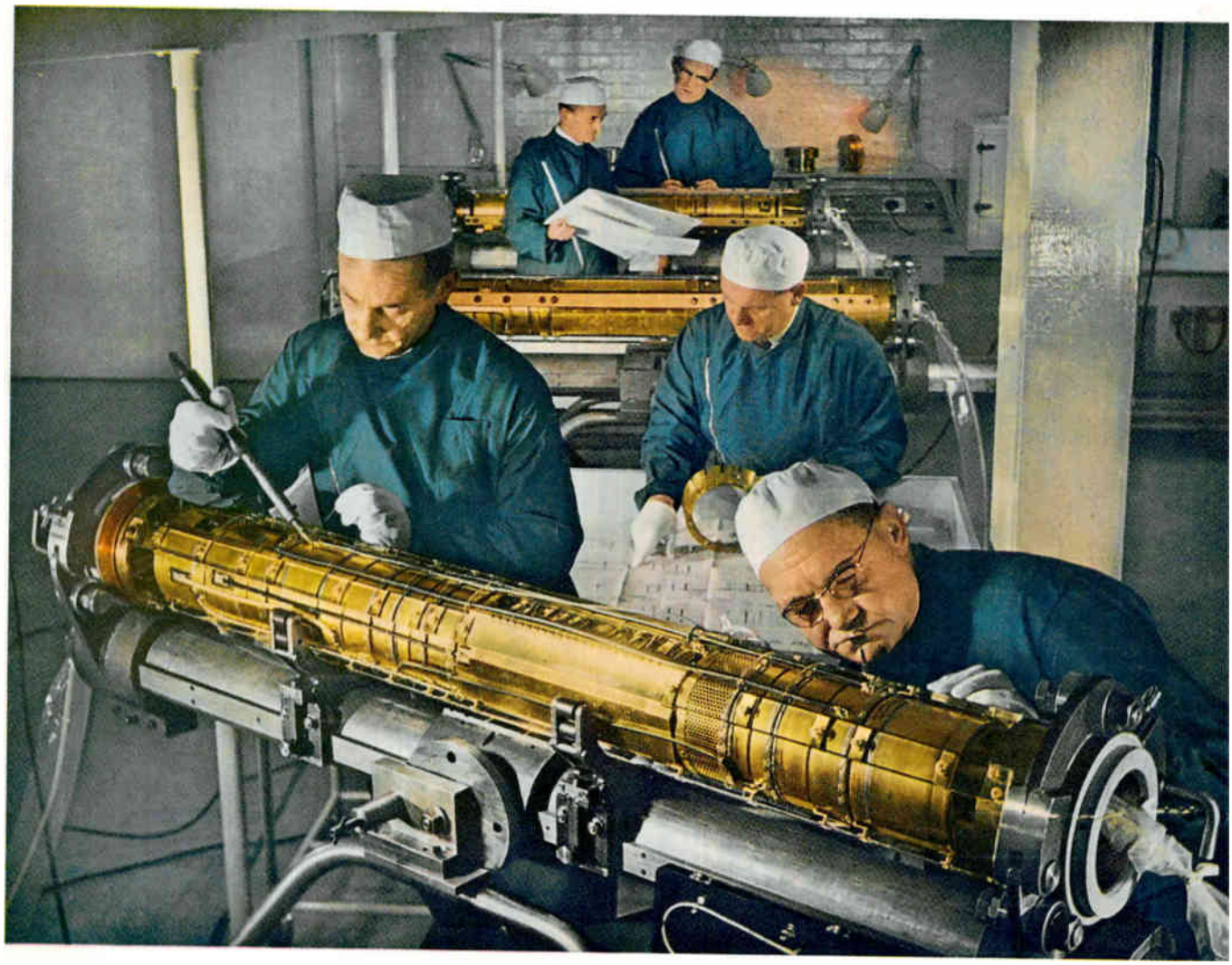
A McGraw-Hill Publication 75 Cents March 9, 1962

electronics

Inspecting repeater amplifiers for undersea telephone cable (below) p 82



INTERNATIONAL IRE SPECIAL . . .

Engineering highlights of the convention;

the recruiting climate; preview of exhibits and exhibitors

50 KC TO 40 KMC

/ERSATILE GENERATORS, OSCILLATORS
ALSO DRIVE hp FREQUENCY DOUBLER SETS

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Instruments bringing high power, wide range, convenience and accuracy to the 10 to 21 KMC range. Frequencies, output voltage directly set and read. Output 10 to 20 db better than previous spot-frequency sets; SWR better than 1.2 at 0 dbm and lower. High power output provides excellent drive for the hp 938A/940A Frequency Doubler Sets. Internal pulse, FM or square wave modulation; also external pulsing or FM'ing. hp 626A, 10 to 15.5 KMC, **$3,400.00**; hp 628A, 15 to 21 KMC, **$3,400.00.**

hp 680 Series Sweep Oscillators

Six models offering electronic sweeping for greater flexibility, simplified operation; range from 1 to 18.0 KMC. hp 686C, 8.2 to 12.4 KMC, hp HO1-686C, 7 to 11 KMC and hp 687C, 12.4 to 18.0 KMC, useful for driving hp Frequency Doubler Sets. hp 682C 1 to 2 KMC, $3,090.00; hp 683C, 2 to 4 KMC, $3,000.00; hp 684C, 4.0 to 8.1 KMC, $2,900.00 hp 686C, $2,900.00; hp HO1-686C, $3,000.00; hp 687C, $3,400.00.

Instrument	Frequency Range	Characteristics	Price
hp 606A	50 KC to 65 MC	Output 0.1 μv to 3 v. Full feedback loop, low distortion	$1,350.00 Δ
hp 608C	10 to 480 MC	Output 0.1 μv to 1 v into 50 ohm load. AM, pulse, or CW modulation. Direct calibration	1,100.00■
hp 608D	10 to 420 MC	Output 0.1 μv to 0.5 v. Incidental FM less than 0.001%	1,200.00 ■
hp 612A	450 to 1,230 MC	Output 0.1 μv to 0.5 v into 50 ohm load. AM, pulse, CW or square wave modulation. Direct calibration	1,300.00 ■
hp 614A	800 to 2,100 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration	1,950.00■
hp 616B	1,800 to 4,200 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration	1,950.00■
hp 618B	3,800 to 7,600 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW FM or square wave modulation. Direct calibration	2,250.00■
hp 620A	7,000 to 11,000 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, FM or square wave modulation. Direct calibration	2,250.00■
hp 626A	10 to 15.5 KMC	Output 10 dbm to —90 dbm. Pulse, FM, or square wave modulation. Direct calibration	3,400.00■
hp 628A	15 to 21 KMC	Output 10 dbm to —90 dbm. Pulse, FM, or square wave modulation. Direct calibration	3,400.00 ■

Δ Rack mounted instruments $15.00 less.
■ Rack mounted instruments $20.00 additional.

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

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Now! GENERATE PRECISE SIGNALS TO 40 KMC

with these new, inexpensive

FREQUENCY DOUBLER SETS!

For convenient, economical, reliable signal generation to 40 KMC, use these new hp Frequency Doubler Sets and either your own existing signal sources or one of the dependable, bench-proven hp signal generators on the next pages.

hp Model 938A supplies power from 18 to 26.5 KMC when driven by a 9 to 13.25 KMC source; hp Model 940A supplies power from 26.5 to 40 KMC when driven by a 13.25 to 20 KMC source.

The hp 938A and 940A have the same output versatility as the driving source. These broadband instruments accept cw, pulsed or swept input signals from signal generators, swept signal sources or klystrons.

Each contains a broadband crystal-harmonic generator, plus a dual rotary vane attenuator, for generating and accurately setting the output level 0 to —100 dbm. Output power depends on input power and is typically 0.5 to 1.0 mw when the driving source is an hp 626A or 628A Signal Generator or an hp 686A Sweep Oscillator. Output power is known, even though an uncalibrated signal source is used, since the output monitor is accurate to ± 1 to ± 2 db, depending on model and frequency.

hp 938A/940A conversion loss is approximately 17 db at 10 mw input. Maximum input power 200 mw, saturation output 2 mw. Attenuator accuracy ± 2% of reading or 0.2 db (whichever is greater). Attenuator range 100 db; output SWR less than 1.2 at 10 db or more attenuation. Sturdy construction permits signal source to be mounted on top of Doubler Set, presents output at convenient bench level. hp 938A, $1,500.00; hp 940A, $1,500.00.

Check these Precision hp SIGNAL GENERATORS

ACCURATE SIGNALS–

hp 606A Standard Signal Generator 50 KC to 65 MC

Output adjustable from 3 v full range to 0.1 μv rms (+23 to −120 dbm). Feedback assures power into a 50 ohm load constant within ± 1 db over the frequency range. Reliable internal crystal calibrator permits checking points at 100 KC and 1 MC intervals with an error of less than 0.01%. Very low distortion, broad modulating capabilities. Typical hp speed, ease of operation. hp 606A, **$1,350.00.**

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hp 608D—10 to 420 MC

Highest stability, low incidental FM and frequency drift. Calibrated output 0.1 μv to 0.5 v throughout range. Built-in crystal calibrator provides frequency check accurate within 0.01% each 1 and 5 MC. Master-oscillator, buffer and output amplifier circuit design. Direct calibration, ideal for aircraft communications equipment testing. hp 608D, **$1,200.00.**

hp 608C—vhf Signal Generator

High power (1 v max.), stable, accurate generator. 10 to 480 MC. Ideal for testing receivers, amplifiers, driving bridges, slotted lines, antennas, etc. hp 608C, **$1,100.00.**

UHF SIGNAL GENERATORS

hp 612A—450 to 1,230 MC

Same high output power, low incidental FM, broad modulation capabilities as hp vhf signal generators. Frequency, output directly set on large precisely calibrated dials. hp 612A, **$1,300.00.**

hp 614A—800 to 2,100 MC

Easy to use, direct-reading, one-dial frequency control, high stability and accuracy. Ideal for measuring receiver sensitivity, signal-noise ratio, conversion gain, SWR, transmission line characteristics. hp 614A, $1,950.00.

hp 616B—1,800 to 4,200 MC

Ruggedly built, compact to save bench space, offers same hp precision, ease of operation, compactness of the other hp uhf instruments. hp 616B, $1,950.00.

SHF SIGNAL GENERATORS

hp 618B—3,800 to 7,600 MC
hp 620A—7,000 to 11,000 MC

These instruments provide the simple, versatile operation and varied pulsing capabilities common in hp signal generators to the lower regions of the shf range. The 618B and 620A may be synchronized with an external sine wave or with positive or negative pulse signals, as may other hp signal generators. hp 618B, $2,250.00; hp 620A, $2,250.00.

March 9, 1962

electronics

A McGraw-Hill Publication 75 Cents

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GOLD-PLATED AMPLIFIERS for a trans-Atlantic telephone cable. Standard Telephones and Cables Ltd. plates all major metal surfaces to prevent growth of whiskers. *Whiskers could cause short circuits during the long, unattended life of the repeaters. See p 32* COVER

* COMPONENTS AND MODULES. Previews of what many manuacturers will be introducing at the IRE Show. New products range from tubes through logic building blocks. *One firm is showing a thin-film Hall effect voltage generator* 22

* INSTRUMENTATION AND SUBSYSTEMS. Roundup of typical test equipment, recorders, signal sources and other gear being displayed this month in the New York Coliseum. *Typical of recent developments is a cro that shows transient waveforms in full* 32

* GOLDEN ANNIVERSARY BANQUET. The IRE's six top awards will be presented. *This year, a Scot wins the Medal of Honor* 35

* JOB-HUNTING at the Show? Here's a rundown on the kind of engineers recruiters want and how much they'll probably offer. *There is less demand for recent graduates, more for specialists* 36

* ENGINEERING HIGHLIGHTS of the 1962 IRE Convention. Thirteen selected papers cover 3-D solid-state displays, microwave computers, electro-optical circuits, biological power supplies, semiconductors, superconductors, thermoelectrics, electronically-steerable antennas, new microwave tubes, atomic weather stations and electrostatic recording. *These papers look ahead into fields that will be of increasing importance in our profession's next half century* 51

SEMICONDUCTOR PLASMAS: Using Their Instability Characteristics. Did you know that plasmas may be immobile as well as mobile? Solid materials like germanium and silicon exhibit characteristics similar to those of gaseous plasmas, leading to new components like the oscillistor. *This tutorial article provides a basic background in important work that should have interesting uses in millimeter-wave electronics.* M. Glicksman 56

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An International Art

IT IS OFTEN DIFFICULT for those of us who live in the United States to think of our country as anything but the biggest and the best, and as the world leader in everything from art to electronics. While talking about Bell, DeForest, Edison and others we sometimes forget the contributions of such men as Ampere, Volta, Ohm and Tesla.

The Institute of Radio Engineers says that more than 70,000 engineers and scientists from 40 countries will attend the 1962 International Convention in New York. If you attend the show and talk with some of the foreign engineers and scientists, you will, we think, be impressed not only by what is going on in other countries but by how much other countries know of what is going on in yours.

The impact of developments elsewhere in the world has been evident for some time in our pages. In our 1960 index, for example, there are 157 items under the "Foreign Electronics" listing. Our index for the first half of 1961 alone contains 151 such items. Our editor spent three months abroad last spring gathering material for his "Electronics in Europe" article published last June. And the annual market report, published in the first issue of this year, contained a section on international trade.

Take a closer look at the first half-dozen issues of ELECTRONICS in 1962:

January 5: An article on a servo-tuned transceiver for airborne vhf communications, from Japan.

January 12: A page on Leo Esaki's "Kink Effect in Bismuth Semiconductors."

January 19: Discussion of twist connectors, developed under a French patent.

January 6: An article on the British banana-tube color-television display system and a production technique article on a new method of assembling high-density cordwood-stacked modules.

February 2: Another Japanese article, on the field-effect transistor as a negative-resistance device, plus an item about Canadian work on generating millimeter waves with ferrites.

February 9: An article from Poland on a semiconductor analog of a cold-cathode counter tube, and a British article on an automatic sensitivity

control for a vidicon tv camera.

February 16: A reference sheet from Australia on a design chart for calculating electron-beam parameters.

Our stateside editors scan a great deal of foreign literature each week in search of articles of interest to our readers, and our overseas editors send in a steady stream of choice items.

Electronics is truly international in character, both the art and the magazine.

Coming In Our March 16 Issue

TWO FROM ENGLAND. Though it wasn't planned that way, our next issue underscores the point made in today's editorial. Two of the articles come from England, one by T. K. Hemingway, of English Electric Ltd. and another by Peter Barratt, of Pye Ltd.

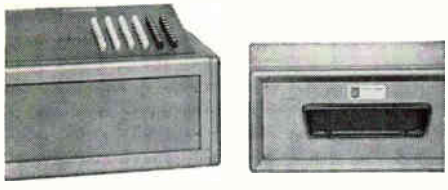
Dr. Barratt's final article (we regret to report that he died suddenly Feb. 11) is a comprehensive, seven-page review of the effects of long-term nuclear radiation on electronic materials, components and equipment. It supplements a report, by a trio of Americans, published last year (p 62, Feb. 10, 1961) on the effects of transient radiation. The approach in the new article is how to design equipment to live with the effects of nuclear radiation when the dose rate is low, but the exposure period long. Hemingway describes a complementary compound emitter follower and compares its characteristics with cascade emitter followers for certain applications.

Assistant Editor Lindgren will conclude his four-part series on bionics with a report on applications and new directions. An example is the learning networks developed as analogs of biological systems.

NEW ELECTRONIC BREAKTHROUGH!

SECURITY DEVICES LABORATORY *presents...*

THE FIRST SIMULTANEOUS DATA TRANSMISSION SYSTEM



SDL presents a data transmission system so new it hasn't been named! Here is the simultaneous system that promises to be faster, cheaper and easier to operate and maintain.

FASTER Up to 18 characters per second with a single pair of connecting wires.

CHEAPER Own for approximately 2 years' rental of a similar system.

EASIER Basic servicing can be learned in an hour by non-technical personnel.

SEE US AT THE SHOW BOOTH 1625

SDL SECURITY DEVICES LABORATORY
ELECTRONIC DIVISION OF SARGENT & GREENLEAF, INC.
ROCHESTER 21, N.Y.

COMMENT

Wasted Manpower?

Your groundrule applied to the suggested compromise by DOD on outline proposal preparation (*Crosstalk*, p 3, Feb. 9) is excellent.

Conceptual ability of our scientists and engineers must be rewarded appropriately, not restricted by government regulations.

WILFRED ROTH
Roth Laboratory for
Physical Research
Hartford, Connecticut

The Crosstalk editorial concerned the "great waste of manpower" involved when a large number of companies prepare proposals for military development contracts. A suggestion by DOD's director of electronics is that the government continue to solicit proposals from all firms with the inclination and ability to tackle a project, but that the proposal merely outline approaches to a system, without working out the engineering details. The approaches would then be evaluated by government scientists, and detailed proposals would be invited only from companies submitting the most feasible approaches.

The suggested groundrule is that if a company submits a usable item, it gets first crack at the R&D contract. If the government has an over-riding reason for placing the engineering work elsewhere, then the originators of the idea should be compensated fairly.

Processing PC Boards

I just had the pleasure of reading Kenneth Day's *Production Techniques* article entitled Processing PC Boards in Small Shops, which was printed in the February 9 issue (p 80). We took the liberty of circulating your magazine to many interested people in our company. This includes the people in our research laboratory who are directly interested in all usages and applications of Kodak Photo Resist.

We were very interested in the part of the article where the author mentioned that general agitation during the developing of the resist board helps to wash away the unexposed resist. The author then indicated that the board is air-dried and then washed in lukewarm water. We are not in any way suggesting that the procedure be changed, because, obviously, success cannot be disputed. However, we generally follow the practice of flushing the board with water immediately after developing and before drying.

We were particularly intrigued by the author's method of etching using glass marbles to support the board in a horizontal plane.

DON R. SPEAR
Eastman Kodak Company
Rochester, New York

Automatic Conelrad Radio

We read with interest your fine article on Nuclear Attack and Industrial Survival (p 35, Jan. 12).

As pointed out in this article, the NEAR system for attack warning is dependent upon power lines and, therefore, is not as effective as the automatic Conelrad radio we have developed. Additionally, people in automobiles and in other locations where power lines do not reach could not be warned by the NEAR device.

Our "automatic Conelrad" device, when built into or attached to a radio or tv set, will automatically turn on the radio or tv receiver and automatically tune the set to the Conelroad frequency whenever Conelroad broadcasts.

This eliminates the need to turn on the radio and tune to Conelrad, as required by the NEAR system, thereby eliminating the possibility of confusion. Our device will add only about $20 to the retail cost of a radio or tv set.

F. M. MACKEN
PM Motor Company
Chicago, Illinois

The NEAR system (National Emergency Alarm Repeater) uses power lines to transmit a 240-cycle air-raid alarm. With one receiver per home, over a billion dollars of transmitters and receivers are involved. So far, no decision has been reached as to whether the utilities or the individual would pay for the receivers. The only definite decision is that the government is not to pay for any of it.

CHRISTIE ANNOUNCES

100-200-250-400-600 AMP.

"TRANSIENT FREE"

D-C POWER SUPPLIES

Dynamic Regulation ±0.5 volt

Ripple 1 Millivolt

Recovery Time 50 Microsec.

Output Impedance 1 Milliohm

VOLTAGE RANGE: 15-36 volt d-c.
STATIC REGULATION — LINE & LOAD: ±0.05%.

CURRENT LIMITING: Adjustable.
DUAL A-C INPUT: 220/440 volt, 3-phase, 60 cps.

PROTECTION: Ultra-fast over-voltage and over-current protection.

STANDARD FEATURES: 10-turn voltage adjustment pot., voltmeter, ammeter, input contactor, pilot light.
OPTIONAL: Available in 19" rack style.

The above performance specs apply to the 100 amp. model. For complete specs of all 5 "Transient-Free" models, write for Bulletin CEC 194.

Some 200 other Power Supply and Battery Charger Models in the range of 15 to 1500 amp.

Write for catalog.

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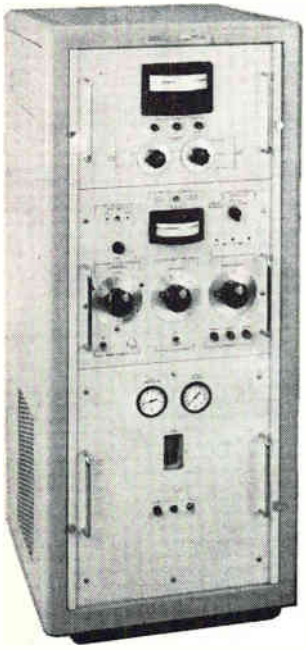
Today's Highest Precision in
Power Sources, Power Measurement



SIERRA MODEL 290C

Calorimetric Test Set

Accuracy: 1% limit of error, 30-1000 watts or 2-3% error 10-1500 watts
Frequency range: DC to 12.4 GC
- Null balance mode for accuracy
- Direct-reading mode for speed
- Differential mode for convenience

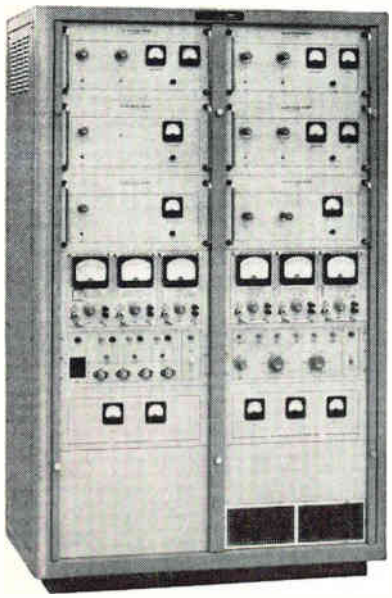
Price: $4,500.00

Dual water loads available for use with Model 290B

Model	Frequency	Max. VSWR	Price
286B	dc-4 GC	1.25	$1600.00
287A-C	5.8-8.2 GC	1.10	1600.00
287A-XB	7.0-10.0 GC	1.10	1550.00
287A-X	8.2-12.4 GC	1.10	1500.00

MODEL 190A CALORIMETER

with associated accessories, constitutes another power measuring system available from Sierra. Ranges 300, 600, 1500, 3000 watts max., water loads available for dc to 12.4 GC. Model 190A, $860.00



SIERRA MODEL 1223

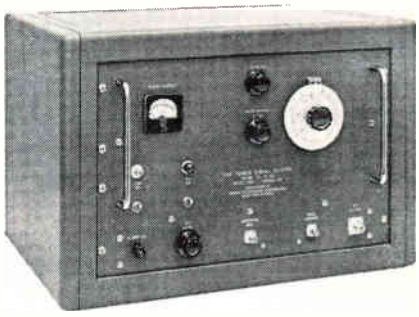
RF Calibration Test Set

Calibrates power measuring devices to 1% accuracy (probable accuracy 0.5%).
Includes six power sources, six power monitors (i.e., transfer standards), power and frequency selector, and associated units.
Frequencies: 30, 100, 300, 400, 500, 1300 MC
Power ranges: Six ranges for 30 to 500 MC (5, 15, 30, 60, 100, 125 watts)
Four ranges at 1300 MC (5, 15, 30, 60 watts)
Price: $15,000.00

SIERRA MODEL 215A

VHF-UHF Power Sources

Output continuously adjustable 10% to 100% of maximum
Frequency dial accuracy: ±2%
Reset accuracy: 0.1%
Modulation: External sine or square wave
Frequency stability: ±0.05%
Power output: 50 w nominal, 35 w minimum
Price: $3,300.00



Model	Frequency Range
215A-50	25-50 MC
215A-150	50-150 MC
215A-470	150-470 MC
215A-1000	470-1000 MC

SIERRA ELECTRONIC CORPORATION

A Division of Philco Corporation

7697A Bohannon Drive, DAvenport 6-2060 (Area Code 415)
Menlo Park, California

ELECTRONICS NEWSLETTER

Thin-Film Devices Give 30 to 40-Db Gain

BLUE BELL, PA.—Active thin-film devices utilizing controlled internal field emission to obtain d-c power gain of 30 db were reported last week at a Philco-sponsored symposium on hot electrons in thin films. The meeting was attended by some 200 people from research labs, military agencies and other companies.

J. P. Spratt, of Philco Scientific Lab, said the gain was observed in a three-terminal device resembling the Metal Interface Amplifier (p 30, Dec. 15, 1961). An aluminum base and overlapping layers of aluminum and aluminum oxide are deposited on a germanium substrate. Current flow from an aluminum emitter into the germanium depends on the electric field in the insulator.

Gain of 40 db and oscillation above 1 Mc were reported for another device with unnamed emitter. The mechanism is not certain, but may involve transport of hot electrons (electron energy is substantially above the Fermi energy) through metal films.

Internal photoelectric emission in thin-film sandwiches containing insulating layers of aluminum oxide and tantalum oxide was observed by Gerald Lucovsky. With a high-power mercury arc source, tantalum oxide devices showed open-circuit voltages of 0.9 v, shot current densities of 3 ma/cm^2, and quantum efficiencies of 0.1 percent. Such devices might be developed into economical, lightweight, radiation-resistant solar energy converters.

Army Develops 10-Lb Doppler Radar Set

U. S. ARMY Signal Research and Development Laboratory, Fort Monmouth, has developed a hand-held, doppler radar set that weighs 10 lb without batteries. It has a range from 100 yd to over 1¼ mi.

Signal return is presented audibly to the operator. An auxiliary unit will provide visual display. The set gives distinctive sounds when it spots moving vehicles or men.

Except for two vacuum tubes, transistors and other solid-state components are used. Circuits are contained in a housing, about the size of a breadbox, on which a 1-ft dish antenna is mounted.

Polaris' New Guidance Makes First Flight

MARK 2, the advanced version of the Polaris guidance system that will be used in the 2,500-mi A-3 missile, made its maiden flight from Cape Canaveral last week. Mark 2 is only about one-third the weight of Mark 1 and is considered more accurate and reliable.

Mark 2 was designed by MIT, with support from GE and Raytheon. GE will produce the system, using three-dimensional welded modules produced by Raytheon (ELECTRONICS, p 62, Oct. 9, 1959). The reduction in electronics size accounts for about half the weight and size savings.

The gimbal package has been reduced to about the size of a basketball. The system includes a gyroscopic-type accelerometer which uses a new electromagnetic device called the ducosyn. It provides gyro suspension plus signal or torque generation, functions formerly handled by separate devices.

Mark 2 also contains two of another new type of accelerometer, which MIT calls pulsed integrating pendulum accelerometers. The gyros are about the size of tennis balls.

Radar Rendezvous

WESTINGHOUSE is developing a radar-transponder system that will enable a chaser vehicle to intercept a satellite in space.

It uses four fixed-plane spiral antennas facing the target, one for transmitting the interrogation pulse, the others for measurement of range, azimuth and elevation angles by an interferometer technique.

By using different frequencies for transmission and reception and widening receiver bandwidth as the target is approached, minimum range limit is avoided.

The system will be detailed by H. A. Reuter, of Westinghouse Electric's Air Arm division, at the IRE Convention

Will Robot Ships Solve Maritime Costs Squeeze?

SHIP OPERATORS are stepping up research in techniques to solve problems of overcapacity, high operating costs and climbing rates, reports *International Management*, McGraw-Hill publication.

One of the more futuristic developments may be virtually unmanned ships, electronically-controlled from the home port and steered around other ships by radar and guidance equipment.

Russia soon will commission a fully-automated tanker on the Caspian Sea. Japan is building a 35,000-ton, highly-automated tanker for the Russians and two more tankers with remote controls for machinery are being built in the USSR.

Congressman Urges Space Act Patent Flexibility

BOSTON—Patent ownership problems in the National Aeronautics and Space Act must be eliminated quickly and cannot wait for an overall federal patent policy, according to Rep. Emilio Q. Daddario, of Conn., chairman of the patents and

inventions subcommittee of the House Committee on Science and Astronautics.

He told a symposium on patent rights under government R&D contracts that the apparent trend in Congress toward a general government title policy may now be checked. He doesn't think the situation warrants turning all patent titles over to the government, nor a policy giving the government only license rights for government use.

"The preponderance of evidence," Daddario said, "suggests, however, that the most practical method of administering an overall policy will involve the license approach with exceptions, rather than a title approach with exceptions."

Propose Reactor-Powered Voice and Tv Satellite

RCA REPORTS it has conceptually-designed a satellite that could handle 8,000 two-way, single-sideband, voice channels or five tv channels. It would carry a 60-kw atomic power supply of the reactor-generator type under development by AEC and NASA.

RCA says the high power would make ssb feasible and also reduce ground terminal costs. Tv broadcasts could be relayed directly to home receivers from broadcast studios. The satellite would weigh three tons.

Boosters soon to be available would raise the satellite to a 300-mi-high parking orbit. An electric propulsion unit would slowly raise it to the 22,300-mi-high synchronous orbit and then maintain it in the correct position and attitude.

Two Real-Time Computers Make Plane Reservations

EASTERN AIR LINES last week opened a $6 million computer center in Charlotte, N. C. It will provide, by phone or telegraph line, reservation data immediately to agents' desks in 42 cities.

The center uses two Remington Rand Univac 490 real-time computers, able to handle 30,000 transactions an hour, transmits at 4,000 wpm and store data on some 1,500 flight segments over a full year. Each computer has 14 input-output channels.

Remington Rand also announced three airlines have signed up for its Airlines Interline Development System, based on a real-time computer. It will enable agents on one line to make and confirm reservations on another line by phone. Queries are to be made by Unicall, which transmits voice inquiries to the computer and responds with stored, computer-generated voice replies.

Doped Sapphire Promises Lasers in Orange Range

LOS ANGELES—Possibility of lasers operating at higher frequencies was reported this week by Ricardo Pastor, of Quantatron, Inc., at a meeting of the American Institute of Metallurgical Engineers.

Manganese-doped sapphire crystals, he said, show "great promise" for lasers and masers. Valence control was described as "excellent" for Mn^{+2} and Mn^{+4}, with the latter more promising for lasers in the orange range. The crystals have fluoresced, but have not been lased.

Pastor also said his company has obtained concentrations of iron in sapphire some 100 times higher than previously and has good valence control with Eu^{+3} in calcium fluoride. Work with sapphire indicates possibility of many more lattice attitudes for laser use.

Air Force Starts Up Alaskan Dialing System

AIR FORCE installations in Alaska this week began using the Alaskan Switching System installed by Western Electric as part of the Defense Communications system. It is the first direct distance dialing network in Alaska. Automatic switching stations are at White Alice stations near Anchorage, Fairbanks, Galena and Lake Illiamna. Additional switching equipment has been installed or modified at 32 other locations.

In Brief . . .

TWO FOREIGN agreements have been signed. ITT will make and sell Nippon Electronic communications equipment. Pirelli SpA, of Italy, will make and sell General Instrument components and equipment. GI also reports it is increasing it nanocircuit production to 2,000 a month.

G. C. DEWEY CORP., an R&D firm, has acquired Pitometer Log Corp. and will go into manufacturing.

AREA REDEVELOPMENT Administration has made second loan in Boston area (p 12. Feb. 9), $487,500 to Contronics.

AUTONETICS has received a $16.9 million contract for B-52 radar terrain-avoidance computers.

COLLINS RADIO reports $7.5 million in contracts for retractable antennas for hardened missile sites, digital data modems for Air Force's 465L system and airborne communications-navigation equipment.

ADDITIONAL Hawk missile contracts to Raytheon total $4.7 million for parts, radars and development. A $300,000 subcontract for telemetry goes to Advanced Electronics.

CUBIC CORP. has a $420,000 contract for three-dimensional-positioning rocket scoring kits, and a subsidiary, Temec, Inc., $940,000 for a wideband scanning antenna.

SYLVANIA has ordered $1 million in digital tape units for military computers, from Consolidated Electrodynamics.

LEACH reports an Army radar-guided Mauler missile has been flown operationally with one of its command-destruct receivers.

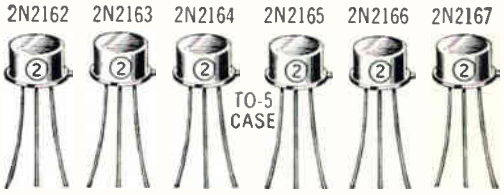
LITTON INDUSTRIES plans to built a $16 million plant in Atlanta, Ga., probably for production of data processing systems.

FCC ANNOUNCES it will use a computer to speed radio and tv license processing.

RELIABILITY study of the Orbiting Geophysical Observatories will be made by Planning Research Corp.

New from Sprague! **SEE THEM AT IRE SHOW BOOTH 2416**

HIGH SPEED SILICON CHOPPER TRANSISTORS



Sprague Surface Precision Alloy Transistors are especially designed for low-level chopper applications. Their specifications have been tailored to meet your actual circuit requirements. Compare these standard Sprague units with ordinary alloy devices for the following characteristics:

- **Low Offset Voltage**
- **Low Dynamic Resistance**
- **Low Output Capacitance**
- **Low I_{CBO}**
- **High Frequency Response**
- **Matched Pairs Available**

TYPE	Min. BV_{CBO} (Volts)	Max. I_{CBO} (μa)	Max. V_{EC} (mv)	Min. h_{FE}	Max. C_{OB} (pf)	Min. f_T (mc)
2N2162	30	.01	2	20 at 1 kc	10	14
2N2163	15	.01	2	20 at 1 kc	10	14
2N2164	12	.02	1.5	25 at 1 kc	10	24
2N2165	30	.02	3	2.5 at 4 mc	10	10
2N2166	15	.02	3	2.5 at 4 mc	10	10
2N2167	12	.02	2.5	4 at 4 mc	10	16

For application engineering assistance without obligation, write Transistor Division, Product Marketing Section, Sprague Electric Co., Concord, N. H.

For complete technical data, write Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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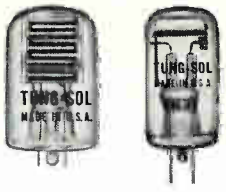
CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES
FUNCTIONAL DIGITAL CIRCUITS

SPRAGUE®
THE MARK OF RELIABILITY

NEW "HIGH ENVIRONMENTAL" TUBES

Tung-Sol's "High Environmental" transmitting, series regulator and modulator tubes —including hard-glass miniature—are designed and built to withstand the toughest extremes of shock, vibration and temperature with highest standards of performance and reliability.

PHOTOTUBES



Tung-Sol's new series of experimental photo-emissive and photo-conducting devices offer reliable full-spectrum coverage from infra-red to far ultra-violet in any of countless control applications.

CERAMIC HYDROGEN THYRATRONS

This new Tung-Sol family of ceramic hydrogen thyratrons includes the 8191, 8192, and 8036 which deliver peak output powers of 135 KW., 450 KW., and 6.5 MW., respectively. All are flange-mounted, with flying leads, to permit easy installation and good electrical connections, consistent with minimum tube size as demanded by airborne radar and other highly compact applications.

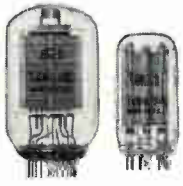
SUBMINIATURE TUBES

Now greatly expanded, the Tung-Sol line of rugged subminiatures is designed to highest performance standards, including MIL specs, for exacting industrial and military uses. Included are pentodes, triodes, diodes, VR tubes, reference tubes and thyratrons.

HYDROGEN DIODES

Tung-Sol has expanded its hydrogen diode family to include tubes with ratings up to 2 amperes average at 25KV peak inverse voltage. These tubes, the 7789, 7790, 7791 and 7792 serve as charging diodes or clippers in radar modulators and as general-purpose, high voltage rectifiers.

COMPACTRONS



Tung-Sol compactrons offer definite advantages, both engineering and economic, to equipment manufacturers. Basic design considerations include careful attention to tube usage from a functional standpoint. The 12-pin configuration provides the versatility necessary to produce multi-purpose, multiple structure tubes.

NEW 5000-VOLT SILICON RECTIFIER

This uniquely designed 5000-volt unit features a special double-seal to assure maximum reliability in the toughest high-voltage industrial and military applications. These rectifiers are smaller than competitive devices and less expensive. They are furnished with clip-mounting terminals for ease of installation.

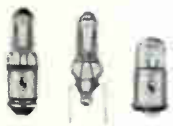
PRESS-FIT DIODES AND ASSEMBLIES

Tung-Sol premium-quality press-fit diodes offer electrical characteristics that are equal to or exceed those delivered by the stud-mounted 1N2154-1N2160 series. These economical units make practical the use of a single device for applications requiring from 1 to 30 amperes. Also available: a wide line of standardized rectifier modular assemblies in a variety of voltage ratings. The assemblies are the smallest made today for the 2 to 50 ampere range.

TUNG-SOL SHOWCASE

HIGHLIGHTS OF THE NEWER TUNG-SOL COMPONENTS AND EQUIPMENT

SUBMINIATURE LAMPS



Tung-Sol subminiature incandescent lamps are produced in many combinations of bases and filaments and are designed to operate over a broad range of voltages. Life expectancies range from 500 to more than 5000 hours. The Tung-Sol T 1¾ unit, the newest addition to the line, is intended for indicator service in aircraft, military and commercial applications.

NO. 4 READ-OUT LAMP

The No. 4 Tung-Sol lamp is a high-intensity miniature light source particularly well suited for photo-electric read-through applications. It may readily be adapted to a wide variety of uses where an intense, small spot of light is required.

TRANSFORMER-RECTIFIERS

Nine of every ten transformer-rectifiers supplying airborne power to the nation's newest commercial, military and experimental aircraft were designed, developed and manufactured by Tung-Sol's Chatham Division. Chatham manufactures more than thirty different transformer-rectifiers with ratings from 5 amps through 200 amps.

POWER TRANSISTORS

Tung-Sol germanium Cold-Weld power transistors feature ultra-low K-factors, maximum junction temperatures of 110C°, low saturation voltage, and high breakdown voltages which contribute to the superior performance of these peak-power devices. Copper-to-copper Cold Welds eliminate heat-produced contamination.

DYNAQUAD™

Tung-Sol's new 4-layer PNPN bistable transistor slashes component requirements and offers substantial circuit simplification. One example of this component advantage: a 10-bit shift register designed with Dynaquad requires ⅓ the printed circuit board area as that in a conventional transistor circuit.

REGULATED POWER SUPPLIES

This new hand-carry 100 ampere regulated d-c power supply, Model R2432-100 is the first of a series to be introduced by Tung-Sol's Chatham Division. Weighing less than 100 pounds, 50% lighter than comparable competitive units, the R2432-100 features solid-state reference and control circuits in addition to complete internal radio noise suppression.

YOU'RE INVITED . . . Stop at the Tung-Sol IRE exhibit—Booths 2627, 2629, 2631, 2633. If you won't be able to attend the IRE show, Tung-Sol will be glad to send you full details. Just write: Tung-Sol Electric Inc., Newark 4, New Jersey. Sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N.J.; Melrose Park, Ill.; Newark, N.J.; Philadelphia, Pa.; Seattle, Wash. CANADA: Toronto, Ont.
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TUNG-SOL®

WASHINGTON OUTLOOK

FAA OUTLINES EQUIPMENT NEEDS

FEDERAL AVIATION AGENCY envisions an additional investment of $492 million in vhf omnidirectional radio and instrument landing systems and $164 million more for primary radar equipment in the next five years. They will be key elements in a program to modernize air traffic control along lines suggested by the Project Beacon report (ELECTRONICS, p 14, Nov. 17).

Outlining its plans to equipment manufacturers last week, FAA said voice radio will continue to be the chief means of air/ground communications. Prospects of achieving a practical automatic data link system are dim. Communications will be limited to the 360 vhf channels available between 118 and 136 Mc with 50-Kc spacing. Ground equipment will be completely modernized to 50-Kc capability within five years.

The agency also will require identity-reporting (plus yet-to-be-developed altitude-reporting) radar transponders for all aircraft operating in the new system within airspace under positive traffic control—an area to be greatly expanded in the five-year period. For large commercial planes, FAA wants sophisticated equipment providing at least 4,096 identity codes and altitude readout in the 100-ft increments to altitudes in excess of 100,000 ft. A simplified transponder for private planes is to provide 64 codes and altitude reports in 100-ft increments to at least 15,000 ft. To display beacon data to traffic controllers, FAA wants ground processing equipment that shows altitude numerically next to aircraft targets and shows identity alphanumerically.

TAX CREDIT BILL IS ON ITS WAY

TAX REVISION BILL including a tax credit designed to stimulate investment in such growth industries as electronics, is over its biggest single obstacle. The House Ways and Means Committee has approved it. After the expected passage by the House, it will promptly be taken up by the Senate Finance Committee.

The main feature is a $1.8 billion tax break for business based on the amount a company spends for equipment. The formula allows a concern to subtract from its income tax eight percent of its spending on new equipment. The same credit is provided for purchase of used equipment, to a maximum of $50,000. This applies to expenditures made after Dec. 31, 1961.

The House version imposes federal income taxes on income earned by overseas subsidiaries of U.S. corporations, particularly those that might be considered "tax haven" operations. Other revenue-raising provisions include withholding on payments of dividends and interest and tighter treatment of deductions for business travel and entertainment. Most of the provisions of the bill are highly controversial.

CONGRESS WON'T RUSH SATELLITE SYSTEM

CONGRESS WILL GO SLOWLY on legislation for a communications satellite corporation. Though Hugh Dryden, NASA deputy administrator, says early passage will speed system development, most Washington officials feel there is little need for haste. Congress is hearing views now.

The Senate Space Committee heard NASA, the State Department, FCC and some businesses last week. Next week, the Space Council will lead off the House Interstate Commerce Committee's consideration of the President's proposal for a billion-dollar corporation open to investment from manufacturers and communications carriers (ELECTRONICS, p 12, Feb. 16).

"TVA" Senators want a government-developed system under strict government control. Estes Kefauver (D-Tenn.) will push this, but will probably have little backing. Robert S. Kerr (D-Okla.) would permit creation of a corporation by American carriers only.

Even within the administration there are conflicting views. FCC Chairman Newton Minow testified in favor of the Kerr bill last week.

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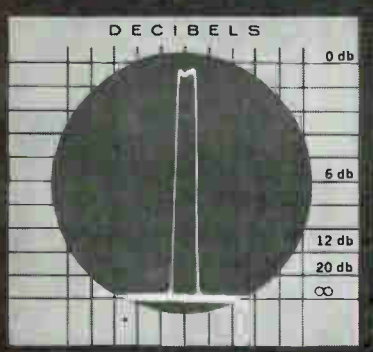
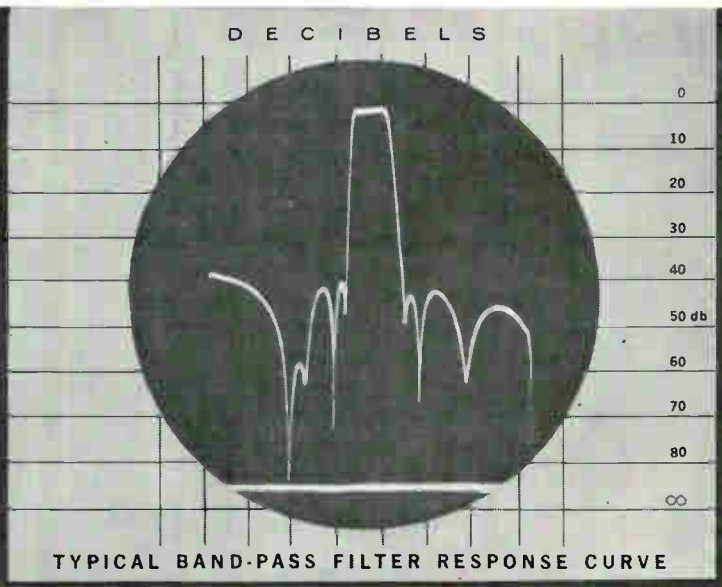
Accurate to within ±1db over 80-db dynamic range

Below is band-pass filter response curve without benefit of log amplifier. At right, same curve after amplification by LA-5100.





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This extremely accurate log amplifier enables exact measurements of attenuation in networks, filters, amplifiers, and other devices exhibiting dynamic operating ranges down to 90 db. Total rf response of device under test can be displayed in a precise logarithmic ratio on a standard dc-coupled oscilloscope. Write for complete technical data.

- Gives true log presentation over frequency range 500kc-100mc, with flatness better than ±½ db.
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- Continuously variable log-expand control permits uncompressed presentation of first 5 db of each range.
- Direct-reading meter for point-by-point measurements.
- Oscilloscope output jack for sweep display measurements.
- Designed for rack mounting: 7" x 14½" x 19".

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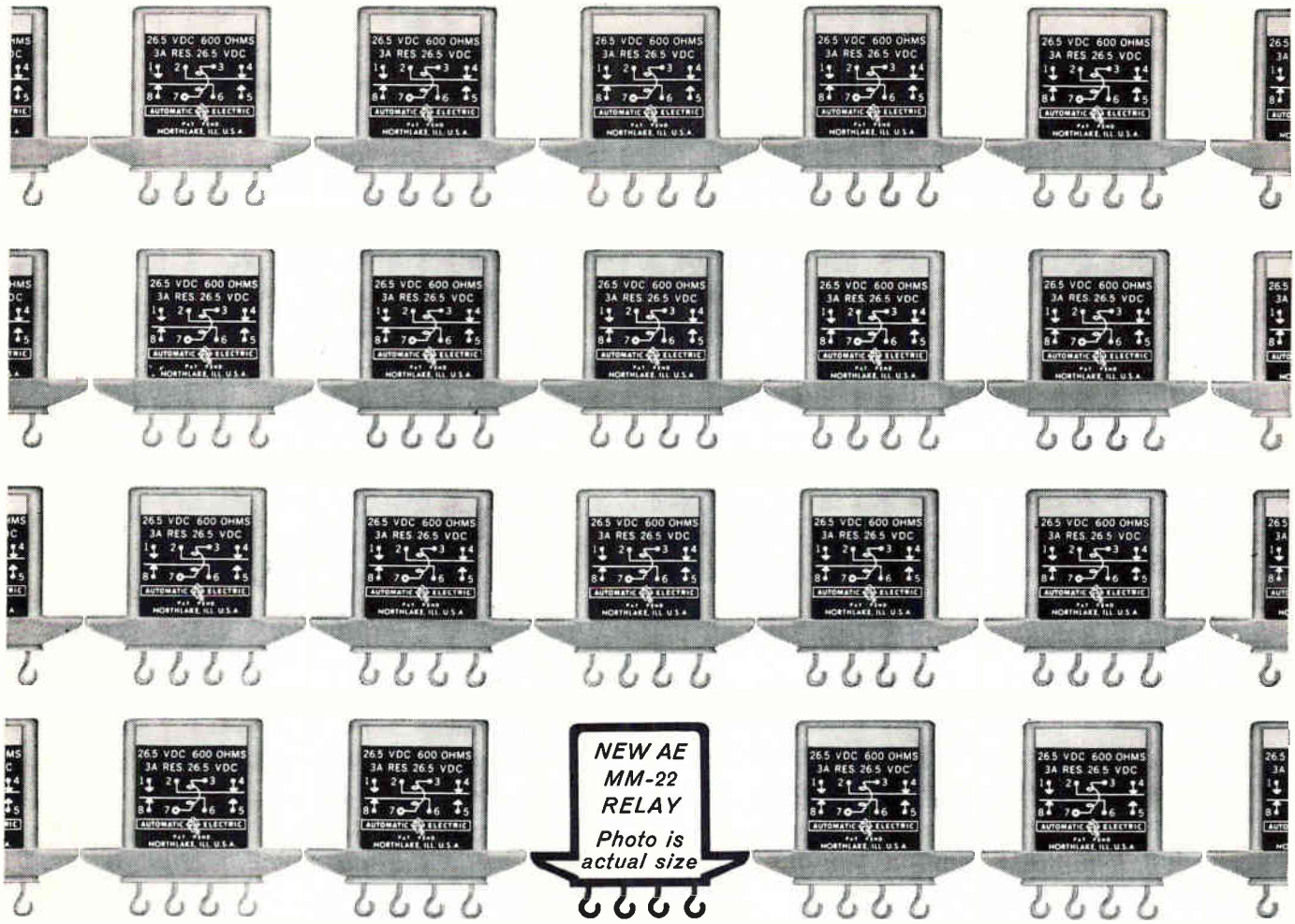

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If you have had the trying experience of having to test twenty, thirty or forty MIL-R-5757/10 type relays to get but ten satisfactory ones, we proudly say this new AE MM-22 relay will prove the answer to your problems. For the complete background on the design, development and specifications, please ask for Circular 1999. Write to the Director, Military Equipment Sales, Automatic Electric, Northlake, Illinois.

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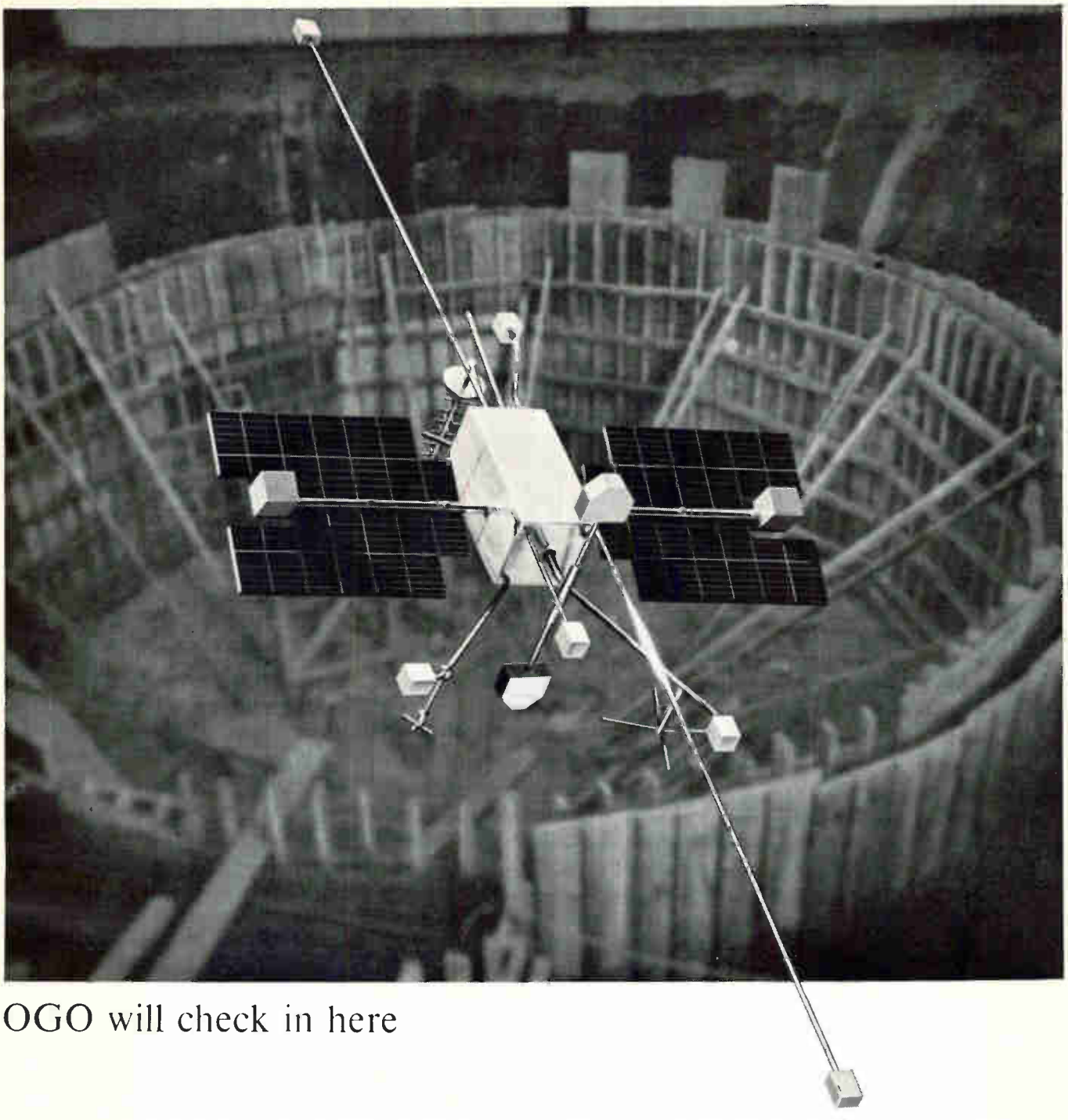

OGO will check in here

Soon a new space chamber 30 feet in diameter will fill this deepening bowl of earth. Here OGO (NASA's Orbiting Geophysical Observatory) will be subjected to conditions of solar heating, vacuum, and vehicle radiation to the cold of outer space. The new space chamber will be the sixth at STL. It will enable engineers and scientists working on OGO, Vela Hotel and other STL projects to test large, complete spacecraft as well as major subsystems. And along with other advanced facilities at STL's Space Technology Center, it will provide unusual scope for engineers and scientists to verify and apply new techniques in design, development and fabrication of spacecraft. STL's expanding space programs have created new opportunities for engineers and scientists in the following fields: Aerodynamics, spacecraft heat transfer; Communication Systems; Electronic Ground Systems; Power Systems; Propellant Utilization; Propulsion Controls; Reentry Body Evaluation; Systems Analysis; Thermal Radiation; and Trajectory Analysis. All qualified applicants are invited to write Dr. R. C. Potter, Manager of Professional Placement and Development, for opportunities with STL in Southern California or at Cape Canaveral. STL is an equal opportunity employer.

