" broadcast over nationwide TV when the historical landing takes place. Developed by Westinghouse under NASA contract, the device uses molecular techniques, and is reported very reliable.



SATELLITE STUDY—Sixteen manufacturers are studying ways to put medium-altitude satellites into orbit. The Communications Satellite Corporation will negotiate contracts with one or more of the firms making the study. Meanwhile, CSC is getting ready to shoot off its first high-altitude satellite — "Early Bird" — in March. According to CSC engineers, the Bird will be able to handle two-way phone talks, TV, EDP, telegrams and press dispatches.

NEW MARKETING TOOL—Industry now has a new statistical tool to help in market analysis, forecasting, and tracing effects of economy shifts. It is the Commerce Department's "input-output" study which analyzes the industrial structure, based on markets in raw materials and semi-finished products. The study attempts to reveal flow of goods, what each industry buys from another, and how much is shipped to every other industry. It is said to fill gaps in economic analysis found in estimates of gross national product, national income, and product gage.

EXCISE CUT BATTLE—Electronic Industries Association recently asked for repeals of manufacturers' excises on radio and television receivers, phonographs and components. This is only a part of the coming excise tax push that now has various industries, electronics included, jockeying for position. Only some $2 billion to $3 billion of $14 billion in excises will be cut or repealed this time around.

TECHNICAL CHANGES STUDIED—A new national commission on technology, automation, and economic progress includes Patrick E. Haggerty, President of Texas Instruments, Inc., and John I. Snyder, Jr., President of U. S. Industries, Inc. The commission has until Jan. 1, 1966 to report to President Johnson and the Congress with (1) forecasts on effects of automation on occupation, industry and geography, (2) suggested policies for labor and management, (3) recommended steps to be taken by the government.

JOHNSON WOOS BUSINESS—The President, apparently eager to thaw the chill of distrust between business and government, has ordered the Department of Commerce to present new aid programs. In effect, DOC will rule on need, or lack of need, where new federal business-control programs are proposed. DOC will speed up and improve quality of statistical data on production and sales of goods. Efforts to expand foreign markets will be improved. Finally, incentives will be offered to encourage modernization.

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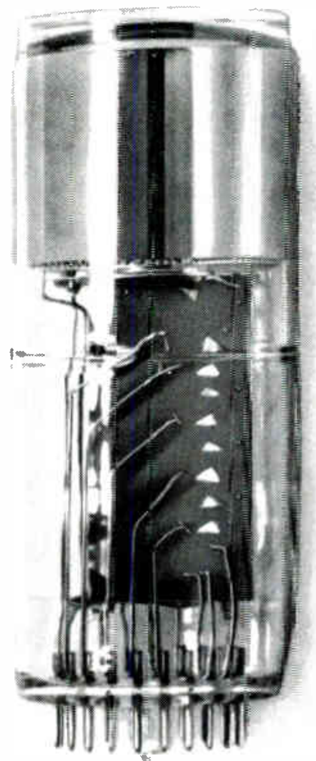

RCA-C31000 Bi-Alkali Photocathode...2 Nsec Rise Time

UNPARALLELED QE...24% (Typical) @ 3850 Å

$$10 \frac{\text{electrons}}{\text{Cm}^2\ \text{Sec}} @ 25°\text{C}$$

RCA now offers a heretofore unobtainable combination of highly desirable photomultiplier characteristics in one tube. Foremost of these attributes are unparalleled high speed and low noise characteristics coupled with high quantum efficiency.

These are just a few of the exciting benefits of RCA's new Photomultiplier—the developmental RCA-C31000. A "universal" type of tube for pulse applications, this 2" photomultiplier has a rise time of less than 2 nanoseconds. In addition, the improvement in the noise characteristic has been demonstrated by the measurement of thermionic emission values as low as 10 electrons cm^{-2} sec^{-1} at 25°C from the photocathode.

This new phototube offers unexcelled QE. For example: RCA-C31000, with its bi-alkali photocathode, has a typical quantum efficiency of 24% at 3850 angstroms. Many S-11 types with CS_3Sb cathodes have a QE of only 16% at 4200 angstroms. And of high importance, its dark current values are improved by as much as three orders of magnitude over S-11 types.

RCA-C31000, already finding application in liquid scintillation counting, time-of-flight measurements, medical equipment, and coincidence counting, has as among its numerous features: Low residual radioactivity envelope • 50 ohm output line to eliminate ringing • Teflon socket supplied, to accommodate base of rigid-pin construction • Uniform collection efficiency • CuBe substrate for stability • 8% (max.) Pulse Height Resolution • Freedom from shock excitation • No after pulse.

For more information on RCA-C31000, or other RCA Photomultipliers, including versions with semi-flexible leads, or potted voltage dividers, see your RCA Representative. For technical data, write: RCA Commercial Engineering, Section K31Q, Harrison, New Jersey.

RCA Electronic Components and Devices

The Most Trusted Name in Electronics

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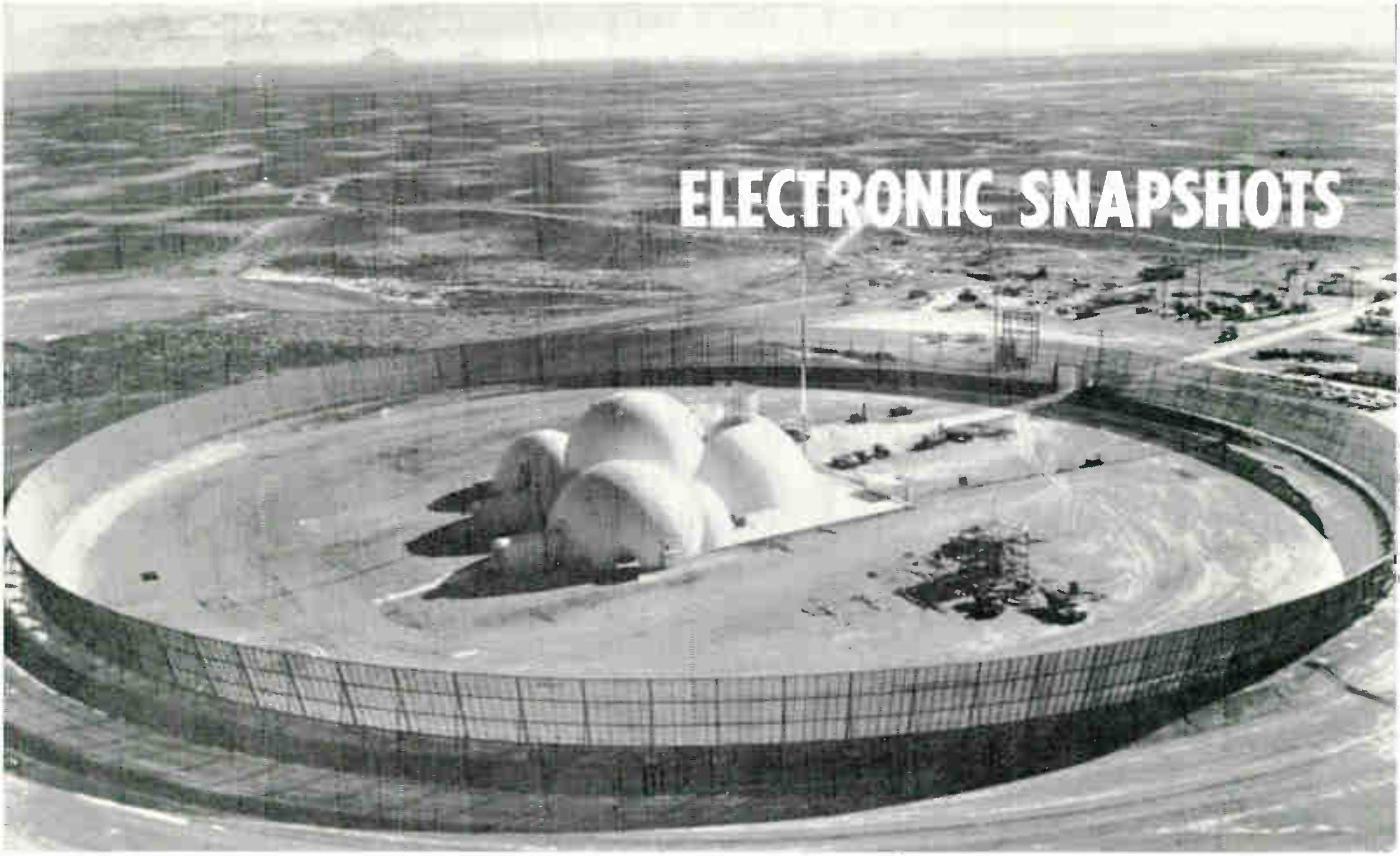
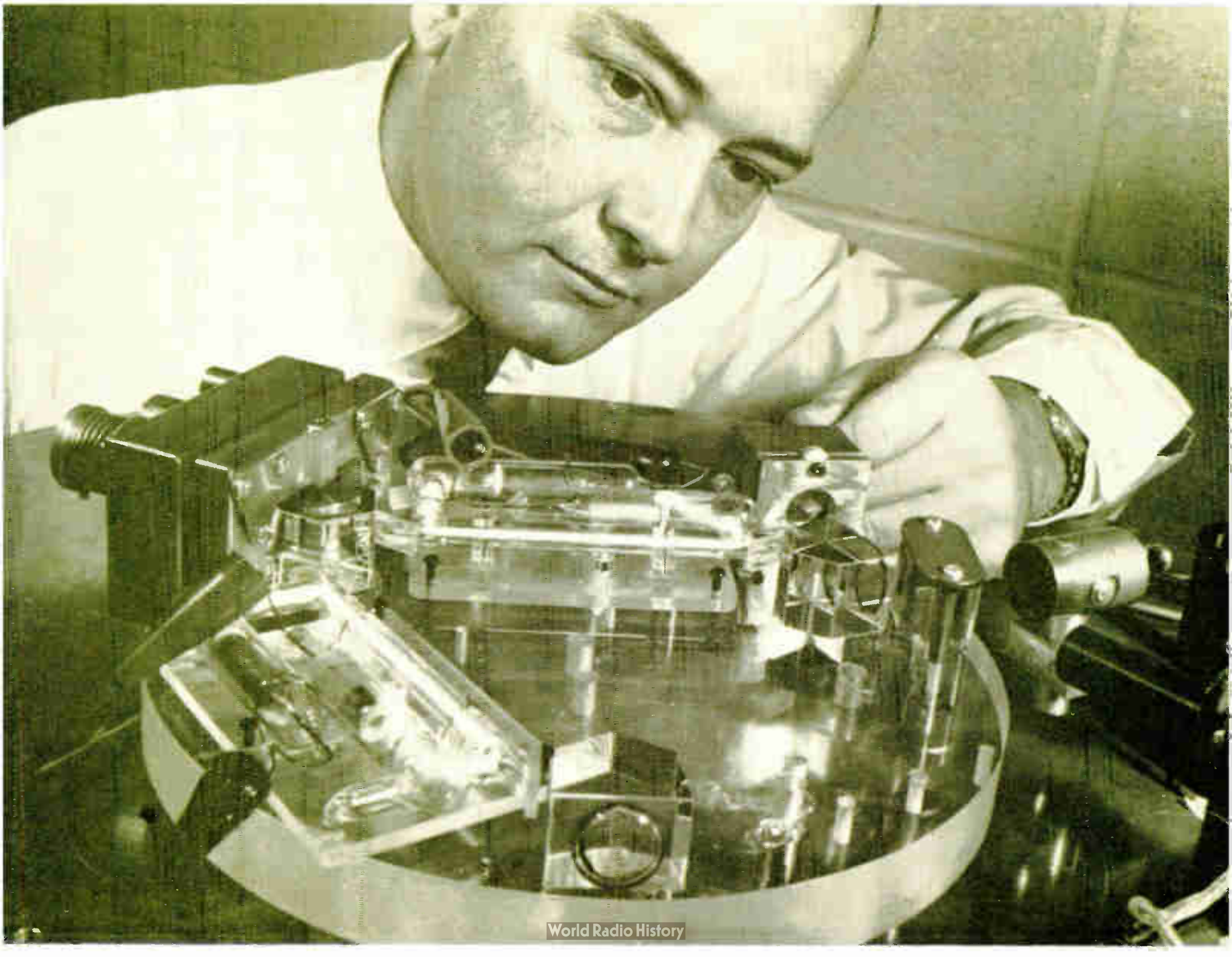
ELECTRONIC SNAPSHOTS





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The Changing
STATE-OF-THE-ART
In the electronic industries

◀ ADVANCED RADAR

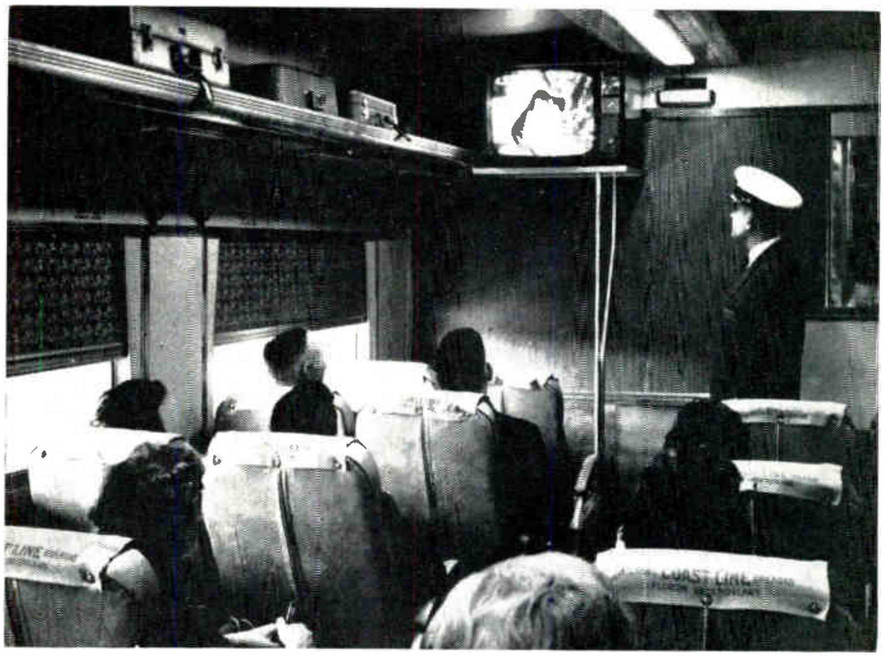
Experimental multi-function array radar (MAR-I) designed and installed by Sylvania at White Sands, N. M., to detect, track and identify missile warheads, is being tested and evaluated as part of the Nike-X program.

▼ ANTI-BOMB CABLE

Coaxial cable for Bell System's new blast-resistant communications route run along 4,000-mile trench across U. S. Cross country cable will add 9,000 telephone circuits to 15,000 circuits now spanning the nation.

◀ MINIATURE GYRO

Robert E. Var, scientist at Honeywell labs, operates small LIG, for Laser Integrating Gyro. LIG uses three prisms, and internal reflection principle to form small, low-loss triangle cavity. It works on 1.15 micron from a helium-neon discharge, rf or dc pumped.

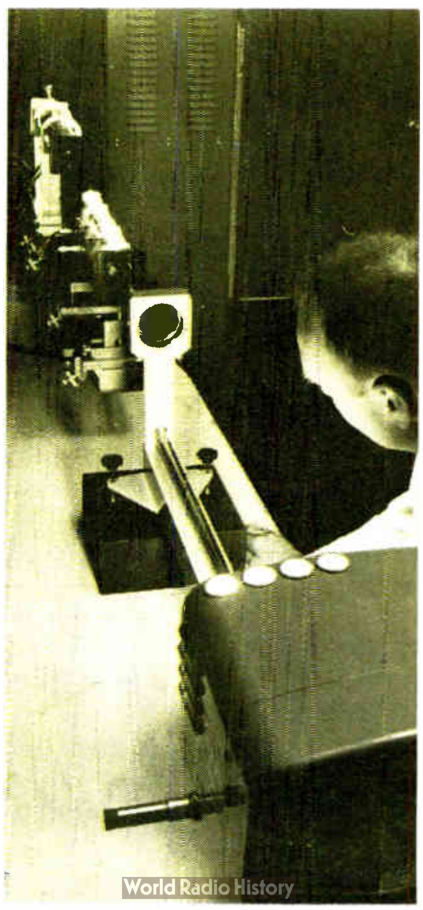


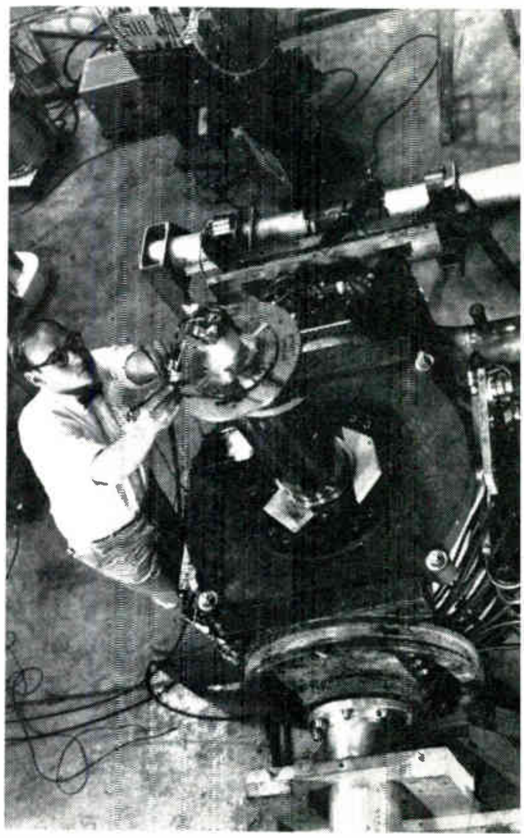
▲ A NEW YORK TO FLORIDA SPECIAL

For the first time in railroad history, television sets are being installed for passengers aboard the Atlantic Coast Line's "Florida Special" by the Olympic Radio & Television Division of Lear Siegler, Inc. The initial passenger reaction is "enthusiastic."

▼ LASER BEAM VIEWER

Engineer J. R. Hansen, Westinghouse, prepares to view complicated patterns in a laser beam with a new infrared pattern viewer. "Eye" of the viewer is a thin film of liquid crystals in round vacuum cell on white column. With laser beam, film heat will cause crystals to shift in color and display beam's structure.





▲ STRONGEST MAGNET

D. Bruce Montgomery, National Magnet Laboratory at MIT, adjusts apparatus on giant new water-cooled magnet, capable of putting out 255,000 gauss. It is a solenoid with three concentric copper coils, designed by Mr. Montgomery's research team under Air Force contract to probe magnetic properties of matter.

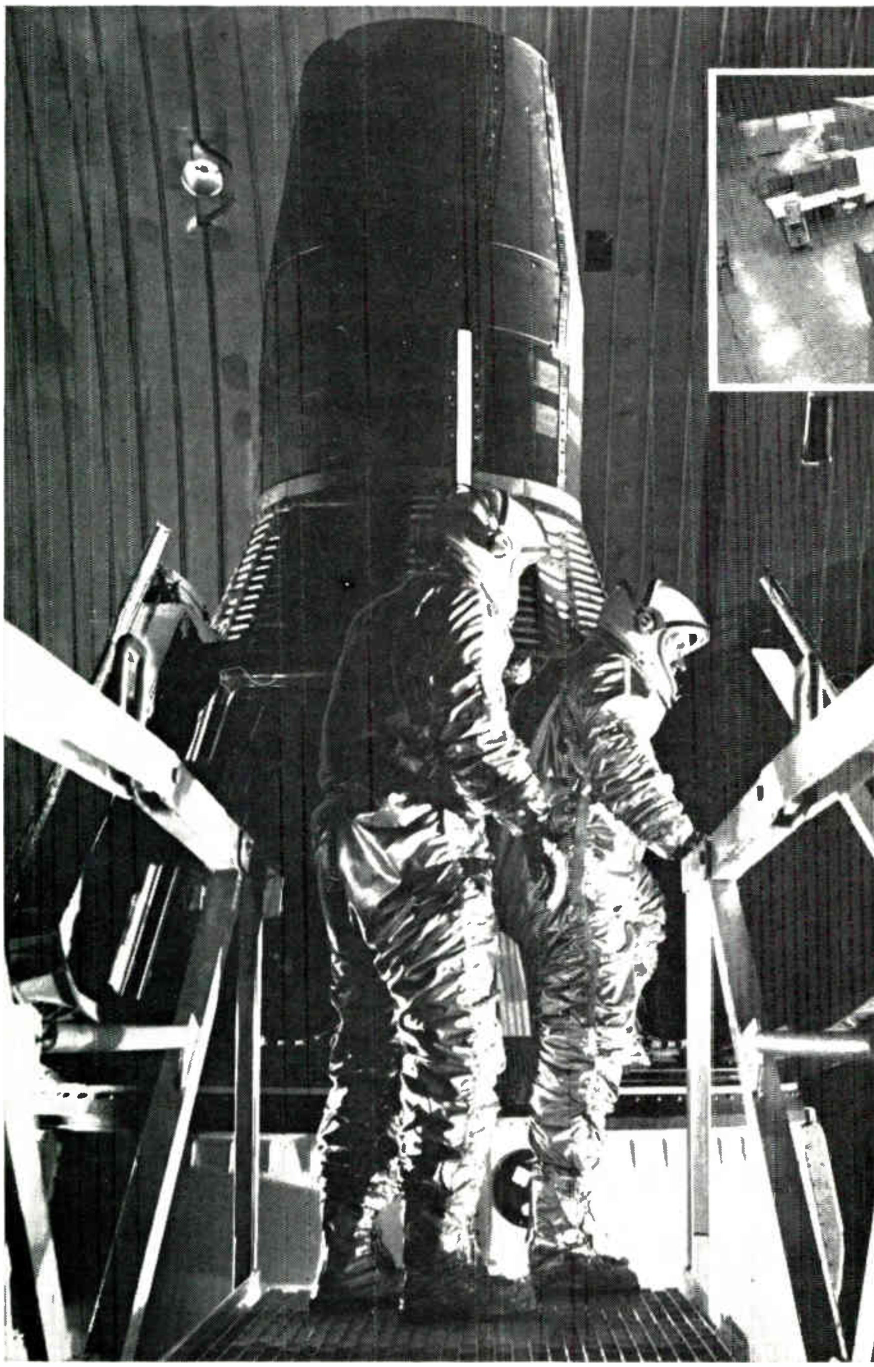
World Radio History

DEEP SPACE AT "GROUND ZERO"

When NASA's astronauts board their Gemini spacecraft it will be with the feeling of old hands at familiar jobs. Even ground crews will operate with the facility of seasoned experts. This is the way it must be, even though it will be a first for both men and machines—each person, each system functioning in unison.

McDonnell engineers designed and built the trainers and simulators for Gemini's orbital rendezvous missions as well as launch, orbital flight and reentry.

The Gemini Mission Simulator is one example of how the skills and facilities of McDonnell Electronics Division are applied to mirror desired situations through true simulation.



GEMINI MISSION SIMULATOR

Our brochure, "Skill in Electronics" will show you why McDonnell is a leader in end-mission related electronics such as Trainers and Simulators.

Write to:

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APPLYING ELECTRONICS AS AN INTERDISCIPLINARY SCIENCE

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This is where the eagle sits

Look who stepped out of the Great Seal to wear a CMC Crusading Engineers' medal. If you think he looks proud you should see us! **He sits on the first and only solid-state, fully militarized electronic counter meeting full Mil Specs.**

If you want the safety of a counter providing full Mil Specs reliability at a price surprisingly close to a commercial counter, then check these specs: 0 to 100 Mc frequency range; oscillator stability of 1 part in 10^9; meets or exceeds MIL-E-16400, including appropriate temperature, humidity, vibration, shock, and RFI specs; built-in time interval measurement. Three militarized plug-ins available: 500 Mc heterodyne converter, 3 Gc heterodyne, and a 15 Gc transfer oscillator.

It may take some time, but you can probably expect copies of this counter from our creative competition at high-powered H-P and big, bad Beckman. But they'll be copying the instrument originated and designed by CMC. State-of-the-art development of a fully militarized solid-state counter isn't the first technological coup for CMC. Add to it the first all solid-state counter, first 10-line-per-second low-cost printer, first dual plug-in-counter, and numerous others.

Write today for a complete spec sheet on our new Model 880 so you can compare when and if the others arrive on the market. And remember, we won't give you the bird, we'll give you a medal.

CMC

12976 Bradley · San Fernando, California · Phone (213) 367-2161 · TWX 213-764-5993

COMPUTER MEASUREMENTS COMPANY IS A LEADING DESIGNER AND MANUFACTURER OF ELECTRONIC INSTRUMENTATION TO COUNT, MEASURE, AND CONTROL.

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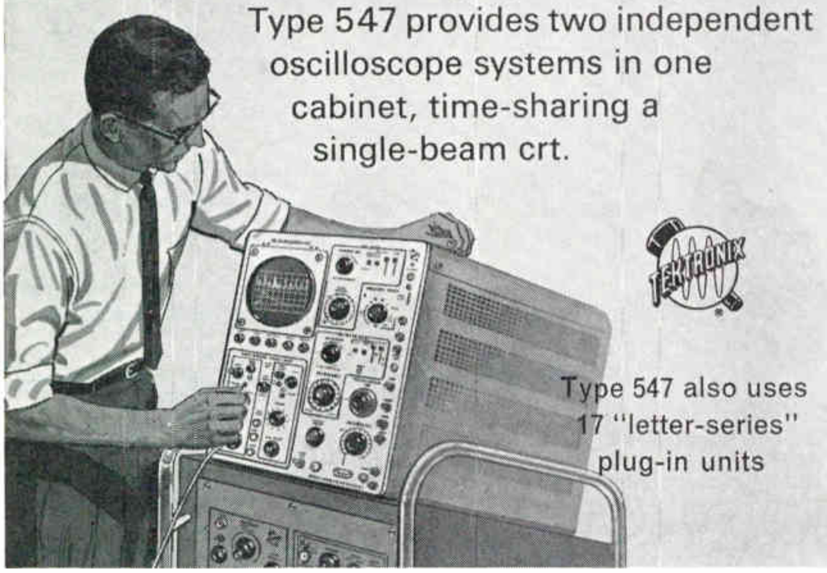
Tektronix oscilloscope displays both time-bases separately or alternately

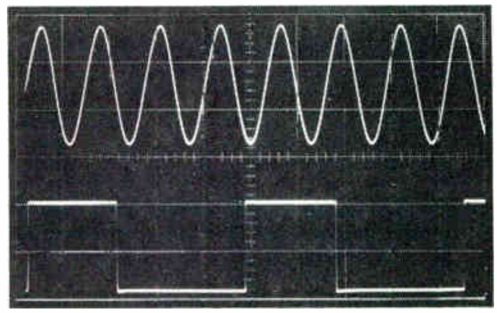
NEW TYPE 547 and 1A1 UNIT

DUAL TRACE	**DC-to-50 MC** **50 MV/CM** **DC-TO-28 MC, 5 MV/CM**
SINGLE TRACE	**2 CPS-to-15 MC** **500 μV/CM** **(CHANNELS 1 AND 2 CASCADED)**

With automatic display switching, the Type 547 provides two independent oscilloscope systems in one cabinet, time-sharing a single-beam crt.



Type 547 also uses 17 "letter-series" plug-in units



Single-exposure photograph.

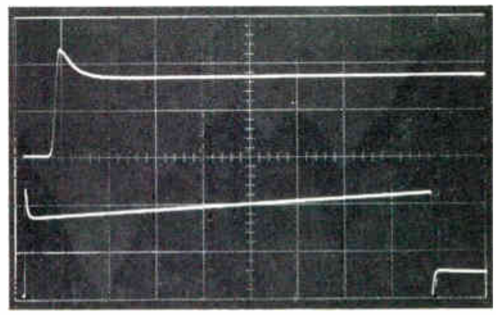
2 signals — different sweeps

Upper trace is Channel 1/A sweep, 1 μsec/cm.
Lower trace is Channel 2/B sweep, 10 μsec/cm.

Using same or different sweep rates (and sensitivities) to alternately display different signals provides equivalent dual-scope operation, in many instances.

Triggering internally (normal) permits viewing stable displays of waveforms unrelated in frequency.

Triggering internally (plug-in, Channel 1) permits viewing frequency or phase differences with respect to Channel 1.

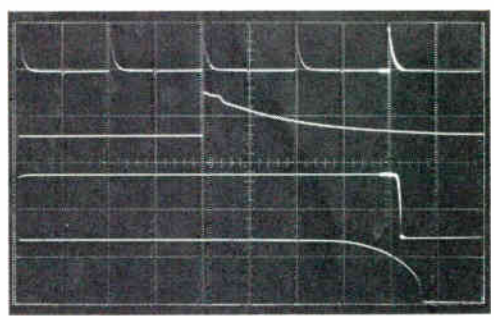


Single-exposure photograph.

same signal — different sweeps

Upper trace is Channel 1/A sweep, 0.1 μsec/cm.
Lower trace is Channel 1/B sweep, 1 μsec/cm.

Using different sweep rates to alternately display the same signal permits close analysis of waveform aberrations in different time domains.



Single-exposure photograph.

2 signals — portions of each magnified

Trace 1 is Channel 2/B sweep, 10 μsec/cm.
Trace 2 (brightened portion of Trace 1) is Channel 2/A sweep, 0.5 μsec/cm.
Trace 3 is Channel 1/B sweep, 10 μsec/cm.
Trace 4 (brightened portion of Trace 3) is Channel 1/A sweep, 0.5 μsec/cm.

Using sweep delay technique—plus automatic alternate switching of the time bases—permits displaying both signals with a selected brightened portion and the brightened portions expanded to a full 10 centimeters.

B sweep triggering internally from Channel 1 (plug-in) assures a stable time-related display without using external trigger probe.

Some Type 547/1A1 Unit Features

New CRT (with internal graticule and controllable illumination) provides bright "no-parallax" displays of small spot size and uniform focus over the full 6-cm by 10-cm viewing area.

Calibrated Sweep Delay extends continuously from 0.1 microsecond to 50 seconds.

2 Independent Sweep Systems provide 24 calibrated time-base rates from 5 sec/cm to 0.1 μsec/cm. Three magnified positions of 2X, 5X, and 10X, are common to both sweeps—with the 10X magnifier increasing the maximum calibrated sweep rates to 10 nsec/cm.

Single Sweep Operation enables one-shot displays for photography of *either* normal or delayed sweeps, including alternate presentations.

2 Independent Triggering Systems simplify set-up procedures, provide stable displays over the full passband and to beyond 50 Mc, and include brightline automatic modes for convenience.

Type 547 Oscilloscope (without plug-in unit)	$1875
Type 1A1 Dual-Trace Unit	$ 600
Rack-Mount Model Type RM547	$1975

U.S. Sales Prices f.o.b. Beaverton, Oregon

For a demonstration, call your Tektronix Field Engineer

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TWX: 503-291-6805 · Cable. TEKTRONIX · OVERSEAS DISTRIBUTORS IN 25 COUNTRIES
TEKTRONIX FIELD OFFICES in principal cities in United States. Consult Telephone Directory
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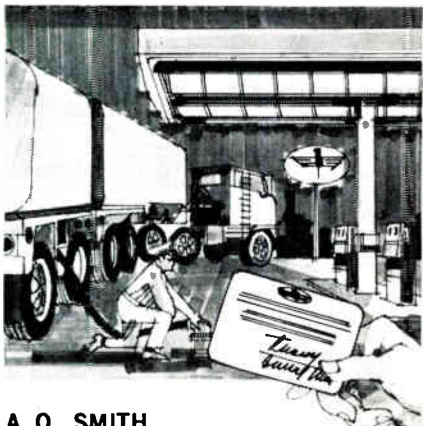
World Radio History

Look who's counting on Durant now!



A. O. SMITH MARKETING SYSTEM KEEPS ACCURATE GASOLINE INVENTORY AND CREDIT CONTROL WITH DURANT COUNTERS

Designed and built by A. O. Smith Corp., this system uses Durant's subtracting predetermined electric counter and an electric totalizing counter. It automatically subtracts every gallon dispensed — to keep an accurate record of gallons remaining from a prepaid increment or credit limit. And it keeps a running total of gallons sold. When the dealer balance reaches "zero", a circuit is interrupted stopping the flow of gas. The service station operator can obtain more gas from the storage tank by dialing a code number. Result: bulk delivery, inventory and credit control costs are substantially reduced.

U.S. WEATHER BUREAU MEASURES RAINFALL 100 MILES AWAY — IT'S REGISTERED ON DURANT COUNTERS

That's how sophisticated weather science is becoming. A new system utilizing a "radar precipitation integrator" samples a returning radar signal from 150 points over a 30,000 sq. mile area in Oklahoma — five times each hour. This provides instantaneous measurements of precipitation at all these locations — and registers it cumulatively (in tenths of inches) on Durant Electric Counters miles away. Installed in a river basin display panel at River Forecast Centers, the counters provide a fast, accurate "picture" of accrued rainfall at all times. The Durant units used for this system have electric reset — ideal to instantly clear the display at the end of a measuring period.

TEXAS INSTRUMENT'S NEW QUARTZ GAGES CONVERT PRESSURE TO ELECTRIC CURRENT — MEASUREMENTS ARE RECORDED ON DURANT COUNTERS

The new units measure absolute pressure from vacuum to 500 psi utilizing interchangeable pressure sensitive elements. Texas Instruments Inc. developed these new Fused Quartz Pressure Gages to provide faster, more accurate pressure measurements. And Durant Instrument Counters were specified to assure it! The reason: high speed and unique design with 100 increments on unit wheel provide the ability to produce readings at speeds of 150,000 increments per minute.

DURANT ELECTRIC COUNTERS

Accuracy you can count on — at high, low, intermediate speeds

There's no operating condition too tough for Durant electrically actuated counters. Exceptionally accurate and dependable, they fit a range of applications from simple production counting to intricate instrumentation and automation. And there's a model for practically any readout you can name. For more information write for our Electric Counter Catalog.

DURANT INSTRUMENT COUNTERS

Wide choice of features to custom-match your design

These high speed counters for digital readout indicators are available *as-you-need* to meet practically any design requirement. There's a choice of: number of figures, rotation, side of drive, type of wheel imprint — and more. Components can also be ordered separately. All mount in die-cast aluminum frames, operate quietly at high speeds with low torque. To get all the facts — write for catalog 400.

The complete line of Durant counters — from single stroke models to high speed electromechanical systems — provide the answer to any count/control need. For specific application data, write direct. Durant Manufacturing Company, 685 N. Cass Street, Milwaukee, Wisconsin 53201.

DURANT®

MANUFACTURING COMPANY

MILWAUKEE, WISCONSIN

4300

Circle 14 on Inquiry Card

World Radio History

HI-FI GROWTH ESTIMATED FROM 10% TO 15% A YEAR

In the mid-1950s when the term "high fidelity" was known mainly among "hi-fi" buffs, high fidelity component sales were about $25 million. As "hi fi" became a household phrase, sales quadrupled to about $100 million in 1963.

This industry estimate was offered by Walter O. Stanton, president of the Institute of High Fidelity, Inc., and head of Pickering & Co. He figures that hi-fi industry sales growth ranges between 10% and 15% yearly. (Other current estimates place hi-fi components at about $50 million for 1964 and a possible $55 million for 1965.)

These figures are only fractions of the general consumer phonograph sales which totaled about $417 million in 1963, according to Electronic Industries Association. Data include low-cost as well as hi-fi units. Some estimates for 1964 and 1965 respectively are $405 million and $410 million.

LITTON OFFICIAL PREDICTS CORNER-STORE EDP

The business equipment industry is one of the most dramatic examples of this era of exploding technology, Charles B. Thornton, board chairman of Litton Industries, told the Business Equipment Manufacturers Association in Los Angeles.

In the past 15-20 years the industry has grown 10 fold and by the early 1970's will become a $10 billion industry, double its size today, he said.

He observed that new low-cost, high-efficiency computers are being introduced that will make it possible for the corner drug store, the family doctor, the neighborhood grocery and the barber shop all to take advantage of the tremendous capability of the computer.

U.S. COMMERCE DEPT. OFFERS EXPORT PROMOTION SERVICE

Sample Displays, newest export promotion service of the Bureau of International Commerce, are now open for business at U. S. Embassies in Beirut, Lebanon; Manila, Philippines, and Nairobi, Kenya, the U. S. Department of Commerce announced.

The service will also be offered at the U.S. Trade Center in Bangkok, Thailand, in addition to regularly scheduled promotions of specific product themes.

"Primary objective of the new service," according to Eugene M. Braderman, Director of the Bureau of International Commerce, "will be to assist U. S. firms in establishing agents and distributors in foreign markets."

NEW FIELD PORTABLE TV RELAY SYSTEM

All-solid-state portable TV system introduced by Microwave Associates works from auto cigaret lighter. Works from 1.9 to 2.1 gc and mobile relay band. Applications include high-speed data sending, radar, telemetry, multi-channel TV. Usable to 50-mile radius.

INDUSTRY OUTLOOK CLOUDY BUT PROMISING FOR 1965

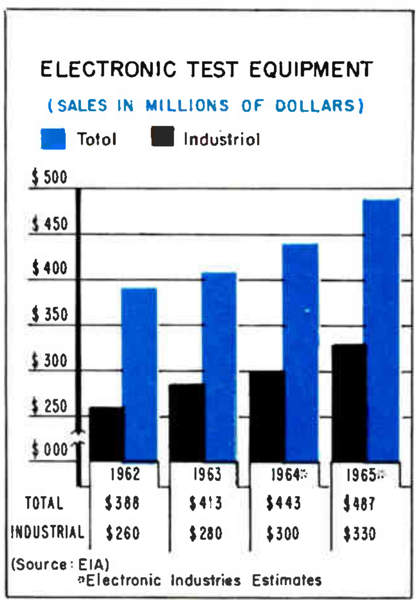
The electronics industry, spurred by the general prosperity, closed its books on a successful year which saw sales move up by about 5½%.

A new report just issued by The Value Line Investment Survey states that the only conspicuous weak spot is the continuing slump among some military electronics firms. However, even those companies have taken steps to improve their earnings picture by cutting costs.

The report points out that the continuing upward trend in new orders suggests that favorable year-to-year comparisons for most companies will continue at least through early 1965. It cautions, however, that the possibility of a downturn in general economic activity late in 1965 has different implications for various industry segments.

A number of companies, especially those which depend heavily on a strong fourth quarter for a successful full year, might prove particularly vulnerable to a serious economic recession. Similarly, several companies which have been most sensitive to over-all business fluctuations, may also suffer setbacks.

The report estimates that 46 of the 59 companies in the electronics industry under continuing review by the Value Line have increased sales in 1964 over 1963, while 48 of the companies show improved earnings.



SALES GROWTH EXPECTED FOR N/C EQUIPMENT

Increasing sales of numerical controls for machine tools were anticipated at a recent conference of the Numerical Control Society.

In the past ten years, numerical control machine sales have grown to about 5,000 units. One source estimated that about 500 N/C machines had been installed from 1954 to 1960. It was further estimated that nine times as many units—some 4,500—had been installed between 1960 and 1964.

LARGE SHARE OF SPACE MONEY FOR ELECTRONIC PRODUCTS

The lion's share of certain space hardware dollars still goes for electronic hardware. NASA estimates show electronic products and equipment represent some 40% of launch vehicle costs.

Electronic goods also represent about 70% of spacecraft costs, and 90% of tracking and data acquisition systems costs. Of about $5.2 billions now being spent by NASA, from $1.8 to $2 billion reportedly go to electronic suppliers. Most of the balance of the funds are spent for ground installations and salaries.

World Radio History

Another New High Order of Reliability!

El-Menco

*MYLAR-PAPER DIPPED CAPACITORS

TYPE MPD

ASSURE A LOW FAILURE RATE OF
Only 1 Failure in ~~7,168,000~~ 14,336,000 Unit-Hours for 0.1 MFD Capacitors★

Setting A New High Standard Of Performance!

★ Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 105°C with rated voltage applied — have yielded a failure rate of only 1 per 1,433,600 unit-hours for 1.0 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield ONLY 1 FAILURE IN 14,336,000 UNIT-HOURS.

CAPACITANCE AND VOLTAGE CHART

● *Five case sizes in working voltages and ranges:*

200 WVDC —	.018 to .5 MFD
400 WVDC —	.0082 to .33 MFD
600 WVDC —	.0018 to .25 MFD
1000 WVDC —	.001 to .1 MFD
1600 WVDC —	.001 to .05 MFD

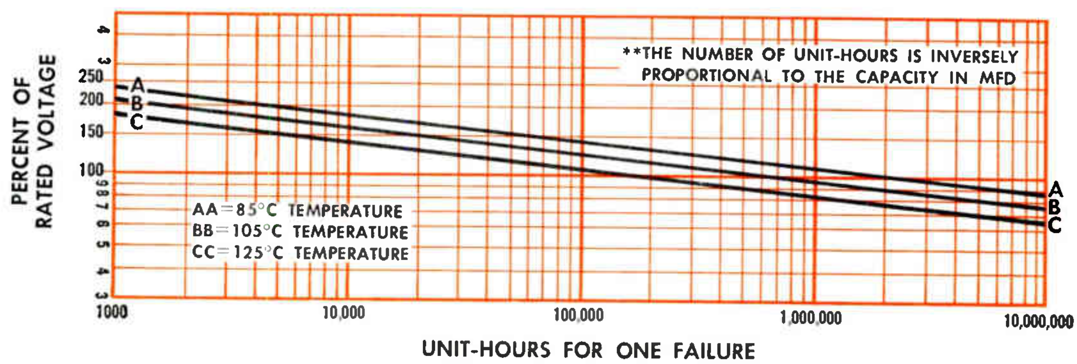
SPECIFICATIONS

- **TOLERANCES:** 10% and 20%. Closer tolerances available on request.
- **INSULATION:** Durex phenolic epoxy vacuum impregnated.
- **LEADS:** No. 20 B & S (.032") annealed copper clad steel wire crimped leads for printed circuit application.
- **DIELECTRIC STRENGTH:** 2 or 2½ times rated voltage, depending upon working voltage.
- **INSULATION RESISTANCE AT 25°C:** For .05MFD or less, 100,000 megohms minimum. Greater than .05MFD, 5000 megohm-microfarads.
- **INSULATION RESISTANCE AT 105°C:** For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microfarads.
- **POWER FACTOR AT 25°C:** 1.0% maximum at 1 KC

These capacitors will exceed all the electrical requirements of E. I. A. specification RS-164 and Military specifications MIL-C-91B and MIL-C-25C.

Write for Technical Brochure

MINIMUM LIFE EXPECTANCY FOR **1.0 MFD *MYLAR-PAPER DIPPED CAPACITORS AS A FUNCTION OF VOLTAGE & TEMPERATURE



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World Radio History

LETTERS

to the Editor

Octave Calculations

Editor, ELECTRONIC INDUSTRIES:

Re: Item 75, p 58, EI, Dec. 1964 "Frequency Changes in Octaves"

Most engineers have slide rules: mine is an old Log Log Trig. Duplex. Try this:

Step 1) Divide f_1 by f_2 (f_1 = 350 MC) $(f_1/f_2) = R_1$ f_2 = 22 KC
R_1 = 16,000

Step 2) On the LL 3 scale, enter R_1 = 16,000

Step 3) bring left index of C-scale to align with R_1 on LL 3

Step 4) move slide to *(2)* on the LL 2 scale

Step 5) at the hairline read *(14)* on the CI scale

Answer: *14 Octaves*

For values that are above the extreme value (20,000) of the LL 3 scale, note the 6 db/octave is the same as 20 db/decade and account for excess powers of 10 in this manner.

Conversely: for X db loss:

Step 1) $\frac{X}{6}$ = No (No of Octaves)
2^{No} = the frequency ratio:

Step 2) move hairline to 2 on LL 2

Step 3) move left index of C to hairline

Step 4) suppose X = 26
$\frac{X}{6} = 4.33$
Move slide to 4.33 on the C scale

Step 5) at the hairline on the LL 3 scale read 20.3

Step 6) multiply f_2 by 20.3 to obtain f_1

Most decent slide rules have enough scales to do something like what I have just suggested.

D. K. Leichtman
Engineering Specialist

Sylvania Electronic Systems
Wehrle Dr. and Cayuga Rd.
Williamsville, N. Y. 14221

Measurements and Calibrations

Editor, ELECTRONIC INDUSTRIES:

In reference to your recent editorial regarding Measurements and Calibration, and to your invitation to companies with qualified facilities and personnel to issue certificates traceable to the National Bureau of Standards.

I am enclosing our Service Division Brochure giving full information on our capabilities. Copies are available to your readers. Our facilities have been approved by Government agencies and our procedure is in accordance with Mil-C-45662A.

We therefore forward you this information with hopes that it will be of use to your reference file and to your readers in need of such services in this area.

Dave Krantz
Service Mgr.

Sunshine Scientific Instrument
1810 Grant Ave.
Philadelphia, Pa. 19115

An Answer . . .

Editor, ELECTRONIC INDUSTRIES:

This is written in answer to Mr. M. T. Turner's plea in your December Letters to the Editor of Electronic Industries.

The Nordson Corporation, Amherst, Ohio, is the American distributor for a West German-made measuring device called mikrotest. Two models are available—one for measuring thicknesses to 0.050, and the other for thicknesses greater than 0.050. The mikrotest is a hand tool and measures thicknesses of non-magnetic films or sheets that are backed by steel. It can be used on contoured surfaces and may fit your needs if you can provide a steel backing at the area to be measured.

W. C. Durning
Methods & Standards

Philco Corp.
Western Development Labs.
3825 Fabian Way
Palo Alto, Calif. 94303

A Correction

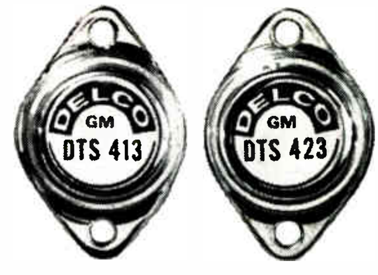
Editor, ELECTRONIC INDUSTRIES:

I find your Filter Chart on page 71 of the November 1964 issue extremely useful. However, the circuit figure shown within the graph should be changed to show C_2 in the place of C_R.

This should correct all errors in the article and make the written material correlate with the illustration.

L. J. Martens
Equipment Design Eng.

General Electric Co.,
Mountain View Rd., Lynchburg, Va. 24502



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DELCO RADIO

DIVISION OF GENERAL MOTORS • KOKOMO, INDIANA

World Radio History

A COOL 400 V

Delco Radio's new DTS 413 and DTS 423 power transistors, are conservatively rated at 75 and 100 watts. Our standard TO-3 package assures low thermal resistance (junction to heat sink 1.0°C per watt) for cool power. The silicon element gives you high voltage protection, high frequency response and low saturation voltage.

The price is low (less than 3¢ a volt for sample quantities) for two reasons: special inter-digitated geometry of the devices and our unique 3D* process for high yields.

Now you can reduce current, the size of other components, and increase efficiency in high energy circuits. Vertical and horizontal TV outputs, for example.

Your Delco Radio Semiconductor distributor has these two new power transistors on his shelf. Call him today for data sheets, prices and delivery.

*Triple sequential diffusion

RATINGS	DTS 413	DTS 423
VOLTAGE		
V_{CEO}	400 V (Max)	400 V (Max)
V_{CEO} (Sus)	325 V (Min)	325 V (Min)
V_{CE} (Sat)	0.8 (Max)	0.8 (Max)
	0.3 (Typ)	0.3 (Typ)
CURRENT		
I_C (Cont)	2.0A (Max)	3.5A (Max)
I_C (Peak)	5.0A (Max)	10.0A (Max)
I_B (Cont)	1.0A (Max)	2.0A (Max)
POWER		
	75 W (Max)	100 W (Max)
FREQUENCY RESPONSE		
f_t	6 MC (Typ)	5 MC (Typ)

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DELCO RADIO
Division of General Motors

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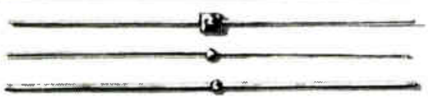
World Radio History

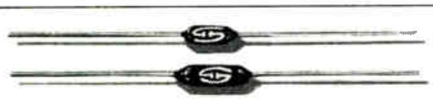
microminiature

ceramic capacitors

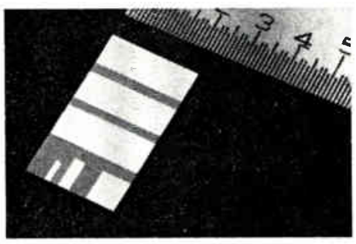
Scionics has a broad line of microminiature ceramic capacitors including rectangular and round pellets as small as .050 dia. by .020 thick.
These high reliability multilayer capacitors have been used for more than three years by a large number of companies building equipment for military and aerospace applications.



Pellet ceramic capacitors with ribbon and 30 gage wire leads. Values: 22pf to .1mfd, 50 WVDC. Sizes: from .050 dia by .030 thick



Dip coated ceramic capacitors. Values: 47pf to 1.0mfd, 50 WVDC; 47pf to .01mfd, 200 WVDC. Sizes: from .075 dia by .190 long



The Scionics Multi-cap, miniature capacitor has several discrete capacitors on one ceramic chip providing improved volume utilization and lower cost.

Epoxy molded ceramic capacitors. Values: 47pf to 1.0mfd, 50 WVDC; 47pf to .01mfd, 200 WVDC. Sizes: from .1 dia by .2 long.

Hermetic seal ceramic capacitors in CK06 metal case provide absolute humidity protection. Values: 47pf to .01mfd, 200 WVDC.

Scionics has developed and delivered many special miniature ceramic capacitors including tubular hermetic seal units and special pellet capacitors.

CAPACITOR DIVISION — 8900 Winnetka Avenue, Northridge, California / 213-341-5500 / TWX 213-341-7559
The Scionics Corporation — Capacitor Division • Instrument Division • Information Systems Division

SCIONICS

SCIENCE AND ELECTRONICS FOR INDUSTRY

Circle 19 on Inquiry Card

Circle 20 on Inquiry Card →

World Radio History

Is it possible that you may be penny-wise and pound-foolish by purchasing "lower cost" resistors?

Let's not be too quick with the answer!

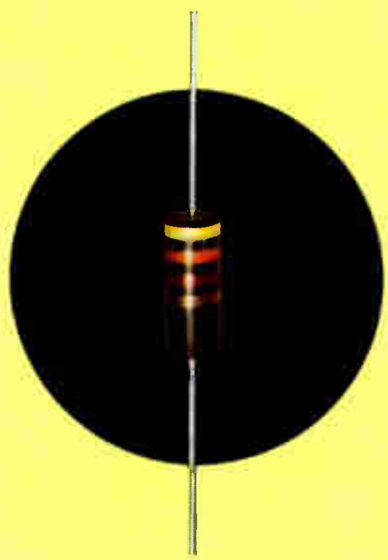
■ Here are some factors you should not overlook! When an assembly line test shows up a faulty cheap resistor, the correction costs you real money—more than you had hoped you would save by using resistors of marginal dependability. And, when you are mass producing in a highly competitive field, each reject can make the complete assembly a "no profit" item. Can you afford to mess around with such costly gambling?

Allen-Bradley does not believe so—and neither do the countless customers that have been using A-B quality resistors—by the billions—during the last several decades. Consequently, Allen-Bradley offers but *one* line of commercial resistors—whose "quality" has never been topped. When you specify Allen-Bradley resistors, there can be no doubt about the quality of the resistors going into your equipment.

All Allen-Bradley resistors are made by an exclusive hot molding process on special automatic machines designed and patented by Allen-Bradley. With the "human element" virtually eliminated, such uniform quality and consistent properties in production are so automatically assured that long term resistor performance can be accurately predicted.

What the Purchasing Department may consider too much of a "premium" to pay for the acknowledged superiority of Allen-Bradley hot molded fixed and variable resistors most likely would prove to be a "dividend" earned by your shop for its trouble free production and an improved quality of your equipment. After all, satisfied customers remain as advertisements for your product which money cannot buy.

So you see there are economic advantages in standardizing on Allen-Bradley hot molded resistors. Let's become better acquainted! Please write for Technical Bulletin 5050: Allen-Bradley Co., 222 W. Greenfield Avenue, Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.



A-B HOT MOLDED RESISTORS are available in 1/8, 1/4, 1/2, 1, and 2-watt ratings, and in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits.

A-B QUALITY

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

46-02-5E

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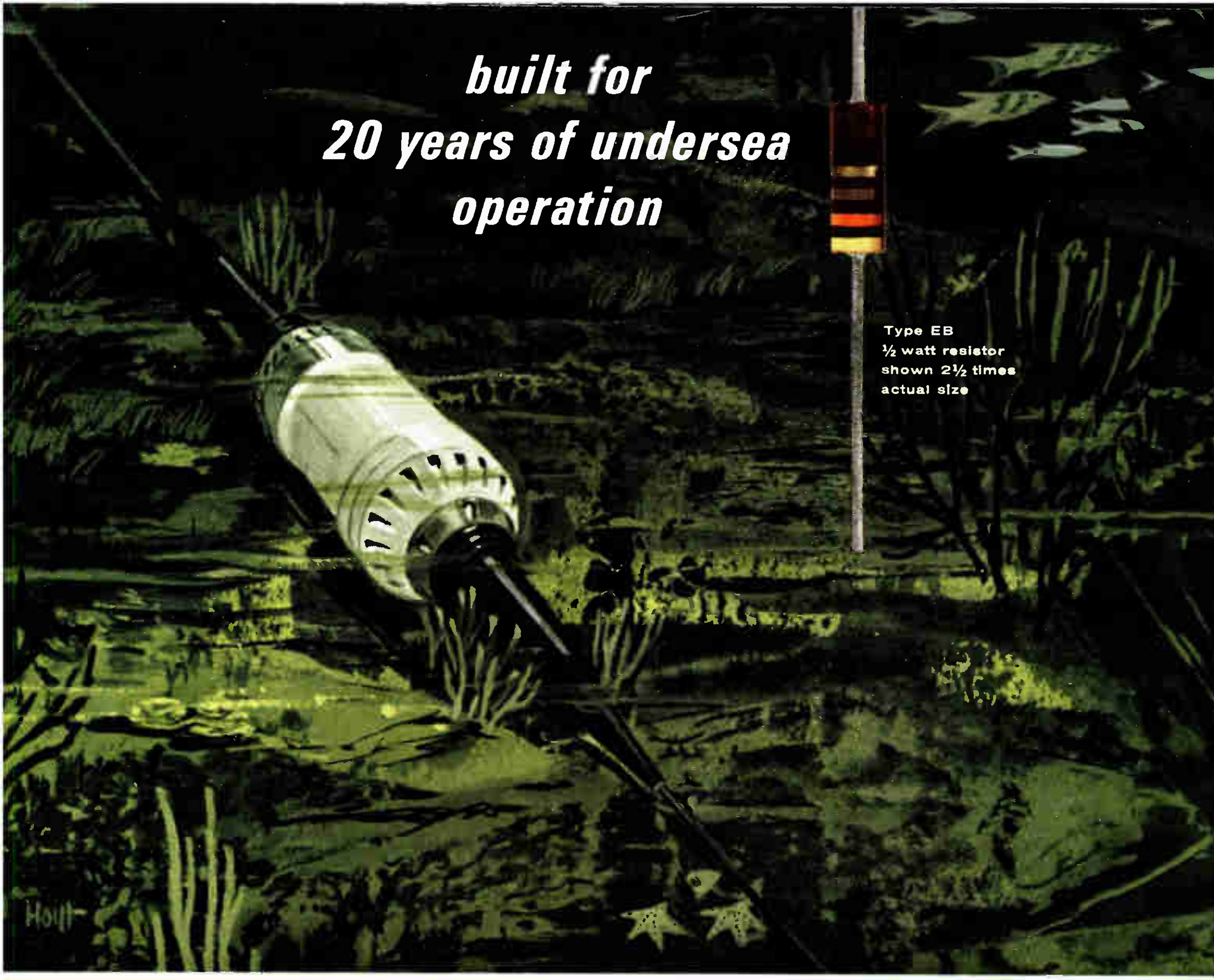


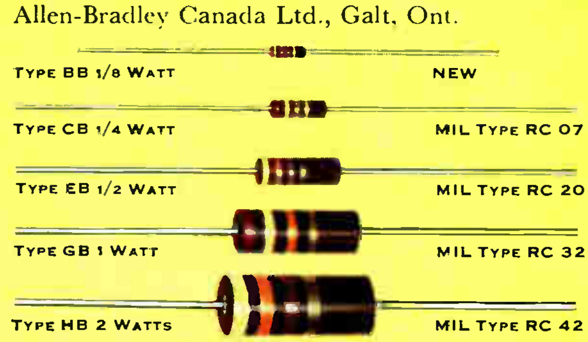
Western Electric submarine telephone cable repeaters require the proven dependability of **Allen-Bradley hot molded resistors**

■ Western Electric faced a unique engineering challenge when building repeaters for a new transoceanic telephone cable — they are designed to operate in the murky world of the ocean bottom for a minimum of twenty years, without failure. For this kind of reliability, each component had to be as close to perfection as humanly possible. Allen-Bradley is proud that the quality of their standard Type EB ½ watt, hot molded resistors after some selection and screening enabled them to meet these most exacting requirements.

This outstanding performance of Allen-Bradley fixed resistors is the result of the unique hot molding process — developed and used exclusively by Allen-Bradley. It results in such uniformity from resistor to resistor — year in and year out — that long term resistor performance can be accurately predicted.

Allen-Bradley *can only produce* the top quality resistors that you would receive in return for any order — large or small — which you place with us. The price is right — it represents the care that goes into the making of all Allen-Bradley hot molded resistors. The "quality" reputation is worth more to Allen-Bradley than the orders that could be obtained by tampering with the quality of the resistor. You can be "*sure*" of "*quality*" — when you buy from Allen-Bradley.

To use Allen-Bradley quality resistors, when everybody knows that resistors can be bought at a lower price, will, in itself, attach the label of quality to your product. Let us send you our Technical Bulletin 5050: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



HOT MOLDED FIXED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits. Shown actual size.

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37-09-4E

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See the special socket? It's a handy new convenience. You can attach the socket to the circuit—and insert a Class E taper-tab relay later on.

This new method can simplify packaging, shipping and inventory. You don't have to ship a printed-circuit board with the relay in place. Ship them separately—with all the resultant benefits.

At the receiving end, it's easy to insert the complete series ETA assembly with its plastic dust cover. Remove it anytime, quickly. The socket stays in place.

Want some helpful details? Just drop us a line, and ask for AE's Product News on the ETA socket.

Widest Mounting Choice

In addition to this new ETA socket with printed-circuit terminals, other Class E relay sockets are available with dual taper-pin and taper-tab terminals. And the relays themselves can have conventional solder, taper-tabs, or wrapped-wire terminals, or pins for plug mounting.

This amounts to the industry's widest selection of Class E relay connections—another good reason to check Automatic Electric for *all* your relay needs. Write the Director, Relay Control Equipment Sales, Automatic Electric, Northlake, Illinois 60164.

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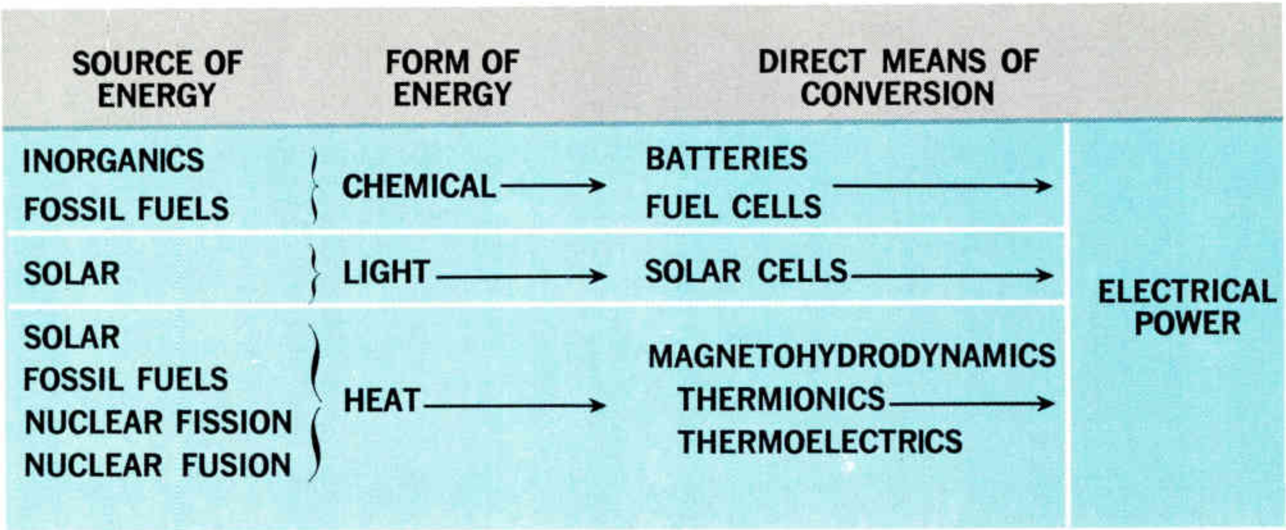

Fig. 1: Direct-energy-conversion technologies

State-of-the-Art Report On Electrical

NEW TECHNIQUES OF GENERATING ELECTRICAL ENERGY have been fostered by government, military and space requirements. The evolving technology should make a big impact on our every-day use of electrical power. For instance, the quiet energy converter that powers a soldier's portable radar set could one day power his lawn mower.

Government requirements for specialized power sources stem in part from the need for high reliability and long life, light weight and compactness, silence, and ability to operate in remote places under extremes of environment. Power requirements go from tens of watts for communications, navigation and weather satellites to millions of watts for space propulsion. To date, the solar cell has been the mainstay for space power below a few hundred watts. Radioisotopic thermoelectric generators (RTG) have also been demonstrated as feasible for space. Many other systems are now under development, and are expected to become practical during the present decade.

Primary Energy Sources

The various primary energy sources available, and the energy conversion techniques that can be employed to convert them into electrical power, are shown in Fig. 1. The three basic forms of this energy are the sun, fossil fuels and nuclear reactors and isotopes. As time goes by and our fossil fuel reserves are consumed, the nuclear and solar sources will be the chief sources of electrical power including that produced by central-station power plants which supply our conventional power lines.

In Fig. 1, inorganics include the hydrogen and oxygen that go into fuel cells and the lead, zinc and manganese dioxide that go into batteries. Fossil fuels include oil, gasoline, natural and produced gas and other hydrocarbons, including a host of organic chemicals useful as energy sources. Nuclear fusion and fission include, besides the reactor heat source, the heat in the waste material or alpha, beta and gamma emitting isotopes. These latter will be referred to as isotope heat sources and will be useful for power levels up to a kilowatt or so. Included are some artificially produced isotopic alpha heat sources such as polonium (also occurring naturally), plutonium and curium. Photons from the sun can be utilized, mostly in the visible region, or in the degraded form of heat. The type of energy converter selected determines the form of energy used. It is interesting to note that such heat sources as sunlight, isotopes and reactors actually require a new type energy converter for efficient electrical generation.

Energy Conversion Techniques

There are many methods of energy conversion, the most promising at the moment being those listed in Fig. 1.

In the battery, the electrodes take part in a chemical reaction which produces a flow of electrons and ions resulting in an external flow of electrons in a load. Primary batteries are useless after the chemicals have been consumed. However, secondary (storage) batteries are capable of being recharged or having the chemical process reversed by external power being applied.

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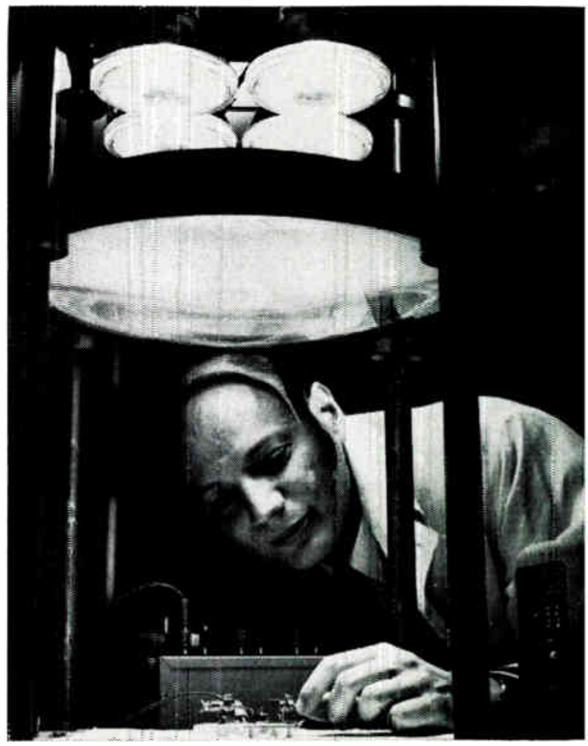
Extensive R & D on half a dozen direct means of energy conversion is expected to result in widespread applications of several of these devices quite soon. Those of particular interest to electronic engineers are detailed.

By **PAUL RAPPAPORT**
RCA Laboratories
Princeton, New Jersey

Energy Sources


Author P. Rappaport of RCA Labs Technical Staff testing power output of a solar cell under a simulated source of solar energy.

A fuel cell is a form of battery in which the chemicals are constantly added and the by-products are constantly removed. The electrodes are also used up in different ways, but the life of the fuel cell is usually limited by the amount of fuel (chemicals) that can be supplied. Fuel cells have high efficiencies, ranging from 20 to 70% depending on the system. The major use for fuel cells in the near future will be for high power, short duration missions, in space, where the expensive fuels—hydrogen and oxygen—are used to achieve high efficiency.

The solar cell converts light photons directly into electricity by the photovoltaic effect, giving an efficiency of 10% for a sunlight spectra of photons, and considerably higher efficiency for a monoenergetic source of photons. If the source of photons is a heat source, the process is called the thermal photovoltaic effect (TPV).

The means for converting heat into electricity are manifold. One method, the conventional turbine-generator system, operates at efficiencies of about 40% in central-station power plants. Another method, known as magnetohydrodynamics (MHD), may someday compete with rotating turbine-generator systems for central station power. MHD is analogous to a rotating machine except that the electrical current, in the form of hot ionized gasses or plasma, is forced through a magnetic field, producing a potential difference between electrodes which is perpendicular to the magnetic field and the gas flow. Electrical power can be generated by an MHD system at a much higher efficiency than the 40% obtainable at conventional power stations. Because of the high temperature (about 3000°C), and magnetic field that is required, plus the need for high velocity gas flow, the MHD technique would be most efficient in a large installation. It could produce megawatts of power from heat produced by a reactor. The major problem to be solved is to find materials that won't corrode at the high temperatures involved, in the presence of a high velocity ionized gas.

Thermoelectric (TE) and thermionic (TI) devices convert heat into electricity quite simply. Efficiencies from a few percent to about 30% are possible with these Carnot-cycle-type heat engines.

The conventional conversion technique of the dynamic or rotating turbine-generator unit mentioned before is by no means completely out of the race as a compact, portable and efficient device useful in space. It may suffer from inherent reliability problems and operational difficulties because of the mechanical motion, but it is the reference against which other systems have to compete and be proved superior before their operational use is assured. This is especially true in the 30 to 300 kw power range. In a similar sense, the battery is the reference against which other systems must compete at lower powers.

Details of Direct Energy Conversion Systems

Detailed here are the three specific energy conversion techniques of particular interest to electronic engineers—solar cells, thermoelectrics and thermionics. These techniques are truly *static* and are called

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
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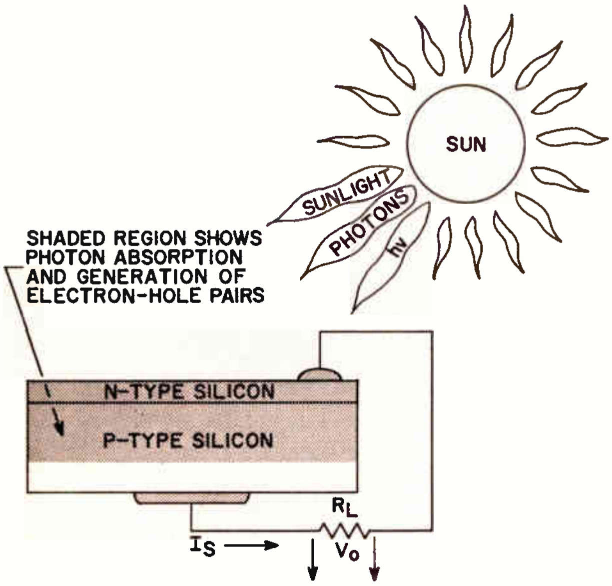

Fig. 2: Basic action of solar cell. Shaded region has intense ionization due to electron-hole pairs generated by light.

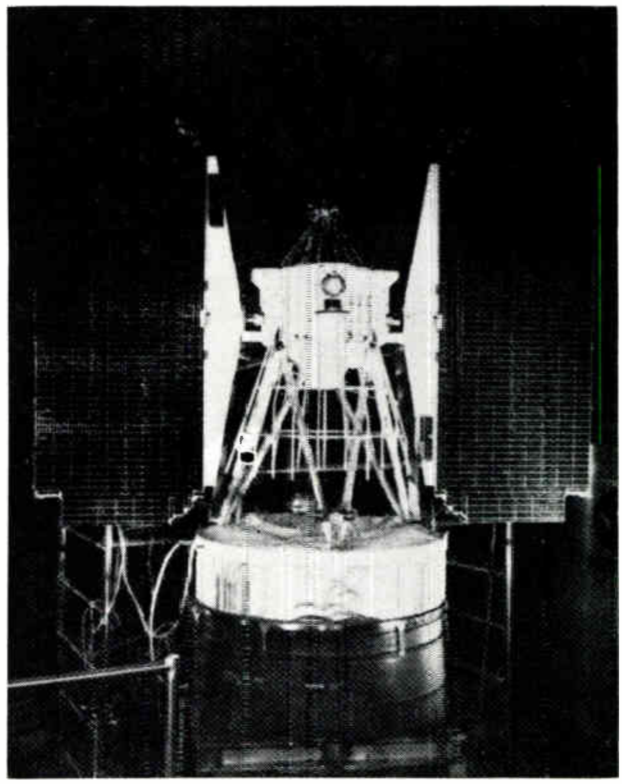

Fig. 3: Satellite, utilizing solar cells on extended panels.

ELECTRICAL ENERGY SOURCES (Continued)

direct energy conversion (DEC) devices. Fuel cells, MHD and dynamic machines all involve motion, and because of this, their ultimate reliability may not be as good as the completely static systems.

High reliability is the key. Without high reliability, the newer techniques will not be able to compete with the more conventional and less costly techniques presently in use.

An intriguing fact about energy conversion is that work in this field is based on many old ideas only now becoming practical because of new materials and technologies. Solar cells employ the photovoltaic effect which was discovered by Becquerel in 1839; the thermionic converter is based on the Edison effect discovered in 1821; and the thermoelectric effect was discovered by Seebeck in 1883. These three basic technologies are well entrenched in the electronics industry, where they have been utilized in vacuum tube and semiconductor technology. This explains why the electronics industry is now in the power business.

The Solar Cell

The solar cell is the only new energy-conversion device in production. A product of the new semiconductor industry, it is essentially one half of a transistor, a p-n junction, that has a large surface area. When this area is exposed to sunlight, the energy in the solar photons is converted into electricity by the p-n junction, Fig. 2. The shaded region is one of intense ionization due to electron-hole pairs generated by the light. The photons must have enough energy to break the silicon atom-to-atom bonds to produce this ionization. An energy of about 1 electron volt (e.v.) is required, and fortunately about two thirds of the solar photons have energy exceeding this value. The p-n junction is merely a potential barrier, similar to the barrier formed when two dissimilar metals are brought together. This barrier allows a unidirectional current flow. Electrons flow from the p-type to the n-type silicon, and holes from the n-type to the p-type silicon, which constitutes a current flow as shown. Power can be delivered to a matched load with an overall efficiency of at least 10%. The p-n junction presents a non-linear characteristic to the current voltage load curve. Thus, it is possible to deliver nearly 75% of the power generated to the load.

Such cells are ideally suited to provide low values of electrical power in space craft and will probably continue to be the mainstay for such use over the next 5 to 10 years. Well over 150 U.S. satellites have thus far used solar cell power, ranging from the 5 w Vanguard to the 400 w Nimbus weather satellite. While development emphasis has been on space applications, the long range future for solar cells also includes terrestrial applications. A truly

Table 1
SOLAR CELL MATERIALS

Material	Bandgap Energy (e. v.)	Efficiency (%) Theoretical	Efficiency (%) Measured
Silicon	1.11	20	14
Indium Phosphide	1.25	23	3
Gallium Arsenide	1.35	24	11
Cadmium Telluride	1.45	21	7
Gallium Phosphide	2.25	17	1
Cadmium Sulfide	2.4	16	7

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low-cost solar cell could have a profound effect on the economy of the emerging nations of the world.

When used for space power, the individual cells (a few square centimeters in area) are connected in series-parallel arrays. The cells are either attached to the surface of the satellite or they are attached to solar panels which project from the satellite, as shown in Fig. 3. On the Nimbus satellite shown, 10,944 2 x 2 cm cells are employed to yield about 400 w. Each panel is about 24 sq ft in area and is constantly oriented normal to the sun.

Many other solar energy conversion devices show promise of competing with solar cells for space power, but they have not yet been developed to the stage of (1) converting solar energy to electricity with 10% system efficiency, (2) operating without special power conditioning equipment to produce high voltages, (3) relative insensitivity to orientation effects, (4) being relatively light and rugged, and (5) requiring no special solar collector or heat radiator.

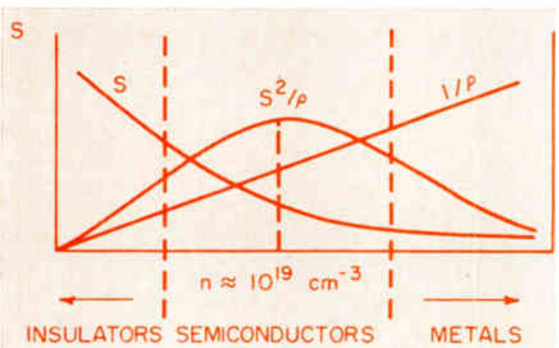


Fig. 4: Theoretical dependence of Seebeck coefficient S, electrical resistivity ρ, and S^{2}/ρ on carrier concentration n.

Fig. 5: Si-Ge thermoelement with tungsten contacts.

Solar cells also have limitations. They are (1) quite sensitive to damage from radiation (important in many space applications); (2) high in cost (important in terrestrial applications); (3) useless during dark periods, thus requiring storage equipment; and (4) limited to power levels up to a few kw, although power in the 10 kw range may be as feasible for solar cells as for other systems now being contemplated.

Almost all of the several million solar cells produced in 1964 were made of single-crystal silicon. Substantial research and development has been conducted, however, to determine whether the use of other crystalline materials, such as gallium-arsenide and cadmium-sulfide, would be feasible. Data on various semiconductors for solar cell use are given in Table 1. The efficiencies shown are the best measured to date.

Solar cells currently in use require single-crystal material. Silicon and gallium-arsenide are the most promising materials investigated to date. Silicon n-on-p cells have more radiation resistance than the p-on-n variety. Silicon solar cells are produced by five companies. Gallium-arsenide cells, which promise greater radiation resistance than silicon, are presently in development and in pilot-plant production.

While the present results with GaAs, as given in Table 1, represent many years of great effort applied to a most stubborn material, improvement in efficiency and reduction in cost are still necessary before the position of silicon for solar cells is challenged. However, for high temperature operations (Venus or Mercury satellites), and when the solar cell is exposed to high radiation, GaAs cells will be preferable to Si cells.

Two of the most urgent requirements for future solar cells are lower cost and lighter weight. Presently, cells range from $200 to $1000 per watt; as a result, their extensive use for terrestrial applications is not now economical. The major reason for this high cost is the need for single-crystal material in the cells. However, it has long been known that non-single-crystal films can be used for solar cells; for example, the selenium- and copper-oxide films which are used in the photoelectric exposure meter. More recently, the cadmium-sulfide and the cadmium-telluride film type solar cells were developed. The exposure meter type devices have efficiencies less than one percent, while the CdS cells have yielded efficiencies up to 5 percent.

Film devices are basically light in weight and offer potential advantages for space applications. This lightness of weight stems from the fact that only very thin layers (microns) of most semiconductors are required for converting solar photons into electricity. Most of the 10 to 20 mils of silicon or gallium-arsenide used in single-crystal devices serves as structural support. The thickness of semiconductor film required for solar cells is determined by their optical absorption.

CdS and CdTe films are being studied by several different organizations, the state of development being about equal. Small area (100 cm²) films, made by evaporating the semiconductor and then forming a barrier layer with copper, yield efficiencies up to 5%. However, in large area (100 cm²) films, the efficiency drops to about 1 to 2% because of series resistance effects. Power-to-weight ratios of about 10 w per pound are claimed for flexible CdS cells. This improvement, by a factor of 3 over silicon cells, is important for space applications, even though these CdS cells are only 1 to 2% efficient. Higher efficiencies and lighter weight substrates should yield cells

World Radio History

with power to weight ratios above 40 w/lb. It has been pointed out that such devices in very large area films (1,000 m^2) could supply power in the kilowatt range and may compete on a cost, weight, and time-available basis with a system such as SNAP 8. The large areas in such a solar cell system would require some ingenious unfurling technique so that an area about a third the size of a football field need not be launched while open. Presumably, a flexible cell would permit such a solution.

Thermoelectric Energy Conversion

The technology of thermoelectric energy conversion is developed to the point of demonstrated feasibility; yet TE devices are not in widespread use. Efficient thermoelectric generators utilize semiconductor p-n junctions similar to the solar cell. However, where the solar cell converts photons on a particle or quantum basis, TE converts the heat produced by photons according to the thermodynamic principles of heat engines and limited by the Carnot cycle.

In this process, heat is applied to the p-n junction contact. The electrons and holes increase. In n-type material this results in an excess of electrons, which sets up an electron gradient forcing electrons along the n-type arm toward the cold end. A similar process occurs in the p-type arm resulting in the motion of holes toward the cold end. This flow of charge in both arms results in a potential across a load.

The thermoelectric figure of merit, Z, is generally regarded as the best single criterion in selecting a material's usefulness as an energy converter. It is defined as follows.

$$Z \cong S^2/K\rho$$

where S is the Seebeck coefficient (after the discoverer of this effect) or the voltage developed per degree centigrade temperature difference between the hot and cold end; K is the thermal conductivity of the material in watts/cm-degree C, and ρ is the electrical resistivity in ohm-cm. In general, the higher the figure of merit, Z, the higher the efficiency of a TE converter, since (assuming $ZT<<1$),

$$\text{Efficiency} \cong 1/4\, Z\Delta T$$

where ΔT is the difference between the hot and cold temperature.

How the important parameters, S and ρ, vary for insulators, semiconductors and metals, is shown in Fig. 4. Note that the product S^2/ρ is maximum in the region of semiconductors. Theory predicts that semiconductors with carrier concentration of about 10^{19} carriers/cm^3, or heavily doped semiconductors, are optimum for TE conversion. The thermal conductivity plays an important role in the process, since the heat, besides generating carriers at the hot end of the generator, can also be conducted away to the cold end without taking part in the energy conversion process. Unfortunately, semiconductors are good heat conductors via the crystal lattice. Because of this, it has been recognized that in semiconductor alloys, the heat conductivity is lower because of the disruption in the crystal lattice. Therefore, semiconductor alloys and compounds are deemed best for TE conversion. *(Continued on page 42)*

Table 2
THERMOELECTRIC MATERIALS

Material	Max. Useful Temp. °C	Z avg $10^{-3}/°C$	$Z\Delta T$
BiTe	250	1.8	0.18
CdS	1,200	0.2	0.21
PbSnTe	550	1.0	0.40
PbTe	600	1.0	0.45
SiGe	1,000	0.6	0.51
AgSbTe	600	1.5	0.68

Fig. 6: Energy conversion efficiency of Si-Ge alloys.

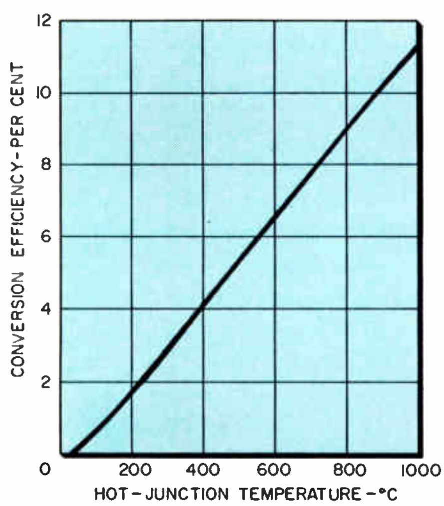
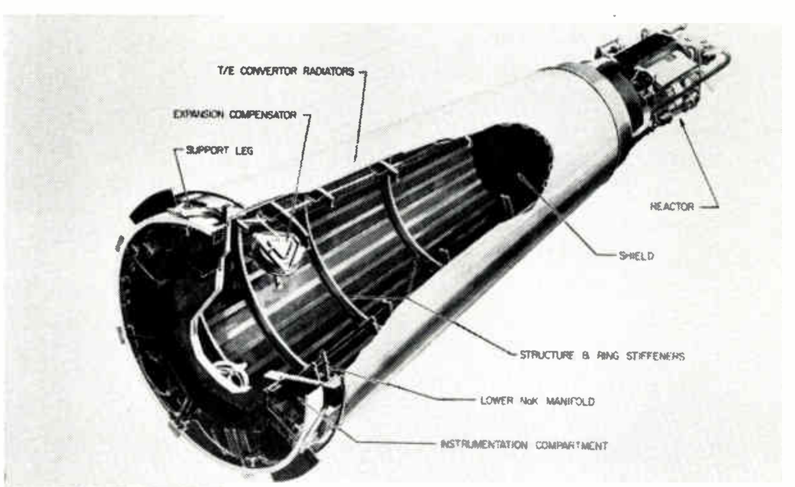


Fig. 7: SNAP 10-A atomic power unit.



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- Rack or modular mounting?
- Low or high power?
- Precision or loose regulation?

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SILICON MODULES

Low Power

Regulation:
0.02% load, 0.01% line
Ripple: 0.5 mv RMS max.
Recovery Time:
Less than 25 microseconds
Remote Programming:
Provided on all units over output range

Model	Volts	Amps	Size (See Series Chart)	Price*
PS20-400	0-20	0-0 4	1	$140
PS32-250	0-32	0-0 250	1	$140
PS50-150	0-50	0-0 150	1	$155
PS3-1 5F	2.5-3.5	0-1.5	1	$130
PS6-1F	4-8	0-1	1	$120
PS12-900F	10-14	0-0 9	1	$115
PS18-800F	16-20	0-0 8	1	$120
PS24-700F	[illegible]	[illegible]	1	$120
PS28-600F	26-30	0-0 6	1	$120
PS48-400F	46-50	0-0.4	1	[illegible]
PS10-2A	0-10	0-2	2	$160
PS20-1 5A	0-20	0-1.5	2	$160
PS32-1 25A	0-32	0-1.25	2	$165
PS50-750A	0-50	0-0 75	2	$180
PS10-4A	0-10	0-4	4	$195
PS20-3A	0-20	0-3	4	$195
PS32-2 5A	0-32	0-2.5	4	$200
PS50-1 5A	0-50	0-1.5	4	$215

*Price listed for quantities of 1 to 14. Discounts available for larger quantities.
Note: "F" models are also available with reduced current output at lower prices.

Series Chart—Dimensions:

Series	Width	Depth	Height
1	3 1/4"	4 1/8"	5"
2	4 5/8"	5 3/16"	6"
4	5"	6 11/32"	6"

HALF RACK SERIES

Low and Medium Power

Regulation:
Line — 0.01% or 2 mv
Load — 0.05% or 10 mv
(.01% or 3 mv for units with suffix "A")
Recovery Time: Better than 50 μsec

- Constant Voltage/Constant Current Operation
- Remote Programming
- Rack Adapters Available
- Coarse and Fine Voltage and Current Controls

Model	Volts	Amps	RMS Ripple mv	Price
HR20-1.5°	0-20	0-1.5	0.25	$164
HR40-750°	0-40	0-0.75	0.15	149
HR20-5A	0-20	0-5	0.5	299
HR20-10A	0-20	0-10		379
HR40-2.5A	0-40	0-2.5		299
HR40-5A	0-40	0-5		349
HR60-2.5A	0-60	0-2.5		379
HR60-5A	0-60	0-5		449
PHR20-5A	0-20	0-5		250
PHR20-10A	0-20	0-10		325
PHR40-2.5A	0-40	0-2.5		250
PHR40-5A	0-40	0-5		295
PHR60-2.5A	0-60	0-2.5		325
PHR60-5A	0-60	0-5		395

°Single Meter Units

Models prefixed "P" are Series 8 Modular Supplies with blank front panels and voltage control on back. Units may be intermixed on same rack adapter used for Silicon Modules —or may be front-panel mounted with conventional rack adapters.

MERCURY INSTRUMENT

Medium and High Power

Regulation: 0.01% or 3 mv all units with Suffix "A."
0.05% or 15 mv all other units
Ripple: 1 mv RMS max.
Recovery Time: Better than 50 μsec

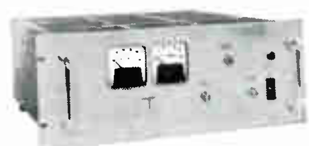
- Constant Voltage/Constant Current Operation
- Remote Programming
- Remote Sensing
- Variable Current Limiting Short Circuit Protection

Model	Volts	Amps	Panel Ht.	Price
†M 15-5	0-15	0-5	3½"	$425
†M 15-10	0-15	0-10	3½"	$510
†M 36-2.5	0-36	0-2.5	3½"	$415
†M 36-5	0-36	0-5	3½"	$445
†M 60-2.5	0-60	0-2.5	3½"	$490
†M 160-1	0-160	0-1	3½"	$515
M 15-15A	0-15	0-15	5¼"	$595
M 15-30A	0-15	0-30	5¼"	$695
M 15-50A	0-15	0-50	7"	$945
M 36-10A	0-36	0-10	5¼"	$550
M 36-15A	0-36	0-15	5¼"	$645
M 36-25A	0-36	0-25	7"	$725
M 36-30A	0-36	0-30	7"	$795
M 60-5A	0-60	0-5	5¼"	$565
M 60-10A	0-60	0-10	5¼"	$725
M 60-15A	0-60	0-15	7"	$895
M 160-3A	0-160	0-3	5¼"	$725
M 160-5A	0-160	0-5	7"	$925

Includes ammeter, voltmeter, complete range remote programming, variable current limiting and constant current operation. †Constant current not included in these models but is available as an option.

HIGH-EFFICIENCY SERIES

High Power



Regulation:
0.2% or 50 mv, SR36-25, SR36-40
0.3% or 50 mv, SR20-40, SR20-70
Ripple: 100 mv RMS max
Recovery Time: 10 millisec

- High Efficiency operation
- Economy provided by unique regulation techniques
- Variable Current Limiting Short Circuit Protection
- Highest quality components
- Remote Sensing

Model	Volts	Amps	Panel Ht.	Price
SR20-40	2-20	0-40	7"	$695
SR36-25	2-36	0-25	7"	695
SR20-70	2-20	0-70	8¾"	925
SR36-40	2-36	0-40	8¾"	850

Note: Standard Semi-Regulated Supply Includes ammeter, voltmeter, complete range remote programming and variable current limiting.

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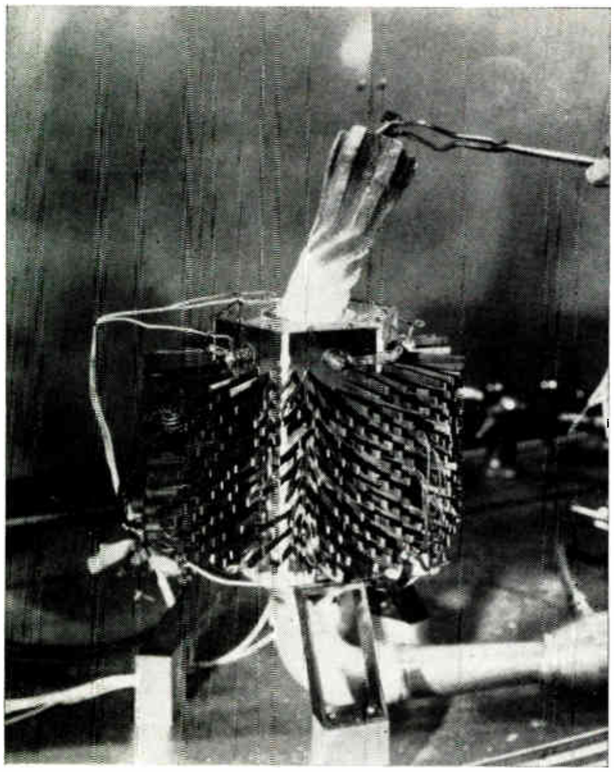


Fig. 8: RCA fossil-fueled thermoelectric test generator.

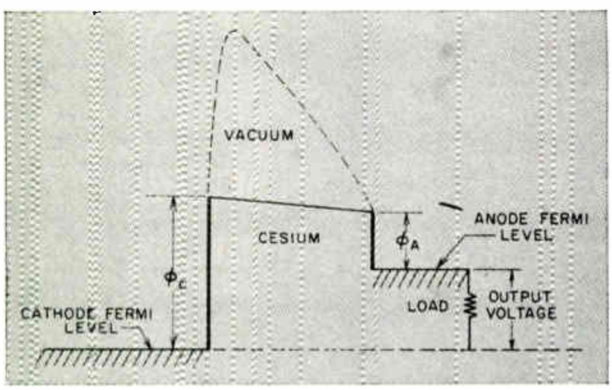


Fig. 9: Potential energy diagram for thermionic converters.

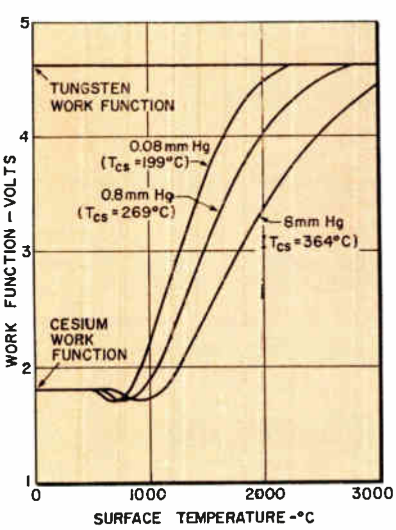


Fig. 10: Work function of tungsten in cesium vapor.

As yet, theory has not been able to predict the maximum limit of Z nor the material which would best produce it. Most of the materials used today have $Z\Delta T$ ranging between ½ and 1. A $Z\Delta T$ of 1 would be considered quite useful today. $Z\Delta T$ products for some of the best thermoelectric materials discovered, are shown in Table 2. The cold temperature is assumed to be 150°C; however, in space applications where a higher radiator (cold) temperature is required, the best results are achieved by the higher temperature materials (e.g. SiGe).

Besides a maximum in $Z\Delta T$ for efficiency, reliability is important, since the materials must operate at high temperature. Until 1962, the tellurides, especially PbTe, were the most widely used materials for TE power generation in spite of some extreme difficulties, such as high volatilization, contacting problems and poor material strength. With the discovery of the TE properties of GeSi alloy in 1962, the situation quickly changed. GeSi can operate at considerably higher temperatures, has no volatile constituents, can be contacted permanently and has about five times the fracture strength of PbTe.

A photograph of a GeSi element with permanent tungsten contacts is shown in Fig. 5. This is the geometry used for space applications. The curve in Fig. 6 shows the percent conversion efficiency as a function of temperature for a cold temperature of 25°C. The thermoelectric materials can be stacked together to take advantage of the fact that Z is greatest in different materials at different temperatures. Thus, a three-state generator is possible using BiTe, PbTe and GeSi with transition temperatures at about 200°C and 500°C. Such a device could possibly provide efficiencies in the 15 to 17% range.

Thermoelectric generators are of interest for converting heat from fossil fuels, reactors and isotope sources. Systems capability can range from milliwatts to kilowatts. Such systems can be portable and can be used in unattended operation for long periods under severe environmental conditions.

Thermoelectric generating systems that use fossil fuels, such as gasoline and propane, are operating today in a number of specialized terrestrial applications. Many new systems are being designed for both military and industrial applications, where the more conventional power generators are either unsatisfactory or unavailable. Radioisotope-thermoelectric (RTG) power systems have been constructed for a variety of uses and a number of such systems (SNAP-3 and 9A developed by the Nuclear Division of the Martin Company for the AEC) have successfully operated in space environments. More advanced RTG systems, for both space and terrestrial requirements, are under development. Solar and nuclear reactor thermoelectric systems are under development for space applications, but full operation in the space environment has not yet taken place.

Perhaps the largest program to date to use thermo-

World Radio History

electrics is SNAP-10A. This is a 500 w system where the heat energy is generated by a compact reactor and the electrical energy by a large number of GeSi TE elements. This system is being developed by the Atomics International Division of North American Aviation for the Atomic Energy Commission. At present, the system is under test and is scheduled for flight testing next year. It is the most advanced in development of any DEC reactor system and is expected to be the basis for higher power systems of the future.

A cutaway drawing of the SNAP-10A reactor TE unit is shown in Fig. 7. The unit is about 10 ft long and 5 ft at its greatest diameter. The reactor at the top can generate about 32 kw of thermal power. This heat is removed by Nak (sodium-potassium eutectic alloy) liquid which is pumped through forty stainless steel tubes positioned about the conical outer surface of the power unit. Thirty-six thermoelectric couples, each consisting of an n-type and p-type silicon-germanium element, are mounted on each of these tubes. The hot junction of each couple is formed at the stainless steel tube, which is the source of the thermal energy for the converter. The other ends of the elements are connected to individual aluminum radiators which reject the waste heat to space and form the cold junctions. (The individual radiators appear as the skin of the outer surface in the illustration.) Because the voltage developed by each thermoelectric couple is small, many couples are connected in series to provide an output of approximately 30 v.

The use of thermoelectrics in RTG's (isotope) appears to be promising for space and terrestrial applications. The power level of these devices is limited because of the large amount of isotope required. For example, a 100-watt generator would require about ½ million curies of Sr^{90} assuming a 5 percent conversion efficiency. Isotopes are also expensive; therefore, widespread use is not probable. Shielding requirements cause increase in weight; however, alpha emitters like Pu^{238}, while very expensive, require much less shielding. A number of isotope systems are under development, such as Snap-9, 13 and 17A by the AEC. For space applications, possible advantages of RTG over solar cells is that storage battery requirements are much less severe, and there would be little or no sensitivity to radiation belts.

For terrestrial use in military and special industrial requirements, fossil fuel TE generators seem ideally suited. Such generators are most often considered where conventional power is not available and where portable sources of electric energy such as batteries and motor-generated sets prove unsuitable. Battery power systems have been beset by problems, such as weight, shelf life, operating life, and poor resistance to adverse ambient environments. Although large motor-generator sets (2 to 10 kw)

(Continued on page 45)

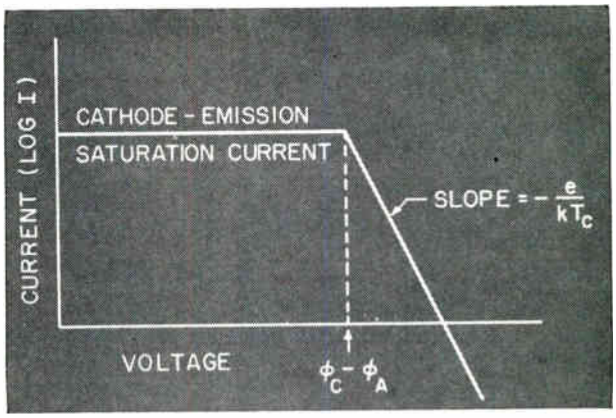


Fig. 11: Idealized V-A characteristic for thermionic converter.

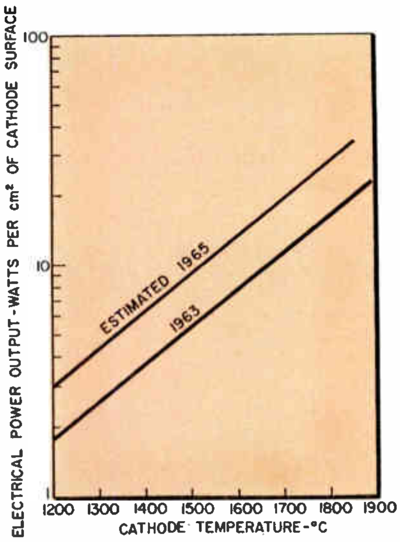


Fig. 12: State-of-the-art performance of thermionic converters.

Fig. 13: Thermionic converter for operation in nuclear reactor.

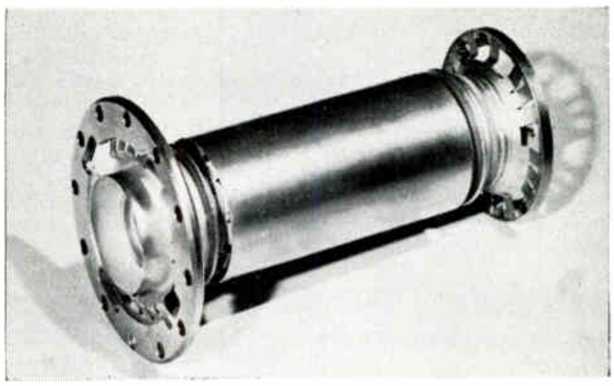
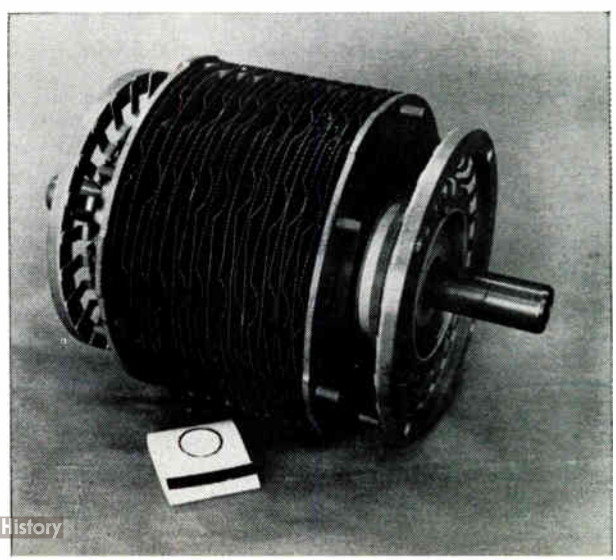


Fig. 14: Thermionic converter for operation in external loop.



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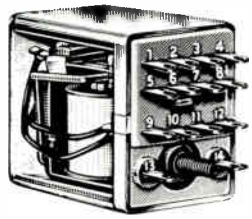

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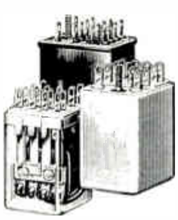
An extraordinary combination of features distinguish the KH relay. Small size (only slightly larger than one cubic inch), 4-poles, exceptional electrical stability over a long life, a wide choice of mountings . . . all of these and more are found in the KH.

SWITCH FOUR CIRCUITS FROM LOW LEVEL TO 3 AMPS

This is a four-pole relay normally used in a 4 Form C arrangement. It can be supplied with a 2 Form Z (DPDT-DB) configuration or, by not wiring certain contact terminations, any four-pole combination of Forms A or B may be achieved. Beryllium copper is used for the contact arms for excellent conductivity and long mechanical life.

Both AC and DC relays are available. Minimum power requirement for AC relays is 0.55 volt amperes at 25° C. DC relays will operate on only 0.5 watts at 25° C. KH relays are rated at 3 amperes, as shown below. Under certain favorable conditions, KH relays will switch up to 5 amperes providing extended life is not required.

TERMINAL BLOCK CONSTRUCTION CONTRIBUTES TO RELIABILITY

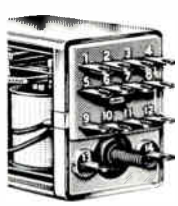


Glass reinforced alkyd, a material of exceptional dimensional stability and dielectric properties, is used for the terminal block. The terminals are molded into the block. This construction serves to keep the relay in precise adjustment throughout its life. The pierced solder terminals are easily accessible, speeding hook up.

CHOOSE FROM WIDE VARIETY OF MOUNTINGS

The terminal block is uniquely embossed to allow for mounting KH relays on metal strips or angles. This embossing, around the two bottom terminals, keeps the relay from turning when the nut is tightened on the stud. The KH may be mounted in a variety of ways. A tab-and-stud mounting plate on any side or the top of the dust cover is available. Also, a choice of three sockets may be used to make the KH a plug-in relay. One socket has printed circuit tabs, the other two have pierced solder terminals.

CHOICE OF ENCLOSURES TO MEET ALL REQUIREMENTS



Dust covered KH relays (KHP) can be ordered with translucent nylon or clear Lexan cases. Hermetically sealed relays are designated KHS, and are enclosed in a steel cover. The nylon cases are available on special order in red, blue, green, yellow or black so that relays in various circuits may be color coded.

RELIABILITY OF KH SERIES FIELD-PROVED IN MANY APPLICATIONS

The KH has found its way into such diverse gear as citizens band transceivers, dictating machines, walkie-talkies, computers, aircraft communications equipment, scoreboards, alarm systems, and many others.

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KH SERIES SPECIFICATIONS

CONTACTS:
Arrangements: 4 Form C (4PDT). 2 Form Z (DPDT-DB).
Rating: 3 amps @ 30 volts DC or 115 volts AC resistive for 100,000 operations.

COILS:
Resistance: DC: 11,000 ohms max.
AC: 3,900 ohms max.
Power: AC: 1.20 volt amperes nominal @ +25°C., .550 volt amperes minimum @ +25°C.
DC: 0.9 watt nominal @ +25°C., 0.5 watt minimum operate @ +25°C., 2.0 watts maximum @ +25°C.

TIMING VALUES:

Nominal Voltage @ 25°C.	Max. Values
Pull-in time	13 ms
Drop-out time	10 ms

INSULATION RESISTANCE:
1500 megohms min.

MECH. LIFE:
DC: In excess of 100 million cycles.
AC: In excess of 50 million cycles.

ENCLOSURES:
Dust cover or hermetically sealed.

TERMINALS:
Solder lug and taper tab.

SOCKET:
Solder lug or printed circuit terminals. Available as accessory.

DIMENSIONS:
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are capable of significantly better efficiencies than present day thermoelectric generators, the efficiency of motor-generator sets decreases rapidly as the power ratings decrease. As a result, in the power range below 500 w, the efficiency of thermoelectric generators becomes quite competitive. Also, thermoelectric generators, which have no moving parts, are capable of long periods of unattended silent operation.

A 50 w fossil-fuel TE generator made of special oxidation-resistant SiGe AIRVAC modules is shown in Fig. 8. Such modules have shown excellent life-test results. Free convection cooling fins can be seen extending radially from the generator. The propane burner shown was developed specifically for this application.

Thermionic Energy Conversion

The thermionic energy converter is an electron tube that is capable of efficient conversion of heat into electrical energy. Solar, nuclear, or fossil fuel heat sources can be utilized with this type converter. It operates on the same principle as the TE converter; its higher efficiency results partially because it operates at temperatures up to 2000°C or more, thus giving a higher Carnot efficiency.

When heat is applied to the diode cathode, electrons are emitted by thermionic emission, and are collected at the anode. The voltage developed depends on the difference in work function of the cathode and anode minus any arc drop that occurs between these electrodes.

To avoid the problems of drawing large currents in a diode, a plasma medium is used to neutralize the space charge. Cesium is used for this purpose since it has the lowest ionization potential of any suitable gaseous material. With the use of cesium, it is possible to draw currents as large as the cathode can stand, typically up to 20 amps/cm^2.

The potential energy diagram of a thermionic converter is shown in Fig. 9. The dotted line shows the condition that would prevail if no cesium were added. To achieve efficient operation, the anode would have to be placed at or to the left of the maximum in the diagram, which corresponds to a few microns spacing, not a very practical solution. Under the conditions shown by the black line, where cesium is added, spacing usually is not critical.

Cesium performs another function in the converter in that it sets the surface work function. This is shown in Fig. 10 where it is shown that cesium covered tungsten surfaces can take on a wide range of work functions. For example, in a coverter operating at Cs pressure of 1 mm Hg, an anode temperature of 600°C would yield an anode work function of 1.8 v and a cathode temperature of 1200°C would yield a cathode work function of 2.3 v or a difference of ½ v. Since the Cs coating of the surfaces results from a dynamic equilibrium between the Cs in the gas and the surface, another advantage of Cs is obvious, namely that the surfaces have infinite life as long as the Cs is present. A major disadvantage of Cs is its corrosive nature, especially at high temperatures. Much work has been done to find materials that are compatible with cesium, and indications are that this problem is solved.

A current-voltage characteristic of a TI converter (similar to what one gets with a solar cell) under idealized conditions is shown in Fig. 11. This characteristic is a good approximation to the high temperature, low Cs pressure converter where the ionization takes place by surface contact ionization. This device requires a high-work-function cathode, and very little energy is used for generation of ions. However, when low temperature (1500°C) operation is desired and the Cs pressure is increased so that the arc mode or ball-of-fire discharge is obtained, there is considerable arc drop and the I-V characteristic becomes distorted from that shown in the figure.

The efficiency of thermionic converters has been measured to be as high as 25%. In Fig. 12 is shown the state-of-the-art of power density versus temperature. At 1600°C, power densities over 12 w/cm^2 have been achieved at an efficiency of about 20%. Because

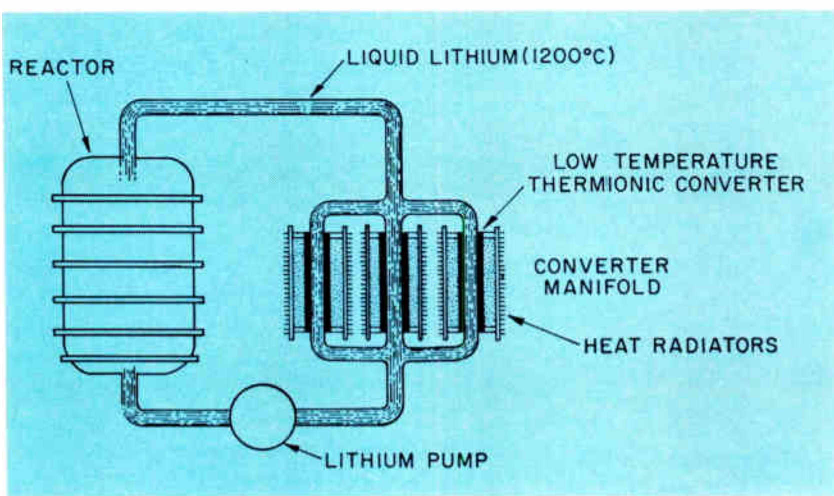
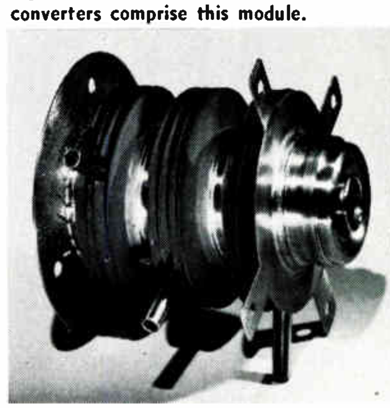


Fig. 15 (left): Reactor thermionic system using liquid lithium.

Fig. 16: Three series-connected converters comprise this module.



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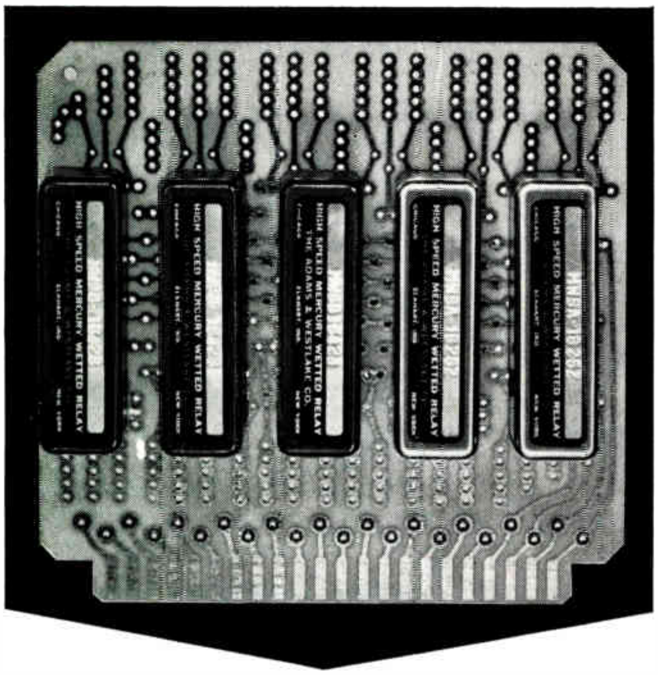

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ELECTRICAL ENERGY SOURCES (Continued)

the efficiency of the converter generally increases with cathode temperature, it is important to operate the cathode at a temperature as close to that of the heat source as possible. Thus, care must be taken to avoid temperature drops during the heat transfer from the heat source to the cathode. Another important factor is the heat rejection at the radiator. The anode must operate at a temperature low enough to avoid electron back emission. In practice, this temperature may be as high as 500 to 800°C. This high heat-rejection temperature is a very important factor in thermionic energy conversion. It means, for instance, that if heat is to be rejected by radiation, which is the case for space applications, a relatively small and lightweight radiator may be used. It also means that for ground applications this reject heat is at a sufficiently high temperature to be used by other heat-conversion methods.

A nuclear reactor is one of the ideal heat sources for TI converters. Present-day power plants use coal or nuclear fuel to produce heat to boil water; the generated steam is then used to drive turbines which in turn activate generators to produce electricity. A large amount of auxiliary equipment in the form of boilers, pumps, heaters, preheaters, condensers, and turbines is required. In time, all this equipment may be replaced with a thermionic nuclear reactor which can utilize the heat the reactor is capable of generating at a very high energy level, and convert it directly into electricity without moving parts, noise, or auxiliary equipment and with a minimum of maintenance. The thermionic converters may be placed inside or outside the reactor. If they are inside, the fuel may either be used as the cathode itself or the cathode may be indirectly heated by the fuel. If they are outside the reactor, the converters may be arranged at the periphery of the reactor or they may be heated from liquid metal in an external loop (the liquid metal is heated by the reactor similar to the SNAP-10A system). The specific method chosen will depend upon the final application. It will also depend on the power level required, and whether it is to be used in space or for terrestrial applications.

An example of a converter designed for operation inside the reactor is shown in Fig. 13. This converter is designed to produce 150 w of electricity, and has run successfully for 310 hrs in a reactor. Many of these converters connected together could be used in a nuclear reactor power system which could produce power of a megawatt or more.

Shown in Fig. 14 is an example of a converter to be heated from liquid metal in an external loop in a reactor system. This converter is designed to deliver 80 w, and has operated successfully on a liquid-lithium loop in a simulated space environment. A systems concept of this type is shown in Fig. 15.

(Continued on page 48)

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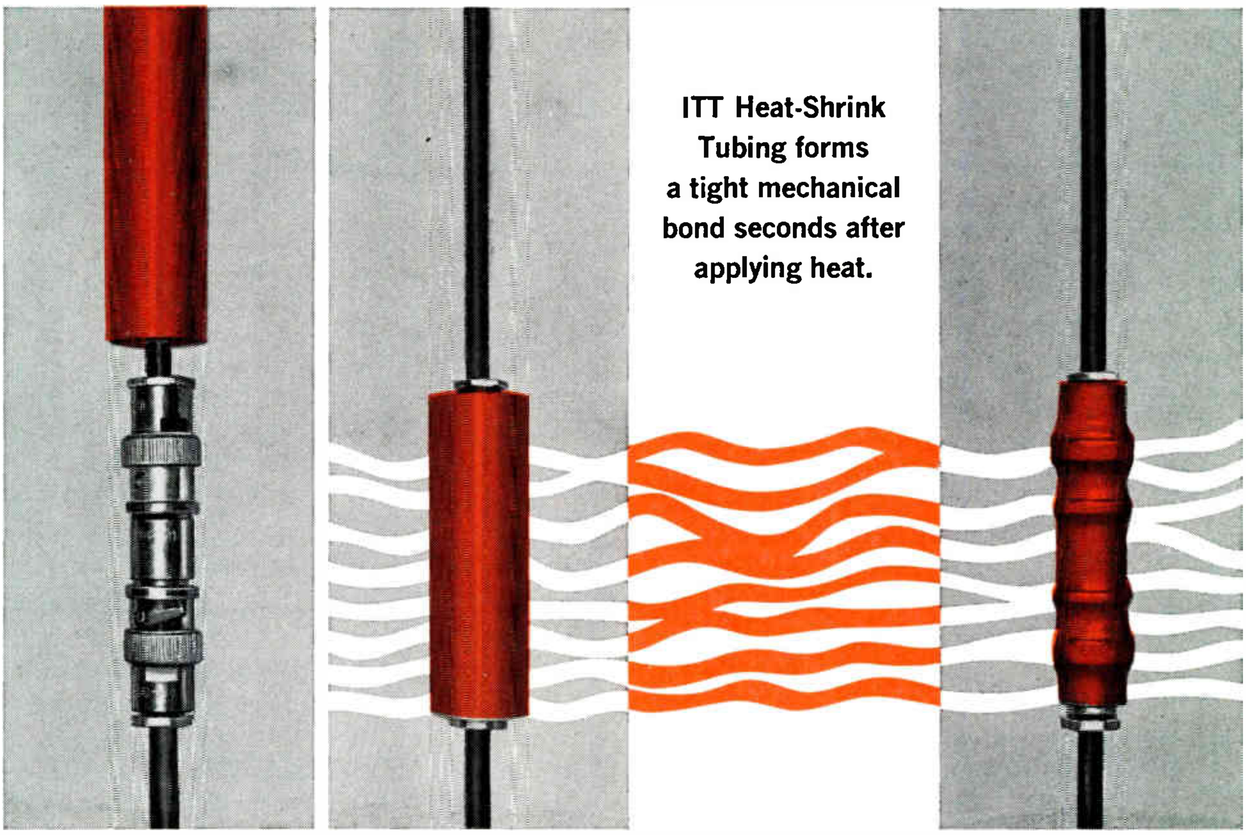

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ITT Heat-Shrink Tubing is used to insulate terminals and tools, to assemble and weatherproof wire bundles and to protect them against abrasion, to vibration-proof and weatherproof electrical connectors. Possibly you can add to the growing list of other mechanical and electrical insulation applications.

This highly versatile tubing is made of irradiated polyolefin which, upon exposure to heat at 250° F., shrinks in seconds to form a tight mechanical bond over even irregularly shaped items. Heat can be applied by a hand held industrial hot air gun (for applications such as terminal insulation in junction boxes) or by conveyor belt through-oven installations for mass production. In fact, almost any heating method except direct flame can be used.

ITT Heat-Shrink Tubing is available now from stock in a variety of colors (for color coding), sizes (up to 1″ diameter) and wall thicknesses (for increased strength and high dielectric).

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ELECTRICAL ENERGY SOURCES (Concluded)

Because of the inherent low cost and high efficiency of thermionics, the concept of a fossil fuel converter is quite interesting. Several problems exist here, however. The first is that of the burner. Temperatures above 1200°C are required, and it would not be efficient to use oxygen or forced air. Several companies have developed fossil-fuel burners to work in air with burning efficiencies over 50%. A greater problem is that of providing a barrier around the metallic cathode to prevent unburned combustion products, such as hydrogen, from penetrating into the plasma region, thus causing rapid deterioration. Various ceramics have been successfully used for this purpose, with the added complication that the converter becomes more fragile and less able to withstand temperature cycling associated with start ups. This problem, however, seems soluble and should not limit the fossil fuel application.

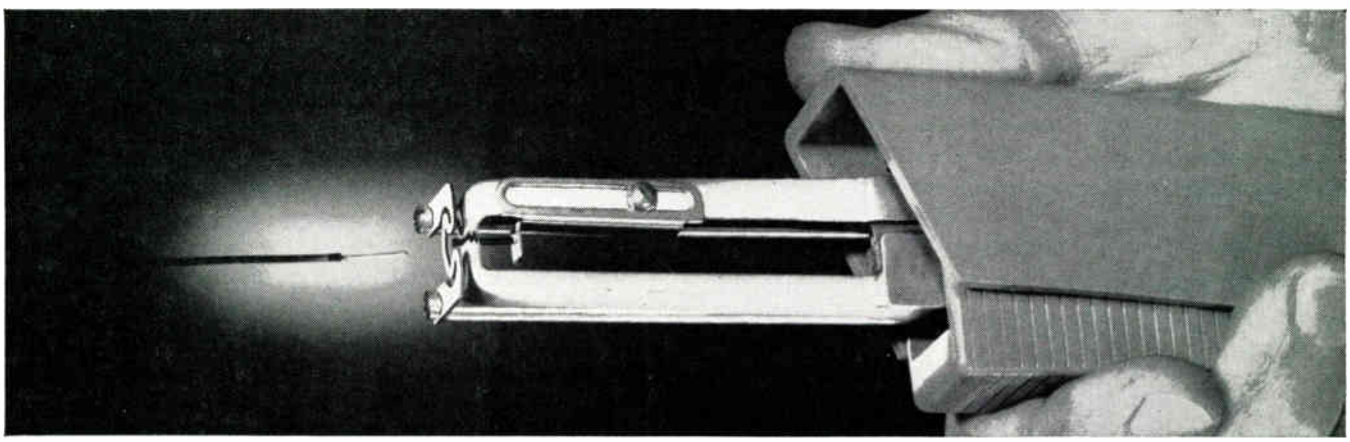
The thermionic converter is a very low-voltage, high-current device. In order to generate ¼ v at perhaps 200 a, some form of power conditioning is required. Fortunately, tunnel diodes are being made as high efficiency inverters for this purpose and may help solve this difficult problem. However, where a large number of converters are used in one system, as in a reactor, a solution such as connecting converters in series must be sought. One solution to this problem is to construct converters that are integrally connected together to fit one heat source. The cathode of one converter is connected to the anode of the next, and so forth. A three converter module, built and successfully tested for the U. S. Air Force, is shown in Fig. 16. A special insulator technique had to be developed for this purpose. Using this same approach, the stacking of many converters in series would seem to be practical.

While the feasibility of the TI converter has been established for a large number of applications, the question of reliability still has to be proven. Converters have been operated by various organizations for 2000 to 5000 hrs of life. Steady improvement is being achieved. When repeatable life of 10,000 to 20,000 hrs is obtained, a large increase in demand for this device is expected. It is basically a very low-cost, lightweight, efficient and simple (therefore hopefully reliable) device.

How Close Are Practical Applications?

When can these devices be expected to come into real use? Three important factors are (1) the time it takes for the device to achieve operational reliability, (2) how urgent is the need, and (3) the cost.

A little "crystal balling" in Table 3 provides a very rough guess as to when a use will come into existence and what the price has to be for the use described. The cost level of $1 to $10 a watt is not far from reality at the present time. The cost of ten cents a watt or less is a distance off. If the governmental



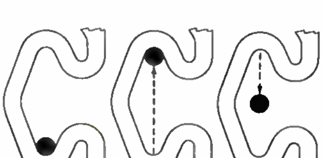
UNIQUE ONE SQUEEZE THERMAL WIRE STRIPPER

The new Ideal Swing-Grip® thermal wire stripper uses a unique mechanical action to strip in a single, continuous squeeze. Swinging grippers move the wire into contact with the thermal element so no twisting of the tool is necessary. The same grippers hold the insulation slug during removal, completely eliminating any contact with the conductor strands. Single element assures uniform heat.

"Beading" is reduced by the thin section of the element blade. "Drag-out" or "stringing" of insulation is eliminated since the heated element is not used to pull the slug.

The tool is light weight and designed to remain cool during production operations. Head size has been held to a minimum for easy access in close quarters. Three simple adjustments and a variety of element shapes permit precision stripping of Teflon and other thermoplastic insulations on a range of wires from 30 to 12 AWG. Write us for specifications.

Curved heating element contacts wire first on one side . . . then on other side, severing insulation all around wire. Removing wire from tool pulls off insulation held by the grippers.



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need for very large-area solar cells is urgent enough to put several companies into the production business, a very low cost could indeed result, since the film type cells are definitely suited to a mass production technique. It is interesting to note the pattern; first governmental need and expenditure, then reduction in cost and improvement in reliability, and finally consumer use. It happens in other industries (especially aviation) and it can happen in electronics.

When will the various energy conversion systems become operational and when will widespread use be seen? Applying the "crystal ball" again, we came up with Table 4. The information is presented only for perspective. The fact that almost all are predicted for widespread use has to be somewhat tempered by the definition of "widespread."

There is little doubt that we are at the beginning of a transformation in our electrical energy sources and that those who have the patience will see stand-by power sources in the homes that can afford them. This could be a TE, TI, or fuel cell device. There will be homes that will be fed purely by fossil fuel, probably gas, with all the electricity coming from an energy conversion device. The conventional central station power plant and automobile power plant still seem secure. However, with a technological breakthrough, no one can tell what role direct energy conversion will play in our future.

Table 3
FACTORS REQUIRED FOR UTILIZATION OF DEC

Customer	Application	Initial Equip. cost per watt*
Government	Space Military	$1000
Military and Industrial	Special Purpose	$10–100
Consumer	Auxiliary Power Boats Appliances	$1
Under-Developed Countries	Water Pumping Lighting Appliances	10¢

* not including fuel costs

Table 4
POSSIBLE TIME OF USE FOR ENERGY CONVERTERS

	Operational	Widespread Use
1960–1970	Solar Cells TE Solar Dynamic TI (Fossil Fuel)	TE
1970–1980	Fuel Cell (Fossil Fuel) TI (Reactor)	Solar Cells (Large Area) Fuel Cell (Fossil)
1980–1990	MHD	TI (Reactor)
1990–	—	MHD

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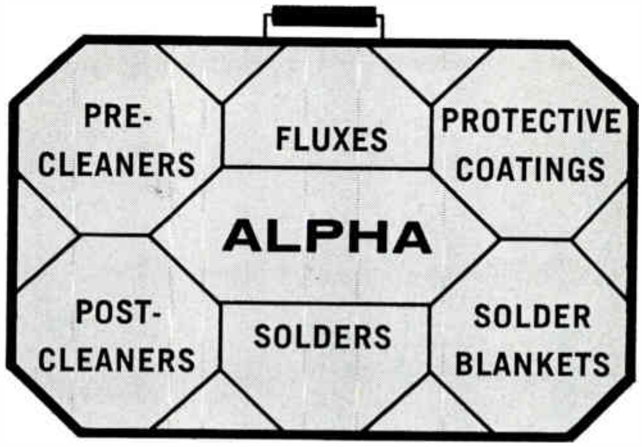

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Every Alpha salesman is thoroughly trained in the use of the equipment and materials required to secure reliable, economical printed circuit soldering. He carries a unique Alpha Solder-Chemical Kit containing 33 different items to help evaluate your printed circuit soldering process.

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New Process Cuts Printed Circuit Costs

STANDARD PRACTICE in the printed circuit industry has always been to laminate copper sheet to an insulation board and then etch away up to 90% or more of the copper, leaving the desired "printed" circuit. If copper circuit patterns could be "deposited" directly on the insulation board, savings should be possible because there would be no waste copper and less steps in the process. Photocircuits Corporation (Glen Cove, N. Y.) after a decade of research, thinks it has the solution.

Announced in a paper presented by Robert L. Swiggett, Executive Vice-President of Photocircuits, at the National Electronics Conference in Chicago recently, the new process utilizes chemical deposition of ductile, fine-grained copper on nonconductive, catalytic adhesive inks which have been selectively applied to an insulating base. According to Swiggett, the deposited copper has excellent bond strength to the base insulator and is extremely solderable. The thickness of the copper can be suited to the application, from 0.0001 in. to 0.060 in. or more.