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Your every job in designing, using, and applying analog and digital computers is made easier with this practical handbook. It brings you reliable help on formulas, techniques, circuits, components, systems, and much more. **Edited by H. Huskey, Univ. of Calif., Berkeley; and G. Korn, Univ. of Arizona. Prepared by a Staff of Specialists. 1251 pp., 1099 illus., $25.00**

2. FOUNDATIONS OF FUTURE ELECTRONICS

Brings you current thinking in those scientific areas believed to have the greatest impact on the electronics of the future, and helps you develop insight into various aspects of this field. **By D. Langmuir, Space Tech. Labs., Inc.; and W. Hershberger, Univ. of Calif., Los Angeles. 514 pp., 181 illus., $10.75**

3. SYNTHESIS OF OPTIMUM CONTROL SYSTEMS

Explains advanced design techniques for high performance systems requiring the ultimate in response. Included in the coverage are four basic methods of optimizing a control system. **By S. S. L. Chang, New York University. 381 pp., $11.75**

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Presents important concepts and techniques for effective analysis and synthesis of vacuum-tube and transistor linear circuits. Using two-port theory as a foundation, explains concepts and demonstrates practical applications. **By A. J. Cote, Jr., and J. B. Oakes, The Johns Hopkins Univ. 411 pp., 263 illus., $10.75**

7. ACADEMICAN V. I. SMIRNOV'S LINEAR ALGEBRA AND GROUP THEORY

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Offers fundamental concepts of reliability theory and demonstrates their bearing on the solution of practical reliability problems. Includes reliability formulations and mathematical models, solutions of typical examples, and illustrates applications. Also introduces new concepts tested and developed by author. **By S. R. Calabro, International Electric Corp., 355 pp., 50 illus., $10.50**

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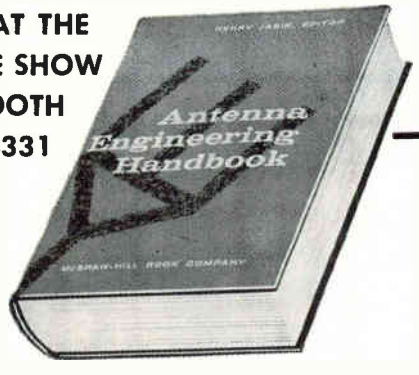

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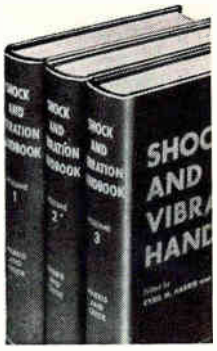

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Brilliantly analyzes strides in space technology. Interpretations, opinions, and predictions are given by 13 recognized experts on endless possibilities of peace-time applications of space technology. They outline concepts, objectives, and values these uses involve, and examine challenges they impose in the race for space. **Edited by S. Ramo, Thompson Ramo Wooldrige, Inc. 320 pp., 58 illus., $6.95**

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Provides information in the form of articles, design charts, nomographs, and actual ready-to-use circuits that helps you solve design problems involving transistors and other semiconductor devices. Gives component values for scores of circuits, important data on newer developments, and more. **Edited by J. Carroll Managing Editor, *Electronics*. 390 pp., over 600 illus., $9.50**

16. ELECTROMAGNETIC COMPONENTS FOR SERVOMECHANISMS

Here is a rich storehouse of practical facts to help you select rotating components and use them effectively in precision servomechanisms. Discusses electrical and mechanical characteristics . . . shows how equivalent circuits can be used for understanding system performance of a-c components . . . and more. **By S. Davis, Consult. Electrical Eng.; and B. Ledgerwood, Chief Editor, *Control Engineering*. 342 pp., 315 illus., $11.50**

17. ANTENNA ENGINEERING HANDBOOK

Provides information on all areas of antenna engineering to help you solve problems in the design and use of antenna systems. From basic fundamentals to modern applications, this big handbook offers the kind of detailed treatment you need for successfully working in today's complex field of antenna engineering. **Edited by H. Jasik, Jasik Labs.; Prepared by a Staff of Specialists. 1013 pp., 993 illus., $22.00**

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(why pay more?)

You're looking at 22 lbs. of new ideas, actual size — Packard Bell's new, portable, dual-beam oscilloscope.

Once upon a time, dual-beam oscilloscopes were priced so dear that most users limped along with one-beam 'scopes (simultaneous viewing of two signals was like watching tennis, not to mention the problem of disparate time bases). Then, Packard Bell decided to do something about the high cost of two beams. While others talked about *value engineering*, we *used* it. Where others designed on tradition, we designed on function. While others solved old problems, we looked for new ideas.

It worked! Now, $1,000-worth of oscilloscope costs only $570 from Packard Bell.

Compare these features:

DC to 5Mc bandwidth at 100mv/cm (1mv/cm at 20Kc) with no phase shift between beams.

Schmitt trigger circuit with both internal and external adjustable trigger levels.

Horizontal sweep of 1 microsecond/cm to 1 second/cm in five steps.

All control variables, including trigger, have fixed settings with overlapping continuous adjustments.

Compact size (10 7/16" high, 8 11/16" wide, 13 3/16" deep) and light weight (only 22 lbs.) for *true* portability.

More features and specifications on the reverse side of this sheet.

Attention, Prove-it-yourselfers:
Automatically request a free trial demonstration by dropping this return card in the nearest mail drop. Find out for yourself that dependability and equivalent performance cost only half what they used to.

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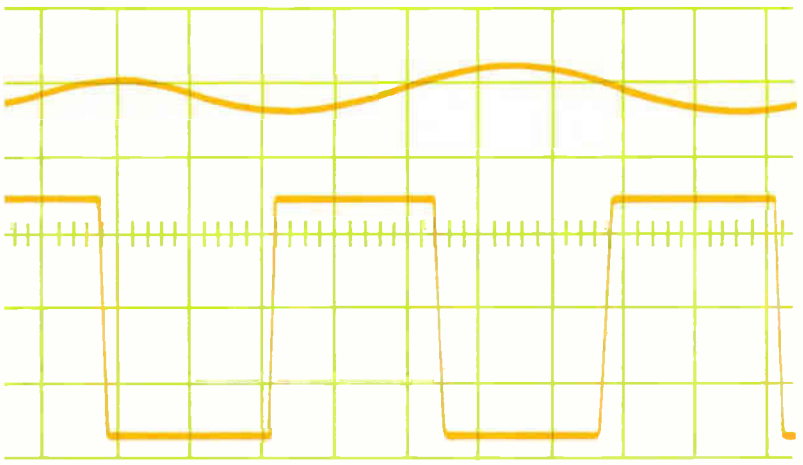
Packard Bell Electronics

MODEL 5Mc 2P
oscilloscope

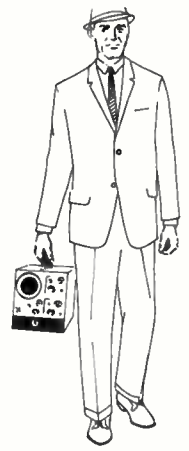
TWO BEAMS FOR THE COST OF ONE



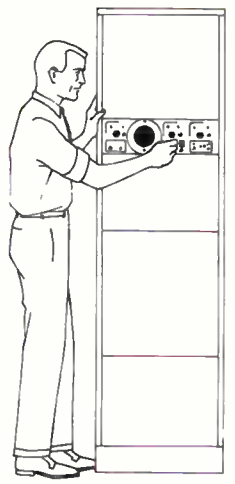
PACKARD BELL'S DUAL-GUN OSCILLOSCOPE

$570

(Less than most one-gun 'scopes)



The 22 lb. 5Mc 2P is the world's most portable dual-beam oscilloscope — ideal for field applications.



The 5¼" high 5Mc 2R fits standard relay rack, offers all of the in-use features of the portable model.

DISPLAY

High resolution. flat-faced, 3½" diameter CRT has two separate electron guns in one envelope. Each beam is usable over the *full face* of the tube. Beams stay in "sync" when raised or lowered. Accelerating potential is 1400 volts. Type 3AZP31 CRT is normally supplied, with P2 and P7 phosphors also available. Graticule brightness is adjustable by a variable control on the front panel.

VERTICAL SYSTEMS

BANDWIDTH: DC to 5 Mc (3db) on each of two identical vertical amplifiers at a sensitivity of 100 v/cm to 100 mv/cm. A pre-amplifier is built-in on the lower vertical amplifier providing 2.5 cps to 200 Kc at 10 mv/cm and 2.5 cps to 20 Kc at 1 mv/cm. Accuracy on any range after calibration on one range is 5%.

RISE TIME: Approximately 0.07 microseconds.
IMPEDANCE: 1 MΩ in parallel with 30pF capacitance.
VERTICAL SHIFT RANGE: Approximately two diameters.
MAXIMUM VOLTAGE: 600 volts DC or peak-to-peak AC. Electrical ground can be isolated from case ground by disconnecting a shorting bar on the front panel.

HORIZONTAL SYSTEM

SWEEP: The sweep is supplied from a constant-current RC charging network through a differential amplifier providing sweep linearity of 1%.
SWEEP RANGE: 1 microsecond to 1 sec/cm in 5 steps with an overriding continuous variable adjustment on each step calibrated at X1, 2, 5 and 10. Accuracy on any range after calibration on one range is 3%, except on the slowest range.

SWEEP MAGNIFIER: Continuously adjustable from the center of the tube face to X10, calibrated at X1, 2 and 5.
HORIZONTAL POSITIONING: Greater than 10 diameters so that any position of the trace can be observed.
TRIGGER: A Schmitt trigger circuit provides for both internal and external trigger levels. Triggering range: ±0.5 cm to ±2.5 cm from the mean range internal, ±0.5 to ±2.5 volts external; continuously adjustable.

GENERAL

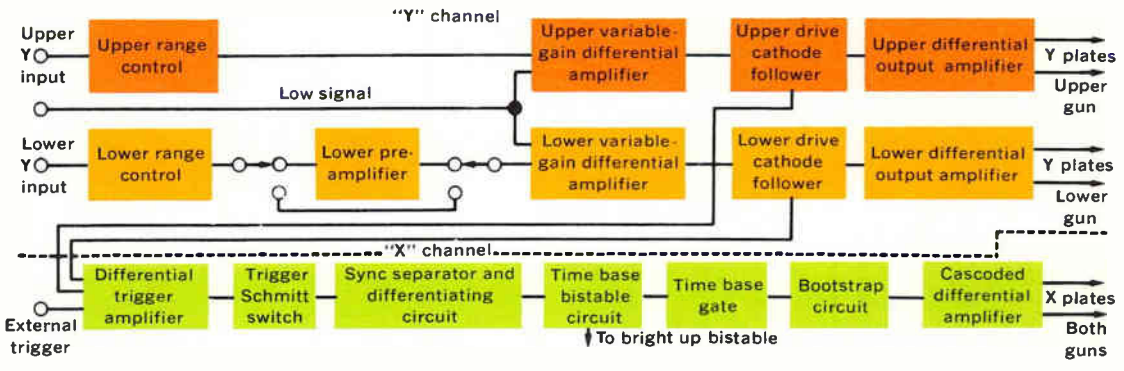
BEZEL MOUNT: Mounted by snap-fasteners, the bezel is easily removed for access to the removable graticule and light filters. The camera adapter replaces the bezel and is held in place in a similar fashion.
Z-AXIS MODULATION: Either beam, or both can be modulated through terminals on the rear.
EXTERNAL SWEEP: Access to the horizontal amplifiers is provided through terminals on the rear. Provision is made for either single-ended or differential input. Sensitivity is continuously adjustable from 0.2 to 2 v/cm. Frequency response from DC to 200 Kc (3db).
CALIBRATION SIGNAL: A square wave 60 cycle 1.0 v peak-to-peak signal, from a Zener diode with 1% accuracy, is available on the front panel for calibration.

POWER: 115v AC ± 10%, 60 cycle.
CONSUMPTION: 75 watts.
MAINTENANCE: Only two types of vacuum tubes are used in addition to the CRT. Access to both sides of all circuit boards is provided.
DIMENSIONS: 5Mc 2P (Portable) 10 7/16" high (front), 9⅝" high (rear) x 8 11/16" wide x 13 3/16" deep. Weight — 22 pounds. 5Mc 2R (Rack Mount) 5¼" high x 19" wide x 13 5/16" deep.
PRICE: 5Mc 2P or 5Mc 2R including two sample leads, $570.00 f.o.b. Los Angeles. Price is subject to change without notice.
WARRANTY: Packard Bell Oscilloscopes carry a warranty for one year, including CRT.

ACCESSORIES

PRE-AMPLIFIER: Model 100 Differential Pre-Amplifier provides a sensitivity of 100 microvolts/cm from DC to 10 Kc. Packaged external to the basic scope, transistorized and battery powered.
'SCOPE CALIBRATOR: Model 101 'Scope Calibrator provides 3 different signals for oscilloscope calibration.

PROBE: Model 102 Probe provides 10 Megohms input impedance in parallel with an adjustable capacitance from 3 to 12 pF.
CAMERA ADAPTER: Model 103 Camera Adapter is available for a Polaroid Camera.



BLOCK DIAGRAM of dual-beam 'scope shows independent vertical channels and common horizontal channel. Pre-amplifier in lower channel provides for increased sensitivity but may be bypassed. Outputs from cathode followers trigger the sweep when either vertical channel signal reaches magnitude sufficient for 0.5 cm vertical deflection. At a point in sweep-stability control's excursion, the sweep bistable becomes free-running and further adjustment causes variation in free-running sweep frequency. Output of X channel is applied to both sets of horizontal deflection plates. Adjustment compensates for differences in deflection plate sensitivities.

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MORE STABLE MORE RELIABLE

than fragile crystals and divider circuits

HATHAWAY FREQUENCY STANDARDS

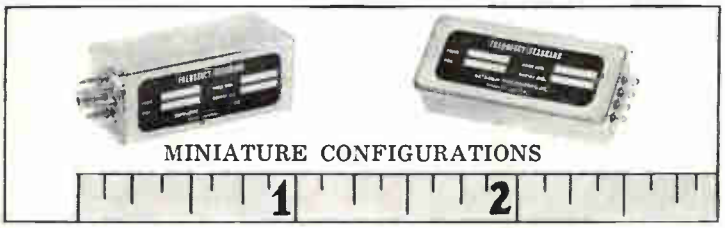
The logical answer is the Hathaway tuning fork if your resonator must generate a frequency below 10,000 cps, be accurate to .002%, immune to high shock and vibration, insensitive to pressure changes, and maintain stability at temperature extremes.

For example, the Type 65 featured here has wide application in aircraft and missile guidance systems, and as a constant speed control of aircraft generators. It is used as a time reference for high speed counting, ballistics measurements, and geophysics...in instrument power supplies...as a fixed audio oscillator. **And our tuning forks will eliminate the count down circuits required with crystals, at the same time meeting all military environmental requirements.**

Here's what you can expect from the advanced Hathaway design: silicon transistor drive and amplifier, optional thermostatically controlled heater, provision for exact frequency setting, and standard octal socket mounting for easy replacement.

For details on how the tuning fork frequency standard can give your product lighter weight in a smaller package, greater reliability and stability, write to us at the address below. Our engineers also will be happy to appraise specialized applications.

TYPE 65
Freq: 240 to 2000 cps.
Accuracy: ± .02% (−54°C to +85°C, no heater power); ± .002% (+15°C to +35°C, no heater power); ± .005% (−54°C to +85°C, with heater).
Vibration: Maintains ± .02% accuracy at 20g from 10 to 2000 cps.
Shock: Operating: 50g for 8.5 ms. Non-operating: 100g for 8 ms.



IRE — Booth 1920

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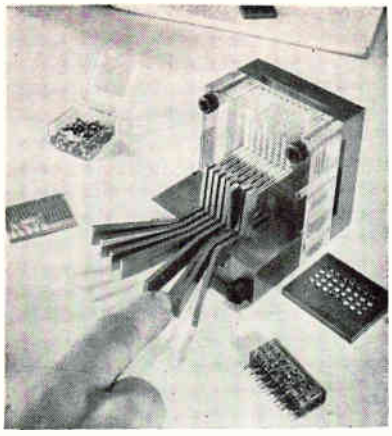
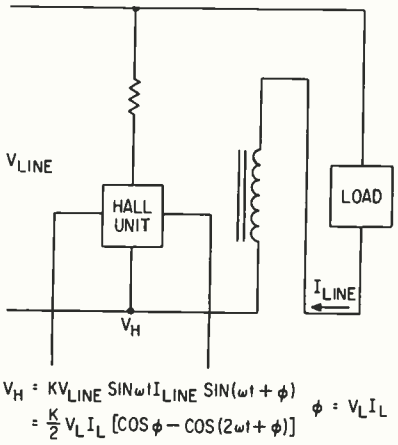
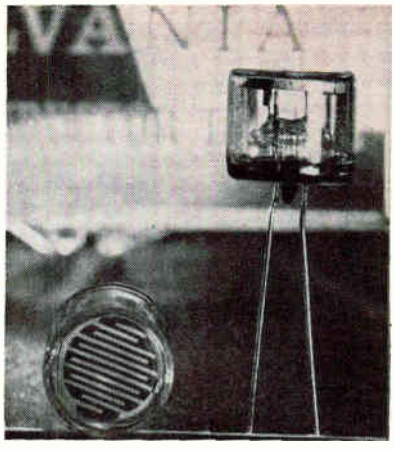
CIRCLE 21 ON READER SERVICE CARD



Piano key technique assembles pellet components in nest for Mallory modules



Hall generator power measurement circuit suggested by Beckman Helipot for thin-film device



Sylvania's photo-conductive cells are gas-filled, have internal color dot to indicate cell damage

PREVIEW OF EXHIBITS:

Components and Modules

NEW YORK—Among the components and circuit building blocks being introduced this year at the IRE Show is a Hall effect voltage generator made of indium antimonide vacuum-deposited on a glass substrate. Its developers say the thin-film technique significantly raises sensitivity and impedance levels.

Input and output impedances ranging up to 600 ohms permit easier load-matching, according to Helipot division of Beckman Instruments. The thin-film element is encapsulated in a package $\frac{5}{8}$ in. sq. The film is 7 microns thick, the glass plate, 12 mils.

Applications, in addition to mathematical function and measurement, include amplification, frequency doubling and heterodyne generation. The circuit illustrates power measurement. If the control current is proportional to, and in phase with, line voltage while magnetizing current is in phase with line current, Hall voltage output is a d-c term proportional to real power and an a-c double frequency term proportional to volt-amperes.

Amperex Electronics Corp. is showing a line of instant-heating tubes, called harp-cathode tubes because of the cathode shape. First is a twin tetrode, a high-efficiency class AB, linear amplifier that Amperex considers especially suitable for single-sideband.

The company is also showing a 2.5-mm reflex klystron with midband power of 100 mw and a 10-mw minimum over an 8-Gc tuning range, and an 8.6-mm, 100mw reflex klystron.

A series of epitaxial varactors designed for use in harmonic generators will be shown by Sylvania Electric Products, Inc. They have breakdown voltages from −6 to −120 v and cutoff frequencies from 10 to 140 G at −6 v.

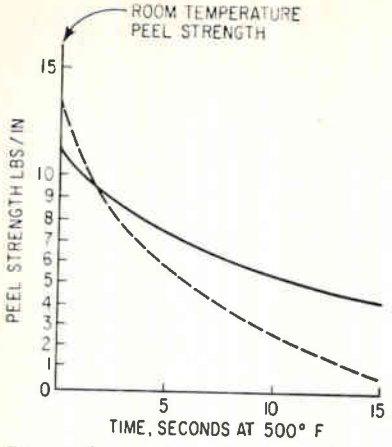
General Electric's Rectifier Components department will have silicon controlled rectifier stacks in three fin sizes. The 3 × 3 in. and 5 × 5-in. sizes for law and medium currents mount five types of scr's; a high-current stack is made of six aluminum extrusions 4 × 4 × 5-in. Temperature maximum is 150 C. GE is also introducing a double-diffused, 250-amp silicon rectifier which will withstand a one-cycle surge of 5,000 amp.

P. R. Mallory & Co. will demonstrate its "piano key" technique for assembling microcircuits. Ceramic capacitors, composition resistors and film resistors are fabricated as pellets 98 mils in diameter and 63 mils thick.

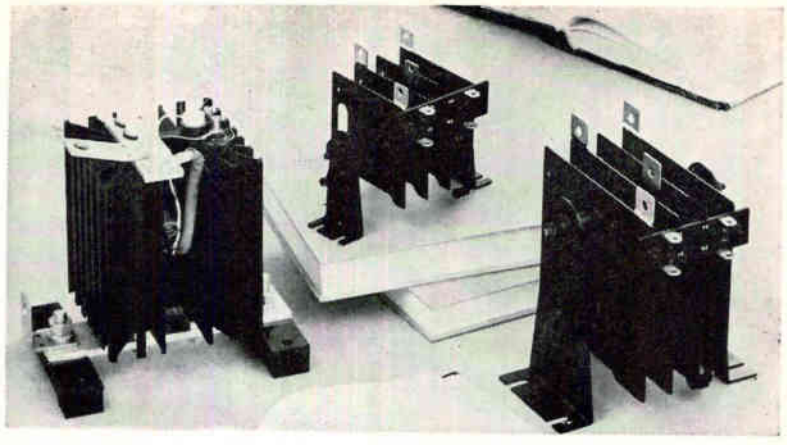
These are loaded into channels in the machine, then are transferred into a nest as the machine operator depresses the keys. The pellet-fitted nest is resistance-welded on one side to a connector grid punched from solder-coated copper. The pattern is then lifted from the nest, another grid is soldered to the other side and the circuit is encapsulated. A binary divider is shown. Mallory will also introduce prepackaged silicon rectifier circuits.

Among other miniature components are Fansteel Metallurgical Corporation's solid tantalum micromodule capacitors. Ratings are 0.01 to 50 μf. The company is also showing sintered tungsten wafers for semiconductors and pushbutton cricket switches and parts.

Facilogic modules which can be used for breadboarding, personnel training or specialized equipment assembly will be introduced by the Data Systems division of Harmon-Kardon, Inc. Some 33 modules, con-



Comparison of peel strengths of Synthane's G10R and G10 laminates at 500 F



Silicon controlled rectifier stacks made by GE. Largest one uses six aluminum extrusions

taining up to four logic functions each, go into a metal frame. Up to 1,320 modules will fit into a rack.

Connections can be made to fronts or rears of the units. A system can be breadboarded from the front with pin-jacks, while semipermanent wiring is placed at the rear. Circuits are printed on the modules. Circuits are available for 250 Kc, 500 Kc and 5 Mc. One power supply will operate up to 100 modules.

Automatic Electric has come up with an economical memory relay for multielement code systems. Four relays are mounted on a common heel piece. Each of four coils is equipped with a separate armature that operates on one bifurcated contact spring. The device will translate or store any binary number from 1 to 24 or will send digital or binary information.

Barber Coleman Co. is showing a brushless d-c motor based on a shaded-pole motor. A simple transistor oscillator converts d-c to a-c to drive the motor. One use is in fan and blower cooling systems for electronic equipment.

International Resistance Co. is introducing a NOR unit with four inputs and four outputs. Containing a transistor, diode, capacitor and resistors, it can be used to build complete logic elements and combine those, in turn, into large or small switching systems for data reduction, computers, instrumentation and control circuits. Among logic elements which can be built up with the units are binaries, multivibrators, half-adders, counters and shift registers. Units operate with pulse widths of 1-μsec and maximum full-load delay of 0.1 μsec.

Time & Frequency has an electronic tuning fork oscillator packaged in a vacuum tube without oven. It uses a silicon transistor oscillator, has a frequency range of 400 cps to 12 Kc, is accurate to 1 ppm at 26 C and 50 ppm at −54 C to 125 C.

James Electronics Inc. is showing its light-actuated choppers, for d-c modulation, relay and similar applications. The chopper uses two photoresistors and alternately flashing light sources to produce a single pole-double throw switching action. The company says electrical noise is low, there is no mechanical vibration and modulating efficiencies are up to 98 percent.

Among the battery displays are 44 types for transistor equipment by Burgess Battery Co. They are made up of eight basic types of individually sealed wafer cells that can be stacked in metal cans to meet virtually any requirement, the company says.

Andrew Corp. is showing two high-temperature coaxial cables for aircraft, missiles and space vehicles. Spiral-wrapped dielectrics are quartz-filled Teflon, for 350 C service, or braided silica, for 825 C.

Synthane Corp. will exhibit a new grade, G-10R, of laminate for printed circuits. It uses no structural adhesives, to avoid high-temperature peeling and wire failures during dip soldering. With 2-oz copper foil measured on $\frac{1}{16}$ and $\frac{1}{8}$-in. widths, peel strength is 2 to 4 lb at 500 F.

IRE-AIEE Merger Will Be Discussed at Session

MEMBERS of the IRE will have an opportunity to ask questions about the proposed consolidation of the IRE and AIEE during a special session on the opening day of the IRE Convention. The session will be held Monday morning, March 26, in the grand ballroom of the Waldorf-Astoria Hotel.

The discussion will be conducted by a panel comprising the eight-man joint committee which was formed by the boards of directors of the two societies to study the proposal. No registration fee is required for this one session.

If the societies and their members approve the consolidation, it would be effected on January 1, 1963. The counterpart of the IRE Convention would be an International Convention and Electrical and Radio Engineering Show, probably held in New York each spring. Attendances of 100,000 would be expected at the combined show, compared to the 70,000 anticipated this year for the IRE meeting.

You visit the IRE Show to get answers

And Leach Corporation wants to make your search easier. If you have design problems in Data Recording, Telemetry, or Electronic / Electromechanical Switching and Control, Technical Specialists from Leach's Relay Division and Electronics Division will travel to New York during the show to meet with engineers on special problems. Can we arrange a conference for you with one of them?

Problems in sensitive or high performance relay and control applications, telemetry, miniaturized data recording?

Leach Technical Specialists would like to confer with you if you have design problems in

Telemetry receivers (acceptance of electrical signals).

Subminiature Relays including crystal can, pico and mona types.

Magnetic recorders (permanent storage).

Time delay and matrixes (temporary storage).

Solid state relays and control devices.

Extremely sensitive relays for computers and data processing applications.

Logic modules and programmers (switching and routing).

Amplifiers, VCO modules (signal conditioning).

Ground playback equipment (presentation).

Technical specialists will arrange conferences by appointment.

A conference will be arranged in advance to save your time. Simply complete the Conference Appointment form in the lower part of this page or call collect to the New York Office. Leach will confirm the date and hour to you by mail or telegram.

New products to be shown

When you visit the Coliseum, we'd like to demonstrate (at Booth 1900) several new products in missile telemetry, miniature high-environmental tape recorders and high performance relays.

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Please arrange for me a conference on the subject of:

- ☐ Telemetry receivers (acceptance of electrical signals).
- ☐ Logic modules and programmers (switching and routing).
- ☐ Amplifiers, VCO modules (signal conditioning).
- ☐ Time delay and matrixes (temporary storage).
- ☐ Magnetic recorders (permanent storage).
- ☐ Ground playback equipment (presentation).
- ☐ Solid state relays and control devices.
- ☐ Subminiature Relays including crystal can, pico and mona types.
- ☐ Extremely sensitive relays for computers and data processing applications.

Other or specific individuals you would like to see _____

Best times for me are Day_____, Hour_____, or Day_____, Hour_____.

Please confirm my appointment to me:

NAME_____

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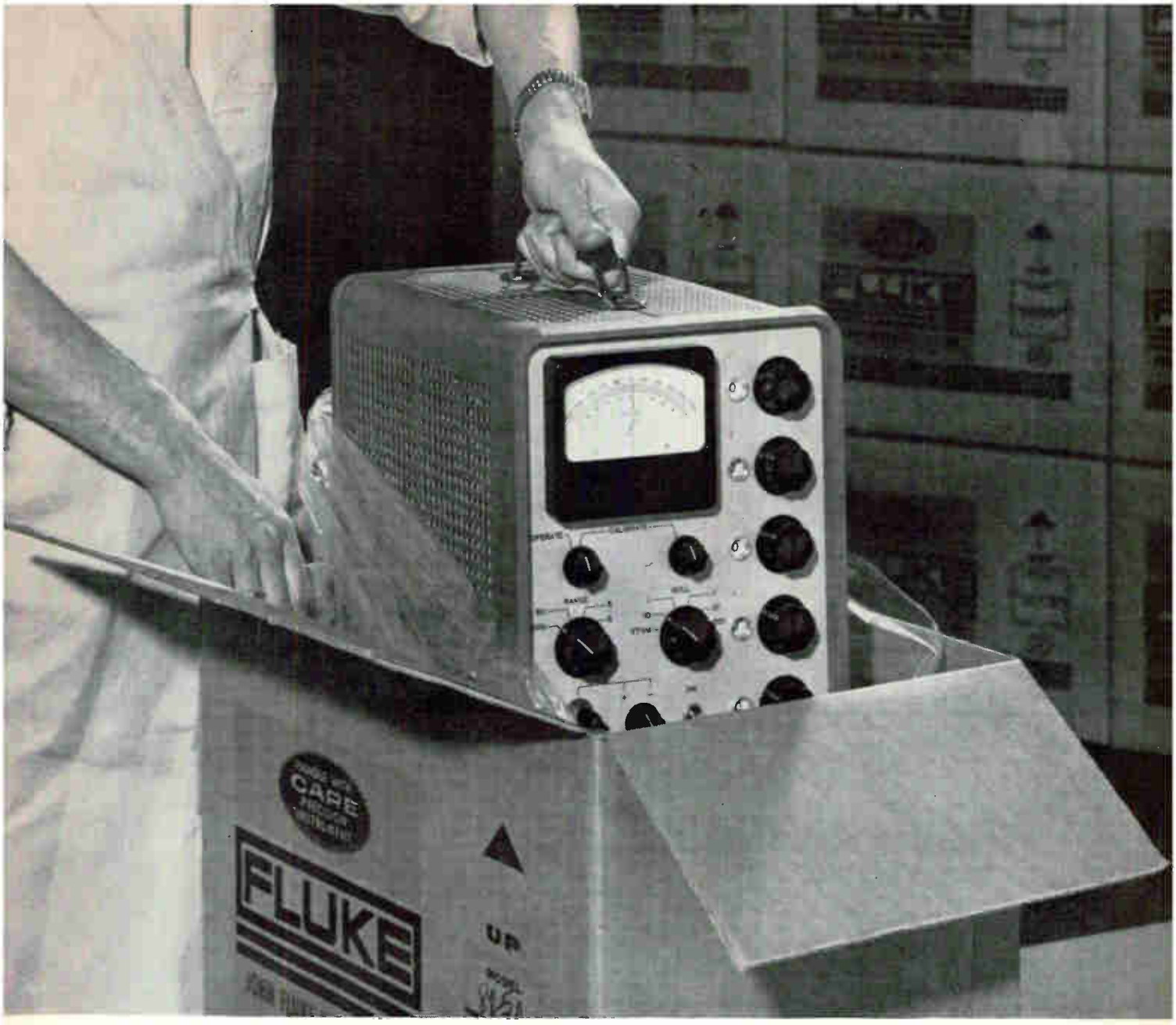
ADDRESS WHILE AT IRE SHOW_____



THIS NEW VOLTMETER WAS DESIGNED BY 15,000 CUSTOMERS

You had a hand in the engineering of the FLUKE MODEL 825A DC DIFFERENTIAL VOLTMETER. Customer suggestions spanning seven years and 15,000 differential voltmeters have helped create the most versatile and reliable instrument of this type ever offered.

Beginning with an overall accuracy of ±0.025%, this advanced model features these significant advantages: recorder output — no zero controls — taut band meter suspension — flow soldered glass epoxy printed circuit boards.

To fully utilize the inherent advantages of high accuracy differential voltage measurements, Fluke Model 825A provides two major features not found in other instruments:

1. *Infinite input impedance at null from 0 to plus or minus 500 VDC; this feature is extremely important since all voltages to be measured have significant source resistance. With the Model 825A operated at null, there will be no measurement errors due to circuit loading. The majority of other voltmeters provide a maximum of 10 megohms input impedance. Should the unknown voltage have a source resistance in the order of 5000 ohms, the measurement error due to source loading only will be at least 0.05% and does not include the basic error specification of the voltmeter itself.*

2. *Polarity reversing switch: A feature that enables you to measure either positive or negative voltages with equal ease. This is not merely a polarity reversal of front panel binding posts—but rather the internal 500 V reference supply is made either positive or negative with the front panel switch. This effectively provides you with two voltmeters for the price of one.*

PARTIAL 825A SPECIFICATIONS

OVERALL ACCURACY:	*±0.025%*
MAXIMUM FULL SCALE NULL METER SENSITIVITY:	*1 MV*
MAXIMUM NULL METER RESOLUTION:	*5 uv*
STABILITY OF REFERENCE SUPPLY:	*±0.005% per hour after warmup or ±0.005% for ±10% line voltage change.*
REFERENCE ELEMENT:	*Standard cell (zener diode optional)*
INPUT VOLTAGE:	*117/234 VAC ±10% from 50 to 400 cps*

Write, wire or phone for short form catalog F-162

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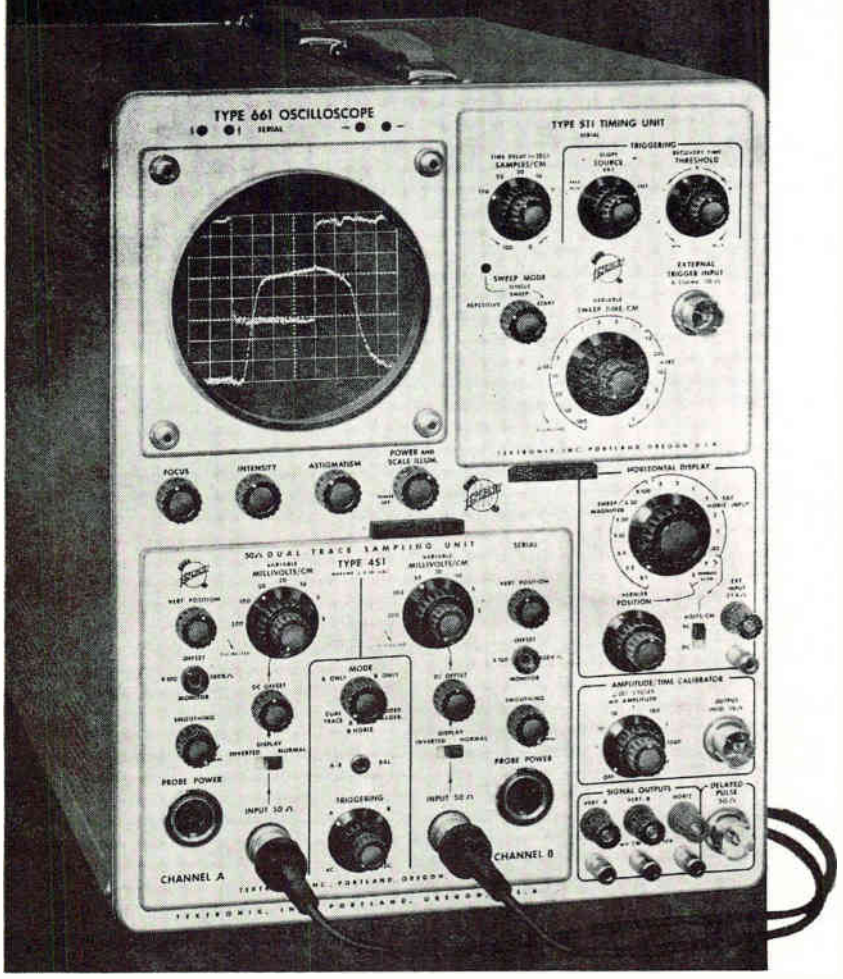
SIMPLIFY YOUR PULSE-SAMPLING MEASUREMENTS

with this NEW Tektronix Dual-Trace Oscilloscope



For complete information — please call your Tektronix Field Engineer.

Tektronix *Type 661*

Here's what you can do:

- . . . Trigger internally–observe the leading edges of both A and B traces. Matched internal delay lines in both channels assure accurate time comparisons.
- . . . Measure pulse risetimes with 0.35 nanosecond response in both channels. Time-measurement range extends to 1 millisecond.
- . . . Display repetitive signals on 16 calibrated equivalent sweep rates from 1 nsec/cm to 100 μsec/cm, accurate within 3%. Magnifier provides sweep expansion from 2 to 100 times . . . time per dot remains the same for digital readout.
- . . . Change the probes' signal source without affecting the dot transient response.
- . . . Reduce time jitter and amplitude noise, if needed, on the more sensitive vertical ranges and faster sweep rates by means of a smoothing control.
- . . . Measure millivolt signals in the presence of a substantial dc component by means of a dc-offset voltage monitorable at the front panel.
- . . . Calibrate with amplitude signals available from the front panel. Calibrate with timing signals traceable to National Bureau of Standards.
- . . . Show lissajous patterns in addition to single and dual-trace displays and signals added algebraically.
- . . . Drive X-Y plotters or similar readout accessories.
- . . . Drive external equipment, with fast delayed-pulse output.
- . . . Add plug-in units as they come along.

Here's how you do it:

1. Plug in the power cord and signal source,
2. Set the controls on the vertical and timing plug-in units,
3. Take the measurements.

In one compact laboratory oscilloscope you have a complete pulse sampling system with risetime of 0.35 nanosecond. Using the 50Ω inputs, or the Tektronix passive probe or cathode-follower probe designed for use with the instrument, you can meet most of the general-purpose-measurement demands in repetitive-signal applications.

Type 661 Oscilloscope (without plug-ins)	$1150
Type 4S1 50Ω Dual-Trace Sampling Unit	$1430
Type 5T1 Timing Unit	$ 750
Probes:	
Type P6026 Passive Probe.	$ 140
Type P6032 Cathode-Follower Probe. .	$ 160

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

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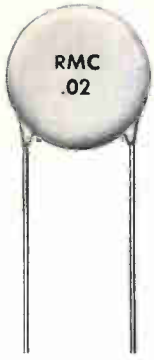
SEE THE LATEST TEKTRONIX INSTRUMENTS AT THE IRE SHOW—BOOTHS 3502-3508

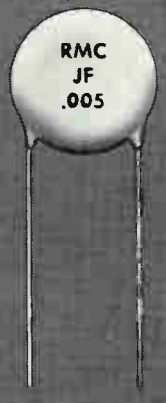
TYPE C

Temperature compensating type that meets or exceeds EIA RS-198 specifications. Rated at 1000 working volts.



TYPE B

Designed for by-passing, coupling or filtering applications. Manufactured in capacities between .00015 and 04. MFD.



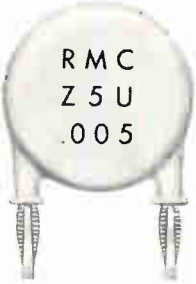
TYPE JF

Feature a superior frequency stability over similar types. Available in capacities between 150 MMF and 10,000 MMF.

RMC DISCAPS

TYPE JL

Exhibit minimum capacity change over extreme temperature range. Change is only ±7.5% between −60 and +110° C.



FIN-LOCK LEADS

Special leads for printed circuits. Eliminate lead crimping. Available on all DISCAPS of standard voltages, ratings and spacing.

TYPE SM

For use in applications where limited space is a prime factor. Meet all specifications of EIA RS-198 for Z5U capacitors.

DISCAP CERAMIC CAPACITORS

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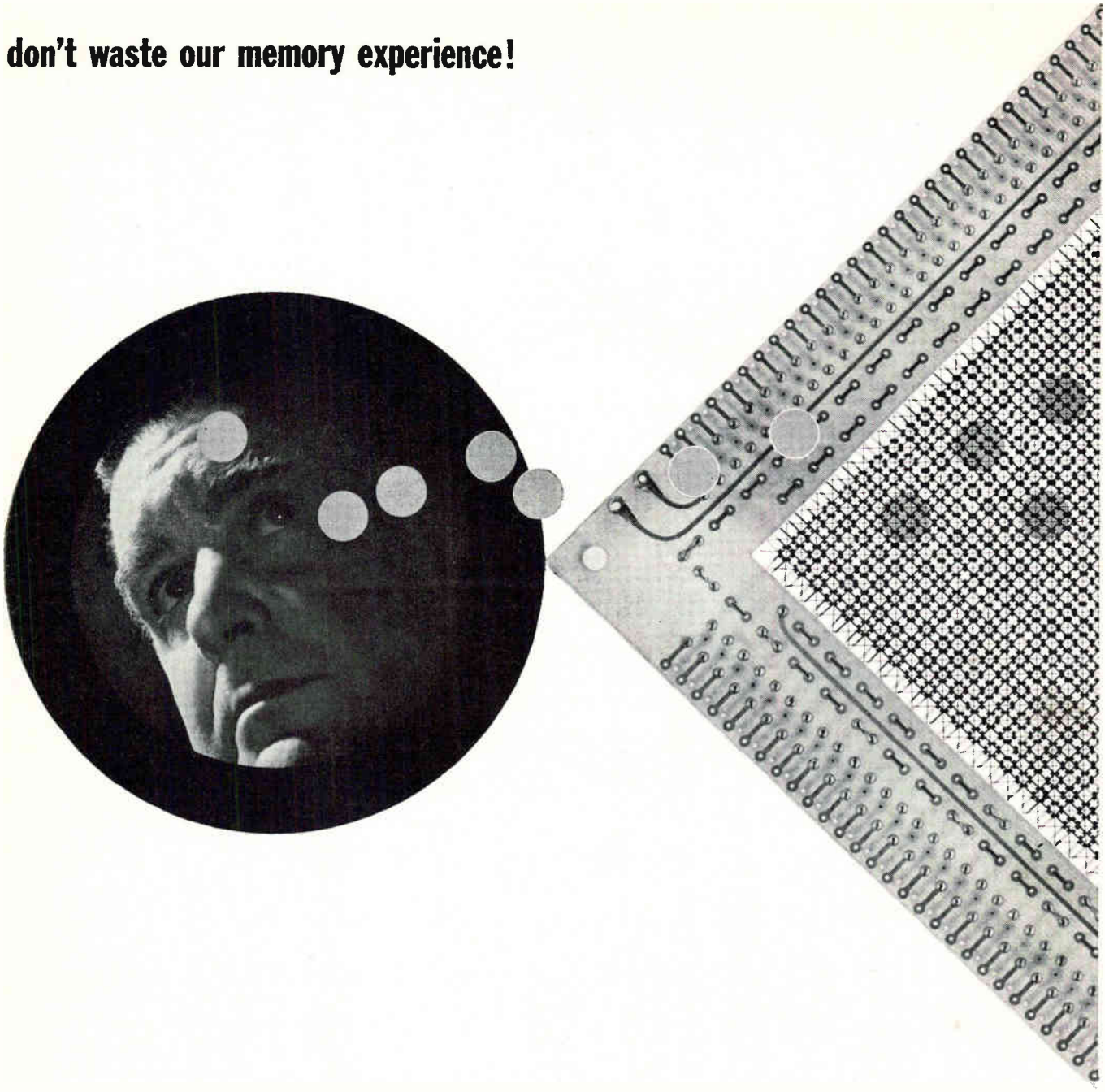
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 4242 W. Bryn Mawr Ave., Chicago 46, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

See us in Booth 1414 I.R.E. SHOW

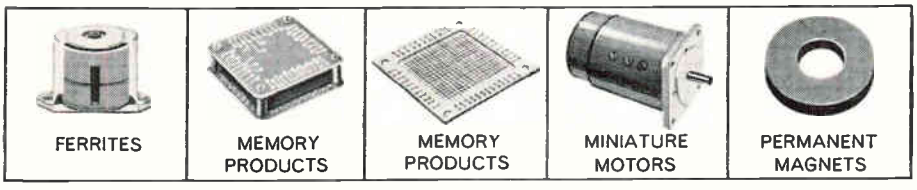
don't waste our memory experience!



Whatever your needs — cores (toroid or multi-aperture), planes, stacks or complete memories — you owe it to yourself and the project to see how we can help. ■ Magnetism is our business. For the record, we discovered and patented the first ferrite memory core, have pioneered developments in miniaturization, temperature control, switching times, logic circuitry, resistance to severe environmental conditions, and the application of multi-aperture devices to logic functions. ■ This experience backed by complete, specialized production and testing facilities can help you build maximum reliability into your systems. **For a complete file of engineering data on our memory products, phone or write** Electronics Division, Keasbey, New Jersey.

INDIANA GENERAL

Visit us at the IRE show — Booths 1310-1316



NEW!

Model CFI 1,000 to 10,000 mc

Model CFI 950 to 11,260 mc

TRANSISTORIZED CALIBRATED FIELD INTENSITY RECEIVER...

This is the Polarad Model CFI—the latest in field intensity measurement test equipment. It's transistorized for portability...excellent for airborne applications. The built-in impulse calibrator enables RFI measurements in accordance with latest military requirements. Plug-in tuning heads under development, will extend the frequency range beyond the present 1,000 to 10,000 mc capability.

FUNCTIONS AS A MULTI-PURPOSE MICROWAVE RECEIVER, TOO!

As an all-purpose receiver, the CFI offers AM, FM, CW and Pulse capability. These features make this the most versatile receiver you've ever used: 3 impulse bandwidths; 70 db dynamic range; sensitivity —90 dbm; direct reading meter circuits. You can use the CFI for all general laboratory and field work. Call your Polarad representative for a demonstration, or mail the card.

SEE POLARAD AT BOOTHS 3302-3308 AT THE I.R.E. SHOW

POLARAD

SPECIFICATIONS

FREQUENCY: 1,000 to 10,000 mc in four plug-in tuning units (950 to 11,260 mc as receiver)
SENSITIVITY: to —90 dbm
FREQUENCY DIAL ACCURACY: ±1%.
IMPULSE CALIBRATOR includes built-in impulse generator, RF attenuator (—60 db), IF attenuator (0—20 db), in 1 db steps
ANTENNA EQUIPMENT: 4 directive and 1 omni-directional; mounting tripod
OUTPUTS: Audio, Video and Recorder
METER CIRCUITS: Average and slideback peak, direct-reading peak and quasi-peak
INTERNAL CALIBRATION SIGNAL: Impulse type; 1 to 10 gc ±0.5 db flat output
IMPULSE BANDWIDTHS: 1 mc, 5 mc, and 8 mc
VIDEO BANDWIDTH: 3.5 mc
IMAGE REJECTION: 60 db
POWER INPUT: 12 volts DC; 115 volts AC; 50 to 420 cps

POLARAD

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43-20 34TH STREET, LONG ISLAND CITY 1, NEW YORK

MAIL THIS CARD FOR SPECIFICATIONS

A 1 2 B 3 4 C 5 6 D 7 8 E 9 10 F 11 12

POLARAD ELECTRONICS CORPORATION

Please send me information and specifications on:

- ☐ Model CFI Calibrated Microwave Field Intensity Receiver
- ☐ Model TR Microwave Receiver (see reverse side of page)
- ☐ Model IC-120 Microwave Impulse Generator (see reverse side of page)

MY APPLICATION IS_____

Name_____

Title_____ Mail Station_____ Dept._____

Company_____

Address_____

City_____ Zone_____ State_____

NEW...TRANSISTORIZED

THIS IS THE MICROWAVE RECEIVER POLARAD MADE BETTER!

MODEL TR 950 TO 11,260 mc

We started with a receiver that will perform 4 basic functions—AM-FM receiver; pulse and pulse-position demodulator; field intensity receiver; and a sensitive microwave power meter. Then we transistorized most of the circuitry, and equipped it to operate at 12 volts D.C.

To all this we added a choice of three impulse bandwidths, greater sensitivity, a 70 db dynamic range, standard weighting circuits, slideback peak feature and an aural tuning aid.

Frequency coverage is accomplished with 4 true plug-in tuning heads, with greater frequency range to come in new tuning units under development. All in all the most advanced, versatile microwave receiver you can own. Get a demonstration from your local Polarad Representative, or mail the card.

MODEL IC-120 1,000 cps to 10 gc

New Transistorized Impulse Calibrator Adapts Your Receiver For Field Intensity Work

Model IC-120 (1000 cps to 10 gc) can operate with your Model TR Receiver to make calibrated field intensity measurements. It can also be used for noise measurements, bandwidth determination, and as a signal source for spectrum analyzers.

POLARAD

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No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

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POLARAD ELECTRONICS CORP.

43-20 34th St., Long Island City 1, N. Y.

SPECIFICATIONS

SENSITIVITY: to −90 dbm.
FREQUENCY DIAL ACCURACY: ±1%.
IMAGE REJECTION: 60 db.
IMPULSE BANDWIDTHS: 1 mc, 5 mc, 8 mc.
VIDEO BANDWIDTH: 3.5 mc.
OUTPUTS: Audio, Video, Recorder.
GAIN STABILITY With AFC: ±2 db.
WEIGHTING CIRCUITS: Average, Slideback, Quasi-Peak, and Peak.
SLIDEBACK CONTROL: For aural indication of peak amplitude.
POWER INPUT: 12 volts DC; 115 volts AC; 50 to 420 cps

POLARAD

ELECTRONICS CORPORATION

43-20 34TH STREET, LONG ISLAND CITY 1, NEW YORK

FREE LIFETIME SERVICE

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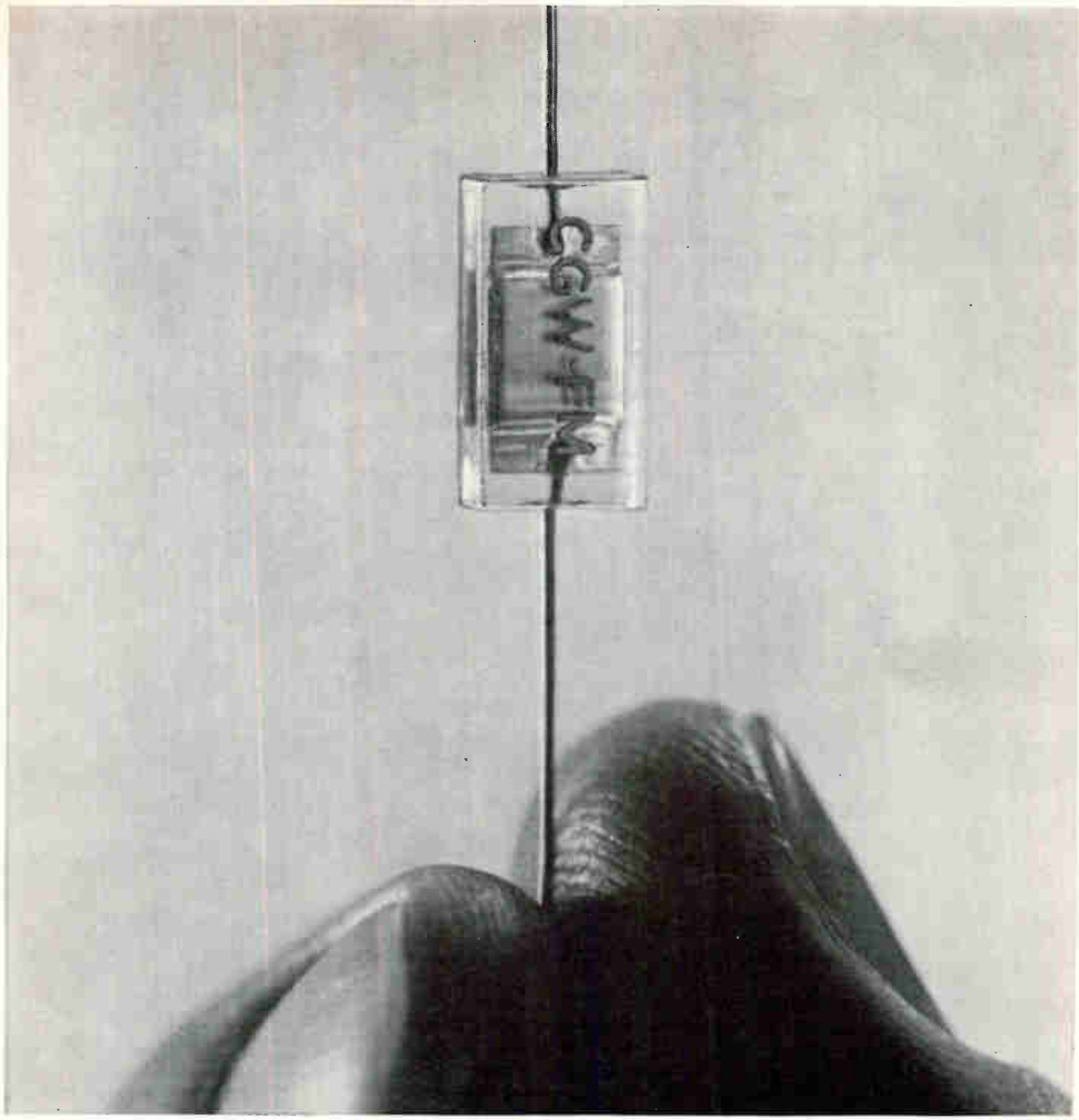

SECOND BEST?

That's the Corning CYFM capacitor. It's topped only by the Corning CYFR—the first one that completed the Autonetics/Minuteman hi rel program.

We learned how to make the CYFM while working to improve reliability. It's electrically and environmentally interchangeable with the CYFR. The major difference is price, and that's because we use refined processes on the CYFR for applications requiring guaranteed failure rates and reliability.

All in all, the CYFM is a positively sealed capacitor for complete environment-proof performance (it goes far beyond MIL-C-11272B), and it sells for less.

Developmental testing of the CYFM went 6,000,000 test hours, and included load life, boiling salt, salt spray, fluxes, and solvents.

You can get its reliable capacitive element of foil and ribbon glass, *frozen* inside glass with hermetic seals at the leads, in four types. The CYFM-10 gives *pf* values from 0.5 to 300; CYFM-15, 220 to 1200; CYFM-20, 560 to 5100; CYFM-30, 3600 to 10,000. Your Corning distributor can give you fast delivery at factory prices.

But, when you must have the ultimate in *guaranteed* reliability to your specifications, specify the CYFR. It's available in the same sizes and capacitance range. The CYFR is second to none.

For complete information, write for data sheets to Corning Glass Works, 539 High St., Bradford, Pa.