Known as the CC-4 additive process, it avoids the high cost of tooling associated with other additive processes such as die stamping, electro-plating, powdered metal fusing, metal spraying and vacuum deposition. The process is compatible with artwork and tooling of conventional etched circuit boards. In addition, it offers other than cost saving advantages over conventional printed wiring. It has successfully been applied to flexible films, ceramics, molded plastics and epoxy coated metals. Most important, plated-through holes with the CC-4 process give uniform deposition of copper resulting in superior solder joints, Fig. 1, and greatly improved repairability characteristics.

Steps in the CC-4 process are shown in Fig. 3. Some of the important tools of the process are:

- A stable copper solution which will continuously deposit heavy coatings of a ductile, fine-grained copper at low cost only on surfaces which have been specially catalyzed.
- A family of non-conductive catalytic adhesives which will accept the copper from the solution in such a way that they maintain good bond strength between the insulating support and the copper conductors. (These adhesives can be applied either over the entire surface of an insulator or applied in a pattern by screen printing or some other stencilling method.)
- Means of making surfaces of insulators catalytic to the bath without the application of a catalytic adhesive.
- Resinous masks which can be applied by a variety of methods over catalyzed surfaces to prevent the deposition of copper where desired.

Among materials that can be used for insulation boards are: paper base phenolics, polyester glass G10, G11, etc., Mylar™ and other flexible films, ceramics, plastic molded parts, low-loss materials such as Teflon™, H-film™, Kel-F, and resin-coated metal blanks.

Credit for conceiving the CC-4 process is given to Frederick W. Schneble, Director of Research at Photocircuits.

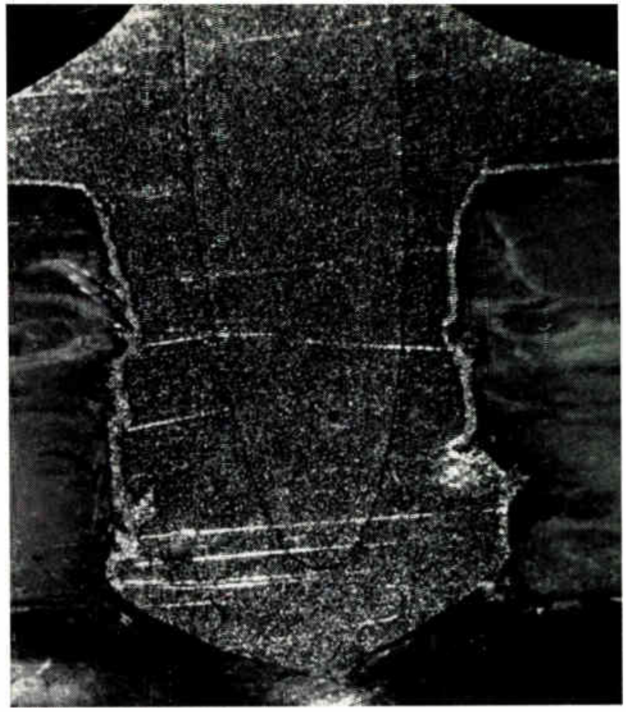


Fig. 1: Typical solder joint in a one-sided CC-4 printed-circuit board, with punched holes that have been plated through.

Fig. 2: Western Electric Relay Assembly using CC-4 process circuit on a resin coated metal blank. Plug-in fingers are hard gold plated, and a solder resist mask is used.

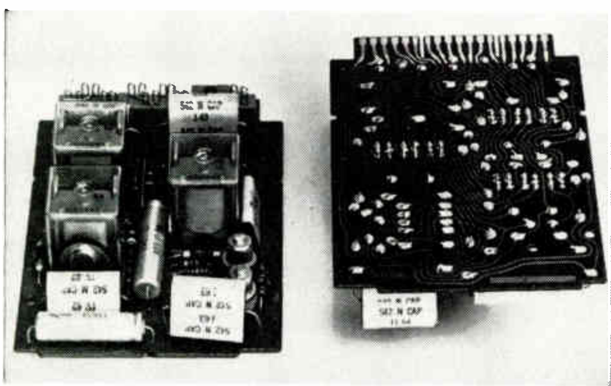
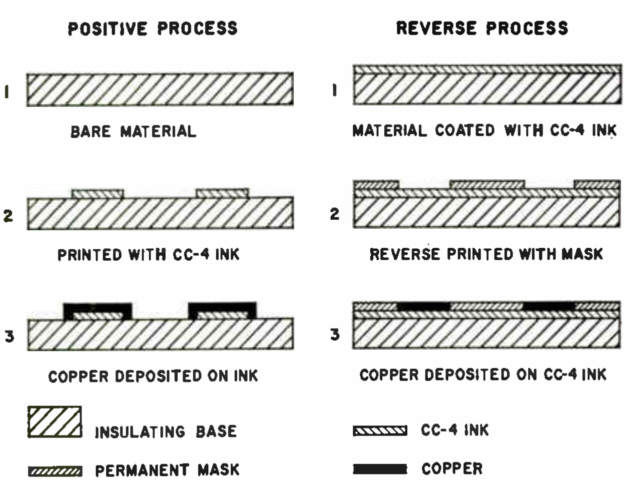


Fig. 3: CC-4 printed-circuit process.



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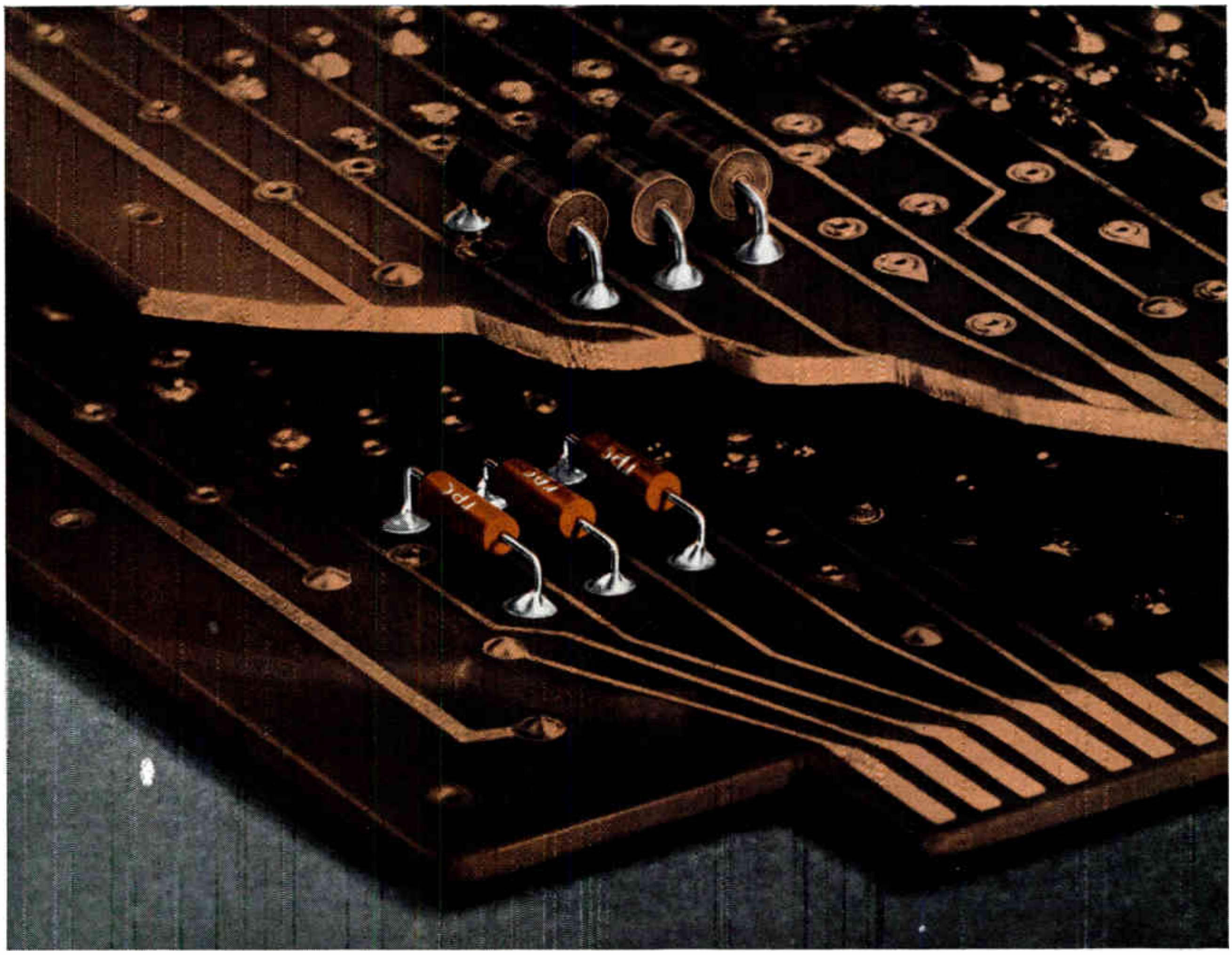

Where three's a crowd... go miniature!

To be precise, these RPC miniature wire-wound resistors are the answer to your crowded layout problems. Except for power rating they meet all requirements of Military Style RB56, yet they measure a scant ⅛ inch in diameter. What's more, they're completely encapsulated in epoxy . . . so you can use them freely in "hot spots".

Three versions cover resistance values from 1.0 ohm to .4 megohm and are conservatively rated at up to 250V. Longest length is .375 inch.

RPC miniatures make ideal calibrating resistors in dense bridge or voltage divider circuits. And the two-inch leads allow plenty of play for locating printed circuit board holes. Quality control throughout their manufacture assures the following performance parameters:

Resistance Values
1 ohm to 400,000 ohms
Power Ratings *0.15 watt to 0.3 watt*
Voltage Rating *Up to 250V*
Terminations
Weldable axial
Insulation *Epoxy encapsulated*
Tolerance
±1% standard; ±.5% to .05% custom
Temperature Coefficient
30 PPM/° C, −55° to +125° C standard
Size *Diameter, .125 inch*

Moral: If you need precision, but are pressed for space, write today for complete information on the RPC Miniature Series.

rpc

Resistance Products Co.

914 S. 13th Street, Harrisburg, Pennsylvania 17104. ● Phone 717-236-5081

MANUFACTURERS OF QUALITY RESISTORS: *PRECISION WIRE-WOUND, CARBON FILM • RESISTANCE NETWORKS*

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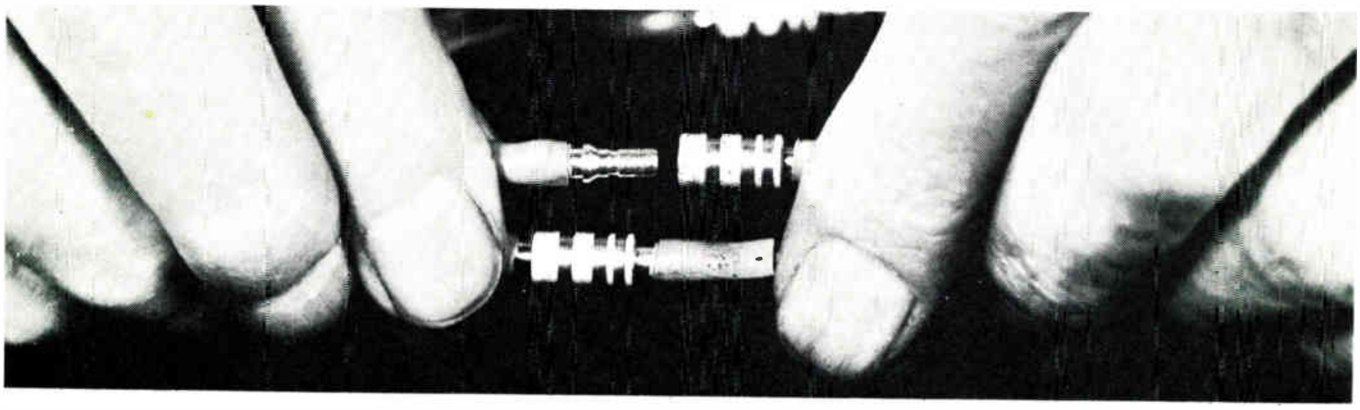


1965 Connector Specifications Guide

Part 2: Connectors for Coaxial Cable and Shielded Cable

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
FEATURE

IN THIS PART 2 of the connector survey ELECTRONIC INDUSTRIES tabulates the coaxial and shielded cable products of 69 suppliers in the electronic connector industry.

Indicated in the charts are the types of connectors offered by each manufacturer. These range in size from standard to ultraminiature. Configurations and uses include a variety of r-f and high voltage types, both rectangular and round multiple coax connectors for rack and panel use, printed circuit board connectors, feed-through and splice, twin coax and triaxial types. Included also are connectors for flexible or rigid line, hermetic seal types, and those with special dielectrics such as irradiated polyethylene or glass-filled silicone for radiation resistance and very high temperature uses.

Second of A Series of Reports
Industry's Most Complete
ELECTRONIC CONNECTOR SURVEY

Watch Future Issues For:

PART 3: MULTI-PIN CONNECTORS (Shell and Rack & Panel Types)

PART 4: PLUGS, JACKS, CORDS AND TERMINALS

PART 1: PRINTED CIRCUIT CONNECTORS, appeared in last month's issue of E. I.

Design innovations

Though the field is far from new, coaxial connector designers continue to produce some of industry's most exotic connectors. This is partly due to a continuing program of weight reduction and miniaturization and partly through genuine effort to increase reliability in the presence of more severe environments.

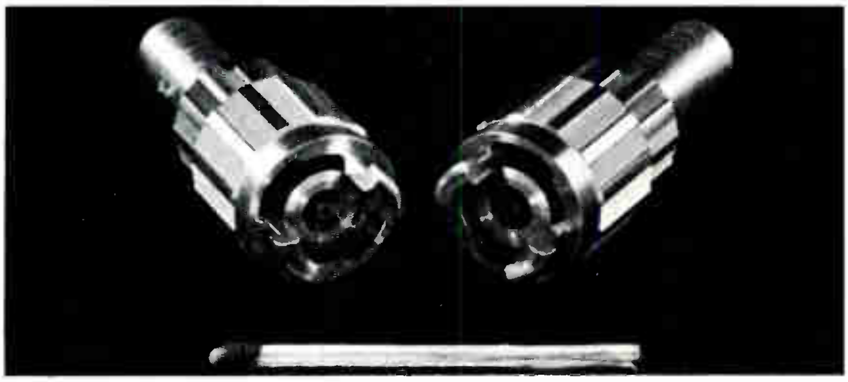
Titanium, a material that is 44% lighter than stainless steel and needs no plating is being featured in new lightweight connectors. Other examples are Amp's "Coaxicon" connector in which the inner and outer conductors are simultaneously crimped in one stroke, and Gremar's "Simplicon" 50-ohm connector. Incidentally, this connector provides a VSWR of 1.05 max. through 5 GC, and needs neither crimping nor soldering of the inner conductor. The user of the Simplicon merely trims his cable, inserts it into the connector and tightens the cable clamping nut.

Triaxial Connectors

Several companies offer impedance matched connectors designed for triaxial cables which have the center conductor, inner braid and outer braid concentric and isolated from one another The connectors are similar to coaxial connectors, but with an extra shell over the coaxial body. Triaxial assemblies are used in pulse applications and where r-f noise must be kept to a minimum.

(Text continued on page 55)

World Radio History



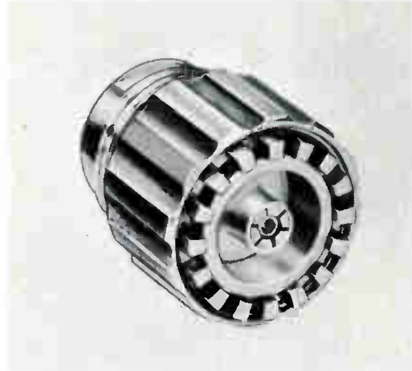


Fig. 1: Subminiature Fast-Lock connector (opposite page) uses only straight "push-pull" action (National Connector). Fig. 2: Hermaphroditic coaxial connector (above) for applications up to 18 GC (Amphenol). Fig. 3: New Type GR900-BT coaxial connector (above right) for use on 50-ohm rigid line, exhibits VSWR of only 1.01 at 9 GC. Curves for VSWR at nine frequencies are at right

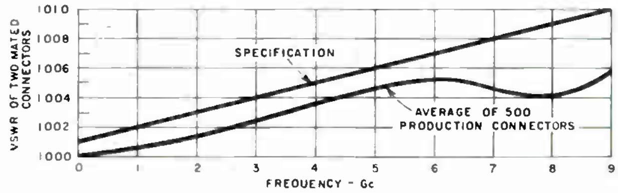


TABLE 1 COAXIAL CONNECTOR CHARACTERISTICS*

CONNECTOR SERIES	APPLICATION DESCRIPTION	CABLES	KV (Peak)	FREQ.	VSWR	IMPEDANCE
BNC	r-f, Weatherproof, Bayonet-Locking	¼ in.	0.5	2.5 GC	1.1	52, 50
BNC "Improved"	r-f, Weatherproof, Bayonet-Locking	¼ in.	0.5	10 GC	1.1	50
BN (BNC Predecessor)	r-f, i-f, Screw Type	¼ in.	0.250	200 MC	—	—
C (Improved version of N)	r-f, Weatherproof, Bayonet-Locking	⅝ in.	1 4	10 GC 2 GC	1.25	50, 70
HIGH IMPEDANCE	Pulse Systems. 10–9 sec. R. T.	—	—	—	—	125
HN (Enlarged version of LN)	r-f, Weatherproof, Screw Type	⅝ in.	5	4 GC	—	50
LC	r-f, Weatherproof, Screw Type	RG 17, 18/U RG 19/U, 20/U	5 10	1 GC	—	50
LN (Enlarged version of N)	r-f, Weatherproof	RG 14/U	1	—	—	50
LT	r-f, Screw Type	RG 117A/U	5	1 GC	—	50
MHV	r-f, HV, Weatherproof	¼ in.	5	50 MC	—	—
N	r-f, Weatherproof	⅝ in.	0.5	3.5 GC, 10 GC	—	50
PULSE (Ceramic)	r-f, Shipboard, Bayonet-Locking	13/16 in.	15	—	—	—
PULSE (Rubber)	HV, dc	—	5 (50,000 ft)	—	—	—
QDS	r-f, Weatherproof, Quick Connect	⅝ in., 13/16 in.	0.5, 10	10 GC	—	50
QDL	r-f, Weatherproof, Quick Connect	RG 17, 18	9	1 GC	—	50
SC	r-f, Weatherproof, Screw Type	—	1	10 GC	—	50
SM	r-f, Non-weatherproof, Screw Type	¼ in.	0.1	1 GC	—	50
SUBMINIATURE	r-f, MIL-C-22557A	0.080 0.110	—	—	—	50
TNC (Improved version of BNC)	r-f, Screw Type	—	0.5	10 GC	1.25	50
TWIN	r-f, Weatherproof	2-cond. RG 22, 22A/U	0.5	200 MC	—	95
TPS	r-f, Weatherproof	—	1.5	—	—	50
UHF	r-f	—	0.5	200 MC	—	—

* Chart shows general characteristics of basic series of coaxial connectors. Additional information appears in "MIL Handbook 216—RF Transmission Line Fittings."

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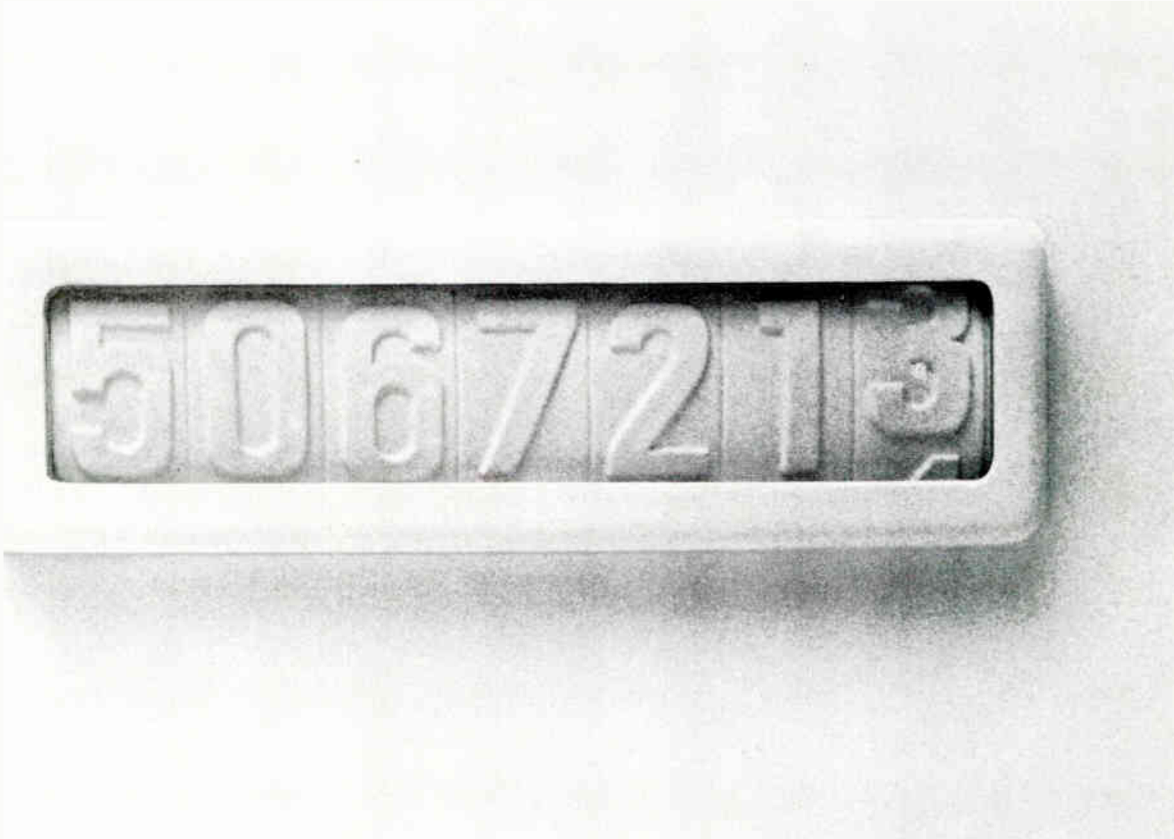
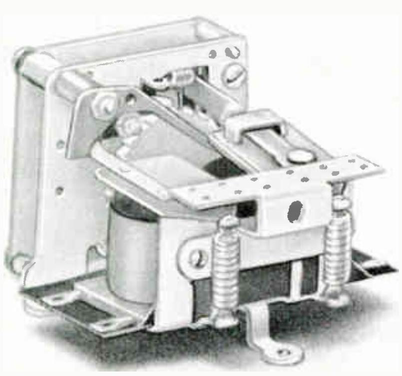


It's got a lot of living to do!



This long-life Guardian MER electrical-reset stepper was good before—had a life of at least 1,500,000 steps. But our Product Improvement Laboratory wasn't satisfied . . . felt that even more was possible. So they went to work. And through changes in design and materials they tripled its life . . . without increasing its cost.

Now you can anticipate at least 5,000,000 operations from this MER stepper—and chances are you'll do even better. This isn't wishful thinking—we actually operate these steppers to failure to find out what they'll do.

So if you need smooth, high-speed stepping with dependable responses and long life, specify Guardian MER Steppers. Bulletin F tells all. Write today for your copy without cost or obligation.

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Guardian Electric Mfg. Company, 1550 W. Carroll Ave., Chicago, Ill., Dept. **EI 52**

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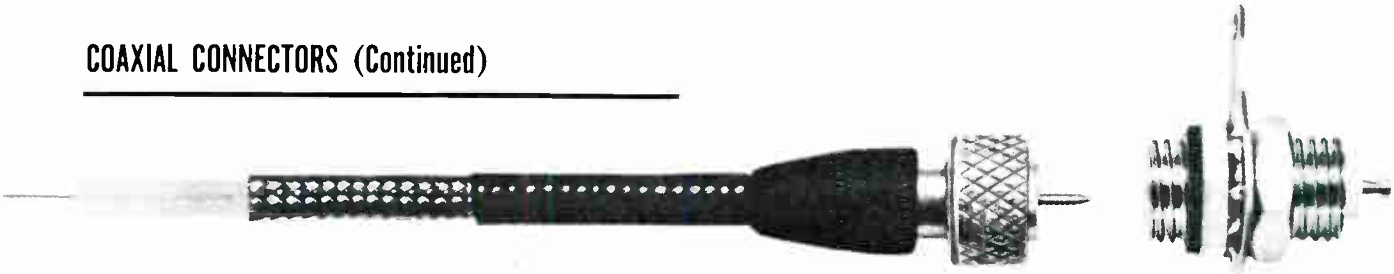


Typical Coaxial Plug and Receptacle

Coaxial Cable Splices

Silver plated and Teflon insulated splices that are available permit the joining of two or more coaxial cables with sufficiently uniform impedance factor to permit predetermined compensation in the circuit for production. Splices are used for continuation of the cable shielding or for inserting instruments in the circuit. They are also used for locating resistors and other components within the splice, or simply to save time and work in the repair of a defective coaxial cable.

Specifying Considerations

When specifying connectors, it is important for the customer always to include specific electrical and mechanical needs as well as operating environments to be encountered, if they are known.

Performance requirements in existing Military Specifications for r-f connectors are limited to tests at sea level for high potential, salt spray corrosion and for leakage of hermetically sealed types.

In lieu of electrical and environmental performance tests, these specs stipulate dimensions for the connector component parts. This often restricts the performance a manufacturer can guarantee for a standard connector. As a result, connectors or adapters are modified to meet more stringent performance requirements and therefore, in many cases, actually exceed applicable Military Specifications.

(Continued on page 56)

TABLE 2

COAXIAL CABLE IMPEDANCES AND SIZES

CABLE	CHARACTERISTIC IMPEDANCE	OUTSIDE DIAMETER (O.D.)
RG 55B U	53.5	0.206
RG 58C U	50	0.195
RG 59B U	75	0.242
RG 62A U	93	0.242
RG 71B U	93	0.250
RG 140 U	75	0.233
RG 161 U	70	0.090
RG 174 U	50	0.100
RG 178 U	50	0.075
RG 179 U	70	0.090
RG 179A U	75	0.105
RG 180B U	95	0.145
RG 187A U	75	0.110
RG 188A U	50	0.110
RG 195 U	95	0.080
RG 196A U	50	0.080

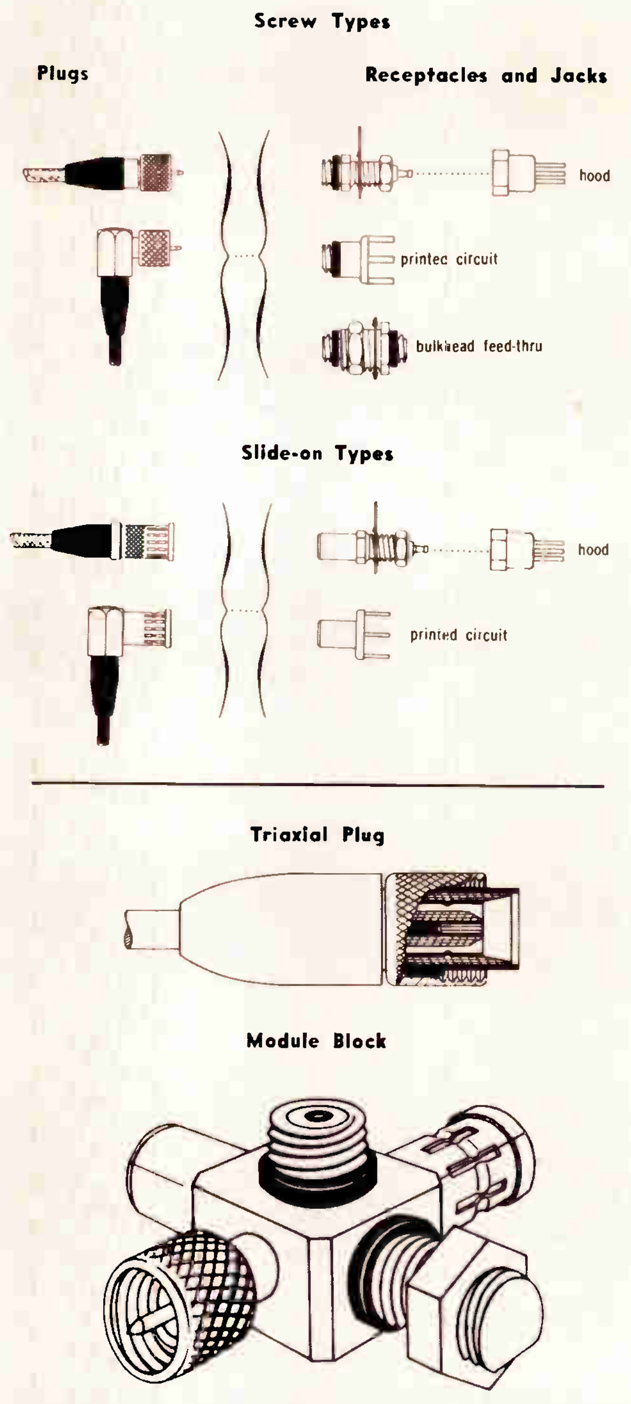


Fig. 4: Types of coax connectors not shown above include quick-connect, hermetic seal, locking, and a variety of adapters (Microdot).

World Radio History

COAXIAL CONNECTORS (Continued)

Connector Interchangeability

Some degree of interchangeability exists between the coaxial connectors of at least a few manufacturers. This is indicated by the information being supplied that cross-references interchangeable or equivalent types.

Star-Tronics recently produced a TNC Connector Interchangeability Chart listing about 300 different "house" numbers and eight manufacturers, and relating the designations used by these manufacturers to about 35 Star-Tronics Types. Table 3 was prepared with the assistance of the manufacturers listed, and is believed to be highly accurate at the time this is being printed. But, it is pointed out that envelope dimensions, cross-mating characteristics, finishes and other parameters are functions of individual manufacturer machine and plating standards.

LIST OF COAXIAL CABLE CONNECTOR MANUFACTURERS, and their products, appears on page 60.

Coaxial Cable Splices

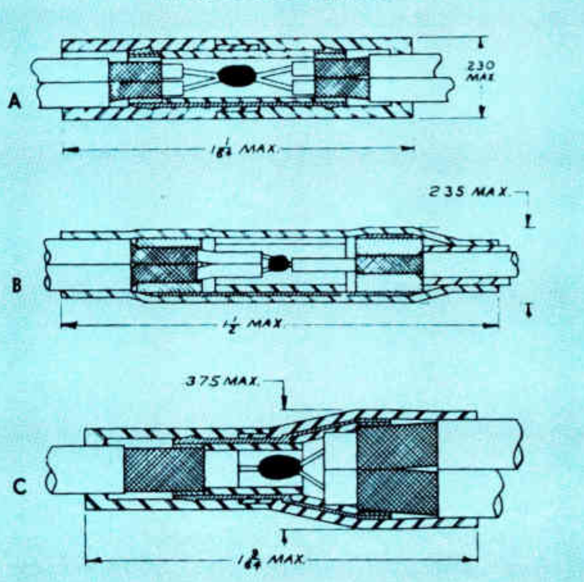


Fig. 5: Types of coaxial cable splices. (A) will accommodate the following cables at either end: 4 RG 196/U; 3 RG 161/U; 2 RG 187/U; and 1 RG 195/U. (B) can be adapted to various combinations of wire and coax. (C) will take 2 RG 195/U's at one end and one at the other (Nugent).

TABLE 3

TNC INTERCHANGEABILITY CHART

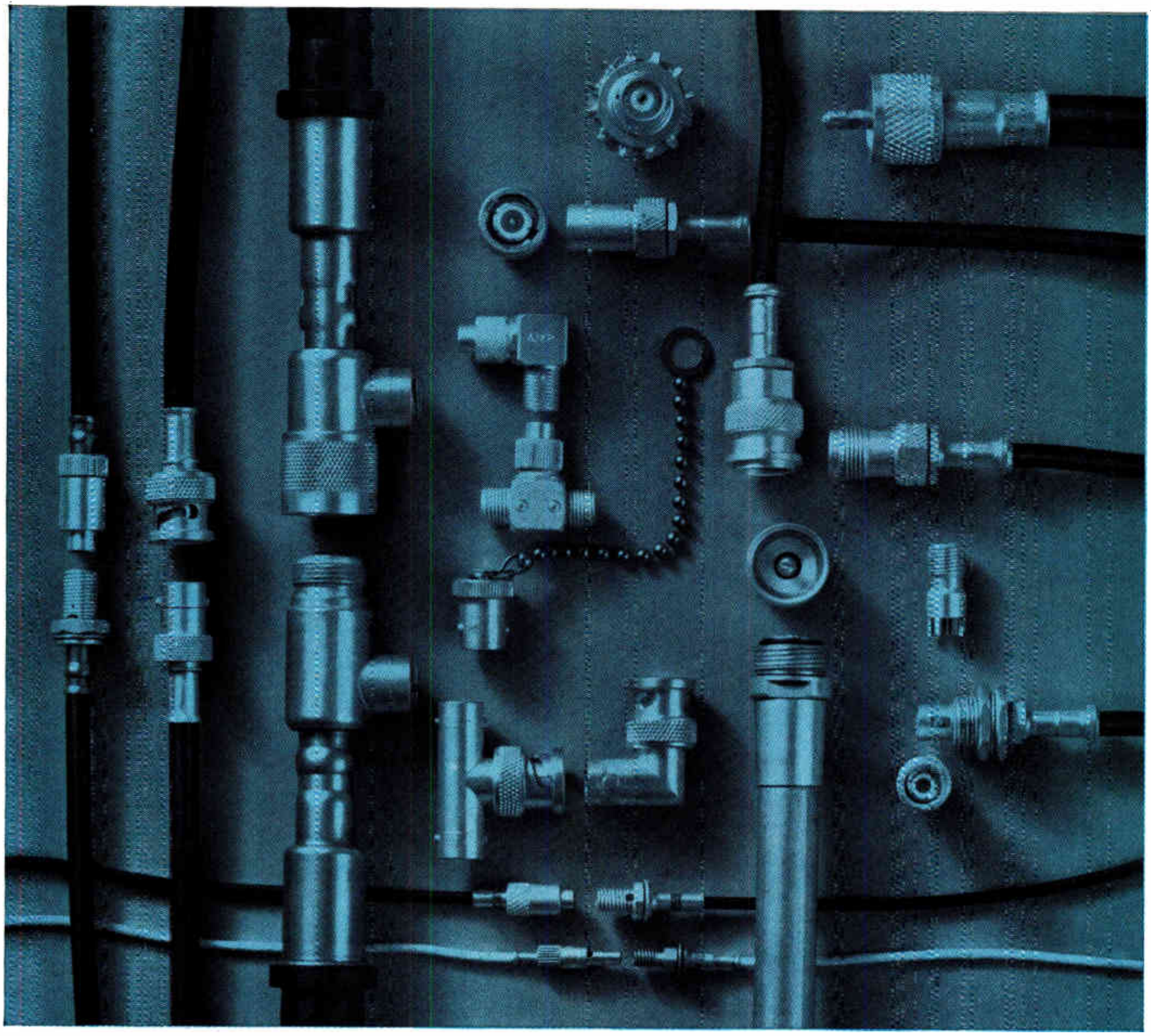
IMPROVED CABLE CLAMPING

FOR CABLES RG-55, 58, 142, 223/U (WHERE APPLICABLE)

Connector Configurations	STAR	DAGE	KINGS	GREMAR	IPC/FXR	AUTOMATIC METALS	CANNON	AVIEL	GENERAL R. F.
PLUG, STRAIGHT	8001	8000-1	KA51-03	6000	79875	100-T1000A	TNC-PL1-M-55	40-010	166B
PLUG, STR., CAPTIVE PIN	8036	8125-1	KA59-22	6001		100-T1100A	TNC-PL9-M-55	40-020	9166B
PLUG, RIGHT ANGLE	8012	8019-1	KA51-04	6035	79075	100-T2000N	TNC-RPL8-M-55	40-060	2015A
PLUG, RESISTIVE, 75Ω, ½ WATT, W/CHAIN	8122	8105-1		6059		5T022-75			2892
JACK, STRAIGHT	8003	8005-1	KA31-02	6002	79600	100-T3000A	TNC-JC2-F-55	40-070	175B
JACK, STR., CAPTIVE PIN	8033	8221-1		6003		100-T3100A	TNC-JC7-F-55	40-080	9175B
JACK, PANEL	8006	8007-1	KA11-04	6015		100-T3000A-10		40-110	177B
JACK, BULKHEAD	8007	8009-1	KA11-01	6029	79425	100-T3000A-75	TNC-JB4-F-55	40-150	2016B
JACK, BLKD. (PRESS'D.)	8231		KA11-05		77350	100-T3001-75			2022C
JACK, RT. ANGLE	8230	8025-1				101-T4100A			2057B
RECEPT., PANEL	8009	8011-1	KA71-07	6013	31-2300	10-T3000	TNC-RP18-F-0		2008A
RECEPT., BLK'D.	8032	8001-1	KA71-02	6025	31-2301	60-T3000	TNC-RB2-F-0	40-200	184A
RECEPT., PANEL, RT. ANG.	8043	8015-1		6022	77950	14-T4000	TNC-RRP1-F-0		138A
RECEPT., BLK'D., RT. ANG.	8093	8016-1	KA71-05	6048	76975	60-T4000	TNC-RRB-F-0		2019A
RECEPT., BULKHEAD, STR., PRESS'D.	8117	8012-1	KA71-04	6028	79800	60-T3501	TNC-RBH4-F-0	40-230	2007A
RECEPT., BLK'D., RT. ANG., PRESS'D.	8229	8047-1				60-T4001A			
RECEPT., PANEL., PRESS'D.	8228		KA79-02			13-T3001A			2089A
RECEPT., MALE PANEL MT.	8028	8147-1		6049		15-T1000			2039
ADAP., STR., PANEL MT. F-F	8015	8219-1	KA91-04	6019		T3000-10			143B
ADAP., STR., BLK'D., (PRESS'D.) F-F	8047	8003-1		6021	79100	T3001-75			
ADAP., STR., F-F	8016	8013-1	KA91-02	6041		T3000	TNC-TNC-AS2-FF	40-270	171
ADAP., STR., M-M	8017	8160-1	KA91-03	6020	72950	T1500		40-290	2018
ADAP., STR., M-F	8074			6137		T1100			2773
ADAP., RT. ANGLE, M-M	8037					T2500			
ADAP., RT. ANGLE, M-F	8013	8014-1	KA91-05	6017	79125	T2100		40-240	172B
ADAP., TEE, F-M-F	8014	8002-1	KA91-06	6011	79700	T7200		40-250	193B
ADAP., TEE, F-F-F	8173			6012		T7600	3TNC-AT1-3F		2770
CAP & CHAIN, MALE	8118	8143-1	KA81-01	6058	78750	1-T722	TNC-CC-M-2¼		2049
CAP & CHAIN, FEMALE	8115	8167-1	KA81-02	6202	77-625	3-T755	TNC-CC-F-2¼		2172
CRIMP STYLE									
PLUG, STRAIGHT	3104	8209-1, 8209-2	KA59-05	7067	36825, 36925	101-T1900	TNC-PL13-M-55		2900, 2901
PLUG, RIGHT ANGLE	3124	8210-1, 8210-2	KA59-06		97875, 97900	101-T2900	TNC-RPL6-M-55		2902, 2903
JACK, STRAIGHT	3106	8211-1, 8211-2	KA39-03		36850, 36950	101-T3900	TNC-JC6-F-55		2904, 2905
JACK, PANEL	3126		KA19-03			101-T3900-10	TNC-JP1-F-55		2906, 2907
JACK, BLK'D., STRAIGHT	3127	8212-1, 8212-2	KA19-02		97750, 97775	101-T3900-75	TNC-JB3-F-55		2908, 2909

Chart provides a convenient cross-reference between basic TNC connector configurations and the nearest equivalent parts offered by nine manufacturers (Star-Tronics).

World Radio History



Meet the RF matchmakers

The A-MP★ COAXICON★ product line of coaxial connectors are RF matchmakers from the word "go." Why? Well, in case you haven't heard, there's a new specification—MIL-C-39012—which spells out the performance requirements for RF connectors. And our COAXICON Connectors have been designed, tested and modified to match this specification in every sense of the word. COAXICON Connectors have already exceeded the requirements of MIL-C-23329.

Why not? After all, one-crimp-terminated COAXICON Connectors are a product and design of their time. Their advanced design features provide high mechanical reliability. Take the special cable grip and support for example, or positive crimping of the center conductor, or really "anchoring" the braid so that values of 85 pounds are the norm for RG 58/U cable.

But more than merely meeting a design specification, these RF COAXICON Connectors meet *performance* specifications. They were "improved" at a time when MIL-C-23329 and MIL-C-39012 were being introduced and implemented by the military.

All A-MP COAXICON Connectors are applied with matching application tools that provide solderless, one-crimp termination of inner conductor, outer braid and cable support—*simultaneously.* This special technique assures you reliable, uniform terminations at lowest applied cost. And, the *complete* COAXICON Connector family includes threaded, miniature and subminiature, BNC and TNC Series, and UHF Connectors for every cable size, in addition to a full line of adaptors—right angle, "T" and feed-through—to match almost any panel installation. Try matching AMP's COAXICON Connectors spec for spec with other RF connectors on the market. Write today for complete information.

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AMP INCORPORATED
Harrisburg, Pennsylvania

INDUSTRIAL SALES DIVISION

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

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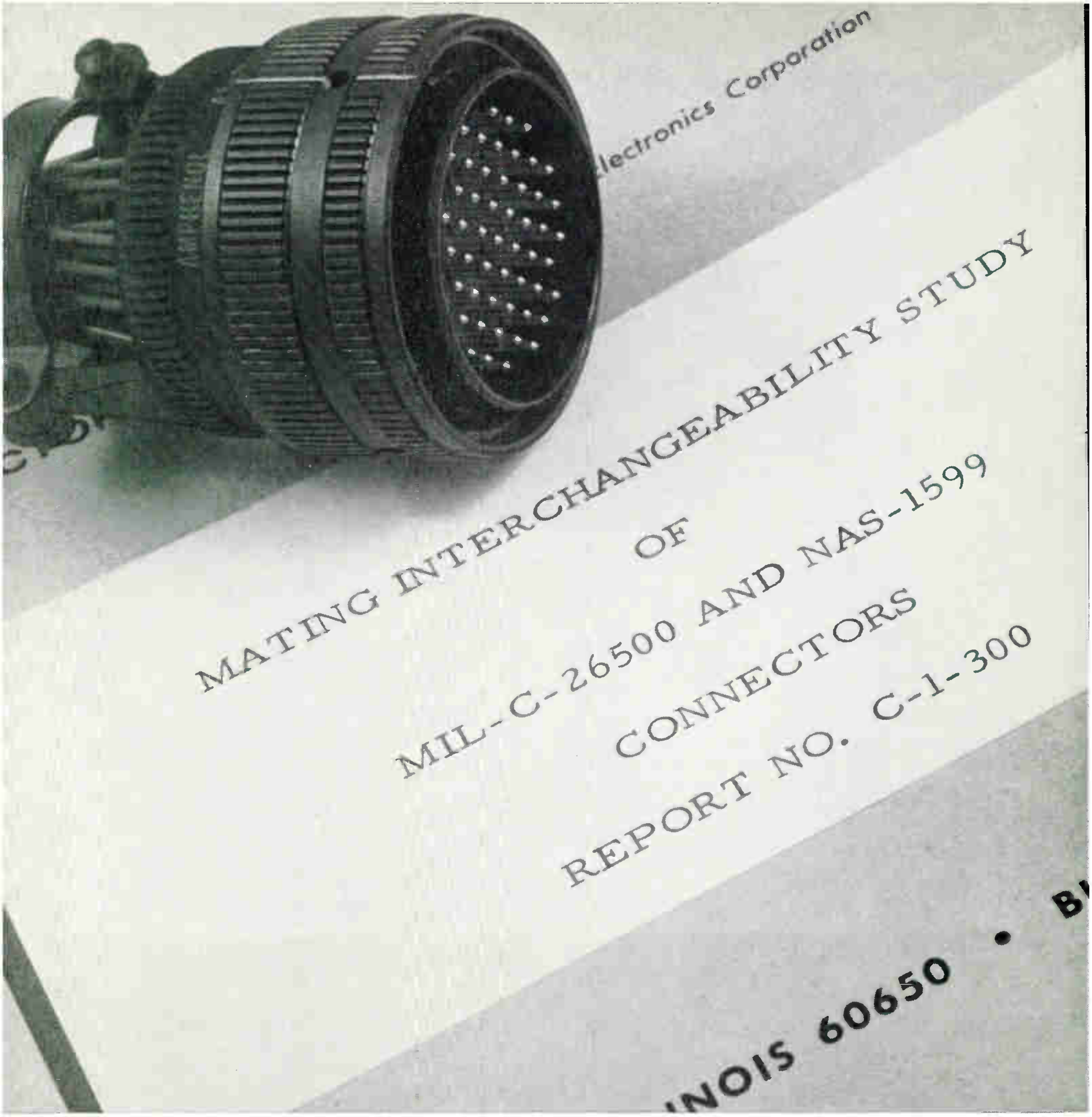

An up-to-date report on MIL-C-26500 connectors

The MIL-C-26500 connector has been called the most nearly perfect environmental connector yet produced for the space age.

No other connector is made to such tight dimensional tolerances for perfect mating. A compression seal measured in thousandths of an inch at the insert interfaces prevents entrapped air or contaminants from interrupting electrical performance

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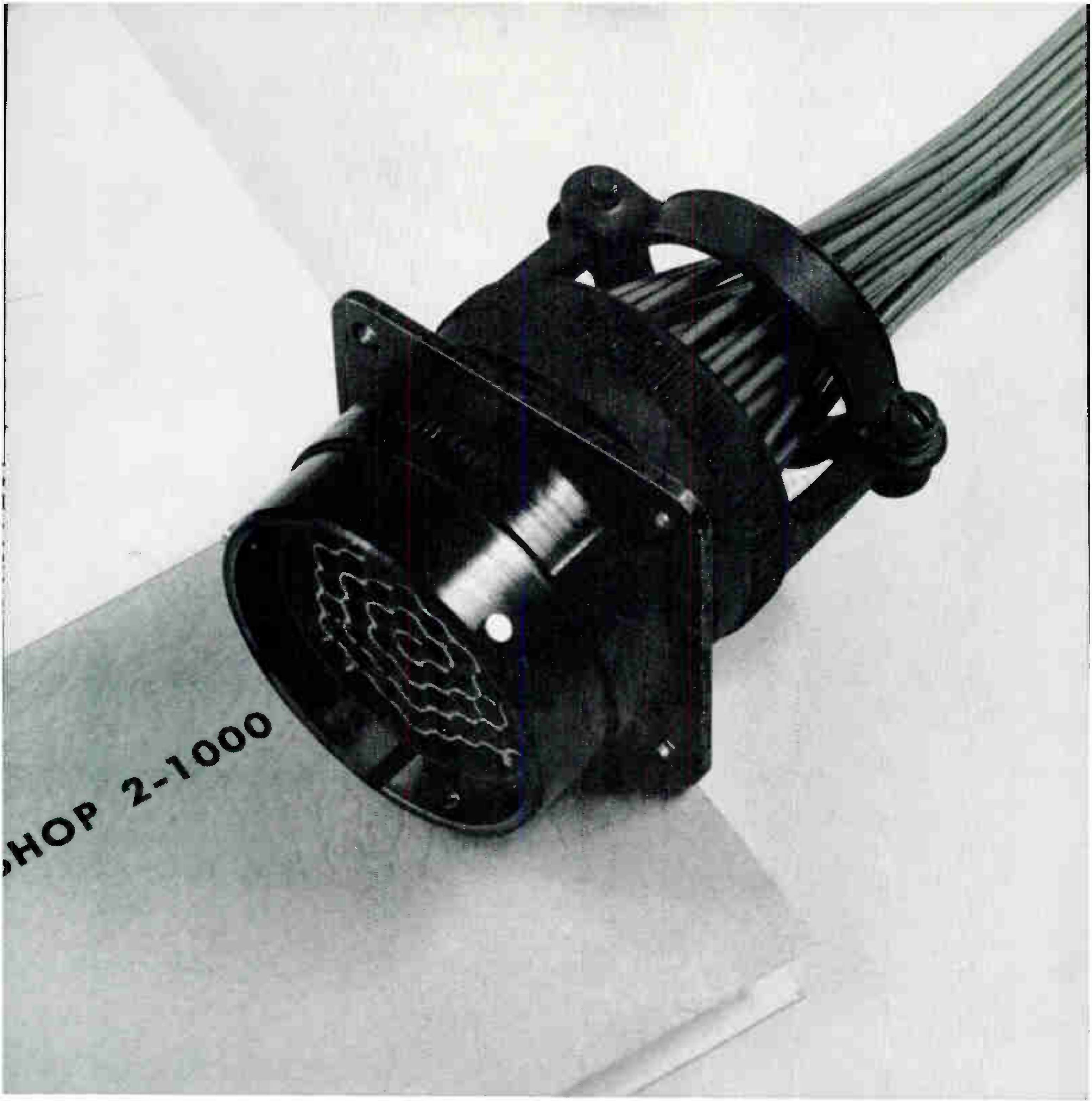

under altitude cycling. This positive environmental seal is what you get with the Amphenol MIL-C-26500 connector.

Maybe you've heard claims like: "Interchanges with MIL-C-26500." Or "Intermates with MIL-C-26500."

In too many cases, they do *not* mate with an accepted MIL-C-26500 connector like the one in the picture.

They will couple with the Amphenol connector. They look like the Amphenol connector. They may even check out on some routine tests. But one of two things happens when you mix an unqualified connector with the military version of the 26500 connector: (1) An interfacial gap which defeats the whole concept of a sealed connector, or (2) interfacial compression that will result in extreme galling or wearing of the coupling.

Mixing MIL-C-26500 connectors with unqualified connectors is never recommended by either Amphenol or the military.

Check the facts for yourself. A new engineering report is now available on request: "Mating Interchangeability Study of MIL-C-26500 and NAS-1599 Connectors." *Amphenol Connector Division, 1830 S. 54th Avenue, Chicago, Illinois 60650.*

Amphenol® CONNECTOR DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION

Specify Amphenol . . . the leading name in cable, connectors, rf switches, potentiometers, microelectronics

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COAXIAL CONNECTORS (Concluded)

MANUFACTURERS OF COAXIAL CABLE and SHIELDED CABLE CONNECTORS

Manufacturer	COAXIAL CABLE CONNECTORS: Rack and Panel Mtg.	Cable Mounting	Cable Splicing	Feed Through	Printed Circuit	Solderless Terminals	Solder Terminals	Miniature	Subminiature	Microminiature	Microwave Types	UHF Types	Rigid Line Adapters	Triaxial Connector	SHIELDED CABLE CONNECTORS: Rack and Panel	Cable Mounting	Microphone Connectors	Modular Terminal Blocks	Miniature	Assembly Tools
ACI, DIV. of KENT CORP., 206 Center, Princeton, N. J.	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]		X[1]							X[1]	X[1]				
ADVAC PRODUCTS, INC., 174 Richmond Hill Ave., Stamford, Conn. 06904				X																
AMECO, INC., P.O. Box 11326, Phoenix 17, Ariz.	X	X	X	X		X	X	X			X	X	X		X	X		X	X	X
AMP, INC., Harrisburg, Pa.	X	X	X	X	X	X		X	X	X	X	X	X	X[2]	X	X	X	X	X	X
AMPHENOL RF DIV., 33 E. Franklin St., Danbury, Conn. 06813				X	X	X		X	X	X	X	X	X	X	X[3]	X[3]	X[3]		X[3]	X
ANDREW CALIFORNIA CORP., 941 E. Maryland Ave., Claremont, Calif.	X	X	X	X							X	X	X							
ANDREW CORP., P.O. Box 807, Chicago, Ill. 60642			X								X	X	X							
ARCO ELECTRONICS INC., Community Drive, Great Neck, N. Y.	X	X				X	X		X		X				X	X	X			
ASTROLAB, INC., 35 Commerce St., Springfield, N. J. 07081					X			X	X	X	X	X	X							
AUTOMATIC METAL PRODUCTS CORP., 323 Berry St., Brooklyn 11, N. Y.	X	X	X	X		X	X	X	X		X	X	X							
AVIEL ELECTRONICS, INC., 1755 Berkeley St., Santa Monica, Calif.	X	X	X	X	X		X	X	X		X	X	X	X						
BENCO TELEVISION ASSOCIATES, LTD., 27 Taber Rd., Toronto, Canada	X	X	X	X		X		X			X	X	X		X	X			X	
BENDIX CORP., Scintilla Div., Sidney, N. Y.	X	X					X	X	X		X								X	
BILL JACK INDUSTRIES, 143 S. Cedros Ave., Solana Beach, Calif.		X	X	X	X	X	X			X				X						
BIRD ELECTRONIC CORP., 30303 Aurora Rd., Cleveland, Ohio 44139											X	X	X							
BIRNBACH RADIO CO., INC., 145 Hudson St., New York 13, N. Y.															X	X	X		X	
BURNDY CORP., Norwalk, Conn. 06852	X	X	X	X	X	X	X	X	X	X				X	X	X		X	X	X
CARLOMA CORP., 4610 N. Lindbergh Blvd., Bridgeton, Mo.				X			X													
CINCH MFG. CO., 1026 S. Homan Ave., Chicago, Ill. 60624	X	X							X						X		X	X		
CO-AX, INC., Box 247, Roslyn, N. Y.	X	X				X	X	X	X		X	X	X							
CONNECTORS INC., 128 Broad St., Stamford, Conn.	X	X	X	X			X					X								
CONTINENTAL CONNECTOR CORP., 34-63 56th St., Woodside, N. Y. 11377	X																			
DAGE ELECTRONIC CO., INC., Hurricane Rd., Franklin, Ind.		X	X	X	X	X	X	X	X	X	X	X	X	X						
DIELECTRIC PRODUCTS ENGINEERING CO., INC., Littleton, Mass.				X							X	X	X							
DOW-KEY CO., Thief River Falls, Minn.	X	X	X	X			X	X			X	X	X		X	X	X		X	
D-CEMCO, INC., 1024 W. 9th St., P. O. Box 8, Upland, Calif.	X	X	X	X	X	X	X			X	X	X	X							
ECCO ELECTRONIC COMPONENTS CORP., 30 Marbledale Rd., Tuckahoe, N. Y. 10707		X		X				X				X								
ELCO CORP., Willow Grove, Pa.				X											X	X	X	X	X	X
ELECTRONIC CONNECTORS, INC., Kew Gardens, N. Y. 11415	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
ENTRON, INC., 2141 Industrial Pkwy., Silver Spring, Md.			X									X								
ERCONA CORP., 432 Park Ave., New York 16, N. Y.	X	X	X	X	X	X	X	X	X		X	X	X	X[4]	X	X	X	X	X	
GENERAL RADIO CO., West Concord, Mass.	X	X		X		X	X	X	X		X	X	X							
GENERAL RF FITTINGS, INC., 702 Beacon St., Boston 15, Mass.	X	X	X	X		X	X	X	X		X	X	X							
GREMAR MFG. CO., INC., 7 North Ave., Wakefield, Mass. 01880	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X				
HUGHES CONNECTING DEVICES, P.O. Box H, Newport Beach, Calif.	X			X				X	X	X				X	X				X	X
ITT CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles, Calif. 90031	X			X	X		X	X	X	X	X	X		X	X		X	X	X	X

(Continued on following page)

World Radio History

MANUFACTURERS OF COAXIAL CABLE and SHIELDED CABLE CONNECTORS

(Continued)

	COAXIAL CABLE CONNECTORS														SHIELDED CABLE CONNECTORS					
	Rack and Panel Mtg.	Cable Mounting	Cable Splicing	Feed Through	Printed Circuit	Solderless Terminals	Solder Terminals	Miniature	Subminiature	Microminiature	Microwave Types	UHF Types	Rigid Line Adapters	Triaxial Connector	Rack and Panel	Cable Mounting	Microphone Connectors	Modular Terminal Blocks	Miniature	Assembly Tools
JERROLD ELECTRONICS, 15th St. & Lehigh Ave., Phila., Pa.		X	X	X		X					X	X								
KINGS ELECTRONICS CO., INC., 40 Marbledale Rd., Tuckahoe, N. Y. 10707	X					X	X	X	X		X	X	X							
LAB-TRONICS, INC., 3656 N. Lincoln Ave., Chicago, Ill. 60613	X	X										X	X	X	X	X	X	X		
LITTON INDUSTRIES, Winchester Div., Main St. and Hillside Ave., Oakville, Conn.	X	X						X												
MARCONI RADIO DIV., ENGLISH ELECTRIC CORP., 750 3rd Ave., New York 17, N. Y.	X	X									X	X	X							X
MICON ELECTRONICS INC., Roosevelt Field, Garden City, N. Y.	X	X	X	X	X	X	X	X	X	X	X	X								
MICRODOT, INC., 220 Pasadena Ave., S. Pasadena, Calif.	X	X	X	X	X	X	X	X	X	X	X	X	X	X[5]	X	X	X	X	X	X
MODULAR ELECTRONICS, INC., Osseo, Minn. 55369	X	X	X	X	X					X										
NATIONAL CONNECTOR CORP., Science-Industry Ctr., Minneapolis 28, Minn.	X	X		X		X	X													
NUGENT ELECTRONICS CO., INC., 802 E. 8th St., New Albany, Ind.	X	X	X	X	X	X	X	X	X	X	X	X		X				X	X	
NU-LINE INDUSTRIES CO. INC., 1015 S. 6th St., Minneapolis, Minn. 55415	X	X		X			X	X												
OMNI SPECTRA, INC., 8844 Puritan Ave., Detroit, Mich. 48238	X	X	X	X				X	X		X	X	X						X	
PEM MACHINE & TOOL CO., INC., 39A Myrtle St., Cranford, N. J.											X	X	X							
PHELPS DODGE ELECTRONIC PRODUCTS CORP., 60 Dodge Ave., North Haven, Conn.		X									X	X	X							
PHYSICAL SCIENCES CORP., 314 E. Live Oak Ave., Arcadia, Calif.				X		X			X					X					X	
PROGRESS WEBSTER CORP., 5 Bridge St., Watertown 72, Mass.															X	X	X		X	
PYLE-NATIONAL CO., 1334 N. Kostner Ave., Chicago, Ill. 60651	X	X		X		X	X									X			X	
REGO INDUSTRIES, INC., 830 Monroe St., Hoboken, N. J.	X	X				X	X				X	X			X	X				
RYE SOUND CORP., 145 Elm St., Mamaroneck, N. Y.																	X		X	
SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y.	X	X	X	X	X				X			X	X		X	X				
SPENCER KENNEDY LABS., INC., 1320 Soldiers Field Rd., Boston, Mass.	X	X	X	X		X	X	X			X	X	X		X	X		X	X	X
STAR-TRONICS, Georgetown, Mass.	X	X	X	X		X	X	X	X		X	X	X							
SUPERIOR ELECTRIC CO., 383 Middle St., Bristol, Conn. 06012															X					
TECHNICAL MATERIEL CORP., 700 Fenimore Rd., Mamaroneck, N. Y.	X	X	X	X	X	X	X	X	X			X	X	X						
TELEPHONE DYNAMICS CORP., 32 Sunrise Hwy., Baldwin, L. I., N. Y.								X									X		X	
THOMAS & BETTS CO., 36 Butler St., Elizabeth, N. J.			X			X														
TROMPETER ELECTRONICS, INC., 7238 Eton Ave., Canoga Park, Calif. 91303		X		X				X			X	X		X[6]	X	X		X	X	
TRU-CONNECTOR CORP., 245 Lynnfield St., Peabody, Mass.	X	X		X		X		X			X	X								X
U. S. COMPONENTS, INC., 1320 Zerega Ave., Bronx, N. Y. 10462				X	X	X		X							X				X	
VACUUM CERAMICS, INC., Cary, Ill.				X							X									
VERITRON WEST, INC., 20245 Sunburst St., Chatsworth, Calif. 91311				X			X	X	X	X				X						
WEINSCHEL ENGINEERING, Gaithersburg, Md.		X									X		X							
ZORON, INC., 4853 N. Ravenswood Ave., Chicago, Ill. 60640																	X			

1. Furnished only as components of custom-designed system interconnecting assemblies.
2. Including twinaxial and twin r-f cable connectors.
3. Connector Div., 1830 S. 54th Ave., Chicago, Ill.
4. Also twinaxial connectors.
5. Including twinaxial and multi-coaxial connectors.
6. Including twinaxial connectors and patch assemblies.

ELECTRONIC INDUSTRIES

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. . . may not come in a flourish, but in the quiet hours at home when the job is done. That something extra, too, is the thing that Sperry strives to provide. It has made us a leader in low level PNP/NPN silicon transistors.

LOW LEVEL AMPLIFIER PROBLEMS? Use a 2N2524 and its PNP complement, 2N2605. Beta of 100 @ 10 microamps — both in TO-46 package.

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NEED HIGH VOLTAGE? You'll get 100v collector to emitter with the 2N2600A and its NPN complement, 2N2519.

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DESIGNING A MICROWATT SWITCH? With the 2N3340 and 2N3341, you'll get 10 microwatts per flip-flop.

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Here's something extra, for instance, popular NPN's, such as the 2N930A (typically in TO-18 cans) come to you at no extra cost in TO-46 package (2N2524). The transistors mentioned above represent a few ways to solve problems in designing circuits for military and industrial products. As a leader in low level silicon transistors, Sperry Semiconductor has developed the most complete line of PNP/NPN Complementary Silicon Planar Transistors – more ways to do the best job. ☐ For complete information on the Sperry complementary line, circle the reader-service number below. ☐ **SPERRY SEMICONDUCTOR, Norwalk, Connecticut 06852.**

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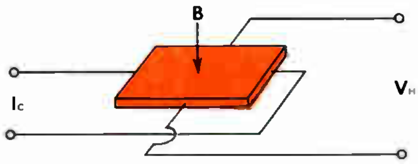
THE HALL EFFECT and its applications*

The Hall effect is the generation of a voltage across opposite edges of an electrical conductor which is carrying current and is placed in a magnetic field.



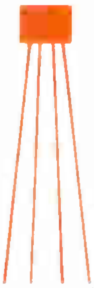
The Hall phenomenon may be expressed by the equation:

$V_H = K_{HOC} (I_C \times B)$

V_H is the Hall voltage,
K_{HOC} is the open circuit sensitivity constant,
I_C is the control current,
B is the component of the magnetic flux density perpendicular to the device

K_{HOC} is a constant determined by the Hall element material and geometry. I_C and B may be d-c or time-varying. If I_C is held constant, the output, V_H, is proportional to B. The Hall effect can be applied to a gaussmeter, linear transducer, non-contact switch, d-c and a-c non-contact current measurements, angular transducer and many other applications. Placing the Hall device in the air gap of a magnetic circuit results in a Hall Multiplier which opens up an entirely different area of applications. In the air gap of a magnetic structure, the magnetic flux density, B, is a function of the field current, I_F. Therefore, the Hall voltage output is proportional to the instantaneous product of the field current, I_F, and the control current, I_C. I_F and I_C may be d-c or time-varying. The Hall Multiplier may be used as a modulator, chopper, power transducer, analog multiplier, and in many other applications where an output voltage, V_H, is desired as a function of the instantaneous product of two independent inputs, I_F and I_C.

*Send for complete booklet.



Model BH-700 "Hall Pak" (actual size) one of 12 off-the-shelf devices

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ABSOLUTE MEASUREMENTS: 12 ranges from .1 gauss (1/5 of earth's field) to 30,000 gauss full scale.

STRAY FIELD MEASUREMENTS: Down to 100 gammas (.001 gauss) full scale.

INCREMENTAL MEASUREMENTS: Resolution of 1 part in 10,000. See a .01 gauss variation in a 100 gauss field.

DIFFERENTIAL MEASUREMENTS: A difference of 1% between two points produces a full scale reading.

HALL DEVICE PROBES: Measure flux density in gaps only .006" long and solenoid fields down to .065" in diameter. Active areas can be as small as .0002 square inches for high resolution.

If the Model 240 doesn't meet your requirements, send for information on the other 5 Bell Gaussmeters. Also complete instrumentation for production testing and inspection of magnets.

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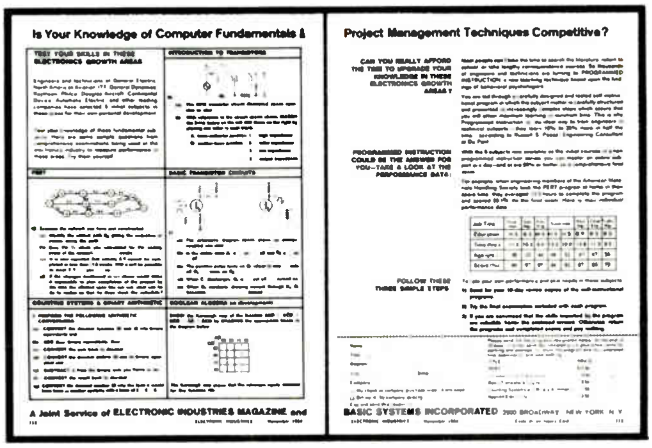
Why did Engineers from over 600 Companies answer this Ad?



They decided to keep their skills competitive by teaching themselves PERT, Transistors and Transistor Circuits, Binary Arithmetic, and Applied Electricity. They did it with these Programmed Instruction* courses and then they started to write us . . .

Compare your answer with theirs...

"I have recently received your programmed instruction course. The method which you employ is excellent, I cannot see how anyone could help learning the subject matter."

". . . I believe it is the best instructional method I have encountered . . ."

". . . it seemed to motivate me to learn . . ."

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*The "teaching machine" technology.

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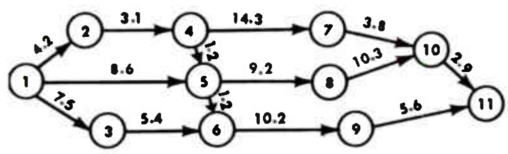
Test your Knowledge

of these fundamental subjects. Here are some sample questions from comprehensive examinations being used in the electronics industry to measure performance in 2 of these 5 areas.

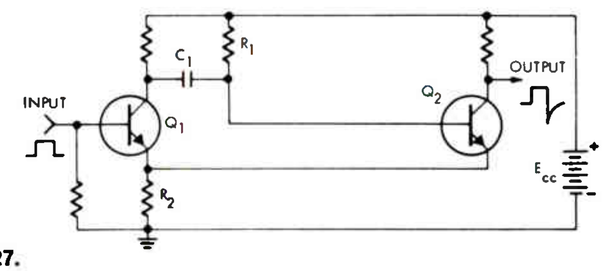
Try them yourself . . .

PERT



12. Examine the network you have just constructed.
   (a) Identify the critical path by giving the sequence of events along the path: ______________.
   (b) Give the T_E which you calculated for the ending event of the network ________ weeks
   (c) It is now reported that activity 6-9 cannot be completed in less than 11.8 weeks. Will it still be possible to meet T_L? ☐ yes ☐ no
   (d) If the changes mentioned in (c) above would make it impossible to plan completion of the project by the time the allotted span has run out, what can he do to replan so that he does meet the schedule?

BASIC TRANSISTOR CIRCUITS



27.
   (a) The schematic diagram above shows an emitter-coupled one-shot ______________.
   (b) In the stable state Q_1 is ☐ on ☐ off and Q_2 is ☐ on ☐ off.
   (c) The positive pulse turns on Q_1 which in turn: ☐ cuts off Q_2 ☐ turns on Q_2.
   (d) When C_1 discharges, Q_2 is: ☐ cut off ☐ turned on.
   (e) When Q_2 conducts, drawing current through R_2, Q_1 becomes ______________ biased.

To rate your own performance and skill needs in these 5 subjects:

1) Send for your 10-day review copies of all 5 self-instructional programs.

2) Try the final examination included with each program.

3) Only if you are convinced that the skills imparted by the program are valuable to you should you keep the programs. Otherwise, return them with completed exams and pay nothing.

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Introduction to Transistors	9.50	☐
Basic Transistor Circuits	9.50	☐
Counting Systems and Binary Arithmetic	7.50	☐
Applied Electricity	12.50	☐

BASIC SYSTEMS INCORPORATED 880 THIRD AVENUE/NEW YORK, N.Y.

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SATELLITE DATA COMPRESSOR

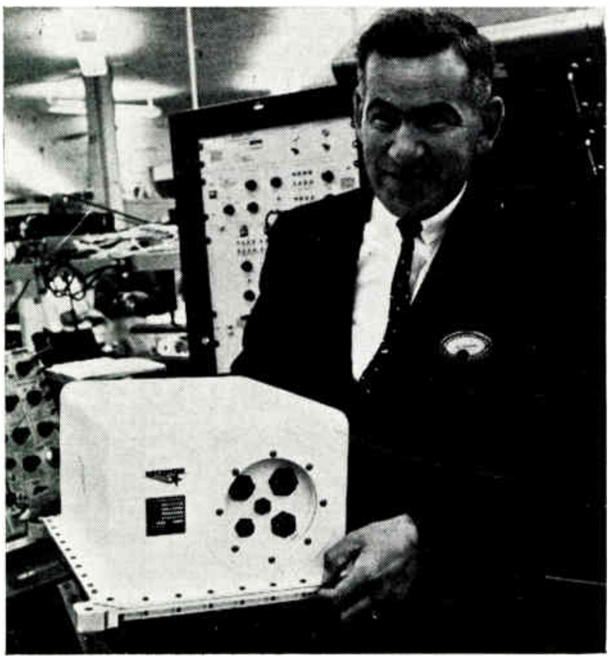
IN A GOOD DEAL OF SCIENTIFIC SPACE EXPLORATION the problem is not getting data back from the satellite, but keeping the instruments from acting like an orator. While it is possible to sort out the right facts from the stream of telemetry by using computers, it would be easier to eliminate the unwanted data before it is sent. A data compressor, developed by Lockheed Missiles & Space Co., Sunnyvale, Calif., does this.

The unit uses integrated microelectronic circuits. In addition to other components, it contains 24,000 magnetic memory elements and 467 micro-miniature circuits in less than 1 cu. ft.

The unit operates on the principle that if a sequence of numbers transmitted by telemetry is always the same, or any one number varies only a little within a certain limit of tolerance, there is no reason to transmit the sequence. As soon as any number gets larger or smaller than the limits of the sequence tolerance, it is sent. In other words, it transmits only interesting information.

The system handles up to 14,400 samples/sec. It operates with pulse code modulation telemetry system having 4 simultaneous sampling rates. The operating constants, such as the tolerance levels, can be altered from the ground during a satellite flight by a command link.

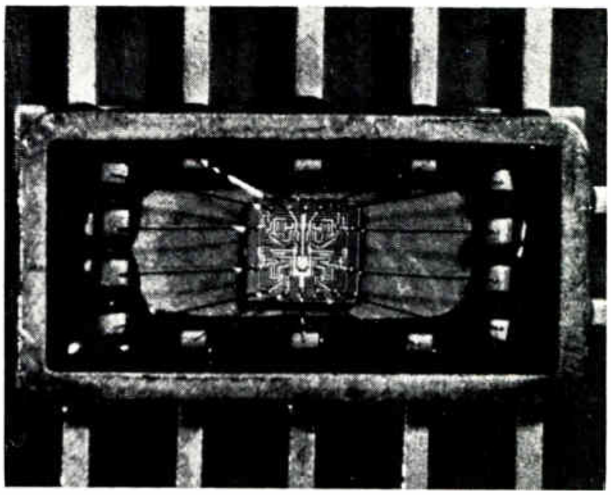
The unit eliminates redundant data from being transmitted.



DIGITAL INTEGRATED CIRCUITS

LOW POWER, HIGH SPEED, HIGH NOISE IMMUNITY, high fan-out, and high capacitance-driving capability are features of the TTL Digital Solid Circuit® semiconductor networks.

Series 54 silicon double-epitaxial line has speed



The series uses a multi-function concept—packing up to 4 circuit functions into one monolithic bar of silicon.

high enough for computers, while power needs are low enough for most aerospace systems. Typical characteristics include propagation delay of 15nsec., fan-out of 15, noise margin of 800mv, and power dissipation of 10mw/gate. The circuits operate from a single 5v. power supply, and have a temp. range from −55° to +125°C.

The compatible family of 7 multi-function positive NAND gates and J-K flip-flop is made in the transistor-transistor-logic (TTL) form. Here, transistors perform diode functions. The extra transistor gain allows wider component tolerances, thus increasing yields.

A special design feature of the line is low output impedance in the ON and OFF conditions. This provides high-speed even when driving high-capacitance loads. The low output impedance also terminates all data lines with low impedance in both "O" and "I" logical stages. This diminishes the effect of capacitively and inductively coupled noise. Performance parameters are largely independent of temp., loading, and capacitance.

The series is a product of Texas Instruments Incorporated, P.O. Box 5012, Dallas, Tex.

More What's New on Page 70

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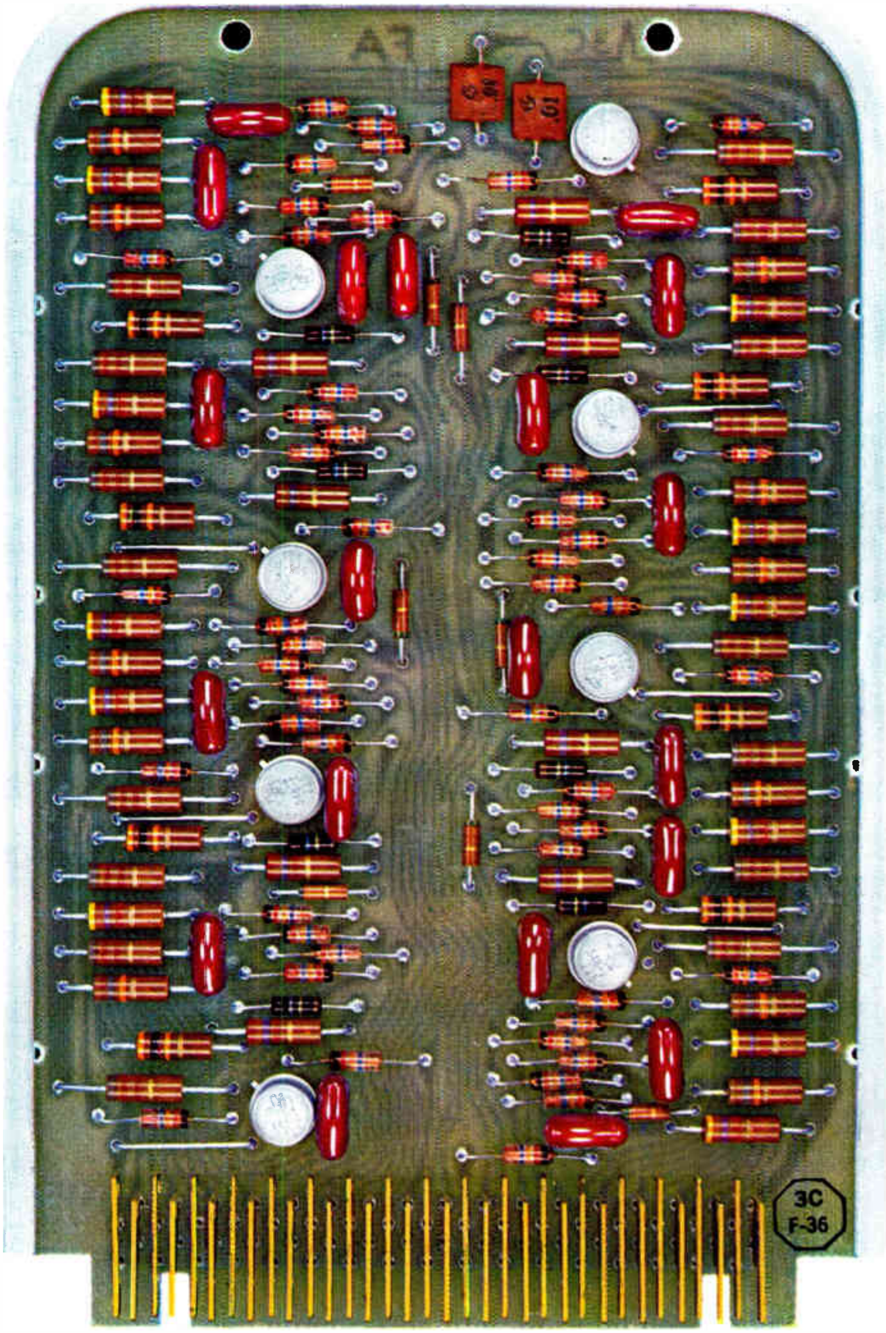
only one . . .



. . . circuit module manufacturer is totally committed to the design, manufacture and sale of packaged circuits. From 200 kilocycles to 20 megacycles. From standard card and encapsulated packages to state-of-the-art interplanetary probe pellet packaging. From comprehensive catalogs of extensive circuit product lines, to design aids and manuals. From plug-in to rack-mount power supplies. From standard BLOC card cages to front access tilt, slide and split drawer rack mounting hardware. From germanium to silicon. Only one company.

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COMPUTER CONTROL COMPANY, INC.
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WHAT'S NEW

FERRITE SHEET MEMORY MODULES

A NEW ELECTRONIC SWITCHING SYSTEM, currently used by the Bell Telephone System, uses an array of multiple-aperture ferrite sheet memory modules in place of conventional memory banks. The conventional memory banks use criss-cross grid laced at the intersections of the ferrite cores. The new approach uses a flat sheet of ferrite punched with 256 tiny holes. The 256 holes, located within the 1 in. square sheet, behave similar to 256 conventional ferrite cores.

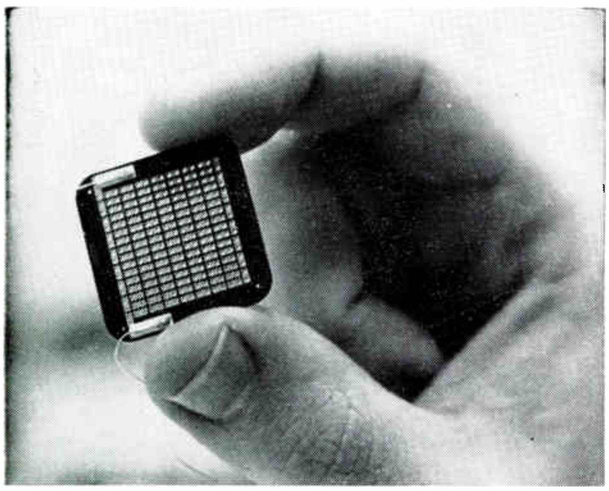
The new memory modules make possible such improvements as automatic follow-up and completion of phone calls when the line is busy the first time a number is dialed, or multiple station conference calls.

Western Electric has been able to make these sheets by attaining and maintaining precise control of particle size in the ferrite materials used. This was made possible by using a Stokes Tornado Mill, developed by F. J. Stokes Co. 5500 Tabor Rd., Philadelphia 20, Pa. This granulating equipment has a vertical flow path and a 360° screen which is completely surrounding a whirling multiple-blade rotor.

The ferrite raw materials are wet-mixed, dried, and pulverized in a Tornado Mill which uses a 20-mesh screen. The finely divided powder is then calcined to produce a magnetic ferrite of the proper crystalline structure. The resulting black powder is milled with a binder, dried, and run through a second Tornado Mill. This Mill has a 60-mesh screen and delivers ferrite press powder of the proper particle size needed for uniform pressing of the flat ferrite sheets.

The thin sheets are made by pressure compacting the ferrite powder using a 256-pin die. The perforated sheet is then sintered at a high temperature, using a controlled atmosphere to develop suitable magnetic properties. A copper circuit pattern with attached leads is then applied to the sheet and it is then wired by passing fine wires through each hole.

The 256 holes in this magnetic memory module, made by the Western Electric Co., act similar to 256 ferrite cores.



COLD-TIP SOLDERING

A NEW SOLDERING TOOL has been developed that is a departure from the conventional tools. The hand-held soldering tool does not get hot; rather, it causes heat to be generated on the surface of the work piece.

The tool, called Positermn ™, uses two tips which form a "V" shape. Every element in the circuit, except the junction between the tips and work, have a very low resistance. As current flows through the circuit, heat occurs only at the points of high resistance, which is on the surface of the work. These points of high resistance are created through a tip design that makes good electrical contact, while limiting the contract area.

Tip causes heat to be generated only on work surface.

The tool also features a solder-feeding mechanism which is combined with the heating tool. This feature is possible because the tips never become hot. Just as it is the work that gets hot and not the tool, it is the work that melts the solder, not the tips. The tips and solder nozzle are positioned with respect to one another. This allows heat to be generated on one part of a typical joint, while solder is applied to the other. The obvious benefit of this solder-feeding heating tool is that one of the operator's hands is freed, and he is forced to properly apply solder to the joint.

The solder tool is a product of the Westinghouse Aerospace Div., Baltimore, Md.

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For custom designs, Astrodata's extensive experience provides a well-qualified capability for satisfying your specific performance needs.

Model 884 Wideband (dc to 100 kc) Floating, Guarded Amplifier . . .
Model 885 Wideband (dc to 10 kc) Differential, Isolated Amplifier . . .

high-gain/performance amplifiers for low-level, wideband systems at lowest cost. Completely transistorized, these state-of-the-art amplifiers use field-effect transistors in place of mechanical choppers to achieve lowest drift rate, freedom from microphonics and maximum reliability. Gain range to 3000 and a continuously adjustable 10-turn vernier control are provided as standard features. Two differential models with ±10 ma or ±100 ma output current from a low impedance can drive long lines, A to D converters, multiplexers, galvanometers or tape recorders. Transfer characteristic is optimized to provide wide frequency response with minimum overshoot, fastest settling and overload recovery times, and minimum phase shift. Common mode rejection is greater than 120 db with up to ±300 volts dc or peak ac common mode voltage.

All models have built-in power supplies, feature drift less than 1 μV per week, wideband noise less than 4 μV rms, linearity better than 0.02%. Can be used either separately or in the same rack module with Model 1155 Universal Signal Conditioning Unit or Model 890 Electronic Filter to form complete, isolated signal conditioning channels.

Model 885-135 Differential Amplifier to drive multiplexers, tape recorders and A to D converters.

GAIN RANGE: 1 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ±5 volts at ±10 ma
DRIFT: ±1 μV for 40 hours
TEMP. COEFF: ±0.2 μV/°F
NOISE: 2 μV rms

Model 885-235 Differential Amplifier to drive data systems, long lines and galvanometers.

GAIN RANGE: 3 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ±10 volts at ±100 ma
DRIFT: ±1 μV for 40 hours
TEMP. COEFF: ±0.2 μV/°F
NOISE: 2 μV rms

Model 1155 Universal Signal Conditioning Unit

Uses plug-in circuit cards to supply excitation or bias, attenuation, circuit completion, balancing, filtering and calibration. Used with low-level or high level signals from thermocouples, strain gages, resistance temperature sensors, thermistors, potentiometers and voltage sources. Can function separately or in same rack module with Models 884 or 885 Amplifiers or Model 890 Filter to provide complete conditioning, calibration and normalizing of transducer signals.

Model 126-101 Charge Amplifier. All solid-state unit with internal dynamic calibration.

INPUT RESISTANCE: 10,000 megohms
INPUT RANGE: 1 to 10,000 psi, g lbs
GAGE FACTOR RANGE: 1 to 11 or 10 to 110 pcmb per psi, g or lb, continuously adjustable
FREQUENCY RESPONSE: 0.3 cps to 150 kc
STATIC CALIBRATE MODE: Extends response virtually to dc for dead weight testing.

Model 120 Nanovolt Amplifier gives you high-gain/low-noise amplification for seismic transducer signals, cryogenic studies, thermocouple or strain gage signals.

GAIN RANGE: 200 to 1,000,000
BANDWIDTH: dc to 100 cps
NOISE: 0.05 μV rms
INPUT RESISTANCE: 1 megohm
OUTPUT LEVEL: 0 to ±5 volts at ±5 ma

Model 121Z Nanovoltmeter provides 0.1 μV full scale bridge balance detector or thermocouple indicator for standards and calibration work, in the field and in laboratories.

FULL SCALE RANGES: ±0.1 μV to ±100 mv
INPUT RESISTANCE: 1 megohm
ZERO SUPPRESSION: ±0.5 μV to ±5 mv
AMPLIFIER OUTPUT: Gain 30 to 3 million, delivers ±5 volts at ±5 ma
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16b

World Radio History

By MASAMITSU KAWAKAMI
and KIYOSHI TAKAHASHI
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Asst. Professor of Electronics
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The development of semiconductor devices is following certain, well-defined directions. This handy "tree" chart shows the relationship between them, and the dates when they were announced or became available.

The Evolution of Semiconductor Electronics

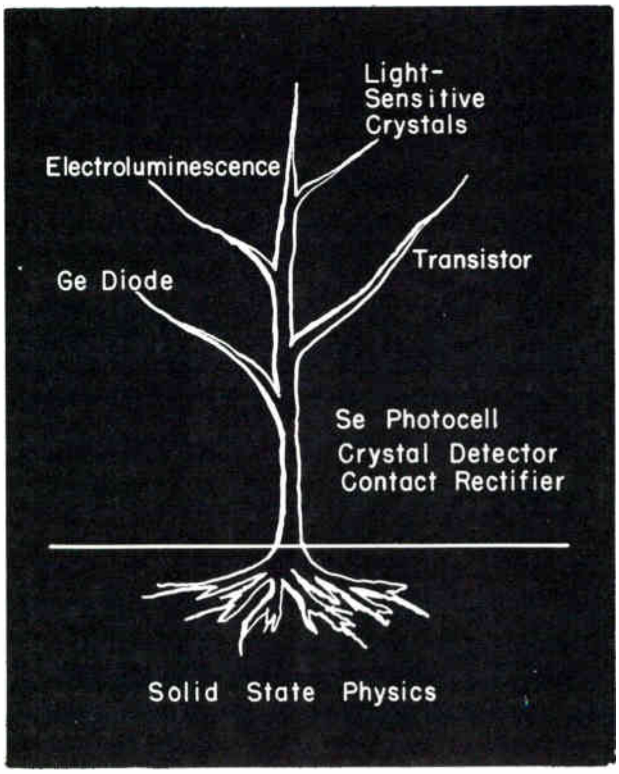
ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
FEATURE

A FAMILY TREE drawing is used to chart the history of semiconductor electronics in this article. The roots represent basic research and the branches represent semiconductor devices. Growth of the tree since it was last published corresponds to the development in this field.

* * *

Since the sprouting of the semiconductor sapling drawn by W. C. White*, in 1952 it has grown tremendously. At that time, it was a relatively simple sapling having just a few branches. Now, 12 years later, it has grown into a large tree, and there are many new branches, Fig. 2. Who could have foreseen such a rapid growth? This growth is due to rich soil, i.e., the developments in solid state physics.

Because of space limitations all devices and developments could not be shown, and some branches were necessarily cut out.



Significance

The roots of this tree are the many basic researches that have made this science grow and which are expressed in general rather than specific terms.

*Electronics, p. 98, Sept. 1952

The large main divisions of the trunk represent the functional classification and the individual branches represent the devices.

In a sense, the lengths of the branches are measures of engineering development and commercialization.

Dates

Assignment of definite dates to some device or development is always a difficult problem. This is especially true for some researches, so the roots could not be given.

In case of the individual branches that are dated, space limitations necessitate brief titles. Qualifying words to make the item more specific are not included.

Where possible, the dates apply to the year when the device was commercially available. This is satisfactory, of course, and fairly definite for devices such as the "transistor" or "diode." But, it is not practical for others not readily available, such as "nemag" or "oscillistor."

Thus, on branches where commercial availability is not a good criterion, the dates apply to the year when the report concerning the device was published.

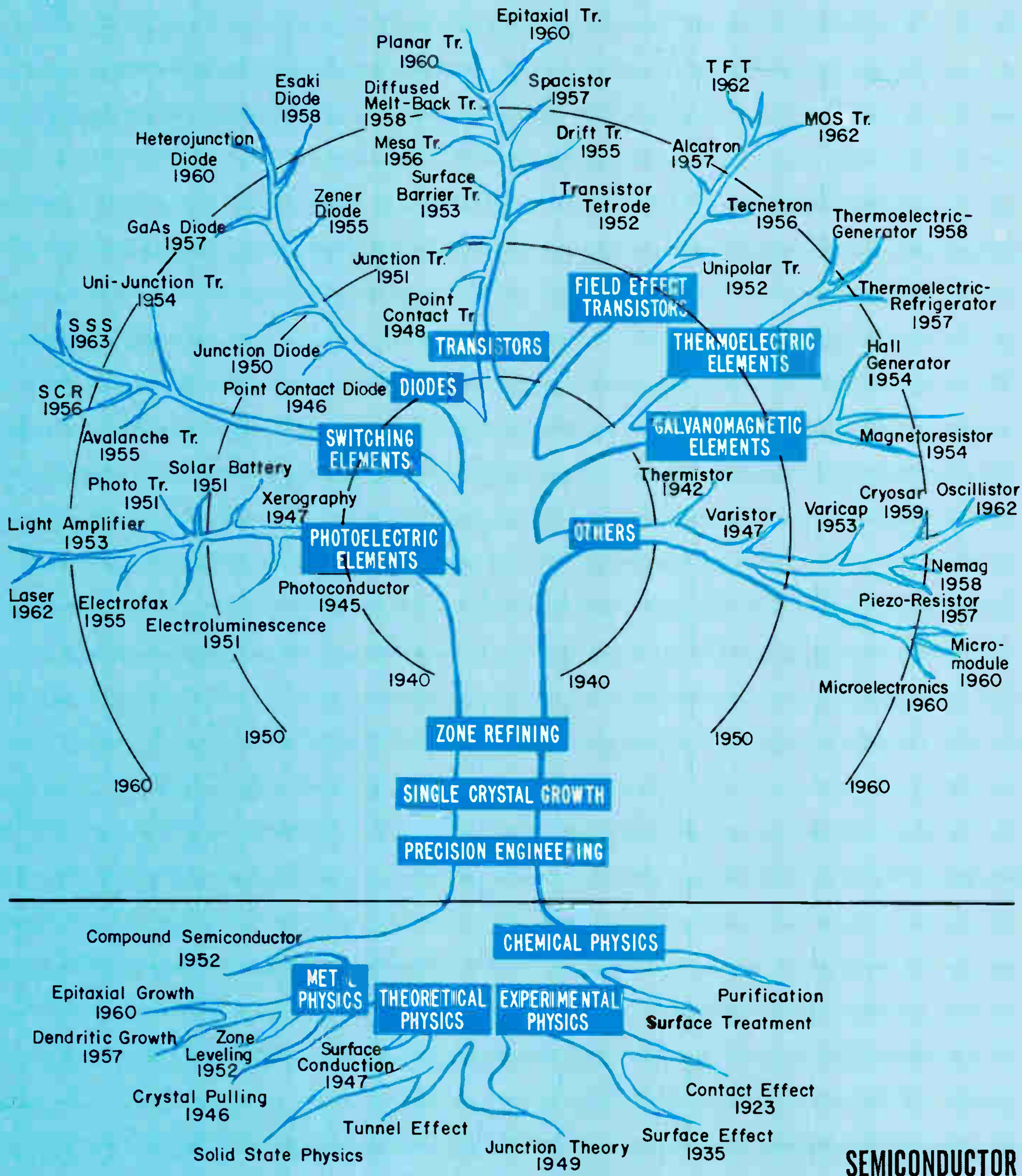
This tree will grow larger with the years. We hope that some new seeds are dropped from this tree, and that new saplings of our science will sprout in the near future.

Fig. 1: At the time when this "semiconductor sapling" (left) was drawn, few devices were available.

Fig. 2: Due to developments in solid state physics, the "sapling" shown at the left has grown into the full size "tree" at the right. Roots of this tree signify the many basic researches that have made this science grow. The large main divisions of the trunk represent the functional classification. The individual branches represent the devices themselves. Where possible, the dates denote the year the device was commercially available. Where commercial availability is not a good criterion, the dates apply to the year when the report on the device was published.

World Radio History

ELECTRONIC INDUSTRIES



SEMICONDUCTOR GENEALOGY

World Radio History

SPECIFICATIONS FOR HIGH VOLTAGE SILICON DIODE STACK

Rectifier Configuration (half wave, full wave, center tap, bridge, doubler, etc.)__________

Design Requirements;

A. Voltage

1. Dc Output Voltage__________
2. Maximum Allowable "On-Voltage"/Stack______Volts at______Amps
3. Switching Transient Peak Voltage______Duration______
4. Likely External Transient Voltages__________

B. Frequency

1. Input Voltage Frequency______No. of Phases______

C. Current

1. Dc Output Current__________
2. Duty Cycle: Time "ON"______Time "OFF"______
3. Non-Repetitive Surge Current______Duration______

D. Environmental Conditions

1. Ambient Temperature Range__________
2. Cooling Fluid__________
   Rate______Temperature______
3. Atmospheric Pressure Range__________
4. Contamination Requirements:
   Stack to Surrounding Medium__________
   Surrounding Medium to Stack__________

E. Circuit Considerations

1. Describe Transient Suppression if Used__________
2. Type of Filter on Output__________
   (Give filter schematic)
3. Nearest Ground Plane (distance)__________

F. Mechanical

1. Size__________
2. Weight__________
3. Attitude__________
4. Vibration Requirement__________
5. Accessibility Requirement (individual components)__________
6. Special Mechanical Requirements (i.e. terminals, mounting screws, etc.

This check list contains all the information needed by the stack manufacturer. With this information the diode stack manufacturer can provide a suitable assembly which, if it meets the specs, will work admirably in the circuit.

How to Specify

The series connected silicon diode stack has been very successful in high voltage rectifiers. For this reason it is automatically the choice in new radio and TV transmitters, radar modulators, induction heating generators, electrostatic precipitators and like equipment. In fact, many engineers are converting existing equipment from mercury vapor rectifiers to silicon.

There are certain pitfalls in the use of these high voltage stacks. Thus, this article will guide the designer in writing the proper specs.

* * *

Two vital boundary conditions govern the choice of diode stacks; peak reverse voltage and peak forward, or surge, current.

Peak Reverse Voltage

Due to transients the peak reverse voltage seen by the stack is generally much higher than the value given by rectifier circuit-constant tables. Unfortunately, it's hard to predict the amplitude and duration of these transients, especially in 3-phase circuits. The designer has two choices: he can apply a rule-of-thumb and say that they can easily be kept below, say, 150% of the dc voltage, or he can measure them on prototype equipment.

Transient Voltage Measurement

The measuring method is shown in Fig. 1. Voltage across the rectifier output is divided by resistors shunted with capacitors. The resis-

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World Radio History

High-voltage silicon diode stacks can be used in place of vacuum tube rectifiers in some applications.
If the proper stack is chosen, equipment reliability can be increased when compared with tube rectifiers.
This article will guide the designer in writing the proper specifications and making useful measurements for silicon diode stacks.

High Voltage Silicon Diode Stacks

tors assure accurate division of the dc voltage. The capacitors swamp out stray capacitance and divide the transient (high-frequency) voltage accurately. The output across the 1 kΩ resistor is connected to an oscilloscope via coax cable. (Care must be taken to assure that this resistor never becomes open circuited in which case high voltages may appear at the scope.) The scope must have a frequency response of at least 10 MC.

The procedure for measurement is to switch the supply and load on and off randomly while observing the scope trace with a slow sweep of, say, 1 cm/sec. The transients are readily seen if the intensity is turned up high.

The above test should be conducted initially at, say, ¼ of the normal operating voltage. This is to protect the prototype diodes from destruction by unexpectedly high transients. The measured transient is then multiplied by 4 to arrive at a preliminary value. If this value is within the stack's capability, verification proceeds at full voltage.

Reducing Voltage Transients

In a rectifier with a choke input filter such as in Fig. 1, the transient voltage seen by a diode stack can be much higher than the dc voltage. The transient voltage can be greatly reduced by adding suppressors. There is as in all designs, a trade-off between the cost of the suppressors and the saving in diode cost.

A severe transient can be produced when the magnetizing current of the high voltage transformer is interrupted by the primary circuit breaker, Fig. 2. With a choke input filter no path exists for the energy in the magnetizing circuit to flow. Thus the voltage across the diodes can build up to a high value.

This transient may be suppressed by shunting the transformer primary with either a resistor, Thyrector, or Thyrite arrestor. Another means of suppression is to use a capacitor input filter.

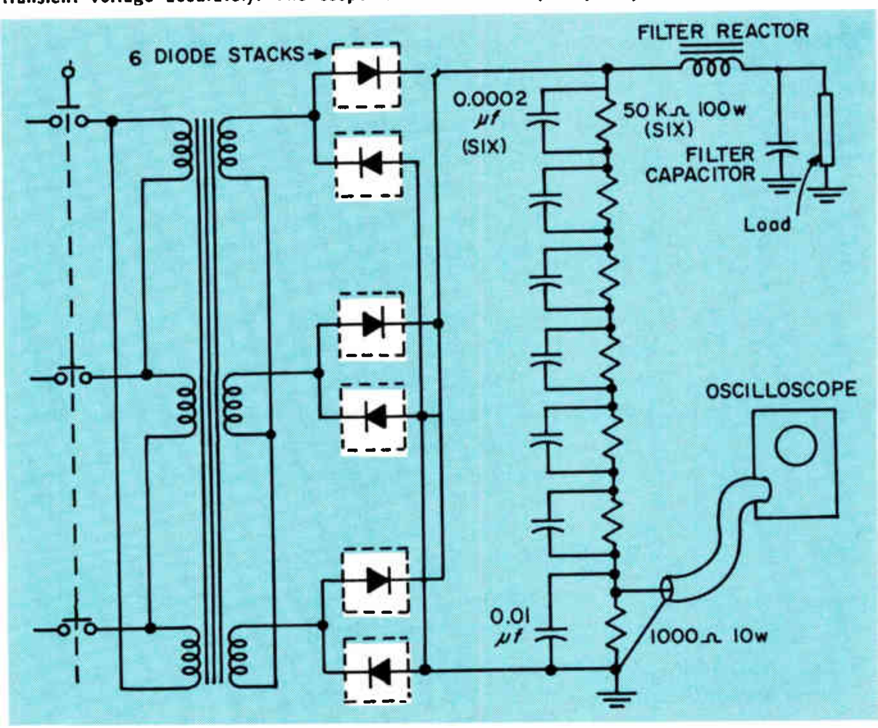
Capacitor input filters are rapidly gaining favor because of the absence of the L-C circuit. If the capacitance is high, the regulation is better than with an L-C filter. The supply also has a much lower internal impedance at low frequency. This is an asset in certain types of amplifiers such as transmitter modulators. When capacitor input filters are used care must be taken to design for the high inrush current through the diodes when the circuit is energized.

Current Surges

A high voltage rectifier usually ends up with the silicon diodes being chosen on the basis of surge current rating rather than average current handling capability. Thus, both the amplitude and duration of the highest surge current that can be withstood by the diode stacks must be known. This surge is usually due to a short circuit in the dc side of the filter. It can be either calculated or measured.

(Continued on page 76)

Fig. 1: Measuring voltage transients. The resistors across the rectifier output assure accurate division of the dc voltage while the capacitors swamp out stray capacitance and divide the transient voltage accurately. The scope must have a frequency response of at least 10 MC.



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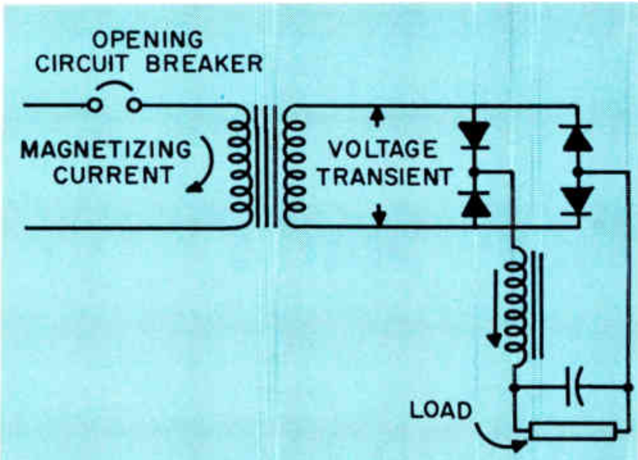

Fig. 2: Transient voltage can be produced when the magnetizing current of the transformer is interrupted by the circuit breaker.

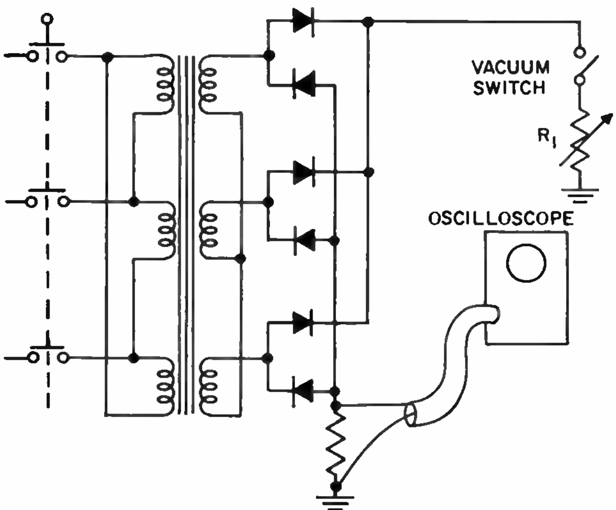

Fig. 3 (above): Configuration for measuring the amplitude and duration of the surge current in the diode stacks.

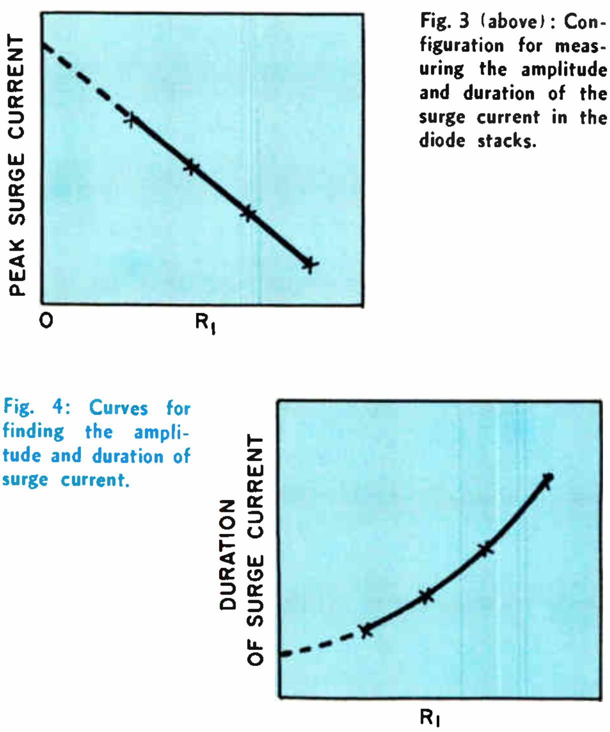

Fig. 4: Curves for finding the amplitude and duration of surge current.

The worst surge current that can be seen by the stack will occur when a short circuit current occurs at the output of the diodes, ahead of the choke input filter (if any) and where the supply line is well regulated. In this case the surge current will be

$$I_{surge} = \frac{\text{Normal Secondary Current}}{\text{\% Reactance of Transformer}} \times 1.5^*$$

The percentage reaction of a high-voltage supply transformer is typically 5%. This means that the maximum surge current is typically 30 times the normal current.

The designer is cautioned against departing from this simple means of calculating surge current amplitude. One never knows when the equipment will be connected to a stiff line or when someone will hang a grounding switch onto the positive terminal of the stack.

A more difficult calculation is the duration of the surge current. This duration depends on the operating time of the overload sensing relay plus the time to operate and quench the arc in the circuit breaker. Manufacturers of these components should be consulted for this information. Again the alternative is to make the needed measurements on prototype equipment.

Fig. 3 shows the setup for measuring amplitude and duration of the surge current in the stacks. An artificial overload, R1, may be applied by means of the vacuum switch. The dc current is measured by observing the voltage across the non-inductive resistor R2 on an oscilloscope. R2 should be low, say 10 mΩ.

The test procedure is to measure the amplitude and duration of the overload current for decreasing values of R1. The result is plotted on curves such as Fig. 4. If R1 cannot be reduced to zero, the points of the curve may be extrapolated to zero.

Control of Surge Current

The surge current may be limited by current limiting reactors which are usually inserted in series with the primary of the high voltage transformer. Their purpose is to increase the percentage reactance of the circuit. Alternatively the transformer may be respecified with a higher percentage reactance. Any shortening of the duration of the surge current must involve an improvement in the response time of the overload detecting and clearing components. As in the case of voltage transients, a trade-off exists between the cost of the surge-reducing components and the cost of high-surge-current diode stacks.

Specification of a Diode Stack

The designer can now, with the foregoing vital data and with his knowledge of the circuit and the environmental conditions, fully specify the diode stacks.

*The multiplier is used to allow for offset current.

World Radio History

By ANATOL I. ZVEREV
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The oldest use of all-pass networks is for phase correction. The theory of this was developed by Zobel. Today their use has expanded to many new applications. This expansion of uses required a more general synthesis procedure, like the one described here.

Practical Design of All-Pass Networks

THE ALL-PASS NETWORK is one of the most important components—especially in a large number of communication and target-detection systems. Because of the large number of uses, it is hard to talk about general cases. But, it is helpful to mention a few outstanding uses:

1. Expansion of signals in the time domain
2. Phase-correction of signals
3. Phase-splitting of signals
4. Intermediate step in network synthesis
5. Delay of a signal without introducing frequency modulation

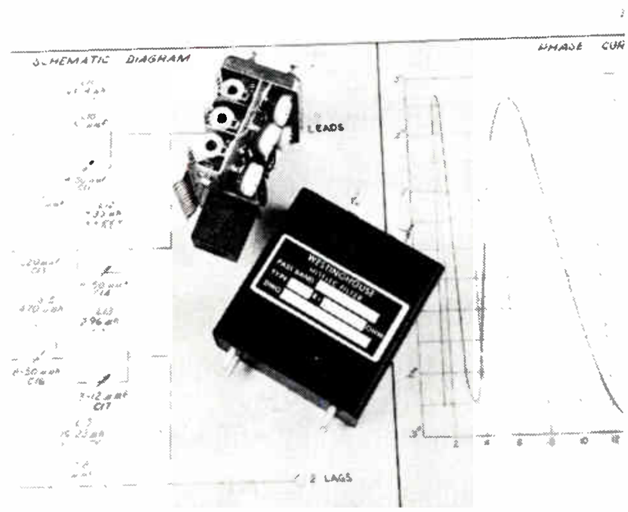
* * *

In the first case, a time-delay network with phase, usually parabolic, versus frequency response is obtained. In the second, a network is designed to a specified phase-frequency characteristic. In the third case, two all-pass networks with a common input are synthesized to provide, within the given frequency limits, two outputs which are constant in amplitude but whose phases are in quadrature. In the fourth, all-pass networks are used only in the intermediate synthesis procedure. And with the aid of transformations, the resulting networks take the forms of well-known filter types, such as the high-pass, low-pass, bandstop or the band-pass In the fifth case, the all-pass network takes the form of a simple delay line.

The oldest use of all-pass networks is for phase correction. The theory of this was developed by Zobel. In recent years, a more general synthesis procedure has been used. A specific phase response is satisfied by complex calculation of a system with prescribed phase characteristic. Phase correction is still an important function of phase synthesis.

All-Pass Network as a Lattice

The all-pass network is used in lattice form. The following discussion of the lattice applies, therefore, to the network. Simple lattices in cascade may be transformed to a single equivalent lattice. This in turn may be transformed to its unbalanced form. This reduces the number of elements used.



All-pass network design requires sophisticated design ability. This is not obvious from physical appearance of end product.

A chain of lattices and its desired equivalent lattice leading to a more practical network are shown in Fig. 1. In the case of lattices with equal characteristic impedances:

$$(Z_a)\,(Z_b) = (Z_{an})\,(Z_{bn}) = (Z_{ak})\,(Z_{bk}) = Z_o^2 \qquad (1)$$

where $k = 1, 2, \cdots, n$.

Z_a and Z_b are the impedances of the lattice arm.

n is the number of lattices.

k is the number of lattices between 1 and n.

Therefore:

$$Z_o^2 = Z_a Z_b \qquad (2)$$

The composite transmission constant g for any kind of non-equal lattices with equal impedances will be expressed by:

$$g = g_1 + g_2 + \cdots + g_n = n\,(a + jb) \qquad (3)$$

The index associated with g shows the number of the lattice to which it refers. The transmission constant for any lattices will be expressed by:

$$g_k = 2 \tan h^{-1} \sqrt{\frac{Z_{ak}}{Z_{bk}}} \qquad (4)$$

Knowing that: (Continued on following page)

World Radio History

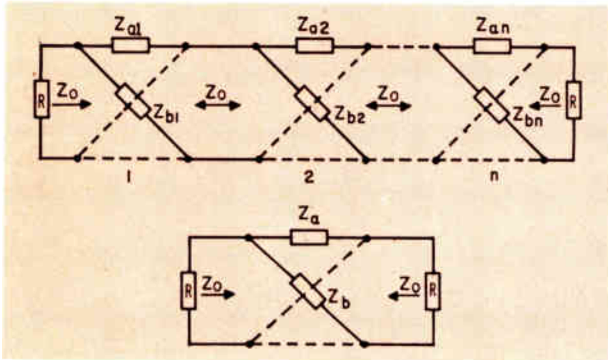


Fig. 1: A chain of lattices and its substitute lattice.

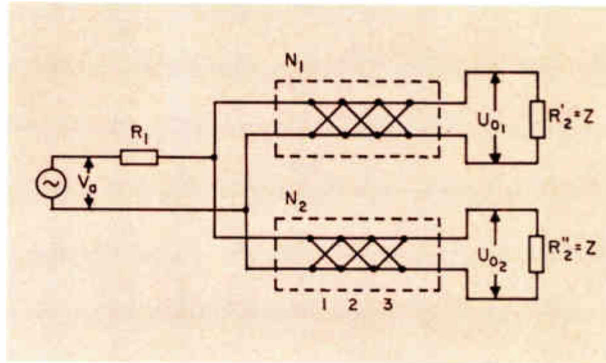


Fig. 2: Principal schematic of phase networks (splitter).

ALL-PASS NETWORK (Continued)

$$\tan h^{-1} x = \frac{1}{2} \ln \frac{1 + x}{1 - x}, \tag{5}$$

we can obtain

$$g_k = \ln \frac{1 + \sqrt{\frac{Z_{ak}}{Z_{bk}}}}{1 - \sqrt{\frac{Z_{ak}}{Z_{bk}}}} \tag{6}$$

For the first-order lattice:

$$Z_o = \sqrt{\frac{L}{C}}$$

$$g_k = \ln \frac{1 + j\omega \sqrt{LC}}{1 - j\omega \sqrt{LC}} = \ln 1 + j2 \tan^{-1} (\omega \sqrt{LC}).$$

This is an all-pass network whose phase b is given by:

$$b = 2 \tan^{-1} (\omega \sqrt{LC}).$$

Normalizing the characteristic impedance Z_o:

$$\sqrt{\frac{Z_{ak}}{Z_{bk}}} = \frac{Z_{ak}}{Z_o} = z_{ak}. \tag{7}$$

From expression (6) it follows that

$$g_k = \ln \frac{1 + z_{ak}}{1 - z_{ak}} \tag{8}$$

According to expression (3) for the transmission constant, a similar expression in a different form will be:

$$g = \ln \frac{1 + z_a}{1 - z_a} = \ln \prod_1^n \frac{1 + z_{ak}}{1 - z_{ak}} \tag{9}$$

This expression can be solved in order to evaluate the normalized impedance z_a and z_b.

$$z_a = \frac{Z_a}{Z_o} = \frac{\prod_1^n (1 + z_{ak}) - \prod_1^n (1 - z_{ak})}{\prod_1^n (1 + z_{ak}) + \prod_1^n (1 - z_{ak})} \tag{10}$$

$$z_b = \frac{Z_b}{Z_o} = \frac{1}{z_a}$$

This means that z_a and z_b are reciprocal impedances. If we have equal lattices connected in cascade as in the case of pulse stretching networks, the expression for z_a and z_b will be slightly modified and will take the form:

$$z_a = \frac{(1 + z_{ak})^n - (1 - z_{ak})^n}{(1 + z_{ak})^n + (1 - z_{ak})^n} \qquad z_b = \frac{1}{z_a} \tag{11}$$

In the case of purely reactive components, the characteristic function H of the resulting lattices will be:

$$H = \frac{\bar{z}_a \bar{z}_b - 1}{\bar{z}_b - \bar{z}_a} \tag{12}$$

where $\bar{z}_a$ and $\bar{z}_b$ are the lattice arms, normalized to the load resistance R (which should be equal on both sides of the networks). That is:

$$\bar{z}_a = \frac{Z_a}{R} \qquad \bar{z}_a = \frac{Z_b}{R} \tag{13}$$

The products in (10) could be defined in the following fashion:

$$P_1 = \prod_1^n (1 - z_{ak}) \quad P_2 = \prod_1^n (1 - z_{ak}) \tag{14}$$

Using these values and substituting them in (10) for $\bar{z}_a$ and $\bar{z}_b$, the following expression for operating condition will be obtained:

$$e^a = \sqrt{1 + |H|^2} \tag{15}$$

In more open form, this is:

$$e^a = \sqrt{1 + \left| \frac{P_1^2 - P_2^2}{4 P_1 P_2} \left(\frac{Z_o}{R} - \frac{R}{Z_o} \right) \right|^2} \tag{16}$$

where Z_o is a characteristic impedance of the network when it is different from the load impedance.

Practical Application

Initially, it is assumed that the phase splitter in Fig. 2 is synthesized in non-elementary fashion. When the synthesis is done, information is obtained for symmetrical non-equal all-pass lattices such as 12 to 112 MC phase splitter design in Figs. 3 and 4.

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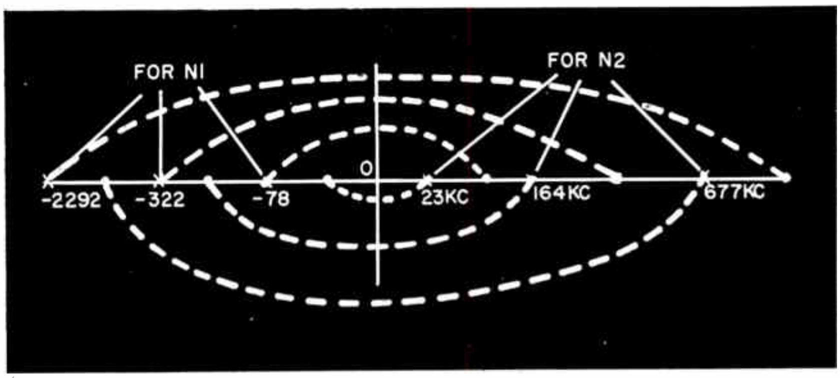
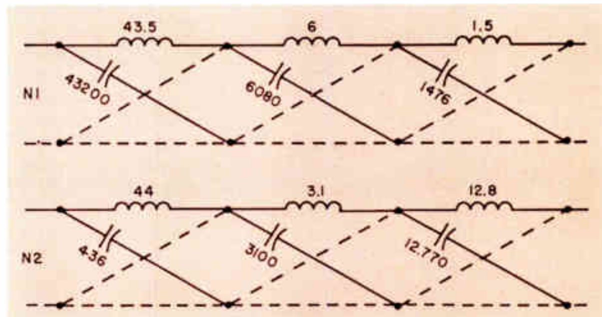


Fig. 3: Poles and zeros location of voltage ratio after synthesis of Fig. 2.

Fig. 4 (below): The elements of six pole networks according to the pole and zero distribution that is shown in Fig. 3 above.



The symmetrical lattice has some obvious bad points. First, it contains many repetitive elements and secondly, the lattice is a balanced network. Above, equivalence of several non-equal lattices to one combined lattice is shown. The following is devoted to the method of transforming first order networks to its equivalent half-lattice or differential bridge.

Despite simplicity, the first-degree networks are not the most practical. This becomes apparent when an attempt is made to produce a pair of networks operating over a wide band of frequencies covering several octaves. Then it is found that a network which is operating over a low frequency portion of the passband, as an all-pass network, is at the same time acting as a low-pass filter at the higher frequencies, with the cutoff inside of the prescribed frequency limits.

The cause of this is the self-capacitance of the coils and lead inductance of the capacitors. All-pass sections with characteristic frequencies at low frequency cause a problem. It is usually impossible to place the self-resonance of the network coils outside of the passband.

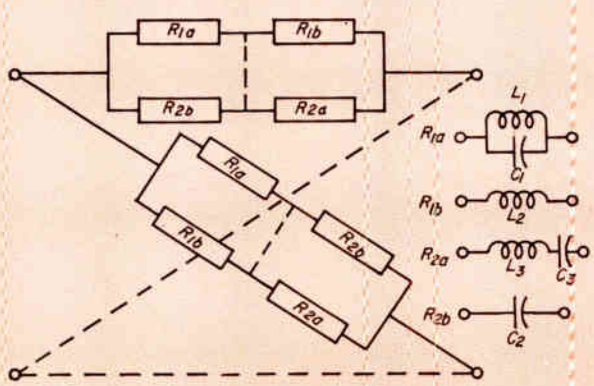
The remedy is to combine pairs of the first-degree network together in the form of a second-degree network. It is possible to place across the biggest coil, the offender in the first order lattice, capacitance which can absorb the self-capacitance of the coil. It is advisable to combine one section of the high frequency and one section of the low frequency together to get a better second order lattice. The highest and lowest of what remains is next to be combined. The combining is continued until either one or none is left.

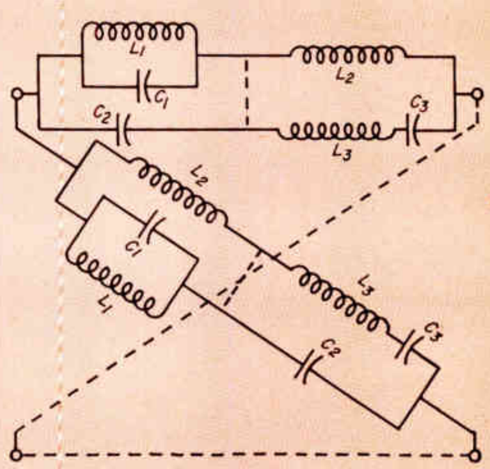
The second remedy is to make the impedance as low as possible, keeping in mind that the capacitors can also be offenders if they are too large. It may turn out that different impedances have to be used for different sections in tandem sections. In this case, impedance matching attenuators have to be fitted in the networks where appropriate.

In Fig. 5, the equivalent cascaded connection of two lattices with equal characteristic impedances is shown. Fig. 6 shows the intermediate step in the transformation to combine two cascaded lattices into

Fig. 5 (below): First step to combine 2 lattices into one.

Fig. 6 (right): Equipotential points connected for simplicity.





World Radio History

one equivalent lattice. The dotted line between the impedance in each arm shows that at these points the potentials are equal and therefore could be connected together (bridge is perfectly balanced).

The addition of three simple lattices can be done in a simple way. The first step is to combine two of the lattices, as done before, and then combine the resulting second degree lattice with the remaining simple lattice (of the first order). The best method for combining the simple lattices is to combine, at first, two lattices that have the lowest and highest poles. This method is used because, in an extreme case, the poles may not be realized in the single lattice forms.

Fig. 5 also shows the elements of a first and second order lattice which will be combined into a single third order lattice. Both lattices are ideal in the sense that no losses are involved. In the upper dipoles in Fig. 6, where equipotential points are connected for simplicity (by dotted lines), there are two circuits which resonate at the same frequency. The first anti-resonance will be between L_1 and $(C_1 + C_2)$, the second one between L_2, L_3 and C_3. The second anti-resonance is hidden and must be "extracted." In the lattice arm of Fig. 6, the first anti-resonance is produced when C_1 resonates with $L_1L_2/(L_1 + L_2)$ and the second anti-resonance with C_2, C_3 and L_3. The second resonance in this circuit is also hidden and must be "extracted." The intermediate step of transformation consists of simplification as per above.

Fig. 7 shows the circuit after the proper dipole transformation has been applied. The two anti-resonance circuits in each arm of the lattice are

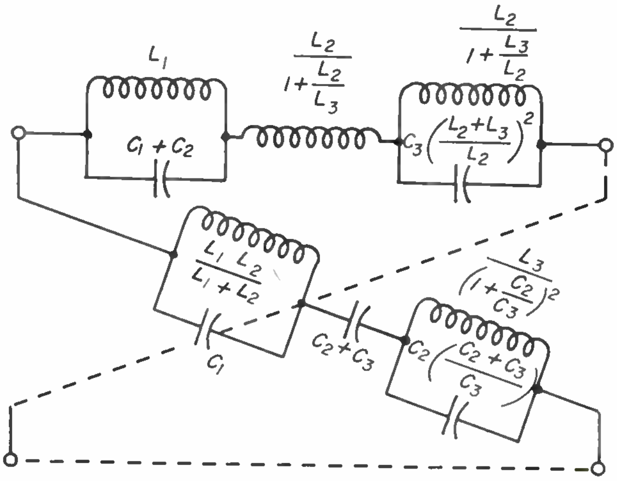


Fig. 7: The dipoles shown in Figure 5 were transformed into the above to facilitate simplification of the circuit.

resonated at the same frequency. They may be combined by the simple addition of impedances. Fig. 8 shows the final schematic of a semilattice as a result of design and transformation with two reciprocal branches at all frequencies. This is a practical structure which is reduced to six coils and six capacitors.

The element values in Fig. 8 are given in terms of first and second order lattices that were originally combined. As a possible alternative for realization, the bridged-T equivalent form can be mentioned; but the necessity of high quality mutually coupled inductances and presence of parasitic capacitance between these inductances reduces the domain of its use.

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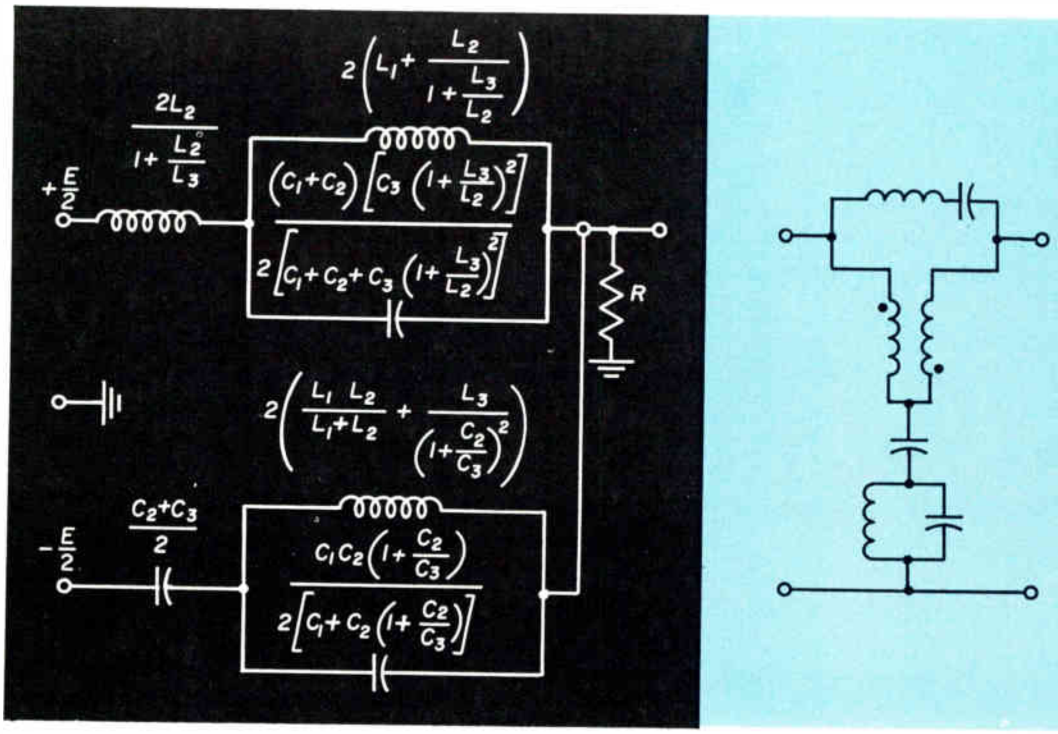

Fig. 8: Third order all-pass network in the form of a differential bridge. Its equivalent bridget-T type circuit is shown on the right.