See us at the I.R.E. Show, Booths 2623-2625

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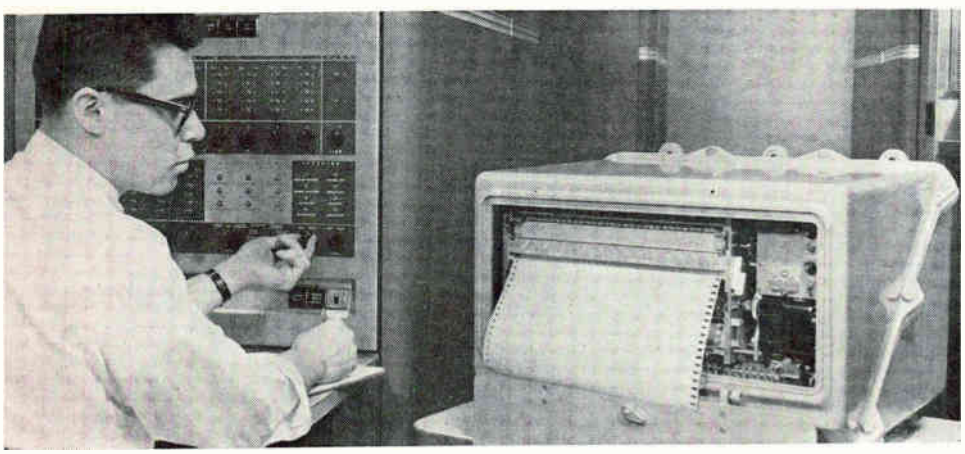
CIRCLE 31 ON READER SERVICE CARD 31

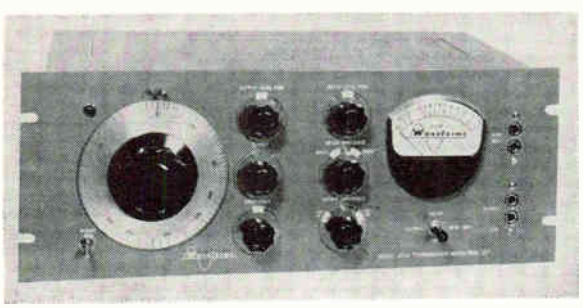
PREVIEW OF EXHIBITS:

INSTRUMENTATION AND SYSTEM COMPONENTS



Event-time recorder idles until it gets an input signal, then records up to 10 events a second

ITT sampling oscilloscope being used to test power conversion module of Ranger spacecraft



Waveforms, Inc., transmission meter gives direct readings in dbm

NEW YORK—This year's IRE show will match 1961's in size—850 exhibits occupying all four floors of the Coliseum—and in value of equipment displayed—about $15 million.

Systems developed for the industry's biggest customer, the government, will again provide some of the top-drawing displays. But the bread and butter exhibits will center on the gear that electronics companies sell each other.

Many of the instruments and system components slated for introduction are outlined below. For details on other new products, see the section beginning on page 144 of this issue.

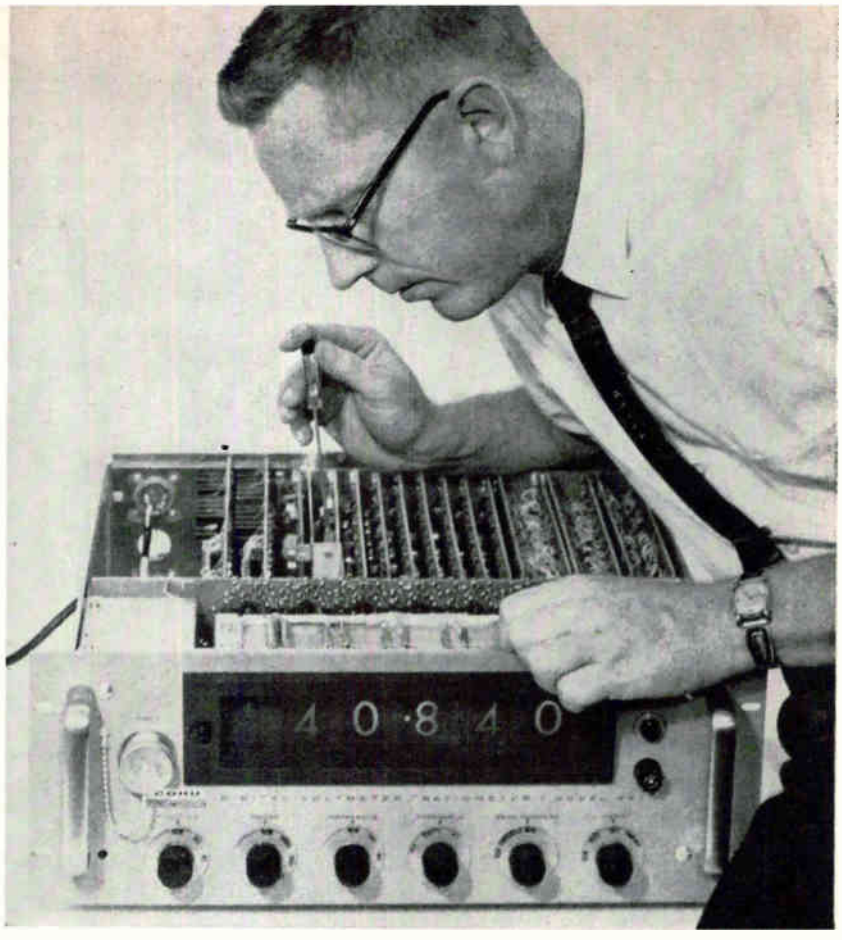
A sampling oscilloscope able to fully display transient waveforms from d-c through 5 Mc will be shown by ITT. It uses magnetic deflection of a 14-in. rectangular crt.

A random sampling technique assures that a-c waveshapes, low and sonic frequencies are displayed completely. Spot size of less than 0.5 mm is obtained by gun design and high accelerating potential.

Vertical and horizontal channels have interchangeable pre-amplifiers. Additional plug in units, including dual trace and high gain d-c amplifiers will be made available. Transistors are used in over half the circuits.

Weston Instruments div. of Daystrom, Inc. will show a 50-channel event-time recorder that operates only when an event signal is applied. It facilitates interpretation of monitored signals and conserves chart paper. The chart moves only when a signal is received.

Simultaneous time indications



Digital voltmeter-ratiometer by Kintel uses mercury-wetted relays and solid-state circuits, has accuracy of 0.1 percent at a-c and 0.01 percent at d-c

are displayed on each channel at a maximum recording rate of 10 events per second. Developed for use with multi-input control systems, it is suitable for process control and missile launching applications. Transistor, modular subassemblies are employed.

A line of meters using taut band suspension movements will also be introduced by Weston. The taut band system are dimensionally interchangeable with pivot-and-jewel movements, but are claimed to improve sensitivity, repeatability and ruggedness.

Texas Instruments' Apparatus division will display a medium-frequency oscillograph recorder that features rectilinear writing on roll or Z-fold paper with either ink or heat methods. The device has transistor circuits, uses interchangeable plug-in input units, provides high sensitivity, common-mode rejection and high impedance. A two-channel model with eight chart speeds will be shown.

An all solid-state analog-to-digital converter, designed for data acquisition systems, processing control and data processing systems, can be modified for many digital data handling applications, TI says. Its speed is 1.5 μsec per bit.

Two pulse generators are being displayed. One model features repetition rates of 2.5 to 25 Mc. Rise time is 6 nsec and width and delay are variable coincidentally. Amplitudes from two separate outputs, 0 to 5 v and 0 to -5 v, are independently variable.

The second model is a combination of specific modules. Pulse repetition frequency is from 100 cps to 5 Mc. Pulse can be delayed over a 20 to 1,000-nsec range. Rise time is variable from 20 nsec to 1 μsec. Fall time is variable over the same range.

TI is also showing a table-top machine for high-volume, single device or batch testing of a variety of transistors and diodes. Only two controls are required. Prewired plug-in boards handle programming.

Four oscillograph recorders using the direct carbon transfer writing technique will be shown by American Optical Company's Instrument division. One is a single-channel portable unit with a frequency response from d-c to 90 cps at 30 mm peak-to-peak. It weighs 20 pounds, looks like a tape recorder and features pushbutton four-speed chart control. Two other models are two-channel and three-channel versions of this, with interchangeable preamplifiers.

An eight-channel console unit, will also be introduced. It has a frequency response of d-c to 100 cps flat within 1 percent. Amplitude calibration is accomplished by push-button injection of a square wave, accurate to 1 percent of any position of the fixed sensitivity control. Chart speeds from 1 to 250 mm per second can be selected. Sensitivity of this unit is 1 volt per cm and linearity is 0.5 mm maximum.

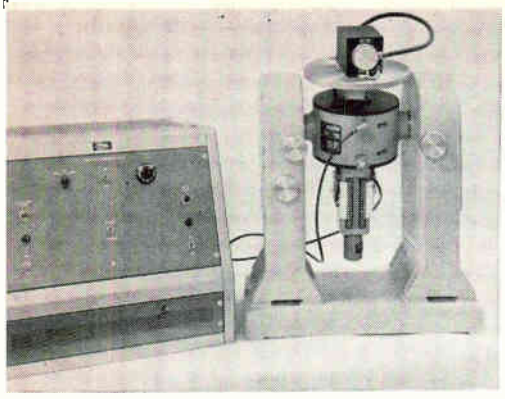
Alden Electronic & Impulse Recording Equip. Co. will demonstrate how sonar input signals tape-recorded during an oceanographic expedition are fed into a precision graphic recorder. The recorder was developed jointly with scientists at Woods Hole Oceanographic Institute. The firm will also show other recorders used in meteorology, navigation, geophysics and other fields.

Among components to be shown by Leeds & Northrup Co. is a phase sensitive a-c to d-c controlling converter. The unit is packaged in a fist-sized plug-in assembly. Input impedance is 500 ohms, output impedance 10,000 ohms. When d-c output is -4 to $+4$ volts, output linearity is $\pm$ 2 mv. Nominal a-c to d-c gain is 2.

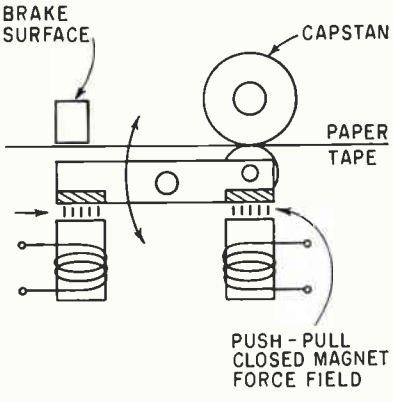
L & N is also displaying a high-gain, solid-state d-c coupled, operational amplifier. Built on a plug-in card, it can be adjusted for various functions by different input and feedback network configurations. These are on cards that plug in to the amplifier. Maximum amplifier output is $\pm$ 10 volts d-c, with a d-c linearity of 0.1 percent.

Hewlett-Packard is showing a 10-cps to 1-Mc solid-state oscillator with a push-button frequency selector. Three switches, each controlling a single digit, choose 900 base frequencies from 100 to 999, while a fourth selects any decade multiplier from $\times$ 0.1 to $\times$ 1,000. It uses negative feedback for stabilization and a biased-diode control to maintain output level independent of frequency. Frequency accuracy is 1 percent and output constancy 2.

A stabilized voltage standard by

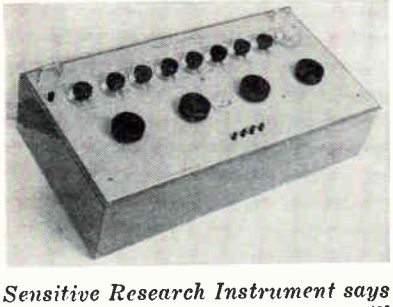


Reeves Instrument's tumbling table checks single-axis inertial gyros. Tachometer feedback controls rate loop second order effects



High-speed photoelectric tape reader by Rheem Electronics has roller brake assembly suspended in a push-pull magnetic field. It will stop in 0.5 msec

American Optical Company's carbon transfer oscillographs look like tape recorders



Sensitive Research Instrument says its precision potentiometer will measure to 2.0999999 v in steps of 0.1 μv without switching ranges

the Kintel division of Cohu Electronics, Inc. covers the range from 0 to 111.1110 volts in steps as small as 1 μv. The instrument employs a chopper circuit and stable reference voltage to achieve stability of 0.005 percent and an accuracy of within 0.01 percent of dial setting. It is one of several products to be displayed, including a closed-circuit tv gear, a digital voltmeter-ratiometer and a solid-state, digital d-c voltmeter.

A transistor digital clock for time display and control applications will be shown by Non-Linear Systems, Inc. The clock may be combined with other equipments in the NLS line to create automatic data loggers, testing and other systems. Time is measured in hours, minutes, and seconds up to 23 hr, 59 min, 59 sec. Other ranges are also availablle.

The firm will also show a clamp-and-hold digital voltmeter that can provide four-digit measurements of varying voltages to an accuracy of ± 0.01 percent ± 1 digit, in three ranges up to ± 999.9 v. Slewing rate of the instrument is 1,000 v per second, input impedance is 10 megohms. NLS will also introduce a low-cost four-digit digital voltmeter with ± 0.01 percent full-scale accuracy.

A series of stable microwave oscillators with short-term stability of five parts in 10^8 peak deviation and long-term stability of one part on 10^4 will be introduced by Laboratory for Electronics Inc. The instruments employ transistors, a triode and cavity. Coverage from 1 to 3 Gc is provided by eighteen models, each covering a 200-Mc increment.

A vhf-uhf noise generator shown by PRD Electronics, Inc. will provide noise-figure readings on a front panel meter over the range of 0 to 20 db. A klystron power supply providing all operating voltages, with a front panel meter for reading beam voltage or current, will be introduced. The company will also display a series of signal sources, employing reflex klystrons, external cavities and self-contained power supplies.

A series of varactor harmonic generators will also be shown by PRD. Included are five types that cover the frequency output range from 4 to 40 Kmc. They use a varactor bias of 6 to 8 volts d-c, with a maximum current of 22 ma. Harmonic power outputs ranging from 0 dbm to −40 dbm are provided, depending on the model, with an input of 100 ± 20 milliwattts.

Transmission measuring set with a built-in, low-distortion oscillator covering the range from 20 cps to 20 Kc will be introduced by Waveforms, Inc. Levels of from +20 dbm to −70 dbm are available to drive lines from 37.5 through 600 ohms, balanced or unbalanced. Both 150 and 600-ohm lines may be matched or bridged and levels from +40 to −10 dbm read. Panel meter readings are directly in dbm at all input and output impedances.

Other transmission measuring sets include a unit that converts any audio oscillator into an audio signal generator able to match circuits from 37.5 through 600 ohms balanced or unbalanced. Another set is designed for voice and carrier frequencies.

The firm will also show a sine-wave oscillator with decade attenuator and fine output control, covering the frequency range from 5 cps to 600 Kc, on a 5 to 50 decading format.

A group of power supplies to be shown by Kepco, Inc. include a 0-36 v, 30-amp dual regulated unit. Ripple output is less than 1 mv, with regulation of better than 0.05 percent. Recovery time is less than 50 μsec.

A calibrated, tunable, infrared signal generator will be shown by Telewave Laboratories, Inc. With an output power to 10 μw and variable wavelength from 1 to 14 microns, the instrument is suited for lens testing, resolution measurements, detector and system frequency response measurements. Modulation by a square wave of stable nature, from 2 to 2,600 cps is available. A tungsten source with short time constant is used. Both collimated beam and point source output are available.

Transistor portable deviation meter covering 20 to 500 Mc will be introduced by Motorola for servicing f-m two-way radio. Deviation ranges of 1.6, 8 and 16 Kc may be read full scale, with ± 5 percent accuracy on the latter two. Unit can operate from 117 volts a-c or as a portable from two internal mercury batteries. — LHD, LDS, HCH, CMW, TM

IRE Presents Six Awards at Banquet

PRESENTATION of six awards and 78 fellows citations to leading engineers and scientists will be one of the high points of the IRE's Golden Anniversary Banquet March 28 in the grand ballroom of the Waldorf-Astoria Hotel.

The highest award, the 1962 Medal of Honor, will go to Edward V. Appleton, principal and vice chancellor of the University of Edinburgh, Scotland, for his "distinguished pioneer work in investigating the ionosphere by means of radio waves." He won a Nobel Prize in 1947 for his work in physics.

Victor H. Rumsey, professor of electrical engineering, University of California, receives the Morris N. Liebman Award for a recent contribution to the radio art. Rumsey made basic contributions to development of frequency-independent antennas.

The Browder J. Thompson Award, for the best IRE technical paper by an author under 30, goes to Henri B. Smets, European Nuclear Energy Agency, Paris, for "Analysis and Synthesis of Nonlinear Systems."

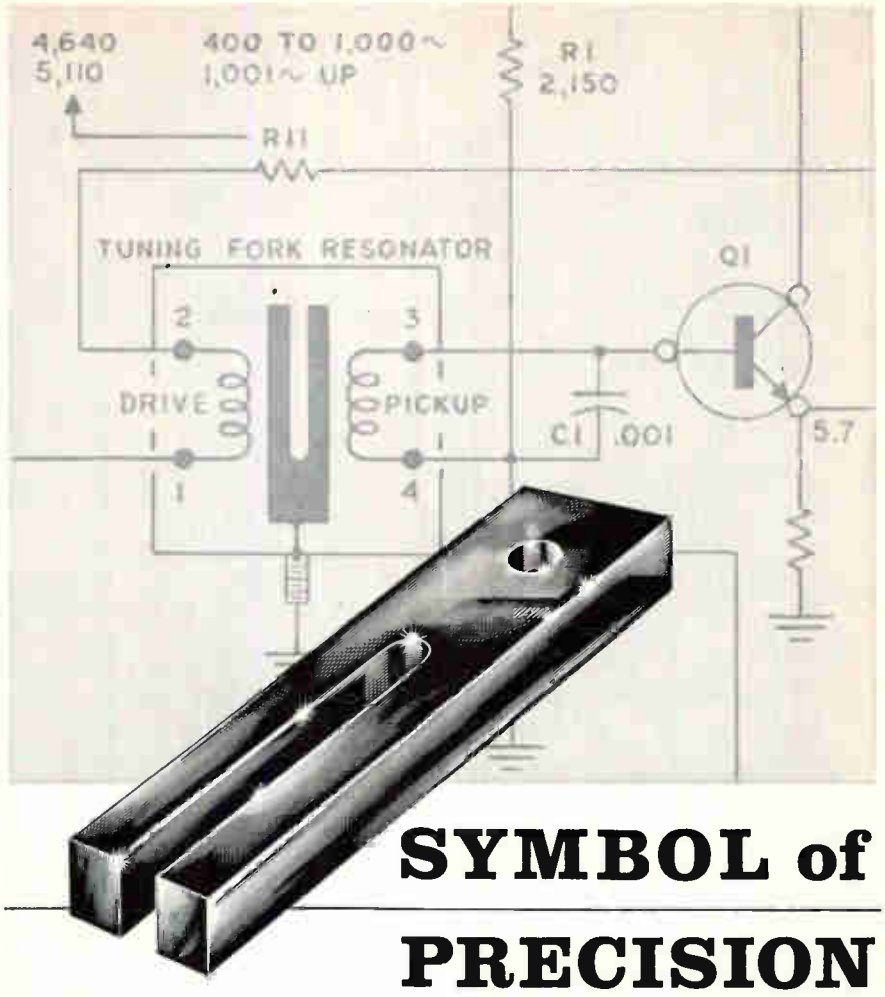
The Harry Diamond Award to a person in government service, goes this year to William Culshaw, of National Bureau of Standards, for accomplishments in microwave optics and interferometry.

George A. Morton, of RCA, wins the Vladimir K. Zworykin Award for contributions to tv. Morton was cited for developments in camera and imaging tubes.

The W. R. G. Baker Award for the best transactions paper goes to Marvin Chodorow and Tore Wessel-Berg, of Stanford University, for "A High-Efficiency Klystron with Distributed Interaction."

The awards will be presented by Patrick E. Haggerty, IRE president and president of Texas Instruments. Thomas F. Jones, Jr., head of the School of Electrical Engineering, Purdue University, will be spokesman for the fellows.

Gen. David Sarnoff, RCA president and former IRE secretary, will be the principal speaker at the banquet.



SYMBOL of PRECISION

Why has the **PHILAMON**® Tuning Fork become the Symbol of Precision for frequency and time standards?

Because of its appearance? Hardly. You'll never see the fork—it is hermetically sealed in an evacuated steel container.

PERFORMANCE is the reason. The only reason.

Everything — Philamon's patented design, premium materials, meticulous workmanship and exhaustive testing — is aimed at one goal. Producing a Tuning Fork Resonator which will generate *and keep* on *generating* a precise signal.

It is this single-minded emphasis on performance that has given Philamon Laboratories—

A Reputation for Dependable Frequency Control.

Made to MIL and commercial standards, Philamon's Patented Tuning Fork Resonator is available as a separate component or as the heart of a Philamon Frequency Control Package. These silicon-transistor, modular packages give you a wide choice in preselecting a signal for frequency, accuracy, output voltage and waveshape.

If you have a problem that lends itself to the capabilities of a Tuning Fork Resonator — an instrument also superb as a narrow bandwidth filter — our engineers can, and would like to, help you solve it.

For complete information, write, phone or wire:

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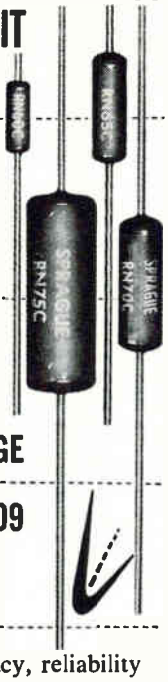
FILMISTOR®

METAL FILM RESISTORS OFFER 5 TEMP. COEFFICIENTS TO MEET ALL CIRCUIT REQUIREMENTS

RUGGED END-CAP CONSTRUCTION FOR LONG TERM STABILITY

EXCEPTIONAL RESISTANCE TO MOISTURE AND MECHANICAL DAMAGE

SURPASS MIL-R-10509 PERFORMANCE REQUIREMENTS



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

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

Filmistor Resistors, in ⅛, ¼, ½ and 1 watt ratings, surpass stringent performance requirements of MIL-R-10509D, Characteristics C and E.

Write for Engineering Bulletin No. 7025 to: Technical Literature Section, Sprague Electric Co., 35 Marshall Street, North Adams, Mass.

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

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50TH ANNIVERSARY OF THE INTERNATIONAL IRE • ire • SPECIAL

Recruiting: More Selective

NEW YORK—Advance reports indicate that job-hunting and personnel recruitment will again be one of the favorite extracurricular activities at the IRE Convention.

The people organizing the show will try to keep actual recruiting activities within the Coliseum to a minimum. Exhibitors will be permitted to post five personnel listings on a special bulletin board, as in the past. However, show officials are asking that no recruiting interviews be held in the display booths.

Checks made during the past several weeks with personnel specialists show that recruitment activities will not be as intense as in some years past. This reflects the change in the military procurement picture, toward small quantities of highly specialized devices and systems.

Recent graduates, junior engineers and nonspecialists will find that they do not have as many job choices as in the past years. Recruiters say that few companies stockpile personnel any more, lowering the demand for trainees.

Engineers with experience will find job-changing possibilities fairly good in such key specialties as communications, computer design, semiconductors, automation systems, radar and advanced military systems.

Salaries show a slightly rising trend. Here are some approximate ranges for annual pay:

- Recent graduates can generally expect $6,500 to $9,000, depending on degrees won and other indicators of proficiency.
- Junior engineers with one or two years experience are worth between $7,000 and $10,000.
- Men in the digital data equipment field are commanding between $8,000 and $14,000.
- Among fields paying more than $10,000 a year are instrument design, data transmission systems and environmental test systems. Salaries range up to $14,000 or $15,000.
- Salaries between $12,000 and $16,000 are being offered tv equipment designers, solid-state engineers and some classes of radar specialists.
- Advanced data processing and some missile guidance and control posts pay $14,000 to $18,000.
- Experienced component designers and military systems engineers are probably worth $16,000 to $20,000.
- Top men in specialized fields such as advanced servo systems, radar systems, communications equipment, computer design and advanced component design are being offered better than $20,000 a year.

The relatively higher salaries industry is willing to pay engineers has resulted in plans to raise pay for government service. Federal pay would go as high as $28,000 a year (ELECTRONICS, p 12, March 2).

Government agencies are major employers of engineers, scientists and technical personnel. NASA alone estimates it will need some 13,000 new trained people by 1970. The agency, for example, is now trying to recruit 2,000 scientists and engineers for the new Manned Spacecraft Center in Houston.

USSR Educates Twice as Many Engineers as We Do

WASHINGTON—National Science Foundation has published an analysis of Soviet education that indicates the USSR is producing two to three times as many scientific and professional graduates yearly as the U. S.

The USSR has only half as many college graduates as the U. S. But a greater percentage of graduates study science and engineering. The Soviet rate of growth in these fields is more than twice that of the U. S., the study found.

We produce about 90,000 science, engineering and applied science professionals a year. The USSR is now graduating 190,000 a year and is expected to step this up to 250,000 a year during the 1960's.

NEW HIGH IN RELIABILITY

Transitron's EXCLUSIVE

HEATLESS SEAL RECTIFIERS

TWICE SIZE

This new line of heatless seal silicon rectifiers by Transitron, the originator of the silicon rectifier, brings to the electronic industry a notable new advance in the state of the art.

The reliability of internal rectifier junctions is now further enhanced because no heat is used to seal the packages. Cap and base are joined by the "cold flow" of copper into steel as the parts are forced together under high pressure. Rectifier junctions are no longer exposed to contamination by the sputtering or splashing of molten metals or by flux fumes and gases, weld flashes, or hot sparks. Therefore the new process creates the most reliable hermetic seal yet attained in silicon rectifiers. Consequently heatless seal rectifiers meet or exceed all required military and industrial tests for moisture resistance and hermeticity. Four series now in quantity production are available for immediate delivery.

For further information, write for bulletins indicated in the chart at right.

SERIES TYPE	PEAK INVERSE VOLTAGE (VOLTS)										BULLETIN NUMBER
	50	100	150	200	250	300	350	400	500	600	
3 AMP TYPES	1N1581 (TM7)	1N1582 (TM17)		1N1583 (TM27)		1N1584 (TM37)		1N1585 (TM47)	1N1586 (TM57)	1N1587 (TM67)	TE-1351F
20 AMP TYPES	1N248A	1N249A	TR152	1N250A	TR252	TR302	TR352	TR402	TR502	TR602	TE-1351K
35 AMP TYPES	TR53	TR103	TR153	TR203	TR253	TR303	TR353	TR403	TR503	TR603	TE-1351K-1
MILITARY TYPES		1N253		1N254				1N255		1N256	TE-1336

Bases and caps supplied by Standard Pressed Steel Co., Jenkintown, Pa.

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Gudebrod helps increase your production because we carefully test, measure and maintain close tolerances on such characteristics as slip resistance, fray resistance, breaking strength, wax content, fungistatic effectiveness. These and other tests assure you that when Gudebrod lacing tape is used production increases. *Knots don't slip . . . harnesses stay tied . . . assemblies remain firm . . . there are fewer rejects!*

Whatever your lacing needs—Teflon*, dacron†, glass, nylon, high temperatures, special finishes—Gudebrod makes it or will produce a tape to meet your special requirements. If you want a tape to meet 1500°F . . . Gudebrod Experimental Research Project 173 is the answer. If you want a tape that meets MIL-T-713A . . . Gudelace® (Style 18 Natural) is the answer.

MAKE THE H-R TEST! Write for samples of Gudelace or other Gudebrod lacing tapes and have them tested in your harness room. Compare a harness tied with a "Quality Controlled" Gudebrod tape and any other tape. This test will convince you that when you specify Gudebrod you specify *real* economy—increased production with fewer rejects.

Write for our free Technical Products Data Book. It explains Gudelace and other Gudebrod lacing tapes in detail.

*Dupont's TFE fluorocarbon fiber. †Dupont's polyester fiber.

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Electronics Division
225 West 34th Street
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Visit Gudebrod Booth 4032 at the IRE Show

MEETINGS AHEAD

IRE SPECIAL

IRON & STEEL INDUSTRY INSTRUMENTATION CONFERENCE, Instrument Society of America; Hotel Roosevelt, Pittsburgh, Pa., Mar. 14-16.

EXTRA-HIGH VOLTAGE COMMUNICATION, CONTROL & RELAYING, AIEE; Baker Hotel, Dallas, Texas, Mar. 14-16.

AUDIO ENGINEERING SPRING CONVENTION; AES Ambassador Hotel, Los Angeles, Mar. 19-26.

IRE INTERNATIONAL CONVENTION, Coliseum & Waldorf Astoria Hotel, New York City, Mar. 26-29.

ENVIRONMENTAL TESTING SEMINAR For Engineers in the Instrumentation Field, Gulton Industries; at Gulton, Metuchen, N. J., Mar. 26-30.

QUALITY CONTROL CLINIC, Rochester Society for Quality Control; University of Rochester, N. Y., Mar. 27.

ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, AIEE, IAS, IRE, University of Rochester; University of Rochester, N. Y., Mar. 28-29.

ELECTRON BEAM SYMPOSIUM, Alloyd Electronics Corp.; Boston, Mar. 29-30.

QUALITY CONTROL ADMINISTRATIVE APPLICATIONS CONFERENCE, American Society for Quality Control; University of Montreal, Montreal, Canada, Mar. 29-30.

ELECTRONIC & ELECTRICAL INDUSTRIAL-COMMERCIAL EQUIPMENT SHOW, Electrical Manufacturers Representatives Assoc. of Michigan; Artillery Armory, Detroit, April 4-6.

CHEMICAL & PETROLEUM INSTRUMENTATION SYMPOSIUM, Instrument Soc. of America; Du Pont Country Club, Wilmington, Delaware, April 9-10.

BUSINESS EQUIPMENT EXPOSITION, Business Equipment Manufacturers; McCormick Place, Chicago, April 9-13.

PLASMA SHEATH SYMPOSIUM, AF Cambridge Research Labs; New England Mutual Hall, Boston, April 10-12.

SOUTHWEST IRE CONFERENCE; Rich Hotel, Houston, April 11-13.

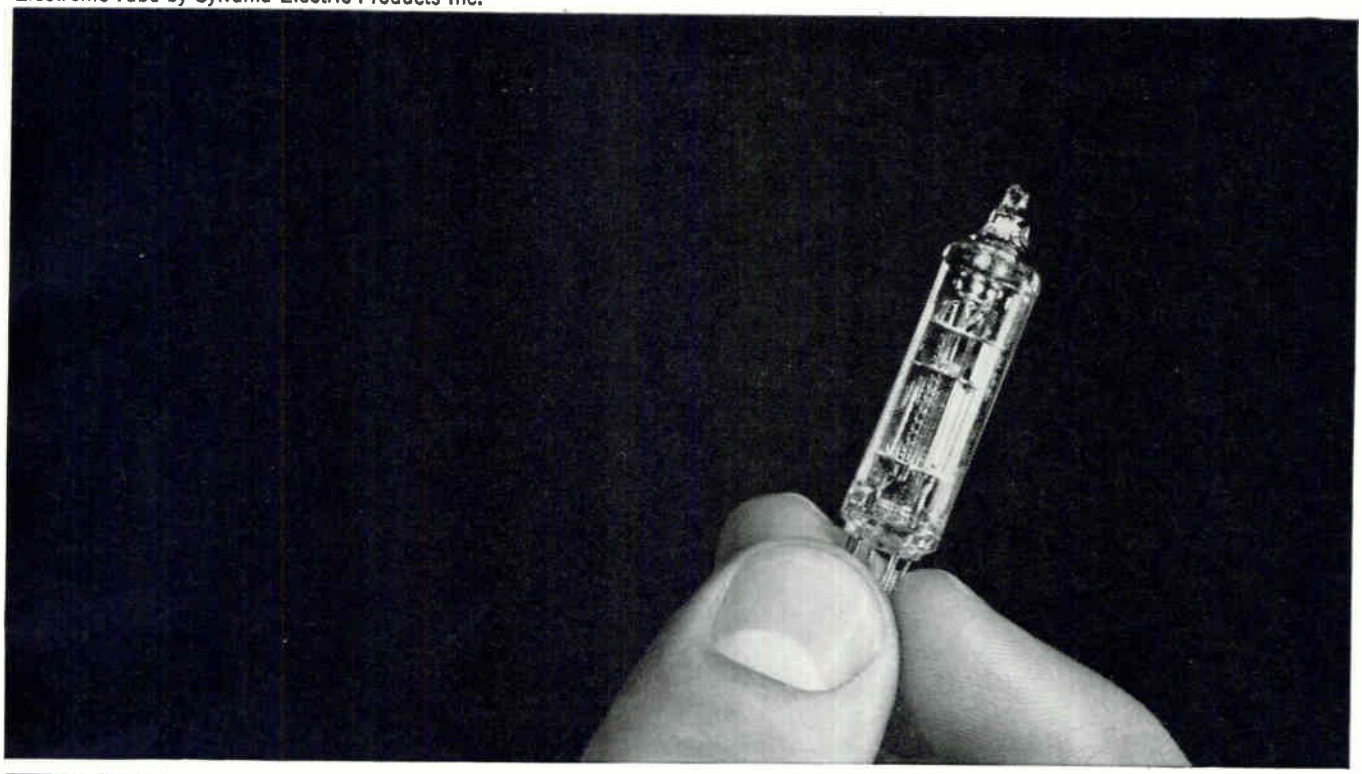
JOINT COMPUTER CONFERENCE, IRE-PGEC, AIEE, ACM; Fairmont Hotel, San Francisco, Calif., May 1-3.

HUMAN FACTORS IN ELECTRONICS, IRE-PGHFE Lafayette Hotel, Long Beach, Calif., May 3-4.

ELECTRONIC COMPONENTS CONFERENCE, IRE-PGCP, AIEE, EIA; Marriott Twin Bridges Hotel, Washington, D. C., May 8-10.

NATIONAL AEROSPACE ELECTRONICS CONFERENCE, IRE-PGANE; Biltmore Hotel, Dayton, Ohio, May 22-24.

Electronic Tube by Sylvania Electric Products Inc.



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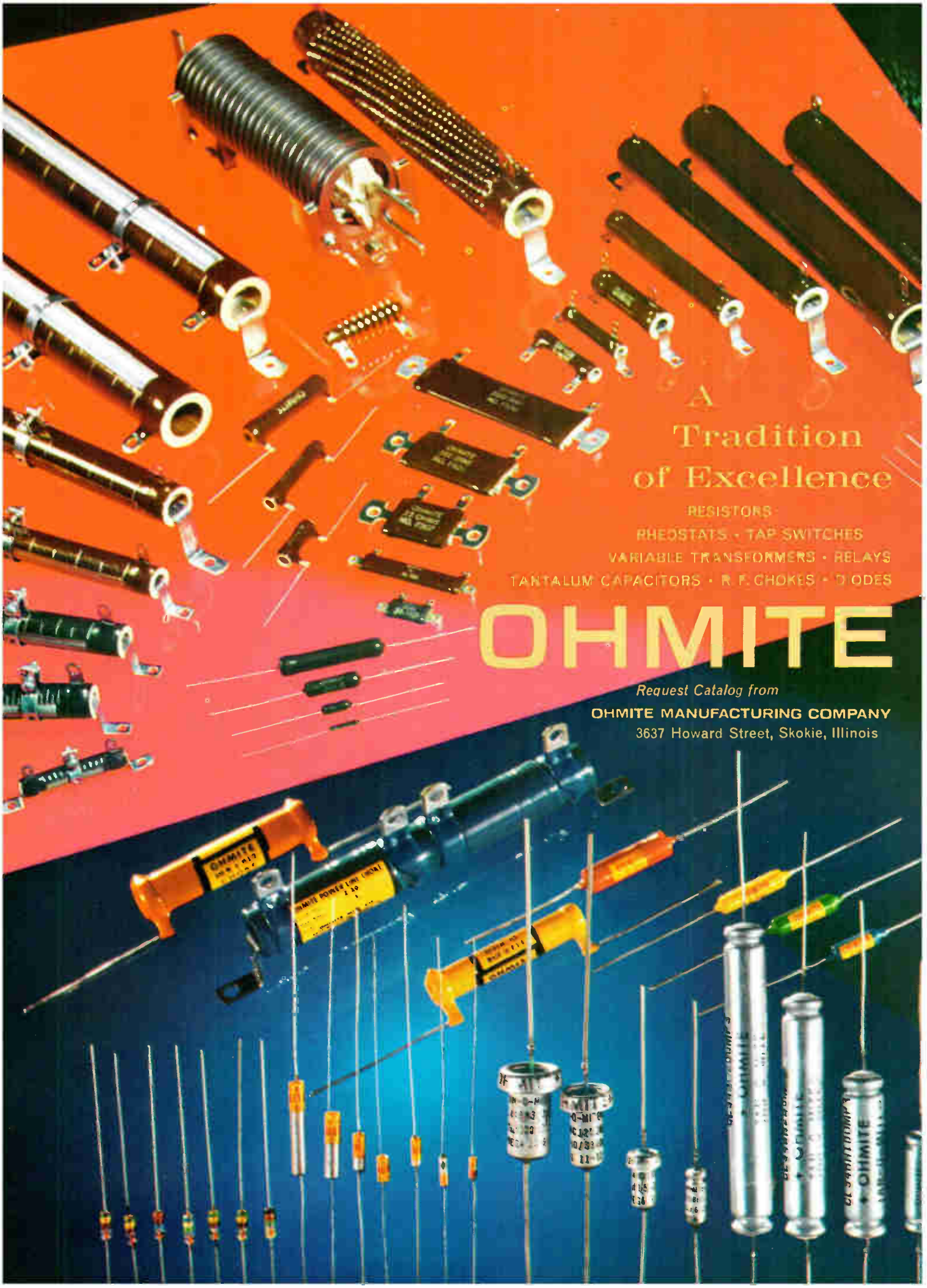
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LOW NOISE TWT EXTENDS RADAR RANGE

A limitation on the effective range of a radar equipment is the noise level in the receiver: the limiting range is reached when signal to noise ratio approaches unity. The signal to noise ratio in the equipment cannot be better than that in the first stage, therefore the use of a low noise amplifying tube in that stage is of paramount importance.

STC offers two tubes of eminently suitable design for use in S-band:

Type W9/2E for broadband coverage with a gain of 40 dB and noise factor of about 8·5 dB. It is intended for operation over the whole frequency range 2·5 to 4·1 Gc/s with fixed voltages. An aluminium foil mount is available with coaxial r.f. connectors.

Type W10/3E for narrow band operation with about 23 dB gain and 6·8 dB noise factor with the grid voltages set for optimum noise factor at the appropriate centre frequency.

W10/3E has a frequency range 2·7 to 3·3 Gc/s in solenoid curcuit 495—LVA—003 with waveguide r.f. connectors or frequency range 2·8 to 3·8 Gc/s in solenoid circuit 495—LVA—006 with coaxial r.f. connectors.

W9 2E

W10 3E with mount 495-LVA-006S

NEW BACKWARD WAVE OSCILLATORS

The new K- and Q-Band backward-wave oscillators in the STC range incorporate a d.c. isolator in the output waveguide to permit operation with grounded cathode as well as grounded output terminal. These oscillators are tuned purely by variation of the line (slow wave structure) voltage which may now be positive to ground. Two grids are provided for amplitude modulation: grid 2 set positive relative to cathode and grid 1 at zero, or negative with a superimposed modulating signal requiring only low energy.

* *SPECIAL ANNOUNCEMENT:*

Improvements to the K-band oscillator have more than doubled its original output power at the upper frequencies.

Type Y333/1E

ABRIDGED DATA

Band	Valve Code	Freq. Range (Gc/s)	Line Voltage (V)	Output Power (mW)
K	Y322/1E	18–26·5	650–3000	30 to 200
Q	Y333/1E	26·5–40	700–3200	10 to 80

Write for Data Sheets to:

Standard Telephones and Cables Limited

VALVE DIVISION: BRIXHAM ROAD · PAIGNTON · DEVON · ENGLAND

USA enquiries for price and delivery to ITT Components Division, P.O. Box 412, Clifton, N.J.

62 18MS

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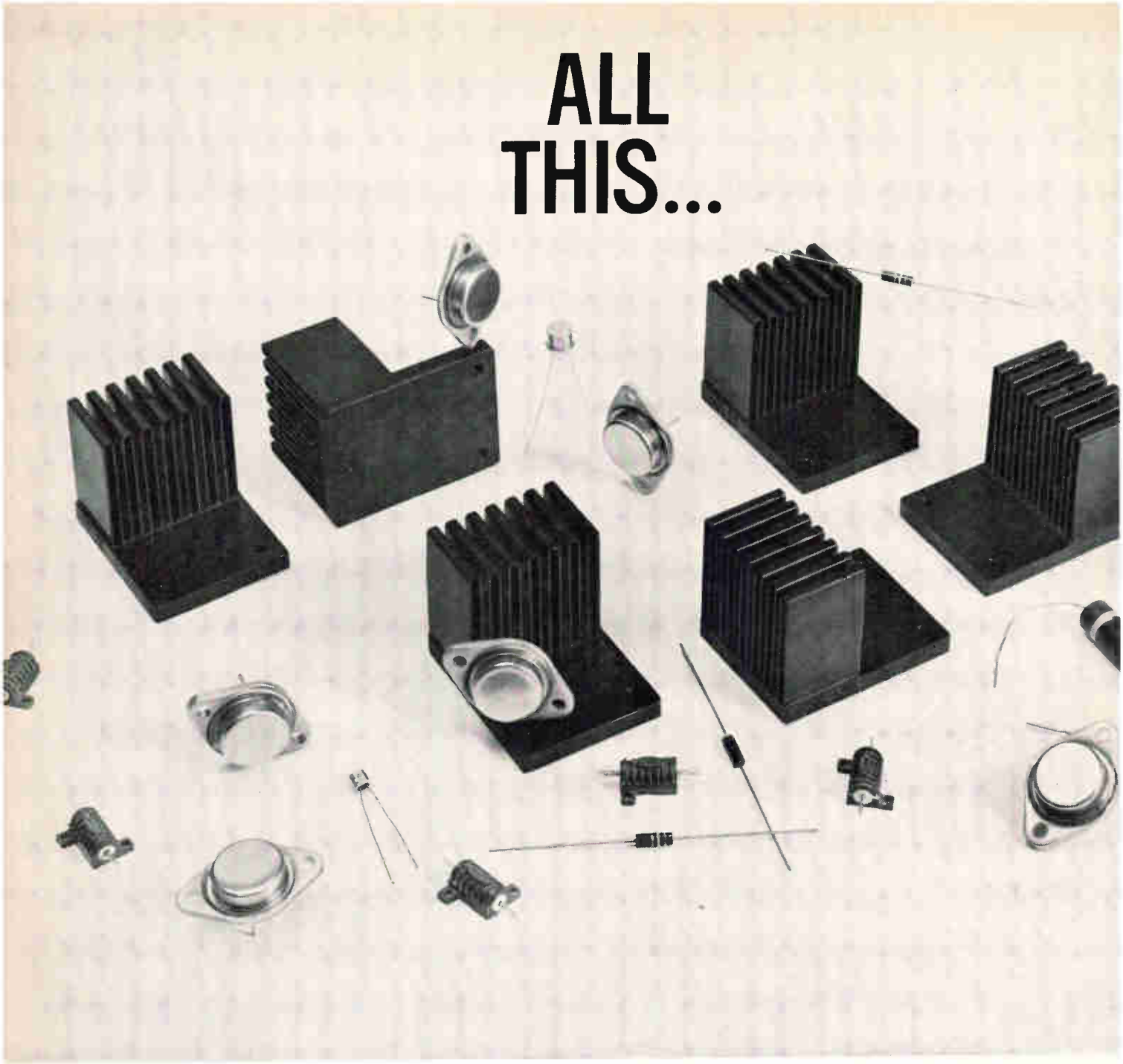

Westinghouse high gain silicon transistor

- GAIN OF 1000 OR MORE AT 2 AMPS
- COLLECTOR CURRENT—10 AMPS
- TRUE VOLTAGE RATINGS TO 150 VOLTS
- HARD SOLDERED CONSTRUCTION FOR THERMAL FATIGUE RESISTANCE

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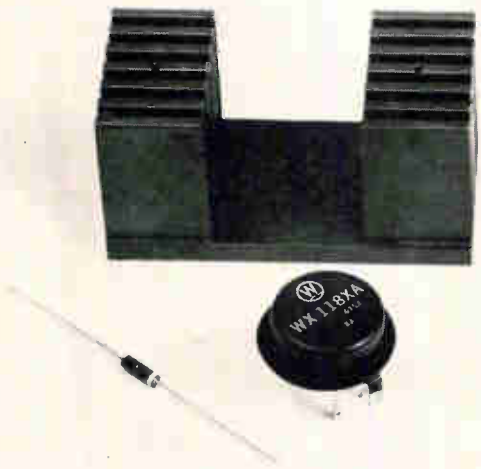

simplifies circuitry, gives 5 times greater reliability, costs 2/3 less

Westinghouse now offers a complete family of high-gain silicon power transistors which provide a gain of 1000 or more at 2 amps . . . with guaranteed minimum gain of 400 at 10 amps (WX 118 X series) . . . a guaranteed minimum gain of 100 at 10 amps (WX 118 U series). They have power dissipation of 150 watts, operate at temperatures to +150° C. These devices offer great advantages in increased reliability, space, weight, and cost savings. They are ideally suited for applications in high power, high efficiency regulators, amplifiers, and switching circuits. For full information call your nearest Westinghouse representative, or write to Semiconductor Dept., Youngwood, Pa. **You can be sure . . . if it's**

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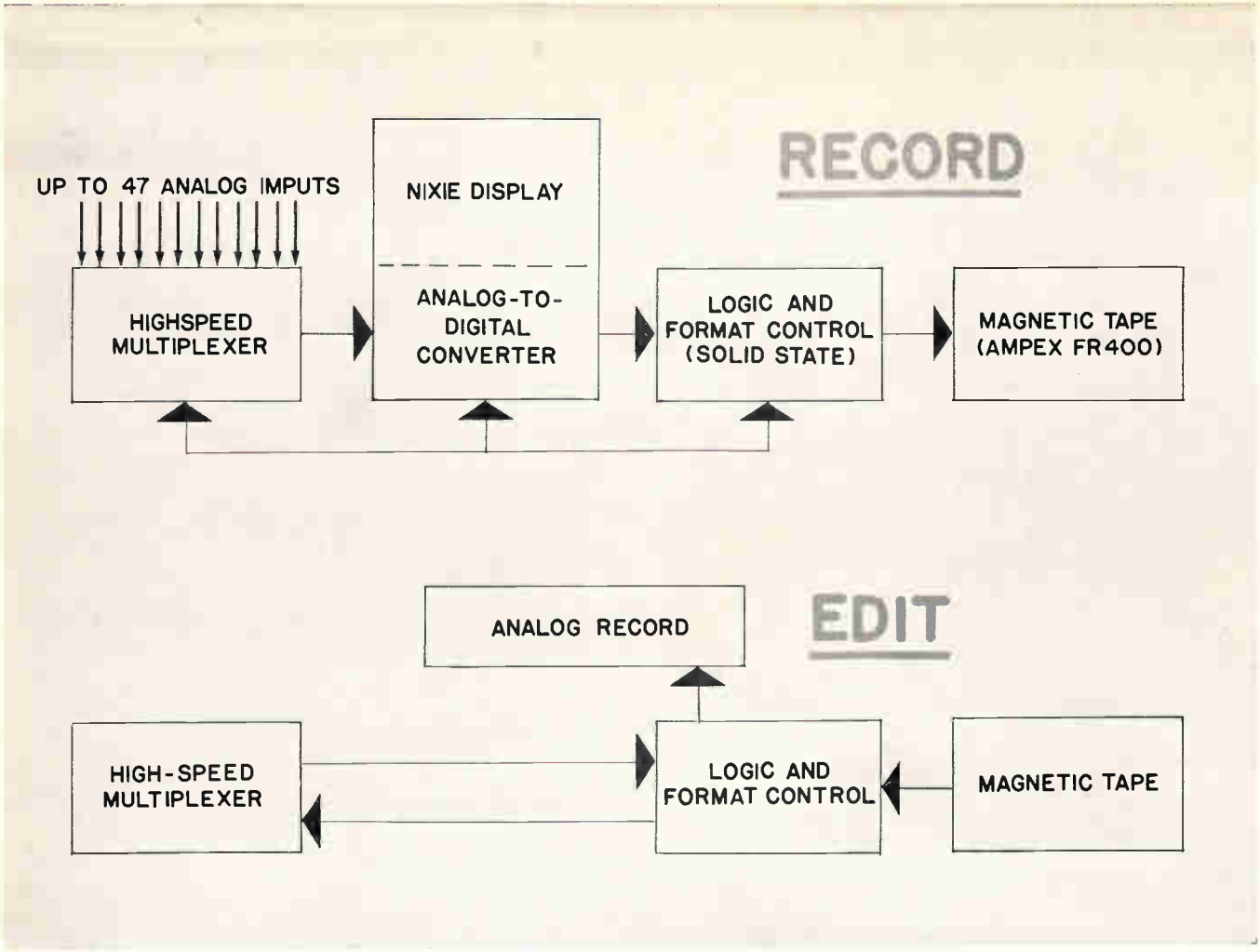

Simplified diagram shows RADATAC in "Record" and "Edit" modes. Sampling rate of 3750 per second provides nominal 80 scans per second for 47 input channels.

HOW TO CUT THE COST OF PREPARING DATA FOR COMPUTER ENTRY

Radatac bridges the language gap between transducers and computer

Whether you own a computer or rent computer time for analysis, checkout or process control, RADATAC can save you money. This compact, portable unit converts analog inputs to digital format, stores information, provides visual display for data editing prior to computer entry.

These features simplify the mechanics of transforming raw data into meaningful results. They let you edit out the less significant data, thus save computer time. They let you bring taped digitized data from plant or lab to the computer, whether the latter be at your home office or at a service center.

RADATAC, originally developed by Radiation Incorporated for missile program applications, embodies system-proved components. Yet, RADATAC costs far less than an equivalent built-up system.

Investigate the savings you can make on digital data acquisition with RADATAC. Write Radiation Incorporated, Dept. EL-32, Melbourne, Florida.

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Resulting in:

- **Extreme Flexibility**
- **Strongest Bond**
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If you're using flexible printed circuitry now or have tried in the past with little success, Schjeldahl's Schjel-Clad Copper Mylar lamination offers you the strongest bond and the purest finished product.

With Schjel-Clad Copper Mylar, all inherent characteristics of Mylar and copper are maintained. The "creep" factor is very low; circuits don't shift. The bond is uniform, eliminating air bubbles and "fish eyes" in the final product.

The bonding agent is Schjel-Clad, a special thermo-setting Schjeldahl adhesive which assures high purity and high bonding strength in the lamination. Low distortion of circuits etched on Schjel-Clad Copper Mylar is proof of its dimensional stability. It can be etched by the use of standard etching materials and also can be exposed to chlorinated cleaning solvents for short periods of time without damage.

AVAILABILITY

Schjeldahl's Copper Mylar is available in various composites from 10 mil Mylar laminated to 5 oz. copper to ½ mil Mylar on 1 oz. copper.

*du Pont trademark for its polyester film

This material is available with copper on both sides of Mylar, or Mylar on both sides of copper. There are a number of **circuit fabricators** who are familiar with Schjel-Clad. A listing is available on request. **The applications listed below show a number of uses or proposed uses of Schjel-Clad:**

Computers	Business Machines	Printed Wiring
Aircraft	Switchboards	Circuitry
Television and Radio	Automobiles	Shielding
Transformers	Memory Systems	Harnessing and Wiring

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Attn.: Carl R. Bergquist, LAMINATING DIVISION

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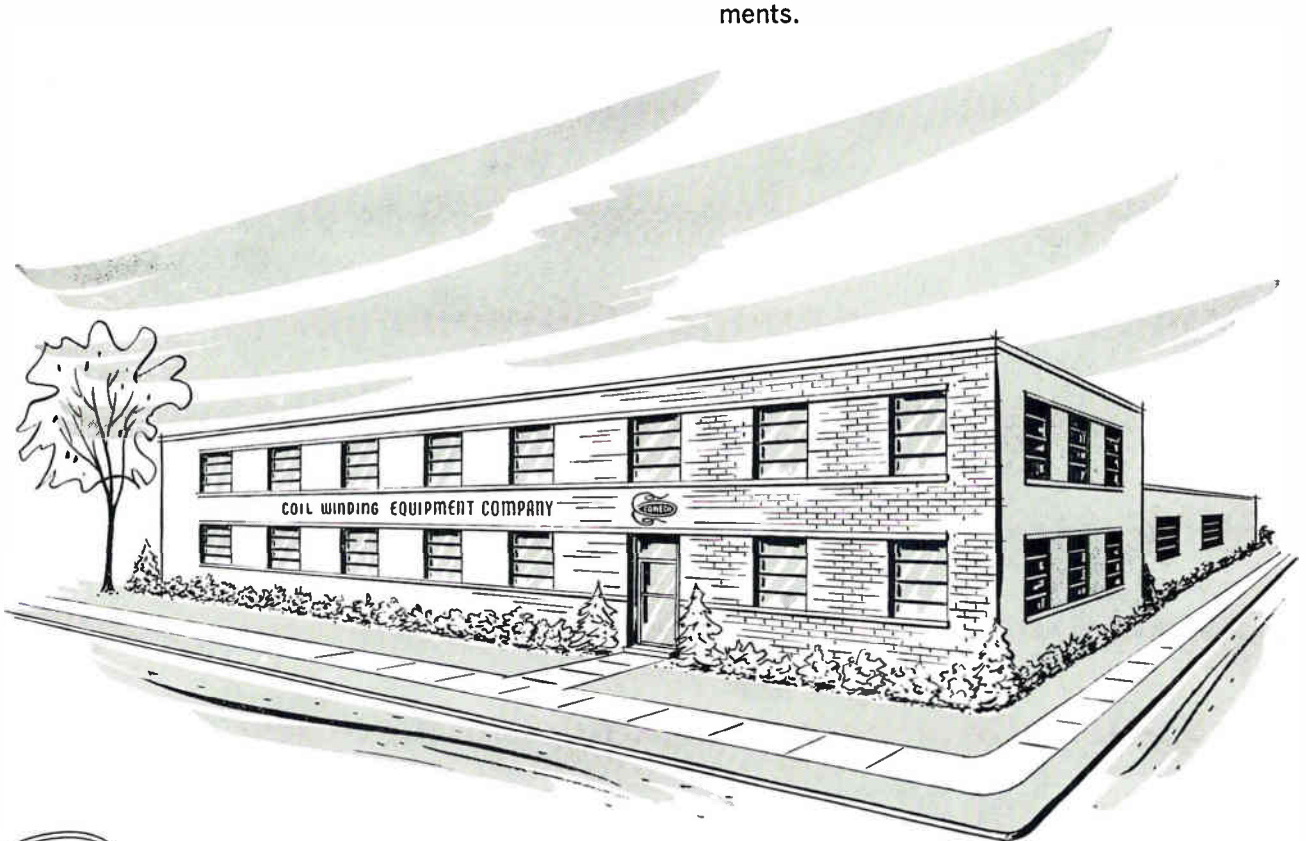
Into this new building has gone all the past experience and 'know-how' of the past 20 years, the kind of skill and background that has produced much of the equipment that's now standard throughout the industry.