World Radio History

Tunnel diodes offer advantages as storage elements in a shift register—they can provide very high shift rates. Design details and circuit values are included in the concise explanation.

Shift Register Design Using Tunnel Diodes

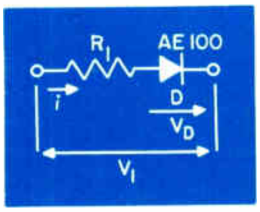

Fig. 1: Basic circuit of a tunnel diode in series with a resistor connected to dc.

A SHIFT REGISTER is a binary storage facility within which the stored bits of information may be shifted by applying shifting pulses.

For storage elements, generally flip flops or magnetic cores are used. This article describes a shift register using tunnel diodes for storage, providing one tunnel diode circuit for each bit of stored information.

* * *

Fig. 1 shows the basic circuit of a tunnel diode in series with a resistor R_1, connected to a dc voltage source of emf V_1. Looking at Fig. 2, there are two stable points of operation, A and B, if R_1 and V_1 are designed properly. Point A can be assigned to a stored "0," point B to a stored "1."

Fig. 3 shows four such storage units connected together to furnish a 4 bit ring shift register. The information is stored in the tunnel diodes D_1, D_2, D_3, D_4, as well as in the capacitors C_1, C_2, C_3, C_4.

When a shift is to occur, first the tunnel storage diodes are all switched to their stable point A. This is done by decreasing the supply voltage V_1 to 0 and afterwards increasing it to the value it had before. This is done at high speed so the capacitors C_1 to C_4 can not discharge in the meantime. Immediately afterwards a second pulse, derived from the shifting pulse, feeds the charge of each capacitor to the tunnel storage circuit to its right by a short decreasing of the voltage V_2. Thereby all bits have been shifted to the right one section by the shifting event.

For details, suppose that in tunnel diode storage circuit number one a "one" is stored, in number two, a "zero," in number 3 a "one," and in number four a "0."

Then according to our assumptions made above we have:

between points a_1 and 0 a voltage of 0.45v
between points a_2 and 0 a voltage of 80 mv
between points a_3 and 0 a voltage of 0.45v
between points a_4 and 0 a voltage of 80 mv.

The voltage drop at the resistors R_{21}, R_{22}, R_{23}, and R_{24} may be neglected, since the design has $R_{11} = R_{12} = R_{13} = R_{14} > R_{21} = R_{22} = R_{23} = R_{24}$.

The rectifier diodes CR_1, CR_2, CR_3, and CR_4 are biased to cutoff by a voltage of +0.5 on line 2. Therefore, the capacitor C_1 is charged by the resistor R_{31} to the potential of point A_1, about 0.45v. Similarly, C_2 is charged to about 85 mv, and so on.

As already mentioned above in the beginning of shifting, the voltage on line 1 is decreased to zero for a very short time T_1 and increased again. Thereafter all points, A_1 to A_4 have the same potential of 80 mv. The potentials on points b_1, b_2, b_3, and b_4 at first remain the same, that is, 0.45v, 80 mv, 0.45v and 80 mv, as the circuit is designed $R_{31} = R_{32} = R_{33} = R_{34} > R_{11}$ and finally time constant R_{31} C_1 $< T_1$.

Immediately after that event, bias voltage on line 2 is decreased to zero potential for a short time, thereby bringing the potential of point d_2 to —0.45v if we neglect the voltage drop across CR_1 for simplicity. This is like rising the supply emf across the storage element R_{12} D_2 by 0.45v, thus switching it to point of operation B (refer to Fig. 2) having transferred a "one" to tunnel diode D_2.

Diode CR_2, however, does not switch on when potential on line 2 is decreased to zero. Capacitor C_2 was charged to only 80 mv, thus leaving tunnel diode circuit D_3 unswitched in the position A. That means that tunnel diode circuit D_3 has stored a zero.

Proceeding in this manner we find, after the shifting event, the "one" formerly stored in D_3 is now stored in D_4, and the zero of D_4 has been shifted to D_1. In this way, the shifting event transferred the storage pattern by one digit. After capacitors C_1 . . . C_4 have been charged to the new potentials on points a_1 through a_4 by resistors R_{31} through R_{34}, the circuit is ready for the next shifting pulse.

The stored pattern is not confined to the chosen example of 1010, but can assume all possible combinations such as 1111, 0000, 1110, 1100 and 0001 as well.

Fig. 4 shows a circuit which had been tested in pratical operation, using tunnel diodes A100 by Telefunken, Germany.

The transistors Q_1 and Q_2 with transformer T derive the proper pulses for line 1 and 2 from the shifting pulse fed to point I of the circuit. Trans-

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World Radio History

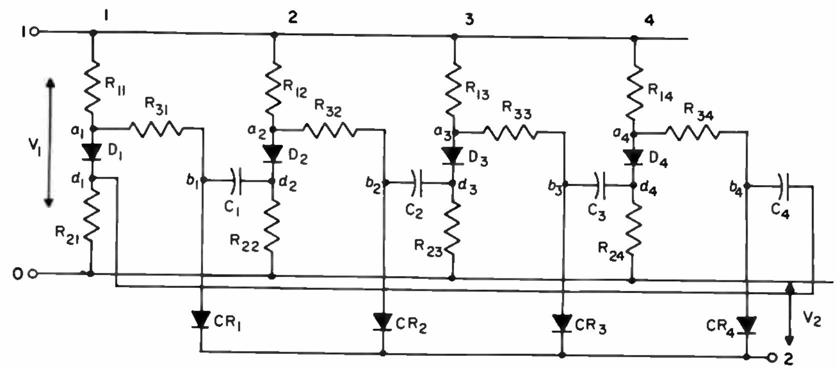


Fig. 3: Four storage units connected together to furnish a 4 bit ring counter. The information is stored in the tunnel diodes as well as the capacitors C_1-C_4.

former T provides the low impedance impulse source for line 2, by potentiometer R_8 adjusting pulse height on line 2. Potentiometer R_9 adjusts the storage feed voltage V_1. The additional capacitors C_p were inserted for convenience of experimenting. The reason for this were pulses occurring in the lab and outside (for example plugging in solder iron), accidentally switching the high speed, (low switching energy) tunnel circuits. Therefore, in practice good shielding will be needed when using high speed circuit elements.

The shifting rate was chosen to be as low as 100 cps for testing the performance and for studying the influence of tolerances of tunnel diodes to stability of operation. The circuit worked properly, being able to shift all combinations.

Every one of the four tunnel diodes following the other differed in peak current by 8.5%, while the diodes CR_1 through CR_5 had been selected for equal characteristics.

The circuit could shift all possible combinations within tolerances of ±7.5% of V_1, or ±8% of V_2 respectively. Those tolerances seem to be handled well in practical circuits. Maximum available shift velocity may be very high, as the theoretical frequency limit of tunnel diodes is exceedingly high. It is supposed that the speed limit is set by the network providing pulses on line 1 and 2.

Mr. Schmidt, cand. phys., I thank for performing experimental work and measurements.

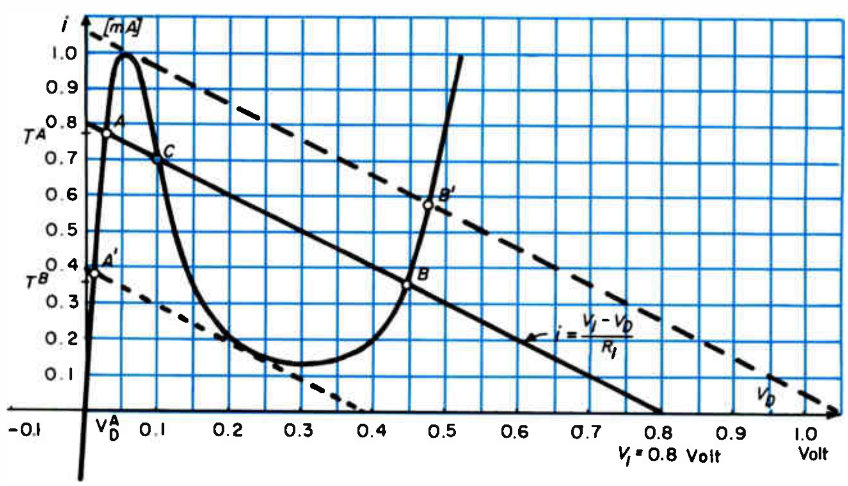


Fig. 2: Looking at tunnel diode curve there are 2 stable points of operation, A & B if R_1 and V_1 are properly designed.

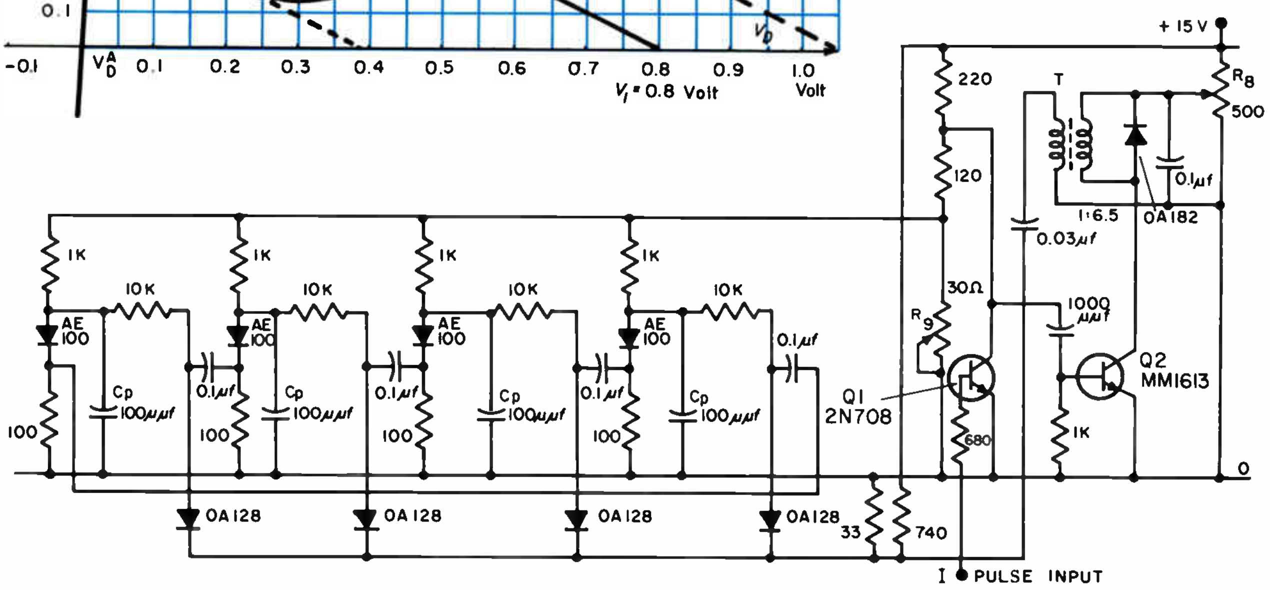


Fig. 4: A shift register circuit using tunnel diodes that has been tested.

World Radio History

#76 Parallel Tuned Circuit Calculations

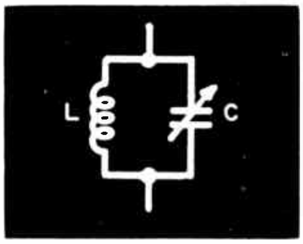


Fig. 1: Practicable parallel tuned circuit.

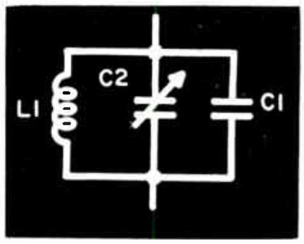


Fig. 2: Practical parallel tuned circuit.

PRACTICABLE PARALLEL TUNED CIRCUIT ELEMENTS, Fig. 1, become practical when comprised of specific component parts, Fig. 2.

The "practicable" circuit, of Fig. 1, is theoretically capable of performing the function of the "practical" circuit, of Fig. 2. But, it is impractical! For, for any given frequency band there are infinite combinations of inductance, L, and capacitance, C. Obviously, the selection of L and C equivalents from commercially available sources will be very difficult . . . unless a well organized approach is used.

The following is a method of finding the commercial inductance and capitance equivalents of Fig. 2. It requires knowledge of the frequency band, and of the variable capacitor features. It assumes high component part Q.

(a) Define the frequency band by $f1$, the lowest frequency, and $f2$, the highest frequency.

(b) Select a variable capacitor from a catalog. Define it by C2 max, maximum capacitance, and C2 min, minimum capacitance.

(c) Keeping in mind that $\pi = 3.14$ (3.14159 26536 etc.), and that $\omega = 2\pi f$, solve for:

$$L1 = [(1/\omega 1)^2 - (1/\omega 2)^2]/(C2\ \text{max} - C2\ \text{min}) \quad (1)$$

$$C1 = [(1/\omega 1)^2/L1] - C2\ \text{max} \quad (2)$$

(d) Select $L1$ from the adjustable inductances listed in the catalog.

(e) Select $C1$ from the trimmer capacitors listed in the catalog.

Experience will guide you in choosing type of mounting, temperature coefficients, voltage/current ratings, etc.

The following example will serve as a practical guide:

(a) The frequency band is 535 KC to 1605 KC:

$$f1 = 0.535 \times 10^6\ \text{cps}$$

$$f2 = 1.605 \times 10^6\ \text{cps}$$

(b) The variable capacitor is chosen to be a Hammarlund No. MC-325-M:

$$C2\ \text{max} = 320 \times 10^{-12}\ \text{f}$$

$$C2\ \text{min} = 13.5 \times 10^{-12}\ \text{f}$$

(c) Solve for $L1$ and $C1$:

$$L1 = [(1/\omega 1)^2 - (1/\omega 2)^2]/(C2\ \text{max} - C2\ \text{min}) \quad (1)$$

$$= [(1/3.36 \times 10^6)^2 - (1/10.07 \times 10^6)^2]/(320 \times 10^{-12} - 13.5 \times 10^{-12})$$

$$= 258 \times 10^{-6}\ \text{h, that is: } 258\ \mu\text{h}$$

(d) $$C1 = [(1/\omega 1)^2/L1] - C2\ \text{max} \quad (2)$$

$$= [0.0888 \times 10^{-12}/258 \times 10^{-6}] - 320 \times 10^{-12}$$

$$= 345 \times 10^{-12} - 320 \times 10^{-12}$$

$$= 25 \times 10^{-12}\ \text{f, that is: } 25\ \text{pf}$$

Two checking equations are now introduced:

$$f1 = 1/[2\pi\sqrt{L1(C1 + C2\ \text{max})}\,] \quad (3)$$

$$= 1/[6.28\sqrt{258 \times 10^{-6}(25 \times 10^{-12} + 320 \times 10^{-12})}\,]$$

$$= 0.535 \times 10^6\ \text{cps}$$

$$f2 = 1/[2\pi\sqrt{L1(C1 + C2\ \text{min})}\,] \quad (4)$$

$$= 1/[6.28\sqrt{258 \times 10^{-6}(25 \times 10^{-12} + 13.5 \times 10^{-12})}\,]$$

$$= 1.62 \times 10^6\ \text{cps}$$

These sliderule answers, to checking Eq. 3 and 4, confirm the results of Eq. 1 and 2.

(d) $L1$ is selected to be J. W. Miller No. 4315, 178-300 µh, adjustable.

(e) C1 is selected to be Bud No. MT-833, 3-36 pf, compression mica trimmer.

Alignment of this "practical" parallel tuned circuit follows established methods (e.i.: With $C2$ set at max. capacity, $L1$ is adjusted for 535 KC. With $C2$ set at min. capacity, $C2$ is adjusted for 1605 KC. Repeat as necessary).

By the use of Eq. 1 and 2 practical parallel tuned circuits may be designed, breadboarded, and aligned without discouraging "cut and try" exercises.

By PAUL L. CONANT, SR.
Technical Staff
Reliability Division
Collins Radio Company
Dallas, Texas

World Radio History

ELECTRONIC INDUSTRIES

NEW TECH DATA

". . . STATE-OF-THE-ART information on Components and Equipment."

MOS Transistors

Data is available on 2 metal-oxide semiconductor FETs. They are designed for general low-power applications up to 60MC. They combine many features of both conventional transistors and vacuum tubes with certain unique features of their own. The high gain units are designated 3N98 and 3N99. Commercial Engineering, RCA Electronic Components & Devices, Harrison, N. J.

Circle 175 on Inquiry Card

Silicon Planar Transistors

Data is available on the 2N2217-2N2222 Leaf-Let transistors. These h-f low-power transistors are excellent for high speed switching and amplifier applications. The Leaf-Let configuration gives lower saturation voltage, higher gain because of larger emitter area; improved Beta linearity because of larger emitter periphery; and greater reliability because of larger bonding area when compared to other related planar configurations. Bendix Semiconductor Div., The Bendix Corp., Holmdel, N. J.

Circle 176 on Inquiry Card

Engineering Handbook

The 24-page "Handbook of Value Engineering Ideas" will help engineers and purchasing men apply VE techniques to the design of small die cast and molded plastic parts. Case studies, including detailed illustrations, demonstrate VE concepts. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.

Circle 177 on Inquiry Card

Rectifier Bulletin

This brochure gives complete characteristics, ratings, mechanical data, application notes and testing procedures on the Glass-Amp silicon rectifiers. It is fully illustrated with charts and test circuits. Application notes include a device capacitance test circuit, recovery time test circuit, turn-on time test circuit and description of surge conditions, capacitive load operation and mounting procedures. Semiconductor Products Group, General Instrument Corp., 600 W. John St., Hicksville, L. I., N. Y.

Circle 178 on Inquiry Card

Designer's Manual

A 16-page photocell designer's manual is available. In addition, a photocell is described which combines the best performance characteristics of CdS and CdSe. The unit uses a new light-sensitive '5H' material. Speed is 1-2msec. and the slope is 0.9 over the range of 0.1 to 100 ft. candles. The temp. coefficient is 0.5%/°C and the memory 1/15 that of CdSe. The color temp. response is 1.00/1.06 from 2854°K to 6700°K. Clairex Corp., 8 W. 30th St., New York, N. Y.

Circle 179 on Inquiry Card

Transistor Chart

This power transistor selection chart and cross-reference guide contains data needed for selecting germanium and silicon power transistors. Close to 1000 device types are described in a quick reference replacement section, which designates EIA registered numbers and closest available Motorola equivalents. The chart, No. PP 102 R8, may be obtained from Motorola Semiconductor Products Inc., Dept. TIC, Box 955, Phoenix, Ariz.

Circle 180 on Inquiry Card

Tape Components Catalog

This 20-page, 2-color brochure describes a complete line of paper tape components and data systems. Paper tape perforators, readers, accessories, 1- and 2-way data communications systems, and typing systems are described and illustrated. Tally Corp., 1310 Mercer St., Seattle, Wash.

Circle 181 on Inquiry Card

Analysis & Control Paper

A technical paper entitled, "The New Era of X-ray Analysis and Control," is available. Illustrated with photos and diagrams, the article covers 7 distinct and different X-ray techniques for difficult analytical and quality control problems. Philips Electronic Instruments, 750 So. Fulton Ave., Mt. Vernon, N. Y.

Circle 182 on Inquiry Card

Relay Catalog

Illustrated catalog F-5604 gives application data for the Micro-Scan relays. They may be used in multiplexing, direct digital control, data sampling, scanning, and analog acquisition. The 2-color brochure shows stand-up chassis plug-in, low-silhouette PC board, and laydown direct wire-in package configurations. It gives comprehensive specs. and definitions for operating voltage, driving source, relay speed, repetition rate, contact rating and bounce, noise and shielding, environmental limits, and other parameters. James Electronics, Inc., 4050 N. Rockwell St., Chicago, Ill.

Circle 183 on Inquiry Card

Microwave Components Catalog

This 32-page, 2-color, catalog lists a complete line of microwave components and ferrite devices. A special section is devoted to application and selection notes. E & M Laboratories, 7419 Greenbush Ave., No. Hollywood, Calif.

Circle 184 on Inquiry Card

Counter Data File

A complete data file on the 600 series of all-silicon solid-state electronic counters and universal counter-timers is available. The instruments offer freq. readout up to 2.5MC. CMC, 12970 Bradley Ave., San Fernando, Calif.

Circle 185 on Inquiry Card

Disc Files Capabilities

A tech. article describing the capabilities of the Series 4000 disc files is available. Discussed in detail is the capability of the disc files to bridge the gap between low-capacity, high-speed memory drums and cores, and high-capacity, slow-speed magnetic tape memories. Random access times, data storage capacity, operating speeds, disc storage data formating, and storage flexibility of the disc files are described. Bryant Computer Products, 850 Ladd Rd., Walled Lake, Mich.

Circle 186 on Inquiry Card

Hermetic Seal Catalog

This catalog gives complete data and specs. on hundreds of standard seals, and illustrates typical custom-type seals. The general data section contains tech. data of interest to engineers and designers, and discusses numbering and color coding available on E-I seals. Electrical Industries, 691 Central Ave., Murray Hill, N. J.

Circle 187 on Inquiry Card

Delay Line Brochures

This brochure includes a section on definitions reprinted from EIA Standard RS-242. Data such as distributed parameter vs. lumped parameter lines; measurements; applications; and how to specify electro-magnetic delay lines are included. LFE Advanced Components, div. of Laboratory for Electronics, Inc., 1601 Trapelo Rd., Waltham, Mass.

Circle 188 on Inquiry Card

Relay Brochure

A brochure entitled, "Inventory Relays" describes over 100 types. The brochure contains wiring diagrams, outline dimensions, and electrical and mechanical specs. for each unit. Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles, Calif.

Circle 189 on Inquiry Card

PC Board Report

A paper entitled, "Multilayer Printed Circuit Boards Performance and Reliability" is available. The 18-page report is supplemented by tables and block diagrams. Melpar Inc., 3000 Arlington Blvd., Falls Church, Va.

Circle 190 on Inquiry Card

Memory Systems

Data is available on an integrated-circuit, core-memory system with plug-in packaging. The Series ML uses integrated circuits in memory logic decoding, timing, and interface to take max. advantage of their low cost, low power consumption, and space saving capabilities. It is offered in 128, 512, and 2048 word capacities with word sizes up to 26 bits and a 5μsec. cycle time. Fabri-Tek Inc., Foshay Tower, Minneapolis 2, Minn.

Circle 191 on Inquiry Card

World Radio History

Neon Indicator Lights

This 12-page catalog, L-178, presents a complete line of subminiature indicator lights that meet or exceed the environmental and operational requirements of Mil-L-6723 and Mil-L-3661. Complete specs. and data are given for assemblies that: accommodate incandescent or neon lamps; mount in 15/32 in. or 17/32 in. clearance hole; offer a wide choice of lens cap shapes, finishes and colors; provide for use of hot-stamped or engraved legends. Dialight Corp., 60 Stewart Ave., Bklyn, N. Y.

Circle 192 on Inquiry Card

Wire Data Chart

This 9 x 11 data chart shows on 1 side all details on flexible and standard cables, rope strands and concentric strands. On the reverse side is a copper wire table showing wire size, diameters, cross-sectional area in circular mils, weight, etc. Boston Insulated Wire & Cable Co., Boston 25, Mass.

Circle 193 on Inquiry Card

Display Systems Catalog

This 29-page catalog, in color, describes a new type of graphic information display. This highly versatile tool aids human comprehension of a great volume of highly-complex, rapidly-changing information. LTV Military Electronics Div., P. O. Box 6118, Dallas, Tex.

Circle 194 on Inquiry Card

Antenna Catalog

Catalog 23, 96 pages, presents a wide selection of antenna systems. It covers complete product information, performance data and engineering information on antennas for freqs. from 2.5MC to 13.2GC. Transmission lines, including Heliax flexible coaxial cables, range from ¼ to 9 in. with power ratings of 2kw to 3000kw. The catalog introduces latest developments in antenna positioners, flexible elliptical waveguides, microwave and telemetry antennas, coaxial switching matrices and high powered flexible coaxial cables. Andrew Corp., P. O. Box 807, Chicago, Ill.

Circle 195 on Inquiry Card

Technical Papers

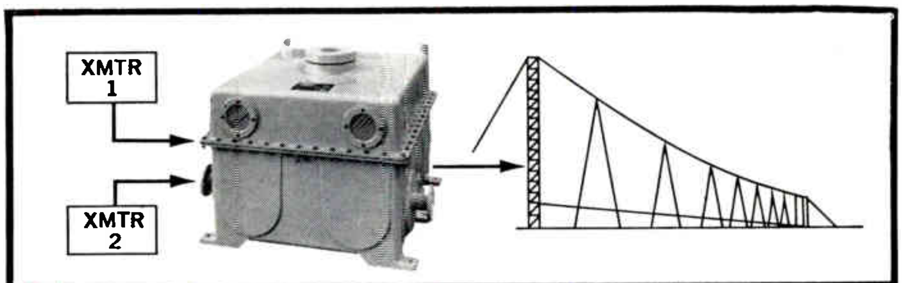
This literature lists 137 technical papers and data sheets. These relate to the state-of-the-art in measuring vibration, shock, force, pressure and turbulance. In addition, papers describing ac and dc signal conditioning equipment are listed. Endevco Corp., 801 So. Arroyo Pkwy., Pasadena, Calif.

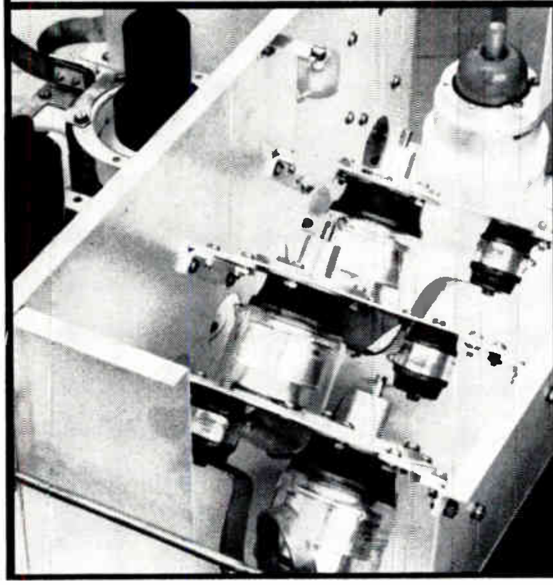
Circle 196 on Inquiry Card

SCR Bulletin

Bulletin CT-27 describes a series of silicon-controlled rectifiers. Forward current is 35a. and peak 1-cycle surge current is 150a. The 12 types of SCRs in the 2N681 series are described by a listing of 14 parameters/type. The bulletin shows curves of firing characteristics, typical forward characteristics in the conducting state, and allowable peak current as a function of forward blocking voltage. Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J.

Circle 197 on Inquiry Card





NEW H-F MULTICOUPLER USES JENNINGS VACUUM CAPACITORS TO ACHIEVE HIGH Q

Jennings vacuum capacitors are used in the reactive filter network of Granger Associates Model 520F multicoupler. The multicoupler connects two h-f transmitters to a single broadband antenna, permitting both to transmit simultaneously without interference or interaction and without significant insertion loss. The high frequency range of 2 to 32 megacycles is divided into two channels, separated by an extremely narrow open band, to accommodate each transmitter. Jennings capacitors provide the low dissipation factor and high Q characteristics which make this close channel operation possible.

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A high degree of reliability was required because the capacitors are used under oil in a sealed enclosure. Jennings vacuum capacitors met these requirements with ease. No field problems have ever occurred which could be related to either electrical or mechanical fault in the Jennings capacitors.

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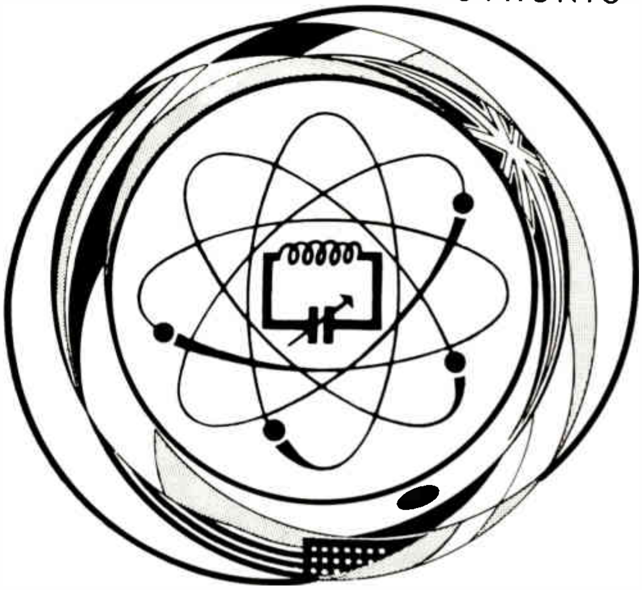

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NEW TECH DATA

Logic Module Brochure

This 36-page illustrated brochure details a line of all-silicon digital logic circuit modules. Booklet gives specs. and logic diagrams for more than 75 modules. The modules are available in 3 freq. ranges: 300KC, 1MC, and 8MC. Scientific Data Systems, Inc., 1649 17th St., Santa Monica, Calif.

Circle 222 on Inquiry Card

Connectors Catalog

Catalog RP-1, 32 pages, describes 9 different connector series for every standard application. The brochure gives mechanical, electrical and environmental characteristics. Full-size diagrams illustrate exact dimensions, and where applicable, the varieties of inserts available for it. Block diagrams or charts simplify ordering. Amphenol Connector Div., Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago, Ill.

Circle 223 on Inquiry Card

Coaxial Cable

The Shieldax Coaxial Cable achieves 100% shielding effectiveness against cross-talk. It also provides the added advantages of good flexibility, easy termination, and good attenuation. Samples, tech. data, and catalogs of the complete line of miniaturized coaxial cables can be obtained from Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif.

Circle 224 on Inquiry Card

Power Meter Bulletin

This data sheet describes the 668 Peak Power Meter. Uses and features as well as detailed specs. are shown. These include power ranges, accuracies, operating impedances, dimensions, auxiliary equipment, etc. Harris-Intertype Corp., 202 Tillary St., Bklyn, N. Y.

Circle 225 on Inquiry Card

Printed Circuit Catalog

This 12-page catalog describes die-cut symbols for PC masters. Trans-Pak die-cut pressure-sensitive symbols are said to cut PC drawing time from 50 to 90%. Chart-Pak, Inc., Leeds, Mass.

Circle 226 on Inquiry Card

Seals & Shields Catalog

This catalog is divided into 7 individual sections. Section HEX-1 deals with 1-piece high pressure seals for standard and rotary switches and seals for indicator lights; section APC-1 covers armored power connectors; section CB-1 deals with protective circuit breaker shields; SF-1 with self-sealing screws, bolts, rivets and captive screws; OR-1 with silicone rubber and molded elastomeric O-rings; SNP-1 with snap-on devices; and SK-1 with colored light filters which change the color of miniature incandescent lamps instantly. APM-HEXSEAL Corp., 41 Honeck St., Englewood, N. J.

Circle 227 on Inquiry Card

World Radio History

Relay Catalog

This stock relay catalog illustrates, gives specs., describes and prices 310 different high reliability relays. It includes a large selection of Mercury-wetted contact and dry-reed relays; telephone-type relays in subminiature to medium sizes with wide choice of contacts and contact combinations; general purpose relays; latching relays; plug-in, hermetically sealed and dust covered relays. Magnecraft Electric Co., 5577 N. Lynch Ave., Chicago, Ill.

Circle 198 on Inquiry Card

Multi-Megohm Tester

Data is available on a Multi-Megohm Tester which combines several megohm testers in 1 instrument. The combination of a variable voltage and a floating input permits, by a simple application of Ohm's law, an infinite number of possible readings. ACA International Corp., 104-33 41st Ave., Corona 68, N. Y.

Circle 199 on Inquiry Card

Logic Module Catalog

Catalog GLM-G describes a comprehensive line of germanium solid-state logic cards and accessory equipment. Provided as an engineering assist, this 35-page catalog furnishes full specs. Equipment described includes flip-flops, gates, amplifiers, decoders, pulse generators, drivers, power supplies, and accessories. Wyle Laboratories, 128 Maryland St., El Segundo, Calif.

Circle 200 on Inquiry Card

Microvolt Relay

Six bulletins are available which cover the specs., theory, and application of Model 370 50μv dc relay. The "New Design Ideas" include details and schematics for the use of the unit in such applications as a differential voltage comparator, a precision temp. controller, a thermocouple trip, and as process control signal trips. Acromag, Inc., 15360 Telegraph Rd., Detroit, Mich.

Circle 201 on Inquiry Card

Torque-Tension Handbook

"A Handbook of Torque-Tension Relationships," 16 pages, covers such topics as torque-tension standards; torque-tension relationship testing; general testing and procedures; a tool testing program; etc. Profusely illustrated with sketches and engineering drawings, the handbook has been expressly written for all those who are concerned with proper fastening. Skidmore-Wilhelm Mfg. Co., 442 So. Green Rd., Cleveland, Ohio.

Circle 202 on Inquiry Card

Console Components Catalog

"Dial Assemblies, Voltmeters, and Phase Generators for Test Consoles," 28 pages, is a 2-color catalog. It describes panel-mounted dial assemblies, ac voltmeters, phase-sensitive voltmeters, dc voltmeters and phase shifters. Uses, specs., and full descriptive data are given, as well as price and delivery information. Theta Instrument Corp., Saddle Brook, N. J.

Circle 203 on Inquiry Card

Mark II Series 400

BORN 8 YEARS OLD!
A new 2PDT relay with established dry-circuit reliability

Electro-Tec's wedge-action design* has been proving itself in 6PDT operations for 8 years. It's established a confidence level of 90%, based on a failure rate of .01% per 10,000 operations. (Tops in the industry.) Now we've put wedge-action to work in a subminiature. Each precious-metal contact combines a long contact wipe area with a 60-gram contact force. Results? Low, low contact resistance, stable within 15 milliohms over 100,000 operations. Extreme shock, vibration, and acceleration immunity. Performance far beyond all MIL-R-5757/8 requirements. (Test data available on request.) Competitively priced, with in-house testing to your high-rel specs.

* U. S. Patent No. 2,866,046 and others pending.

CHARACTERISTIC PERFORMANCE DATA

Contact Rating: Low-level to 2 amps @ 28 VDC
Operate and Release Time: 10 ms max. @ 26.5 VDC and 25°C
Contact Bounce: 300 microseconds max. even at low-level loads
Shock: 100G — 11 ± 1 ms
Vibration: 35G up to 5000 cps

Electro-Tec Corp.

SLIP RINGS • RELAYS • SWITCHES
P. O. BOX 667 • ORMOND BEACH, FLA.
(Area Code 305) 677-1771 • TWX 305-677-5115
Manufacturing facilities: Ormond Beach, Fla. — Blacksburg, Va.

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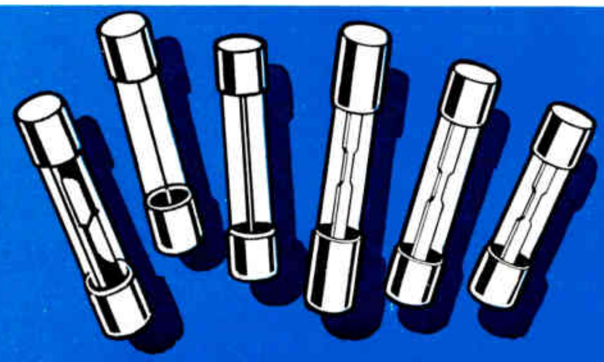

BUSS
quick-acting Fuses

"Quick-Acting" fuses for protection of sensitive instruments or delicate apparatus;—or normal acting fuses for protection where circuit is not subject to starting currents or surges.

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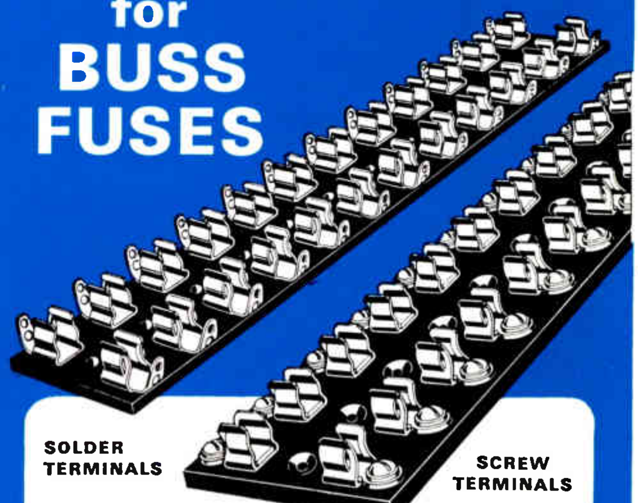

Above standard types available in any number of poles— From 1 to 12... *plus other types for every application.....*

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BUSS : the complete line of fuses

NEW TECH DATA

Relay Principles

This 56-page, full-color handbook, "The Hathaway Drireed in Electronic Switching," No. VII, discusses relay principles and contact characteristics needed to use the Drireed switching concept. It contains 20 pages of testing parameters and reports on test procedures and test equipment. Hathaway Instruments, Inc., 5800 E. Jewell Ave., Denver, Colo.

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Tapes

Tapes of Teflon are described in this illustrated brochure. It gives technical data, tape construction, typical uses. The tapes are used on coils, transformers, power cables, harnesses, motor windings, and slot liners. Permacel, New Brunswick, N. J.

Circle 205 on Inquiry Card

Tape Transport

Brochure No. 2174 contains detailed description and specs. on the TM-11 high-speed, single-capstan drive tape transport. The foldout brochure also describes the TM-11200 tape memory systems. Ampex Corp., 401 Broadway, Redwood City, Calif.

Circle 206 on Inquiry Card

Five-Wire Devices

The 12-page booklet describes and illustrates 5-wire "Twist-Lock" and "Hubbellock" devices. They provide 4 individual connections for 3-phase, 4-wire circuits, plus a fifth connection for the equipment ground. These 5-wire devices are designed for safe grounding of electrical equipment, wiring simplicity and economy. Harvey Hubbell, Inc., Bridgeport, Conn.

Circle 207 on Inquiry Card

Design Catalog

A variety of design possibilities available to the engineer whose circuit requirements include lighted pushbutton switches are described and illustrated in catalog form SP-165. The catalog lists all data needed to design a variety of lighted pushbutton switch sub-assemblies in configurations as simplified or complicated as desired. Oak Electro/Netics Corp., Crystal Lake, Ill.

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Optical Flat Glass

This folder describes the properties of optical grade Vycor brand flat glass. The folder lists optical, mechanical, electrical, chemical and thermal properties of the 96% silica glass in chart and table form. Sizes, special grades and a price list insert are included. Optical Marketing Dept., Corning Glass Works, Corning, N. Y.

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Transducer Catalog

Catalog 1164, 24 pages, features precision-film potentiometer pressure transducers. It shows a full range of pressure transducers featuring infinite resolution, long life and high reliability. It uses a unique carbon-film resistance element, multiple wipers, and direct-coupling of pressure sensing element to potentiometer wipers. Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.

Circle 210 on Inquiry Card

Transistor Discussion

"The Silicon-or-Germanium Question" is the title of this technical booklet Vol. 1, No. 5. It compares the advantages and disadvantages of these 2 types of transistors as applied to dc power supplies. Dressen-Barnes Electronics Corp., 250 N. Vinedo Ave., Pasadena, Calif.

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DC Power Supply

Model M3622 magnetic amplifier and transistor regulated dc power supply has an output voltage of 54 to 64v. @ 200a. It has ±0.1% regulation for line or load; output ripple is 1% max. RMS. Unit meets the requirement of Mil-I-6181D. Features include regulation for transients, turn-on-turn-off transient suppression, overvoltage, overcurrent and elapsed time indication. Complete data available from Perkin Electronic Corp., 345 Kansas St., El Segundo, Calif.

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Scope Cameras

This booklet describes 4 complete, standard camera systems. It contains detailed specs. on available components and accessories which simplify custom-designing a camera. The booklet features a series of waveform photographs, illustrating many typical uses with various lens/object-to-image ratio combinations. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

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Digital Module Catalog

Catalog No. 82 contains a line of silicon 2MC digital modules. Included in the catalog are the logical and electrical specs., as well as applications, mechanical and environmental characteristics. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.

Circle 214 on Inquiry Card

Environmental Equipment

Catalog E-165, 128 pages, provides complete specs. for specialized environmental test chambers, ovens, baths and furnaces. Many of the units have been developed to meet specific Mil specs. or to perform joint testing/production jobs. All can be modified to suit virtually any requirement. Blue Engineering Co., div. of Blue M Electric Co., 138th & Chatham Sts., Blue Island, Ill.

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Power Amplifier Equipment

Data is available on power amplifier equipment for TV relay. Featured is the MA-8518 TWT amplifier with an all-solid-state power supply. The equipment may be used with existing klystron transmitters with output in the 100mw to 1w. range. No tuning is necessary at any freq. in the 6.875 to 7.125GC broadcast relay band. Microwave Associates, Inc., Northwest Industrial Park, Burlington, Mass.

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Lab Standards Bulletin

Bulletin S-28 describes a integrating digital voltmeter and a complete line of laboratory standards. It includes photographs, descriptions and basic ratings of 10 precision instrument models. Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark 14, N. J.

Circle 217 on Inquiry Card

Transfer Function Computer

This illustrated 2-color bulletin describes the Model SA-100 Transfer Function Computer and 4 accessory instruments. The TFC's features rapid, direct, electronic measurement of the transfer function of 4-terminal networks, components, and systems without need for plots tables or calculations. The Wayne Kerr Corp., 18-22 Frank St., Montclair, N. J.

Circle 218 on Inquiry Card

Metal Film Resistor

The DOT miniature metal film resistor is conformally coated. It is designed for in-board mounting within a pierced 1/16 in. PC board. The unit has weldable, offset, flat ribbon gold-kovar leads. The S15-1 metal films have resistance tolerances of ±2%, ±1% and ±0.5%. Resistance ranges are from 20Ω to 50KΩ. Power rated from 20mw @ 125°C amb. to 80mw @ 25°C amb. More data available from Angstrohm Precision Inc., 7341 Greenbush Ave., No. Hollywood, Calif.

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Insulation Testers

Data is available on a series of insulation test sets. It offers simple and reliable insulation breakdown results on components, cable, and equipment. Ten models are offered with voltage ranges between 0-3000 and 0-40,000, and with va ranging from 2.5 to 3,000. Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, Essex County, N. J.

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I-F Hybrids

Data is available on a line of I-F Hybrids. Models HCQ or HCH are available as 90° or 180° types at center freqs. of 30, 45, 60, 70, 90, 100, and 120MC Operation over a 26% bandwidth will yield isolation of greater than 30db at the band center, and 20db at the band edges. LEL, Inc., 75 Akron St., Copiague, L. I., N. Y.

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...... of unquestioned high quality

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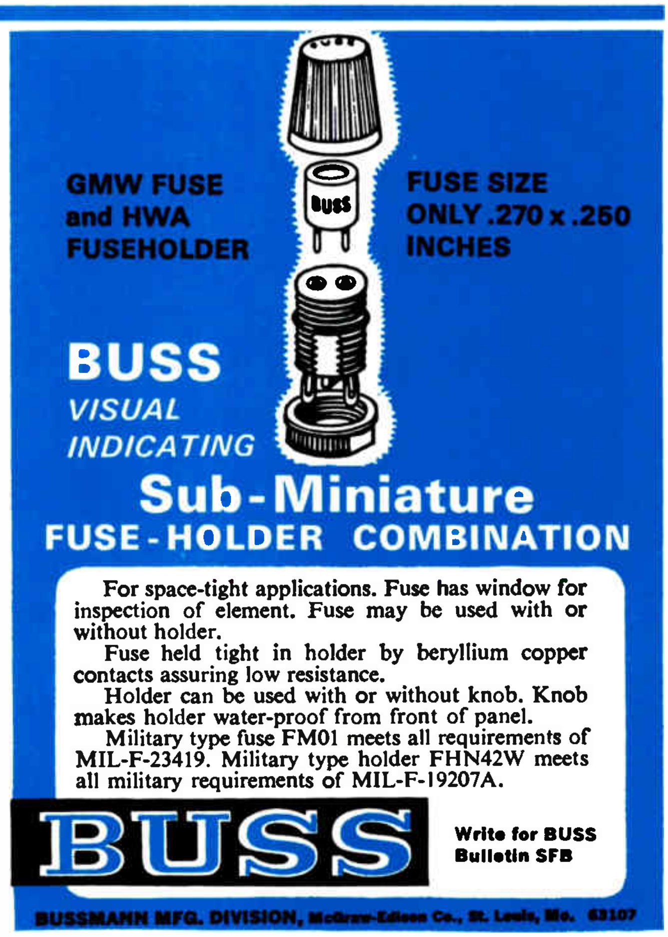

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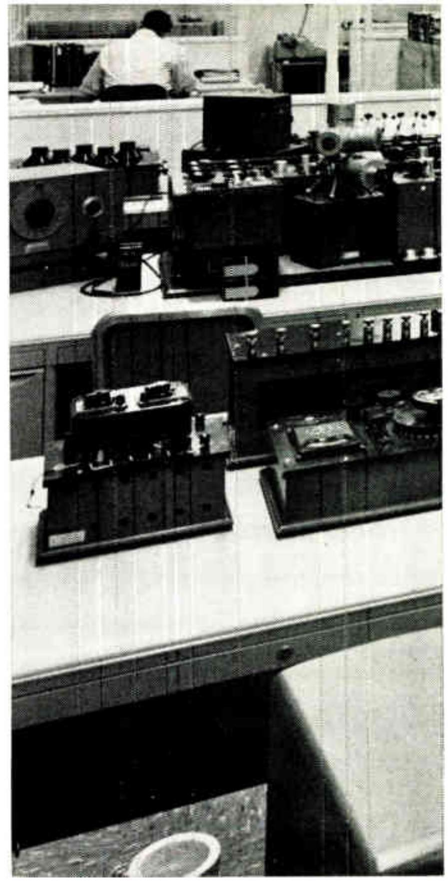
Making Meaningful Measurements

Part 1



How do you know that your measurement is accurate?
Can you place a quantitative value on measurement error?
How do you determine for certain
whether a device is within tolerance and acceptable,
or out of tolerance and a reject?

By S. SILVERMAN and C. SUNTAG

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
FEATURE

MODERN COMPLEX DEFENSE, guidance, control and communication systems are only as reliable as any of their components. Seldom does a single contractor design, develop, manufacture and test all phases. One key to the success of any such system rests in the interchangeability of countless parts; all built to a common specification. Thus, the tests and measurements of a given part must be consistent in each plant and from plant to plant. Interchangeability can only be accomplished when each contractor, prime or sub, including those responsible for the research and development efforts, makes tests and measurements from the same frame of reference. In the United States, this is the National Bureau of Standards (See Fig. 1).

Error Factors

Even with a standard frame of reference for measurements, what is delivered by one vendor may differ from that supplied by a second vendor, even though the part is tested to the same specifications. Why? Because of errors, ignorance, or misunderstanding. Those who can contribute to such errors include:

- the design engineer, who develops the data to be utilized in defining the parameters to be measured;
- the specification writer, who places quantitative values and limits on the drawings and specifications;
- the test engineer, who relates these values into instructions and procedures for their measurement;
- manufacturing personnel, who produce the equipment to the design specifications;
- inspection and test personnel, who measure the specified parameters; and
- the calibration facilities which provide test equipment checked against calibration standards that are traceable to the National Bureau of Standards.

Units of Measurement

To establish measurable relationships amongst various parameters, a Unit of Measurement must be defined and assigned. This is decided upon such that parameter interrelationships are simple and may be easily manipulated algebraically.

Such practical Units of Measurement as may be defined must relate to some natural physical substance which can be measured with a high degree of accuracy, and which would, in its physical state, retain this measurable value to a high degree of permanence. This physical quantity is known as a Standard and possesses values consistent with the defined unit.

Since it is necessary to have these standards available in the various echelons of the measurement

S. Silverman

C. Suntag

S. SILVERMAN, Manager, Standards Lab and Instruments

C. SUNTAG, Manager, Engineering Quality Assurance
ITT Federal Laboratories
Nutley, N. J.

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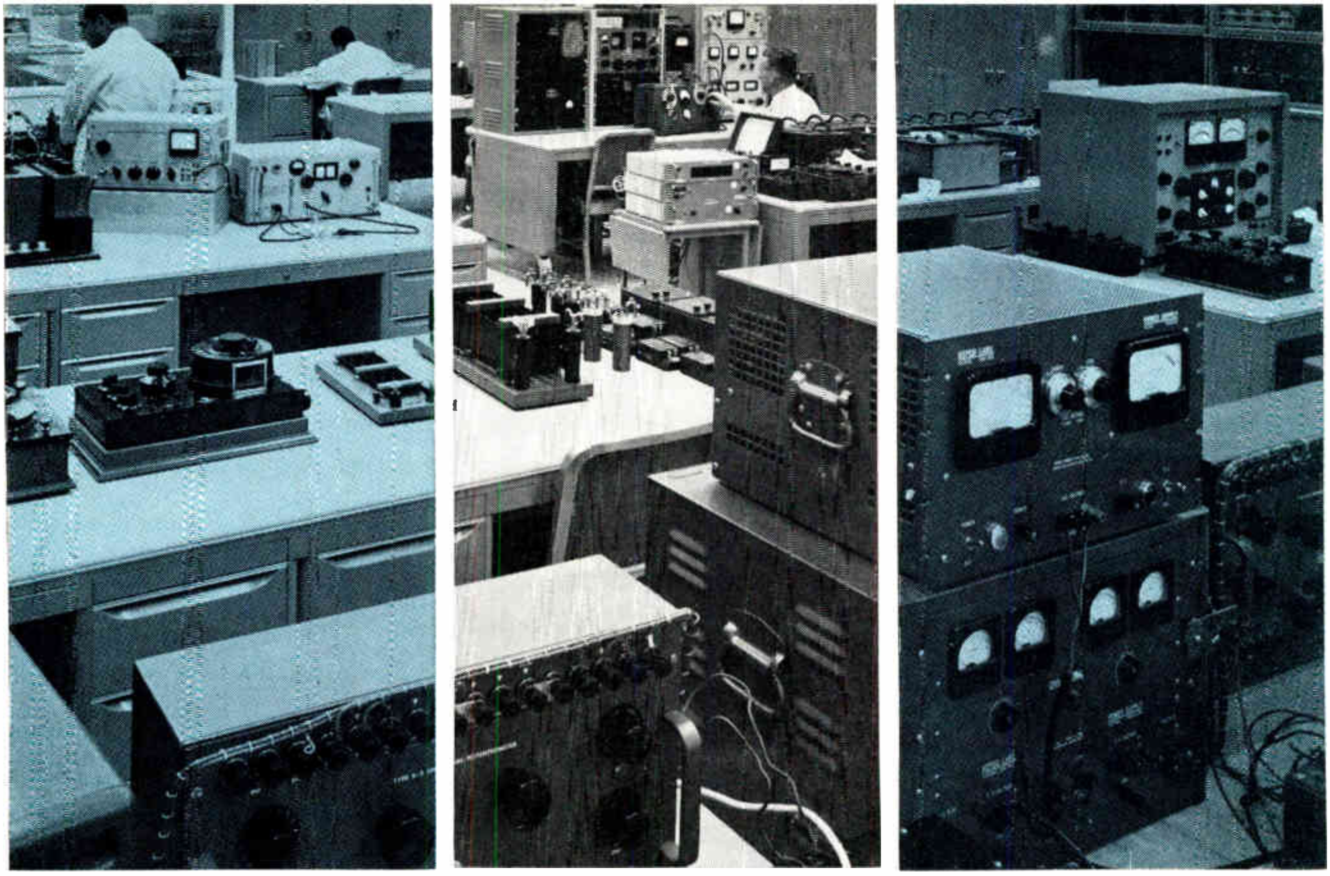

process, they are usually designed to be reproducible with a high degree of accuracy and are used to transfer measurements from the equipment under test to the National Bureau of Standards for comparison with the National Standards.

The selection and definition of the basic units of measurement were made at various periods of technological development. Consequently, they reflect the state of art existing at the time of selection. It is not surprising, therefore, to find that the values assigned to these units varied from time to time.

To properly establish the relationship amongst the assigned units, measurement systems were developed. Presently used is the *CGS system,* based on the three natural units—length (centimeters), mass (grams) and time (seconds); and (recently introduced) the *MKSA system* based on four units—length (meters), mass (kilograms), time (seconds) and electrical current (ampères).

The Measurement Process

The *measurement process* is essentially a comparison of the magnitude of a quantity under test with that of the applicable standard. Because the standard bears some known relationship to the absolute unit of the parameter being measured, the observed value can be related or stated in terms of the absolute or true value.

The difference between the observed value and the true value is known as the *error of measurement.* However, if the magnitude of this difference is known, it may be expressed, as noted, in terms of the true value, or in terms of the assigned value of the standard being used.

Traceability of Measurements

To insure that measurements taken by different people using different physical standards or transfer devices are comparable, it is necessary that all standards of each kind or quantity be related to a physical standard maintained in a central organization such as the National Bureau of Standards. International Standards have also been established to provide interchangeability with other countries, as well. The process of relating the various standards and measuring devices maintained in each plant to the National or International Standards is known as the *traceability of measurements.*

Measurement Error

The measurement error is generally made up of two components—the error of accuracy and the error of precision.

The *error of accuracy* is a measure of the displacement of the observed value from the true value. It is a fixed and constant error.

The *error of precision* is a measure of the closeness together of a series of measurements of the same quantity. It is a random error and establishes the degree of reproducibility of the measurement process.

These two errors result from inadequacies of

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equipment, personnel or techniques used during the performance of the measurements.

There are other sources of error, too, which may affect, to a considerable degree, the true determination of the quantity under evaluation: One such error results from the lack of recognition during the computational process of the principle of significant figures. For example, the number 105, with three significant figures, denotes that the value under consideration is closer to 105 than it is to 104 or 106. Yet, the number 105.0, which appears to be the same number, actually provides additional information. This number indicates that it is closer to 105.0 than it is to 104.9 or 105.1. It therefore denotes an accuracy to the fourth significant figure. A measurement should never be recorded to more significant figures than can definitely be established by the observer. In this regard, the observer must be able to read to one figure beyond the recorded value.

When combining a series of determinations of varying degrees of accuracy, one must be careful not to introduce errors of computation. For example: Consider the sum of the series 105.0 + 25.14 + 5.246. In adding these quantities, 105.0 determines the significant figures in the sum; 25.14 should be added as 25.1, and 5.246 as 5.2. The sum of these quantities is 135.3, not 135.386 or 135.4.

Defining An Uncertainty

One can define the limits of permissible error in connection with any measurement. One can also determine whether it is possible to perform the measurement readily within such limits. In the process, one may become aware of the factors contributing to overall error; and if practical, he can take steps to eliminate them. If not practical, he can establish a range of measured values over which the equipment under test will perform satisfactory to a specified confidence level. Thus, a measurement which can never represent the true absolute value can nevertheless be expressed as a magnitude within defined limits of uncertainty.

In manufacturing, measurements are generally made on a part to determine the closeness of a physical characteristic to a specified value. The permitted limits of uncertainty are defined and should be noted in the specification for the item being evaluated. This permissible variation is referred to as the *tolerance of the parameter.*

Acquiring Data

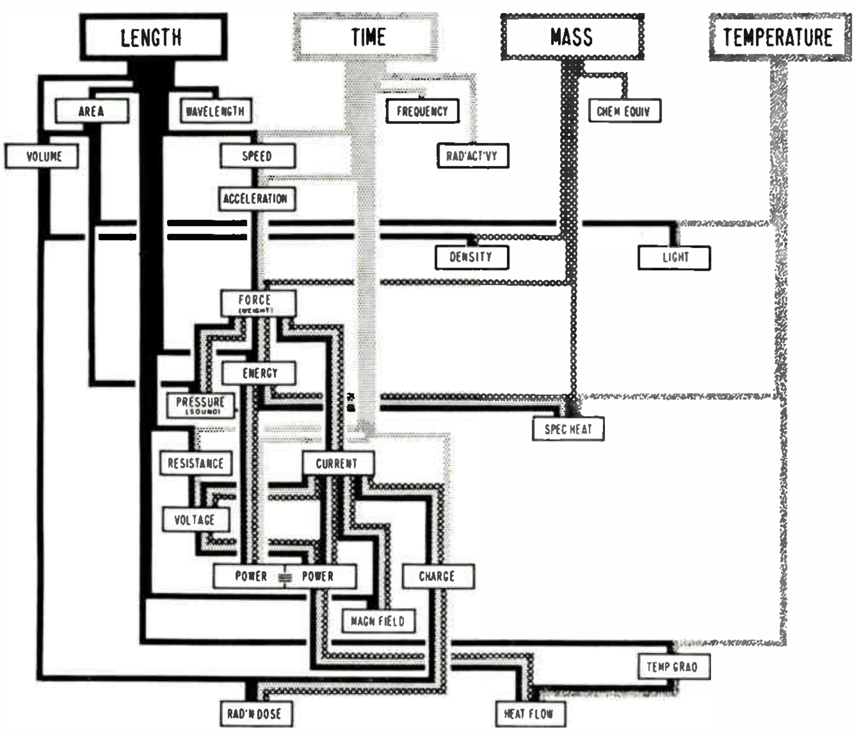
In developing a new product and in establishing the parameters which define it, the engineer usually has recourse to several methodologies:

- He may revise a previous design, using empirical data from prior experimentations or from available reference sources.
- He may generate new data to use in defining the required parameters.
- He may develop a new concept from purely theoretical considerations and calculate the required parameters.

In practice, most designers incorporate several or all of these methods. Each method contributes it's share of error to the measurement process.

When utilizing data from prior experimentation or from reference sources, the engineer must establish the quality and pertinence of these data to his current requirement.

Fig. 1: Genealogy of a measuring system—traceable to NBS.



Vendor's Data

To utilize data on a component obtained from a vendor's catalog, the engineer must ascertain whether the catalog values were obtained under the environmental or operational conditions pertinent to his requirement. In addition, the method of measurement used by the vendor in obtaining these data, the accuracy of his test equipment and standards, the adequacy of his measurement techniques, the number of determinations taken, and many other factors, may play an important part in the pertinence to his design of published data.

The electronic industry has taken a number of steps to con-

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CAPACITANCE

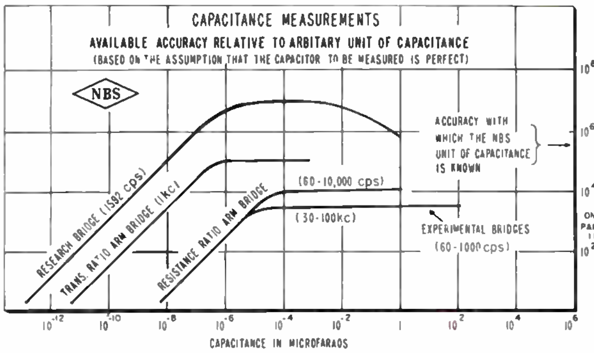
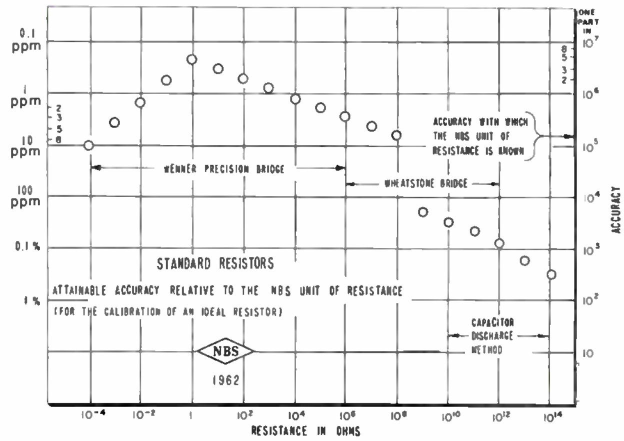


Fig. 2: Accuracies of measurement, based on NBS standards.

RESISTANCE



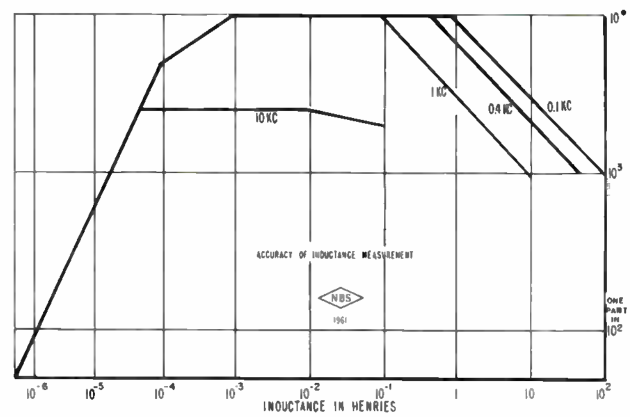
trol the validity of available data. As a result of the high degree of reliability required by many types of equipment used by the military, methods of data collection and the reporting of test results have been standardized. Various government-industry committees have prepared standards for component testing, for defining the parameters to be checked, the stress levels to be applied, the methods of test to be employed, the equipment to be used, the number of samples to be tested and finally the method of reporting the generated data. The results of these tests are accumulated in a variety of interorganizational reports which are constantly being revised and upgraded as new data are generated.

While a substantial amount of data is available in this form, care must be exercised in its use. It is necessary for the engineer wishing to utilize these data to acquaint himself with their extent and limitations and pertinence to his application. Since this is a highly specialized area, many companies have established a central standards group within their engineering areas specializing in component data collection, component evaluation and experimentation and development of company specifications for the procurement of components. This central group then acts as a source of information to the engineer in the utilization of reliable experimental data.