What has been added is an even greater determination to produce better, more efficient equipment...to help you produce a better end-product more efficiently.

All our experience, 'know-how', and facilities are available to help you work out your requirements in this specialized area. Send for our catalog, or write us about your requirements.



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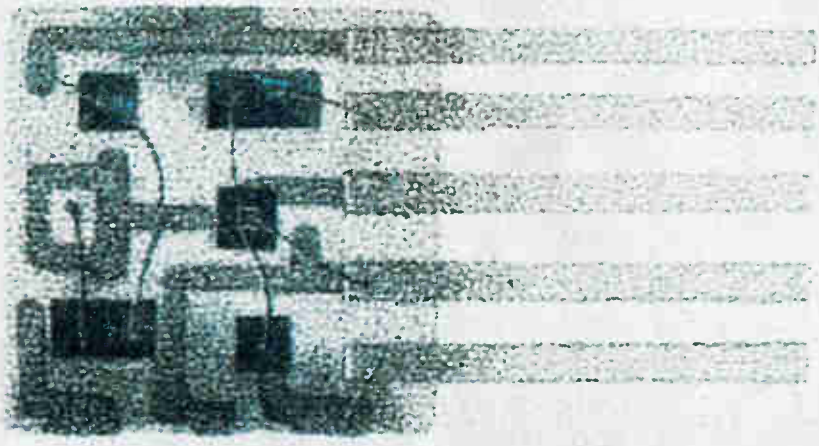
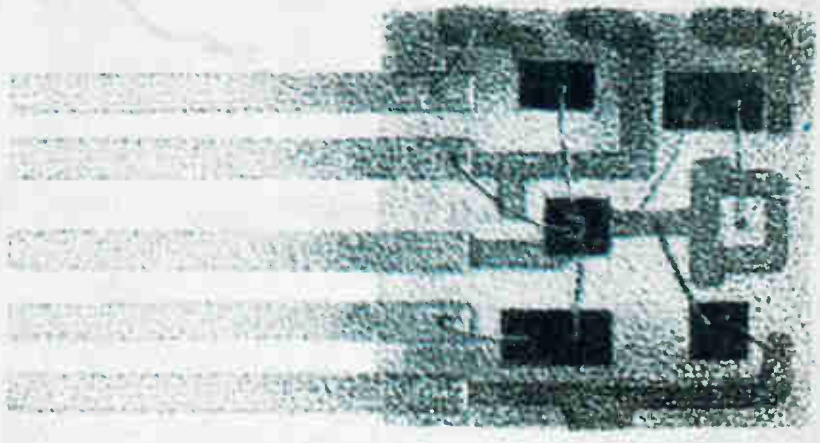
Flip



These magnified halves when combined in this actual size Flip Flop contain 2 transistors, 2 diodes, 4 resistors, and 2 capacitors



Flop

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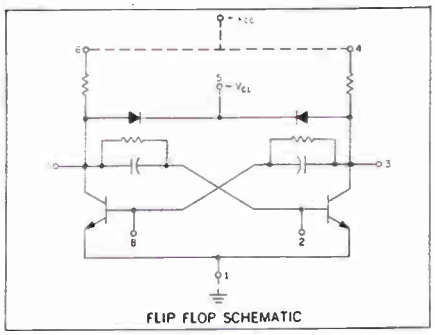
Source for Silicon Nanocircuits. Now you can design military and industrial computer circuits with high-speed, silicon Nanocircuits whose substrates measure as little as 0.17 x 0.17 inches. Latest example of General Instrument's Nanocircuit Program, these new flip-flops utilize matched pairs of semiconductors and operate at speeds in the nanosecond range. The flip-flop schematic shown at right, typical of the many configurations available, consists of two silicon planar epitaxial transistors, two silicon microdiodes, four silicon microresistors and two silicon oxide microcapacitors. ■ Silicon Nanocircuits need no encapsulation. Each component (preselected and pretested for reliability prior to bonding to the substrate) is passivated by General Instrument's unique Molecular Shield™ process. Nanocircuits are unaffected by external ambients. The coating serves only to provide mechanical rigidity. ■ Complete details on all silicon Nanocircuits are available at the General Instrument sales office nearest you. Call or write today. General Instrument Semiconductor Division, 65 Gouverneur St., Newark 4, N. J.



FLIP FLOP SCHEMATIC

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March 9, 1962

Three-dimensional solid-state display showing rotating electroluminescent panel and three target consoles for simulation display (Avco)

ENGINEERING HIGHLIGHTS

1962 IRE CONVENTION

50TH ANNIVERSARY OF THE INTERNATIONAL IRE • ire SPECIAL

Looking into the next half century with microwave computers, electro-optical circuits, biological power supplies, semiconductors, superconductors, thermoelectrics, atomic power and electrostatic recording

LATER THIS MONTH more than 250 papers will be presented to the 1962 International Convention of the Institute of Radio Engineers, which concurrently celebrates its fiftieth anniversary.

This article summarizes thirteen papers that indicate some new directions for the second half century of this profession. There are three papers on modulation of light, an important corollary to the study of optical masers. Last paper in this group of thirteen deals with electrostatic recording. Don't miss it. The technique may change a lot of our ideas about electronic recording. Other papers deal with microwave computers, thermoelectric microwave detectors, superconducting delay lines and a microwave deflection-amplifier tube, said to bridge the gap between conventional triodes and traveling-wave tubes.

Solid-State 3-D Display—A three-dimensional display suitable for use with air-space surveillance radar can be achieved by rotating an electroluminescent panel at 20 rps under a clear plastic dome. The Avco panel has a crossed-grid matrix and displays a spot of light at the intersection of energized horizontal and vertical lines. A floating spot of light to indicate a target is achieved by pulsing the inputs to a cross point. A height band would be

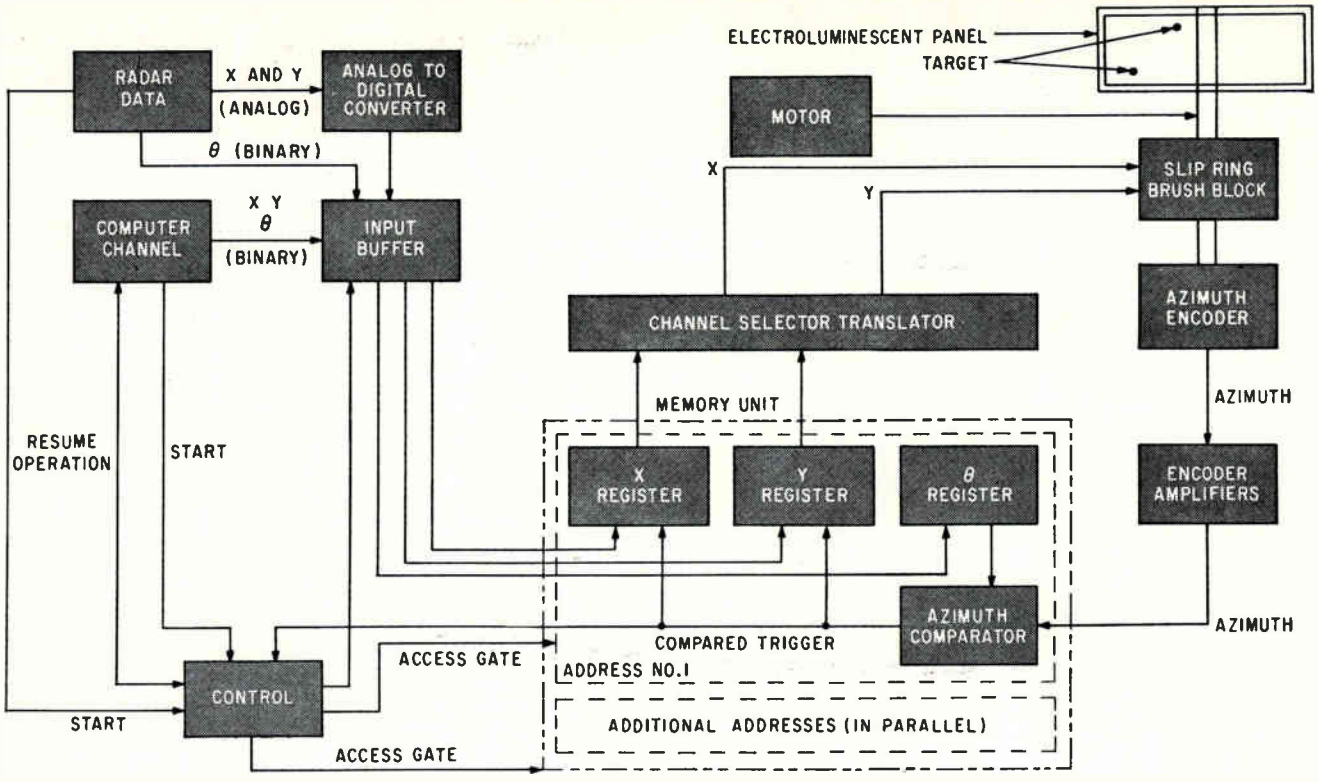


FIG. 1—Rotating shaft of three-dimensional solid-state display drives azimuth encoder whose output feeds back to the control circuits

achieved by applying the signals continuously.

The system permits using color, displaying target tracks, alphanumeric characters and beacon-code signals. A demonstration unit is shown in the photograph and in Fig. 1. The panel is attached to a shaft that is connected to a slip-ring-and-brush assembly and an azimuth encoder that feeds back information to control circuits. Three control panels have switches that can change the position of three targets within the display volume.[1]

Microwave Computing Technique—A computing technique capable of processing data at 1,000 Mc or faster uses two frequencies: 5,500 and 6,500 Mc to represent binary zero and one. Boolean algebra is performed by frequency conversions that produce a signal at either of the logic frequencies. The logic element is made up of mixers and filters. It has six inputs. Two, three or four inputs may be data variables. The remaining inputs are control signals. Both data and control signals use the same logic frequencies. A data signal in one operation may become a control signal in a subsequent operation.

The logic element will form any one of the 16 Boolean functions of two variables; three and four-variable functions are formed with somewhat less versatility. Both logic and control signals are governed by the same clock signal. By programming the control signals, the function of the logic element can be changed with successive clock pulses: such as from an AND circuit to a NOR circuit.

The memory element of the system is an oscillator designed to run at either logic frequency depending on its set. Once set, the oscillator will not change frequency until reset to the other logic frequency by a subsequent logic signal.[2] Test circuits of the memory and parts of the logic element have been built at ITT Federal Laboratories.

Microwave Light Modulation—An electro-optical device developed by Sperry Gyroscope can modulate a light beam at frequencies from 500 to 2,000 Mc. It is primarily a c-w device but can be pulsed. It uses the Pockels electro-optical effect. An ammonium dihydrogen phosphate (ADP) crystal is placed in a microwave cavity in the region of major electric field. See Fig. 2. The crystal axis is parallel to the field. A collimated beam of light is passed through the crystal. A polarizer plate is inserted at the input to the cavity and an analyzer and quarter-wave plate at the exit.

When the cavity is excited at its resonant frequency, the electric field set up in the crystal will cause its complex indices of refraction to vary at the resonant frequency. This produces an alternating rotation of the polarized beam of light. Sufficient voltage is applied across the crystal to cause up to 90-deg rotation of the light thus varying the light level from maximum to minimum. The quarter-wave plate in front of the analyzer optically biases the system to a point midway between maximum transmission and extinction.

The electro-optical effect in ADP can be extended to 15 Gc. Thirty-percent modulation can be achieved in c-w operation; 100 percent with pulse operation. The limit on modulation percentage arises from heating of the crystal; this heating is a function of both frequency and applied r-f field. Work is being done to extend the c-w modulation percentage by cooling.[3]

Ultrasonic Light Modulator—Another electro-optical device makes use of the Debye-Sears effect. Here

light is passed through a liquid ultrasonic delay line. The liquid regions of condensation and refraction act as a diffraction grating. The spacings of the diffraction pattern depend upon the sound wavelength.

This effect, as studied at Columbia University Electronics Research Laboratories, concerns spatial modulation of nearly coherent light. The delay line is a tank of distilled water. Studies relate delay-line input voltage to relative diffracted light intensity. Research workers are trying to obtain a large fractional bandwidth with both low insertion loss and linear phase characteristics.

Work has concentrated on the transducer: an X-cut quartz plate and improvements that may be made by using a quarter-wave matching section instead of backing material. Results using a quarter-wave section 30 microns thick adhered to a 20-Mc transducer are given.[4]

Electro-Optical Spectrum Analyzer—Columbia is also working on spectrum analyzers using the same electro-optical effect. The object is to get a weighted instantaneous power spectrum of an electrical input signal. A frequency coverage of 100 Mc with 10-Kc resolution can be obtained.

After the partially coherent light is spatially modulated, a lens is used to spatially integrate the light distribution. Thus the Fourier transform of the signal is obtained in the focal plane of the lens. A photoconductor mosaic produces an electrical output that is proportional to the power spectrum of the input signal.

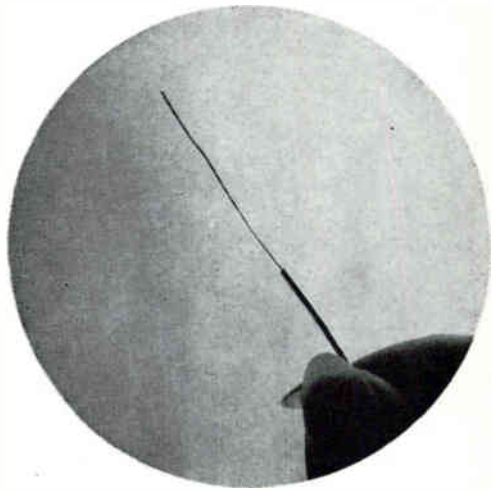
Since a source of collimated monochromatic light is needed to get large dynamic range without degrading the frequency resolution, a ruby laser has been considered as light source.[5]

Biological-Energy Power Supply—Muscular activity and motion of animals may provide power for short-range telemetering equipment for physiological studies. A mathematical model of such a system using mechanical analogs was developed at the University of Wyoming. The system consisted of a mass, spring and velocity damper. Power delivered to the damper was found to be

$$P = \sigma^2 m \omega_1 \left[\frac{c\left(\frac{\omega_1}{m}\right) + \frac{k}{m}}{\omega_1^2 + c\left(\frac{\omega_1}{m}\right) + \frac{k}{m}} \right]$$

where σ^2 is mean square linear relative velocity; m is mass of the moving body; ω_1 is the cutoff frequency of the frequency spectrum assumed for the subject animal; c is the velocity damping constant; and k is the spring constant. To give an idea of order of magnitude: if is 1 ft per sec, m is 100 grams and ω_1 is 6.28 radians per second then maximum power is 58 milliwatts.

A Rochelle-salt phonograph crystal was used experimentally as a mechanical-to-electric energy converter and was excited by relative mechanical motion. The electrical power supply consisted of an impedance-matching transformer, full-wave rectifier, and output capacitor. The supply was capable of deliver-



Superconducting coaxial transmission line (Sperry Gyroscope)

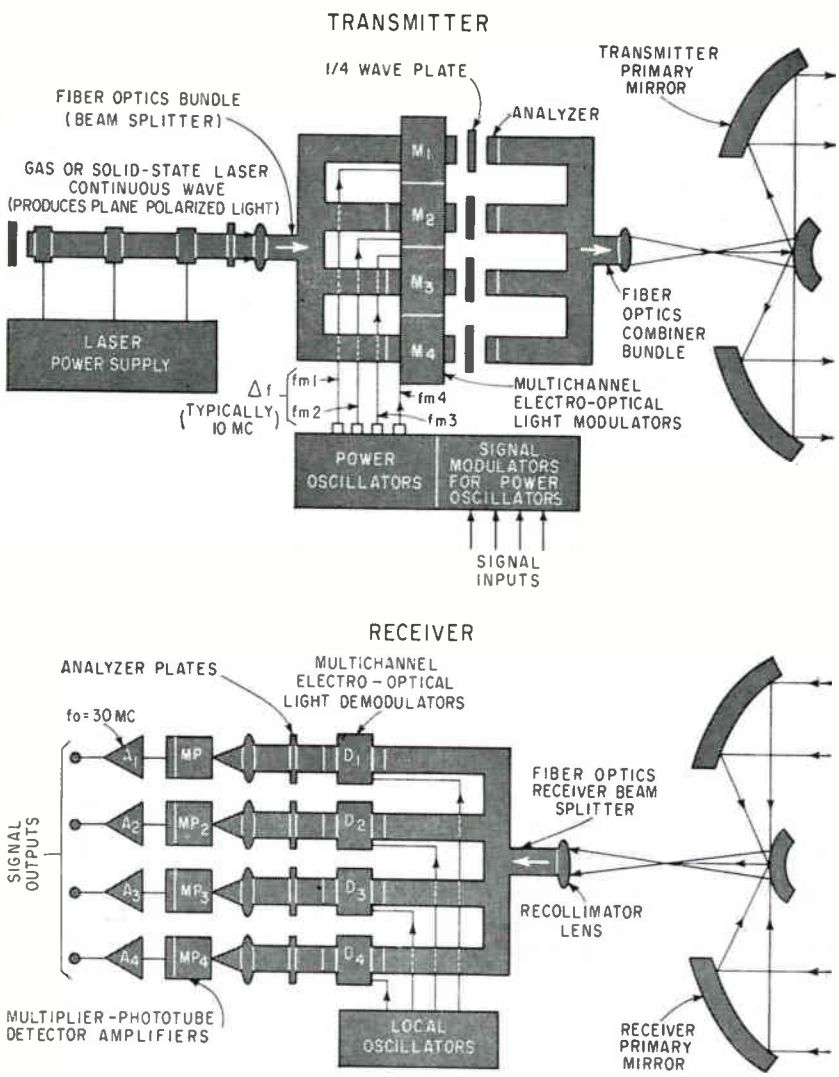


FIG. 2—Transmitter and receiver of a multichannel, broad-band electro-optical communications system

ing fifteen microwatts.

An oscillator using a unitunnel diode operated successfully from the supply. The oscillator required approximately 0.7 microwatt of d-c power at 120 millivolts. It delivered 0.2 microwatt. Figure 3 shows the mechancial and electrical system. Results show that the total motion of an animal and the relative motion between rib cage and diaphragm can be used as a source of power. Surgical implantation has not yet been attempted.[6]

Improved Unijunction Transistor—A small unijunction transistor of improved characteristics may result from a new design approach being tried by General Electric. They use the modulation of the spreading resistance of a small-area ohmic contact by injection of minority carriers from a nearby emitter junction. Previously silicon unijunctions have been filamentary in nature with two large-area base contacts. They have used conductivity modulation of a fraction of the total volume of the filament with a small-area emitter near the center of the filament.

The new device geometry permits reducing the distance from emitter to base 1 for a given stand-off ratio therefore reducing turn on time by a factor of 100 or more. The geometry also reduces emitter saturation voltage, valley and peak-point current. Lower saturation voltage and valley-point current permit bistable circuit applications impossible with conventional unijunctions. Lower peak-point current combined with low emitter leakage current makes possible long time delay circuits using small timing capacitors. The units have been made successfully using pulse alloy techniques.[7]

Superconducting Delay Line—A low-loss superconducting coaxial line developed by Sperry Gyroscope can produce delays from 1 to 20 microseconds at microwave frequencies where lumped-constant delay lines are unsatisfactory because of attenuation. It is possible to use an ultrasonic delay line but it needs a large transducer, introduces about 70-db loss, is bandwidth limited and cannot provide delays down to 1 to 10 microseconds without undue attenuation.

The cryogenic delay line uses the superconducting properties of metals and improved dielectric properties at low temperatures. It requires a cryostat capable of lowering temperature to 4.2 deg K. At X-band, a cable 0.036 in. in inside diameter has a loss of 1.5 db per microsecond; at S-band, loss would be only 0.16 db per microsecond. They have made 0.5-microsec delay lines 0.036 in. in outside diameter.

The dielectric is Teflon. Center conductor is 0.01 in. niobium; outer conductor is lead-tin solder. They expect the lines to be able to handle kilowatts of power. Figure 4 shows loss-temperature characteristics of a typical cryogenic delay line.[8]

Thermoelectric Power Detectors—The heating effect of r-f currents makes thin-film thermoelectric devices useful as microwave power detecting devices. Experiments with coaxially mounted bismuth-antimony devices showed that thermoelectric power is constant at about 100 microvolts per deg C for equivalent film thicknesses ranging from 10 ohms per square to 300 ohms per square. Effects of atmospheric pressure and shape of the thermoelectric device have been studied at PRD Electronics.

When thermoelectric devices must be cascaded to obtain increased voltage output or for other reasons such as matching, drift is automatically eliminated when an even number of the elements is properly arrayed to form a continuous pile.[9]

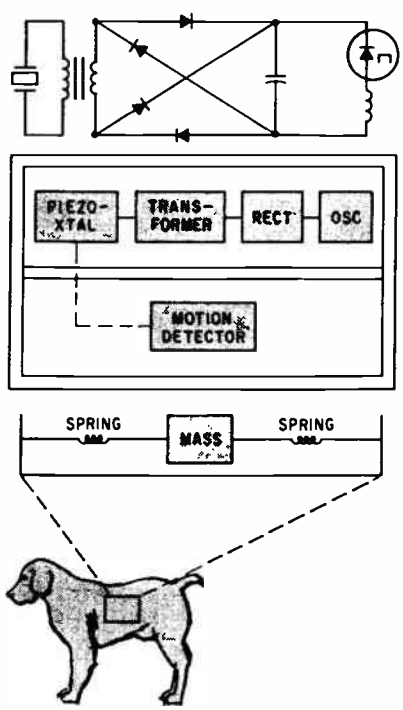


FIG. 3—Mechanical and electrical configuration of biological motion power supply

Inertialess Steerable Antenna—A multiple-beam receiving antenna system for frequencies between 12 and 18 Mc has been built by Army Signal Corps and used on transmissions between Washington, D. C. and Germany. The system showed that it is feasible to separate out the various propagation modes under multipath conditions so that these modes appear at different antenna outputs.

The antenna elements are vertical center-fed dipoles r-f insulated from buried transmission lines by self-resonant cable chokes. There are 24 antenna elements arrayed along in a straight line 6,312 feet long. Spacing between elements varies from 357 feet between foremost elements to 491 feet between rearmost elements. Transmission lines are aluminum-sheathed ½-in. foam-insulated coaxial cable.

Signal-processing equipment consists of 24 wide-band gain-adjustable amplifiers each driving a coaxial delay line terminated in a matching resistor. Each delay line has 14 taps and each tap couples loosely through an adjustable series capacitor to a high-input-impedance wide-band transistor amplifier. There is a total of 336 tap amplifiers. The outputs of each set of 24 tap amplifiers are fed in parallel to one of 14 combiners and thence to any number of conventional receivers.

Each set of taps corresponds to a different angle of the normal to the wavefront against the array axis. The angles range from zero to 29.6 deg. One of the conventional receivers feeds a cathode-ray display tube with a staircase horizontal sweep. The receiver is connected sequentially to each of the 14 combiners so that all inputs are constantly visible.[10]

Microwave Deflection - Amplifier Tube—The frequency spectrum between 100 and 1,200 Mc is troublesome for the designer. Conventional triode tubes suffer from transit-time effects and traveling-wave tubes for this frequency

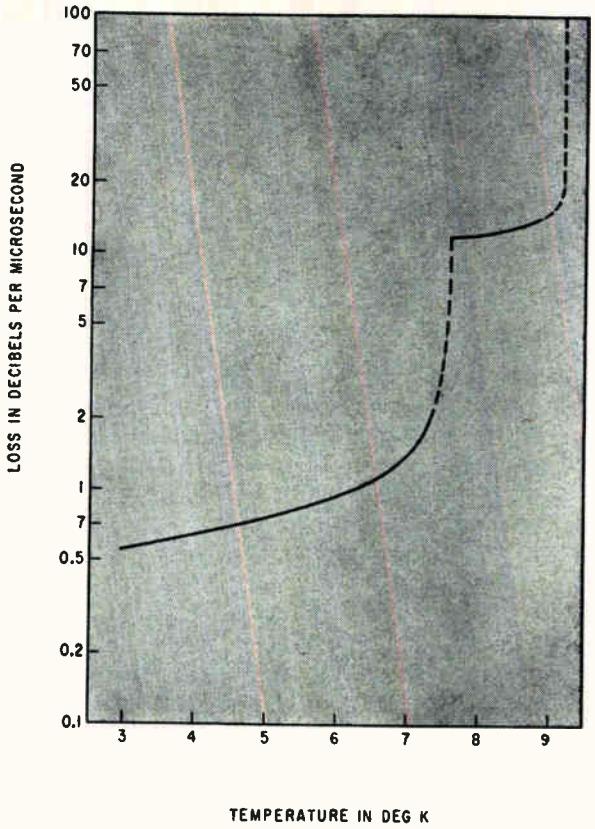


FIG. 4—Loss in decibels per microsecond versus temperature in deg K for cryogenic delay line; radius of niobium inner conductor, 0.031 in.; inner radius of lead outer conductor, 0.14 in.; dielectric, Teflon

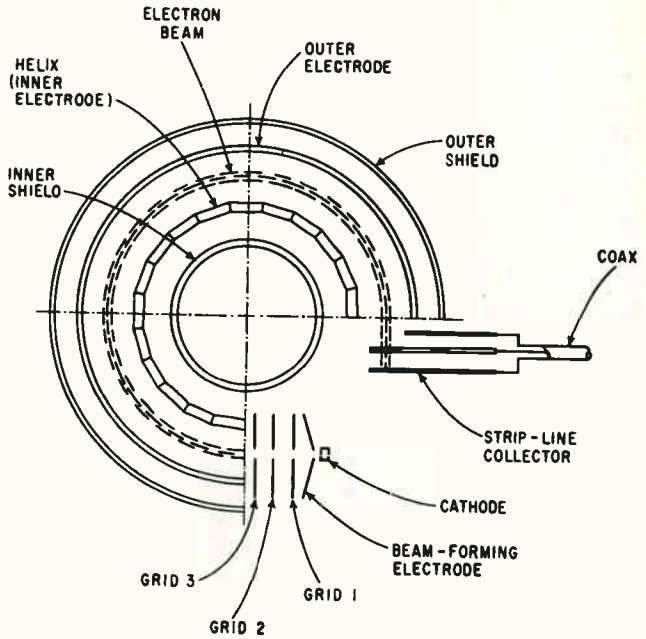


FIG. 5—Electrostatically focused (E-type) deflection-amplifier tube

range are often large and heavy. The RCA tube illustrated in Fig. 5 is a hybrid tube: it is a deflection-amplifier tube with a slow-wave circuit or helix, borrowed from traveling-wave tube design. It provides a synchronous input-deflection circuit and a wide-band output.

The tube has two modes of operation. Output can be taken from the helix as in traveling-wave tubes or from a high-impedance stripline collector or target. The tube has an E-type structure that maximizes beam current while it enhances deflection sensitivity and transconductance.[11]

Atomic Weather Station—A digital data telemetry system powered by an isotopic generator fueled with one pound of strontium-90 is now operating as an unattended weather station in the Canadian Arctic 700 miles from the North Pole. It transmits eight times daily to a manned weather station 250 miles to the south.

The nuclear power supply delivers a nominal 5 watts. Data is sent with an eight-bit word for each weather parameter over two transmitters sending simultaneously on 3.4 and 5.0 Mc.[12]

Electrostatic Recording—Permanent electrostatic recording with nondestructive readout is possible with a system developed jointly by Dupont and Armour Research Foundation. It depends upon injection of equal and opposite charges into fluorcarbon, polyester or polyethylene films. The films are drawn over a knife edge with a resilient conducting backing electrode. In a d-c bias system bias imposed on two knife-edge electrodes in sequence produces zero remanant charge until a signal is applied to the second electrode; a-c bias can also be used.

A thin metallic readout electrode is sandwiched between two electrostatic shields. Readout is by electrostatic induction. Output signals of one volt are obtained by driving the shields in a cathode-follower circuit. The plastic tape is treated with an ion bath after each recording and playback. This neutralization improves recorded signal life, reduces noise from random electric charges and minimizes layer-to-layer print-through during storage. The ions neutralize uncompensated surface charge.

Signal-to-noise ratios up to 40 db have been obtained. Information can be recorded with wavelengths down to one mil; signal life may be greater than 100 years.[13]

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Using Instability Characteristics

Oscillistor and other new components are being developed from results of study of plasma behavior in solid-state materials

SOME SOLID MATERIALS contain charges of both signs and behave in much the same way as ionized gas. These collections of charges can also be called plasmas.

It is generally accepted that a plasma is a collection of positively and negatively charged particles, present in about equal densities so that the overall collection is approximately neutral. However, this is not enough to distinguish the properties of the plasma from those of a collection of charges of one sign alone. At low density, the two would have similar responses to electric and magnetic fields. The distinguishing feature of plasma is its great resistance to internal electric fields, that is, its strong tendency to space-charge neutrality. The potential due to space charge at a point inside the plasma decreases exponentially with the distance from the charge. The mean distance over which the fall-off occurs is given by $\lambda_D = [\epsilon\epsilon_0 kT/2ne^2]^{\frac{1}{2}} = 49\sqrt{\epsilon\ T/n}$ m, where λ_D, the Debye length, is the distance at which the potential gradient due to the inside charge is reduced to $1/e$ of its value by the surrounding opposite charges. At this distance the center charge is effectively shielded. The sphere that surrounds the charge with this radius is the Debye sphere.

The Debye length is proportional to the square root of plasma temperature T and inversely proportional to square root of the electron density n. The formula is written in the mks system: e is the electronic charge and $\epsilon\epsilon_0$ the dielectric permittivity of the medium in which the plasma is situated. The numerical expression is useful in evaluating the Debye length and typical values are given below. For the plasma to have space charge neutrality in the interior, its dimensions must be large compared to the Debye length. The second half of the definition of a plasma thus requires that the collection of charges must occupy a volume of space that contains many Debye spheres.

A number of examples other than ionized gases satisfy these conditions. Negatively charged electrons and the corresponding positively charged ions in a solid make up a neutral collection, and provided the solid container is large enough, they will have plasma properties. The extrinsic n-type semiconductor is an example of such a plasma. Of course, the ions are tightly bound in the lattice or in some other sites in the crystal, and they behave like particles of approximately infinite mass. The case of holes and negative ions is identical to the first example, and a p-type semiconductor is a good example. Plasmas of these two kinds will be called immobile, since they cannot be moved or changed in shape without moving or deforming the containing solid.

In addition to the two cases where one of the charged particles is light and the other heavy, a semiconductor or semimetal may also contain a plasma made up of electrons and holes. An intrinsic semiconductor is an example of this kind of plasma. An electron-hole plasma consists of particles, which are all light like the electron. This plasma may be compressed or expanded

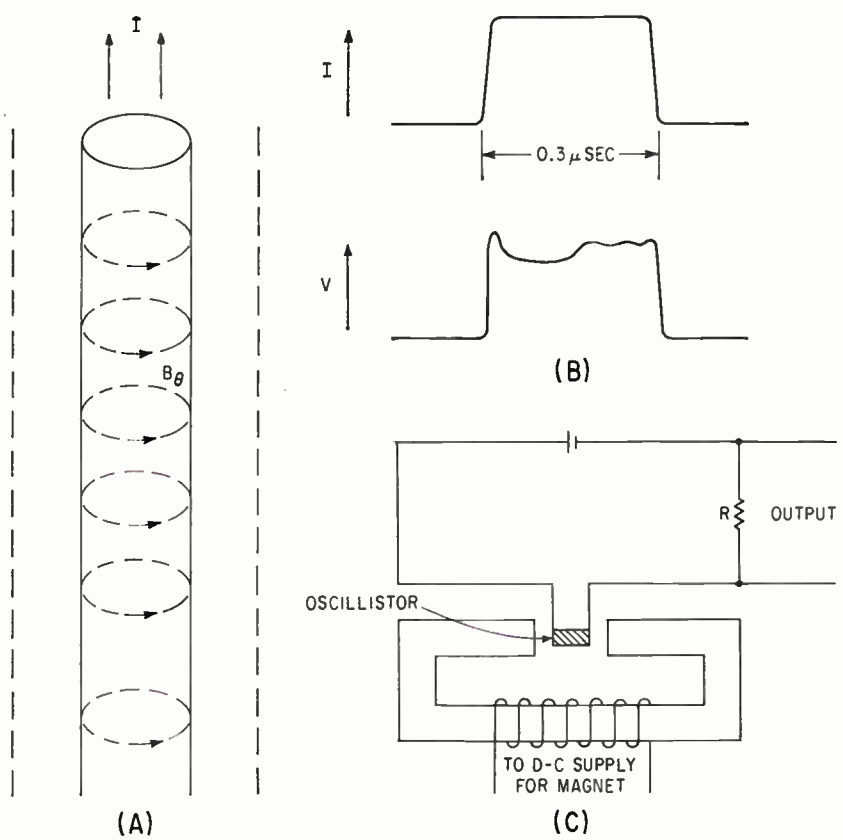

FIG. 1—Electron-hole plasma in a self-pinched condition, (A); pulses depicting the current and voltage in a semiconductor in which the electron-hole plasma is undergoing a self magnetic field pinch, (B); schematic of oscillistor circuit, (C)

# of Semiconductor Plasmas

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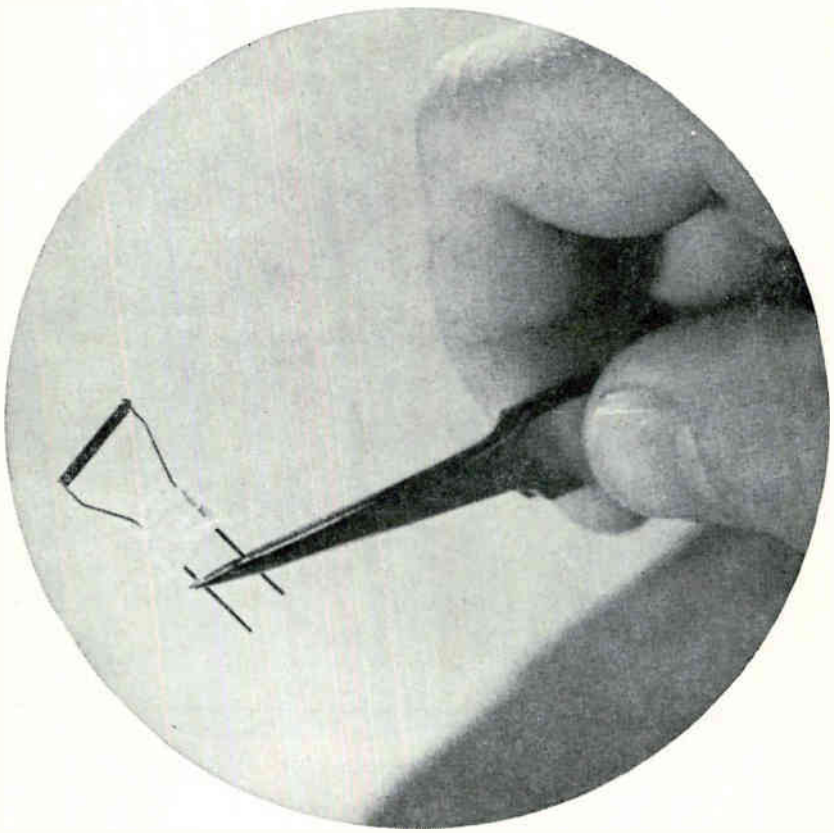

Germanium oscillistor without its magnet. Magnet provides the field necessary to start oscillation

much more easily than where one of the components is bound into the solid lattice, and it will be called a mobile semiconductor plasma.

Before these examples can be called plasmas, they must satisfy the condition that their volume contains many Debye spheres. Intrinsic germanium at 300 K has a density of electrons and holes of about $2 \times 10^{19}/m^3$ and a corresponding Debye length of 10^{-6} m, a short distance. At 77 K fairly pure indium antimonide or extrinsic germanium with electron densities of about $10^{20}/m^3$ have even smaller Debye lengths, 2×10^{-7} m. Even the low density plasma in extrinsic germanium at liquid helium temperature, with its density of electrons and ions of $10^{12}/m^3$ has a Debye length of 5×10^{-4} m. For the first two examples the charge carriers will satisfy the definition for specimens as small as ten microns. In the last case the germanium will not contain a plasma if specimens are smaller than about 1 mm in size.

It is easy to make a semiconductor that contains a plasma, either of electrons and ions or of electrons and holes. There are five different ways to generate a plasma in the semiconductor: heating, d-c discharge, r-f discharge, injection and irradiation. Four of these may be used to generate both mobile and immobile semiconductor plasmas.

First, the plasma may exist in thermal equilibrium. The examples discussed earlier of extrinsic and intrinsic semiconductors fall into this category. There is no need to add energy to the semiconductor to maintain the plasma. It is thus possible to produce this plasma easily in the laboratory, in contrast to the gaseous case. The difference is of course due to the much smaller ionization energy in the semiconductor. In the extrinsic semiconductor the energy necessary to ionize the semiconductor impurities is less than the thermal energy, kT. Usually this is less than one-hundredth of an electron volt, while for gases the energy necessary is at least of the order of four electron volts. Both mobile and immobile semiconductor plasmas may be produced in thermal equilibrium.

The second example, the d-c discharge, is familiar in gaseous plasmas, and is widely used in gas tubes and lamps. The semiconductor phenomenon is called avalanche ionization or breakdown. Particles present in the semiconductor are accelerated in a high electric field to energies large enough so that they may ionize either impurities in the semiconductor (impurity breakdown), producing an immobile plasma, or the host atoms of the crystal, producing a mobile plasma of electrons and holes. This process may be made to occur in the bulk of a semiconductor crystal, or in the high field region of a junction. Because of the large fields required for most semiconductors, the mobile plasma is normally produced in a junction, where the fields of more than 10^7 volts per meter may be achieved without appreciable difficulties with breakdown in the surrounding atmosphere or on the surface. However, in the semiconductors indium antimonide and indium arsenide the field necessary for production of an electron-hole plasma is much lower—only of the order of 2×10^4 to 10^5 volts per meter—and such plasmas have been produced in bulk material.

The third example, r-f discharge, is much like the d-c discharge, in that an r-f field is used to add energy to some carriers initially present, which then have enough energy to produce a plasma on impact with impurities or the host lattice. Such a technique has been used to make an immobile semiconductor plasma in studies at very low temperatures: it has the advantage of not requiring physical contact to the material. There is no reason,

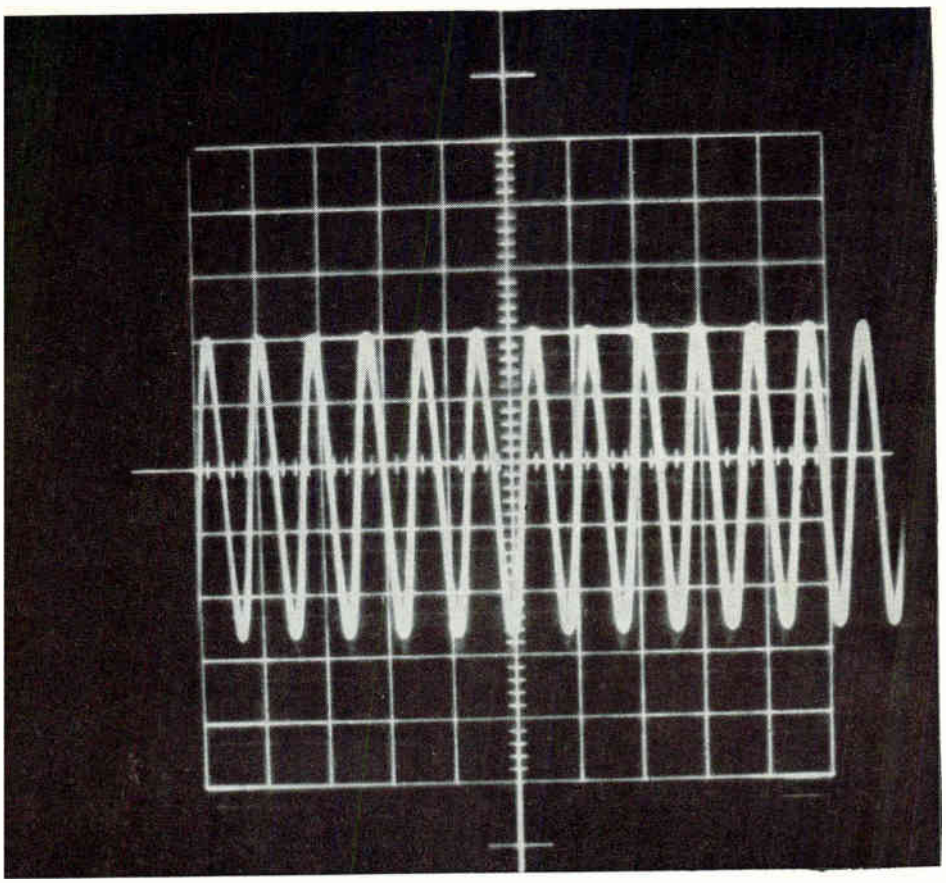

FIG. 2—Typical output waveform of oscillistor[3]

in principle, why it could not also be used to make a mobile semiconductor plasma.

In injection the plasma is made up by adding to the volume the two components, which would be electrons and holes in the semiconductor mobile plasma. These may be injected from contacts to the semiconductor, and a transistor is a good example of a semiconductor containing a plasma of this kind. This technique cannot be used to produce the immobile kind of plasma, since the ions cannot be injected in the usual sense.

The last technique used in the generation of a plasma involves direct irradiation, the addition of energy in another form to the semiconductor to ionize either impurities or the host atoms, and thus produce either the immobile or mobile plasma. Electromagnetic radiation, consisting of photons of energy above the required ionization energy, will produce a pair of plasma particles per photon absorbed when the energy is just above the threshold. Charged particles will ionize the atoms by impact as they traverse the semiconductor, producing many plasma pairs per particle if the material is thick enough.

Plasmas have been made by all five techniques, and their properties have been investigated. In r-f discharge and irradiation, however, it has not been the plasma whose properties were studied, but rather the behavior of the individual carriers in the plasma.

The ability to produce a plasma in a nonequilibrium situation allows some useful devices, such as the avalanche diode and the impact ionization diode, which may be used as switches. The production of the plasma brings with it an increased conductivity, due to the much increased density of the carriers and not to their plasma character.

In general the electrons and holes in the semiconductor plasma have a short mean free path; their collision frequency is thus high (perhaps 1,000 Gc at room temperature, going down to a few Gc at 1 K). Forces that act on the individual electrons thus are quickly distributed to the surroundings through collisions.

The effect of a plasma on an electromagnetic wave may be described by the plasma frequency, that is, the frequency at which the electrons can describe longitudinal oscillations in the plasma

$$f_p = \frac{1}{2\pi}\left[\frac{ne^2}{m^* \epsilon \epsilon_o}\right]^{1/2}$$

$$= 8.98\left[\frac{n}{\epsilon (m^*/m_o)}\right]^{1/2} \text{ cps}$$

m^*/m_o is the ratio of the mass of the plasma particle to that of the free electron. In general, the carriers in semiconductors behave as if they have masses different from that of the free electron, and most of the known values of m^*/m_o are less than one. For intrinsic germanium at room temperature, the electron plasma frequency is about K-band (27 Gc); for indium antimonide with 10^{20} plasma particles per cubic meter, it is about 225 Gc. These plasmas then have their resonant frequency in the millimeter range, and provide a simple way of getting a plasma with such a high plasma frequency.

The plasma frequency is also a dividing point in the response of a plasma to an electromagnetic wave. At frequencies below the plasma frequency, an incident wave is reflected, while at frequencies above the plasma frequency, the wave is transmitted with some attenuation and phase shift. This simple picture, which works well in describing the gaseous plasma, is more complex in the semiconductor plasma examples because of the normally small size of the semiconductor plasma. At the lower frequencies, then, the semiconductor plasma may be much smaller than the penetration depth of the wave and there can be some penetration and transmission of the signal.

When a sufficiently strong current is passed through the mobile semiconductor plasma, the plasma will reduce in size because of the pinching force of its self-magnetic field. This is illustrated in Fig. 1A. At low currents, the electron-hole plasma will occupy the complete volume of the semiconductor, as shown by the dashed lines which illustrate the outer surface of a cylinder. There will be a small azimuthal magnetic field due to the current passing through the material. When the current is large enough so that the force it exerts

on the current-carrying elements (through its own magnetic field) can exceed the kinetic pressure of the plasma, the current will be forced in towards the center, and the cylindrical column of plasma will contract inside the semiconductor. This effect has been observed in a plasma produced by a pulsed discharge in indium antimonide at 77 K. Plasmas with densities in the range 10^{19} to $10^{21}/m^3$ have been pinched to a radius calculated to be as small as about 20 percent of its original value.

An example of the type of observation appears in Fig. 1B. The current pulse is displayed above the voltage pulse: the current is derived from a resistor in series with the semiconductor, while the voltage is that across two probes attached along the length of the semiconductor. At low currents, both pulses are identical, and the same as the one shown in the upper sweep. The voltage pulse shown is observed for an intermediate current, well above the threshold for pinching. The circuit is arranged for constant current and the first fall-off of the voltage pulse, right after the initiation, marks the production of the discharge and the plasma. During the relatively flat part of the pulse which follows, the plasma begins its contraction, which is culminated about half-way through the pulse. The oscillations on top of the pulse are somewhat accentuated here; the latter part of the pulse is flat. Thus the plasma pinches in about 0.15 μsec, and stays pinched in cross-section for times as long as at least 1.5 μsec. The functional behavior of the measurable quantities, such as the threshold for pinching, the dependence of the pinch-time on current and the increased resistance in the pinch, are in good agreement with what is calculated for a pinching plasma. The oscillations on top of the voltage pulse that occur after the pinch is completed are ascribed to hydromagnetic waves induced in the pinching process. The measured frequencies and decay times are in agreement with those calculated.

Another class of instabilities[1, 2, 3] in plasmas was recently discovered. The oscillations were seen independently in both gaseous and semiconductor plasmas, although the workers were unaware of each other's observations for several years. They have been explained theoretically only during the past year. The semiconductor plasma instability was labeled the oscillistor by Larrabee and Steele,[2] who investigated it in some detail. A plasma must be present in the semiconductor: in the first observations, this plasma was produced by synthesis, that is, injection from contacts. A current and a magnetic field parallel to the current are applied to the plasma. (This device is shown in Fig. 1C.) When this occurs, and the values of both the current and the magnetic field are large enough, the plasma exhibits spontaneous oscillations in the current amplitude. These oscillations may be large (70 percent of the d-c current) and persist for long periods. Figure 2 is an oscillogram of a 1-Mc oscillator output. Experiments have shown oscillations in the semiconductors germanium, silicon, indium antimonide, and experiments also have shown that they are not due to a negative resistance of the current and voltage, nor to parasitic oscillating tank circuits associated with the crystal contacts or leads. Frequencies observed normally were in the range 1 Kc to 50 Mc.

Figure 3 shows an idealized geometry with the current and magnetic field. The cylindrical geometry is chosen for ease of discussion.

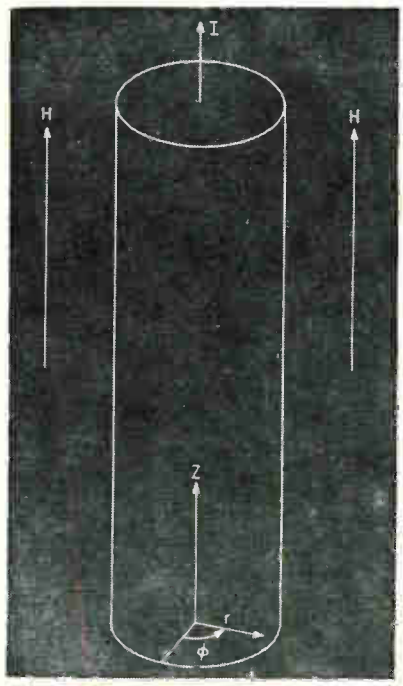

FIG. 3—Geometry for a theoretical model of the oscillistor

Normally, the plasma will be distributed throughout the semiconductor, with a maximum in density at the center and a minimum at the surfaces, where the plasma electrons and holes recombine. However, in the presence of the longitudinal magnetic field, a helical perturbation of the current can be shown to be unstable. The magnetic field acts on the azimuthal perturbed current to increase its radial motion, driving it out to the walls. A theory has been developed for the semiconductor plasma that shows this instability, and predicts the currents and magnetic fields that allow the oscillations to grow. The theory shows that at a given electric field or current, the plasma will be stable until the magnetic field exceeds a calculated threshold value. Above this point, the plasma should become spontaneously unstable. The behavior predicted is in accord with the observations, as to the form of the behavior on the fields, the rough magnitudes of thresholds and frequencies observed, and the dependence of the various parameters on the dimensions of the plasma. The simplicity of the device can be seen in the photograph, which shows a germanium oscillistor without the magnet. Magnetic fields of the order of 3,000 gauss or more are needed to set the current into oscillation.

The instabilities are in the relatively low-frequency range: Kc and Mc. A class of instabilities predicted by Pines and Schrieffer[4] to occur in a plasma with just a current passing through it should be present in the hundreds of gigacycles. These are two-stream instabilities, familiar to engineers working with electron beam devices, but as yet unobserved in the semiconductor plasma. If found, these could provide a potent new device for producing millimeter waves.

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Measuring Capacitance of Varactor

Oscilloscope measures variations in varactor diode capacitance as sawtooth bias voltage sweeps this capacitance over its dynamic operating range. Second oscilloscope trace also presents varactor conduction characteristics as a function of swept input voltage

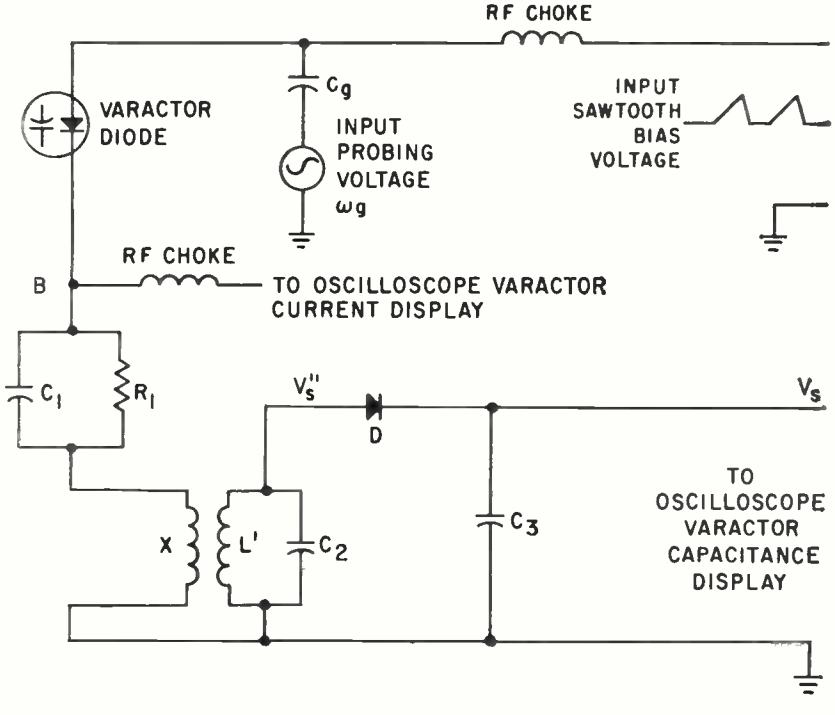

FIG. 1—Varactor diode capacitance changes with increasing sawtooth bias derived from oscilloscope timebase

HERE IS A TEST setup that measures the variation of varactor diode capacitance as its bias voltage is changed. The same circuit also enables the diode leakage current to be measured for the range of bias voltage. Further diode parameters that can be determined with the equipment are barrier breakdown voltage and the exponent of varactor capacitance-voltage characteristic.