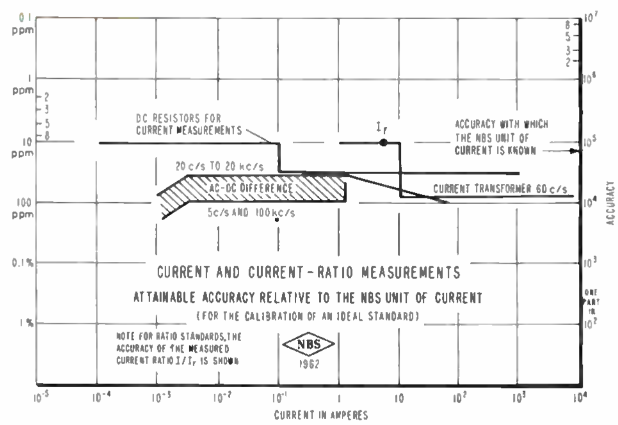
Fallacious Data

Equally important is the method by which the engineer develops his own experimental data. Frequently, he selects a component for his breadboard model with only an assumption of the actual value of the component parameters. On the basis of experimental results in his circuit, and on an assumption of the values of the component parameters on which his data are based, he may establish a fallacious relationship between the effect of the parameter of the component and the corresponding parameter of the design. Further, he will then specify this component for future procurement by referring to the catalog specifications for the component on his specification control drawings. *(Continued on following page)*

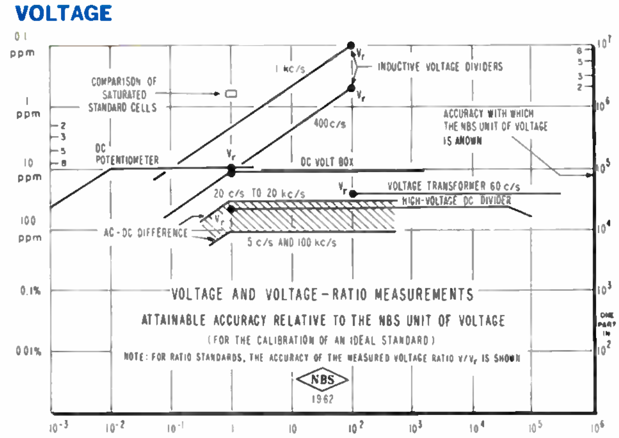
INDUCTANCE



CURRENT



VOLTAGE



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Taking Data

In making R & D measurements, data are typically taken by technicians utilizing a variety of measurement techniques, often not defined and frequently inconsistent with procedures utilized in the manufacturing operation. In a typical research and development operation, written procedures and test methods are rarely developed or utilized. Test methods are generally left to the discretion of the technician performing the measurement. Consequently, it is common to find data collected by different individuals to vary in techniques and test instruments used. Thus, consolidation of such data into a single specification results in a non-constant degree of accuracy in the specified requirements.

Another source of potential error here is in the degree of laxness generally existent in the implementation of a calibration program in an R & D area. Because measuring equipment is often utilized for purely qualitative determinations, a rigid implementation of a calibration schedule is frequently relaxed or deferred. Thus, when quantitative data are to be taken, there is a strong possibility that some equipment may be out of calibration, which results in inaccurate measurements.

Sufficient Sampling Needed

Owing to the cost of experimentation and the lack of time available to perform all desired tests, results are often based on too few observations. As a result, the degree of precision that can only be obtained by a number of repeated measurements of the same parameters is often inadequate. Hence, the results as reflected in the performance specifications are predicted on data which have an unknown degree of reliability.

Planning the Measurement Process

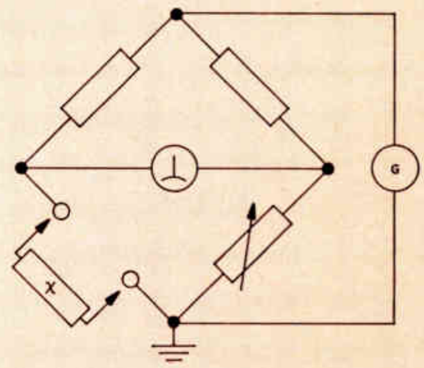
Because any of the above inadequacies may contribute not only to the inability of the manufacturing personnel to meet the specified requirements, or the equipment to perform its intended function, but also to the cost of the manufacturing and measurement program, it is important that the design engineer utilize a portion of his time in the planning of the measurement process within his area of operation.

Since very often the choice of the methods and procedures utilized in the R & D areas is dependent on the equipment available, the contribution of the inadequacy of the equipment and methods used must be considered in the plan. The plan should take into consideration the effect upon the measurement of any anticipated spurious effects of equipment, power and environment. A consideration should be given to all possible types of errors which could affect the accuracy of the results; and, techniques should be developed, when economically feasible, which will enable the balancing out of these inadequacies.

As a result of a planned operation, the engineer will find that there are many precautions which he can take to eliminate or minimize the effects of the errors noted.

An engineer should never utilize a component unless he is knowledgeable of the actual value of the applicable component parameters to the required degree of precision. This may be done by obtaining these values by direct measurement of the component. Another way is to insure that a stock of properly inspected components represents, where possible, random samples from the high and low tolerance range and production process of the supplier of the component.

FIG. 3: THREE METHODS OF CALIBRATION USED IN A STANDARDS LABORATORY



Define the Measurement Process

To minimize the errors which may be caused by the use of non-standard techniques of measurement, a precise definition of the measurement process should be established. The equipment to be used, the degree of accuracy required, the environmental conditions in which the measurements are to be taken and the manner in which the test results are to be recorded, all should be defined. This may be done through the establishment of an engineering practice which would apply to a large percentage of the standard measurements normally taken in any experiment. Specific instructions would therefore be required only for those special measurements not covered in the standard practice. The issuance of these instructions should be followed by a training program for all technicians and engineers who would be engaged in the taking of measurements. A surveillance should be made at periodic intervals to insure that the procedures and test methods are being followed.

Where such a program cannot be applied, provisions should be made to provide a meticulous entry

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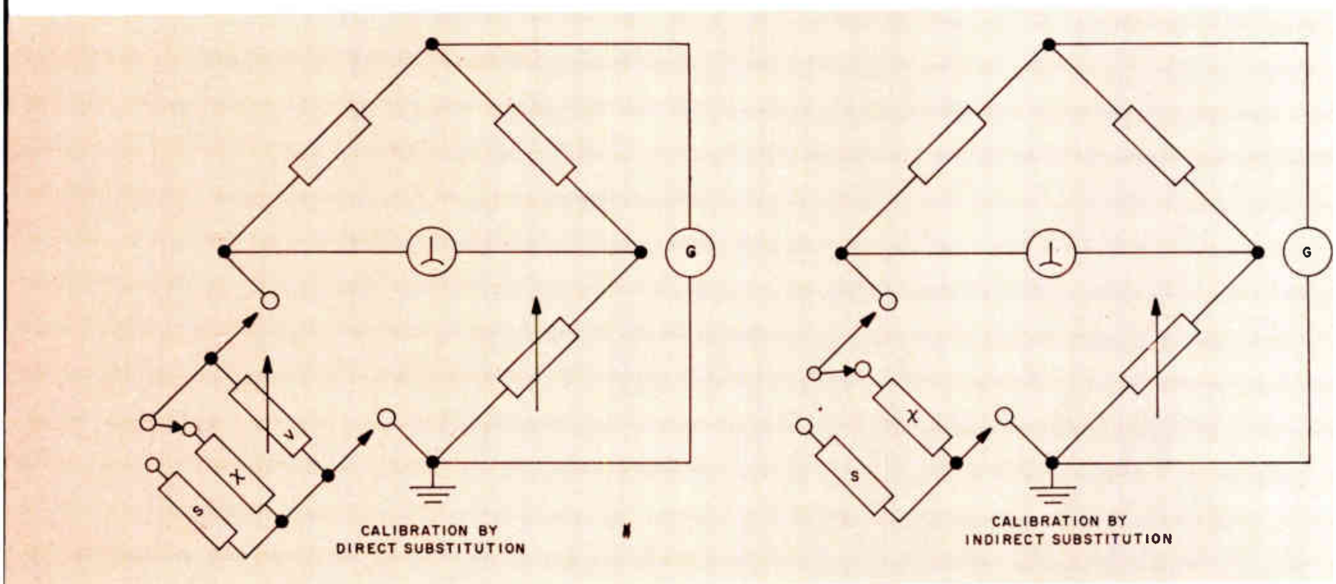
(by the engineer or technician in his notebook) for all data, test methods, equipment used, last calibration date, and environmental conditions under which data were taken. Also, the engineer should review these data for accuracy as well as to insure that any repeated experiments are performed in precisely the same manner. A greater degree of confidence can be had if the experiment is repeated on the same item by another technician using the same method.

Where time and cost considerations do not permit the performance of extensive observations, the limit of uncertainty resulting from the small number of determinations should be reflected in the final data. Through the use of statistical techniques, confidence limits may be calculated based on the number of sample elements. Where these limits are well within the functional requirements, it may not be necessary to perform any additional experiments. If, on the other hand, the error represents a significant effect on the desired results, consideration on the basis of the economy of the entire operation—engineering, manufacturing and functional performance of the equipment—may indicate the desirability for additional experiments. A partial solution to this problem, where time does not permit any extensive engineering effort in the R & D phase, is to follow the results of the equipment performance during the manufacturing process. In this way, the early production operations may be considered as an extension of the engineering development efforts and the data accumulated in the manufacturing area utilized in redefining the specification requirements.

Finally, through the use of more refined statistical techniques, a highly efficient method of planned experimentation may be developed. Through the use of such techniques as Statistical Designs of Experiments, Analysis of Variances, Random Balance, etc., an economical method can be developed for the performance of only those experiments which are necessary to provide a specified degree of confidence to the final results. The use of these techniques does not require the services of a highly trained specialist in mathematics or statistics. The literature cited in this article, as well as many other sources of information, should provide sufficient information for the average engineer to enable him to avail himself of these methods.



Defining the Test Method

In electronic testing, it is often necessary to define the method of test and the equipment utilized to insure compatibility of test results obtained by both supplier and customer. In such cases, it is customary for the specification to denote the parameters which must be evaluated and to require the vendor to submit a detailed test procedure, for approval, which defines his method of evaluating the required parameters. Thus, the buyer can evaluate the adequacy of the vendor's test methods and their compatibility with his own, while at the same time not requiring the supplier to use a specific method.

Another way to handle this problem is to establish industry-wide standards for manufacturing processes and test methods which reflect methods utilized by many organizations for many years. By referencing these standard processes and test methods (in the specification), and by permitting the supplier to define and submit for approval only those methods needed for the exceptional conditions, the desired effects may be reached with only a minimal of review and interference by the buyer.

Assigning Tolerances

In many organizations, various systems have been established for the application of tolerances. One such system is the establishment of standard "block" tolerances to relatively unimportant characteristics. Another method is the classification of characteristics by the degree of importance of the parameter to the function of the equipment. In this classification, the

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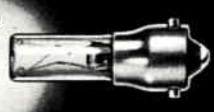
MINIATURE INCANDESCENT LAMP FOR 120 V OPERATION!



This T-2 (¼" dia.) lamp is mounted in a miniature bayonet base—one of the smallest, most reliable 120 V lamps ever offered. It will fit existing equipment permitting conversion to 120 V and the elimination of transformers without complete redesign of fixtures, packaging or spacing.

This is the first small but reliable 120 V incandescent lamp. Excellent resistance to shock and vibration with a rated life of 5000 hours enable it to out-perform larger 120 V lamps. The flat end permits increased end foot-candle output for brighter signals and the miniature bayonet base offers quick, easy installation.

New design economies—greater signal lamp efficiency are yours with this amazing new lamp.

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BY-BUK

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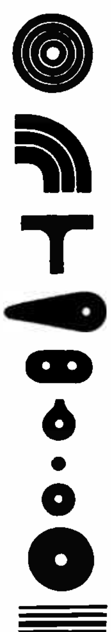
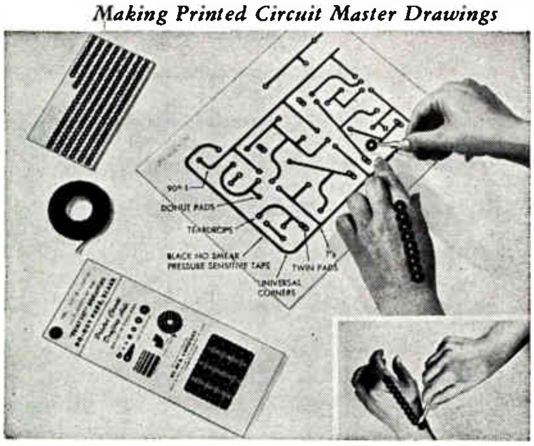
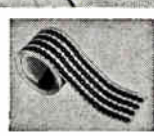
Time Saving Shapes and Narrow Tape for Making Printed Circuit Master Drawings







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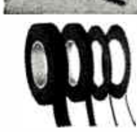

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shop would be permitted to deviate from the non-functional attributes and only require engineering approval in the functional area.

A more recent approach is to use statistical tolerancing. This is based on the concept of substituting an economical approach for the high cost of insuring that every part will mate with its corresponding part in the assembly. The economical approach merely insures that the probability of non-mating will be relatively low. Thus, rather than assign a tolerance to each part so that the sum of the tolerances of all the parts is equal to the tolerance of the final assembly, the tolerance of the mating parts is established on the basis of the root mean square of the sum of the tolerances of all the parts.

Care must be exercised in using this approach, since in small or medium sized lots the distribution may not be normal. Often a part is machined to one extreme of the tolerance to compensate for expected tool wear. In this case, the probability that a part in the assembly area would be at one extreme of the tolerance is high and thus offsets the probability of a normal distribution. However, when the specifications require that parts be manufactured under a state of statistical control with a normal distribution around the nominal value, the use of such an approach would be most advantageous.

In mechanical applications, various tolerance systems have been established and are currently in use. Such systems as the ABC, the ISA, the establishment of Classes of Fits, and several others have been utilized quite effectively for many years. Unfortunately, no such system exists in electronic manufacture. While past usage has established some basic tolerances for the common parameters of the more frequently utilized components, the assignment of specification limits is often based on a variety of methods or factors. Thus, an engineer may establish a tolerance value for an equipment parameter based on experimental results. He more frequently will establish his value on a good estimate of the interface requirements. When he must relate this overall requirement to the detailed requirements of the components which make up the equipment, he will generally utilize values which are of questionable accuracy. *(Continued on following page)*

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of "DESIGN GUIDE for ELECTRONIC-OPTICAL SYSTEMS"

4-page, 4-color wall chart of information for design engineers is available free-of-charge from

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Pitfalls in Specifying From Catalog Data

Many component values utilized in designs are taken from supplier's catalogs. It is, therefore, natural for the engineer to merely specify the component on his bill of materials or his electronic parts lists by the vendor's name and catalog number. While this may be adequate for defining the components already in use, it does not protect the buyer from any changes which the component supplier may make in the future. The supplier is generally under no obligation to request approval from the buyer for any change in his catalog item. Thus, to protect himself, the engineer should prepare a specification control drawing, in which he defines the parameters of the components. In this way, any change in the component must be coordinated with the buyer if it affects any parameter defined on the specification control drawing.

Tolerances vs. Data Uncertainty

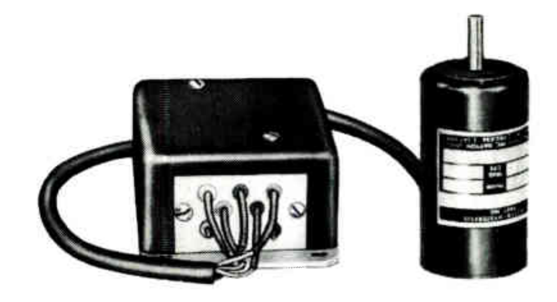
The tolerances assigned to a specified parameter should also reflect any degree of uncertainty in the data supplied by the design engineer. It is important that the degree of imprecision in the development process be transmitted to the specification. Thus, a tolerance limit will then include both the limits of uncertainty of the manufacturing process and those in design. *(Continued next month)*

MEASUREMENTS BY LASER

THE ABSOLUTE INTERFEROMETRIC LASER CALIBRATOR performs highly accurate linear length measurements in other than laboratory environments. The Calibrator, developed by Airborne Instruments Laboratory, a div. of Cutler-Hammer, Deer Park, N. Y., operates over a linear distance of 100 in., with an accuracy of 0.00003 in. or 0.00001 in./ft.

A gas laser operating at the visible wavelength of 6328 Å is used as the light source. The laser source, optics, and photo-detectors are rigidly connected together as a unit. This assembly is mounted to the frame of the machine that will be checked out. A reflector is mounted on the moving portion of this machine. The interference fringes generated by moving the reflector are detected by photosensitive devices and counted by a high-speed forward-backward digital counter. A small digital computing system converts the fringe count into inches, and automatically corrects for atmospheric pressure.

One application of the Calibrator is as an interferometric master which can be used for checking and calibrating linear distances. It has a very high accuracy over long ranges (which is difficult to achieve with any other instrument). It is, therefore, particularly useful for checking and calibrating inspection machines and numerically controlled precision machine tools.



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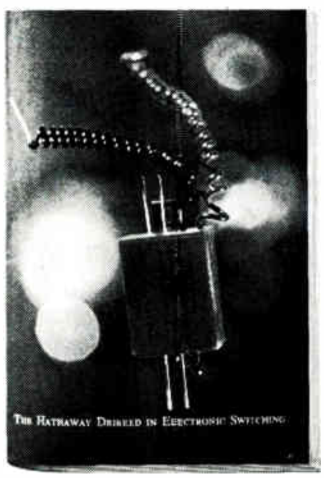

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World Radio History

Laboratory Accuracy in a Portable Dual-Trace Oscilloscope

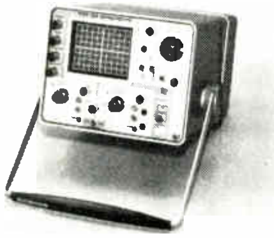


Fig. 1: Type 442 Dual-Trace Scope.

A portable oscilloscope with laboratory accuracy is the result of solid-state components, tight packaging, a new CRT, and several new circuit designs. The circuit designs themselves include several innovations.

THE TEKTRONIX TYPE 442 is classed as a laboratory oscilloscope, and was developed for field engineers and servicemen who service electronic office calculators and computers. The scope weighs 20 lbs. and can be fitted with self-contained rechargeable batteries or a dc or ac power supply.

The dual-trace is obtained by time sharing techniques. Sensitivity is 10mv/div. on channel 1 and 1mv/div. on channel 2 with ac coupling. Response is within 3 db from dc to 15MC. Care has been exercised to minimize drift, obtain high common-mode rejection, good trigger sensitivity, lightweight, and compact size.

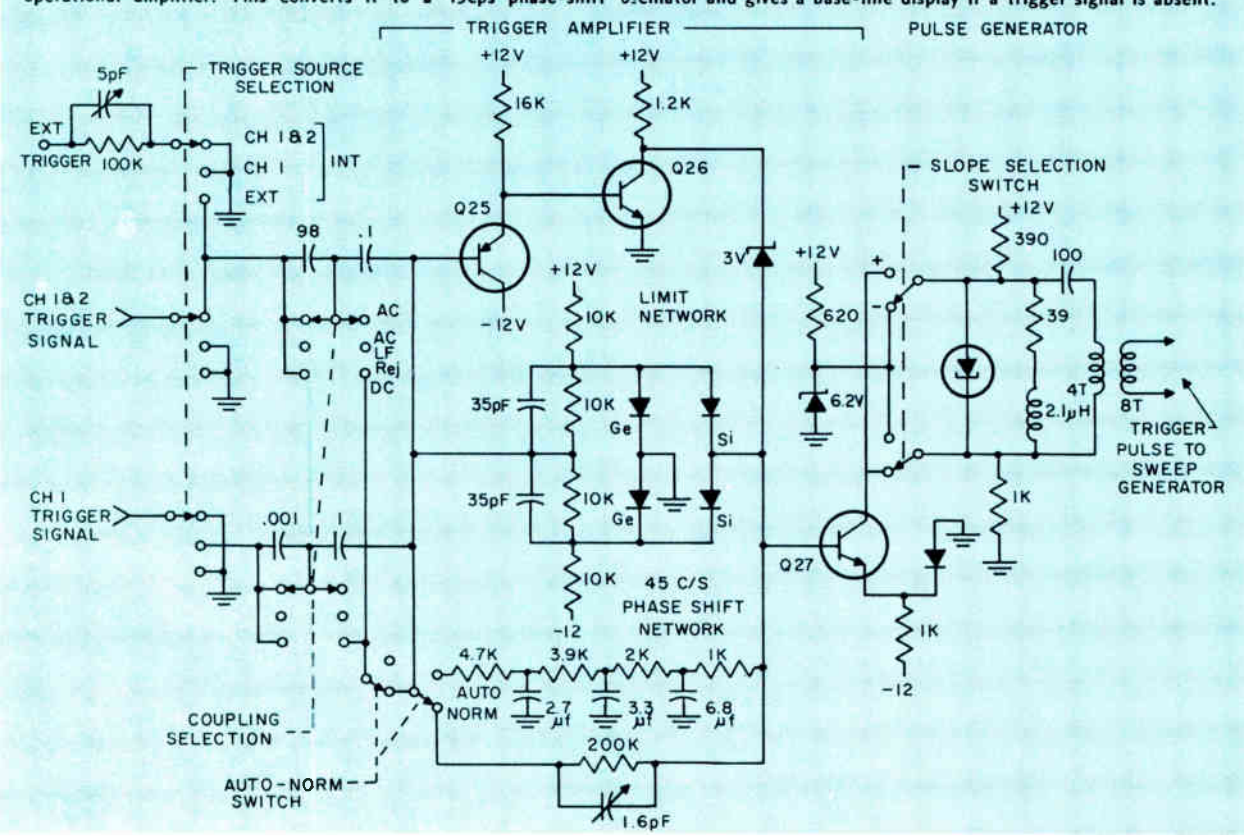
A new rectangular cathode-ray tube is used which has low heater power, short length, a 4.5 in. diagonal screen, and illuminated internal graticule.

Circuits of particular interest are the sweep trigger, sweep generator, and dc power-supply.

Sweep Trigger Circuit

The sweep trigger (Fig. 2) is an operational amplifier with non-linear feedback. A combination

Fig. 2: Sweep Trigger. For automatic trigger mode, a 3-stage RC phase-shift network provides a feedback path around the operational amplifier. This converts it to a 45cps phase-shift oscillator and gives a base-line display if a trigger signal is absent.



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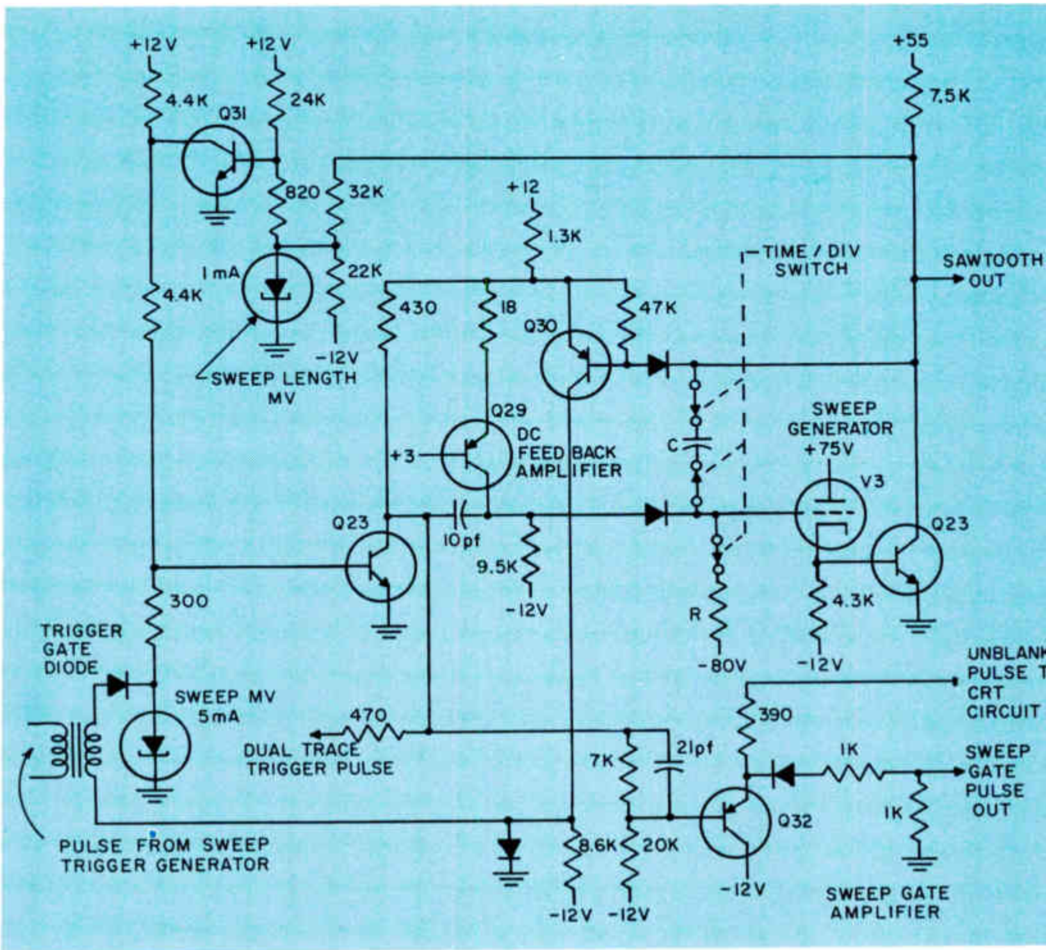


Fig. 3: Sweep Generator is a Miller run-up integrator with dc feedback between sweeps.

Si-Ge diode circuit in the feedback path limits the output swing to approx. ±0.5v., and is established by the difference in forward drop of Ge and Si diodes. The circuit also protects the input transistor from large input transients. The gain is roughly unity before limiting, and 1/10th beyond. For automatic trigger mode, a three-stage RC phase-shift network provides a feedback path around the operational amplifier. This converts it to a 45 CPS phase-shift oscillator and produces a base-line display in the absence of a trigger signal. When a 0.4v. trigger signal occurs, the 45 CPS oscillation ceases. A standardized sweep-trigger pulse is generated by a tunnel diode driven through a grounded emitter stage (Q27) from the operational amplifier. The trigger tunnel-diode pulse switches the sweep tunnel diode through a coupling transformer and a pulse gating diode.

During the rise and return of the sawtooth pulse, the trigger-pulse gating diode is reverse biased and prevents any trigger pulses from interfering with the sawtooth pulse generator (Fig. 3). After the return of a sawtooth pulse to normal, the gating diode is zero biased, permitting a trigger pulse to change the sweep tunnel diode to its high state.

Sweep Generator Circuit

The sweep generator (Fig. 3) is basically a Miller run-up integrator with dc feedback in the interval between sweeps. The dc feedback amplifier (Q29, Q30) is turned off when the sweep tunnel diode fires, allowing the sawtooth pulse to rise. As the sawtooth reaches peak amplitude, the sweep-length tunnel diode fires, causing Q31 to shunt the bias current to the sweep tunnel diode. It switches to the low state, causing the sawtooth generator to return toward normal state. As normal state is approached, the dc amplifier operates and the normal level is held by the direct coupled loop. Bias for the trigger gating diode is established by the state of this dc amplifier. The trigger gate diode is zero biased only if the dc amplifier is operating. This occurs when the sweep is held at the normal level.

Battery Power Supply

The battery operated supply (Fig. 4) is somewhat unconventional in that a highly efficient duty cycle regulator and dc-dc converter are combined. The power transformer is also the energy storage inductor.

Here's how it works. First one transistor (Q33) switches on, putting nearly the full supply voltage across half the primary. The current increases at a uniform rate until the transistor switches off. Then the voltage on all windings rises rapidly to the regulation level where the output rectifiers will conduct. The energy stored while Q33 was on is now transferred to the filter capacitors and the load as the

World Radio History

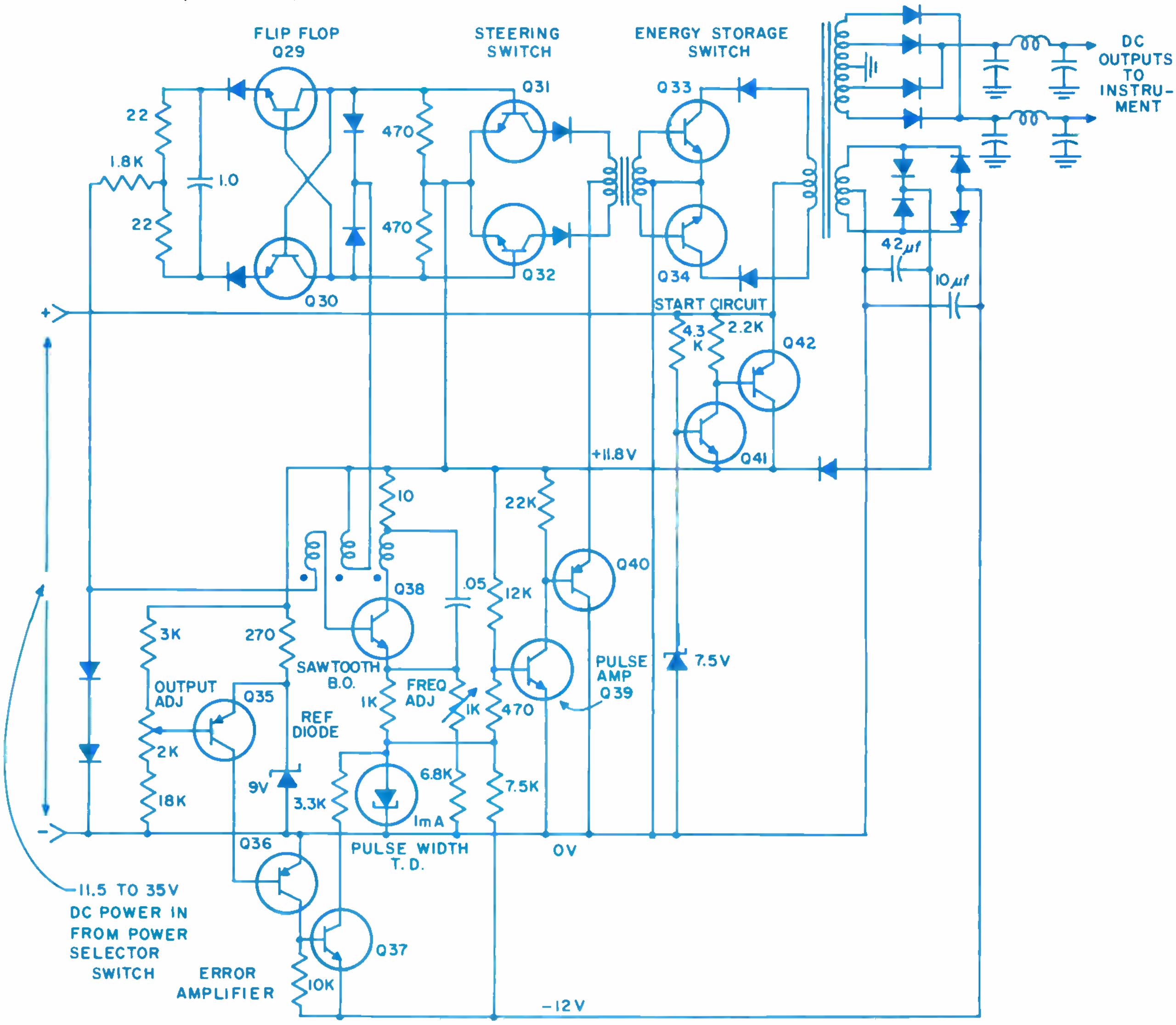
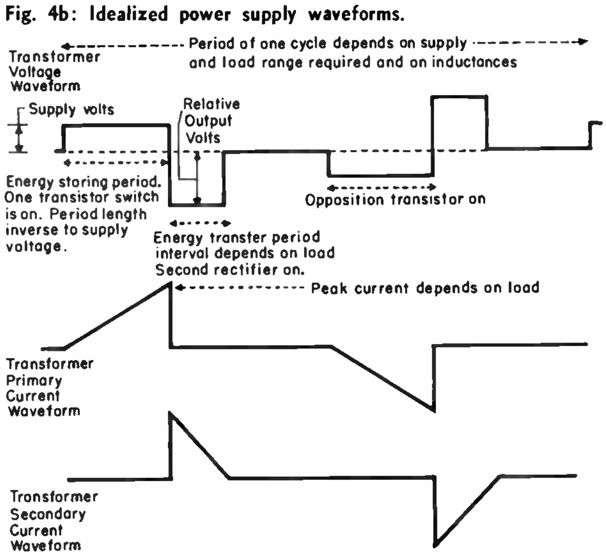


Fig. 4a: In battery supply, a duty cycle regulator and dc-dc converter are combined.

secondary current falls uniformly to zero. As the current reaches zero, the voltage should fall to zero. This does not happen because the inductance rings a cycle or so with the stray capacitance. After a brief interval, transistor Q34 switches on and the same series of events occur except in the opposite direction.

Fig. 4b: Idealized power supply waveforms.



Thus there is no net dc component in the transformer. As the supply voltage varies, the on period of the switches varies inversely and delivers constant energy impulses to the filter capacitors.

The control circuits are normally powered by the regulator. But for start up, control-circuit current is drawn through series regulator Q42. Once the duty-cycle regulator starts, Q42 is disconnected. Since the control and switch circuits are floated with respect to instrument ground, either input power terminal may be grounded. In the control circuit a free-running 8KC blocking oscillator (Q38) periodically turns on the 1ma tunnel diode, and simultaneously shifts the state of flip-flop Q29 and Q30. After the blocking oscillator (BO) fires, the tunnel diode remains on for a period determined by the combination of currents from the BO timing capacitor (decreasing uniformly) and from error amplifier Q35, Q36, Q37. If the secondary voltage is low, the diode stays on longer. The diode pulse is then amplified by Q39 and Q40 and fed through the coupling transformer. It operates one or the other of the main switching transistors as determined by the state of the flip-flop.

World Radio History

EDITOR'S NOTEBOOK

ELECTRONIC INSTRUMENT, built by Varian Associates for earth magnetic field research in the U.S. space program, is helping archeologists map a 2,500-year-old Greek settlement in Italy. The device, a rubidium magnetometer, is more than 100 times more sensistive than any other instrument used in archeology. The settlement is believed to be half-legendary Sybaris. The instrument clearly defines outlines of ruins 15 feet below the water table near the Ionian Sea.

S-BAND CIRCULATOR developed by Raytheon Company has been delivered by jet aircraft and helicopter to a new weather radar atop Japan's two-mile high Mt. Fuji. The 5-kw circulator provides a threefold safety margin for the radar whose 500-mile range covers 90% of the nation. System is fully controlled by microwave link from Tokyo, 60 miles away. Up on Fuji, winds top 200mph and temperatures drop to minus 32°F.

EXPERIMENTAL PROGRAM to study how computers can meet student learning needs—kindergarten through post graduate—has been launched by Florida State University, the State of Florida, and IBM. Using a keyboard terminal link with IBM labs in Yorktown Heights, N. Y., FSU's experiment uses programmed instruction in sequences, with answers supplied where needed, in conjunction with texts.

RECORDED SOUND Encyclopedia is an ambitious project now underway by the National Association of Broadcasters. According to NAB, this "sound barrier" consists of an utter lack of knowledge of the wherabouts of millions of sounds recorded on film. cylinders, discs, wire and tape during the past 40 years or so. NAB is now circularizing archivists, collectors and others for data.

ELECTRONIC RECOGNITION will enable the Duluth, Missabe and Iron Range Railway Co. to identify and sort its 9,500 pieces of rolling stock at high speed. The system, supplied by Sylvania Electric Products, Inc., uses an unmanned trackside scanner to pick up reflected light from special "labels" on each car. Data is fed to a central point. System can read the ore car labels at 100mph in blinding rain and snowstorms, day or night.

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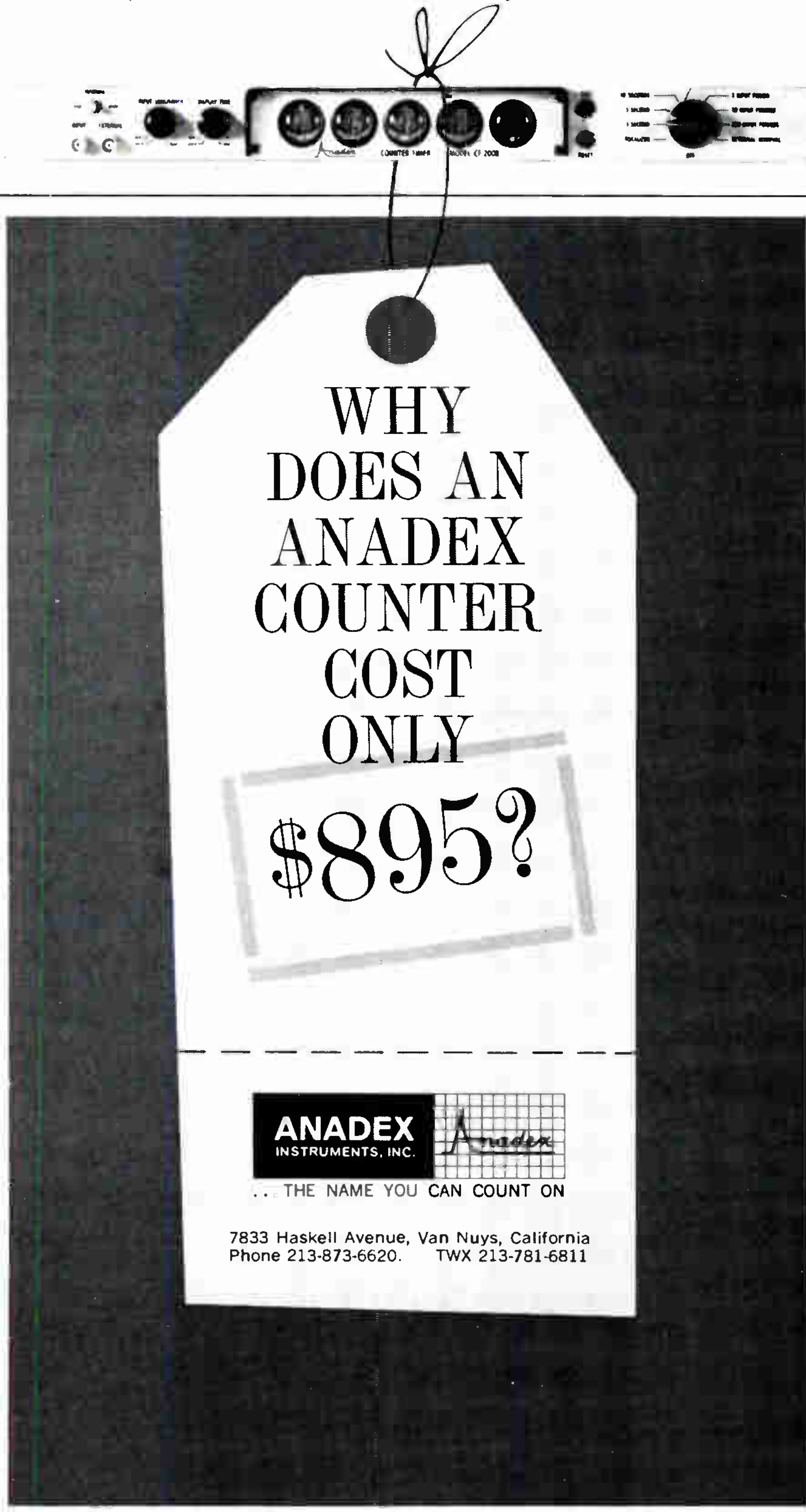

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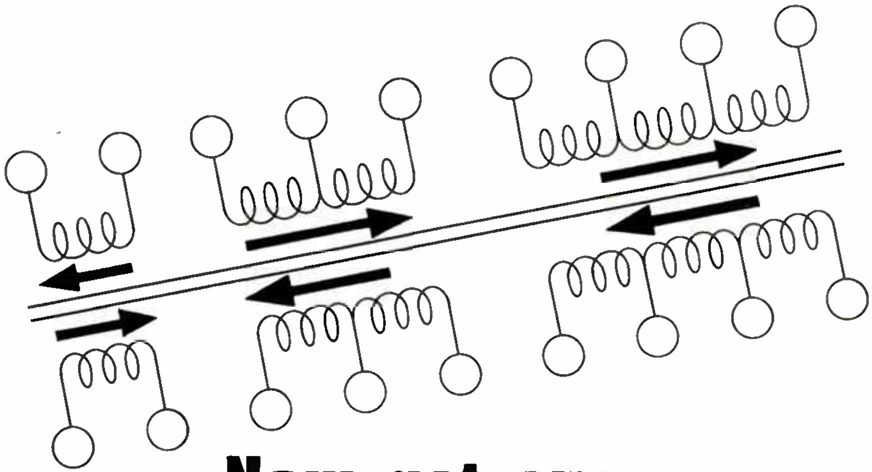

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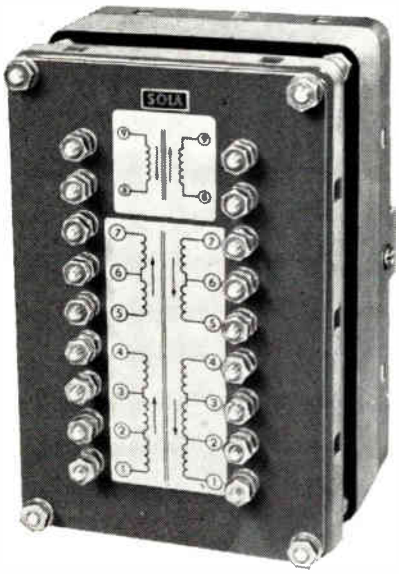

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INTERNATIONAL NEWS

London—The first magnetic tape computer system ever made in Scotland has been delivered to Management Computing Services Ltd., London. The system, a Honeywell 400, was made at the Newhouse, Lanarkshire plant of Honeywell Controls Ltd.

Paris—Compagnie Generale de Telegraphie Sans Fil (CSF) and General Dynamics Corp. have joined forces in France; CSF holds majority interest. The new firm, called Societe D'Equipements Spatiaux et Astronautiques, will design and make satellite tracking gear.

Rome—Sigma Schede s.p.a., leading data processing agents in Italy, and agents for COMPUTRON, INC., Waltham, Mass., held a two-day meeting in Rome for representatives of 118 user firms.

Stuttgart—The 1965 Radio-Products Fair, an exhibit of the electronic achievements of the German radio industry, has been scheduled for Stuttgart's Killesberg August 27 to September 5, 1965.

Hamburg—Radar detectors and a traffic analyzer control made by Telefunken A.G. are being tested at a busy Hamburg intersection to speed traffic and eliminate congestion; lights remain green where traffic is heaviest.

Amsterdam—Data Products Corp. has opened a European sales and service office in The Netherlands, in the international area of the Amsterdam Schiphol Airport.

Tokyo—Mitsubishi, Ltd. has ordered more than $500,000 worth of DISC-fILES® from Data Products Corp., Culver City, Calif.

Tokyo—Nippon Petrochemicals Company and The Bunker-Ramo Corp. announced that the Bunker-Ramo 330 control computer system at NPCC's Chidori ethylene plant in Kawasaki has shown considerable savings, and that all requirements have been met.

Sidney—Qantas, one of Australia's largest airlines, is fitting the latest Marconi doppler navigator, type AD-560, in its fleet of aircraft, for its new route to London via Fiji, Tahiti, Mexico City and Bermuda.

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Solid-State Circuits Conference to Feature Integrated Circuits

Over 80 scientists, engineers, and educators will present papers at this year's ISSCC. The program will be held at both the University of Penna. and the Sheraton Hotel from February 17-19.

THIS LOOKS LIKE THE YEAR FOR INGRATED CIRCUITS. Thus, the editors will be surprised if this isn't the most significant technical conference of the year. According to General Chairman, James B. Angell, every effort is being made to present only state-of-the-art material and forecasts of things to come. It surely looks as though anyone in our industry who isn't "with it" in the area of integrated circuits will be truly obsolete almost immediately! The field is moving so fast that even the exponential growth of transistor technology looks tame by comparison.

Unfortunately, only a digest of the technical papers will be available at the time of the Conference. Some of the papers may never be published in their entirety, although the best undoubtedly will; but, when is the question.

One of the truly hot subjects to be thrashed out is the one of hybrid circuits vs silicon monolithic circuits. Proponents of each will staff a panel on the subject on Wednesday afternoon, Feb. 17. Included on the panel will be E. M. Davis, Manager of Component Development at IBM, Poughkeepsie; E. A. Sack, Manager of Engineering for The Microelectronic Division at Westinghouse, Baltimore; J. M. Goldey, Head of Silicon Development at Bell Telephone Labs., Murray Hill; E. A. Thomas of General Instrument Corp.; J. S. Kilby of Texas Instruments; J. T. Last of Amelco; and G. C. Moore of Fairchild. There seems little doubt that most everyone agrees that the monolithic circuit is the way things will be done in the long term future; yet, there is much disagreement on the near future.

Informal discussion sessions on Wednesday and Thursday evenings should be very worth attending, also. Knotty subjects are to be argued like linear integrated circuits, the impact on training of engineers and scientists by the evolution of integrated circuit technology, progress in thin film active elements, circuit analysis problems, and the merits of various forms of Integrated Circuits.

General Chairman James B. Angell is a Professor of Electrical Engineering and Director of the Solid-State Electronics Laboratories at Stanford University.

Program Chairman Gerald B. Herzog is Head of Solid-State Computer Devices Group, RCA Laboratories, Princeton, N. J.

Those who will discuss special problems of linear integrated circuits include G. J. Herskowitz of Bell Telephone Labs., W. E. Newell of Westinghouse Research Labs., G. Danielson from the Electronics Laboratory of General Electric Co., L. Housey of Texas Instruments, R. R. Wyndrum, Jr., of Bell Telephone Labs., and M. Kahn of Sprague Electric Co.

What will happen to engineers as a result of the impact of integrated circuits will be discussed by R. L. Pritchard of Stanford Electronics Laboratories, Stanford U., R. R. Webster of Texas Instruments, S. K. Ghandhi of RPI, D. Pederson of the University of California, and T. R. Finch of Bell Telephone Labs.

Merits of the various forms of integrated circuits will be considered by a panel composed of A. Shostak and R. Wilcox of the Office of Naval Research, J. J. Suran of General Electric, S. S. Vigliane and D. Joseph of Douglas Aircraft Co., and W. Gorke of

(Continued on following page)

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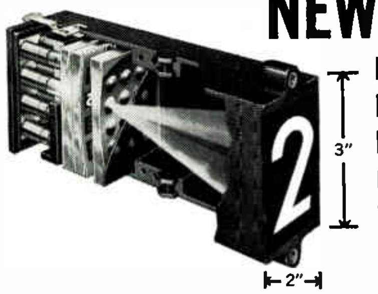

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SOLID-STATE CIRCUITS CONFERENCE (Continued)

the Institut fur Nachrichten-verarbeitung, Karlsruhe, Germany.

Microwave transistor circuits will be discussed by R. S. Englebrecht and A. E. Bakanowski of Bell Labs, F. A. Brand of the U. S. Army Signal R/D Lab., M. J. O. Strutt of the Federal Institute of Technology, Zurich, Switzerland, R. R. Webster of Texas Instruments, and M. Caulton of RCA Laboratories.

Current work in micropower circuit technology (1-10μw) is the subject of a discussion moderated by J. D. Meindl of the Semiconductor/Microelectronics Branch of the U. S. Army Electronics Labs. Others on the panel are R. H. Baker, MIT Center for Space Research, W. F. Sarles of MIT Lincoln Lab., R. Seeds of Fairchild Semiconductor, H. C. Lin, Molecular Electronics Div., Westinghouse, R. D. Lohman, Electronic Components and Devices Div. of RCA, and N. Miller of Motorola Semiconductor Products.

Discussing the problems of thin film active devices for microcircuits will be G. Abraham of the U. S. Naval Research Laboratory, G. B. Herzog of RCA Labs, R. W. Downing of Autonetics, J. P. Spratt of Philco Scientific Lab., T. Longo of Transitron, G. Diemer of Philips Research Labs., Eindhoven, H. L. Wilson of Melpar, and J. Lindmayer of Sprague Electric.

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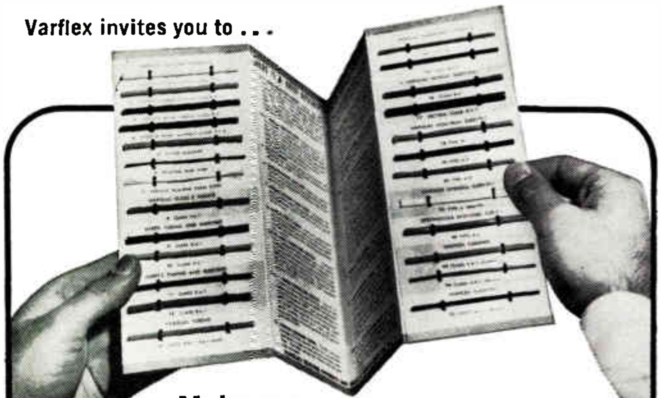

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Recent developments in techniques and circuits for generation of high frequency and microwave power using transistors, varactors and other solid state devices will be critically examined with emphasis on varactor multipliers by a panel consisting of R. P. Rafuse of MIT Research Lab of Electronics, T. M. Hyltin of Texas Instruments, E. H. Speinbrecher of MIT, E. M. Snider of MIT Lincoln Lab., D. B. Leeson of Hughes Aircraft Co., and H. W. Andrews of Bell Telephone Labs.

A panel discussion most pertinent to those working on problems of practical integrated circuit hardware is entitled, "Specifying Digital Integrated Circuits." Moderated by P. G. Thomas of Sperry Rand, other panel members are G. Luecke of Texas Instruments, J. A. Narud of Motorola Semiconductor, H. Bloom of Fairchild Semiconductor, J. Fort of National Cash Register, J. Payton of Litton Industries, and E. J. Rymaszewski of IBM.

• **A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department.**

The program will consist of 48 papers and thirteen evening sessions. Meeting will be held at both the University of Pennsylvania and the Sheraton Hotel. The following is a list of the papers that will be presented:

Technical Papers Program

SESSION	PAPER
I (Integrated Digital Circuits) Irvine Auditorium February 17	• Non-Saturating Monolithic Logic Circuits with Improved Stability. • An Integrated Decade Counter and Binary to Decimal Decoder. • High Speed DTL Logic. • Nanosecond Monolithic TTL Gate. • An Integrated Gated Differential Amplifier for High-Speed Variable Store Digi Detectors.
II (Microwave Circuits I) University Museum February 17	• Balanced Transistor Amplifiers for Precise Wideband Microwave Applications. • A Tantalum Film Gc Amplifier. • Lower Limit of Preamp Noise due to Pump Heating. • A Microwave Tunnel-Diode Amplifier in Stripline. • Resonator Tuning Using Semiconductor Diodes.
III Irvine Auditorium February 17	Keynote Panel Discussion: Hybrid vs. Silicon Monolithic Integrated Circuits.
IV (Digital Circuits and Devices I) Irvine Auditorium February 18	• Systematic Modeling of Solid-State Devices and Integrated Circuits. • A New Charge Control Equivalent Circuit for Diodes and Transistors and its Relation to Other Large Signal Models. • Variable Threshold Logic Family. • Snap Diode Applications: Some Versatile Fast Pulse Generators.
V (New Device Techniques) University Museum February 18	• CW Microwave Oscillations in GaAs. • Isolators Using Semiconductors. • GaAs Laser Inverter. • Frequency Modulation of GaAs Diode Laser. • Avalanche Multiplication in InAs Photodiodes.
VI (Radiative Interconnections) Irvine Auditorium February 18	• The Photon's Impact on Computing Processes. • An Optically-Coupled Digital Integrated Circuit. • Radiative Interconnections of Solid-State Circuit Arrays. • A New Semiconductor Light-Actuated Chopper. • Avalanche Luminescence in Silicon and its Utilization in a Monolithic Light Source Array.
VII (Special Circuit Considerations) University Museum February 18	• Analog Circuit for Determining the Ratio and Product of Two Time Functions. • Thermal Feedback and 1/f-Flicker Noise in Semiconductor Devices. • Circuit Control of Microplasma Switching in Avalanche Diodes. • A Low-Power High-Efficiency DC to DC Converter. • Response of Linear Complementary Symmetry Amplifiers to Pulsed X-Radiation.
VIII (Digital Circuits and Devices II) Irvine Auditorium February 19	• The MOS Transistor. • MOS Micropower Complementary Transistor Logic. • The Use of Insulated Gate Field Effect Transistors in Digital Storage Systems. • A 110-Megabit Gray Code to Binary Code Serial Translator. • A Ferroelectric Transcharger-Controlled Electroluminescent Matrix Display.
IX (High-Frequency Amplifiers) University Museum February 19	• Tuned Noise Figures of Transistors at High Frequency in Grounded-Base and Grounded-Emitter Configuration. • A Transistor Amplifier with 500 MC Bandwidth. • Tunable Resonant Circuits Suitable for Integration. • An Evaluation of the Dielectric Isolation Technique for Linear Circuits. • A Wide-Band AGC Block Suitable for Integrated Realization.
X (Microwave Circuits II) Irvine Auditorium February 19	• Design of the Hot Carrier Mixer and Detector. • Aluminum Alloy Junction Backward Diodes in Microwave Detection Systems. • The Transient Microwave Impedance of PIN Diodes. • Solid-State 1-Watt FM Source at 6 Gc. • Design and Evaluation of a Microwave Tripler.
XI (Low Level Amplification) University Museum February 19	• A Method of Enhancing Gain Stability and Linearity of Transistor Amplifier Systems. • Gain-Compensated Logarithmic Amplifier. • An Integrated Buffer Amplifier. • A Low Noise Integrated Amplifier with Novel Biasing Scheme and Structure.

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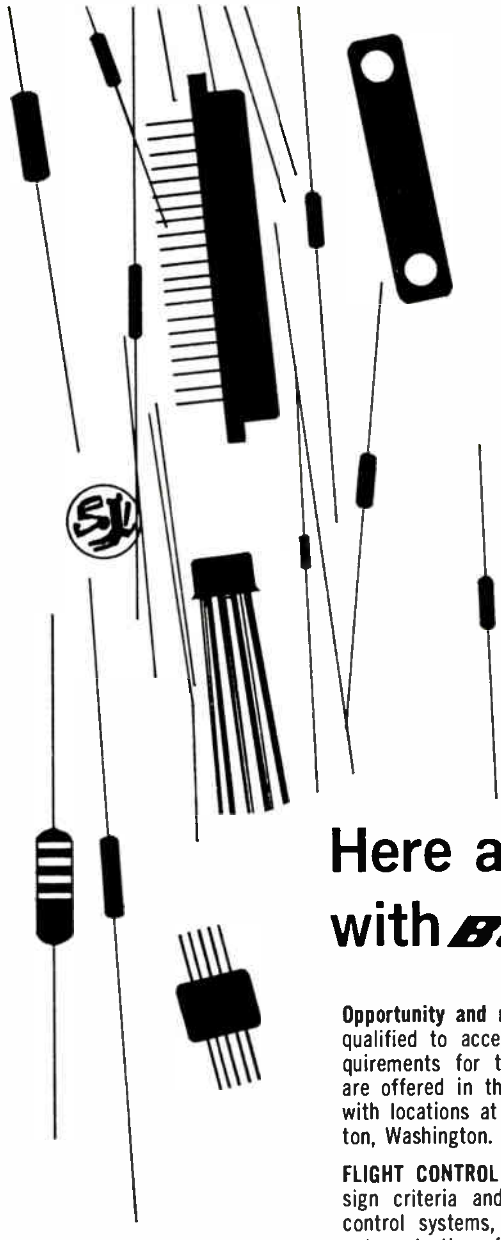

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ENVIRONMENTAL CONTROL — Heat transfer analysis with application to air cycle conditioning of jet aircraft. Emphasis upon avionic equipment conditioning to develop new environmental conditioning concepts.

ANTENNA SYSTEMS — Design, performance evaluation, and analysis of radome, antenna, and RF transmission systems. Experience in antenna, radome, or wave propagation.

NAVIGATION AND GUIDANCE SYSTEMS — Analysis of electromechanical systems and derivation of system transfer functions to quantitatively predict system performance. Experience in feedback control systems.

RADAR TECHNOLOGY — Perform analytical studies of airborne reconnaissance sensors, data processing, and digital transmission techniques as pertain to beyond-line-of-sight transmission of high density information.

WEAPONS DELIVERY SYSTEMS — Analysis of weapons delivery problems and solution techniques. Establish requirements of systems, select equipment by trade-off studies and system analysis, and present results for proposed new weapon delivery system.

ELECTRICAL SYSTEMS — Design and load analysis of aircraft electrical power generation systems. Experience in power factor and load balancing parameters.

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Reporting late developments affecting the employment picture in the Electronic Industries

ENGINEER, R&D EXECUTIVES MORE MOBILE THAN EVER

Engineering and R&D executives today are more mobile than ever before. Moreover, those who change companies, rather than stay put, tend to earn higher incomes.

These are key findings from a nationwide job mobility survey by Kiernan & Company, Inc., an international executive recruiting firm. Hundreds of executives in a cross-section of large and small firms were questioned. Results show a significant increase in number of executives who move around.

R&D executives in particular are highly mobile, the survey reveals. More than 50% of the R&D men queried moved to their present jobs from other companies. The same figure is cited for marketing executives, reputed to be among the most mobile in industry. The engineering group ranks just below the R&D group in job mobility.

Most executives in the study feel that they contribute their greatest value by staying put, but that the way to earn big salaries these days is to change jobs.

ENGINEER WAGES RISE 2.9%, REPORTS LABOR SURVEY

Engineering salaries in private industry rose 2.9% between March 1963 and the same period in 1964, according to a survey by the U. S. Bureau of Labor Statistics.

Conducted annually to determine federal salary policy, the survey reveals that engineering rates have increased by 10.2% since the spring of 1961. The survey is conducted to show median salaries for eight levels of professional engineering responsibility and qualification. It also covers chemists, technicians, draftsmen, and many other fields.

The full survey, entitled "National Survey of Professional Administrative, Technical, and Clerical Pay, February-March 1964," is available for 40¢ from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

TEACHING METHOD

Dr. Herbert Trotter, Chairman of General Telephone & Electronics Inc. demonstrates prototype of blackboard-by-wire system that allows teacher in one location to communicate with students miles away. Dr. Trotter suggests system as part answer to modern education problems. Combined system including TV, telephone lectures, and blackboard-by-wire may alter present teaching methods.

NEW SENATE BILL MAY HELP EASE DEFENSE CUT EFFECTS

The Senate has taken action on the National Economic Conversion Act, a bill aimed at easing the impact of defense contract cancellations on firms and employes.

Under the plan, a National Economic Conversion Commission (cabinet members and federal agency heads) would study government action and policy plus their effects on national manpower and industry.

The bill would require each defense contract or grant to include provisions requiring contractors to set up internal industrial conversion committees. Such groups would be charged with planning for conversion to civilian (industrial and consumer products) work arising from curtailing or ending of contracts.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 114.

STARTING SALARIES UP, BUT RANK LOW AS JOB LURES

A survey of 1964 graduating seniors at the University of Detroit showed that while starting salaries for engineers in all fields were up significantly over 1963, salary ranked a poor fifth among primary reasons given for job selections.

Average monthly starting salaries listed were $626 for B.S. engineers, up from $604 in 1963. Primary factors affecting job selections were "type of work," followed by "location," "type of work employer does," "advancement," and "salary."

Among various conclusions from the survey, employers without graduate schools nearby might have difficulty hiring engineering graduates.

NO SHORTAGE, SAYS HOUSE; SUGGESTS SPECIAL STUDY

House Select Committee on Government Research has come to the conclusion that the U. S. is not really suffering from a shortage of engineering or scientific manpower except in a few specialized areas. The Committee does find, however, that data on future needs is scanty and that severe shortages could develop.

The Committee suggests a single Government agency be formed with specific resopnsibility and authority to coordinate various federal efforts to provide information on engineering and scientific manpower.

TECHNICAL HELP DEMAND HITS PEAK IN OCTOBER

An upswing in recruiting activity in October pushed the Deutsch & Shea Engineer/Scientist Demand Index to its highest point in 1964 to 87.4. The Index remains well under the 100.0 of the base year, 1961, and is 9.8 points below the October 1963 figure.

Behind the rise in the Index is an apparent renewal of recruiting effort by U. S. industry, especially in the East and the Midwest. D&S expects the demand will register about the same level for November, with a sharp seasonal drop showing in December.

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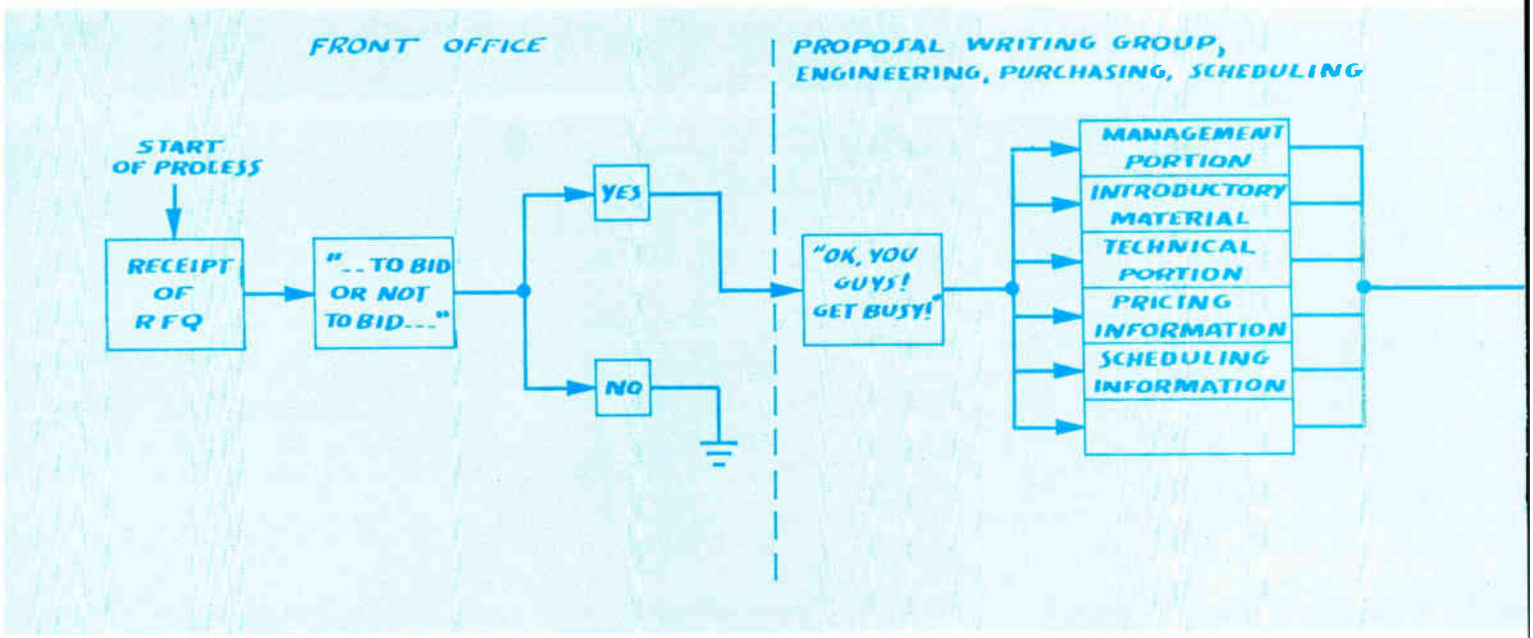

Writing Persuasive Proposals

THE SUCCESSFUL PROPOSAL is the one that convinces the prospective customer that he should invest his money in your products or services. Above all things, to be successful, the proposal must be persuasive. To a large extent this involves being responsive to the RFQ (request for quote). Another way of saying this is; "give the requestor exactly what he asks for."