The measuring technique applies a sawtooth voltage to the varactor diode to provide a smoothly varying bias, and uses a 30-Mc oscillator signal for measuring the actual diode capacitance over the range of sawtooth bias voltage. Barrier breakdown voltage is easily determined from the characteristic curves that the equipment displays on an oscillograph screen—voltage breakdown is indicated by a sharp increase in varactor a-c capacitance at the breakdown point. The oscilloscope display used with this system can be calibrated to permit direct reading of both the a-c capacitance and reverse current at any bias point, while mathematical manipulation gives the exponent of the varactor capacitance-versus-voltage characteristic.

If desired, a more elaborate calibration of the display or addition of a logarithmic amplifier could give a direct reading of the exponent of the varactor C versus V characteristic at any bias point. An instrument using this type of measurement would be suitable for rapid test of varactors by production personnel.

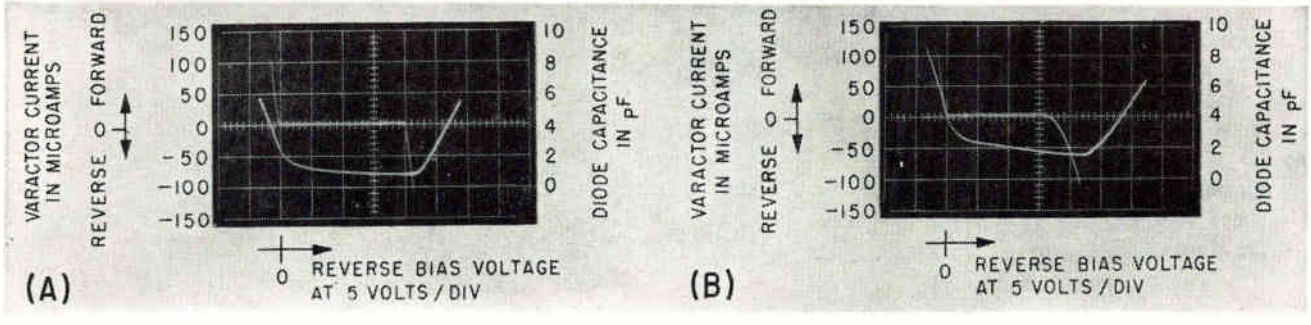

FIG. 2—The U-shaped curves show variation of varactor capacitance with sawtooth bias voltage; zig-zag curves repre-

Diodes Dynamically

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Special Products Operation,
Philco Corporation, Lansdale, Pa.

The circuit shown in Fig. 1 applies to the varactor diode a low-frequency sawtooth bias voltage derived from an oscilloscope. The varactor is in series with a parallel R-C combination and a low-inductance coil with their values chosen so that the total impedance presented to the saw-tooth voltage is R_t.

The voltage at point B is directly proportional to the reverse current of the varactor and can be displayed on the oscilloscope as a function of bias. The vertical deflection can be calibrated in varactor current by short-circuiting the varactor and setting a reference position on the oscilloscope for a known current level. The 30-Mc probing voltage from a low-impedance generator appears across the varactor and the coupling coil X. Since C is chosen to present a negligibly low impedance at the 30 Mc probing frequency, and the impedance of the coupling coil is low compared with the varactor impedance over the bias range, most of this probing voltage is developed across the varactor. The probing voltage is isolated from the saw-tooth generator and the current monitor line by self-resonant 30-Mc chokes. The coupling of the coil X to the 30-Mc resonant circuit is such that the impedance of the coil is not changed. Thus, for analysis, it is assumed that the coupling coil X is so adjusted that a pure resistance R_x appears across its terminals at the probing frequency. This assumption of pure resistance is not necessary for operation of the system, but it simplifies the analysis.

The combination of diode D and capacitance C_n following the 30-Mc resonant circuit forms a peak detector circuit whose time constant is low enough to permit the detected voltage to follow the variations of the varactor capacitance at the saw-tooth frequency. Therefore, at any point of the swept bias, this equation can be written for V_s'', the voltage across the 30-Mc resonant circuit

$$V_s'' = \frac{\alpha R_x A \sin \omega t}{R_x - j \frac{1}{\omega C(V)}} =$$

$$\frac{\alpha R_x \left(R_x + j \frac{1}{\omega C(V)} \right)}{R_x^2 + \frac{1}{\omega^2 C(V)^2}} A \sin \omega t$$

and when $R_x \ll \frac{1}{\omega C(V)}$

$$V_s'' = \alpha R_x C(V)\, \omega A \cos \omega t$$

where A is the amplitude of the probing voltage applied to the varactor, ω is the probing voltage angular frequency and α is the voltage amplification coefficient due to the resonant coupling.

Thus, after peak detection, the oscilloscope input is

$$V_s = \eta C(V)$$

where η is constant.

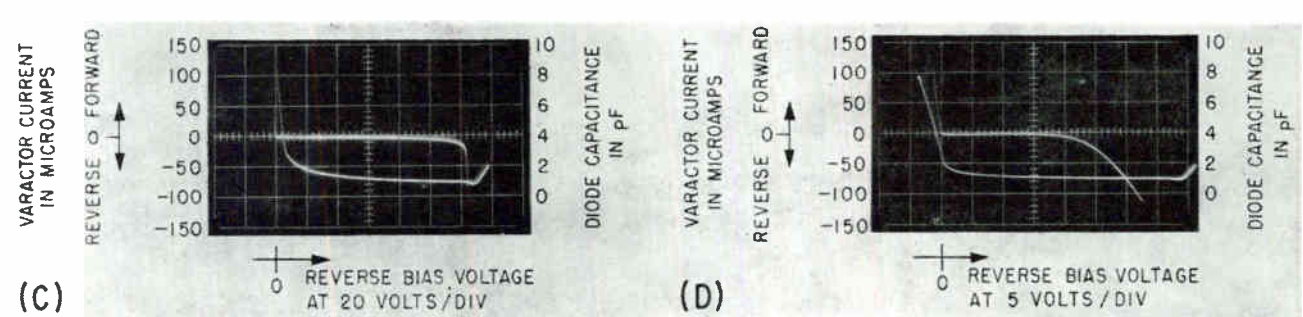
Therefore, the oscilloscope display may be calibrated directly in varactor capacitance. This may be done by recording the beam deflection for known capacitance values. The circuit values and the probing voltage frequency chosen permit measurement of varactor diodes having a range of 0.1-20 pf.

Experimental results are given in Fig. 2—oscilloscope displays for varactors. Figure 2A shows a barrier breakdown at about 20 v bias plus a capacitance of about 2.5 pf at 0 v. This GaAs varactor exhibits no leakage current up to the barrier breakdown voltage, while exhibiting a capacitance variation of about 2.5 to 1 between 0 v and the breakdown voltage. The zero bias voltage point corresponds to the sharp current increase at left of the figure.

Figure 2B shows an oscilloscope display for a GaAs varactor fabricated with the same bulk material but exhibiting a rounded breakdown characteristic due to poor surface properties. However, the capacitance variation with voltage is independent of the leakage current and provides an indication of the barrier breakdown voltage.

Figure 2C is an oscilloscope display of a Ge varactor for which a definite breakdown voltage is observed in both the capacitance and the reverse-current characteristic. However, a small leakage current flows before the breakdown point. The unit has excellent capacitance versus voltage variation; at zero bias the capacitance is about 9 pf while at breakdown it is about 1 pf.

Figure 2D shows an oscilloscope display for a Si varactor. Although significant leakage current begins to flow at about −15 volts, the capacitance variation is practically unaffected. A barrier breakdown voltage of about 38 volts is indicated by the capacitance curve.



sent varactor diode current. A maximum capacitance ratio of about 9:1 is obtained

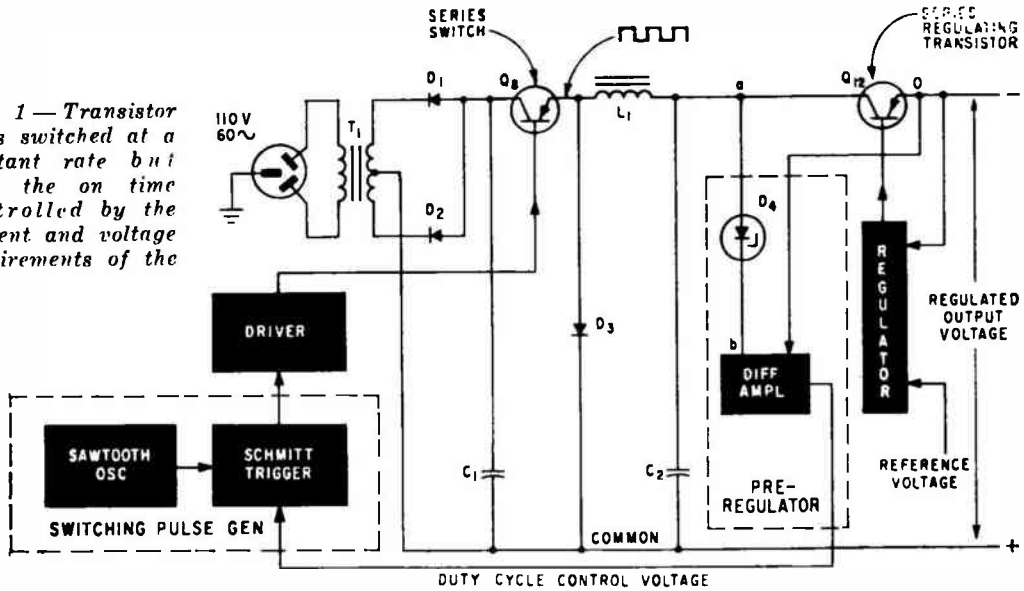


FIG. 1 — Transistor Q_s is switched at a constant rate but with the on time controlled by the current and voltage requirements of the load

Power Supply Uses Switching Preregulation

Dissipation in the series regulating transistor is kept low by controlling the on time of a series switching transistor. A small series inductor improves transient response and saves weight

By J. S. RIORDON, National Research Council, Ottawa, Canada

ONE OF THE LIMITATIONS of a variable voltage regulated power supply is the power dissipation in the series regulating element. When the supply must furnish maximum load current at minimum output voltage, this dissipation reaches its highest level. Consider a supply rated at 2 to 30 v d-c, 0 to 2 amps; typically, the unregulated voltage at the input to the series regulating element will be about 35 v d-c. When 2 amperes are drawn at 2 volts output, the worst case, the power dissipated is (35 − 2) × 2 = 66 watts. Where primary power comes from a utility supply, the low efficiency may be acceptable, but the heat generated will be a problem.

One solution is to use a variable autotransformer bewteen the utility supply and the power transformer. The rectified voltage can then be adjusted until it is only a few volts larger than the regulated output voltage. Adjustment by hand is tedious when frequent variation is required, and is not necessarily fool-proof. Adjustment through a mechanical linkage tying output control and autotransformer together is satisfactory only if line voltage variation is low.

A regulator in which dissipation is minimized is the switching regulator, in which an unregulated voltage is chopped by a series switch and fed into an averaging circuit. Constant output voltage is maintained by controlling the switching duty cycle. While efficient, such a regulator has poor transient response. A combination of relatively efficient control with fast response is obtained by a switching preregulator that will maintain a constant voltage drop across the series element of a conventional regulator. Several variations, including use of a magnetic preregulator, have been discussed in the literature. [1, 2]

Figure 1 is a simplified diagram of a preregulated voltage supply. Voltage from T_1 is rectified by D_1 and D_2 and fed into C_1. Transistor Q_s is a switch, which is opened and closed at a frequency f. Diode D_3

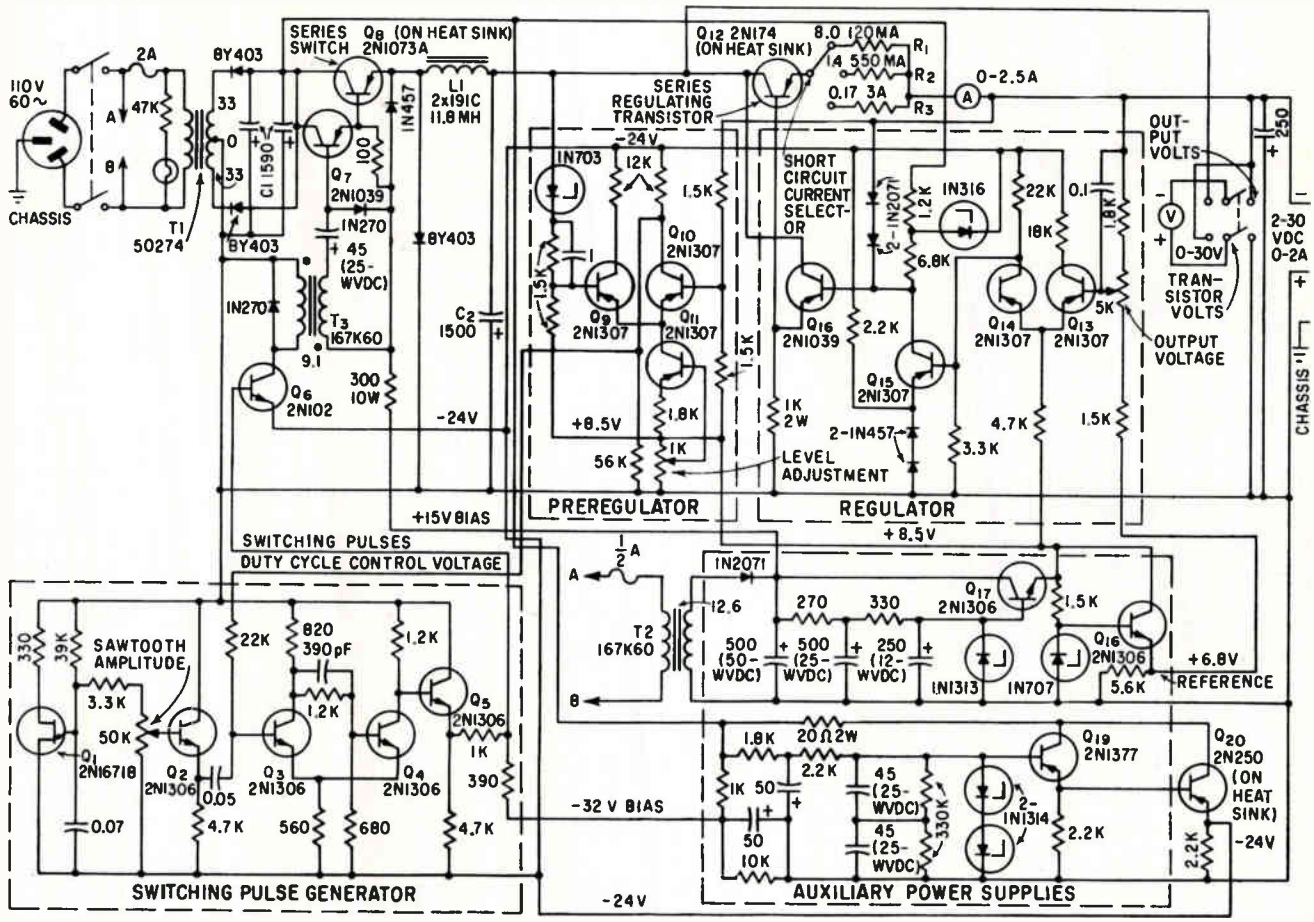


FIG. 2—Output voltage can be varied from 2 to 30 volts and load can vary from 0 to 2 amp. Regulation is 0.1 percent or 30 mv, and circuit is short-circuit proof

carries the current flowing in L_1 when Q_8 is off. The wave train on the emitter of Q_8 is fed into inductance L_{1b}, which, with C_2, forms an averaging network. This voltage is regulated by Q_{12} and its amplifier. The voltage E_{bb} across zener diode D_1 is added to E_a, the collector voltage of Q_{12}. The balance condition of the preregulator differential amplifier is that $E_a + E_{bb} = E_e$, where E_e is the voltage at the emitter of Q_{12}. This balance is maintained by controlling the switching duty cycle of Q_8 through the feedback loop.

Output of the differential amplifier in the preregulator controls the switchover voltage of a Schmitt trigger that is triggered by a positive-going sawtooth wave. When the voltage drop across Q_{12} tends to decrease, the duty cycle control voltage becomes more positive; the result is that Q_8 is switched on for a longer portion of the sawtooth period. Voltage E_{ca} across Q_{12} is thus equal to E_{ab} regardless of E_e.

Figure 2 is the complete schematic diagram of the preregulated supply. The supply will deliver a regulated d-c voltage adjustable from 2 to 30 volts at currents up to 2 amperes, and it will withstand a continuous short circuit without damage or overheating. Short circuit current may be set to any of three values, depending upon the expected load. An attempt has been made throughout to use commercially available components; no selected transistors or specially wound transformers are required.

High-frequency switching is desirable in that it allows choke L_1 to have a low value and thus substantially reduces the weight of the supply; also, it gives better transient response. On the other hand if switching time becomes appreciable relative to the switching period, efficiency is reduced and excessive heating may occur. In the present design a nominal frequency of 1,000 cps has been used. Total switching time for Q_8 is about 5 percent of the shortest switch-on interval.

The switch must be fairly fast and capable of carrying 2 amperes. The choice lies between a controlled rectifier and a power transistor, but an acceptable power transistor was cheaper and was therefore used. The switching transistor, Q_8, a type 2N1073A, has an f_{ab} of 1.5 Mc; rise time (turn on) is 0.5 microsecond and fall time is 4.5 microseconds. Considerable overdriving is allowed at the base as storage time does not affect the overall circuit operation.

The bias circuit must be able to supply somewhat more current than the maximum anticipated I_{CBO} of Q_8; otherwise Q_8 will be unable to turn off at high temperature and the preregulator will cease to function. Driving voltage is applied between base and emitter of Q_8 through transformer T_3 and a d-c restoring circuit. For full d-c restoration to take place, the forward resistance of the 1N270 diode must

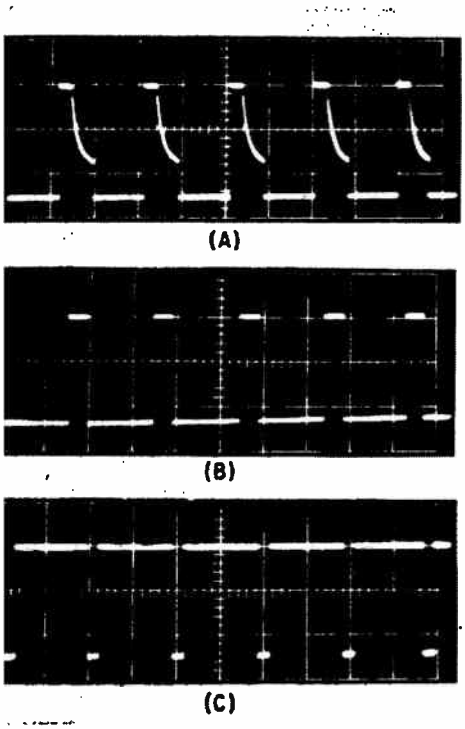


FIG. 3—Waveforms at emitter of Q_5: no load (A), full load (B) and short circuit (C)

be small compared with the input resistance of the following stage. This condition is met if emitter follower Q_5 precedes the switching transistor. Without Q_5, however, Q_6 loads the d-c restorer so heavily that operation is marginal. Both Q_5 and Q_6 must have a maximum V_{cb} rating of at least 50 volts.

When full load current is suddenly drawn from the output, all the current must be supplied initially by capacitor C. Current through L_1 increases to the new level with a time constant proportional to L_1. Provided the current increase in L_1 takes place before the voltage across C has dropped to the output voltage, no large transient appears at the output. A small value of L_1 is therefore desirable.

In a conventional supply the minimum value of L_1 is that which assures continuous current flow with no load. In the present design, however, current flow through L_1 can become discontinuous since, over a wide range, the preregulator automatically compensates for the tendency of peak detection across C_2 by reducing the switching duty cycle. The most suitable value of L_1 is thus the minimum value with which the preregulator is able to maintain a constant voltage E_{ab} across Q_{10} with no load at the output.

In Fig. 2, a sawtooth wave is generated by unijunction transistor Q_1 and fed through emitter follower Q_2 to Schmitt trigger, Q_3 and Q_4. Duty cycle is determined by the d-c feedback voltage introduced to the base of Q_2 through a 22,000 ohm resistor. A possible alternative system is that in which a monostable multivibrator is triggered at a fixed rate, but with its pulse width modulated by the feedback voltage. Such a method was originally used in this design but the requirements of wide range, reasonable stability, and high duty cycle operation in the multivibrator makes it the more difficult method in practice.

The regulator circuit is a high-loop-gain amplifier capable of providing a wide range of d-c output voltage. The latter requirement makes separate auxiliary power supplies necessary. High loop gain is provided by cascading a differential amplifier with a common emitter stage. The two 1N2071 diodes between the base of Q_{10} and the supply output are normally so slightly forward biased that they are nonconducting. However, when the supply is short-circuited, a maximum current I_1 flows through R_1 (where R_1 is R_1 or R_2 or R_3) such that the sum of I_1R_1 and the V_{be}'s of Q_{10} and Q_{12} reach about 1.2 volts (the combined knee voltages of the 1N2071 diodes); the diodes begin to conduct heavily and clamp the voltage between the base of Q_{10} and the output, so that no further increase of current can take place. The resistance R_1 (R_1, R_2 or R_3) is given approximately by $R_1 = (1.2 - \Sigma V_{be}) / I_1$, where ΣV_{be} is the combined base-emitter voltage drop in Q_{10} and Q_{11} with a short circuit current I_1 flowing through Q_{11}. These resistors may be wound from resistance wire and adjusted experimentally to give the desired short-circuit current.

In Fig. 2 the principal functional blocks are outlined in dashed lines. Components within these blocks except the large capacitors in the auxiliary power supplies are mounted on plug-in boards. Heavier components are mounted directly on the main chassis.

Tests made on the power supply of Fig. 2 gave the following results for an input of 105 to 125 volts, 60 cps: output, 2 to 30 v d-c, 0-2 amp; load regulation, 0.1 percent or 30 mv; ripple, less than 3 mv rms; efficiency, 60 percent at full output; current limiting—short-circuit current can be set to 120 ma, 550 ma, and 3 amp by a three-position switch and full regulation is maintained up to 100 ma, 500 ma, and 2 amp respectively; transient response—with a 2-amp current step, the voltage transient has a peak of 150 mv and a duration of 40 μsec.

The voltage across Q_{12} varies between 3 and 5 volts. The variation is caused largely by the dynamic resistance of the 1N703 zener diode in the preregulator. The value of L_1 over the range 2 to 200 mH has no effect on static regulation but does affect transient response; the smaller L_1, the smaller the voltage transient for a current step. For L_1 below about 10 mh, however, the voltage across Q_{12} cannot be maintained constant without a load. For L_1 below about 5 mh, the switch Q_6 may be destroyed when a short circuit occurs at the output.

Figure 3 shows the waveform of the negative-going switching voltage at the emitter of Q_6 under no load, full load, and short circuit conditions. With no load the inductance L_1 conducts for about one-half of the off period of the switch. When conduction ceases, the voltage moves exponentially towards its average value, until the switch again closes. Figure 3B shows that there is continuous conduction in L_1 under full load. When the supply is short-circuited (Fig. 3C), the duty cycle decreases to maintain the voltage drop E_{ab} across Q_{12}.

The sawtooth amplitude control in the switching pulse generator sets the voltage across Q_{12} to the desired level for no load and low output voltage. The level adjustment is set to obtain optimum preregulator performance for full load and short circuit conditions.

The author is indebted to W. G. Hoyle, R. S. Richards, and J. Humphries for a number of valuable suggestions. Special thanks are due N. J. Giffin who built and tested the supply.

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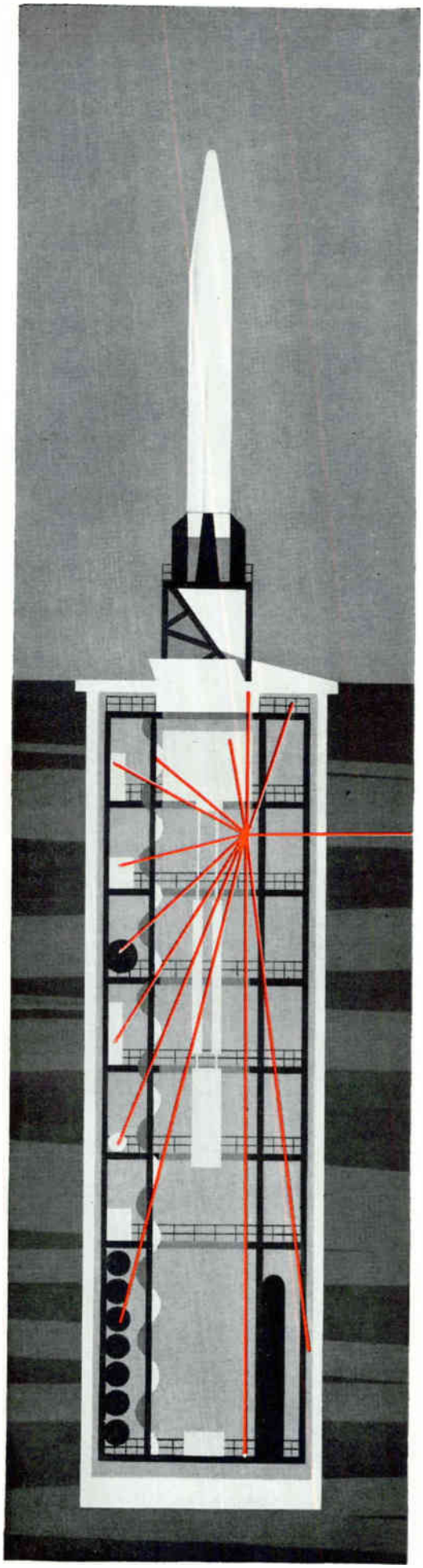

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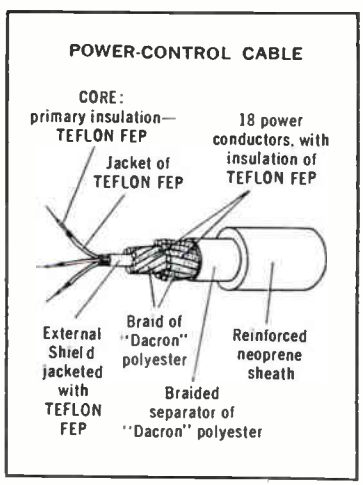

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BETTER THINGS FOR BETTER LIVING...*THROUGH CHEMISTRY*

How to Reduce Distortion

IN DIODE DETECTORS

By PAUL FLEMING JR.
*Collins Radio Co., Dallas, Texas

DEMODULATION attempts to arrive simultaneously at two mutually incompatible results: to recover the original intelligence through nonlinear elements, and to keep the output free from harmonic distortion that arises from nonlinearity. The first of these conditions is brought about by operating the modulation envelope over a curved characteristic so that the frequency components of the envelope will be multiplied.

In the ideal case the curvature can be obtained by the intersection of two straight-line segments, so that no harmonic distortion of the modulating frequency will appear in the demodulated output signal. Because abrupt changes in direction and straight-line characteristics ordinarily do not occur in natural phenomena, it is necessary to investigate the effects of less-than-perfect characteristics.

In Fig. 1, instantaneous voltage across the load resistor is

$$v_{RL} = iR_L \tag{1}$$

The figure demonstrates the method for solving for current i, which can be expressed by the exponential series

$$i = a_o + a_1 v_d + a_2 v_d^2 + a_3 v_d + \cdots \tag{2}$$

where v_d = voltage across diode. Terms a_1, a_2 . . . can be found by the LaGrange interpolation method.

Although not rigorously correct because of the nonlinearity of the diode, it can be assumed that the potential across R_L is greatly attenuated replica of applied potential $e(t)$. In the typical diode circuit, the applied excitation is

$$e = E_c \sin ct + E_m \cos (c - m)t - E_m \cos (c + m)t \tag{3}$$

Neglecting exponential terms beyond the second order, the current through the diode then will contain the terms

d-c, mt, $2mt$, ct, $2(c \pm m)\ t$, $2ct$, $(2ct \pm m)\ t$.

If this expression is multiplied by the Fourier series representing a unit-zero squarewave of frequency c, the resulting expression will be valid for the diode demodulator circuit of Fig. 1.

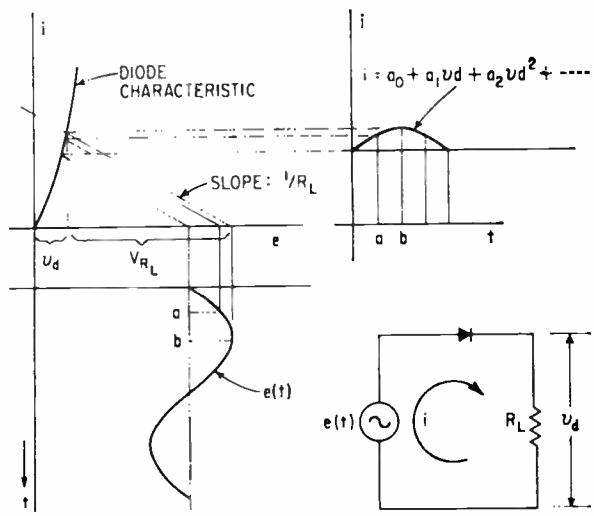


FIG. 1—Graphical determination of instantaneous current in circuit containing a nonlinear element

The expression for the current then includes the frequency terms

d-c	$2ct$	$(nc \pm c \pm m)t$
mt	nct	$(nc \pm 2c \pm 2m)t$
$2mt$	$(nc \pm m)t$	$(nc \pm 2c \pm m)t$
$(c \pm m)t$	$(nc \pm 2m)t$	$(nc \pm 2c)t$
ct	$(nc \pm c \pm m)t$	$(nc \pm 2c \pm m)t$
$(2c \pm 2m)t$	$(nc \pm c)t$	$(nc \pm 2c \pm 2m)t$
$(2c \pm m)t$		

where $n = 1, 3, 5, 7, \ldots$

Only the second, third, twelfth and the fourteenth terms are of interest; therefore a simplified relation for the demodulation products (after substituting $n = 1$ and grouping) is

$$e_3 = iR_L = R_L E_m \left[(a_2 E_c + a_1 B_1) \sin mt - a_2 \frac{E_m}{2} \cos 2mt \right] \tag{4}$$

where $B_1 = 2/\pi$ is derived from the amplitude of the unit-zero square wave.

By definition, second harmonic distortion (per unit) is $D_2 = E_2 / E_1$ (5)

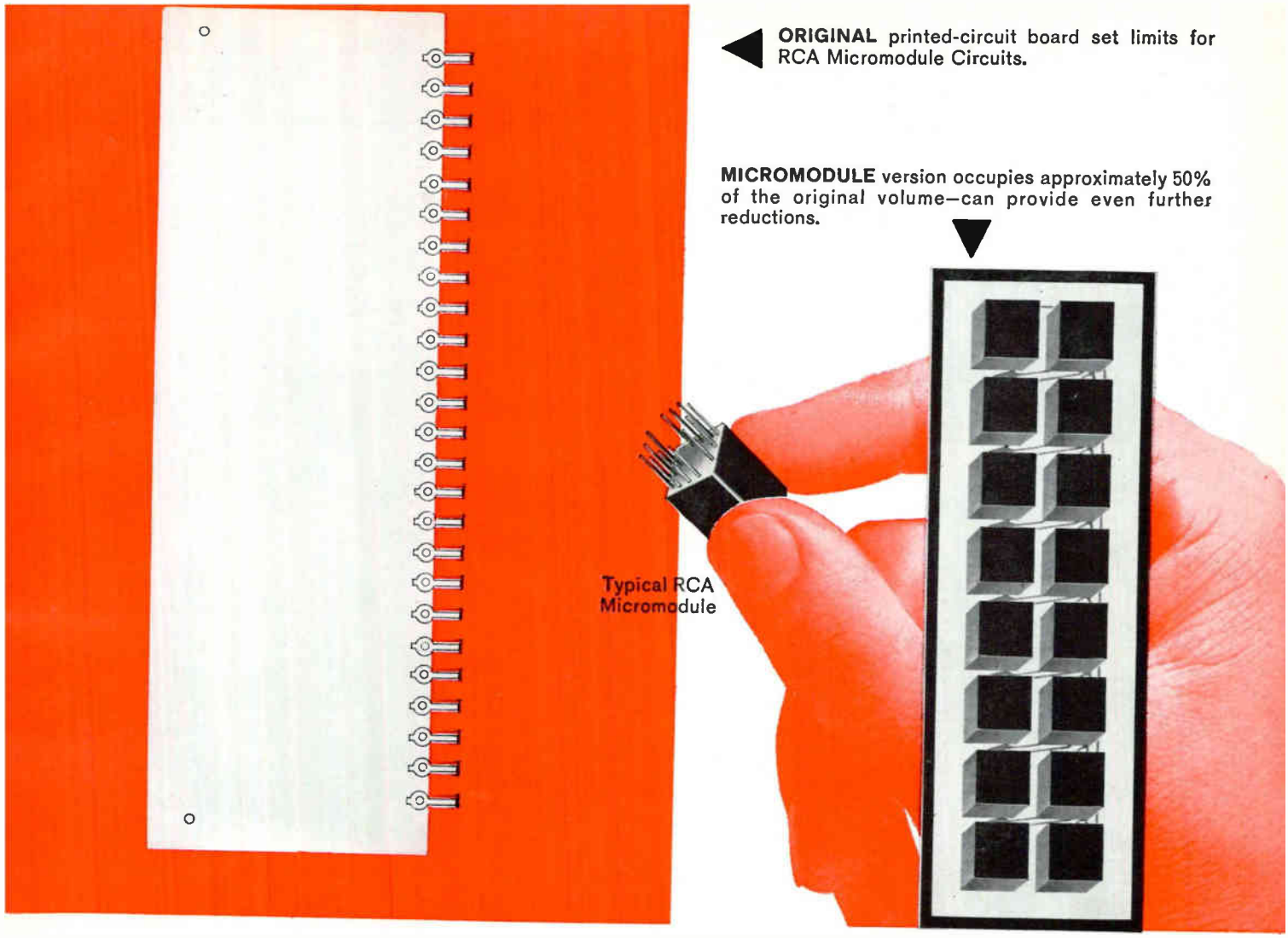
where E_2 is the magnitude of the second harmonic, and E_1 of the fundamental. Therefore,

$$D_2 = \frac{a_2 E_m}{a_2 E_c + a_1 B_1} \cdot \frac{2}{} = \frac{E_m}{2E_c + 2(a_1/a_2)B_1} = (E_m/2)/[E_c + (2\pi)(a_1/a_2)] \tag{6}$$

At first glance, Eq. 6 appears dimensionally inconsistent because all terms except a_1/a_2 are voltages. However, Eq. 2 shows that a_1/a_2 also is a voltage. Equation 6 shows that for small distortion in the demodulated output, E_m should be small, E_c should be large, and ratio a_1/a_2 should be large.

If the percent modulation is kept low, the first condition will be satisfied. However, Eq. 4 shows that the useful output of the detector ($R_L E_m [a_2 E_c$

*Now with Automatic Electric Laboratories, Inc., Northlake, Ill.



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...and backed by 55,000,000 element hours of life-test experience

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LOWER COSTS: If you are looking for cost reductions as well as microminiaturization, RCA Micromodules can now show you the way.

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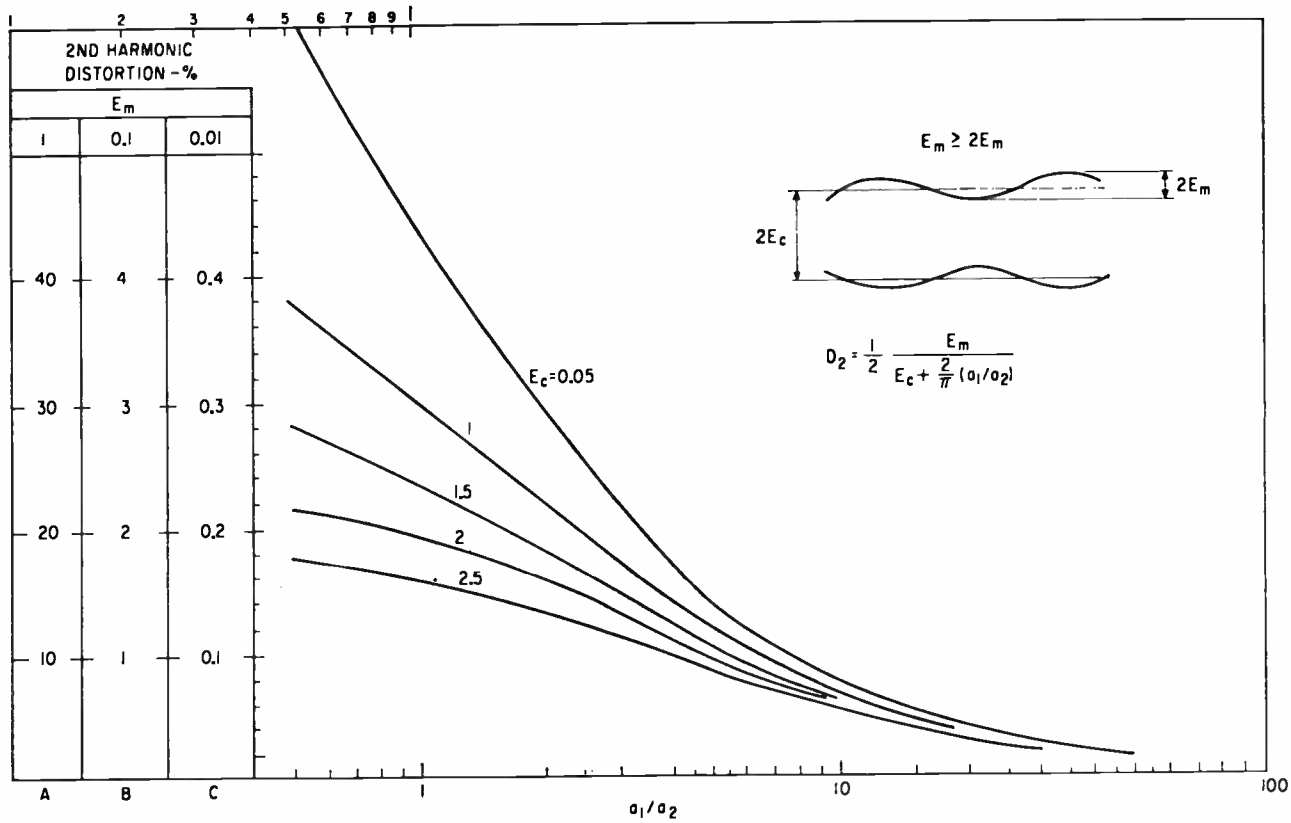

FIG. 2—Graph of Eq. 6, giving second-harmonic distortion for relative levels of modulating, carrier frequencies

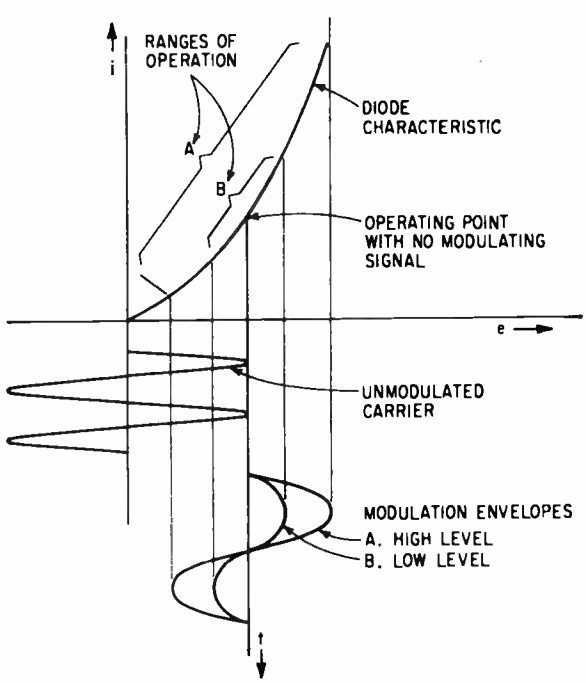

FIG. 3—Modulation envelope operates in region set by magnitude of unmodulated carrier

$+ A_1B_1]$ sin mt) is reduced proportionately with E_m, hence a limit must be placed on reducing this potential. The last of the criteria can be satisfied if the detector characteristic is linear from the break point, thus emulating the ideal diode. The term a_2 is zero for the perfect diode, and Eq. 6 verifies that the distortion reduces to zero for this condition.

Figure 2, derived from Eq. 6, depicts the second-harmonic distortion expected for various relative levels of the modulating and carrier frequencies and for various positive values of the parameter a_1/a_2. If the a_1/a_2 ratio is unity, and the carrier level is 0.5 unit, the distortion will be approximately 44 percent if the modulating level is one unit (An impossible solution since $E_c > 2E_m$ if overmodulation is to be avoided), 4.4 percent for 0.1 unit, and 0.44 percent if the modulating potential is reduced to 0.01 unit.

Another, simple, interpretation can be made of Eq. 6. For a diode curve, such as Fig. 3, assume that the level of the unmodulated carrier establishes a bias point on the characteristic curve. Large modulating levels cause extensive excursions on either side of the quiescent point, with large distortion in the detected signal. Lowering the modulation level reduces the distortion by minimizing the effect of curvature in the diode characteristic in much the same way as reducing the signal applied to an amplifier. Low carrier levels permit the envelope to operate over a more curved region, so that the a_2 term of the exponential series will be large compared with a_1. Increasing the carrier level moves the operation to a more linear portion and the a_2 coefficient is made smaller.

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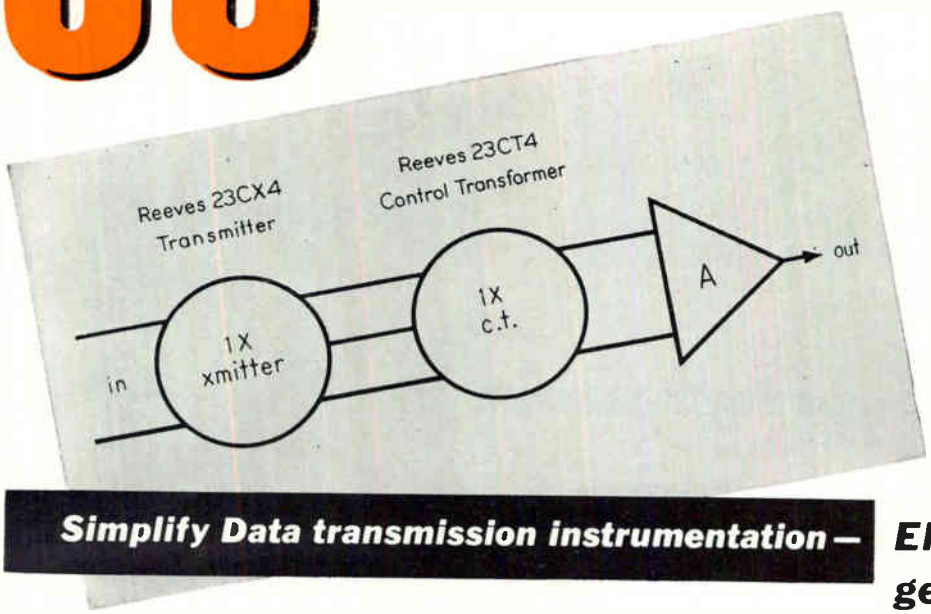
in BuOrd size 23 configuration



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	DIAMETER	POWER RATING (watts)	RESISTANCE (ohms)	CTS SERIES	
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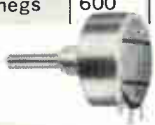
	15/16"	1/4	250Ω—15 megs	Q	
	3/4"	2/10-3/10	250Ω—5 megs	70	
	5/8"	2/10-1/4	250Ω—2.5 megs	200	
	9/32"	1/10	500Ω—10 megs	M250	
	2 & 3 section side by side	1/4-1/3	250Ω—10 megs	X52 X53 U52	*Carbon-ceramic
	2 & 3 section side by side	1/4	500Ω—10 megs	X152* X153*	
	2"	2	5KΩ—50 megs	HVC	MIL-R-94B
MILITARY	1-1/8"	2	100Ω—10 megs	96	RV4
	1-1/8"	2	100Ω—10 megs	95	
	15/16"	1	100Ω—5 megs	90	RV2
	15/16"	1/4	100Ω—15 megs	45	
	3/4"	1/2	100Ω—2.5 megs	65	RV5
	1/2"	3/4	100Ω—2.5 megs	300*	RV6
WIREWOUND VARIABLE RESISTORS					*Carbon-ceramic
COMMERCIAL	1-17/32"	4	3Ω—25K	25	
	1-17/64"	2	3Ω—15K	252	
	1-1/4"	2	1Ω—50K	2W	MIL-R-19
	3/4"	1-1/2 to 3	1/2Ω—5K	110	
MILITARY	1-17/32"	4	3Ω—25K	25	RA30
	1-17/64"	2	3Ω—15K	252	RA20
	1-1/4"	2	3Ω—15K	WP	RA20
CERMET VARIABLE RESISTORS					*Request Data Sheet*
(with Space Age High Stability 500°C Metal-Ceramic Element)	1-3/64"	3	100Ω—2.5 megs	400†	179
	3/4"	1-1/2	100Ω—2.5 megs	500†	180
	1/2"	3/4	100Ω—5 megs	600	175

†Semi-precision



	DIMENSIONS	POWER RATING (watts)	RESISTANCE (ohms)	CTS SERIES	
COMPOSITION TRIMMER RESISTORS					*Request Data Sheet*
COMMERCIAL	1-1/4x.295x.350	1/4	500Ω—1 meg	140	80
	7/16x5/16x1/2	1/8	250Ω—2.5 megs	220	184
MILITARY	1-1/4x.295x.350	1/4	500Ω—1 meg	140	80
	.344 Dia. x .240	1/10	250Ω—2.5 megs	380*	
CERMET TRIMMER RESISTORS					
	1/2x1/2x.260	1	100Ω—1 meg	170	178
	1-1/4x.295x.335	1	100Ω—1 meg	180	177

*Carbon-ceramic

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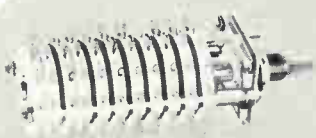

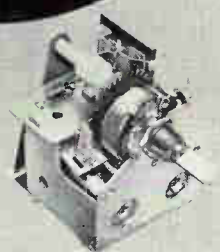

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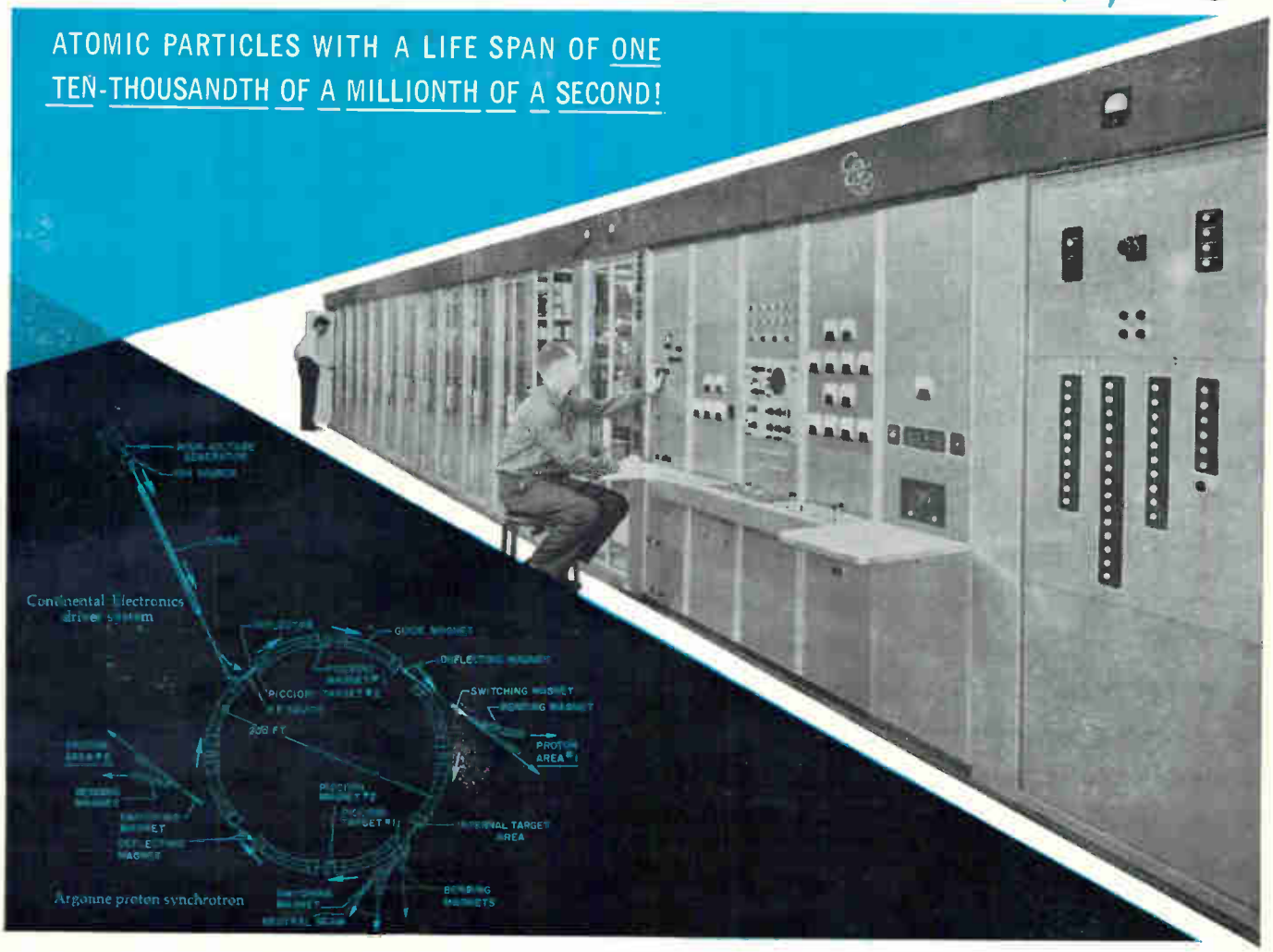

Continental Electronics, specialist in super power electronics equipment, is building the radio frequency driver system for the linear accelerator injector for the proton synchrotron now under construction for the Argonne National Laboratory. This driver system will have a peak power of 5 megawatts,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

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

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

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SILICONE NEWS from Dow Corning

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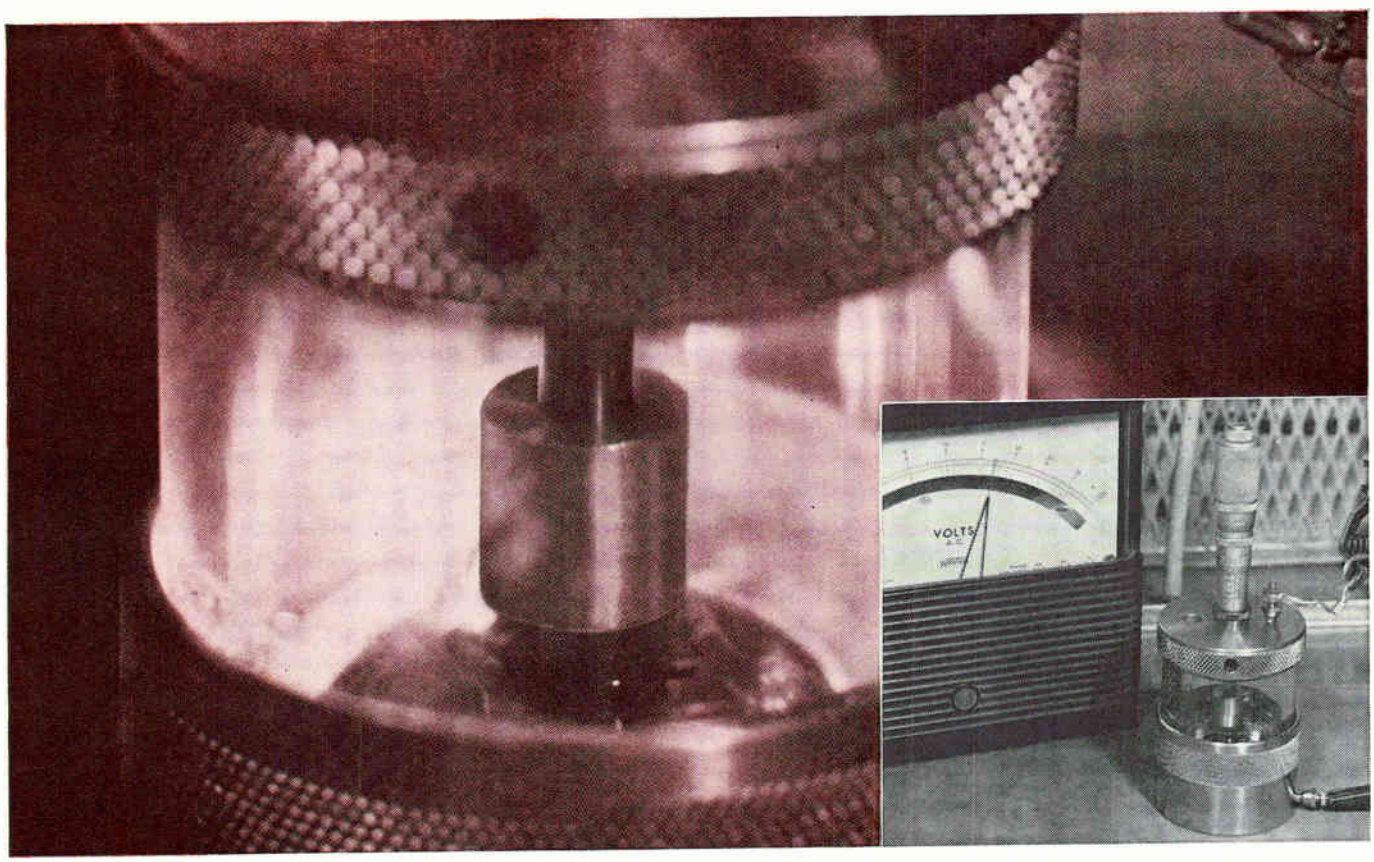

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A part of proving silicones in the laboratory for performance in your product is the development of realistic evaluation equipment like the ball test cell shown. Developed by Dow Corning, it is used in one of the stringent quality control tests for electrical grade fluids . . . available in viscosities of 20, 50, 100, 200, 350, 500, and 1,000 centistokes.

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Flash Point, degrees Fahrenheit, min.	575
Electric Strength, volts/mil, min.	350
Dielectric Constant, maximum	
at 23 C, 100 cps	2.75
at 23 C, 10^5 cps	2.75
at 150 C, 100 cps	2.45
Dissipation Factor, maximum	
at 23 C, 100 cps	0.00008
at 23 C, 10^5 cps	0.00002
at 150 C, 100 cps	0.004
Volume Resistivity, ohm-cm, minimum	
at 23 C—500 volts d-c	1.0×10^{14}
at 150 C—500 volts d-c	0.1×10^{14}
Specific Gravity 25 C	0.968
Refractive Index 25 C	1.403
Pour Point, degrees Fahrenheit	—60
Thermal Expansion Ratio†	1.12
Thermal Conductivity‡	0.00037

†$\frac{\text{Volume at 150 C}}{\text{Volume at 25 C}}$ ‡$\frac{\text{gm-cal}}{\text{deg C cm sec}}$

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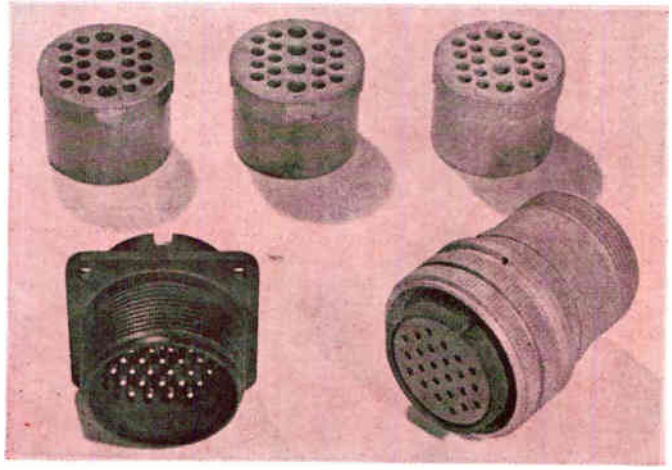

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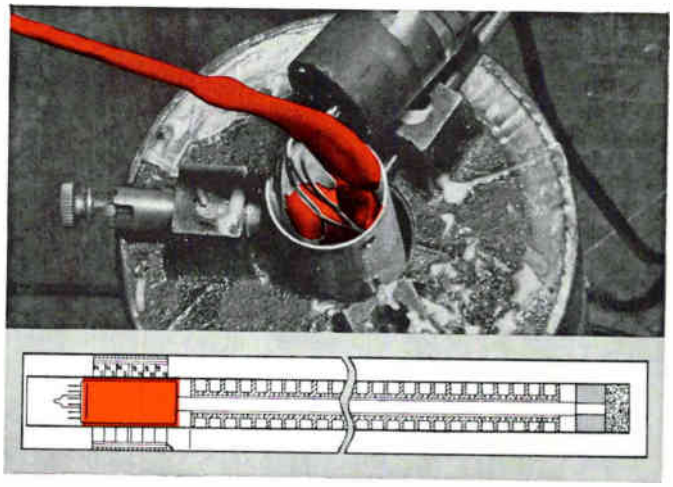

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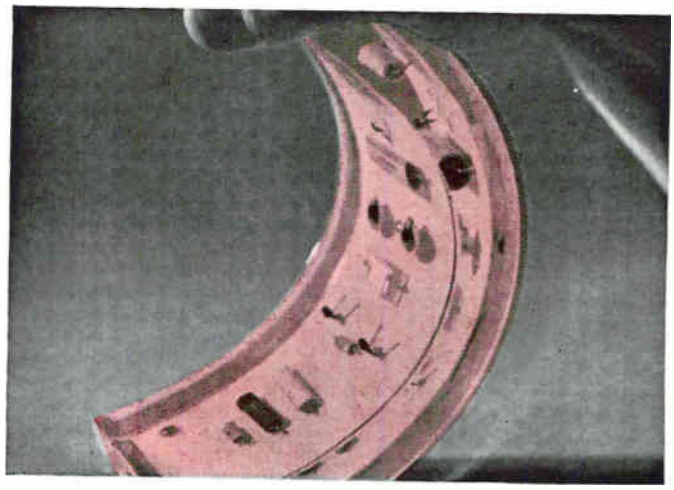

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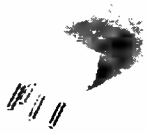

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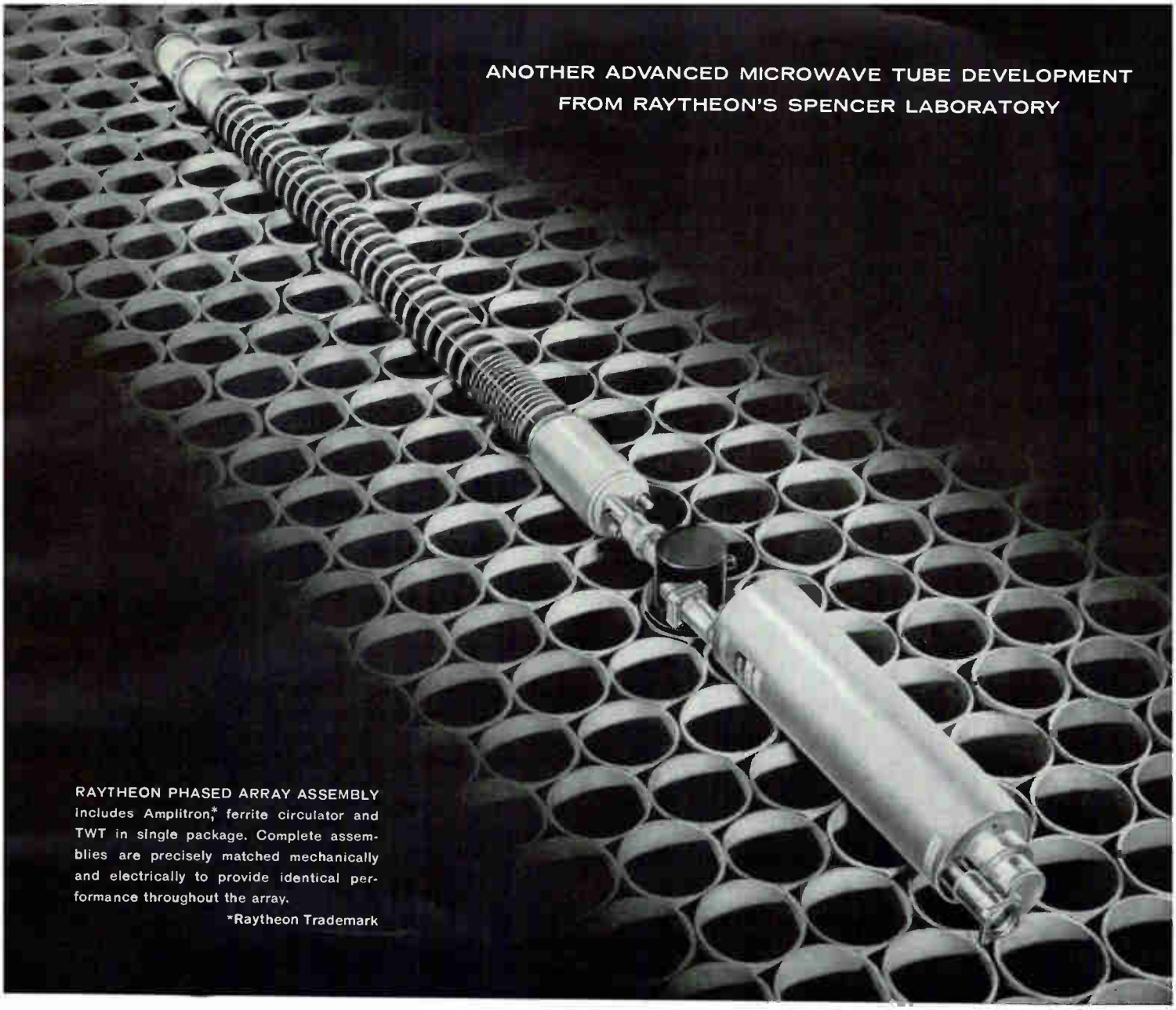

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Raytheon tubes bring new modular solution to phased array problems

TYPICAL OPERATING CHARACTERISTICS

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Peak pwr.	15 kw	Pk. power out.	5 kw	100 kw
Average pwr.	800W	Av. power out.	400W	2.5 kw
Frequency (Mc)	1215-1400	Frequency (Mc)	1215-1400	1215-1400
Isolation	18 db min.	Gain	50 db	13 db
Insertion loss	0.4 db max.	Efficiency	20-25%	70%
VSWR	1.25	Pulse dur.	750μs	500μs

*3-port Wye-junction circulator with load.

New permanent magnet concept makes possible half wavelength mounting of transmitter tubes

Raytheon now has an advanced Amplitron, TWT and ferrite circulator for modular mounting in a permanent magnet lattice. The new assembly provides excellent efficiency, bandwidth and gain over a wide range of power output levels.

The TWT-circulator-Amplitron assemblies are expressly designed for minimum noise and uniformity of phase and gain characteristics from unit to unit. To provide greater operating flexibility, the TWT employs a modulating anode and isolated collector.

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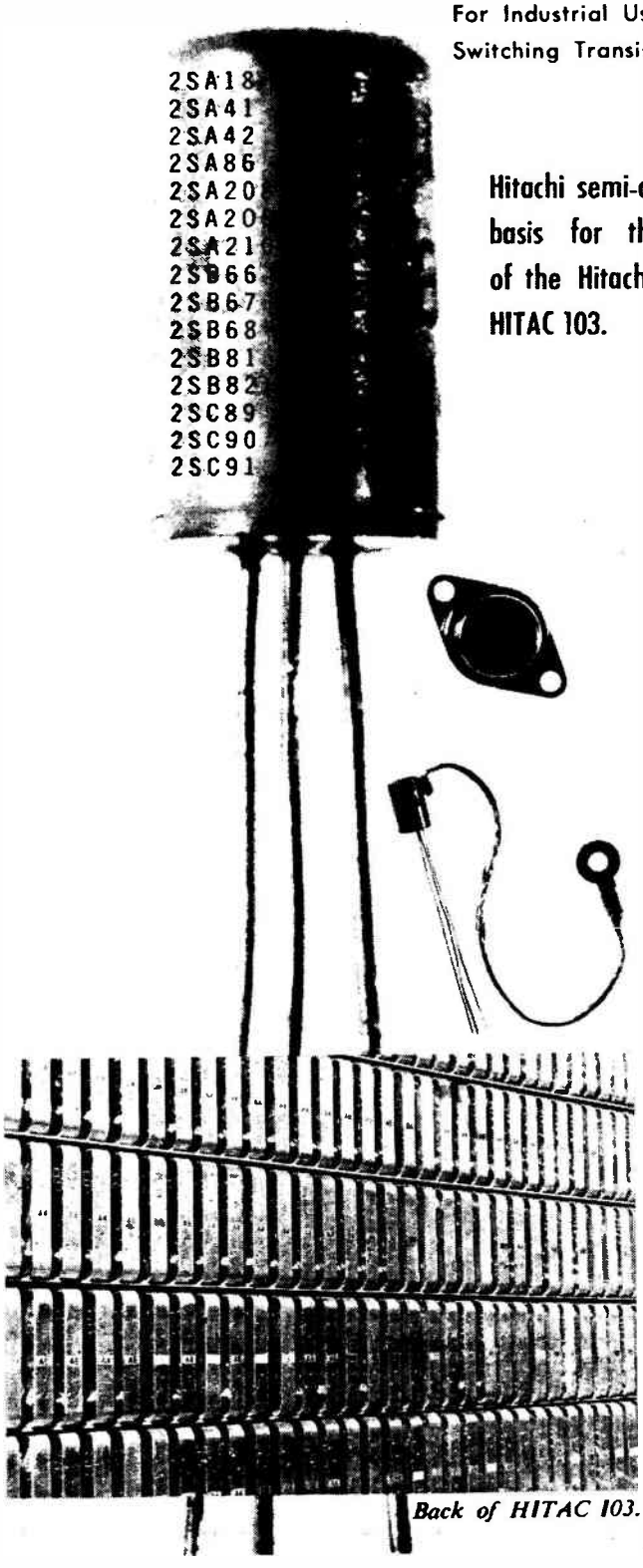

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Tokyo Japan

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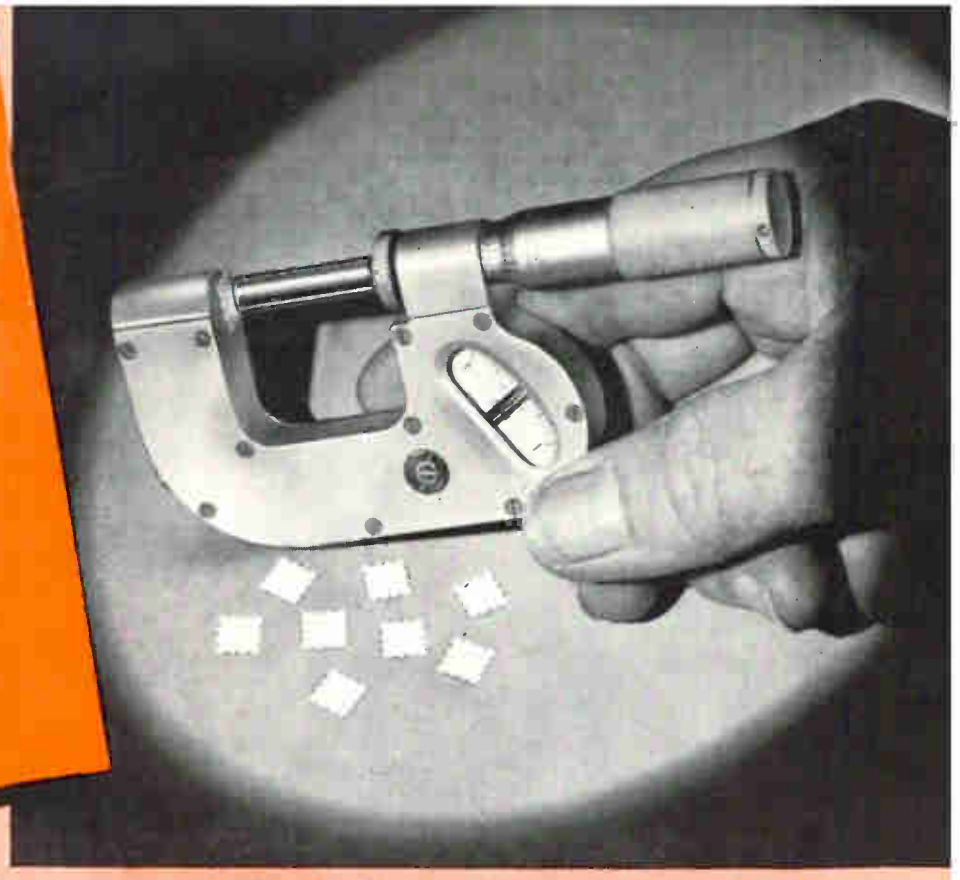
PROGRESS REPORT on NEW TOLERANCES for ALSiBASE ULTRA-THIN CERAMICS



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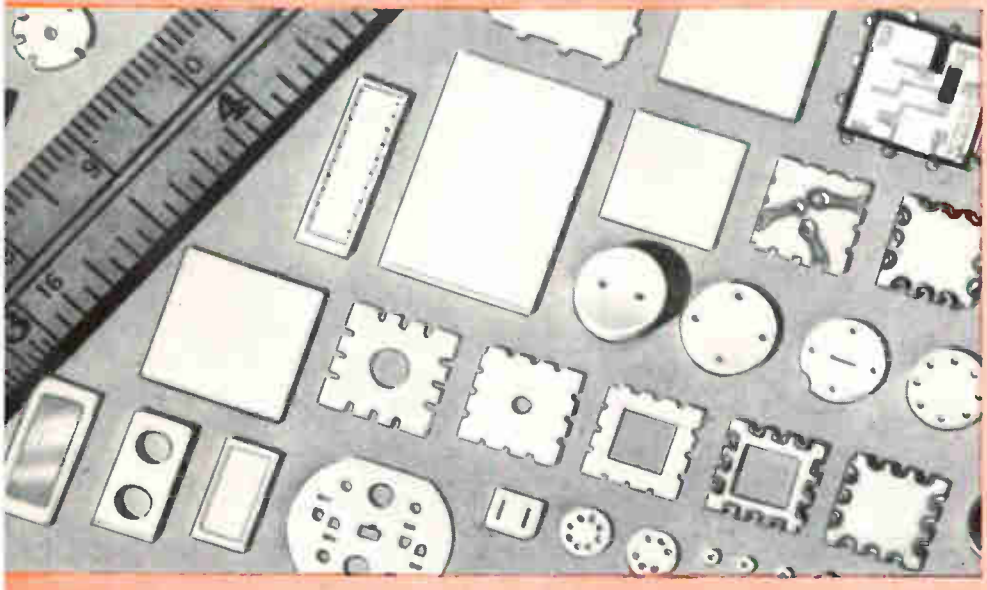

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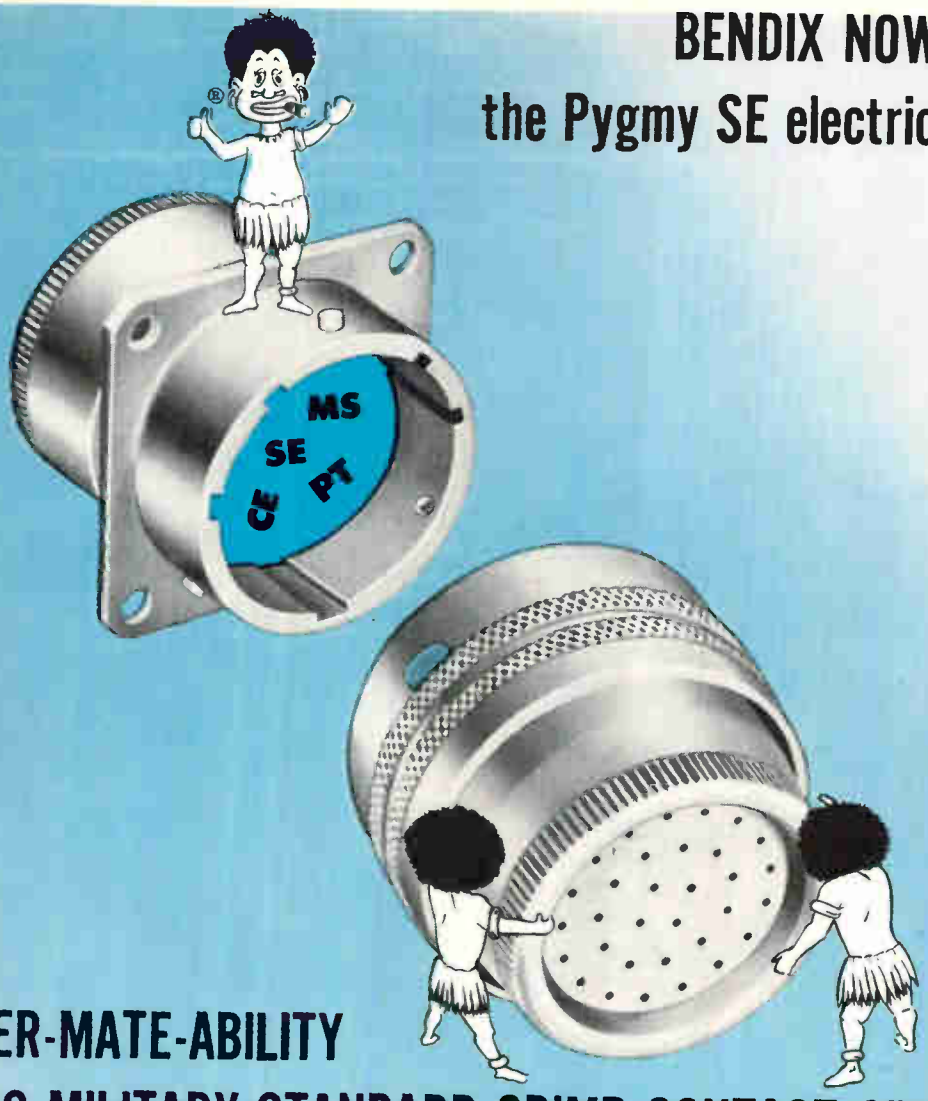

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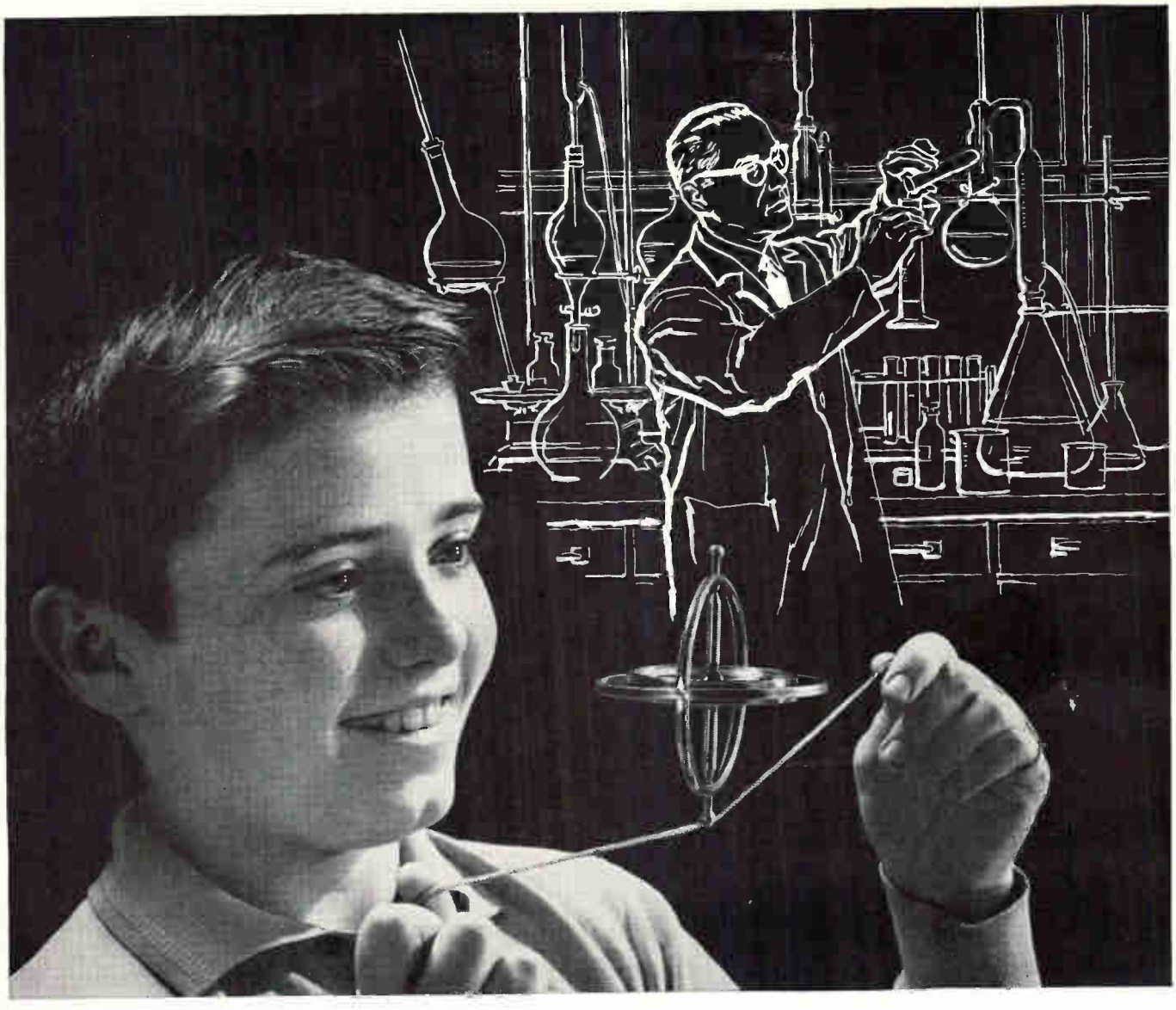

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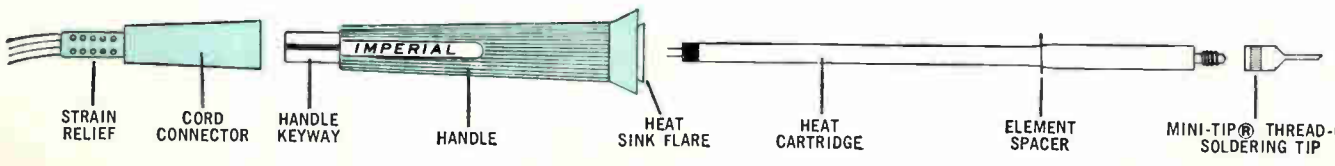

50TH ANNIVERSARY OF THE INTERNATIONAL IRE
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Modulation Extends Airborne Surveying Range

By W. J. ROBINSON
Markham, Ontario

EXPERIMENTAL airborne electromagnetic survey indicates that the detection range for this surveying technique can be greatly increased. The greater detection distance results from modulating the power energizing a long cable on the ground and from modifying the detection equipment in the aircraft.

Ground surveying is often done using a grounded cable energized by a low-frequency motor generator. The same method can be used for airborne surveys with the aircraft flying across the cable at right angles. However, a cable 20 to 30 kilometers long is required, and the cost of laying the cable is high, particularly where there are no convenient roads. Because of the limited range of airborne electromagnetic surveys, they have therefore fallen into disfavor.

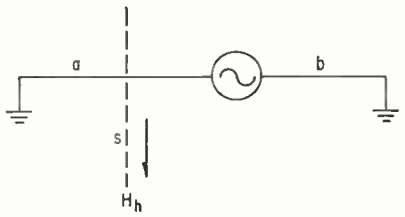

FIG. 1—Return flow in medium produces horizontal field component perpendicular to wire

Current passing through a long straight wire grounded at both ends and on the horizontal surface of a semi-infinite medium of low conductivity produces a field. At any point on the surface, on a line perpendicular to and crossing the cable, the horizontal component of the field resulting from the current in the wire is zero. However, the horizontal field component perpendicular to the wire resulting from return flow in the medium is $H_h = I\,[a/(a^2 + s^2) + b(b^2 + s^2)]\ 10^{-9}$ gauss, where I is current in amperes, s is distance of the point from the wire in meters, and a and b are distances from the line to the ends of the wire in meters, as indicated in Fig. 1.

With 2 amp in a 20-Km cable, H_h at 10 Km from the cable is less than 2×10^{-7} gauss and at 20 Km is less than 10^{-7} gauss. Surveys with single-frequency sine-wave excitation have given somewhat smaller values of H_h, particularly where overburden has had relatively high conductivity. This effect has been checked with model studies. It has been concluded that maximum range using a detector with maximum sensitivity of 10^{-6} gauss is about 10 Km on either side of the wire.

The effect of cable current very near the cable overrides all other effects so that no useful survey results are obtained. For this area, H_h should be approximately $H_h = I\,[a/(a^2 + s^2) - ah/s^2\,(a^2 + s^2)^{\frac{1}{2}} + b/(b^2 + s^2) - bh/s^2\,(b^2 + s^2)^{\frac{1}{2}}]\ 10^{-9}$ gauss, where h is terrain clearance of the aircraft, which is usually 100 meters.

In a test survey in southern Ontario, a 20-Km cable and a 3-Kw, 1,000-cps motor-generator with the generator field excited by a 60-cps voltage were used. The power supply modulation permitted use of an amplifier-detector with large overall gain, flat frequency response between 925 and 975 cps, and a large rejection factor for noise originating in the aircraft. Generator frequency was kept between 925 and 975 cps.

The detector used in the airborne system in Fig. 2 comprises two coaxial coils mounted 0.75 meter apart to limit mutual inductance. Each coil is parallel tuned by a

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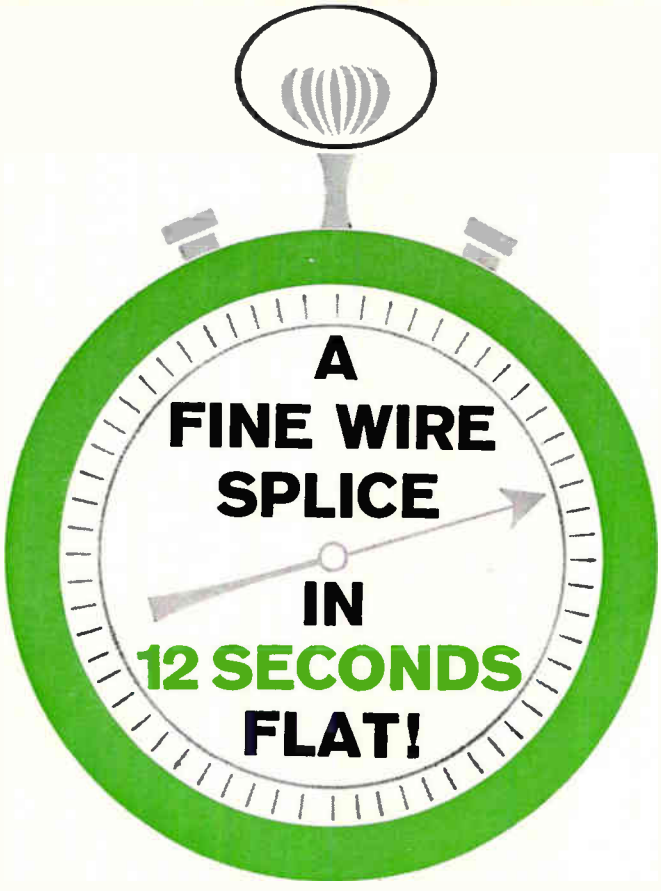

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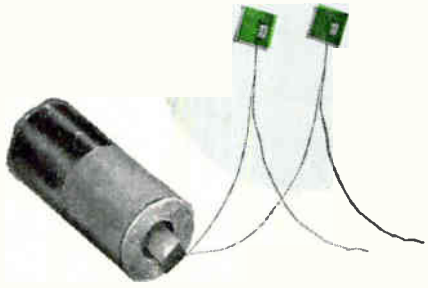

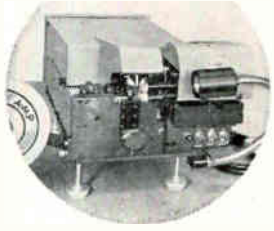

When you use solder to splice very fine magnet wire (34 to 44 gage or finer) to stranded lead wires, you usually end up doing a very slow burn. You get time-consuming stripping problems . . . unreliable wire damage or even wire breakage . . . cold solder joints . . . oxide contamination . . . high labor costs. And speed? Your best might be a splice a minute. The new AMP-FINE-Y-R Splice gets rid of these problems, and it does it fast—once every 12 seconds, 5 times a minute, 300 fine wire splices an hour—for all fine magnet wires from 34 to 44 gage or finer, and for all stranded lead wires 26 gage and finer.

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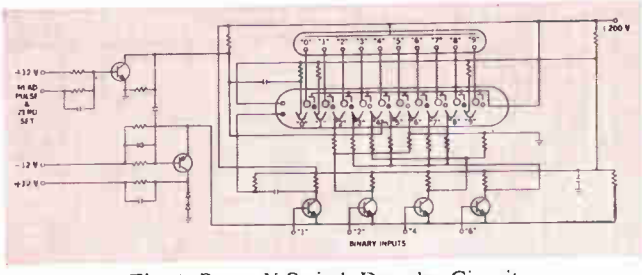

Fig. 1 Beam-X Switch Decoder Circuit

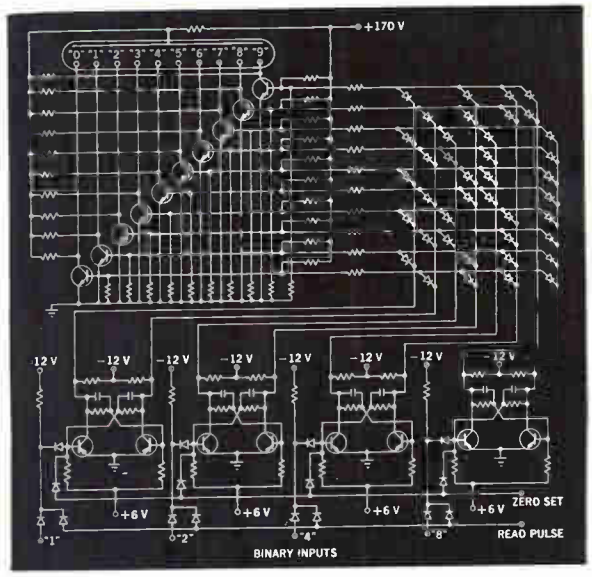

Fig. 2 Typical All-transistor Decoder Circuit

Now, Beam-X Switches are "applications-oriented" for optimum performance of specific digital functions. Typical is the new Type BX-2012, a Beam-X Switch designed to provide the ideal method of converting Binary Coded Decimal data to Decimal form. Ten electrical outputs drive Nixie® Indicator Tubes or printers for visual presentation of the binary data.

Figure 1 illustrates the simplicity of a typical Beam-X Switch Decoder circuit. It also shows the compatability of the Beam-X Switch with semiconductor devices. Only 41 components are required to sample and store the BCD information in decimal form. In addition, the Beam-X Switch Decoder:

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- ACCEPTS 4-LINE BINARY INFORMATION
- NEEDS ONLY 1-LINE ADDRESS
- DECODES THE DATA IN 10 μSECS

Now look at Figure 2, a typical all-transistor decoder which performs the same function. Almost four times as many components are required . . . increasing cost, size and circuit complexity.

Beam-X Switch Decoder performance is available in component or in complete plug-in modular form. Units are available to handle such codes as 8421, 2421, 4221, 5311, Cyclic Gray and other BCD codes. The complete module price . . . $85 in single quantities . . . makes it the lowest cost, all-electronic binary decoder commercially available.

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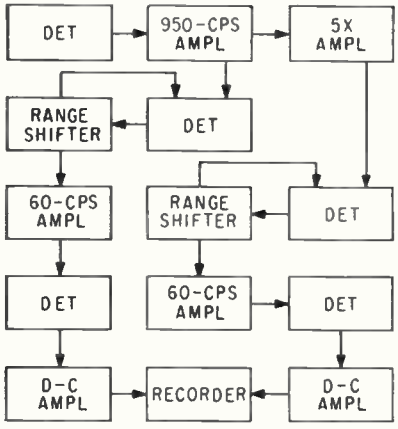

FIG. 2—Detection system provides large overall gain and flat response from 925 to 975 cps

nominal 0.003-microfarad capacitor in series with 3,300 ohms resistance. Values are chosen to tune one coil to 930 cps and the other to 970 cps, giving the pair a flat detection characteristic over the generator frequency range. Overall sensitivity of the two coils is 20 times that of a single untuned coil so that a 10^{-7} gauss field induces 400 microvolts in the detector at 950 cps.

The first conventional 950-cps amplifier has two twin-T feedback networks to reject unwanted frequencies. Output is fed to a channel with maximum sensitivity of 10^{-7} and another channel with maximum sensitivity of 5×10^{-7}. The more sensitive channel has an added amplifier with a gain of 5 and additional filtering.

Signals from both channels are detected, yielding 60-cps outputs that are fed to range shifters. The range shifter for the more sensitive channel reduces gain by a factor of 25 when a signal of 10^{-7} gauss is reached. Gain of the less sensitive channel is reduced by a factor of 30 when a signal of 5×10^{-7} gauss is reached. Thus four detection ranges are provided of 10^{-7}, 5×10^{-7}, 2.5×10^{-6} and 15×10^{-6} gauss.

One channel is recorded continuously while the other is switching, which is particularly important where anomalous conditions make rapid switching necessary. Range shifter output is amplified further, filtered, detected and used to drive a dual-channel d-c recorder. The range shifters are Schmitt circuits with plate relays that switch gain at predetermined signal strength. Hysteresis effects are not important because one channel is always recorded while the other switches.

The test survey indicates that noise is less than 3×10^{-9} gauss and probably could be reduced with further refinements. Effective results can be obtained 20 Km from the cable.

The work described was done at Lundberg Exploration, Ltd., Toronto, the assets of which are now owned by Leach, Hobbs and Brown, Geophysical Instruments, Toronto.

Speedy Tube Warmup Will Be Described at IRE

HEATER-TYPE developmental receiving tube warms up in 1.3 seconds. The warmup time of conventional radio and television receiving tubes is about 11 seconds, while the ceramic-type tubes used in the tests usually require 25 seconds.

The techniques used to attain the fast warmup will be described at the 1962 IRE show in a paper by J. M. Connelly and D. D. Mickey, Receiving Tube Department, General Electric Company. The limited time required for the tube to reach its normal operating condition after power is applied is considered to be a significant advantage in space and military electronics equipment. The fast warmup is also desirable in entertainment equipment.

Two techniques were combined in the development work that resulted in the 1.3-second warmup tube. Bonding the heater to the cathode (they were kept isolated from each other electrically) provided for heat transfer by conduction. Heat is usually transferred to the cathode by radiation. Inserting a ballast resistor in series with the heater caused a relatively high initial surge of current.

Apparently two additional benefits will result from the new type heater-cathode construction. The greater physical strength of the structure can be expected to provide higher reliability, and the heater operates at a substantially lower temperature than is normally required. Radiating heaters of the type under development usually operate at 1,400 degrees C, while the bonded heater-cathode structure requires a temperature of only 775 to 800 C.

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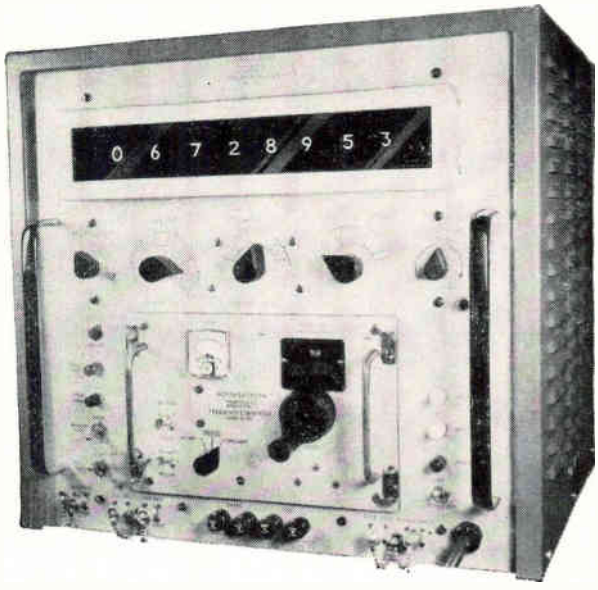

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- Frequency range ....200 MC to 1 KMC
- Input voltage (min.) .....100 millivolts RMS
- Input impedance ....50 ohms, approx.
- Accuracy .....±1 count, ± accuracy of counter
- Power requirements .....furnished by counter
- Weight .....5 pounds

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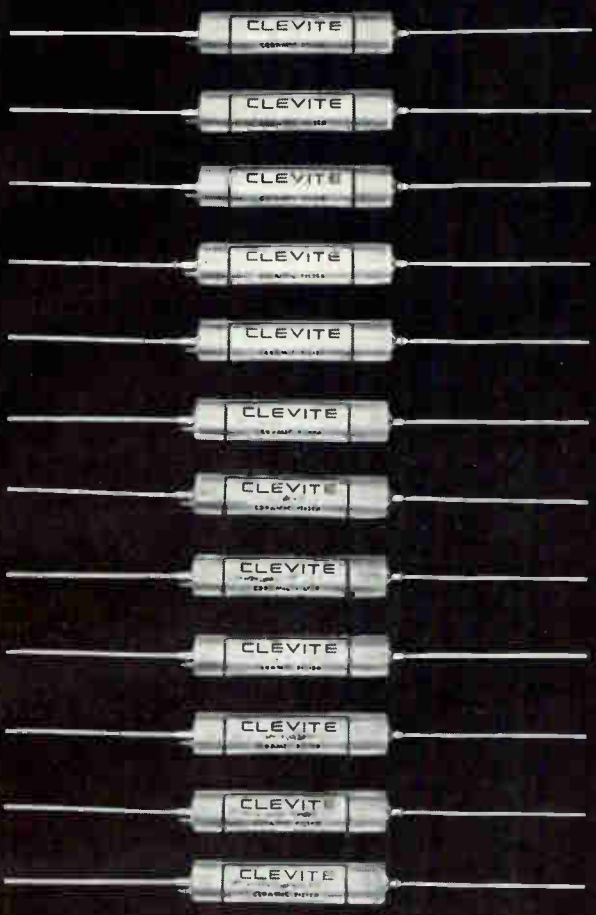

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TL-4D9A	4 kc
TL-6D12A	6 kc
TL-8D16A	8 kc
TL-10D18A	10 kc
TL-16D25A	16 kc
TL-20D32A	20 kc
TL-30D45A	30 kc
TL-40D55A	40 kc
TL-45D60A	45 kc
TL-32E48C	32 kc
TL-50D85C	50 kc

(suffix "A" denotes 455 kc center frequency;
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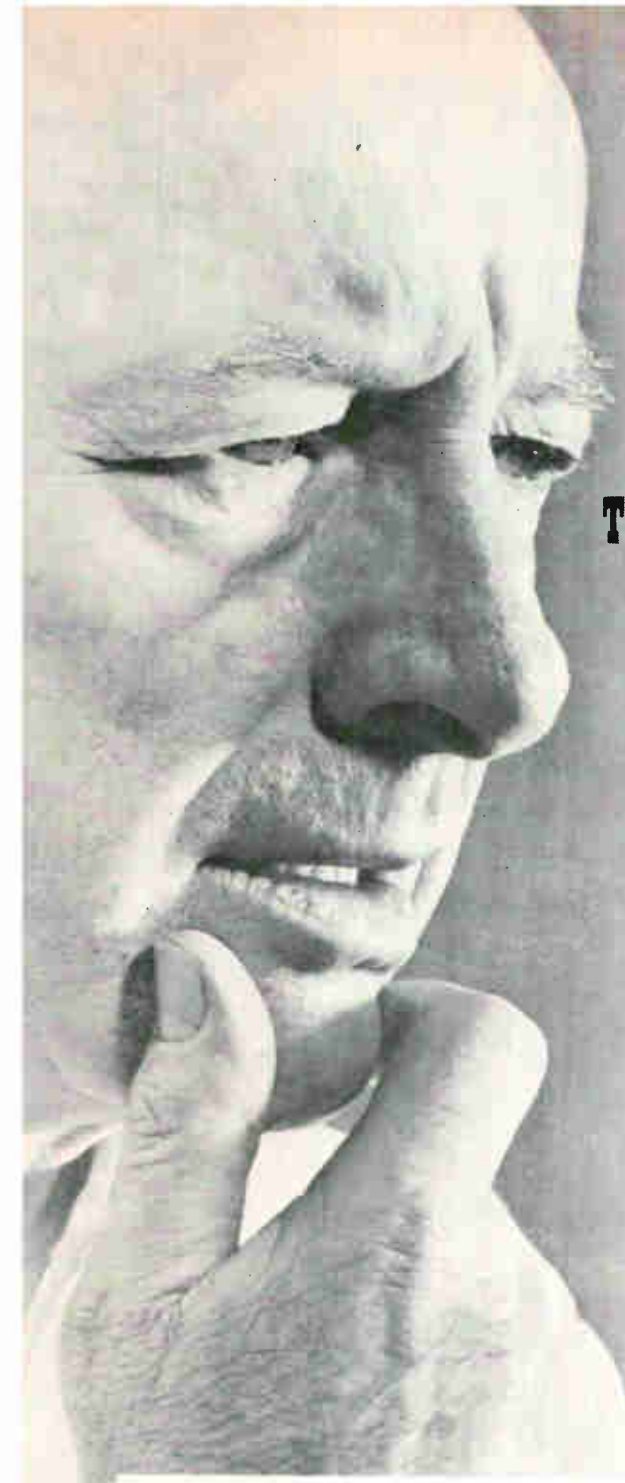


Take an engineer's critical look at

MERCURY-WETTED CONTACT RELAYS

☆☆☆ by P&B ☆☆☆

Your product demands a *superior* relay? Can't tolerate contact bounce, welding or pitting? Must have billions of operations? Need fast switching . . . complete stability and reliability? Our JM Series mercury-wetted contact relays meet all these requirements. No other type relay gives you the combination of all these features:

LONG LIFE BILLIONS OF OPERATIONS

NO BOUNCE

HIGH (100 cps) **SPEED**

SUPERIOR RELIABILITY

☆☆☆☆☆☆☆

ENGINEERING SPECIFICATIONS

Speed: SPDT **Operate:** 3 milliseconds (approx.) at 2 watts. **Release:** 3.2 milliseconds (approx.).

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

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

Terminals: Octal type plugs, 8 and 11-pin; Solder lugs; 14 or 20-pin miniature; AN connectors.

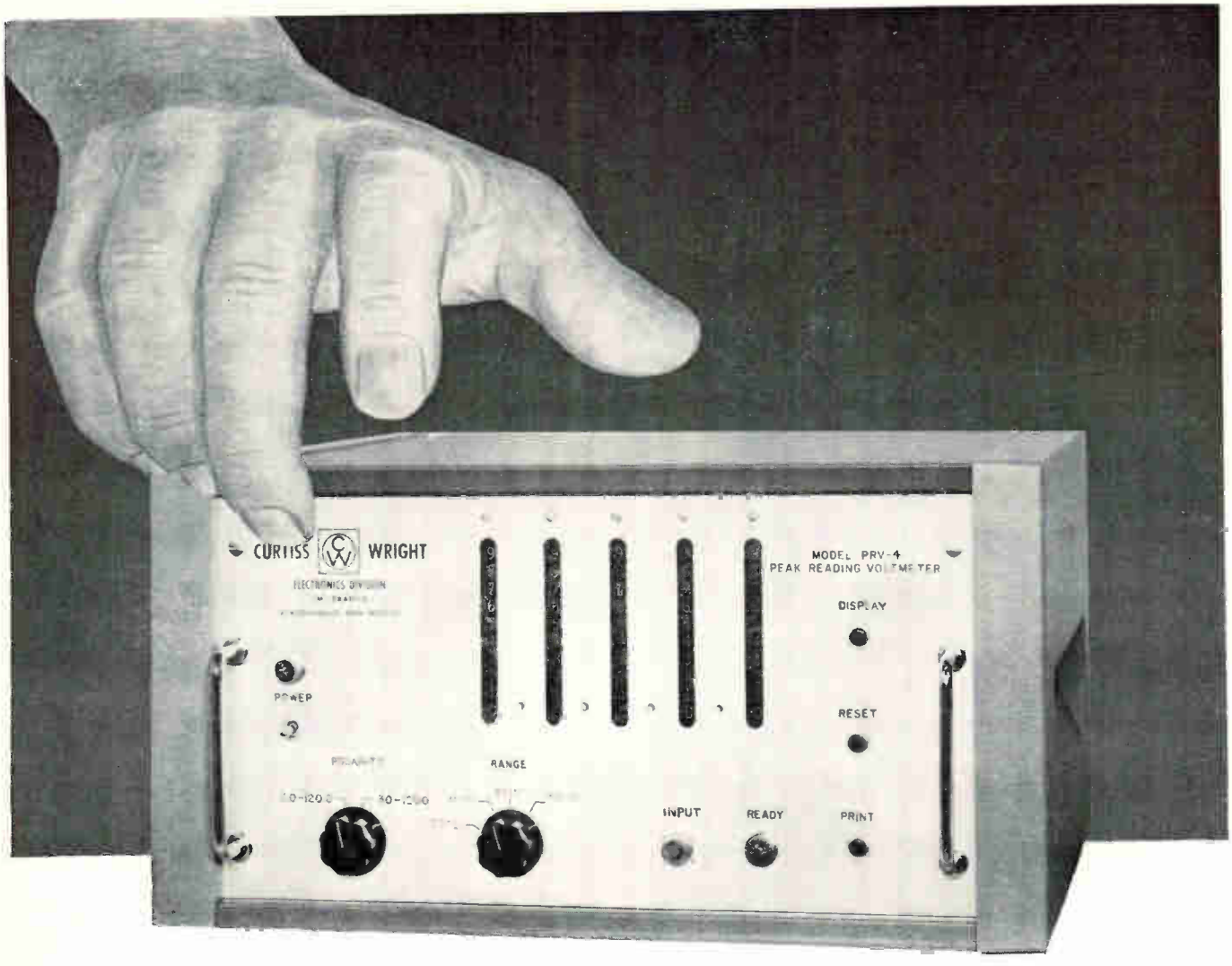
Coil Resistance: 2 to 58,000 ohms.

FREE CATALOG
WRITE TODAY

JM Relays are now available at your local electronic parts distributor.

POTTER & BRUMFIELD

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



Capture...then Read

THE FIRST PEAK OF ANY VOLTAGE

Single Transient Peak Reading Voltmeter

FOR: Blast Studies — Shock Studies — Transient Voltage Measurements on Aircraft Power Busses — Measurement of any single transient phenomena which may be characterized by a voltage pulse.

The Model PRV-4 Single Transient Peak Reading Voltmeter is designed to accept and display the first value of a *positive* or *negative* voltage pulse of arbitrary shape within specified limits. Readout is provided as a four digit decimal value directly in volts with a fifth digit for over-range indication. First peak voltage detected blocks further input values until reset. A four line 1-2-2-4 coded output line is provided for external printout. The PRV-4 will read out peak amplitude of rectangular pulses of one microsecond or greater pulse width. Readout cycle time, 1 millisecond with accuracy of 0.5% of absolute or 10 counts. Range 30 MV. to 1000 V.

Write to Intermountain Branch for complete specifications on the PRV-4 and other models, or for information on custom units available for unique requirements.

ELECTRONICS DIVISION INTERMOUNTAIN BRANCH

CURTISS-WRIGHT CORPORATION

P.O. BOX 10044 • ALBUQUERQUE, N. M. • PHONE: 345-1661 • TWX: AQ-69

NEW

DISPOSABLE "TRU-TOUCH" GLOVES

with the greatest fingertip sensitivity ever developed!

This revolutionary new Wilson glove gives you all three of the things you want most in a disposable industrial glove for inspection or small parts handling. **It's thin** . . . so sensitive you can feel your beard through it, tell whether a dime is heads or tails, feel every tiny dot in a book of Braille! **It's strong** . . . made of PVC with a tensile strength of approximately 1000 psi. **It's inexpensive** . . . 7c a glove, 14c a pair, even less in quantity! You get superior fit without the "snap" or constriction of latex. Touch is never numbed. Ask your Wil-Gard distributor for literature and samples.

STRONG!
Tensile strength:
app. 1000 lbs. psi

THIN!
Actual thickness:
.006 of an inch

DISPOSABLE!
Cost: only
7c a glove

SOLD ONLY THROUGH DISTRIBUTORS

WR-1261-173

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THE WILSON RUBBER COMPANY INDUSTRIAL DIVISION CANTON 6, OHIO

A Division of Beaton, Dickinson and Company • Pacific Coast Warehouse: 530 Howard St., San Francisco 5, California

McCoy
CRYSTALS & CRYSTAL FILTERS

Regardless of its size, type, or frequency any crystal bearing the name McCoy can be relied upon to deliver the ultimate in frequency control despite wide temperature variations and extreme conditions of shock and vibration.

M-1 (HC-6/U)

METAL ENCASED STANDARD SIZE AND MINIATURE CRYSTAL UNITS

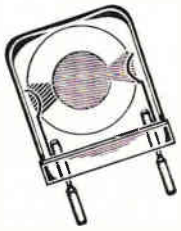
shown actual size

M-20 (HC-18/U)

M-21 (HC-18/U w/pins)

The crystals that made the name of McCoy a synonym for quality. Metal encased, HC-6/U size is available in frequencies from 500.0 kc to 200.00 mc.

Fills the need for miniature crystals in frequencies from 2.5 mc to 200.0 mc. Meets specs MIL-C-3098B and ARINC No. 401.



G-1 (Military HC-27/U)

ALL GLASS STANDARD SIZE AND MINIATURE CRYSTAL UNITS

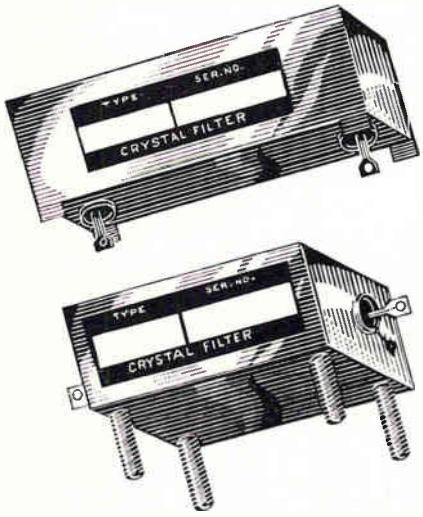
shown actual size

G-20 (Military HC-26/U)

G-21 (Military HC-29/U)

This vacuum sealed, hard glass crystal unit possesses all of the quality features for which the McCoy M-1 is so famous. It has long term frequency stability five times better than the conventional metal types. Available in frequencies from 500 kc to 200 mc.