Do not make the mistake of telling him that what he is asking for is not really what he wants. Right or wrong, no one likes to be told that he doesn't want what he thinks he does want. Of course, after responding to the potential customer's needs, there is nothing wrong with alternate solutions or methods providing that you can justify them.

* * *

A proposal differs from a technical paper because the latter is required only to inform the reader. The proposal must also sell. It must impress the prospective buyer(s) or evaluator(s) who are faced with reading several, all containing more-or-less the same information. The evaluator(s) then has to decide which has a practical solution to meet his detailed needs. For this reason, statements in the proposal must be supported by facts and discussions. The best argument is the one that allows him to identify your contentions with basic scientific principles directly related to solving his problem at a fair price.

Important Points

1. Successful proposals usually have the following:

a. *Interest*—They command the evaluator's attention and awaken customer interest with the direct statement that *his* problem will be solved by *your* product. (Responsiveness to RFQ most important.)

b. *Proof*—They *prove* that your technical approach will meet his needs. (Persuasiveness very important.)

c. *Completeness*—They leave no doubt that *all* pertinent questions have been answered.

d. *Accuracy*—They make no statement that independent observers cannot confirm by referring to basic physical theory.

e. *Brevity*—They are short enough to hold reader interest throughout.

When preparing a proposal, you must remember that, if the text is not readily comparable, in detail, with the Technical Exhibit and other RFQ documents, the evaluator will abstract the proposal and base his evaluation on this. Abstracting is often used even when the proposal is readily comparable with the RFQ. The abstract is more likely to present *your* view if you provide a "Locator" or "Specification Cross Reference" to insure that the evaluator does not miss any important discussions.

2. Three distinct types of persuasive "proof" discussion should be used. The use of all three types is

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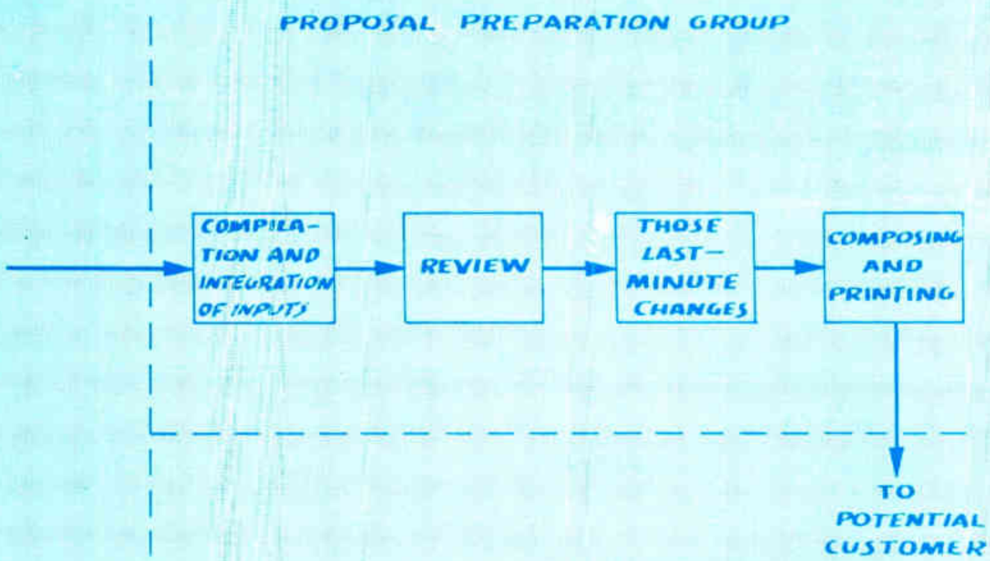

Fig. 1: Flow diagram shows the proposal preparation process from the decision to bid, until the package is completed and sent to the evaluators in buyers company or organization.

All companies are eventually faced with the problem of submitting proposals. These proposals must be intelligent, logical and effective. The material here is an excellent guide for engineers required to help prepare such proposals.

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very important. These are: ethical proof, logical proof, and emotional appeal.

a. *Ethical Proof*—Write from an authoritative standpoint to instill a belief in what you are saying, and a confidence in your company. Sincerity, well-established facts, completeness, and the absence of contradictions must be evident.

b. *Logical Proof*—Show the reader, through facts and the supporting material, that the discussion is not merely your opinion, but is based upon established principles and/or previous tests.

c. *Emotional Appeal*—Treat the evaluator as an important human being, not a logistic machine. Make him aware of your interest in his problems. It is your job to show him that you appreciate his position as an entrusted employee. You must also convince him that you are trying to assist him by proposing the best product or service at the most reasonable price. *A word of advice here:* this is a sensitive area. Don't be maudlin or phoney. You must be assured that the evaluator(s) is assigned to his job because of a proven ability to handle it. If you do not feel this way, you had better try some field other than proposal writing.

Slanting the Proposal

As a proposal writer, or as an engineer assisting, you will probably be responsible for writing the introductory and technical portions. The front matter such as the title page, table of contents, etc., will usually be prepared by the proposal or technical publications group. The management portion will usually be handled by personnel familiar with this. You may have to assist with the scheduling and pricing information. But, your primary interest will be the technical presentation. For this reason, the remainder of this article is concerned with the following general headings:

a. The Introduction
b. Analysis of the Problem
c. Summary of the Technical Approach
d. Detailed Technical Approach

The Introduction

Before writing this section, you should first realize that the executive reader will seldom read the entire document. Usually the higher his rank, the less he will read. Some top executives will read only the Introduction; others may read the Summary of the Technical Approach. It may seem best to combine the Introduction, Analysis of the Problem, and the Summary of the Technical Approach. Here you must make a decision dependent upon the scope of the product or service being proposed. If combining these elements makes this portion of the proposal too long, do not do it.

The introduction must do the following:

(Continued on page 115)

World Radio History

Please type or print

ELECTRONIC INDUSTRIES Professional Profile

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name ______________________ Tel. No. __________

Street Address ______________________ Zone ______

City ______________________ State __________

☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth __________

Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area __________

Salary Desired to Change Jobs and relocate in another area __________

Professional Memberships ______________________

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

STATE ANY FACTS ABOUT YOURSELF THAT WILL HELP A PROSPECTIVE EMPLOYER EVALUATE YOUR EXPERIENCE AND JOB INTERESTS. INCLUDE SIGNIFICANT ACHIEVEMENTS, PUBLISHED PAPERS, AND CAREER GOALS.

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

World Radio History

a. Respond to the RFQ (identify the proposal with the customer's need).

b. Introduce your company or team to the evaluator(s). Point out your company's history of good management—refer to successes with similar programs.

c. Express the reasons for your interest in the program.

d. Review your company's capability, experience, and willingness to devote resources to the program.

e. Highlight the basic and most cogent features of the proposed products or services.

f. Tell the reader what he will encounter in the remainder of the proposal.

Analysis of the Problem

Your problem here is very basic. The evaluator(s) usually adopts the position that unless the proposal reveals a complete understanding of the problem, you cannot provide an intelligent solution. He is mainly interested in knowing that the proposer (1) understands the problem, (2) has the experience and ability to solve the problem, and (3) has evolved a reasonable technical approach.

If you can convince him that you have a thorough understanding of his problem, and the capability to solve it, he will be inclined to award a good over-all rating to the proposal. To really be convincing, you must analyze and discuss the complete problem. The outline of this section should be somewhat as shown below.

a. *Summary of the Customer's Problem:* Present a brief review of the technical and program features.

b. *Specific Technical Aspects:* Identify the problem areas as they relate to the state-of-the-art and the RFQ specs. A discussion of these areas is always requested by the RFQ. A solid discussion at this point will prove your awareness of the technical scope of the problem. Discuss *specific* items such as: (1) Technical problems—What are the major problem areas? Why? (2) Logistics—Does your approach increase the user's inventory and procurement problems? (3) Maintenance and operation—Will your proposed solution mean the hiring or training of highly skilled personnel? Will it require too-frequent maintenance? (4) Reliability—Will the proposed equipment meet the reliability goals? Will it be done at a reasonable price? (5) Relation to existing problems—Will the proposed equipment increase existing operational problems? Will it modify them? How?

c. *Interpretations and Exceptions to Specification:* Specify and discuss your reasons for exceptions and/or special interpretations of the RFQ specification. Justify each exception on some definite basis (economy, unavailability of material, etc.). This specific discussion is always requested by the customer.

d. *Program Aspects:* Discuss *specific* program parameters such as: (1) Financial and scheduling aspects—Does your company or team have the financial capability to support the program schedule? Are there any foreseeable scheduling problems such as subcontracts, long-lead item deliveries, etc.? What inter-relationship will exist between your company, the customer, and other contractors? (2) Procurement—Will the user be able to satisfy his future needs for quantity production? (3) Manufacturing and economy—Can the equipment be economically made in the expected quantities? (4) Cost and incremental cost relations of future modifications—Will changes be costly to incorporate during the life of the contract? (5) Field support—Can your team support this product in the field?

Summary of the Technical Approach

This section is often read by high-ranking executives who can give final approval of expenditures of funds. You must, therefore, be brief, complete and convincing. Include the following types of discussions:

a. *Technical Design Approach:* Cover the present state-of-the-art, and the basic principles you intend to use. Justify your approach.

b. *Specific Advantages of Your Design Approach:* Forcefully present the special features in which your design excels.

c. *Specific Advantages of Your Technical Program:* Present your company's unique qualifications which will enable it to carry out the program. Whenever possible, display intimate knowledge of the potential customer's organizational operations, etc. Cover the various ways in which past and/or present contracts uniquely qualify your organization.

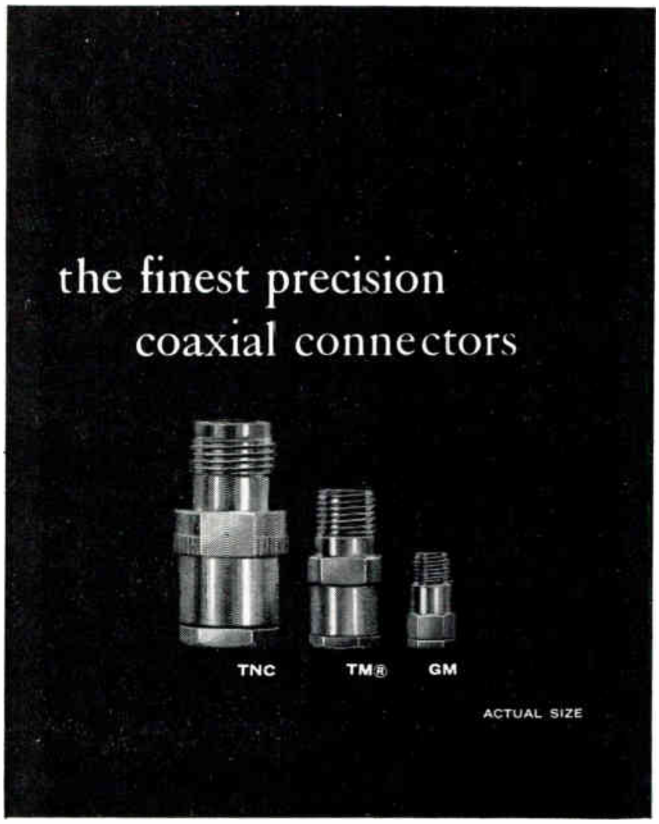
Detailed Technical Approach

To be persuasive this section must make good use of logical argument or proof. You must present the material in a manner that is both professional and clearly understandable. Your detailed discussion should cover a proposal in a descending level of detail as follows: a. System Concept; b. Subsystem Theory (including equipment groups); c. Major Functional Elements; d. Operational Components. Naturally, the less complex your product is the fewer breakdowns will be needed. *(Continued on page 116)*

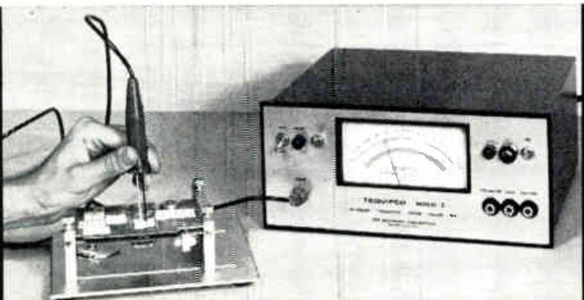
O. L. Wadkins

R. E. King

World Radio History



General RF Fittings, Inc.
702 BEACON STREET, BOSTON, MASSACHUSETTS 02115
Telephone: (617) 267-5120
Circle 55 on Inquiry Card



PRODUCTION LINE IN-CIRCUIT TRANSISTOR TESTER

DESIGNED FOR SIMPLIFIED OPERATION
TEQUIPCO model 5 features automatic adjustment of test conditions. Effects of circuit impedances are balanced to provide a rapid, safe and economical means for testing transistors mounted in assemblies.

MEASURES PULSED BETA FROM 5 TO 500
Direct reading of h_{FE} on a single meter scale. Pulse technique eliminates error caused by junction heating.

SAFE TO TRANSISTOR AND CIRCUIT UNDER TEST
Overload circuits protect the transistor from damage during test. Special test probe used for testing transistors mounted on printed circuit boards.

Send for complete brochure
TEST EQUIPMENT CORPORATION
3009 S. Post Oak Road
P. O. Box 22042
Houston, Texas 77027
(713) NA 2-4570
TEQUIPCO

WRITING PROPOSALS (Concluded)

An illustration of each item (a through c), supported by your discussion, will make your presentation much more understandable. The most effective and persuasive way to structure your proposal is by the use of illustrations with the text built around them. Be sure to use the present tense and the active voice.

Use of Illustrations

Illustrations form an essential element in engineering. Graphical aids are used in all successful articles and text books. A good set of illustrations can sometimes be arranged to tell a complete story without recourse to the text.

Whenever possible, include a frontispiece in your proposal. This is a very valuable item. It can be a photographic composite or an artist's sketch, but in either case it should show the physical arrangement or a plan view of the proposed equipment.

To increase the value of your illustrations, group the same types together. For example, using the proposed concept of a system containing two ground stations and an airborne station, follow a simplified system block diagram with successively more detailed views, such as a simplified block diagram of each subsystem; then a complete block diagram of the major functional elements; and finally, diagrams showing the operational components of each block.

Select other illustrations to bolster the main points of your proposal. Don't try to use them for window dressing. These can include photographs, engineering drawings, artist's sketches, work and information flow diagrams, etc.

Remember too, that charts, graphs, and tables are a very effective means of summarizing test results or calculations to prove a point.

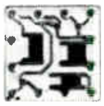
Conclusion

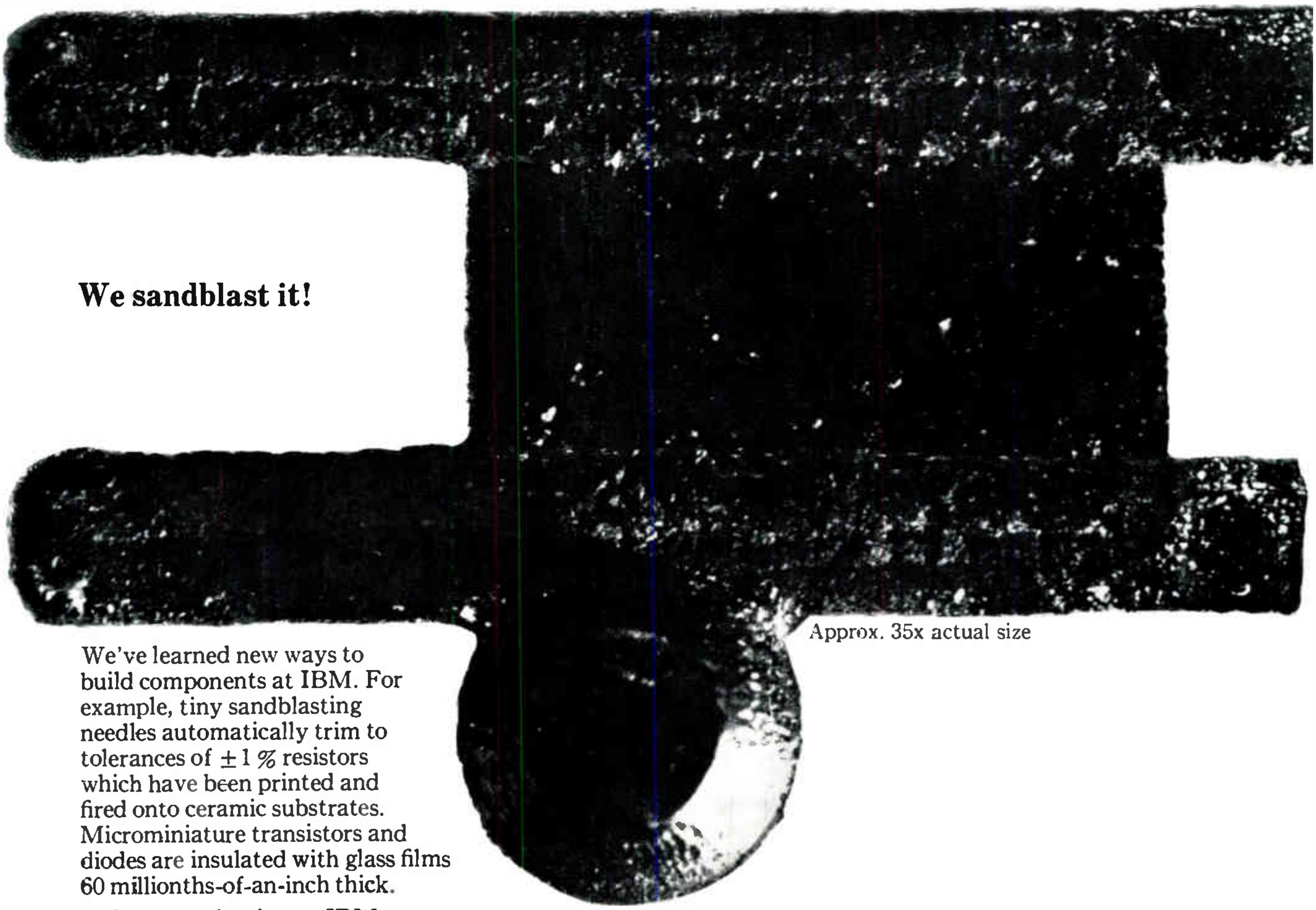
The successful proposal will have taken the evaluator(s) through the same four basic steps through which a good advertisement takes a reader. *First,* it will have commanded his attention. *Second,* it will have aroused his interest. *Third,* it will have created a desire for your product. *Fourth,* it will have resulted in favorable action. Ideally, this action will be an immediate sale, but it may simply direct the potential customer to the next step which may culminate in a later sale. At any rate, if you have skillfully done your job in the first, second, and third steps, you insure as much as possible the success of the fourth and last step.

• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department.

World Radio History

How does IBM trim a resistor only .04 inch wide?





Approx. 35x actual size

We sandblast it!

We've learned new ways to build components at IBM. For example, tiny sandblasting needles automatically trim to tolerances of ±1% resistors which have been printed and fired onto ceramic substrates. Microminiature transistors and diodes are insulated with glass films 60 millionths-of-an-inch thick.

Solid state scientists at IBM are engaged in a broad program of materials research, device and circuit development, and systems design. One result: Solid Logic Technology, the basis for the new System/360 computers. Alongside this program, manufacturing research engineers are developing automatic methods to manufacture and test new devices.

Component technology at IBM is a rapidly advancing field. Semiconductor device engineers, component manufacturing engineers, electrical engineers, and mechanical engineers will find many opportunities to apply their new ideas. Write to Manager of Employment, Dept. 557B, IBM Corporate Headquarters, Armonk, New York 10504.

IBM®

An Equal Opportunity Employer

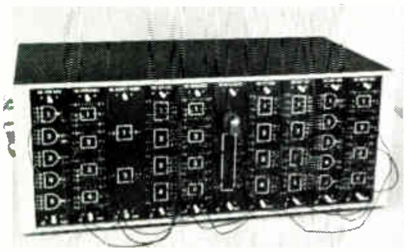
World Radio History

NEW PRODUCTS

". . . advancing the STATE-OF-THE-ART in Components & Equipment.

LOGIC DESIGNER

For integrated circuits. Allows complete systems design using plug-in boards.

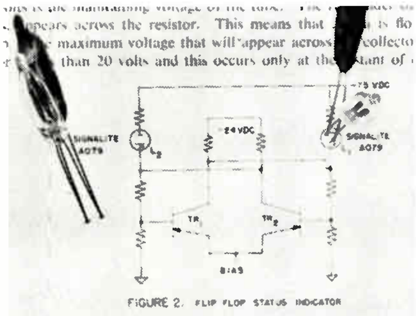


Model DT-2605 Inte-Patch unit is a versatile logic design tool. With it complete systems, including interface with electromechanical devices, can be designed. It uses analog, digital, and hybrid plug-in logic boards which use integrated circuits and discrete components. It also allows integrated circuits to be evaluated. Data Technology Corp., Box 10935, Palo Alto, Calif.

Circle 228 on Inquiry Card

LOW-VOLTAGE NEON LAMP

For low voltage applications and use with transistors as an indicator.

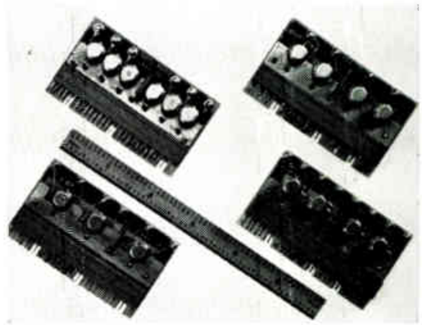


Lamp type A079 is designed to hold its operating characteristics throughout its rated lifetime of 7,500 hrs. Operating characteristics include: max. breakdown voltage, 70vdc; max. maintaining voltage, 58vdc; minimum extinguishing voltage, 47vdc; and design current, 0.3ma. Its operating temp. range is from —55°C to +90°C. Signalite, Inc., 1933 Heck Ave., Neptune, N. J.

Circle 230 on Inquiry Card

MICROLOGIC CARDS

Eliminate the interconnection problem in breadboarding or system construction.

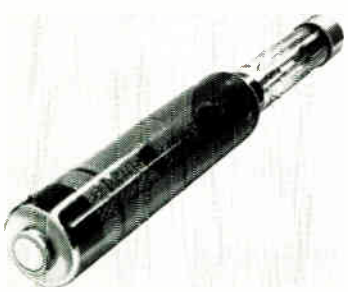


With 8500 series micrologic cards, each logic element has an easily accessible test point located on the upper surface of the board. Breadboarding of logic using these inexpensive devices will allow verification of logic design for military environments before fabrication of high-density packages. Systems Engineering Laboratories, Inc., Box 9148, Ft. Lauderdale, Fla.

Circle 232 on Inquiry Card

ELECTROSTATIC TUBES

High-resolution fast-writing tubes use fiber optic face plates.

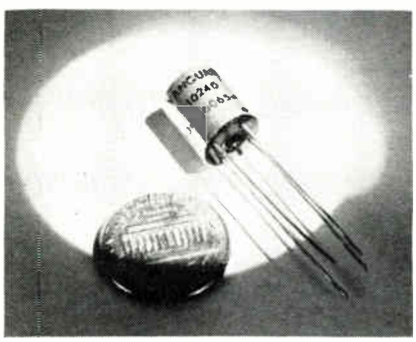


The Type K2427 features high deflection sensitivity and high resolution electrostatic focus. It enables low-level, fast-transient information to be directly coupled to the signal plates, and be contact printed in sharp detail through the fiber optic faceplate. It is capable of a writing speed of 10^{12} trace width/sec. at an overall acceleration potential of 10kv. Performance characteristics include resolution of 500 trace widths/in. and deflection factors of 3 and 10v./centimeter in the signal and time axis, respectively. Electronic Tube Div., Du Mont Laboratories, divs. of Fairchild Camera and Instrument Corp., Clifton, N. J.

Circe 229 on Inquiry Card

VARIABLE INDUCTORS

Tunable r-f coils span total nominal inductance range of from 0.1 to 1000μh.

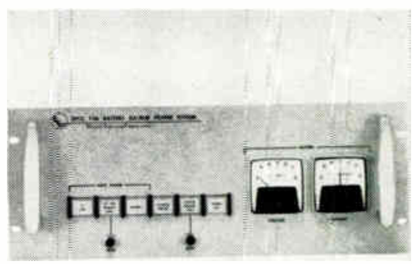


Series 71 miniature inductors feature magnetic and electrostatic shielding by means of a powdered-iron cup core and external, gold-plated brass shield. They meet the requirements of Mil-C-15305, Grade 1, Class B (—55°C to +125°C). The units are shock resistant, moisture, and immersion proof. Temp. coefficient of inductance is +30 ppm/°C nominal; TC of Q is —0.2%/°C nominal. They have a torque device that allows very smooth, manual inductance adjustment while preventing unintentional detuning, without use of a locking device. Vanguard Electronics Co., 930 W. Hyde Park Blvd., Inglewood, Calif.

Circle 231 on Inquiry Card

BACKUP POWER SYSTEM

Provides voltage within ±5% 117 vac whether operating from line or batteries.



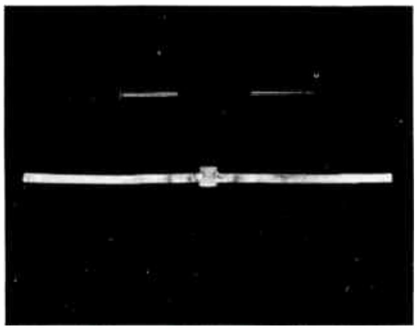
The 746 Battery Back-Up Power System assures continuity of system operation even when the system is in a remote and unattended location. It incorporates a dc-ac inverter and battery charger in 1 compact package. The unit automatically recharges the batteries even with power line variations up to 140vac and as low as 100vac. The system eliminates power line transients; disturbances as high as 560v peak-to-peak on the ac line are not passed to the unit. Standard power rating is 300va @ 117v., 60 cps, and 5a. at nominal 24vdc. Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif.

Circle 233 on Inquiry Card

World Radio History

MINIATURE CAPACITORS

Available in capacitances from 0.5 to 62pf for a working voltage of 300vdc.

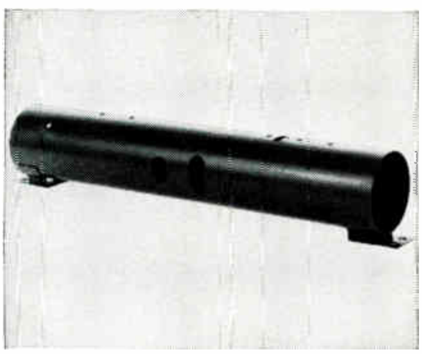


Uniceram Hi Q UY01 capacitors offer a choice of tolerances for each size—from ±0.25 to ±0.50pf at the low C end of the line to from ±1 to ±10% at the high end. All units have a guaranteed min. Q of 3000. The 7/64-in. sq. and ±1/16-in. thick units have ceramic dielectric layers fused into a monolithic structure and encapsulated in solid glass. JFD Electronics Corp., 1462 62nd St., Brooklyn, N. Y.

Circle 234 on Inquiry Card

TUBE SHIELD

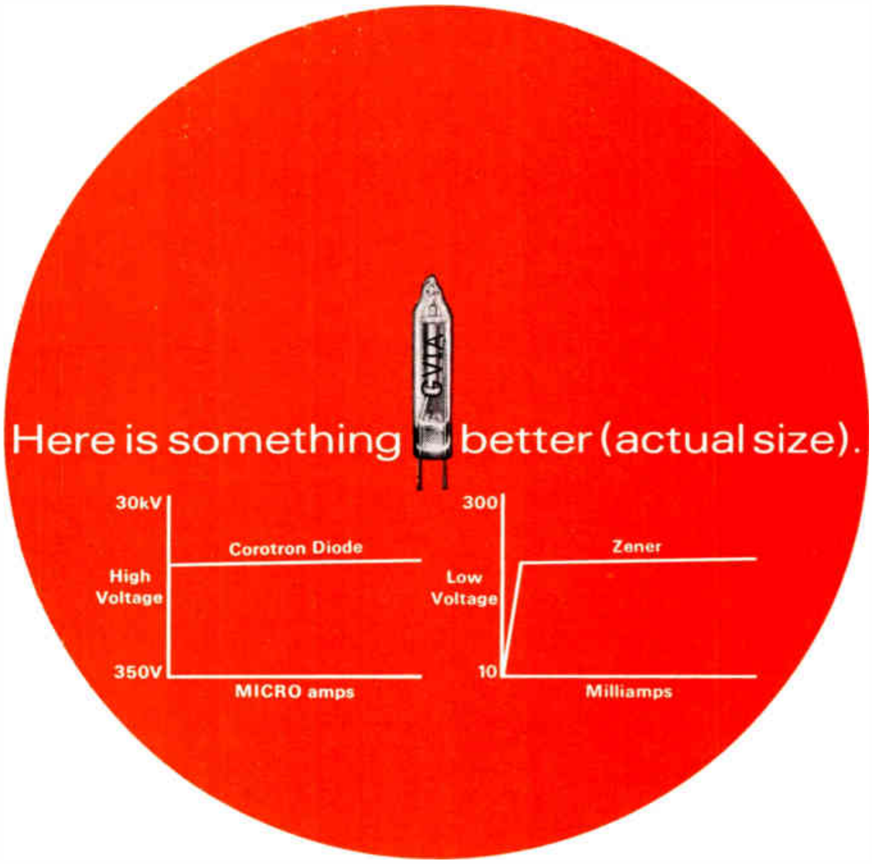
For scan converter tubes. Can be modified to meet any system need.



This minimal retentivity, permanently annealed Netic Co-Netic magnetic shield allows tubes and other magnetically sensitive components to be placed close together. This makes possible more compact assemblies. Multi-layer cylindrical enclosure has an outer layer of Netic alloy extending beyond the tube's physical dimensions. The inner liner of Co-Netic alloy is followed by a Co-Netic section positioned in the critical magnetic area. This acts as a shunt ring. Simple, rugged mounting is used integrally in the outer layer. Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago, Ill.

Circle 235 on Inquiry Card

Who ever heard of a **kilovolt Zener?**



Other Zener-equivalent Victoreen diodes range from 350 to 30,000 volts

In low voltage power supply circuits, transistors and Zeners are OK. But what about high voltage supplies? Wish you could eliminate voltage dividers and dc amplifiers used with low voltage references?

You can. You're wishing for a *Victoreen diode, the gaseous equivalent of an ideal high-voltage Zener.*

A single Victoreen Corotron diode can be used as a reference, shunt regulator, dc coupling element, or portion of a divider. Corotrons are microminiature... free from relaxation oscillation...free from catastrophic failure caused by surges or transients... immune to radiation or ambient light effects... have excellent stability and temperature characteristics.

Sound ideal? That's only half the story. Get the rest by addressing Applications Engineering Department today.

3377-A

VICTOREEN

VICTOREEN

THE VICTOREEN INSTRUMENT COMPANY
5806 Hough Ave. • Cleveland 3, Ohio, U.S.A.

Circle 57 on Inquiry Card

World Radio History

MEASURE capacitance and loss of SEMICONDUCTORS at 1 Mc/s to 100 Mc/s

RF Admittance Bridge, Model 33A; Price, $2,000

This truly **unique** Bridge provides *high resolution* Capacitance **and** Conductance measurements at *high* frequencies and *low* test voltage levels. It offers a number of characteristics that make it particularly valuable for semiconductor testing:

- **Capacitance Range:** ***0 to 150 pF (basic accuracy 1%; resolution, 0.02 pF)***
- **Conductance Range:** ***0 to 25,000 μmhos (basic accuracy 2%; resolution, 0.5 μmho)***
- **Shunt Resistance, shunt inductance, dissipation factor, and Q may also be readily determined.**
- **Test Frequencies:** ***1 Mc/s, 5 Mc/s, 10 Mc/s, 20 Mc/s, 30 Mc/s, 50 Mc/s, and 100 Mc/s; all crystal controlled***
- **Operates with test signal levels as low as 1 mV; continuously adjustable to 100 mV**
- **DC Bias:** ***Internal,—5 V to +100 V External, ±250 V***

Add up these *unusual capabilities* and you have an instrument *ideally suited* for a wide range of measurements that are difficult, *if not impossible, with any other equipment.*

The Model 33A is now being used for:

- **Impedance measurements on transistors (including F.E.T.'s)**
- **Capacitance and loss measurements on diodes (particularly varactors and tunnel diodes)**
- **Determination of dielectric constants including those of thin films**
- **Measurements on resistors, capacitors, inductors, switches, connectors and connection assemblies, and transmission lines**

Why not look into the Model 33A? Our Sales Engineering Representative will be glad to arrange a demonstration at your convenience. Or ask for our Technical Data Bulletin. In either case, a letter, phone call, or TWX to the address below will bring an immediate response.

REACTANCE SLIDE RULE: Our Reactance Slide Rule provides a handy means for **calculating Q and dissipation factor,** and for determining the **resonating capacitance and inductance** for a given frequency. *It is available, free of charge,* by writing on your **company letterhead** to Boonton Electronics, Dept. 1 , at the address below.

BOONTON ELECTRONICS CORPORATION

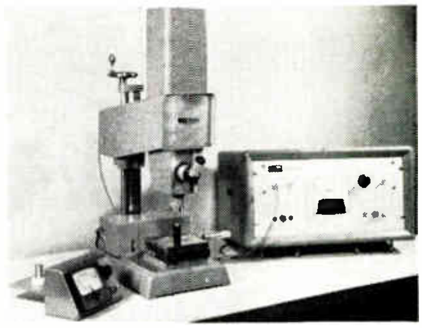
PHONE: 201-887-5110
TWX: 201-887-5059

ROUTE 287 AT SMITH RD.
PARSIPPANY, N.J.

NEW PRODUCTS

MICRO-PLOTTER

Maps the thermal distribution of a complex microcircuit in 3 sec.



This micro-plotter is based upon sensitive infrared detection. It uses a non-destructive, non-contacting measurement technique. Its ½μsec. response time and high spatial resolution open a wide range of microcircuit design and reliability-testing applications. The unit uses a solid-state detector of indium antimonide. A set of sensitive microscope optics focuses the detector cell on the sample. It can resolve microcircuit detail within spot dia. of 0.0014 in. Sierra Electronic Div., Philco, 3885 Bohannon Dr., Menlo Park, Calif.

Circle 237 on Inquiry Card

PHASE ANGLE VOLTMETER

Permits sweep frequency measurement. Measures pulsed coherent sinusoids.

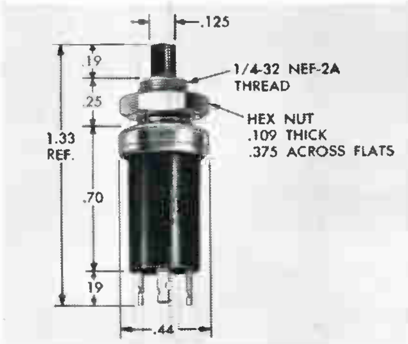
Model VM-301 rejects harmonics by front panel plug-in filters. It is applicable to amplifier and network design, vibration and telemetry analysis, bio-medical research, and phase-sensitive null detection in production and laboratory. The unit measures both phase angle and magnitude of complex ac signals and their vector components with respect to a reference voltage. Frequency range is 10 CPS to 100KC. It fills the need for a null and phase meter for measurements in which signal freq. itself may be a variable. North Atlantic Industries, Inc., 200 Terminal Dr., Plainview, N. Y.

Circle 238 on Inquiry Card

World Radio History

PUSHBUTTON SWITCH

Rated to make and break ¼a. at 115vac resistive load.



Contact resistance of series 46 after 250,000 operations is 0.010Ω typical, 0.020Ω max. Voltage breakdown is 1500vac and life expectancy is 250,000 operations at rated load. Actuating force is 16 oz. to bottom. The mounting nut and cover bushing are cadmium plated brass; contact terminals and shorting bars are silver-plated phospher bronze. Grayhill, Inc., 561 Hillgrove Ave., La Grange, Ill.

Circle 239 on Inquiry Card

TWT OSCILLATOR

Produces over 1000 CW power into mismatched loads as high as 2.5 to 1.

The WJ-282 operates as a forward wave oscillator near the center of the pass-band of the circuit, permitting a low cost power source at 35GC. Beam efficiencies of 13.5 to 16.7% have been obtained. Watkins-Johnson Co., 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Circle 240 on Inquiry Card

ALL-WELDED RELAY

The 2 PDT subminiature unit operates at 100G-shock and 30G-vibration.

The Series "E" relay is designed to handle dry circuit or 2a. switching requirements. It weighs 0.28 oz. and stands 0.410 in. high. It requires 0.131 cu. in. of space, making it especially suited for PC applications. The unit uses Teflon insulating materials to prevent outgassing at high temps. It is offered in a variety of vdc coil ratings, 6 standard mountings and 3 terminal styles. Leach Corp., 1123 Wilshire Blvd., Los Angeles, Calif.

Circle 241 on Inquiry Card

the only thing
NOT UNIQUE
about the
610B
is the name
ELECTROMETER

The Keithley 610B Electrometer measures more parameters over broader ranges than any other dc test instrument! One compact measuring system now gives you the capability to investigate:

VOLTAGE—20 microvolts to 100 volts, without circuit loading (10^{14} ohms input resistance)

CURRENT—10^{-15} ampere to 0.3 ampere

RESISTANCE—2 ohms to 10^{14} ohms

CHARGE—10^{-13} coulomb to 10^{-5} coulomb

In addition, this neat package has only 200 microvolts per hour zero drift. That's ten times better than you can expect from any other tube electrometer, and it approaches the stability of costly vibrating reed devices. Unique, too, is the 610B's 1% meter accuracy, and its .005% unity gain output for impedance matching. An extra large 6-inch taut-band meter and two easy-to-read dials accent ease and convenience of operation.

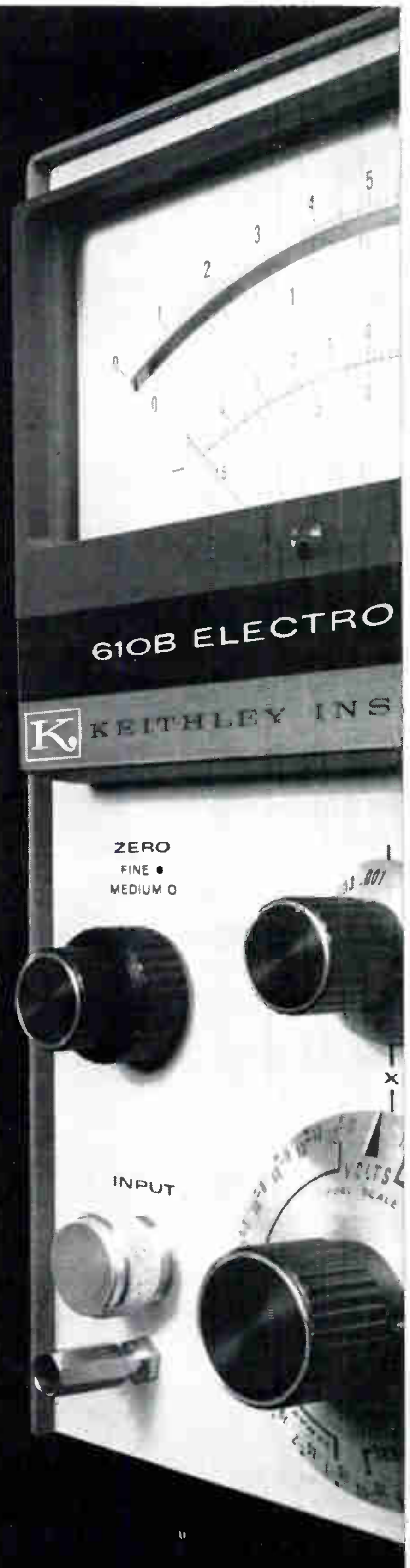
The remarkably superior 610B replaces the 610A . . . and sells for the same price . . .

$565

Send for Engineering Note on 610B Electrometer

other electrometers

Model 610BR
Rack mounting 610B $585
Model 621
37 ranges, line operated. $390
Model 600A
54 ranges, bat. operated. $395
Model 603
50 kc bandwidth amplifier. $750

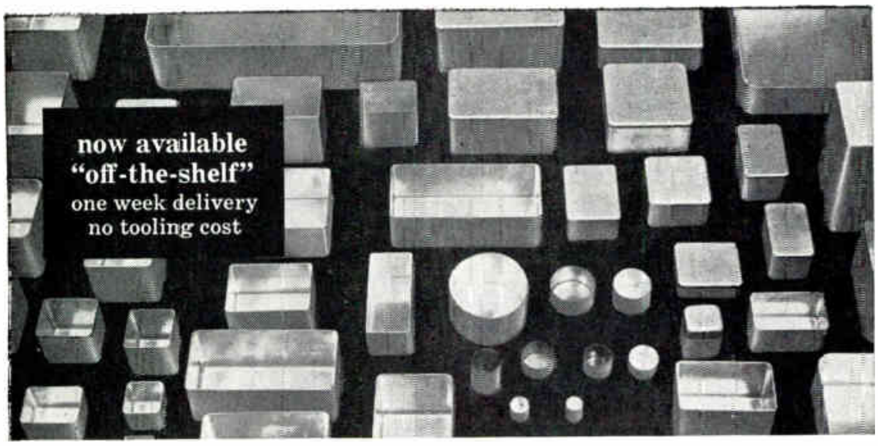


KEITHLEY
INSTRUMENTS
12415 Euclid Avenue • Cleveland 6, Ohio

dc microvoltmeters • differential voltmeters • high voltage supplies

Circle 59 on Inquiry Card

World Radio History



25,000 SIZES AND SHAPES

deep drawn aluminum boxes and covers

Choose from more than 25,000 sizes and shapes. Rectangular, square, round. Sizes from ⅞" x 1⅝" to 28" x 54-3/16". Draft-free deep drawn aluminum. No Welds. Satiny, wrinkle-free surface requires no preparation for painting. Shipment made from $1,000,000 inventory, normally within one week, from the nearest factory. Complete facilities available for economical secondary operations and finishing if required.

SEND FOR NEW 38-PAGE CATALOG

Zero **ZERO MANUFACTURING CO.** 1121 Chestnut St., Burbank, Calif. 91503
Telephone VIctoria 9-5521 area code 213 TWX 213-846-8094
Factories in Burbank, Calif. and Monson, Mass.

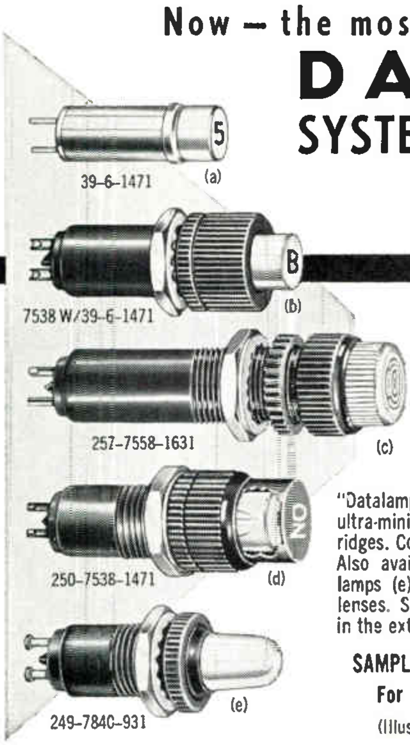
Circle 60 on Inquiry Card

Now — the most adaptable, reliable

DATALITE®

SYSTEM OF INDICATION

For computers, data processing, and other readout applications



Build your light indicators with a system—the DATALITE system. Here's how: Choose a "Datalamp" Cartridge (a) and combine it with a "Datalamp Holder" (b); or use a screw-on "Data Cap" with a rotatable readout lens (c, d)...For multi-indications, "Datalamp" Cartridges may be mounted on a "Data Strip" or "Data Matrix" in any required configuration.

"Datalamp" Holders accommodate DIALCO's own plug-in ultra-miniature Neon or Incandescent "Datalamp" Cartridges. Complete assembly mounts in ⅜" clearance hole. Also available with permanent (not replaceable) Neon lamps (e). Legends may be hot-stamped on cylindrical lenses. Styles shown here are only typical components in the extensive DATALITE system of light indication.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE.

For complete data, request current Catalog.

(Illus. approx. actual size)

Foremost Manufacturer of Indicator Lights

DIALIGHT CORPORATION

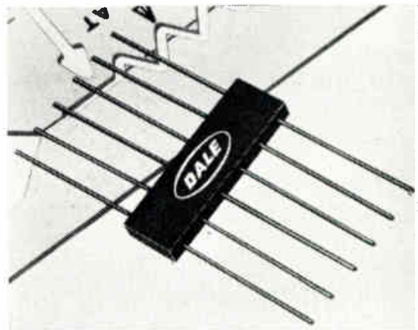
DIALCO®

60 STEWART AVENUE, BROOKLYN, N.Y. 11237 212 HYACINTH 7-7600

NEW PRODUCTS

MICRO-RESISTIVE NETWORKS

Uses metal-film elements encapsulated in molded epoxy. Temp., —55°C to +175°C.



The MN series miniature networks are available with from 2 to 6 elements, each having a power rating of 50mw at 125°C. They can be supplied with matched temp. coefficients and matched resistance ratios, or with mixed high and low resistance values in the same package. Precision metal film elements within each network can be supplied with a resistance range of from 49.9Ω to 75KΩ, and with temp. coefficients of ±25, 50, 100 or 150 ppm/°C. All elements have good h-f characteristics. Dale Electronics, Inc., P. O. Box 488, Columbus, Nebr.

Circle 275 on Inquiry Card

WIREWOUND RESISTORS

Resistance tolerance 1% to 0.001% with T/C stability to 0.5 ppm°C or better.

This complete line of precision wirewound resistors is designed for ultra-stability and reliability. Uses include digital voltmeters, precision servomechanisms, analog computers, and sophisticated instrumentation. Wattage 0.125 to 4.0w. Resistance range 1Ω to 10 megohms. Case size contingent upon wattage. Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J.

Circle 276 on Inquiry Card

DATA LOGGER

Voltage ranges are from 10mv full scale to 1kv full scale.

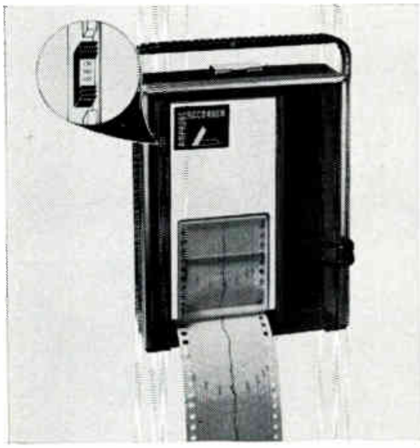
The 7000A Series data logging systems feature 600 points of input scan and a guarded differential 5 digit digital voltmeter with preamplifier. Recorded data is provided in the form of printed paper tape with a variety of other output options available. By changing input plug-in accessories, the system may be used for ac or resistance measurements. Cimron Corp., 1152 Morena Blvd., San Diego, Calif.

Circle 277 on Inquiry Card

World Radio History

STRIP CHART RECORDER

Monitors and records ac voltage up to 520vac on an expanded scale.



Model LAV3X is an expanded scale instrument with 3 ranges: 95-130/190-260/380-520vac. The expanded scale on all ranges assures an accuracy of ±1.25% FS, and easier readouts. The recorder uses an inkless stylus. With the chart removed, the unit can be used as a direct reading meter. Amprobe Instrument Corp., 630 Merrick Rd., Lynbrook, N. Y.

Circle 244 on Inquiry Card

POTENTIOMETER

Rated at a true full 4w. @ 40°C, and derated to zero power at 150°C.

Series 45 potentiometer is 1⅛-in. in dia. and available in a resistance range of 10Ω to 15KΩ linear. Standard tolerance is ±10%. It has a standard bushing mounting, or split-locking bushing for set-and-forget applications. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 245 on Inquiry Card

COUNTER-TIMERS

All-silicon solid-state units have a frequency range to 2.5MC.

The 600 series feature PC motherboards with plug-in circuit cards. This replaces the basic circuit wiring harnesses. Display time is variable from about 0.2 sec. to 5 sec., and is independent of gate time. Memory or non-memory display mode may be selected by a front panel switch. The count gate may be locally or remotely controlled. Computer Measurements Co., 12970 Bradley Ave., San Fernando, Calif.

Circle 246 on Inquiry Card

EVERYTHING ABOUT THIS Acme Electric VOLTROL* STABILIZER IS NEW

New in design — using the newest in approved materials — the newest in construction. That's why you can expect better performance—from the VOLTROL Stabilizer.

FAST RESPONSE

On voltage drops of 15% or voltage surges of 15%, the VOLTROL Stabilizer will automatically correct to nominal voltage within 2 cycles. On lesser fluctuations of 3% to 5%, voltage is corrected to nominal in milliseconds.

AUTOMATICALLY CORRECTS LOW OR HIGH VOLTAGE

On continuous low voltage or high voltage input, output voltage is maintained within ±1% of nominal.

WON'T BURN UP FROM OVERLOADS OR SHORT CIRCUITS

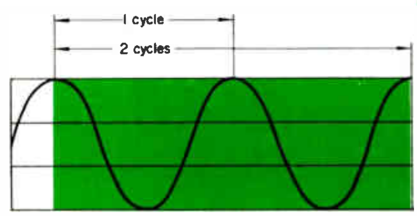
Automatically protected against overload or short circuit condition in the powered equipment.

SUPPLIED WITH TAPS FOR RECTIFIER POWER SOURCE

The new VOLTROL Stabilizer has an output tap to supply regulated AC voltage to rectifier circuits.

1/30 sec.

How fast is 1/30th second? Faster than the blink of an eye. And the VOLTROL Stabilizer under the most severe conditions of voltage fluctuation is faster than that. So, if it's recovery in milliseconds you want — then the VOLTROL Stabilizer is for you.



OPEN TYPES FOR BUILT-IN APPLICATIONS

Why pay for enclosures if the stabilizer is to be installed as part of the equipment? Most sizes of the VOLTROL Stabilizer are available without enclosures for OEM applications. Save money.

Write for new Bulletin 09-B03

Acme Electric

*VOLTROL is a registered trademark of Acme Electric Corp.

SAA 3808-3113

Engineers and Builders of...

REGULATED POWER SUPPLIES
STATIC POWER RECTIFIERS
VOLTAGE STABILIZERS
VOLTAGE REGULATORS

892 WATER STREET, CUBA, NEW YORK
Canadian Representative: Polygon Services, Ltd.
50 Northline Rd., Toronto 16, Ont.

World Radio History

March 22-26, 1965

ELECTRICAL-ELECTRONICS

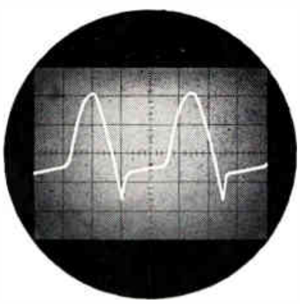
- Exhibit hours (4 days): Monday & Thursday, 9:45 a.m.-9 p.m.; Tuesday & Wednesday, 9:45 a.m.-6 p.m.
- Technical sessions (5 days) 10 a.m.-5 p.m. (Hilton, Tuesday to 10 p.m.)
- 80 subject-organized technical sessions presenting 400 vital "breakthrough" papers.
- Over 1000 Exhibits using 140,000 running feet of display units in N.Y. Coliseum & N.Y. Hilton.
- Gala IEEE Banquet on Wednesday, March 24, 1965 at 6:45 p.m. in Grand Ballroom, N.Y. Hilton.
- Registration: $2.00 IEEE Members, $5.00 Non-members. High School students admitted Thursday afternoon only, $2.00 if accompanied by an adult (not over 3 per adult).

NEW YORK COLISEUM and the NEW YORK HILTON

Buses every few minutes

Circle 71 on Inquiry Card

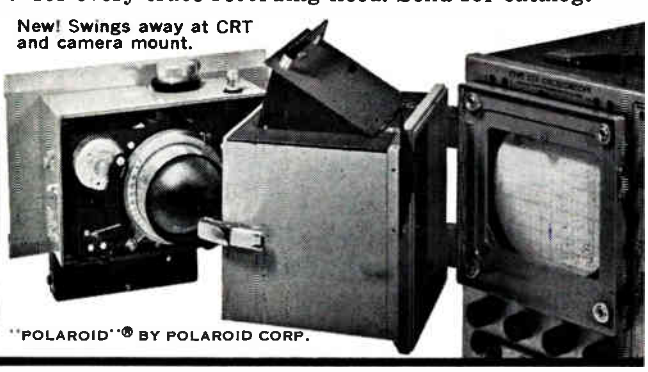
NANO-SECOND TRACES



stopped cold with new Oscillotron® and Polaroid 10,000-speed Land film

A fast f/1.2 lens combined with Polaroid® 10,000-speed film makes it possible to record ultra high speed traces at a 1:1 ratio with the new B-C MII-565 Oscillotron. Interchangeable backs also enable use of Polaroid 3¼x4¼ Land film pack and 4x5 Land sheet films. Synchronous electric shutter. Data recording optional. There's a B-C Oscillotron model for every trace recording need. Send for catalog.

New! Swings away at CRT and camera mount.



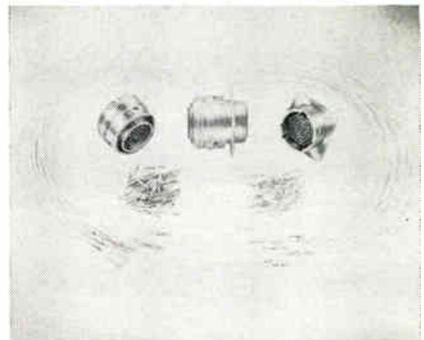
BEATTIE-COLEMAN INC.
Box 1974
Santa Ana, Calif.
92702

"POLAROID"® BY POLAROID CORP.

NEW PRODUCTS

BAYONET CONNECTOR

Puts 3 times the standard number of contacts into a given MS shell.



Shell size 14 of the STK series connector can have as many as 44 No. 22 contacts. Other sizes and insert arrangements include MS 8, 10, 16, and 19, with respectively 7, 19, 61, and 85 contacts. The "Tri-Kam" coupling design provides grope-free engagement, eliminates lock wiring, and insures a positive lock and seal. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 281 on Inquiry Card

FREQUENCY CHANGER

Solid state unit converts 400 cps 3 phase to precision 60 cps single phase.

The Model PS-64-162 converter is capable of converting 400 cps 3 phase to 60 cps single phase at 750va. It features high efficiency, low distortion, precision freq., precision voltage regulation, and RFI protection. Unitron Inc., 1624 N. First St., Garland, Tex.

Circle 282 on Inquiry Card

RELAYS

Provides more than 100,000 operations for magnetic latching or non-latching uses.

These 4 pole/half-size crystal can relays operate in the dry circuit to 2a. range. They are designed for low profile mounting. Featuring a specially-designed magnetic circuit, the BR-32 and 34 relays perform stably on low power consumption. A heat sink/magnetic flux conductor mounted on top of the relay coil greatly improves a heat dissipation. Features include: vibration: 30G, 30-2000 cps; 10-40 cps @ 0.4 in. DA standard; insulation rea: 10,000 megohms min. @ 25°C, 1000 megohms min. @ 125°C; temp. range: −65°C to +125°C. Babcock Relays, div. of Babcock Electronics Corp., 3501 Harbor Blvd., Costa Mesa, Calif.

Circle 283 on Inquiry Card

Circle 72 on Inquiry Card

World Radio History

SAVE more than 50% in assembly time!

NO CRIMPING! ONLY 3 PARTS TO HANDLE!

"wedge-lock"* means reliability in coaxial connectors!

- No indentation of dielectric—Low VSWR!
- No combing or trimming of braid—No "shorting" inside connector!
- Captive contact construction provides positive position of center contact!
- Positive cable clamping — withstands pull on cable greater than inherent strength of cable used!
- No special tools needed for assembly!
- Reusable cable clamping parts!
- Weatherproof - Pressurized (for cables with unperforated jackets)!

Automatic "wedge-lock" Connectors can be supplied in most of the standard connector styles, in series from Micro-miniature through LC/LT, and for virtually all popular cables from 1/16" through 9/16" diameter.

Literature is available . . . Write for brochure WL-WC 1-1062.

*PATENTED

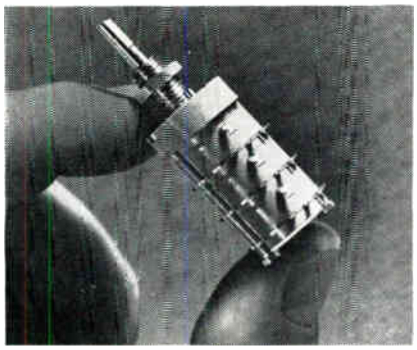
automatic
METAL PRODUCTS CORPORATION
323 Berry Street, B'klyn 11, N.Y. Tel: (212) EV 8-6057

Circle 73 on Inquiry Card

NEW PRODUCTS

ROTARY SWITCH

30° indexing with 2 to 12 positions; continuous rotation or with stops.

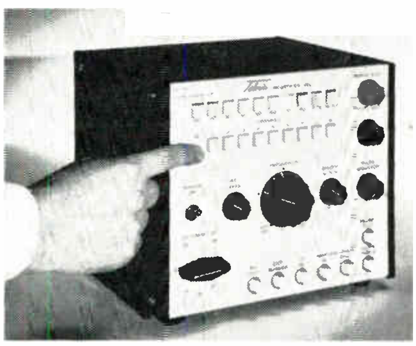


Series 2500 is a totally enclosed, explosion - proof micro - miniature rotary switch. It measures ½ in. in dia., with a max. overall switch dimension of 0.62 in. The unit has 1 to 12 decks. Electrical rating: carries 8a. continuous, makes and breaks ½a. 115vac resistive, ¼a. 28vdc resistive and ⅛a 28vdc inductive. The switch has a contact resistance of 0.005Ω, and will meet minimum RFI requirements Janco Corp., 3111 Winona Ave., Burbank, Calif.

Circle 247 on Inquiry Card

SWEEP GENERATOR

Sweeps entire UHF band in single sweep; provides pushbutton selectivity.



The Model SV-70 UHF sweep generator is used for testing and aligning UHF-TV tuners. The user may switch to any desired channel by pushing 2 back-lighted pushbuttons. It is the first sweep generator to combine wide sweep with positive channel identification and remote control, according to the manufacturer. The SV-70 is a 3-mode sweep generator: in mode 1, it sweeps across the entire channel 14 to 83 band with a 450MC wide single sweep; mode 2 is the positive, digital-controlled channel selection system; in mode 3, it sweeps over a narrow freq. range 20 to 40MC in width. Marketing Dept., Telonic Industries, Inc., 60 N. First Ave., Beech Grove, Ind.

Circle 248 on Inquiry Card

not tomorrow...

not the next day...

but the day after that!

Acopian **guarantees** that any of their 62,000 different single or dual output plug-in power supplies will be shipped in **three days!** Request detailed 12-page catalog and price list from Acopian Corp., 927 Spruce Street, Easton, Pennsylvania, or call collect (215) 258-6149.

Acopian

Circle 74 on Inquiry Card

World Radio History

2 NEW

MAGNETIC SHIELDING

PRODUCTS

1. **SHIELDMU**

Tape and Foil

SHIELDMU is a new, high permeability, fully processed, ready-to-use material for shielding sensitive electronic and electrical components from stray magnetic fields.

IT OFFERS:

- **2 to 3 times more shielding efficiency than material currently available**
- **an easy way to form shields in place around inductive components to save space, time, expense**
- **ductility without significant degradation of magnetic shielding properties**
- **4 levels of permeability performance; availability in a number of thicknesses, widths and continuous lengths**

2. **SHIELDFLEX**

Flexible Tubing

SHIELDFLEX is especially designed to: isolate conductors from external magnetic fields; contain the magnetic field generated by current carrying conductors; provide electrostatic shielding.

IT OFFERS:

- **production economy since cable can be run through a length of Shieldflex for complete magnetic and mechanical protection.**
- **optimum shielding efficiency equivalent to that expected from high permeability shield structures**
- **39 db attenuation in a 1 oersted, 60 cps field**
- **space economy since conductors can be routed very close to components or other conductors.**

Write, wire or call for full details on SHIELDMU and SHIELDFLEX.