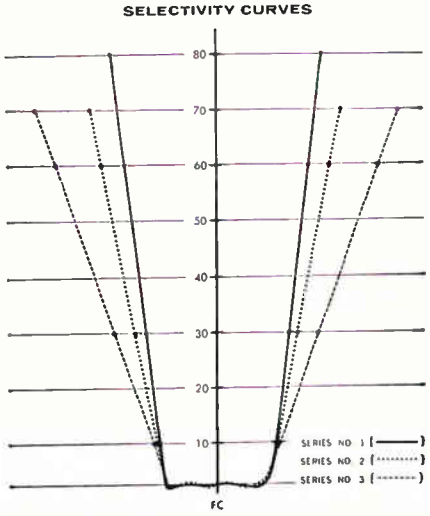
This vacuum sealed, hard glass crystal unit meets the new CR-73/U and CR-74/U specifications. It has long term frequency stability five times better than the conventional metal type. Available in frequencies from 5000 kc to 200 mc.



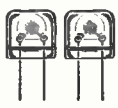
CRYSTAL FILTERS

Our many years experience in designing and producing top quality oscillator crystals have enabled us to develop and produce filters of equal desirability. Current production includes filters in the 1.0 mc to 30 mc range, with bandwidths of .01% to 4.0% of center frequency. A number are available without costly design and prototype charges.

Actual Size for Series 3 Types



See the **New!**
MICRO MODULE CRYSTALS
(GLASS)



AT THE WESCON SHOW
COW PALACE • SAN FRANCISCO, CAL.
AUGUST 22 thru 25 BOOTH NO. 1402

.28" square x .110" thick
frequency range: 7000 kc to 200 mc
Now available in limited quantities

Write today for our free illustrated catalogs which include complete listing of military specifications. For specific needs, write, wire or phone us. Our research section is anxious to assist you.

McCoy ELECTRONICS CO.
Dept. E-8
MT. HOLLY SPRINGS, PA.
Phone: HUnter 6-3411

NEW RADIO TELEMETRY EQUIPMENT FROM GEL

Receivers, Transmitters, Antennas, Accessories and Complete Systems Designed to IRIG specifications . . . Available in **all allocated telemetry frequencies** including microwave

GEL telemetry receivers, transmitters, antennas and other radio link equipment are available for off-the-shelf delivery. GEL equipment represents the latest design featuring low-noise, high-sensitivity, high-stability, ruggedness and reliability.

In designing the receivers provisions were made for FM phase-lock detection, AM synchronous detection and predetection recording. The GEL receivers have maximum flexibility and versatility through the use of readily-replaceable plug-in tuning heads, IF strips, and band-pass filters. Transmitters are designed for maximum stability, fidelity, ruggedness and reliability.

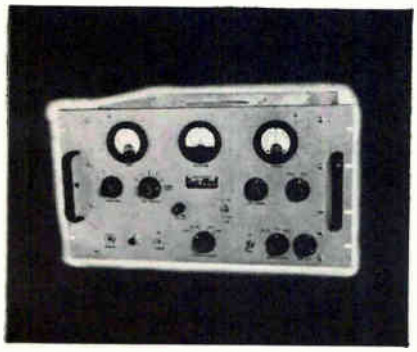
Equipment is available qualified to latest environmental and electronic-interference specifications for satellite, missile, aircraft, shipboard and ground-based operation.

GEL's antenna experience and capability extends through all presently-allocated telemetry bands and through 50,000 mc. Complete in-house antenna capability includes the design and manufacture of radomes, reflectors, feeds, plumbing, pedestals, servo and control units, displays and complete systems.

GEL also designs and manufactures Communications, Electronic Countermeasures, Microwave, Educational and Broadcast equipment.

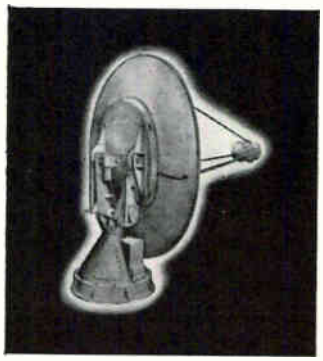
GENERAL ELECTRONIC LABORATORIES, INC.

8440 Second Avenue, Silver Spring, Maryland, Phone: Area Code 301, JUniper 8-4535, TWX: SSPG154



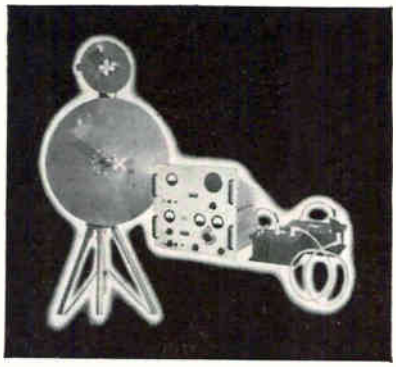
1700-MC Special-Purpose Ground Check-out Receiver Type 49A1. One of a series from 900 MC to 2400 MC.

2200-MC Telemetry Transmitter — Environmentally Qualified, Type 19A2.



1-11 KMC Antenna with polarization drive, azimuth and elevation control, Type 113.

30-260 MC General Purpose Receiver, Type 13B1.



1500-MC R-F Telemetry Link, Type 45A1.

215-260 MC Airborne Telemetry Receiver, Type 11F1.

Write or contact GEL Silver Spring or:

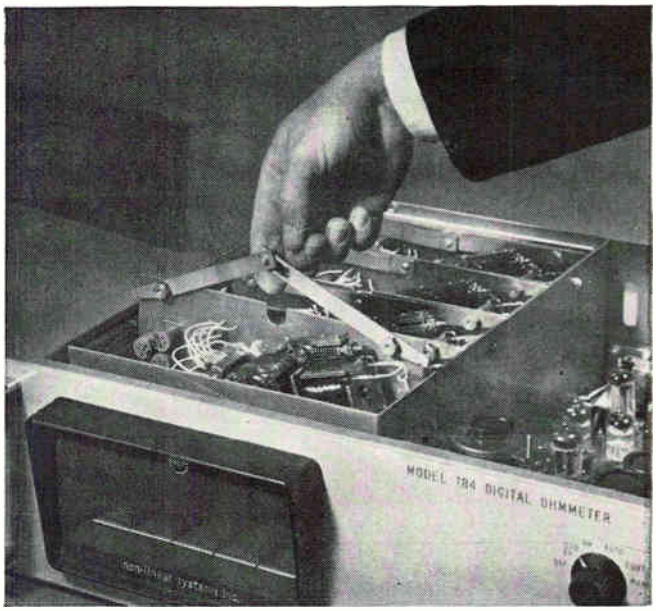
- General Electronic Laboratories, Inc., 195 Massachusetts Avenue, **Cambridge 39, Mass.**, Area Code 617, UNiversity 4-8500, TWX: CAMB218
- Fred Harris Associates, Suite 411, 11 W. Monument Avenue, **Dayton 2, Ohio**, Area Code 513, BAldwin 3-3242
- Kemco, Inc., P. O. Box 998, **Irving (Dallas) Texas**, Area Code 214, BLackburn 3-6703
- Kemco, Inc., 6427 East Kellog, **Wichita, Kansas**, Area Code 316, MUrray 4-8224
- Collins & Hyde, Benet Building, 535 Middlefield Road, **Palo Alto, California**, Area Code 415, DAvenport 6-0647, 0649, TWX: PAL AL 113U
- Collins & Hyde, 1250 East Artesia, **Long Beach, California**, Area Code 213, NEvada 6-0347, GArfield 2-0036

NEW!

TWO DIGITAL INSTRUMENTS WITH HIGH-QUALITY FEATURES AND LOW-BUDGET PRICE TAGS

1. *NLS 484A Digital Voltmeter-Ratiometer With Printer Connection and Built-In Automatic Print Control*
   $1,460, F.O.B. Destination in U. S. A.
2. *NLS 784 Digital Ohmmeter With Printer Connection and Built-In Automatic Print Control*
   $1,460, F.O.B. Destination in U. S. A.

The blue tag indicates that the 484A and 784 are NLS "off-the-shelf" instruments. See demonstrators in action today or take delivery on your own instruments within 10 to 30 days.



Both the 484A and 784 feature plug-in stepping switches.

These new NLS instruments eliminate the need to sacrifice versatility, accuracy, reliability or servicing ease in purchasing a digital voltmeter or ohmmeter in the $1000-1600 price range. ■ Consider versatility, for example. Some low-priced DVMs don't measure DC voltage ratio, don't have automatic range and polarity changing, and don't provide output and automatic control for printers. The completely automatic 484A *does*. With it, you can measure both DC voltage and DC voltage ratio with ±0.01% accuracy . . . make measurements faster and easier than with any meter having manual ranging — without the danger of over-loads . . . plug in a printer for data logging . . . plug in accessories to measure AC or low-level DC or for go/no-go testing. With a 784 digital ohmmeter and a printer, you can measure and record resistance automatically and accurately from 0.1 ohm to 10 megs. ■ Or consider the factors that contribute to the basic reliability of the 484A and 784: simple, time-proven design (thousands of earlier models of the same basic design are in use today) . . . quality construction . . . and use of quality components such as heavy-duty plug-in stepping switches and a precision oven for the Zener reference. ■ Then consider servicing. When it's eventually required, servicing can often be handled right on the spot with electronic parts available in most stockrooms. Plug-in stepping switches can be replaced in minutes and 1000-hour-life readout bulbs even faster without use of tools or soldering or opening the instrument. Contact NLS for complete data, a demonstration, or engineering aid for special applications.

BRIEF SPECS: *484A — ranges: DC voltage ±9.999/99.99/999.9, DC voltage ratio ±99.99% . . . accuracy: ±0.01% of f. s. on each range . . . measuring time: 1 sec. average . . . automatic range and polarity changing . . . input impedance: 10 megs for volts, 1000 megs for ratio . . . AC or low-level DC with accessories . . . automatic control for data logging.*
784 — ranges: 9999./999.9/99.99/9.999/.9999 kilohms . . . accuracy ±0.05% of reading ±1 digit (±0.1% of reading above 5 megs) . . . automatic range changing . . . measuring time: 1 sec. average . . . automatic control for data logging.

See the new NLS instruments at the IRE show.

Originator of the Digital Voltmeter
non-linear systems, inc.
DEL MAR, CALIFORNIA

NEW!

FULL 5-DIGIT VOLT-RATIO-OHMMETER THAT STANDS ALONE IN ACCURACY, RELIABILITY AND VERSATILITY

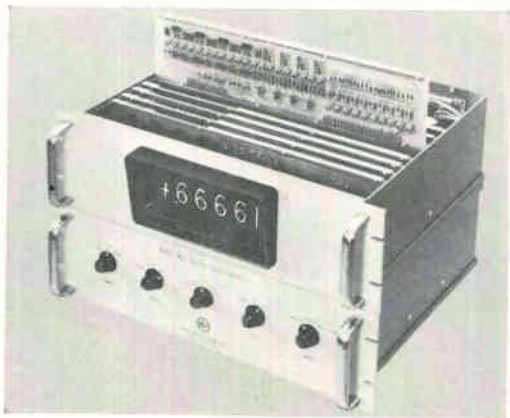
NLS M25 Measures DC Volts, Ratio and Ohms With Full 5-Digit Resolution...With Twice the Speed of Stepping Switch DVMs...With Advanced Circuitry Proved "Under the Gun" for 3 Years.

M25 meets needs of advanced R & D, missile checkout, etc.

Here is an instrument so versatile, accurate and reliable that it is virtually a complete testing center in itself. With the M25, you can measure DC volts to 5 digits . . . turn a knob and measure DC ratio to 5 digits . . . give the knob another twist and measure resistance to 5 digits . . . plug in a printer for automatic data logging . . . program any or all operations remotely . . . or measure AC or low-level DC by adding plug-in accessories. Here is an instrument that does not limit your measuring capability. *Accuracy:* the M25 provides all the benefits of full 5-digit resolution of 0.001% and an accuracy of ±0.01% of reading ±1 digit over the entire range. A unique input circuit gives exceptionally high impedance when off-null. If AC pickup affects DC voltage or ratio measurements, simply turn the input filter on — locally or remotely. *Reliability:* its transistorized circuitry is an advanced version of circuits in 4-digit M24s selected during the last 3 years by missile manufacturers after competitive life testing. Its mercury-wetted contact relays have a life expectancy of 171 years in continuous use. You'll find no fan in the M25 — it dissipates only 65 watts, half that of its highly-reliable 4-digit cousin. *Speed:* it's twice as fast as the fastest stepping switch DVM and compatible with data recorders. *Servicing:* uncrowded packaging and 99% plug-in construction reduce servicing, when required, to board replacement. Its many-sided, long-term usefulness makes the M25 a true value at $5,985 — less than some single-purpose meters. Contact NLS for a demonstration, complete data, or engineering aid for special applications.

BRIEF SPECS: *DC volts: ±0.0001 to 999.99 . . . DC ratio: ±.00001 to 99.999 . . . resistance: .1Ω to 999.99 KΩ . . . input impedance: 10 megs on volts, 1000 megs on low ratio . . . measuring speed: 1.1 sec. . . . price: $5,985 F.O.B. destination in U.S.A.*

The blue tag indicates this is an "off-the-shelf" instrument. See a demo today or take delivery on your own within 30 days.



The M25 features 99% plug-in construction.

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR, CALIFORNIA

Visit our "Cost-Savings Center" at the New York IRE Show, March 26-29. Booths 2615-17

Pocket 70% savings on MYCALEX® Commutator Plates

In line with Mycalex policy, here's the latest cost-saving we're passing on to customers: up to 70% on virtually every commutator in the line. It's all made possible by the MYCALEX METHOD, the molding and finishing process we recently perfected. Thanks to it, plates and dielectric parts of many types and shapes perform at their best, yet average only a fraction of their former cost. Each part offers the performance advantages Mycalex materials are noted for. In fact, price is the only thing that has changed!

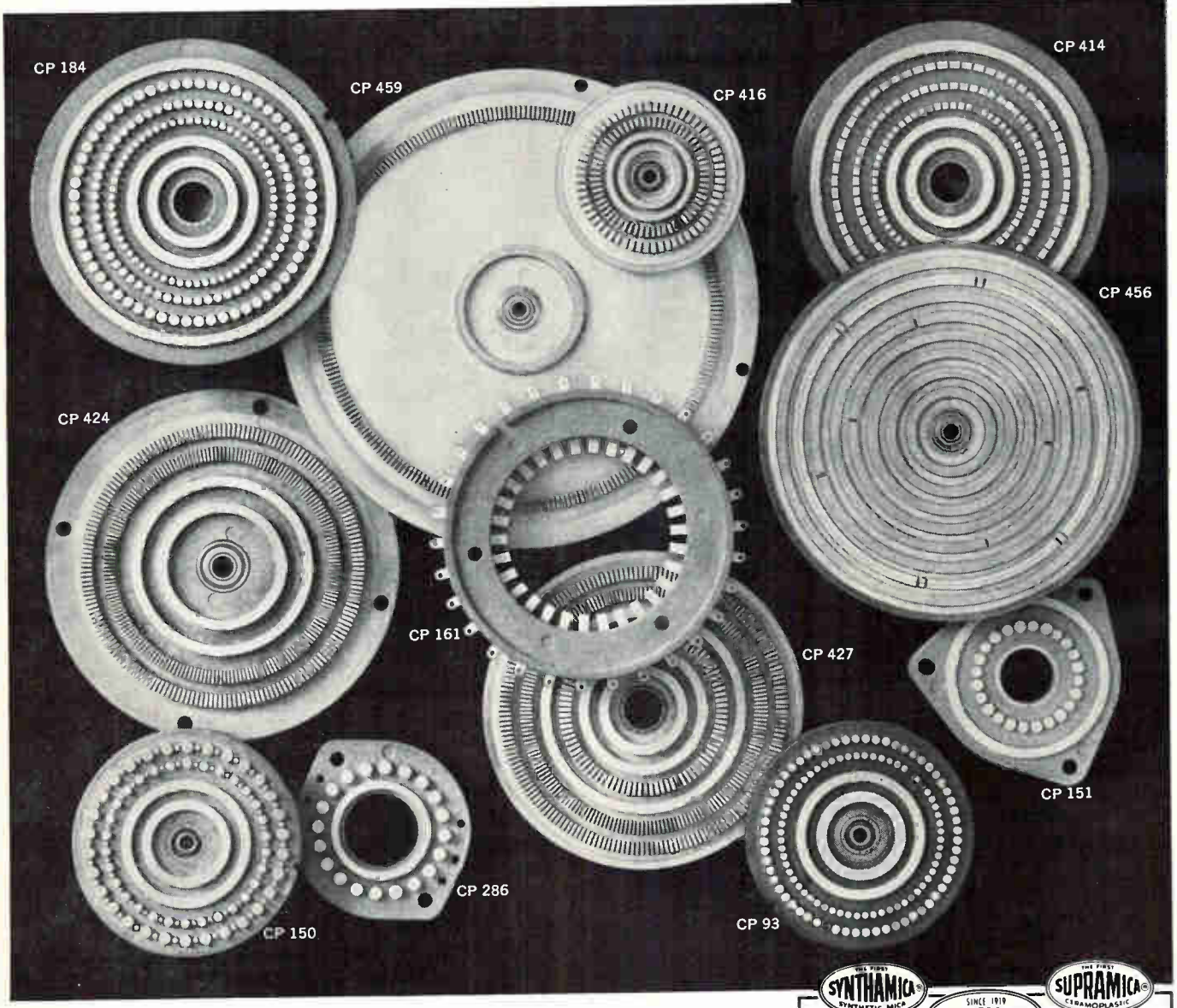
Check the 12 popular plate-types of SUPRAMICA® 555 ceramoplastic shown here. All 21 types in the line deliver thermal endurance up to 650°F., over-1000-megohm insulation resistance and capacitance of only 2-3 micromicrofarads between channels. As many as 450 rectangular contacts with some types, as well.

Important: no tooling or set-up charges on standard plates; minimal charges for custom-designing. Write today for technical information and further details.

Check the savings these typical Mycalex plates offer you!*

TYPE	WAS	NOW
CP 93	$218.00	$ 66.00
CP 150	218.00	66.00
CP 151	70.00	36.00
CP 184	262.00	81.00
CP 286	70.00	36.00
CP 416	295.00	171.00

*Prices based on orders of 1 or 2. Savings markedly higher with larger orders.



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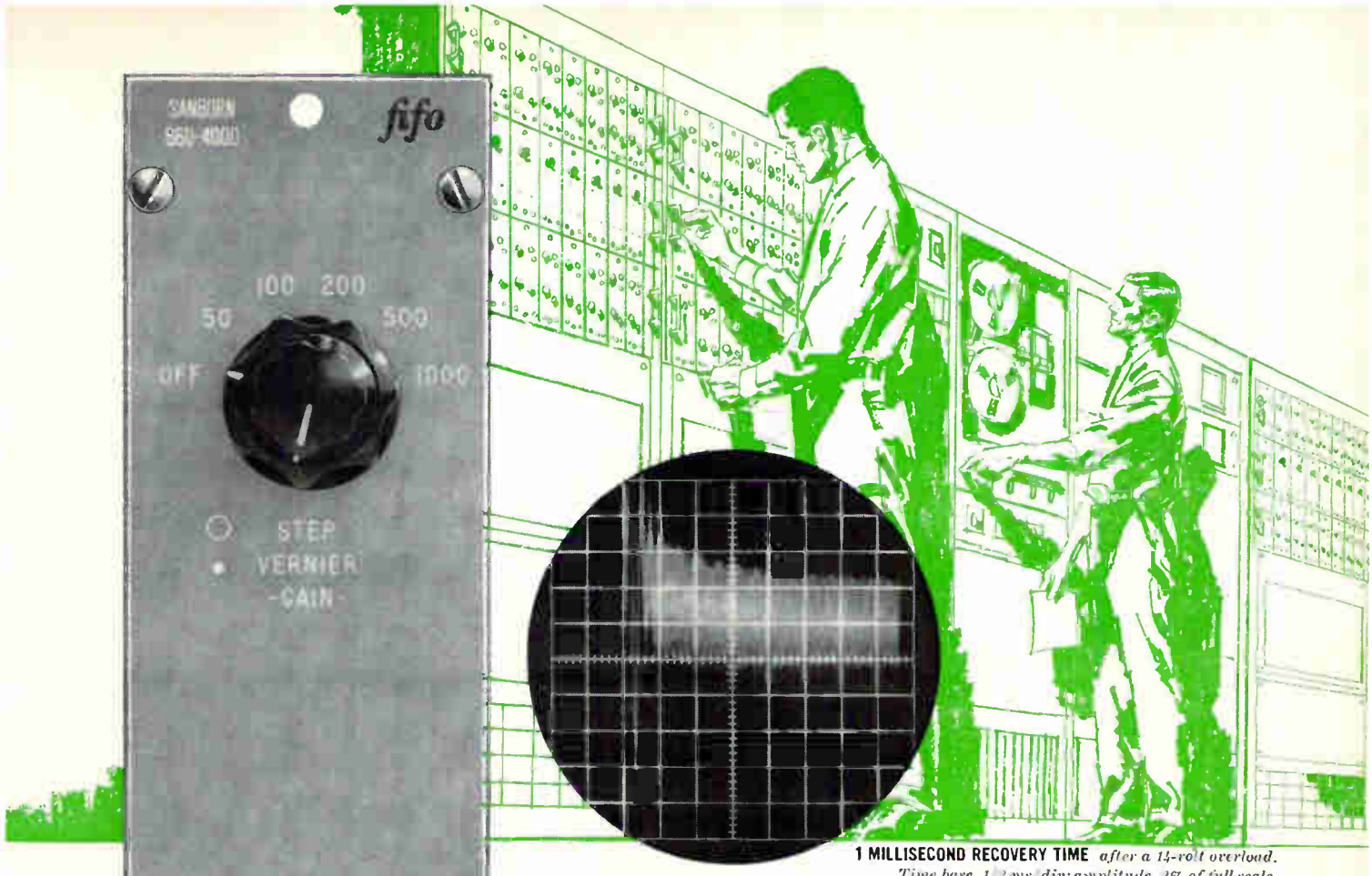

Sanborn® FIFO—fully transistorized, shown actual size

1 MILLISECOND RECOVERY TIME *after a 14-volt overload. Time base, 1/2 ms/div; amplitude, 2% of full scale. A small AC signal was mixed with the overload to increase visibility of recovery trace.*

NEW 0-10 KC Floating Input-Floating Output DC AMPLIFIER

The new FIFO (floating input—floating output) is a fully transistorized amplifier designed especially for obtaining data from wide bandwidth transducers. A single FIFO used with an input scanner can amplify data from many transducers, or the outputs of any number of FIFO amplifiers may be sampled.

Model 860-4000, with gain of 1000, is particularly useful for extracting low level signals from a high noise level. Model 860-4000P (with grounded output isolated from input) can deliver ±5 volts at ±100 ma and is suitable for driving high frequency galvanometers. Both FIFO models have a high common mode rejection ratio and, as illustrated by the 'scope photo, exceptional overload recovery capability.

The FIFO amplifier is available in a portable case with individual power supply. Two channels with individual power supplies are available on a 3½" x 19" panel for rack mounting, or you can mount eight amplifiers in 7" x 19" with a Sanborn Model 868-500F 8-channel power supply.

Contact the Sanborn Industrial Sales-Engineering representative nearest you or write the main office in Waltham for complete information and engineering assistance.

SPECIFICATIONS: MODEL 860-4000 FIFO AMPLIFIER

Isolated, floating, guarded input — 100 meg. impedance min. at DC

Isolated, floating output — impedance less than 35 ohms

Bandwidth DC to 3 db down at 10 KC

Max. Gain of 1000 — 10 mv in gives ±10 volts out across 1000 ohms (floating). Optional Model 860-4000P with power output isolated from input can deliver ±5 volts at ±100 ma at ground potential

Linearity ±0.1% of 10-volt floating output at DC

High Common Mode Rejection — 160 db at DC, 120 db at 60 cps, 100 db at 400 cps, with 1000 ohms unbalance at source

Drift 2 uv, Noise 7 uv RMS

Specifications subject to change without notice.

For DC to 100 cps bandwidth

DATA PREAMPLIFIER 860-1500S

Has floating, guarded input and floating output; delivers ±5 volts across 2000 ohms; linearity ±0.05% of full scale (5 volts); bandwidth DC to 3 db down at 100 cps; rejection ratio 10^6:1 with 5000-ohm source unbalance at 60 cycles. Either fixed gain between 10 and 2000, or with attenuator to provide any selected gain within this range. Amplifier has less than 2 uv drift and less than 3 uv peak-to-peak noise.

INDUSTRIAL DIVISION
SANBORN COMPANY
175 Wyman Street, Waltham 54, Massachusetts
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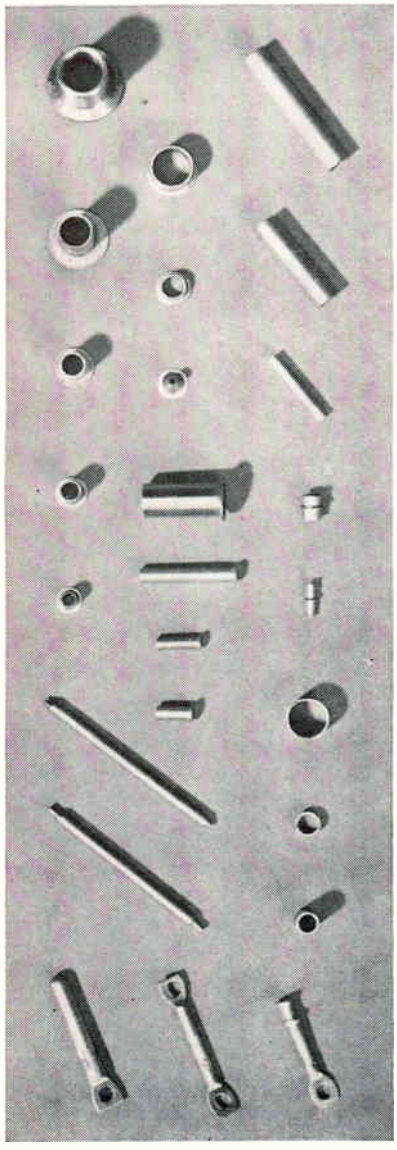
CIRCLE 97 ON READER SERVICE CARD

MICRO-MINIATURE PRECISION COMPONENTS



Some of these parts are so minute, 15,000 of them can fit into a bottle cap. Yet each is precision-made to meet the most exacting tolerances of semiconductor and electronic manufacturers.

30 YEARS OF EXPERIENCE

These component parts are made by SunAir Dynamics, whose experience extends to 30 years in metalworking for the electronics industry.

Now, our newly expanded facilities greatly accelerate manufacture. Precision micro-miniature components can be supplied in high volume to meet tight production schedules.

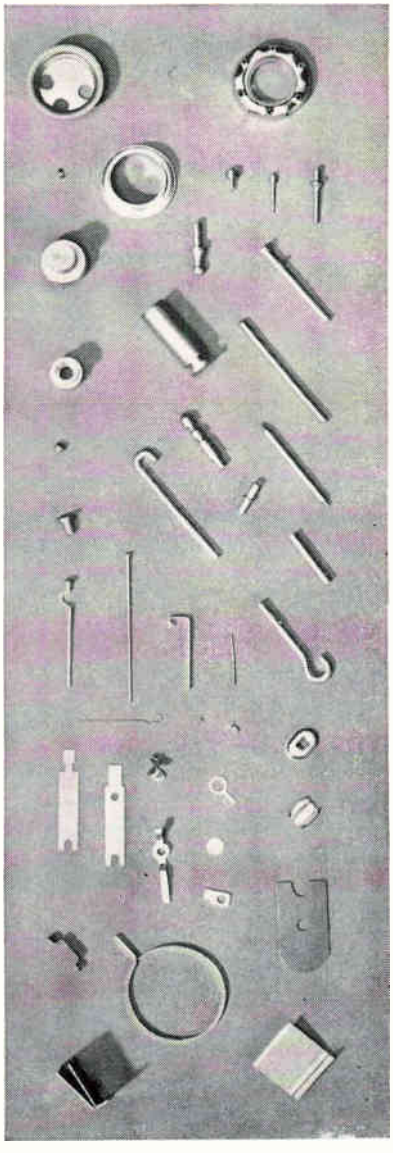
Base tabs, clips, tubes, leads, spring leads, caps, eyelets and headed and tabulated wire forms are available in millions. Skilled SunAir technicians solve your most demanding component requirements. A perpetual inventory of many alloys and precious metals, in ribbon and wire, expedites rapid processing of your needs. A trial order will prove our Quality—Efficiency—Economy.

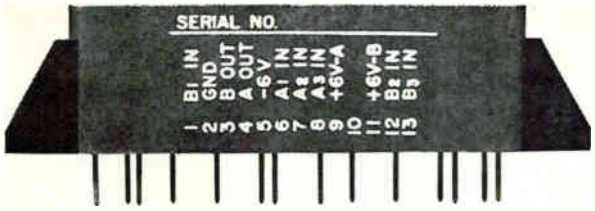
SUNAIR DYNAMICS

CORPORATION

4415 EAST 10th LANE
HIALEAH, FLORIDA

Subsidiary of
SUNAIR ELECTRONICS, INC.





In less time than it takes light to cross this room, a new product, **DELCO'S NEW** high speed **10 MC** silicon modules, could: (1) correct the course of a missile in flight; (2) make it possible for sonar pickups to track and compute the position of targets with microsecond accuracy; and (3) handle any number of other airborne guidance and control functions that previous modules—due to low speed or environmental or performance limitations—could not handle. Delco Radio's 10mc modules, with a maximum gate-switch speed of 40 nanoseconds, convert data 100 times faster—even under the most extreme environmental conditions.

These **SILICON** modules come epoxy encapsulated, and operate over a temperature range of −55°C to +100°C. And these same reliable **DIGITAL** circuits are available packaged on plug-in circuit cards. These Delco **MODULES** are environmentally proved to: **SHOCK,** 1,000G's in all planes. **VIBRATION,** 15G's at 10 to 2,000 cps. **HUMIDITY,** 95% at max. temp. **STORAGE AND STERILIZATION TEMP.** −65°C to +125°C. **ACCELERATION,** 20G's. Designed for systems using from one module to 100,000, and the module's rated performance considers the problems of interconnection. Data sheets are available. Just write or call our Military Sales Department.

Physicists and electronics engineers: Join Delco Radio's search for new and better products through Solid State Physics.

PIONEERING ELECTRONIC PRODUCTS THROUGH SOLID STATE PHYSICS

Division of General Motors • Kokomo, Indiana

DELCO RADIO
DEPENDABILITY
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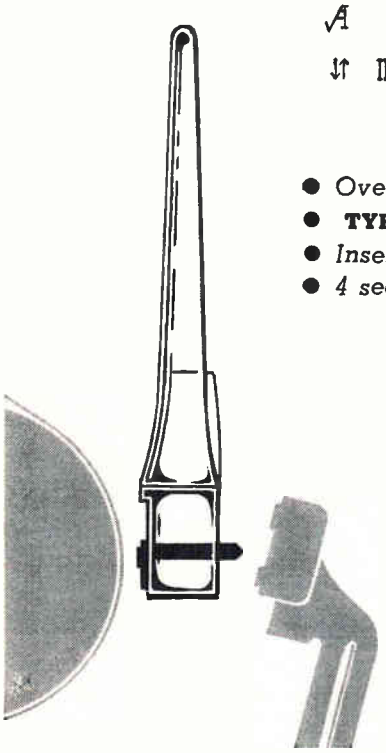

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- **TYPIT** *fits any standard typewriter*
- *Insert symbols as you type*
- *4 seconds per symbol*

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TYPIT *a product of . . .*
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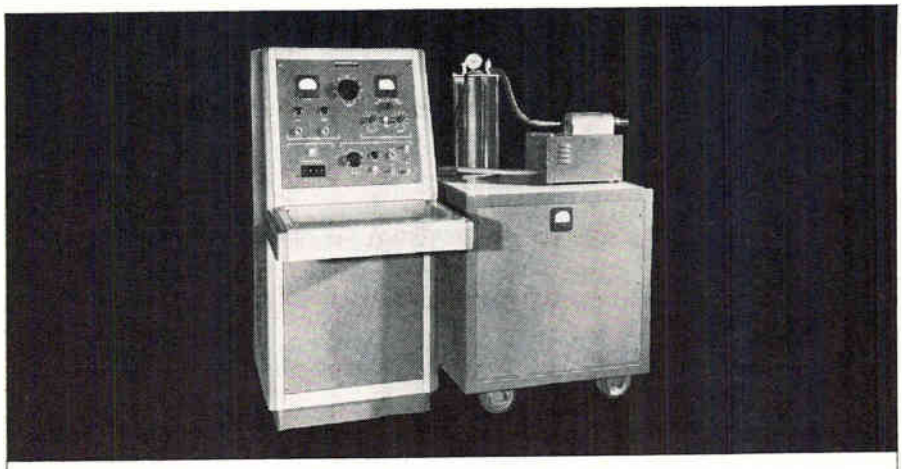

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Newest addition to a line of laser systems manufactured by Trion Instruments, Inc., the LS-4 is 220-volt operated and has the highest energy output of any commercially available system. Its flexible design makes it ideal for research into high-power density effects and radiation studies. Trion Instruments, Inc. also manufactures laser components and accessories.

Write today for details of the LS-4 and the popular LS-2 . . . systems that perform beyond their specifications!

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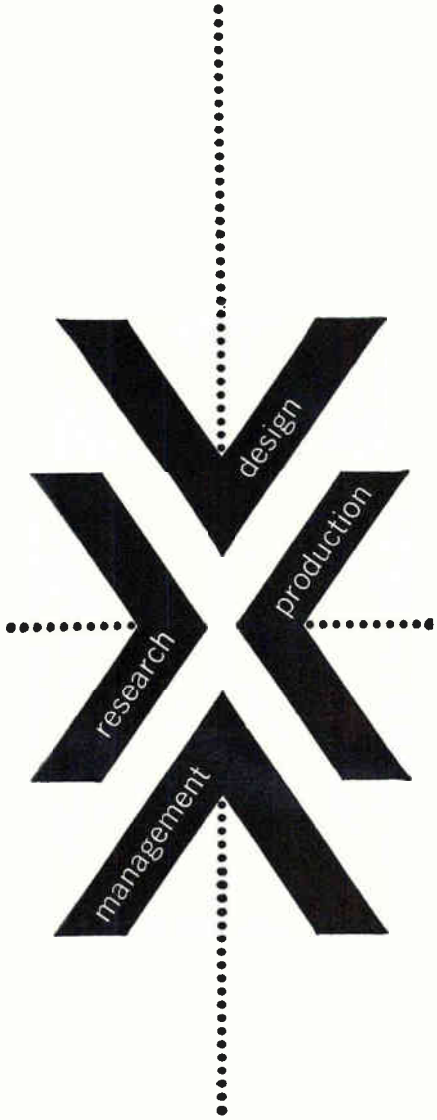
1200 N. Main Street In Ann Arbor, Michigan "Research Center of the Midwest"



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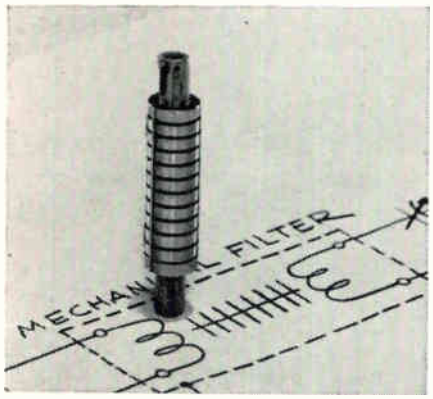
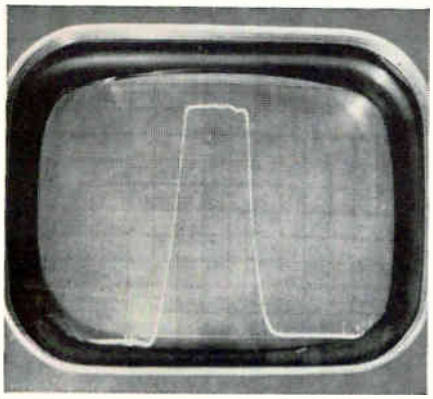
COLLINS FILTERS ... for selectivity from 10kc to 65mc

1 **When your circuit demands steep-skirted selectivity in the 60-600kc range, specify Collins Mechanical Filters**



Only Collins mechanical filters provide steep-skirted selectivity approaching the theoretically-perfect. This selectivity comes from a series of resonating dime-size nickel-alloy discs with Qs of 8,000 to 12,000 . . . up to 150 times more than conventional filter elements. Collins mechanical filters are packaged in cases as small as ⅓ cubic inch. They're electrically and mechanically stable and don't age, break down, or drift as a result of extreme temperature or long, continuous service. Frequency shift, for example, can be held between 1.5 and 2 ppm/°C over a −25°C to +85°C range.

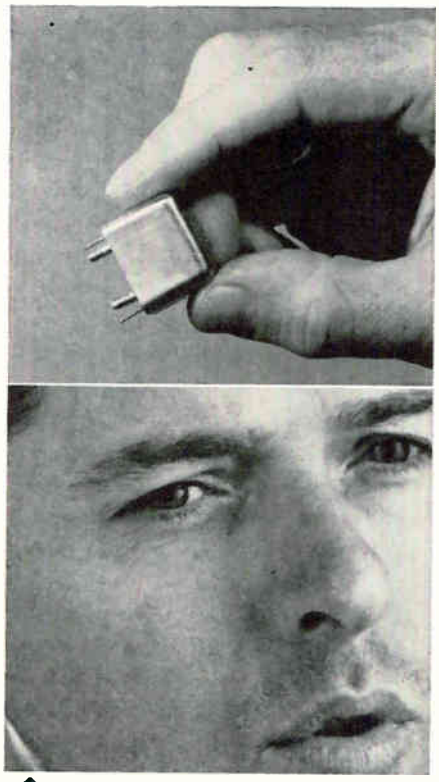


You can select center frequencies from 60 to 600 kc with a wide choice of bandwidths and case styles. All filters display shape factors (ratio of 60db bandwidth to 6db bandwidth) of 2 to 1 or less and have minimum ripple and low transmission loss. And filters with new ferrite transducers show flatter passband response, even lower transmission loss and greater physical strength for missile and other demanding application.

More than 100 standard types of mechanical filters are already catalogued, and the *only* mechanical filter design group in the country is ready to help you with special filtering requirements.

2 **Widest frequency range . . . 10kc to 50mc . . . and smallest size . . . down to less than 1 cubic inch . . . Collins Crystal Filters**

You're closer to finding the right crystal filter for your circuit when you contact Collins because the 10kc to 50mc range will take care of almost any imaginable application. Choosing Collins for crystal filters will also help with your high-density packaging problems. For example, there's a series of filters from 4-20mc in cases well under 1 cubic inch, a 2 to 1 size reduction from what you'd normally expect.



Engineering help at the circuit design stage and rapid development of special prototype filters are other reasons why so many project and design engineers are checking with Collins for crystal filter requirements. In addition, Collins offers the consultation of its design engineers, if required, as well as special application data sheets to help you detail specifications so that we can submit a design and price proposal. If your circuit requirements can be met by one of the many crystal filters whose designs have already been standardized, you can expect deliveries from stock — 90-day deliveries on production quantities.

Besides meeting your specs for center frequency, bandwidth, impedance and size, Collins makes certain your filters will perform under severe operating conditions. As an illustration, Collins filters in the 1-30mc range show a frequency shift of less than .005% from −55°C to +90°C. Below 1 mc, filters have a frequency shift of less than .01% from −40°C to +80°C.

3 **With Collins LC filters, the catalog is only part of the story . . . it's capability and speed that count most.**

You may find exactly what your circuit needs among the hundreds of proven LC filter designs for low pass, high pass, band pass, telegraph tone, aircraft navigation and other applications already on file. But if you don't, we have the capability to design, produce and deliver what you do need.

Through the sub-audio to 65 mc range, we consistently push the state-of-the-art for our customers by delivering filters which meet conditions previously considered impractical or impossible. In temperature stability, in resistance to humidity, in size, in method of packaging, we are filling new and special requirements every day.

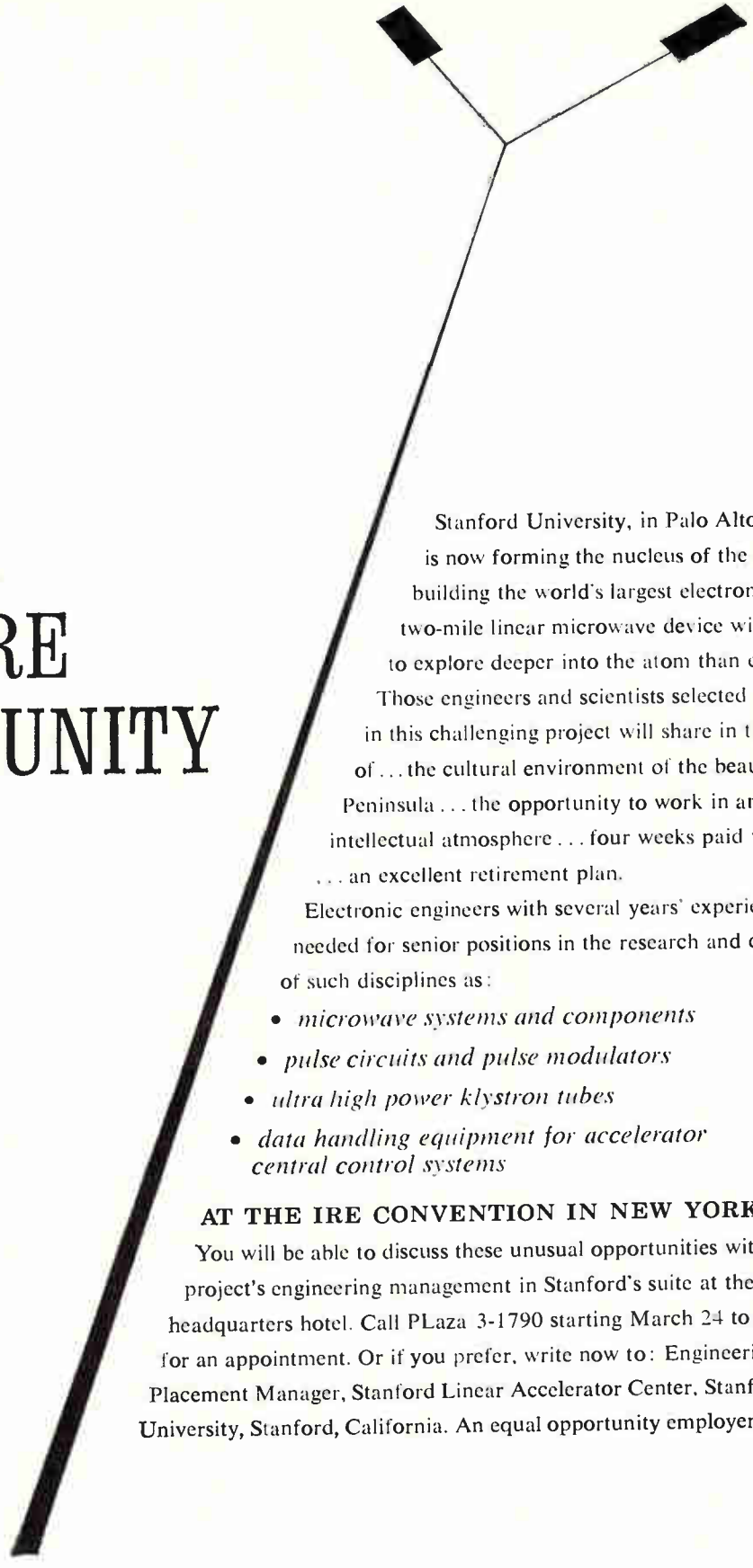
What's more, you get reliability and performance in the same package with the hardware. Your own inspection and test procedures will prove that Collins filters are the result of a quality assurance program that never lets up.

CONTACT

COLLINS

For more information about our capabilities and products, call or write today; ask for Data File 201. Collins Radio Company, Components Division, 19700 San Joaquin Road, Newport Beach, California. Engineering representatives in principal cities.

VISIT OUR BOOTH NO. 2122-2124 AT THE NEW YORK IRE SHOW.



A RARE OPPORTUNITY

Stanford University, in Palo Alto, California, is now forming the nucleus of the engineering team building the world's largest electron accelerator. This two-mile linear microwave device will enable physicists to explore deeper into the atom than ever before. Those engineers and scientists selected to participate in this challenging project will share in the pleasures of . . . the cultural environment of the beautiful San Francisco Peninsula . . . the opportunity to work in an exciting intellectual atmosphere . . . four weeks paid vacation . . . an excellent retirement plan.

Electronic engineers with several years' experience are needed for senior positions in the research and development of such disciplines as:

- *microwave systems and components*
- *pulse circuits and pulse modulators*
- *ultra high power klystron tubes*
- *data handling equipment for accelerator central control systems*

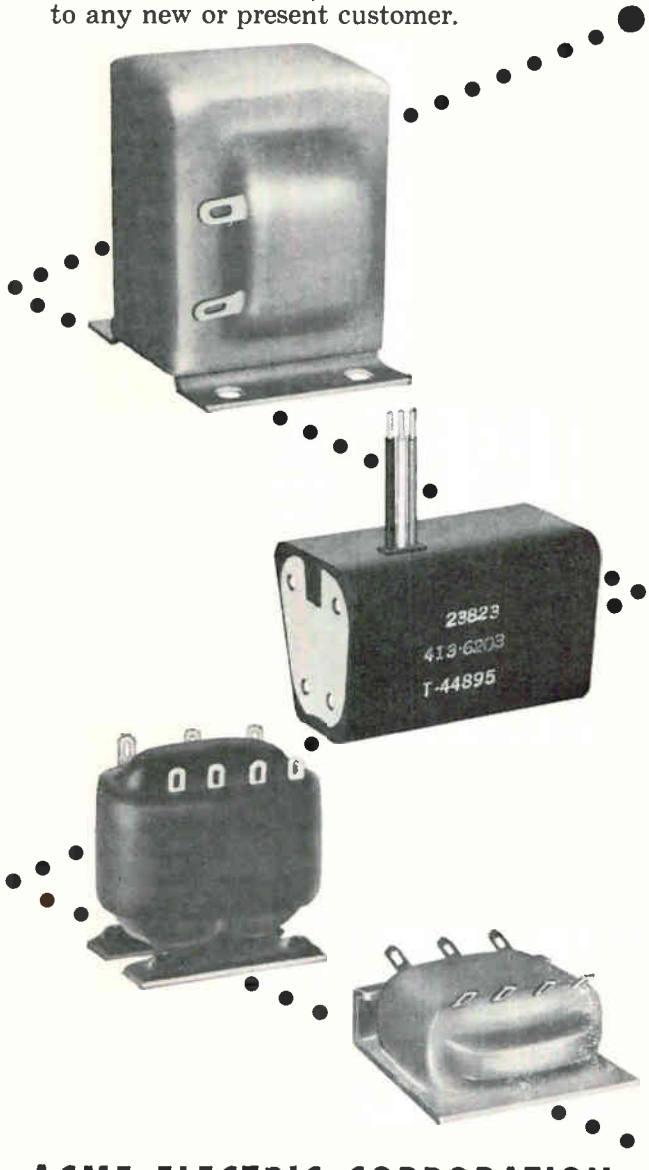
AT THE IRE CONVENTION IN NEW YORK

You will be able to discuss these unusual opportunities with the project's engineering management in Stanford's suite at the headquarters hotel. Call PLaza 3-1790 starting March 24 to arrange for an appointment. Or if you prefer, write now to: Engineering Placement Manager, Stanford Linear Accelerator Center, Stanford University, Stanford, California. An equal opportunity employer.

STANFORD LINEAR ACCELERATOR CENTER

How to Design ENCAPSULATED TRANSFORMERS

For certain applications, encapsulated transformers have distinct advantages over conventional designs. Physical design need not be limited to enclosing cases, thus engineering innovations can often be incorporated to improve performance, weight and size. Knowing how to take advantage of these factors, plus many years of experience in creating and producing hundreds of encapsulated transformers, is the service we offer to any new or present customer.



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Internal Oscillator: Provides 5 freq. Variable over a range of ± 10% from each fixed frequency 50, 60, 400, 1KC, 10KC

Short Term Stability: .01%

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Absolute Calibrated Decade Controls

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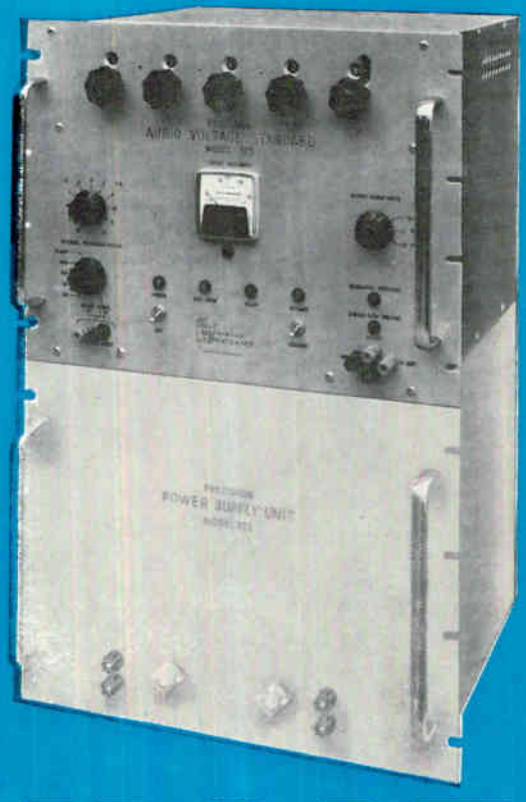


HOLT

INSTRUMENT LABORATORIES • OCONTO, WISCONSIN

CIRCLE 103 ON READER SERVICE CARD

Component Design at the IRE

AT THE TECHNICAL SESSION on Semiconductor Devices (see chart) components men will be briefed on techniques developed for fabricating precision-etched transistors having vapor grown base layers.[1] Devices obtained by this technique may be expected to exhibit gain bandwidth products up to 5 kMc cycles and beyond. At the same session, the basic theory of a unijunction transistor which uses a new geometry to achieve an order of magnitude improvement in some of the important electrical parameters will be described.[2] New circuits will be summarized together with performance data. Other papers to be given at the Semiconductor Devices session will be: the frequency of merit for three terminal electron devices[3]; new techniques developed for using microwave transmission and reflection to determine the physical constants of crystals[4]; and a paper on transistors that can effect improvements in ferrite core and thin film memories.[5] The fabrication process relies on the use of SiO or SiO_2 films as a diffusion mask for n-type impurities. These transistors switch a current through a 20-ohm resistive load in less than 10 nsec.

At the session on Digital Computer Components, six papers will be given, including one paper on the design of magnetic heads for high information storage in noncontact recording.[6] Other talks will be given on microwave computing techniques, logic building blocks for the NCR-315 Data processing system, generalized magnetic pulse recording, and a novel multiple coupling array.

Antenna Arrays

The sessions on Antennas (8 and 23) will cover ten papers on advanced antenna design: pattern characteristics of an antenna focused in the Fresnel region; polarization tracking of antennas; log periodic circuit analysis; scanning characteristics of two-reflector antenna systems; annular slot monopulse antennas; the design and development of a new communications system for long distance communications in the hf band (ISCAN); superdirective antenna arrays for improved vlf reception; the coupling and mutual impedance between conical logarithmic spiral antennas in simple arrays; on random removal of radiators from large linear arrays; and a spacing weighted antenna array.

Electronic Frontiers

The panel on Broadening Device Horizons (session 9) will talk on significant new developments in the field of electron devices which will soon increase the scope of electronics. Frontier areas discussed this year include generators, modulators and detectors of coherent optical radiation; semiconductor devices in the microwave region; and integrated electron devices.[7, 8, 9]

Microwave devices (session 17) include a wideband microwave deflection amplifier tube which bridges the gap between conventional low-frequency amplifier tubes and broad-band microwave traveling wave tubes[10]; a device for extending klystron-interaction power generation capacity by a factor of ten or more[11]; a BWO for local oscillator service at X-band, competitive in size and weight with a reflex klystron oscillator[12]; the use of thermoelectric elements as microwave power detectors[13]; and a broadband uhf parametric amplifier having 17.5 db flat gain, and noise figure under 1.7 db from 406 Mc to 450 Mc.[14]

Microwave components (session 25) will feature talks on a miniature superconducting delay line consisting of a $\frac{1}{2}$-μsec coaxial line with a 0.010-in. diam niobium center conductor, solid Teflon dielectric, and a 0.036-in. ID lead-tin alloy outer conductor; a wide band microwave compressive receiver; a compact uhf high power ferrite isolator; analysis of resonant cavities in parametric amplifiers and frequency multipliers; and a multiple harmonic local oscillator source.

Electron devices (session 28) cover talks on synthetic ruby for maser applications; microwave modulation of light; a working practical solid-state three-dimen-

SOME IRE SESSIONS OF INTEREST TO DEVICE DESIGNERS

Subject	IRE Session	Date	Where Held
Semiconductor Devices	1	Mar 26, pm	a
Digital Computer Components	4	Mar 26, pm	b
Antennas (I)	8	Mar 26, pm	c
Broadening Device Horizons	9	Mar 27, am	a
Microwave Devices	17	Mar 27, pm	a
Antennas (II)	23	Mar 27, pm	c
Microwave Components	25	Mar 28, am	a
Electron Devices	28	Mar 28, am	b
Space Age Components	42	Mar 29, am	d
Lumped and Distributed Microcircuit Components	50	Mar 29, pm	d

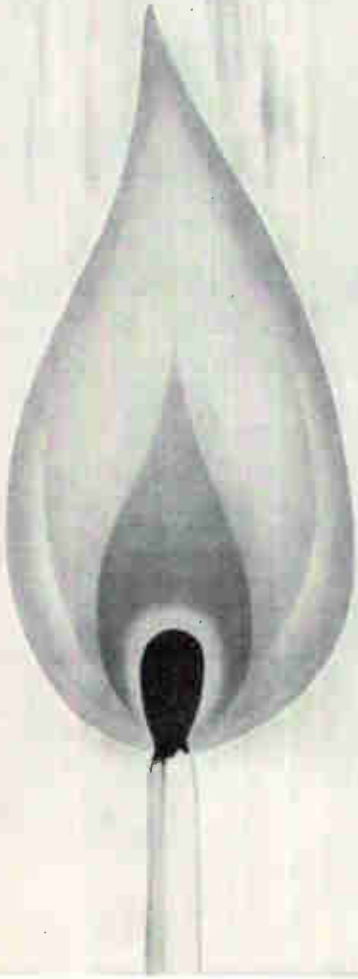
a—Waldorf Astoria, Starlight Roof; b—Waldorf Astoria, Sert Room; c—N. Y. Coliseum, Morse Hall; d—Waldorf Astoria, Jade Room

am sessions begin at 10 am; pm sessions begin at 2:30 pm

EVEN AT HIGH TEMPERATURES, MYLAR® HELPS MOTORS RUN TROUBLE-FREE LONGER!