MAGNETIC METALS

MAGNETIC METALS COMPANY

21ST & HAYES AVE., CAMDEN, N.J. 08101
Phone: 609-964-7842 TWX: 609-964-6772

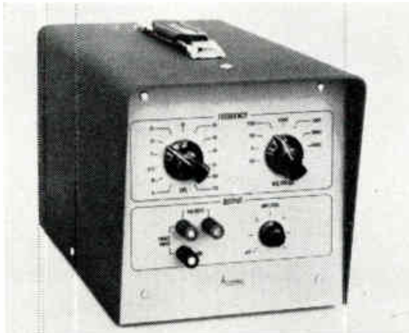
■ Transformer Laminations ■ Motor Laminations ■ Tape Wound Cores ■ Powdered Molybdenum Permalloy Cores ■ Electromagnetic Shielding ■ Metallurgical Services ■

Circle 75 on Inquiry Card

NEW PRODUCTS

FREQUENCY STANDARD

Crystal-controlled freq. standard provides freqs. ranging from 0.5 CPS to 600KC.



The Model CU-2 Multiple Frequency Standard features an accuracy of 0.0005%. Freq. is selected by means of a 13-position selector switch and a 4-decade multiplier switch. Output voltage is a sq. wave with amplitude adjustable to 20v. peak-to-peak. Both single ended and balanced outputs signals are provided. It may be used for calibration and test wherever precision reference or clock freqs. are needed. It replaces both the variable oscillator and freq. counter normally needed. Anadex Instruments Inc., 7833 Haskell Ave., Van Nuys, Calif.

Circle 278 on Inquiry Card

STEPPER MOTOR

Step rate is 0-320 steps/sec.; max. stepping torque is 1.39 oz.-in.

Motor type K82501 general-duty logic stepper is rated for continuous duty; is bidirectional; and also may be operated as a synchronous motor. The output shaft turns a discrete increment each time a pulse is applied to the windings. The A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn.

Circle 279 on Inquiry Card

PUSHBUTTON SWITCH

Switch life exceeds 100 million actuations with rating of 10a., 125/250vac.

Model E33-00G has an anti-rotation plunger shaft with a 3/8 in. flated section. A self-lubricating Delrin cam eliminates operation ambiguity by actuating the switch on the return stroke of the plunger. Panel mounting is by means of a threaded barrel for standard 3/8-32 nut. Simplified wiring using standard 0.187 in. wide QC connectors, solder or screw terminals is provided for all units. Cherry Electrical Products Corp., P. O. Box 438, Highland Park, Ill.

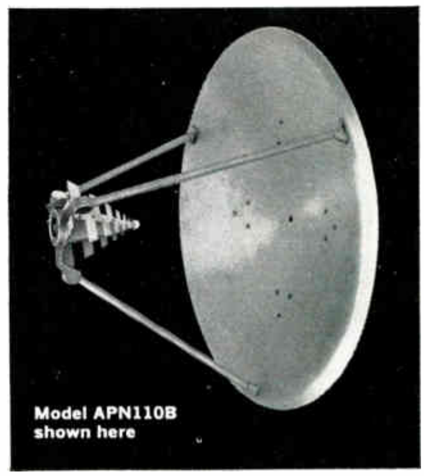
Circle 280 on Inquiry Card

NEW FROM AEL

PARABOLIC REFLECTORS WITH

FREQUENCY INDEPENDENT FEEDS

COVER the RANGE 0.3 to 11 Gc



FEATURES . . .

- ■ Broadband, high gain performance over multi-octave bands
- ■ Linear polarization — with the pyramidal log periodic feed
- ■ Circular polarization — with the conical helix feed
- ■ Impedance-matched to 50 ohms
- ■ Eight standard models . . .
- ■ OFF-THE-SHELF AVAILABILITY

Model No.		Frequency (Gc)	Reflector size (ft.)	Gain, f_{lo} to f_{hi}			
Circularly polarized	Linearly polarized			db	@ Gc	to db	@ Gc
ALN123B	APN112B	0.3-3.0	6	10	0.3	30	3.0
ALN122B	APN111B	1.0-11.0	6	20	1.0	39	11
ALN121B	APN110B	1.0-11.0	3	14	1.0	33	11
ALN111C	APN102C	1.0-11.0	1.5	8	1.0	27	11

Request Bulletin No. 20-8 for complete details

American Electronic Laboratories, Inc.

P. O. BOX 552A, LANSDALE, PA.
(215) 822-2929 • TWX 510-661-4976
suburban Philadelphia

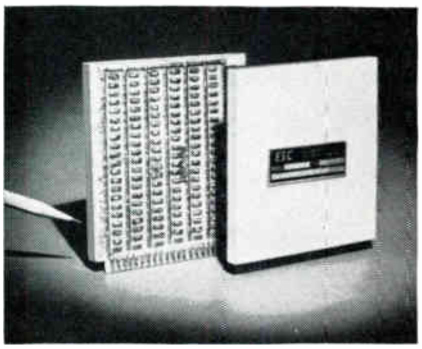
Circle 76 on Inquiry Card

World Radio History

NEW PRODUCTS

TRANSPONDER DELAY LINES

Exhibit delays of 20.3μsec. and 24.65μsec. Each occupy 4 x 4 x ⅜ in. board space.



Models 53-89 and 53-92 can be supplied as separate PC mounting components or together with associated circuitry. Impedance is 400Ω for the Model 53-89 and 470Ω for the Model 53-92. The delay to rise time ratio is better than 50:1. Attenuation is less than 0.12db/μsec., and temp. coefficient is less than 50 ppm/°C over a temp. range of −55°C to +85°C. Taps are provided at 1.45μsec. intervals to a ±0.05μsec. tolerance. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

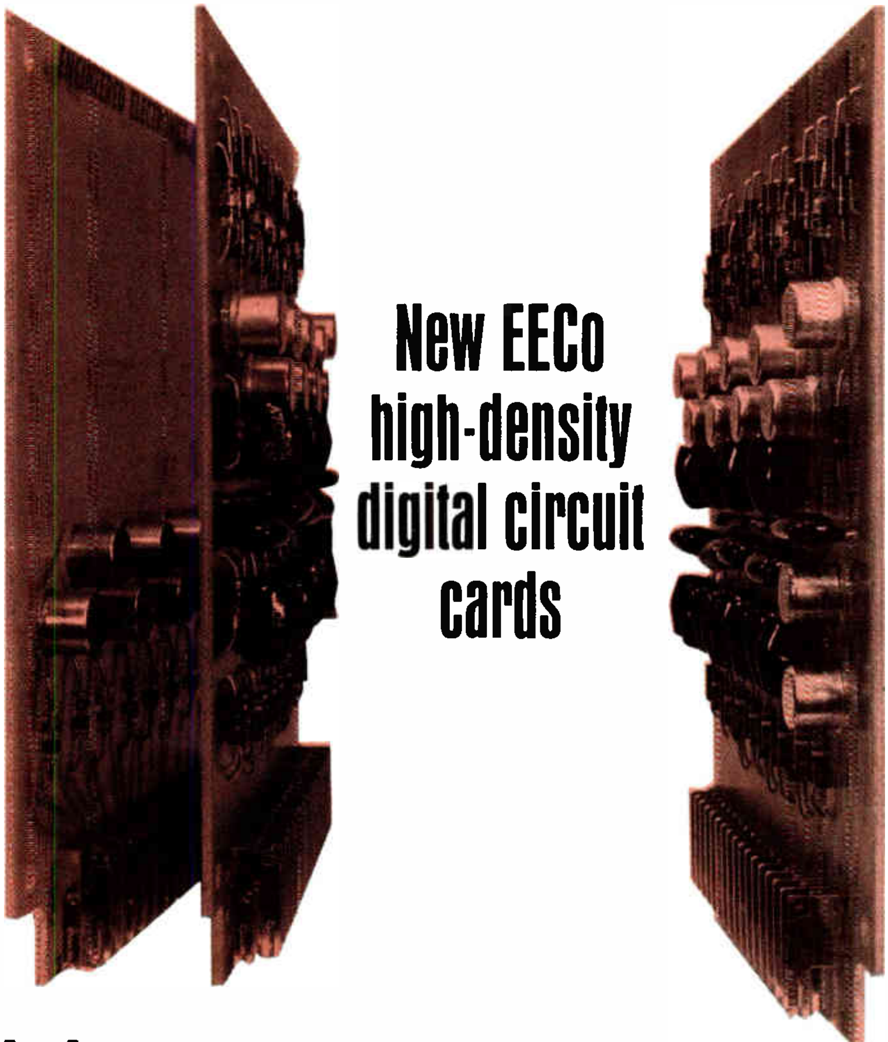
Circle 249 on Inquiry Card

DIGITAL VOLTMETER

Capable of providing 0.005% accuracy at a reading speed of 22msec.

The accuracy of the Model 5600 5-digit voltmeter is based on a percentage of reading, from 1 to 999.99v. The high reading speed is made possible by solid-state switching and a direct-coupled input. Reading time is dependent on the value of the previous reading, except when a polarity or range change is required. The instrument follows a fixed, successive approximation sequence that balances the internal reference against the unknown signal. Resolution is 1 part in 10,000 or 0.001%. High reading speeds are also provided for ac measurements. Dana Laboratories Inc., Irvine, Calif.

Circle 250 on Inquiry Card



bring economy to high-quality circuits

Try these high-density cards—up to twice the usual number of components. There couldn't be a better time! Because EECo has announced price cuts up to 35% on its GA Series line which contains more than 70 **off-the-shelf** modules for both synchronous and non-synchronous use . . . speeds up to **10 mpps.**

How's this for value? Four flip-flops and a nand on a single 4½" x 5" card **at $9 per flip-flop.** Result: substantial savings in hardware and wiring costs . . . plus patented short-circuit protection and EECo's **lifetime** warranty. All circuits use the widely accepted VARICON* connector.

Write, wire or phone for complete information.

*Trademark of ELCO Corp.

***LOOK TO EECo for**...the world's most complete line of packaged digital circuit modules...breadboard equipment which allows a designer to change system modular complement at will—without soldering or other permanent type of attachment.*

ENGINEERED ELECTRONICS Company ®

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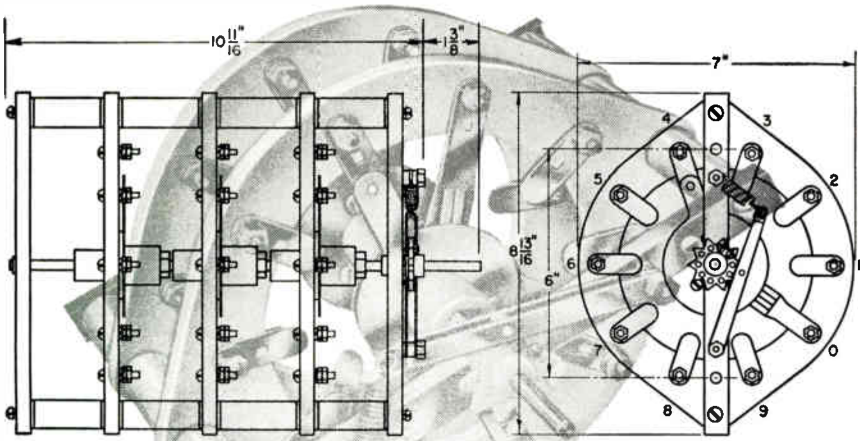
Phone: (714) 547-5651 Cable: ENGELEX

Circle 77 on Inquiry Card

World Radio History

SWITCH TO THE BEST

- 20,000 volt peak flashover at 60 cps
- 40 ampere current carrying capacity
- Current carrying members heavily silver plated
- Coin silver contact shoes



MODEL 90 SWITCH

RSC
FOUNDED 1933

RADIO SWITCH CORPORATION
MARLBORO, NEW JERSEY
Telephone: HOpkins 2-6100

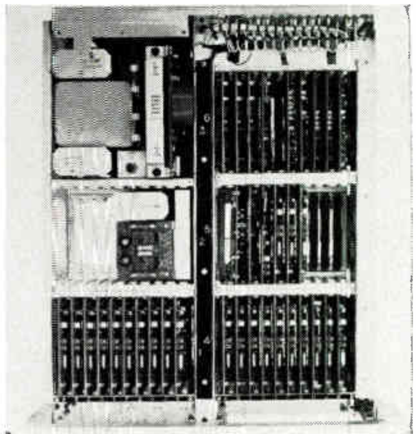
- Low loss silicone impregnated steatite stators and rotors
- White glazed steatite spacers
- Nylon detent wheel
- Stainless steel detent arm
- Sleeve bearings

Circle 78 on Inquiry Card

NEW PRODUCTS

DATA DISTRIBUTOR

Converts computed data to analog form under computer control.



Model 670 series uses solid-state circuitry. It distributes computed data to analog output channel. Accuracy is ±0.02% @ dc; linearity is ±0.01% @ dc, and stability is ±0.01% @ dc. Decommutation rate is 50KC to within ±0.02%; sample time is 30μsecs. to within ±0.02% for 20v. full scale excursion. Accepts input data up to 17 bit decimal, 14 bit binary; address up to 7 bit binary (104 channels max.) Redcor Corp., 7760 Deering Ave., Canoga Park, Calif.

Circle 251 on Inquiry Card

CERAMIC CAPACITOR

Working voltage is 25vdc. Power factor is 1.5% at 1KC.

This capacitor has a capacity of 0.47μfd in a CK06 case. It is available with No. 22 AWG tinned copper leads as standard; it may be ordered with special weldable lead material. Features include temp. range: —55°C to 125°C; insulation resistance: 100K megohms or 1KΩ farads @ 25°C; test voltage: 4 times rated voltage. Electro Materials Corp., 11620 Sorrento Rd., San Diego, Calif.

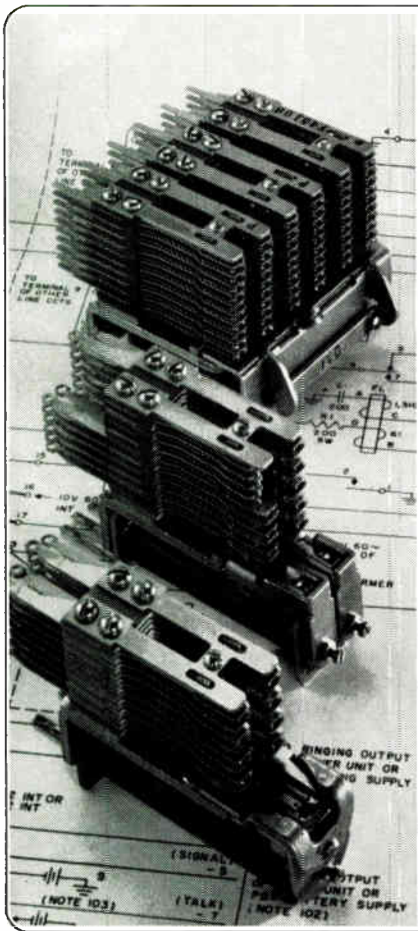
Circle 252 on Inquiry Card

CURRENT REGULATOR

For use with any sine or square wave pulse generator or simulator.

Solid-state regulator Model 106 converts constant-voltage pulses to adjustable constant-current pulses. It is completely self-contained and requires no auxiliary power source. The zener diodes and silicon transistor use the power provided by the driving pulse, which may be from 60 to 135v. Current ranges from 0.01ma to 10ma. American Electronic Laboratories, Inc., Richardson Rd., Colmar, Pa.

Circle 253 on Inquiry Card



telephone quality relays

There is no higher standard for relays. Specify Stromberg-Carlson . . . known to telephony since 1894.

TYPE A: general-purpose relay. Up to 20 Form "A" spring combinations.

TYPE B: multi-contact relay. Up to 60 Form "A" spring combinations.

TYPE BB: multi-contact relay. Up to 100 Form "A" springs.

TYPE C: two relays on one frame; mounts in same space as one Type A.

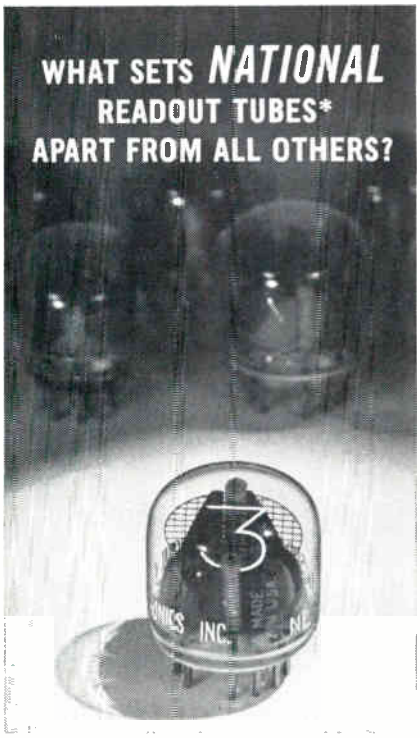
TYPE E: general-purpose relay; universal mounting; interchangeable with relays of other manufacturers.

Write for complete technical data.

STROMBERG-CARLSON
A DIVISION OF GENERAL DYNAMICS
115 Carlson Road • Rochester, N. Y. 14603

Circle 79 on Inquiry Card

World Radio History



KNOW-HOW
MAKES THE DIFFERENCE

National Electronics has more gas tube experience than any other company. This has now been applied to readout tubes . . . that's why National Know-How makes the difference. National Know-How is measured by performance . . . long-life . . . 300,000 hours life and more. National Ultra Long Life Readout Tubes provide both initial and long term uniformity . . . no variation in color or intensity from number to number, tube to tube. Readout is bright, clear, distinct and non-fading.

PLUS FLEXIBILITY . . .
Choice of shapes . . . round or rectangular. Wide range of character sizes (.310" to 2.0").

ECONOMY TOO . . .
Simple, rugged, attractive display. Easy to package. Low initial cost. Request full readout tube technical data and details.

*Manufactured under license from Burroughs Corporation

NATIONAL
ELECTRONICS, INC.
A SUBSIDIARY OF EITEL-McCULLOUGH, INC.
PHONE: (312) 232-4300 • GENEVA, ILLINOIS, U.S.A.

Circle 80 on Inquiry Card

NEW PRODUCTS

DATA-LOGGING SYSTEM

It monitors output of low-level transducers. Input impedance above 1,000 meg./v.

The Vidar 5100 offers microvolt sensitivity on the lowest range. It makes low-level measurements directly without further amplification. The system is floated and guarded from power-line ground with a common mode rejection of 160db at all freqs. The system integrates digital voltmeter, high-speed paper-tape printer, and a system coupler. Channel identification, polarity, 5 digits of data, and range are printed at a max. rate of 600 channels/min. Vidar Corp., Mountain View, Calif.

Circle 254 on Inquiry Card

TUBULAR CAPACITORS

Available in 100, 200, 400 and 600vdcw ratings. Tolerances to ±1%.

Capacitor types MD and MPD are both dipped Mylar® and dipped Mylar-paper construction. They are non-inductively wound and vacuum-dipped to obtain solid impregnation and a moisture-proof coat. In addition to by-pass and coupling uses, the units are said to improve operational characteristics and reduce costs of precision filter and timing circuits. Arco Electronics, Inc., Community Dr., Great Neck, N. Y.

Circle 255 on Inquiry Card

ROTARY CONVERTER

Changes 24vdc to 110v., 60 cycle ac. Output freq. held within about ¼ cycle.

This rotary converter has a capacity of 350w., 115v., single phase. Solid silver collector rings and silver commutator bars eliminates corrosion that may occur to copper and brass parts. It runs on greased-for-life shielded ball bearings and may be operated in either vertical or horizontal position. Kato Engineering Co., Mankato, Minn.

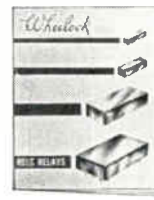
Circle 256 on Inquiry Card

PROVEN

. . . DURING 70,000,000 MISS-FREE OPERATIONS

- 100% Tested
- Coil Ratings: 60 to 1500 mw
- Contact Ratings to 50W Inductive
- Operating Time: —2ms (Typical)
- Coil Voltages: 6 to 120 VDC
- "Cradled Reed" Design

NEW CATALOG describes the complete line of Wheelock Proven Glass Reed Relays. Includes capabilities, limitations, application data, mechanical and electrical specifications.



Wheelock
273 Branchport Ave.
Long Branch, N. J.
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Circle 81 on Inquiry Card

World Radio History

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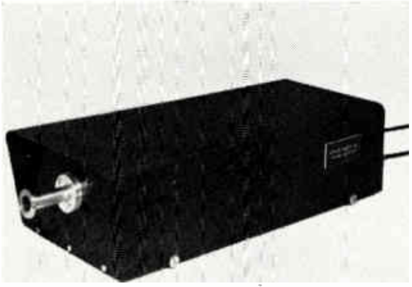
Circle 82 on Inquiry Card

NEW PRODUCTS

LASER

May use 5 different flash lamps and 3 types of cooling.



Ruby laser Model 1010c2 can be operated in high energy, high repetition rate, or Q switched modes, simply by changing the basic flash lamp component and cooling. This is done without involving system optics misalignment or modification. It can deliver up to 250 joules in 1.5msec. In the high repetition rate mode, it is capable of delivering up to 20 pulses/sec., at 0.5 joules/pulse or 10 joules/pulse at 4 pulses/sec. In the Q switched mode, the output can be varied between 1 joule in 30nsec. and 10 joules in 4μsec., at repetition rates as high as 1 pulse/sec. Applied Lasers, Inc., 41 Montvale Ave., Stoneham, Mass.

Circle 257 on Inquiry Card

MULTI-TURN POTENTIOMETER

Power handling capability is 2w. @ 40°C; resistances: 100Ω to 100KΩ.

Model 7300 features rear terminals for higher density packaging. The unit is ¾ in. in dia. and has a body length of 1½ in. behind panel. It uses a stop system which isolates mechanical and electrical functions, and gives it the 100 oz-in. stop-strength of larger units. Heated core winding, silver braze terminations, and screwdriver slotted shaft are standard features. International Resistance Co., 401 N. Broad St., Phila., Pa.

Circle 258 on Inquiry Card

BROADBAND TRANSFORMER

Freq. response flat to ±1.5db over the range of 9 CPS *to 1.2*MC.

Transformer S5-346 has a 17 octave passband. Two balanced secondary windings optimize driving push-pull transistor bases from a single-ended transistor collector. The transformer is said to give better balance and higher efficiency than is possible with conventional R-C coupling circuits. Toroidal windings nearly cancel hum pickup. Spectran Electronics Corp., 146 Main St., Maynard, Mass.

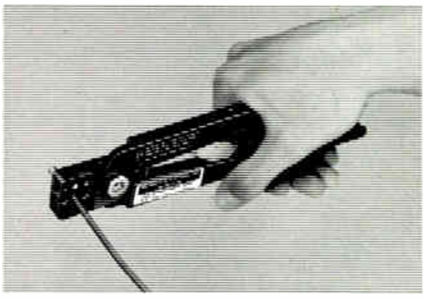
Circle 259 on Inquiry Card

Custom Design Your Own Crimp-type Connectors

EASIER THAN DIALING A PHONE USED TO BE!

This unique Microdot "connector selector," a simple-to-use circular slide rule, enables design engineers to customize crimp-type connectors to their specific requirements. Using this handy selector, you may choose from 40 parts and over 120 combinations of wire size, mating and mounting styles.

"Microcrimp" coaxial crimp-type slide-on connectors are commercially priced, and offer high reliability, small size and ease of assembly. Cable-mounted connectors are available in three mounting versions: line-cable mounting, bulkhead mounting, and snap-lock mounting. Bulkhead receptacles with solder turrets are available with bulkhead or snap-lock mounting.



MICRODOT CRIMPING TOOL

Assembly is fast and simple, on the bench or in the field, with this Microdot crimping tool. Merely strip the cable, crimp center contact, snap-on outer shell and crimp shield.

Write for free "Microcrimp" selector and product bulletins.

MICRODOT INC.
220 Pasadena Avenue
South Pasadena, California

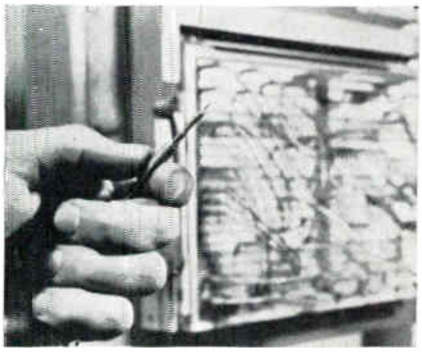
Circle 83 on Inquiry Card

World Radio History

NEW PRODUCTS

PROGRAMMING SYSTEM

Program changes accomplished without multiple coaxial connectors.



Complex switching is facilitated by this coaxial programming system. Changes involving up to 3036 coaxial circuits are accomplished by changing one or more removable front boards in the system. The procedure normally requires changing a series of individual or multiple coaxial connectors. The system comprises a lightweight metal frame which houses a molded plastic board containing individual coaxial spring contacts. One-crimp coaxial contacts connect the system with external equipment. AMP Inc., Harrisburg, Pa.

Circle 260 on Inquiry Card

MAGNETIC DIVISION MODULES

Accuracy is 1% over numerator and denominator ranges of 20 to 1.

With this unit the numerator consists of an ac input signal while the denominator is a dc control signal. These new units make it possible to avoid complex and cumbersome circuitry previously used in solving analog equations and trig function conversion. Additional features are high reliability, and adaptability to any signal freq. from 60 CPS to over 100KC. General Magnetics, Inc., 135 Bloomfield Ave., Bloomfield, N. J.

Circle 261 on Inquiry Card

PRECISION CAPACITOR

Working voltage is 500vdc; operating temp. is −55°C to +125°C.

The SG-11129 glass dielectric piston trimmer capacitor is ¼ in. dia. x 13/32 in. behind panel length. Ranges are 1.0pf to 15.0pf. Temp. coefficient is 0 ±50 ppm/°C. Dielectric strength is 1kvdc at 50% relative humidity and max. rated capacitance. Insulation resistance is 10^6 megohms at 50% relative humidity. Q @ 1MC is 750 minimum. Solid metal electro bands permit soldering and unsoldering without capacitor damage. Elcom Dept., Roanwell Corp., 180 Varick St., New York, N. Y.

Circle 262 on Inquiry Card

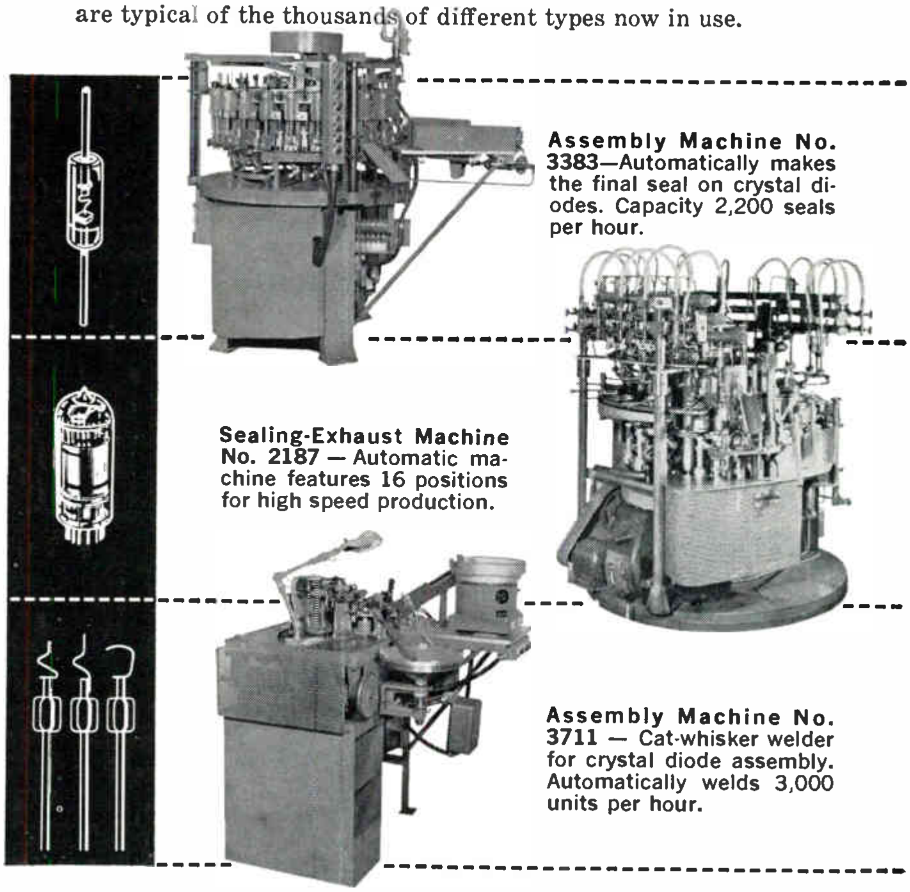
Speed Production...Lower Costs!

with KAHLE

AUTOMATIC PRECISION

ASSEMBLY MACHINES

KAHLE service encompasses the complete responsibility for special machine projects from design to final testing. KAHLE designs and builds high efficiency production machines for manufacturers in electronics, glass and general industry. The machines illustrated are typical of the thousands of different types now in use.



Assembly Machine No. 3383—Automatically makes the final seal on crystal diodes. Capacity 2,200 seals per hour.

Sealing-Exhaust Machine No. 2187 — Automatic machine features 16 positions for high speed production.

Assembly Machine No. 3711 — Cat-whisker welder for crystal diode assembly. Automatically welds 3,000 units per hour.

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DESIGNERS & BUILDERS OF AUTOMATIC MACHINES FOR HIGH SPEED, PRECISION PRODUCTION

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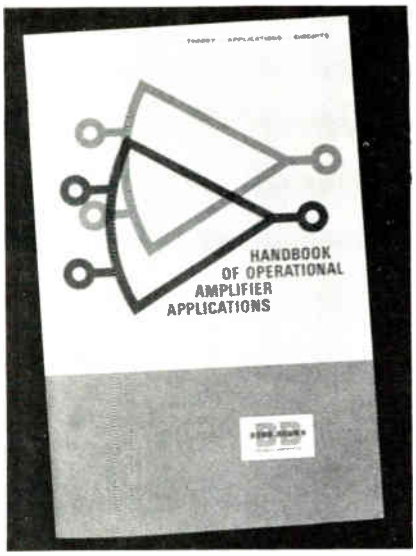
World Radio History



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NEW PRODUCTS

GROUNDOMETER

Measures resistance path through which current must flow to ground.

The type A Groundometer features a transistor operated 1-f bridge power source. It uses a synchronous meter detector to eliminate stray ac and dc ground currents. Full scale ranges are 1-10-100-1K and 10KΩ. It is used for measuring the resistance path of grounding electrodes for lightning arrestors, transformers, relays, transmission line towers, telephone and telegraph equipment, etc. Industrial Instruments Inc., Borden Engineering Div., 89 Commerce Rd., Cedar Grove, N. J.

Circle 263 on Inquiry Card

MINIATURE CONNECTOR

Environmental circular connectors with miniaturization in all 3 directions.

Mini-Mate connectors are bayonet type with #22 crimp contacts on 0.080 centers. They are insertable from the rear but released from the front. The retention system permits each contact to be inserted or released independently. It maintains a minimum of 18 lbs. retention after 10 or more insertions and removals. The contacts provide low engagement forces which average less than 2 oz. They maintained their values with virtually no change throughout a durability test of 2,000 cycles. Matrix Science Corp., 3311 Winona Ave., Burbank, Calif.

Circle 264 on Inquiry Card

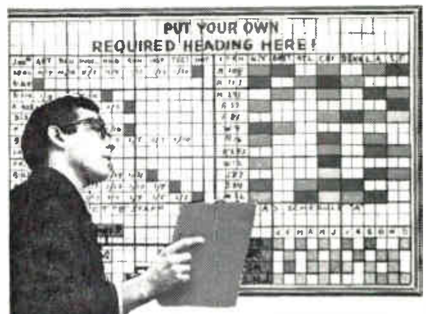
POWER TRANSISTORS

For converter and inverter circuits operating at 50 to 100KC.

These triple-diffused, planar silicon power transistors meet and/or exceed the applicable requirements of Mil-S-19500C. They feature h-f. high gain, high reliability, and low leakage. The transistors may be used for h-f linear amplifier and high-speed switching applications. Silicon Transistor Corp., Carle Place, L. I., N. Y.

Circle 265 on Inquiry Card

Don't Remember
Use a KLING Visual Control Board



Here's KLING Visual Control Board with MAGNETS!

ONE SYSTEM TO CHART YOUR PROGRESS

Lightweight, white steel board with aluminum frame, 24″ x 36″, blank with 1″ square gridlines, 50 color-coded magnets, and markers. Write on magnets and/or boards—or erase—for complete flexibility! No pins. No pegs. No flimsy cards.

$35 complete, ready to use, with magnets, markers, & aluminum frame!

ON APPROVAL TO RATED FIRMS—or send for free booklet E-2

Regal & Wade Mfg., Inc. / KLING SYSTEMS
Maspeth, New York 11378

Circle 85 on Inquiry Card

Sun Geared
PRODUCTIVITY

In the
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industrial area

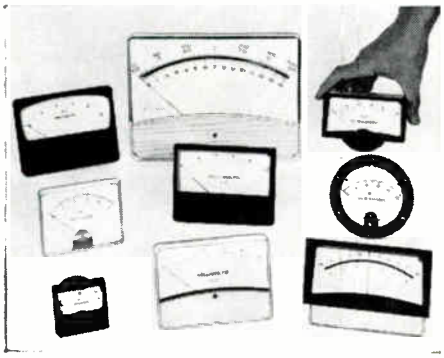
Productivity . . . a plus from employees who can increase their skills. The new GENESYS (Graduate Engineering Educational System) Program brings graduate Engineering training for your employees right to your Daytona Beach Area's plant door. Add to your own productivity...allow our manpower pool to help solve your recruitment problems. Proof of the success of area industrial operations is found in the growth and expansion records of the diversified industries that have selected a Daytona Beach Area plant site.

Write to: Robert H. Miles, Industrial Manager **DAYTONA BEACH** Area Committee of 100 (Ormond Beach, Daytona Beach, Daytona Beach Shores, South Daytona, Holly Hill, Port Orange). P.O. Box 1309, Dept. I-59 Daytona Beach, Florida

Circle 86 on Inquiry Card

World Radio History

±1% tracking plus taut-band in 20 models, 9 styles---with many in stock



API offers 1 percent tracking, at no extra cost, in virtually every popular DC panel meter style, size and sensitivity—clear plastic, black phenolic, or ruggedized-sealed.

As long as you specify taut-band construction, you'll automatically get ±1 per cent tracking—in all but the smallest and most sensitive API meters.

Taut-band is a bonus in sensitive meters

You don't even have to specify taut-band if you order meters in ranges from 0-3 to 0-50 microamperes and from 0-3 to 0-25 millivolts. These meters just naturally come with taut-band. Besides responding best to exceptionally small signals, this friction-less design is much more resistant to damage from shock and vibration.

(Taut-band costs a little extra for less sensitive meters than those named above. There's also a slight charge for 1 per cent tracking in the 0-3 μa or 0-3 mv ranges.)

Immediate delivery for 10 models

Ten API panel meter models, in the most popular taut-band ranges, are now being stocked for off-the shelf delivery.

Ask for Bulletin 39 (Stock List)

For prices on all API taut-band meters
Ask for Bulletin 38

For information on all API meters, taut-band or pivot-and-jewel

Ask for Bulletins 34-B and 107-C

api

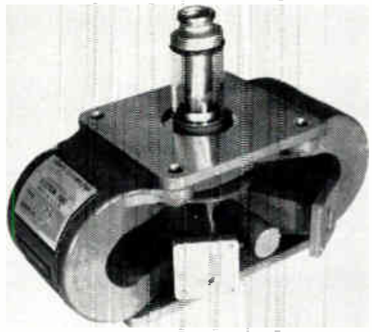
Assembly Products, Inc.
Chesterland, Ohio • Tel: 216-423-3131

Circle 87 on Inquiry Card

NEW PRODUCTS

CROSSED-FIELD AMPLIFIER

Freq. range: 16.0—17.0GC; pk. volt.: 13.5—15.5kv; pk. current: 18—25a.



SFD-220 is a high power, high gain K_u-band crossed-field amplifier. The 100kw tube is a continuous cathode, re-entrant stream device. It is designed for use as the final amplifier in K_u-band coherent radar transmitters. It is forced-air cooled and features ceramic input and output windows. The tube offers 20db gain, and possesses the phase stability needed for high resolution systems, and the broad bandwidth needed for freq. agile systems. S-F-D Laboratories, Inc., 800 Rahway Ave., Union, N. J.

Circle 266 on Inquiry Card

MINIATURE COIL

R-F units for printed circuits. Covers range from 0.9μh to 125mh.

The series 23A vertical mounting coils are wound on Resinite coil forms. These forms combine the mechanical and dielectric advantages of phenolics with high dielectric strength, moisture resistance and non-corrosive properties of cellulose acetate. Temperature range is −55°C to +85°C. J. W. Miller Co., 5917 So. Main St., Los Angeles, Calif.

Circle 267 on Inquiry Card

MONITOR OSCILLOSCOPE

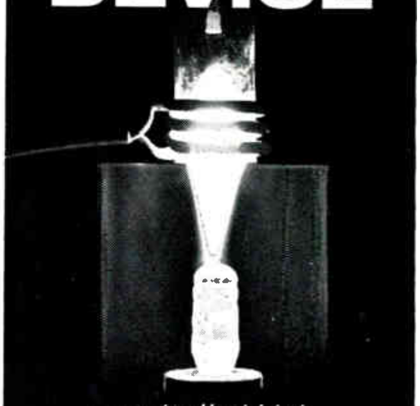
Miniature unit has features of laboratory type oscilloscopes.

Model 7000 Monitor Oscilloscope set allows continuous monitoring of analog tape record-reproduce systems, and other uses where multi-channel dynamic signal display is desired. Features include bandwidths of 5MC ±1db; calibrated sensitivities of 0.1v. RMS/in. to 10v. RMS/in. in 7 steps; calibrated sweep rate of 0.01 to 100KC in 5 steps, plus a 10 times vernier control for sweep rate of 1MC; very stable automatic triggering; and bright, sharp displays. California Instruments Corp., 3511 Midway Dr., San Diego, Calif.

Circle 268 on Inquiry Card

Lepel

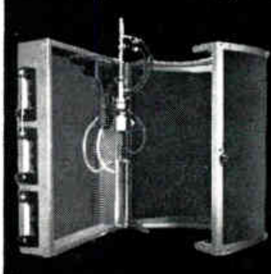
INDUCTION COUPLED
PLASMA DEVICE



a controlled high temperature heat source for

- CRYSTAL GROWING
- SPHEROIDIZING PARTICLES
- HEATING FLUIDS & GASES
- LABORATORY RESEARCH

The new Lepel inductively coupled plasma device is a low cost unit designed to permit laboratories and research departments to conduct experimental work within a modest budget. It can readily be mounted on existing laboratory fixtures or directly on the induction generator. The plasma unit can be supplied with either a single-walled quartz tube or a double-walled water cooled quartz tube. The adjustable water cooled feeder tube provides for passage of solid particles through the plasma.



Enclosure for plasma device includes hinged protective shield of tinted plexiglas and flow meters.

Lepel HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N.Y.C.

Circle 88 on Inquiry Card

World Radio History

IBM

PRINTED CIRCUIT CARDS "COMPUTE" FLAWLESSLY

WITH BARNSTEAD PURE WATER EQUIPMENT

The General Products Division of International Business Machines at Endicott, N.Y., produces printed circuit cards which are literally the "brains" of IBM Computers — large and small.

Because of the extreme sensitivity of electronic equipment it is mandatory that these printed circuits be completely free from foreign or inorganic matter — otherwise Computers will malfunction.

To "rinse away" all foreign matter from these printed circuit cards, IBM in its plating bath make-up, uses water that has been first demineralized and then distilled.

As city water enters the plant, it passes through a Barnstead Demineralizer to remove all mineral content and then through a Barnstead Still for distillation — the ultimate in Pure Water. It is then stored in a Barnstead storage tank to insure a steady supply of Pure Water as needed for the production line.

Installed in 1959, this Barnstead equipment is inspected three times yearly, and to date there has been no maintenance of any kind other than replacement of spent cartridges.

Want to know how Barnstead Pure Water can help your manufacturing and processing operations? Then write for Catalogs "G" and 160. No obligation, of course.

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STILL AND STERILIZER CO.
51 Lanesville Terrace, Boston 31, Mass.

Circle 89 on Inquiry Card

NEW PRODUCTS

CRYSTAL FILTERS

Available with center freqs. spaced 10KC apart from 5GC to 5.150GC.

Model 5399A is a multi-pole matched filter which uses piezo-electric resonators. Since the filter freq. characteristic approximates the signal transform, the output time function is triangular. Measurements of the signal-to-noise ratio improvement provided by the crystal matched filter are close to theoretical values. Uses include pulse radar, pulse doppler radar, pulse communication systems, data and telemetry transmission systems. Damon Engineering, Inc., 240 Highland Ave., Needham Heights, Mass.

Circle 269 on Inquiry Card

PHASE SHIFTER

For 18.0 to 90GC; the unit features VSWR of less than 1.15.

With the DB-910 - 360° precision phase shifters, max. resolution is assured through use of a micrometer-driven, precision mica vane. Insertion loss is less than 1.3db @ 360° and 90GC. Absence of gear train mechanism minimizes backlash. Micrometer readout is precise to 0.001 in. Micrometer dial is positioned for max. ease-of-use. DeMornay-Bonardi, Div. of Datapulse Inc., 780 So. Arroyo Pkway., Pasadena, Calif.

Circle 270 on Inquiry Card

TIME-DELAY RELAY

Withstands continuous energization up to 110% of rated voltage.

The TD-4 relay can be used for any timing use requiring a 2-stage timing interval. One stage is adjustable from 0.1 to 1.0 sec.; the second stage is adjustable from 0.5 to 3.0 sec. The relay is operated from a dc source of 48, 125, or 250v. It is particularly suited for use as a timing unit for the second and third zone (KD-4 and KD-41) relays in a compensator distance relaying scheme. Provides a single time-delay for zone 2 faults, or a longer time delay for zone 3 faults. Westinghouse Electric Corp., P. O. Box 868, Pittsburgh, Pa.

Circle 271 on Inquiry Card

SANWA

ANNOUNCING A NEW SANWA MULTITESTER

Unsurpassed tester performance comes with Sanwa's new multitester Model U-50. Sanwa Electric manufactures 80 per cent of all testers used in Japan. Model U-50 is the result of Sanwa's extensive experience and technology in the electrical instrument industry.

MODEL U-50, 1½" thick 13½ oz.

- Handy, pocket size providing a meter movement of 35 microamperes in sensitivity.
- High internal resistance of the movement checks voltages of high resistance circuits efficiently.
- Thin and compact—two-thirds the weight of similar testers.

TECHNICAL DATA

DC volts: 0.1~1000 in 6 ranges (20kΩ/v)
AC volts: 2.5~1000 in 5 ranges (8kΩ/v)
DC milliamperes: 0.05~250 in 5 ranges
DC ohms: RX1~RX1000 in 4 ranges (min. 1 Ω & max. 5 mg Ω)
Decibels: – 20~+62
*Megohms: 1~500
*Microfarads: 0.0001~0.006 & 0.001~0.2
*Use external power.
Battery — Two 1.5v (UM-3) dry cells.

For detailed information please write.

SANWA ELECTRIC INSTRUMENT CO., LTD.
Dempa Bldg., 2-chome, Soto-Kanda Chiyoda-ku, Tokyo, Japan
Cable: "SANWAMETER TOKYO"

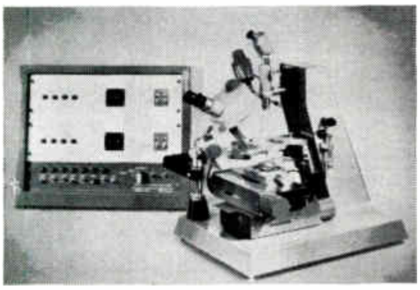
Circle 90 on Inquiry Card

World Radio History

NEW PRODUCTS

PROBING MACHINE

For rapid contacting of integrated circuits, transistors, diodes.



Model XY-540 is an automatically controlled production machine. It contacts components in the slice form prior to the scribing or dicing operations. Up to 16 probes and inkers can be set within a 0.015 x 0.015 in. area. Each probe is adjustable in X, Y, and Z-planes. The probes are stationary while the microcircuit slice is reciprocating up and down to contact the probes. Cycling speed of machine is 10K/hr. Transistor Automation Corp., 18 Moulton St., Cambridge, Mass.

Circle 272 on Inquiry Card

HEAT SHRINKABLE TUBING

All purpose, irriadiated, polyolefin, with a 2:1 shrinkage ratio.

Within 7 sec. following application of heat, (135°C) Alphlex FIT-221 shrinks to ½ its original dia. It forms a permanent, tight fitting mechanical bond even over irregularly shaped objects. Its ability to shrink when heated makes it ideal for insulating components and cables with a wide variation in shape and size. It is thermally stable and will not cold-flow or melt. It retains form stability from −55°C to 135°C. Alpha Wire Corp., sub. of Loral Corp., 180 Varick St., New York, N. Y.

Circle 273 on Inquiry Card

PULSE GENERATOR

Solid-state pulse generator has a repetition rate of 1KC to 200MC.

Model 122 has a risetime of less than 1nsec. Pulse width and pulse delay are 1nsec. to 100μsec. Delay, width and amplitude are fully controllable. Base line offset is ±1v., adjustable, either polarity. The general purpose pulser may be used in testing and development of digital computer systems, telemetry systems and equipment, and high resolution radar systems. E-H Research Laboratories, Inc., Oakland, Calif.

Circle 274 on Inquiry Card

new! A free guide book to the profit potential available in Florida's electronics industry.

Write for your free copy today! Full, factual and detailed information about your future as a Florida industrialist. A partial list of subjects covered: the fantastic "Space-Age Market"; the solid growth of the industry in Florida; the markets for electronic components... instrumentation... and general manufacturing; the welcome climate that offers a tax structure so favorable, you'll *want* to investigate; the unlimited R&D facilities available to you; the ease of recruitment of engineers and technicians, and the solid growth environment Florida offers you.

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World Radio History

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136 Liberty St., New York, N. Y. 10006

- High wetting properties for good bite
- Non-corrosive connections
- Residues removed by heating or water rinse
- No change on aging

Please send samples of your hydrazine-activated
☐ flux ☐ core solder

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Title______
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City______
State______ Zip______

for samples, technical data on hydrazine-activated flux* or core solder. *U.S. Patent No. 2,612,459 and others.

Circle 93 on Inquiry Card

BOOKS

Electrical Correcting Elements in Automatic Control and Regulation Circuits

By G. K. Krug and Ye K. Krug. Published 1964 by Pergamon Press Ltd., and distributed by The MacMillan Co., 60 Fifth Ave., New York 11, N. Y. Price $5.00. 88 pages.

This book provides a summary of the basic theory of automatic regulation. Also, many electrical correcting and stabilizing devices used in practice are described. Practical recommendations on their uses in automatic control systems are given. This book has been translated from the Russian.

Solid Circuits and Microminiaturization

Edited by G. W. A. Dummer. Published 1964 by Pergamon Press Ltd., and distributed by The MacMillan Co., 60 Fifth Ave., New York 11, N. Y. Price $8.50. 346 pages.

Proceedings of the Conference held at West Ham College of Technology, June, 1963.

Physics—Electronics Titles—1960 Volume

Published 1964 by Boston Technical Publishers, Inc., 5 Bryant Rd., Lexington, Mass. 02173. Price $12.50. 455 pages.

Every Key-Word in the titles of major articles or papers which appeared in any of over 200 periodicals has been indexed using electronic computers.

Design of Low-Noise Transistor Input Circuits

By William A. Rheinfelder. Published 1964 by Hayden Book Co., Inc., New York, N. Y. Price $5.50. 160 pages.

The author develops a clear step-by-step method for calculating noise factor by separately calculating signal and noise powers. A complete chapter is also devoted to its measurement. This approach leads to success with the most complicated circuits. Many time-saving graphs and design curves are given for the circuit designer. New approaches in such areas as the problem of crowded frequency bands, generalized noise theory, and noise concepts, are discussed. Practical design details as well as discussions of typical modern circuits are included.

Books Received

Graphical Analysis: Understanding Graphs and Curves in Technology

By Philip Stein. Published 1964 by Hayden Book Co., Inc., 850 Third Ave., New York 22, N.Y. Price $9.95 (Trade Edition) and $8.00 (Text Edition). 270 pages.

Radar Scanners and Radomes

Edited by W. M. Cady, M. B. Karelitz and L. A. Turner. Published & Distributed 1964 by Boston Technical Publishers, Inc., 5 Bryant Rd., Lexington, Mass. 02173. Price $4.50. 491 pages.

Effective Public Relations, 3rd Edition

By Scott M. Cutlip and Allen H. Center. Published 1964 by Prentice-Hall, Inc., Englewood Cliffs, N.J. Price $11.95. 512 pages.

Here are permanent, abrasion-resistant nameplates you can apply *exactly where they're needed.* No moistening, screws or rivets required. Self-bonding Poly-Plates adhere tightly to any clean, dry surface. Made of miracle sub-surface printed Mylar*. Non-conductive . . . safe on or near energized equipment. Any wording, shape, size or color, including rich gold or silver. Low cost.

Write for bulletin and samples. 143

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Eisler — a name to remember in machinery for electronics

At left:
Largest assortment of wet and dry type Glass Cutters.

Below:
An Eisler precision vertical Spot Welder designed exclusively for welding electronic components. Sizes from ½ to 7½ KVA

Write us today for full particulars!

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Advertisers — February 1965

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DATA TRANSMISSION UNIT IN CLOSED-CIRCUIT TV FORM

A new closed-circuit television data transmission console has been disclosed by Cohu Electronics, Inc., of San Diego, Calif.

Called ER-2333, the system uses a 2000 series miniaturized TV camera mounted on an adjustable boom permanently affixed to a desk top. Through a combination of specified lenses and vertical movement of the camera a small section of data, or an entire page, can fill the whole monitor screen.

FLUID CONTROL PASSES TEST IN ARMY MISSILE FLIGHT

A new concept in controls—a fluid system with no moving parts or electronics—has successfully controlled a missile in flight at a Redstone Arsenal Missile Test range, according to Maj. Gen. John G. Zierdt, commander of the Army Missile Command.

The vehicle, a test instrumentation vehicle (TIM), contained a fluid-flow control system developed by Honeywell, Inc. The working fluid senses, computes, amplifies and controls by means of reaction jets. Streams of gas or liquid are directed by channeled plates inside the missile. By directing gas pressure the system performs control functions.

Fluid devices prevent missile from spinning by measuring spin rate and converting the rate to a memory of vehicle body position. Fluid amplifier cascades build up measured signals to power levels needed to control supersonic reaction jets to prevent spinning.

NEW SIEMENS DIVISION

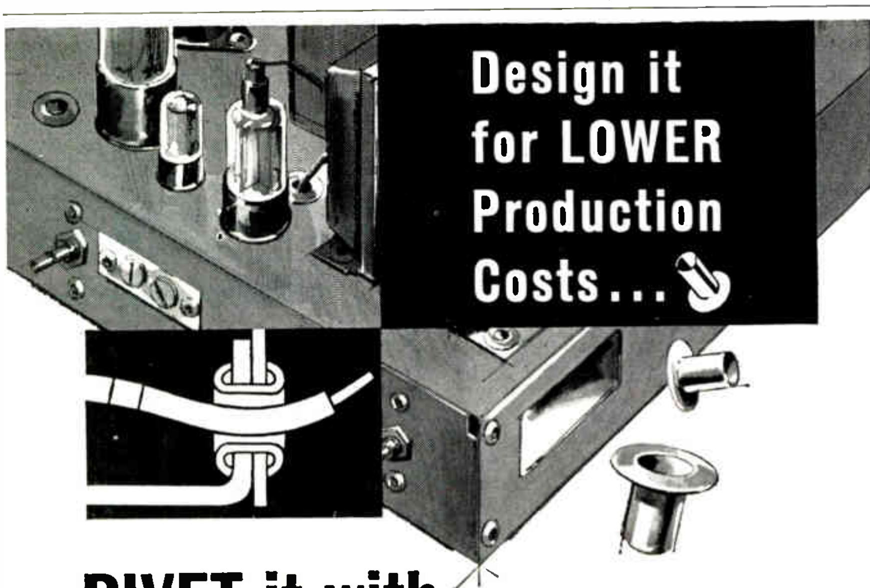
New headquarters for distribution of Siemens components throughout the U. S. is at 230 Ferris Ave., White Plains, N. Y., according to Herbert Stadlinger, Vice President of Siemens America, Inc.

This office and warehouse location, formerly operated by William Brand Electronic Components, Inc., is being enlarged and extended with additional storage facilities to handle the complete Siemens component line.

STANDARDS MEDAL AWARD

In recognition of leadership in the development and application of voluntary standards, Virgil M. Graham, associate director, Engineering Department, Electronic Industries Association, will receive the 1964 Standards Medal of the American Standards Association. Mr. Graham will receive the award from the ASA at its annual Awards Banquet in Chicago on February 16 at the Sheraton-Chicago Hotel, in conjunction with the association's 15th National Conference on Standards. The award honors Mr. Graham for his role in setting the electron tube type designation system, central registration for tube types, standardization work on auto radios, and in international standardization.

Virgil M. Graham



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Every year, more and more assemblies and sub-assemblies for electric and electronic equipment are being riveted with United's Eyelets, because manufacturers are discovering that eyelets provide uniformly strong, dependable fastenings—and in addition, help cut production time and costs, because both the initial **and** the all-important in-place costs are far less!

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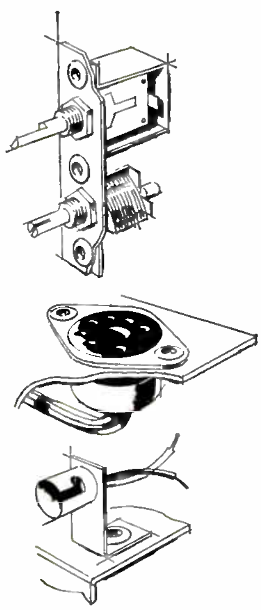

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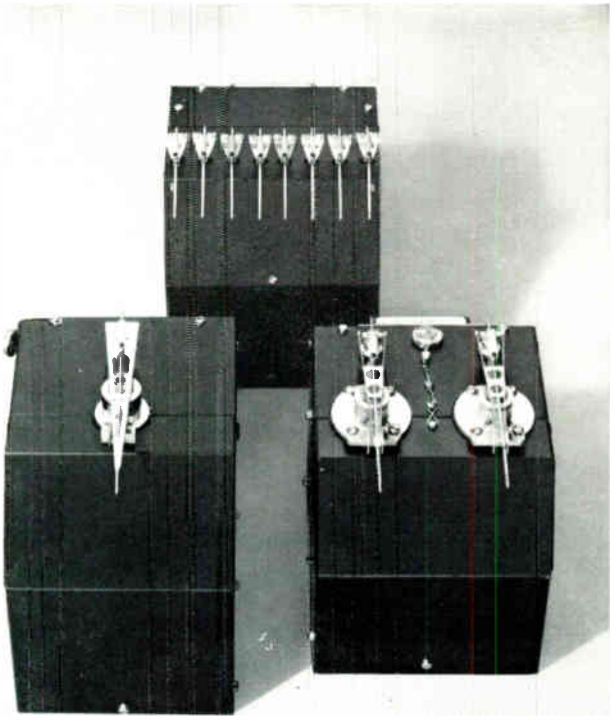

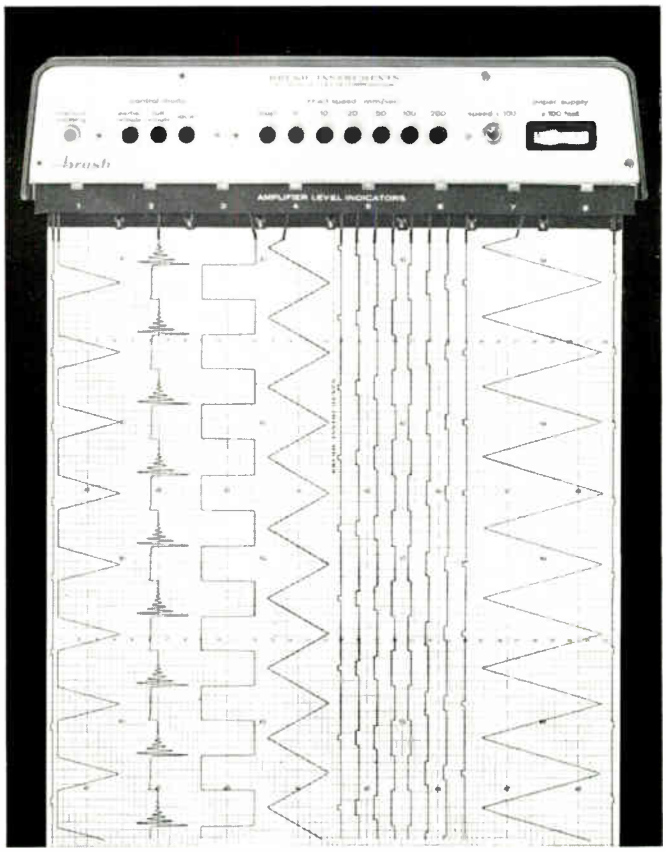

These are Optional Penmotors for the Brush Mark 200 Series 1707 Recorders

You should see the information they give ...in combination!

(modern oscillography will never be the same)

Optional penmotors are the newest of several Brush innovations that change previous notions about today's direct writing recording. The pace-setting Mark 200 now gives you any combination of variables ... 80mm channels for extreme resolution in absolute measurement ... 40mm channels for coordination of dynamic information ... "yes-no" information from time-codes, relays, actuators, etc. *One recorder presents them all ... in any combination ... on the same chart ... on a common time base!* The choice is yours! And, a pressurized inking system with over 10,000 channels of performance produces traces so accurate and crisp that you can't misread the signal. *True* rectilinear motion results from a unique linkage that creates a straight line 99.9% accurate. A super-sensor called the Metrisite "polices" the pen position for instant self-correction without mechanical restraint. The rule book of oscillography *is* changed. Check Brush for *new* standards. Your letterhead request will bring the complete story.

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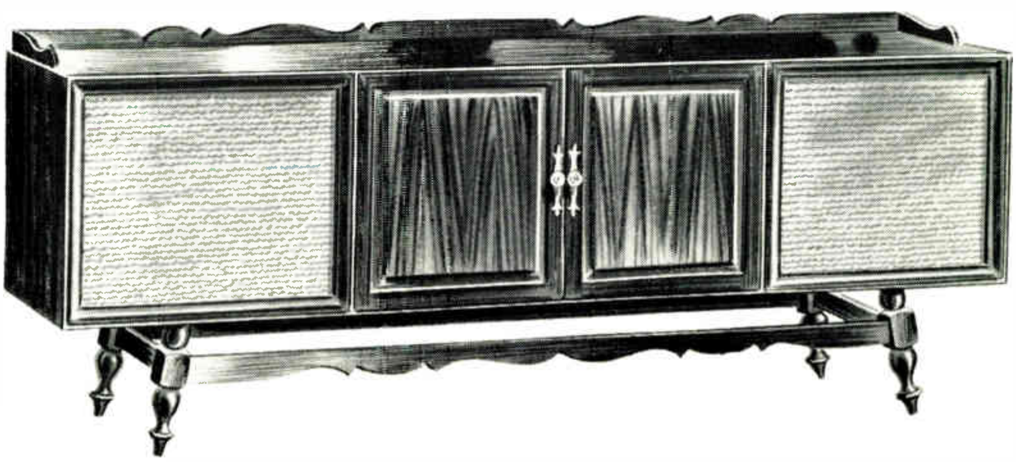

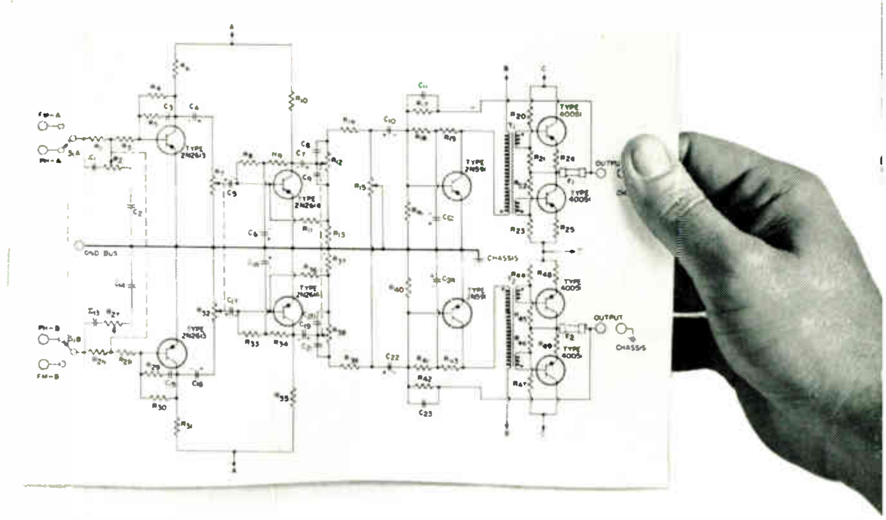

try these mass-produced RCA hi-fi transistors and this simple circuit

With this 5-transistor-per-channel solid-state amplifier circuit, you can make popularly-priced sets for today's big solid-state audio market.

This RCA-developed circuit can be driven by a tuner output or by standard ceramic phonograph pick-ups.

Despite its simplicity and low cost, this stereo amplifier circuit gives excellent performance: high gain with low distortion over a wide frequency range (response flat from 30 cps to 12,000 cps ± 3 db). It delivers 50 watts (RMS continuous) output power (75 watts music power) with a 4-ohm load.

These four low-cost, mass-produced RCA germanium transistors . . . specially designed for hi-fi applications make this a practical reality:

INPUT STAGE: RCA-2N2613 high-gain, low-noise (4 db max) P-N-P alloy-junction small-signal audio amplifier transistor.

PREDRIVER STAGE: RCA-2N2614 P-N-P high-gain, high-voltage alloy-junction small-signal audio amplifier transistor.

DRIVER STAGE: RCA-2N591 P-N-P high-gain, large-signal driver transistor.

OUTPUT STAGE (Class B): Two RCA-40051 P-N-P alloy-junction power transistors featuring excellent linearity.

Together, this RCA complement makes up the best hi-fi transistor value on the market today.

For full technical information request your copy of Advanced Application Note ST-2650 from your nearest RCA Field Office, or write to RCA Commercial Engineering, Section EJ2, Harrison, N. J.

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