Mylar* polyester film resists the three main causes of motor failure—heat, humidity and physical stress. Temperatures in the Class B range have relatively little effect on the electrical characteristics of "Mylar". It's also 35 times more moisture-repellent than rag paper . . . 8 times stronger . . . and can't dry out because it contains no plasticizer. "Mylar" also helps reduce size and weight of motors, and gives them an extra safety margin from shock because it repels moisture so well.

Capacitors benefit from "Mylar", too. Last longer, are more reliable . . . at no greater cost than paper units for similar service. In a wide variety of applications, "Mylar" can improve performance, lower costs. Here are some more reasons: • dielectric strength of 4,000 v/mil.** • thermal stability from –60°C. to over 150°C. • resistance to chemicals, aging, abrasion and tearing. Best of all, you can use less, often pay less . . . because you get all these advantages in thinner gauges. Evaluate "Mylar" for your product. Write for free booklet (SC) detailing properties and applications. Du Pont Co., Film Dept., Wilmington 98, Delaware.



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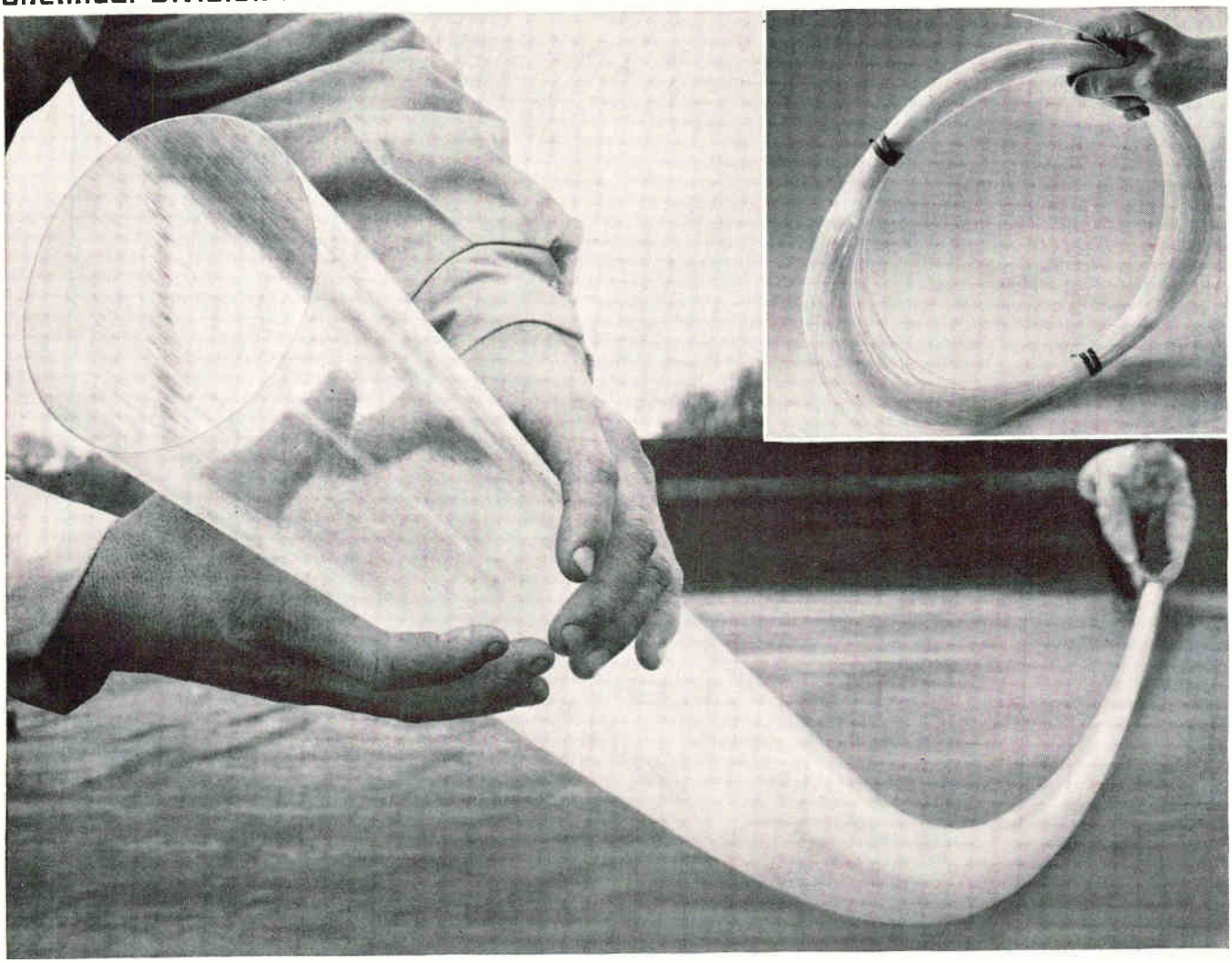
Chemical Division 3M COMPANY



EXTRA-LENGTH EXTRUSIONS (and 6 other reasons) rate KEL-F® 81 high for pipe lining, "spaghetti" tubing!

BRAND PLASTIC

Now—continuous, uniform extrusion of KEL-F 81 Brand Plastic provides practically unlimited lengths of corrosion-conquering pipe linings with diameters as big as 8″, as well as dielectrically strong wire jacketing in diameter sizes as small as 1/16″.

New KEL-F 81 Plastic, with its highly uniform, heavy molecular structure, is melt-processable, extrudes flawlessly without scoring. Lengths are limited only by shipping and handling equipment capacity. With pipe linings, for example, extra length minimizes flange joints, cuts installation and maintenance costs. In addition, linings of KEL-F 81 Plastic extruded by one fabricator, Carmer Industries, Inc., can be formed on the ends to provide their own flange gaskets (see column at right). Lining walls can be made as thin as .007″, as exact as ±.5 mil.

6 MORE KEL-F 81 PLASTIC TALENTS! 1) *Non-porosity:* why KEL-F 81 Plastic won specification as the lining for a 4″ pipe in the Titan I missile, in preference to a competitive plastic material! 2) *Chemical inertness:* KEL-F 81 Plastic resists most corrosive media, withstands organic solvents, strong caustics, concentrated acids, oils and greases, even missile fuels! 3) *Zero moisture absorption:* even with constant contact with corrosive fluids! 4) *800-degree range:* has useful temperature range from −400 to +400°F! 5) *Mechanical toughness:* combines high tensile, flexural and compressive strengths, outstanding abrasion resistance! 6) *High dielectric strength:* excellent arc resistance, at both high and low frequencies! Look to the column at right for additional information on extruded KEL-F 81 Plastic and for the list of authorized processors.

"KEL-F" IS A REG. TM OF 3M CO.

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KEL-F 81 Plastic
BRAND

...in typical applications

SELF-GASKETING LINERS! *Unique end-forming process, developed exclusively by Carmer Industries, Inc.*, not only reduces chance of leakage, it eliminates the need for any additional gasketing at flanged pipe connections!

RODS AND TUBING, as small as 1/16" in diameter, are useful in a variety of chemical processing and aerospace applications. And because KEL-F Plastic affords high dielectric strength and arc resistance, it is widely used for wire jacketing, protective sleeving, other electrical and electronic uses.

FOR MORE DATA about KEL-F 81 Plastic for applications requiring long extrusions, contact the 3M Chemical Division Branch Office in Chicago, Cleveland, Los Angeles or Ridgefield, N. J.

AUTHORIZED PROCESSORS FOR KEL-F 81 PLASTIC

Adam Spence Corp.,
963 Frelinghuysen, Newark, N. J.
Allied Nucleonics Corp.,
2421 Blanding Ave., Alameda, Calif.
Auburn Plastics, Inc.,
511-5th Ave., New York.
Bonny Manufacturing Corp.,
146 Main St., Maynard, Mass.
Booker & Wallestad, Div. of Thermotech Industries, Inc.,
3336 Gorham Ave., Minneapolis 26.
Carmer Industries Inc.,
122 N. 26th St., Kenilworth, N. J.
The Fluorocarbon Company,
1754 Clementine, Anaheim, Calif.
Fluorulon Laboratories, Inc.,
Box 305, Caldwell, N. J.
Garlock, Inc., Plastic Div.,
U. S. Gasket Co., Inc., 608 N. 10th St., Camden 1, N. J.
G-W Plastic Engineers, Inc.,
Bethel, Vt.
Gries Reproducer Corp.,
125 Beechwood Ave., New Rochelle, N. Y.
Modern Industrial Plastics, Div. of Duriron Company, Inc.,
3337 N. Dixie Dr., Dayton 14, O.
Moxness Products, Inc.,
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Penn-Plastics Corp.,
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1400 Orangethorpe, Fullerton, Calif.
L. W. Reinhold Plastics, Inc.,
8763 Crocker St., Los Angeles.
Saunders Engineering Corporation,
3012 Spring St., Redwood City, Calif.
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11617 W. Jefferson Blvd., Culver City, Calif.
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For *general technical information* about KEL-F Plastic, write Chemical Division, Dept. KAX-32, 3M Company, St. Paul 1, Minn.

3M COMPANY

CIRCLE 107 ON READER SERVICE CARD

sional display which eliminates the major disadvantages of other 3-D displays; an image tube (Ebicon) that features low power consumption and can be operated in a compact, light-weight vidicon type camera; and a paper on new developments in ultra fast warm-up planar tubes.

Space age components discussed in session 42 are: a brushless potentiometer that uses Hall effect crystals[15]; a brushless d-c motor with solid-state commutation[16]; a method of specifying precision potentiometers in terms of system requirements[17]; and two papers that evaluate resistors with respect to nuclear radiation and space environments.[18, 19]

Lumped and distributed microcircuit components (session 50) presented cover film-type distributed-parameter circuits; a theoretical comparison of doubly loaded distributed bridge T and Lumped twin T RC notch filters; properties of porcelain enamels and ceramic coatings; properties of thin film and silicon solid-state components and their effect on microcircuit performance; and the use of titanium and titanium oxides in thin film integrated components.

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(15) T. W. Parsons and D. R. Simon, Solid-State Linear and Sinusoidal Synchros, Precision Components Div., Kearfott Div., G.P.L., Clifton, N. J.
(16) G. H. G. Bauerlein, A Brushless D-c Motor, Precision Components Div., Kearfott Div., G. P. L., Clifton, N. J.
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(19) L. Wurzel and S. O. Dorst, The Effect of Radiation Environment on Film Resistors, Resistor Div., Sprague Electric Co., Nashua, N. H.

Windowless Multiplier Tube Designed for Space Systems

GLASS ENVELOPE is not required on a new multiplier phototube developed by IT&T's Industrial Laboratories Div., Fort Wayne, Ind. Because the device will be used in outer space, there is no need for the usual glass envelope, and its elimination permits a wider range of sensitivity. The vacuum under which the tube will operate is higher than usually obtained.

Beryllium-Copper Cathode

Key to the development was the use of a cathode material that would not be poisoned by exposure to the atmosphere prior to use. The material used is beryllium copper, an alloy that will withstand exposure to the atmosphere for a reasonable time without becoming oxidized.

The FW-141 is a sixteen stage windowless electron multiplier designed to withstand repeated exposure to the atmosphere without serious loss of gain. Because there is some loss, however, IT&T ships the units in a vacuum enclosure. Thus, their exposure to the atmosphere is held to a minimum. A vacuum sealed voltage divider network for supplying the necessary intermediate operating potentials is incorporated in the unit.

Current gain of the FW-141 is 100,000 for the last 15 stages. Current gain of stage 1 depends upon the energy and type of input radiation. Sensitivity of this unit is not as high as that of conventional multiplier phototubes. Maximum applied voltage is 3,500 and is set by ion feedback and is dependent on pressure. IT&T recommends the overall operating potential be adjustable over the range of 1,700-2,300 volts to achieve the specified current gain.

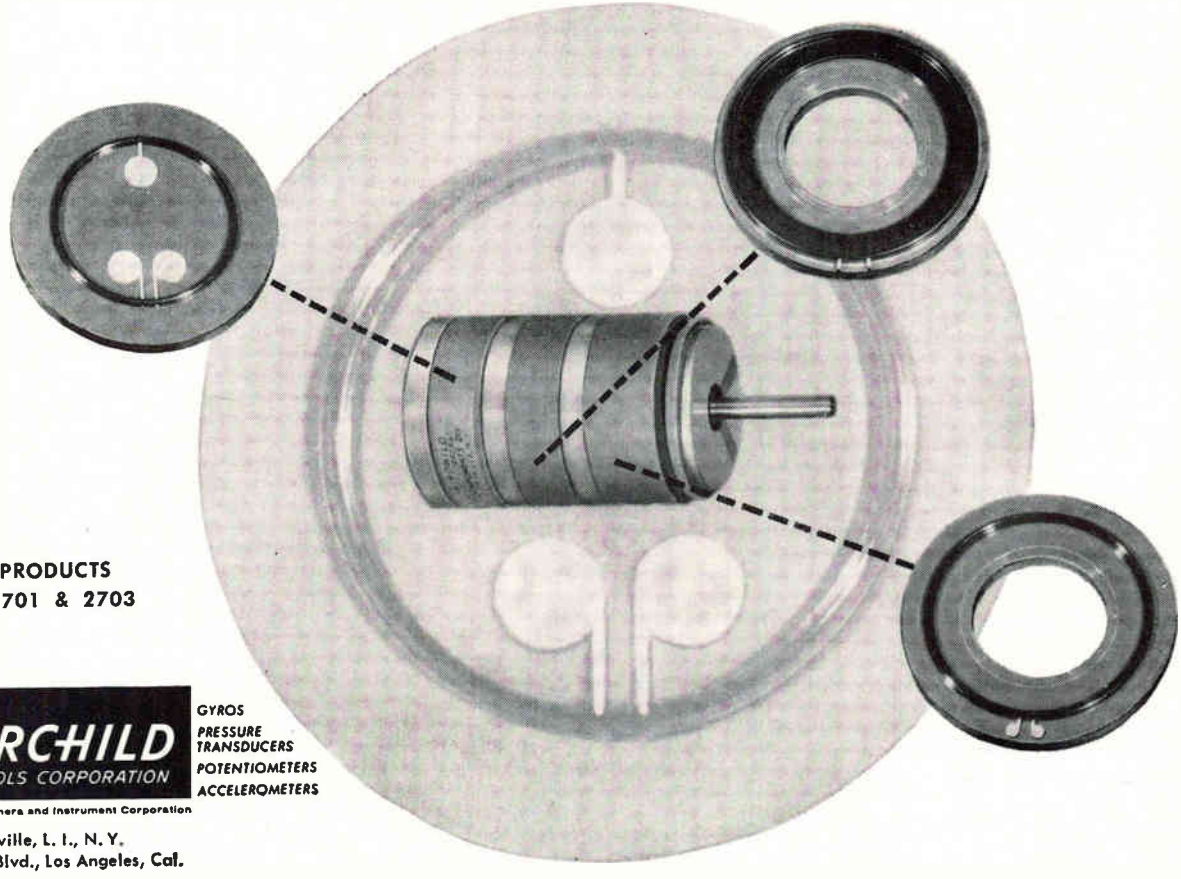
ANOTHER FINE PRODUCT OF FAIRCHILD RESEARCH

FAIRCHILD CONDUCTIVE PLASTIC POTENTIOMETERS

Fairchild, the leader in precision potentiometers, takes another giant stride in technological progress with infinite-resolution, conductive plastic potentiometers having Fairchild reliability "built-in" ■ Fairchild potentiometers utilize a continuous track of specially prepared, conductive, high impact plastic co-molded with an insulating base of the same heat-resistant material to provide superior performance under temperature and humidity extremes ■ Temperature cycling tests of this advanced Fairchild design shows that resistance values are consistently reproduced ■ Resistance stability is maintained by Fairchild's unexcelled production skills which assure sufficient conductor bulk to virtually eliminate effects of wear ■ Low end-loss positive connections are achieved through co-molding of silver terminations with the conductive track. In addition, track geometry can be varied to obtain optimum functional conformity ■ Reliable operating life of many millions of cycles is assured through the resistance stability of Fairchild's conductive plastic potentiometers. For more information, write Dept. 53E.

FEATURES: INFINITE RESOLUTION/UNSURPASSED RELIABILITY/RESISTANCE STABILITY/CONSTANT RESISTANCE VALUES/LOW END-LOSS/LONG LIFE/COMPLETE RANGE OF SIZES

ELECTRICAL		ENVIRONMENTAL	
Resistance Range, ohms	2K — 50K ± 10%	Temperature Range	—65°C to + 150°C
Ind. Linearity	0.5% standard	Humidity	95% to 100% RH at 71°C
Resolution	Virtually infinite (less than .005°)	Vibration	10 G's to 2000 cps
Temperature Coefficient	Negative 3-400 ppm	Life	Over 10 million cycles at 600 rpm
Power Rating	2 watts at 20°C		



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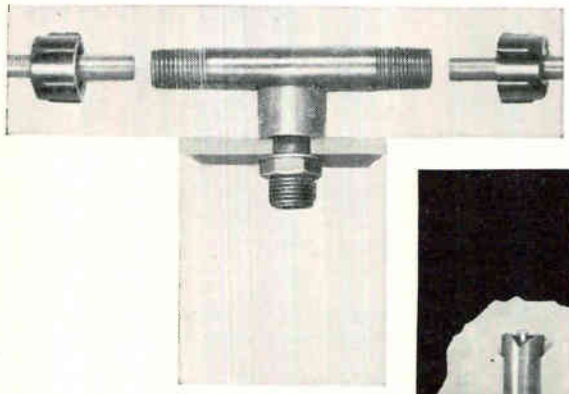

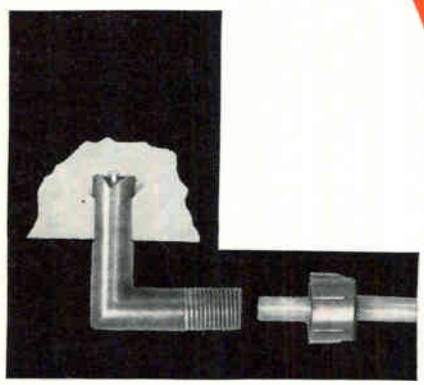

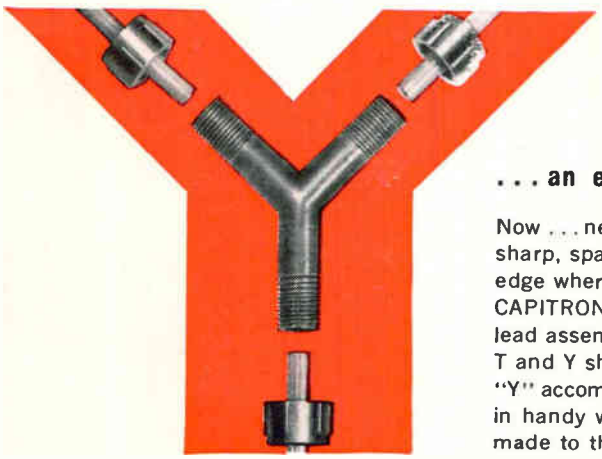

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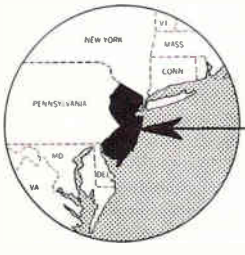

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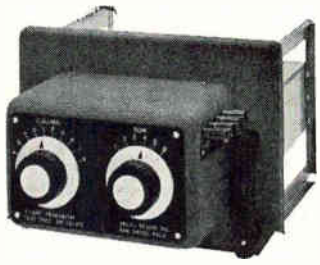

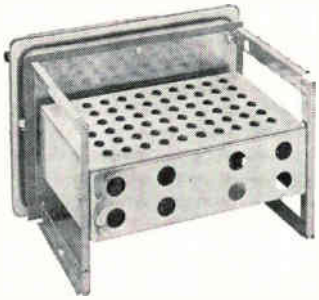

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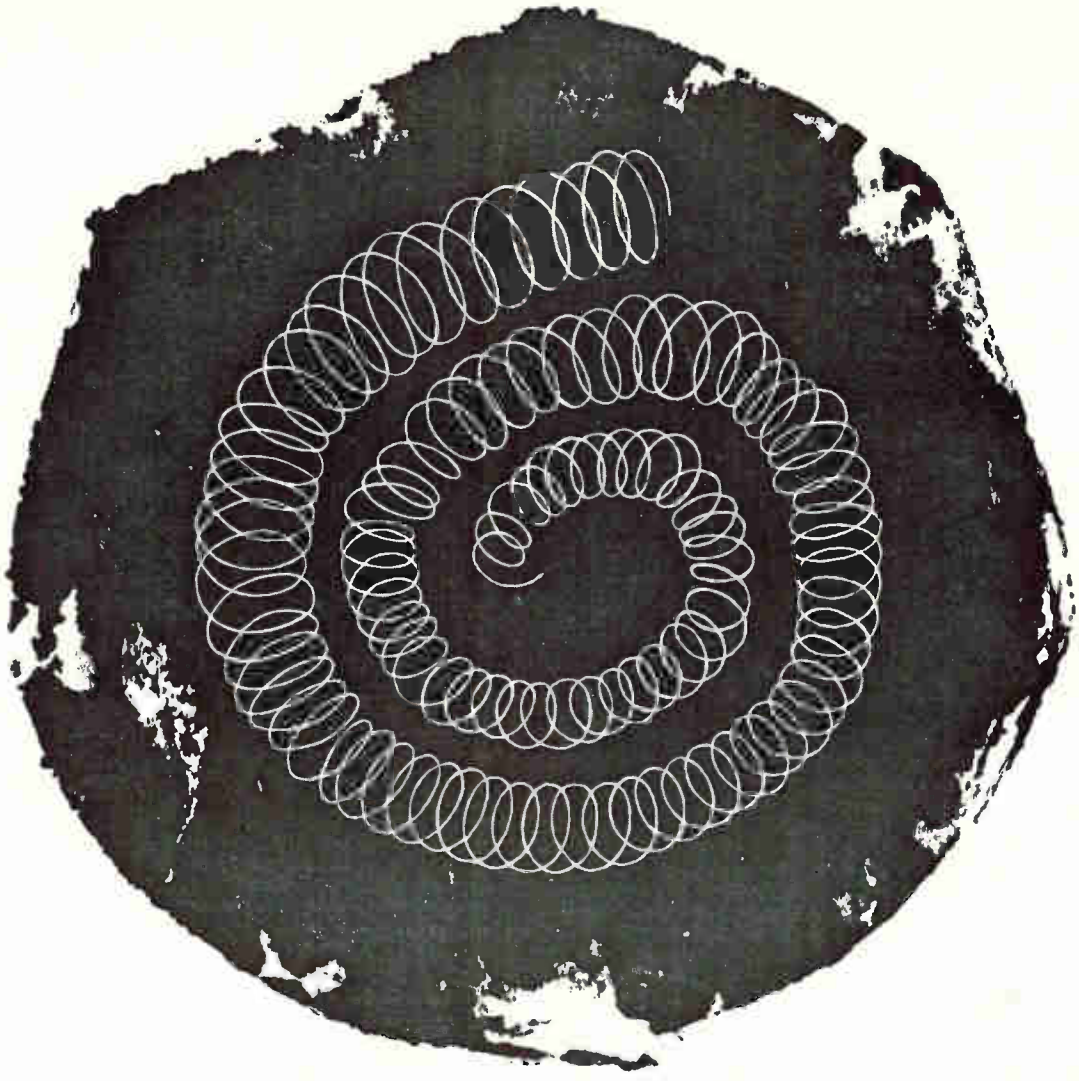

Said Svante Arrhenius: *"The change of the logarithm of a chemical reaction rate constant with respect to temperature, is inversely proportional to the square of the absolute temperature."*

The aerospace industry is searching constantly for strong, light-weight, heat-resistant materials. Finely-spun glass fiber, bonded with a plastic binder, is beginning to exhibit superior properties. Until recently the glass fiber has been far more heat-resistant than any binder.

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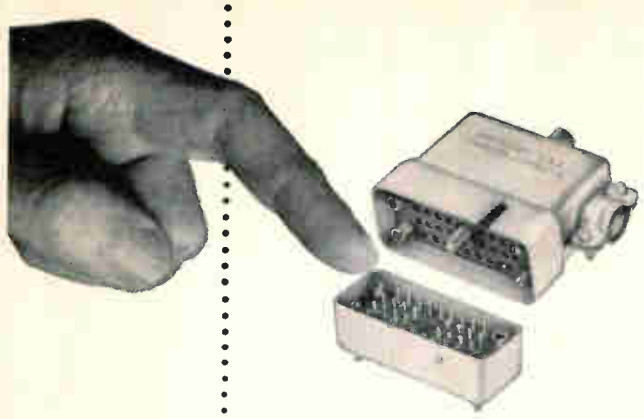
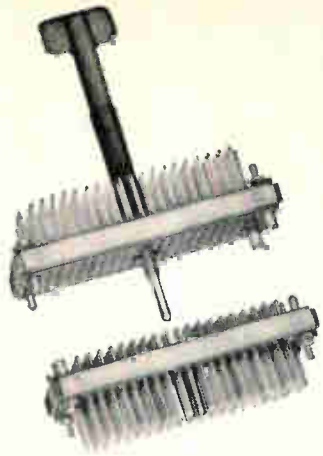


Series 190034 Plug & Socket. 34 contacts illustrated with side opening aluminum hood and protective shells.



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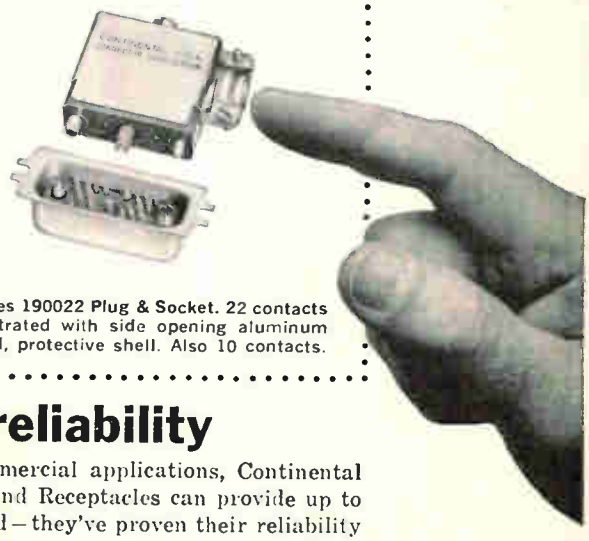
Series 190078 Plug & Socket. 78 contacts illustrated with mounting flange protective shell. Also 104 contacts.



Series 190022 Plug & Socket. 22 contacts illustrated with side opening aluminum hood, protective shell. Also 10 contacts.

small size...big reliability

Designed expressly for critical military and commercial applications, Continental Connector's Series 1900 Center Screwlock Plugs and Receptacles can provide up to 152 connections in less than 3.6 inches length! And – they've proven their reliability in hundreds of heavy duty aircraft, missile, computer and ground support installations. Features include double lead thread action center screwlocks, closed entry contacts, positive polarization, glass filled Diallyl Phthalate moldings. Standard types are available with 10 and 22 contacts for #20 wire, 34, 78 and 152 contacts for #16 wire...available with wire wrap terminals, hoods and protective shields.

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AN IMPORTANT MESSAGE For ELECTRONIC ENGINEERS Interested in

creating the unusual

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. . . to investigate fleet requirements first hand, determining whether present electronic equipment can be adapted to an advanced requirement, or whether a new design is needed,

. . . determine the design and test specifications in accordance with the ship's operating and physical environment.

. . . evaluate and test any suggested design or improvement for operating feasibility on a particular ship or installation,

. . . integrate new systems into a ship's existing electronic environment,

. . . participate in sea trials as a final operating checkout, and as a means of suggesting still further improvements, and

. . . direct and control resulting prototype development projects.

As a Project Engineer at a Naval Shipyard, you would be expected to have an on-the-deck as well as a behind-the-desk capability for designing, integrating, testing and evaluating electronic systems . . . for seeing what is needed and how to get it done.

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. . . to do fundamental research, and experimental development—as well as subsequent reliability and stability studies—on new and novel electronic systems and equipments of all kinds,

. . . help develop Naval Tactical Data Systems for particular classes of ships, including computer integration of data received through radar, sonar, fire control and navigation devices, and the visual presentation of this data by electronic display, and

. . . conduct basic measurement program in electronic/acoustical technology.

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. . . to conduct on-site surveys for shore electronic equipments here and overseas,

. . . prepare installation designs and monitor installation of systems, and

. . . trouble-shoot for existing systems.

Operating out of a Naval Industrial Managers Office, you would help create, install and maintain a variety of shore systems wherever they might be needed . . . seeing that they work and keep on working.

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. . . monitor installation, and provide consultation on installation problems.

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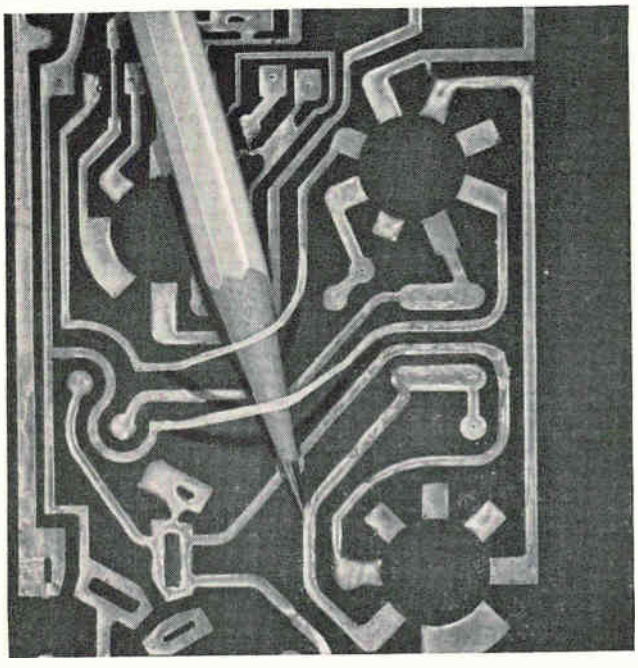
CIRCLE 115 ON READER SERVICE CARD 115

Printed Circuit Designers! AVOID Wire Failures at Soldering Temperatures



You've never had a printed circuit fail at room temperature. But you may often have experienced loose wire trouble in the soldering pot or during solder roller coating.

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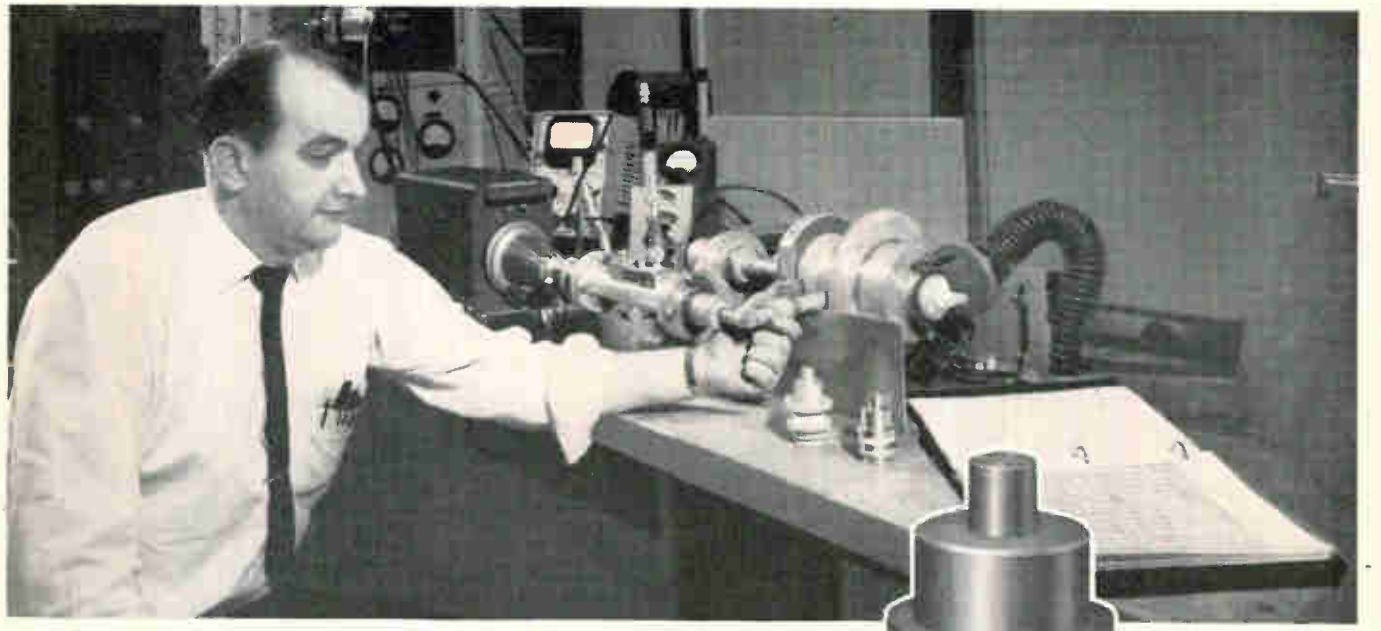

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ZP-1018	Airborne Transponder	Grid-Pulsed Amplifier	1090	2	.02
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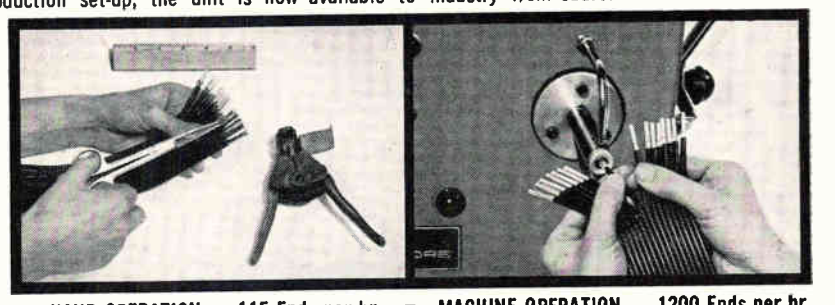
This Machine INCREASED OUR PRODUCTION EFFICIENCY OVER 1000%



HAND OPERATION — 115 Ends per hr. ■ MACHINE OPERATION — 1200 Ends per hr.

Additional Data:

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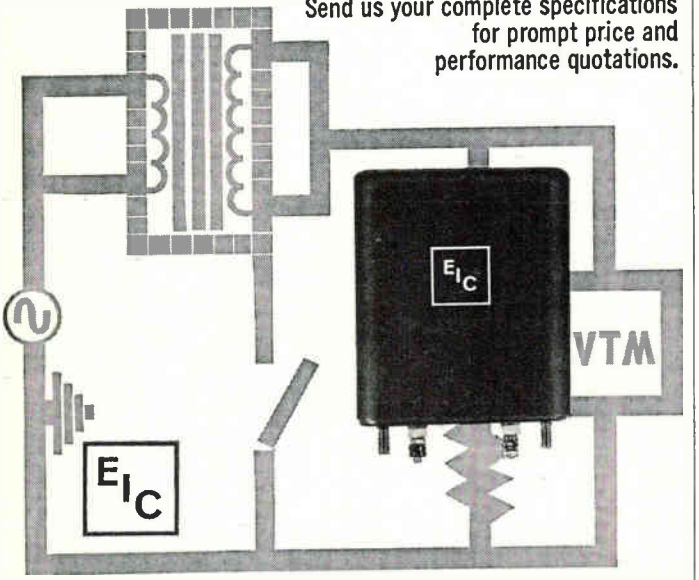

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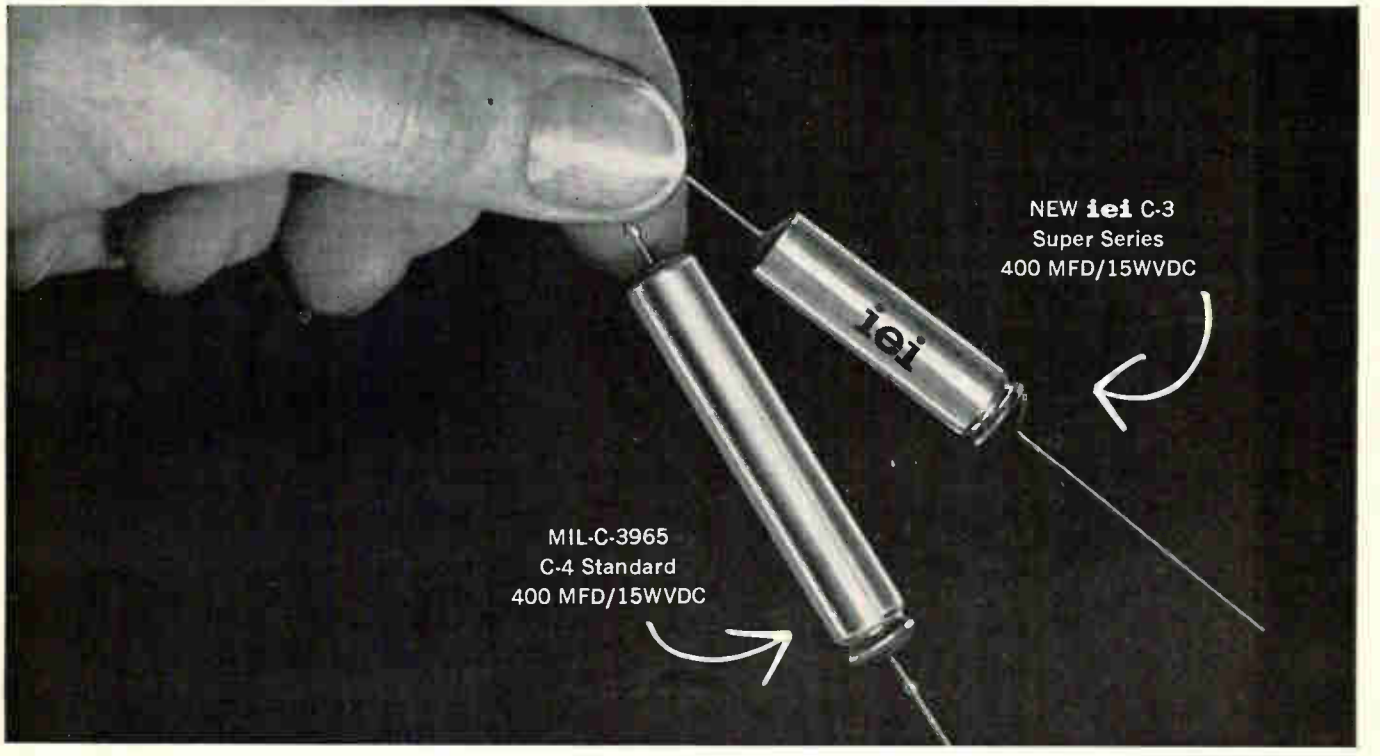
CIRCLE 234 ON READER SERVICE CARD

iei SUPER SERIES... Twice as much capacitance in each MIL case size



Up to 50% Space Savings in 85° Tantalum Foil Capacitors

Without sacrificing performance or voltage rating, **iei** packs twice as much capacitance into each SUPER SERIES case size as is called for in MIL-C-3965/2.

- Capacitances double those in MIL-C-3965/2
- DCL values half those in MIL-C-3965/2
- Impedance values half those in MIL-C-3965/2
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- Weight and space per uF/V cut up to 50%

Only **iei** knows how to make foil capacitors so good and so small. Space-and-weight saving SUPER SERIES polar units are available now. Full specifications in new Form 2850. Write to International Electronic Industries, Box 9036-94, Nashville, Tennessee. A Division of Standard Pressed Steel Co.

Compare These Typical Space and Weight Saving Advantages

Case Size	Voltage	Capacity	
		MIL-C-3965	IEI Super Series
C1	15 WVDC	15 mfds.	30 mfds.
C2		60	120
C3		200	400
C4		400	800
C5		580	1160

International Electronic Industries Div.

SPS

where reliability replaces probability

CIRCLE 119 ON READER SERVICE CARD 119

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to work on interesting and challenging projects

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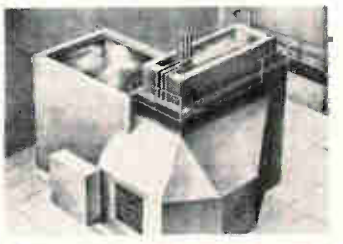

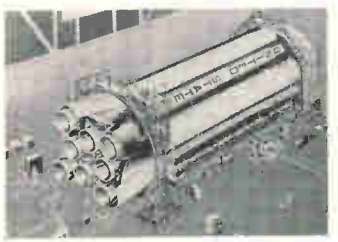

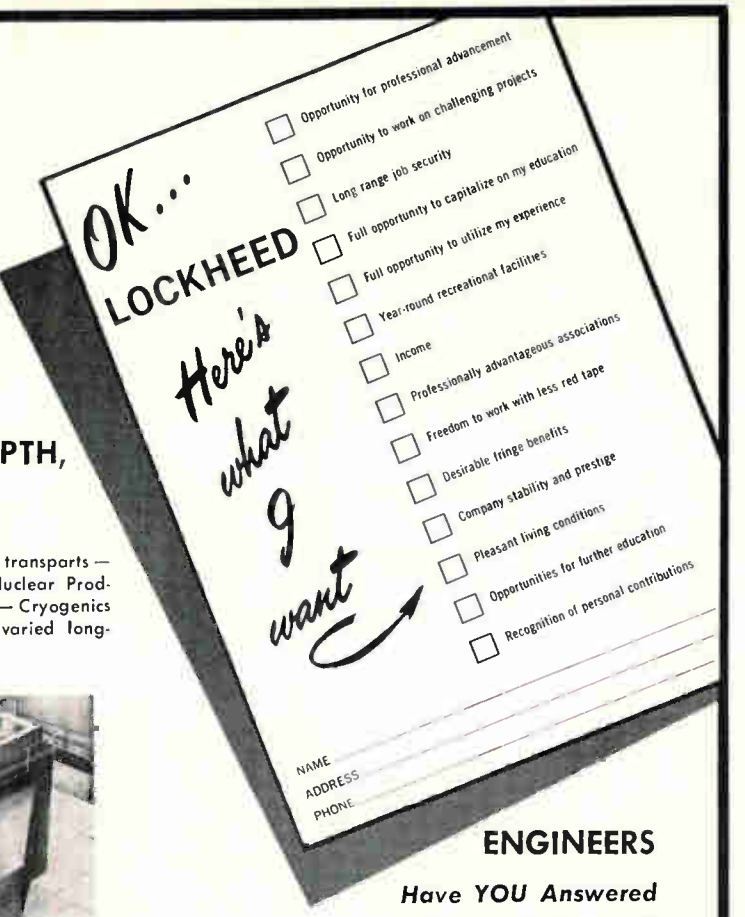

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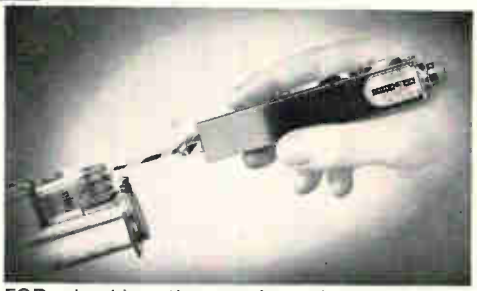

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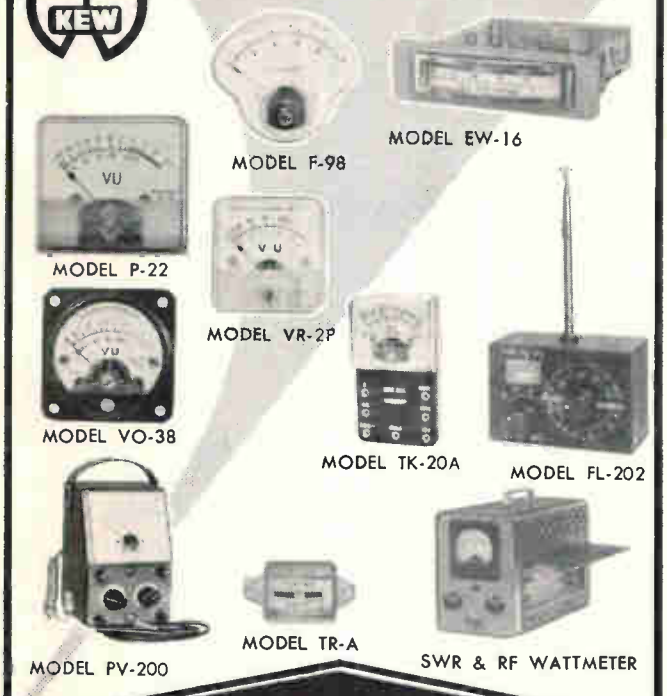
CIRCLE 235 ON READER SERVICE CARD

Around the world it's **KEW**



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CIRCLE 236 ON READER SERVICE CARD

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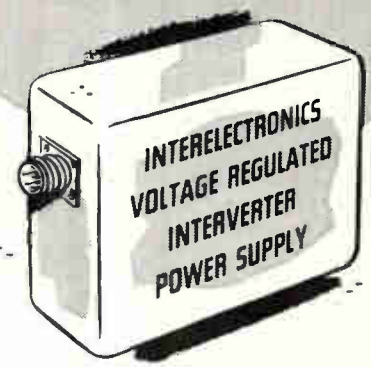
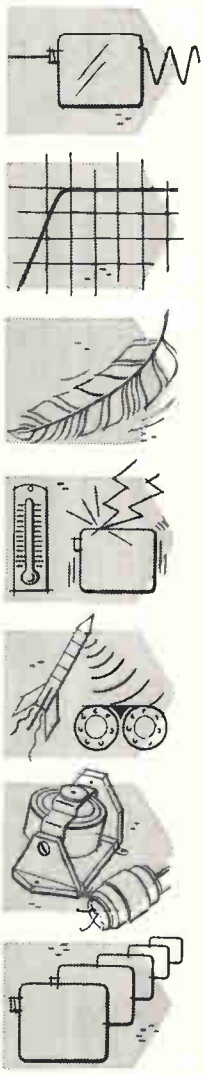
SOLID-STATE POWER INVERTERS,
over 260,000 logged operational hours—
voltage-regulated, frequency-controlled,
for missile, telemeter, ground support,
135°C all-silicon units available now—





Interelectronics all-silicon thyratron-like gating elements and cubic-grain toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. High conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry.)

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards.)

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AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

For complete engineering data, write Interelectronics today, or call LUdlow 4-6200 in New York.

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CIRCLE 121 ON READER SERVICE CARD

ENGINEERS GAIN A NEW PERSPECTIVE AT AC

AC, the Electronics Division of General Motors, has made a distinct contribution to technological advancement in the field of low-altitude aircraft operation. You, too, can develop and improve your career in the areas of guidance and navigation if you are an Electrical Engineer, Mechanical Engineer, Physicist or Mathematician. Current projects include: Integration and Engineering Design of AN/ASQ-48 Weapon System for the B-52C&D aircraft, Inertial Guidance System of the Titan II, and the development of Stellar Inertial Guidance System for use in long range ballistic missiles. If you have related experience and are interested in any of the following positions, please contact Mr. G. M. Raasch, Director of Scientific and Professional Employment, Dept. 5753, 7929 South Howell, Milwaukee 1, Wisconsin.

MILWAUKEE Weapon Systems Program Engineers ■ Radar Design and Development Engineers ■ Radar Systems Engineers ■ Radar Test Engineers ■ Reliability Program Engineers ■ Field Service Engineers ■ Electromagnetic Engineers ■ Supplier Contact Engineers ■ Quality Control Engineers/Analysts ■ Technical Writers and Editors ■ Scientific Programmers ■ Ceramic Engineers

LOS ANGELES RESEARCH AND DEVELOPMENT LABORATORY **(Advanced Inertial Guidance Systems and Airborne Digital Computers)**—Digital Computer Development Engineers ■ Research and Development Engineers ■ Transistor Circuit Design Engineers ■ Systems Engineers ■ Programmers-Mathematicians

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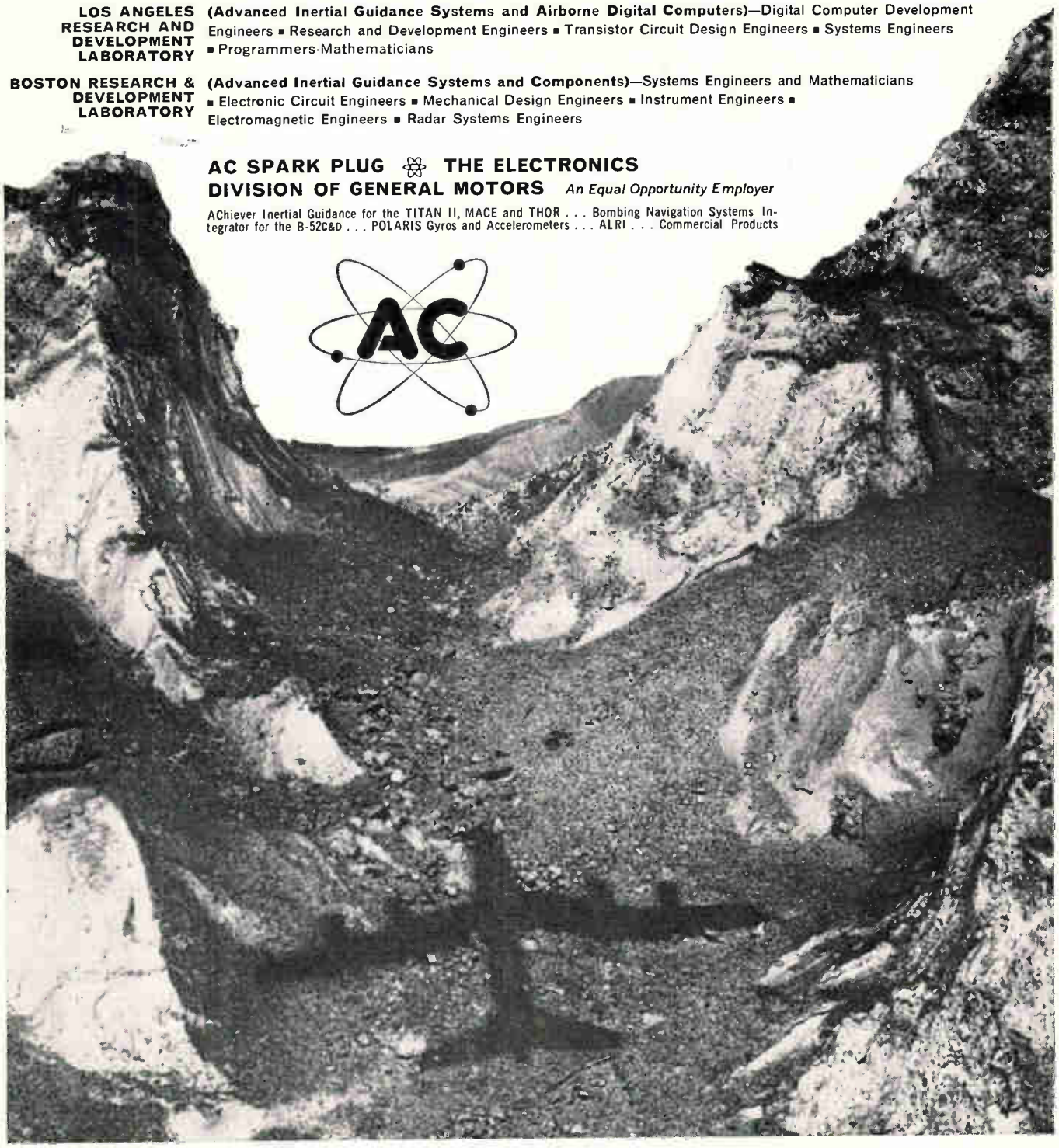


CIRCLE 123 ON READER SERVICE CARD→

Raytheon/Rheem 2N1613 silicon planar transistor, available per MIL-S-19500/181 (U.S.N.)

Rheem Semiconductors Now Manufactured by Raytheon

The Raytheon/Rheem combined product line provides industry with one of the most advanced lines of silicon and germanium semiconductors available. Raytheon not only assures faster delivery on Rheem types through high-volume production and national distribution — but also offers comprehensive application engineering assistance from both coasts.

The Rheem technical staff has been combined with the Raytheon research and development group to create an outstanding capability for development, engineering and production of new semiconductor concepts. Customers can also look forward to continued availability of the famous Mark X and Mark XII ultra-high reliability assurance programs.

A few of the advanced Raytheon/Rheem types now added to Raytheon's broad product line —

SILICON UNIPLANAR DIODES
1N3064 (MIL), 1N914 (MIL), 1N916
RD750 Nanosecond Power Diode

UNIVERSAL DIODES
RD250 Universal Multi-purpose Diode

SILICON TRANSISTORS
MIL Type 2N1613 (USN) Passivated Planar Construction
4 Watt Diffused Silicon NPN Mesa
2N497, 2N498, 2N656, 2N657, 2N696, 2N697

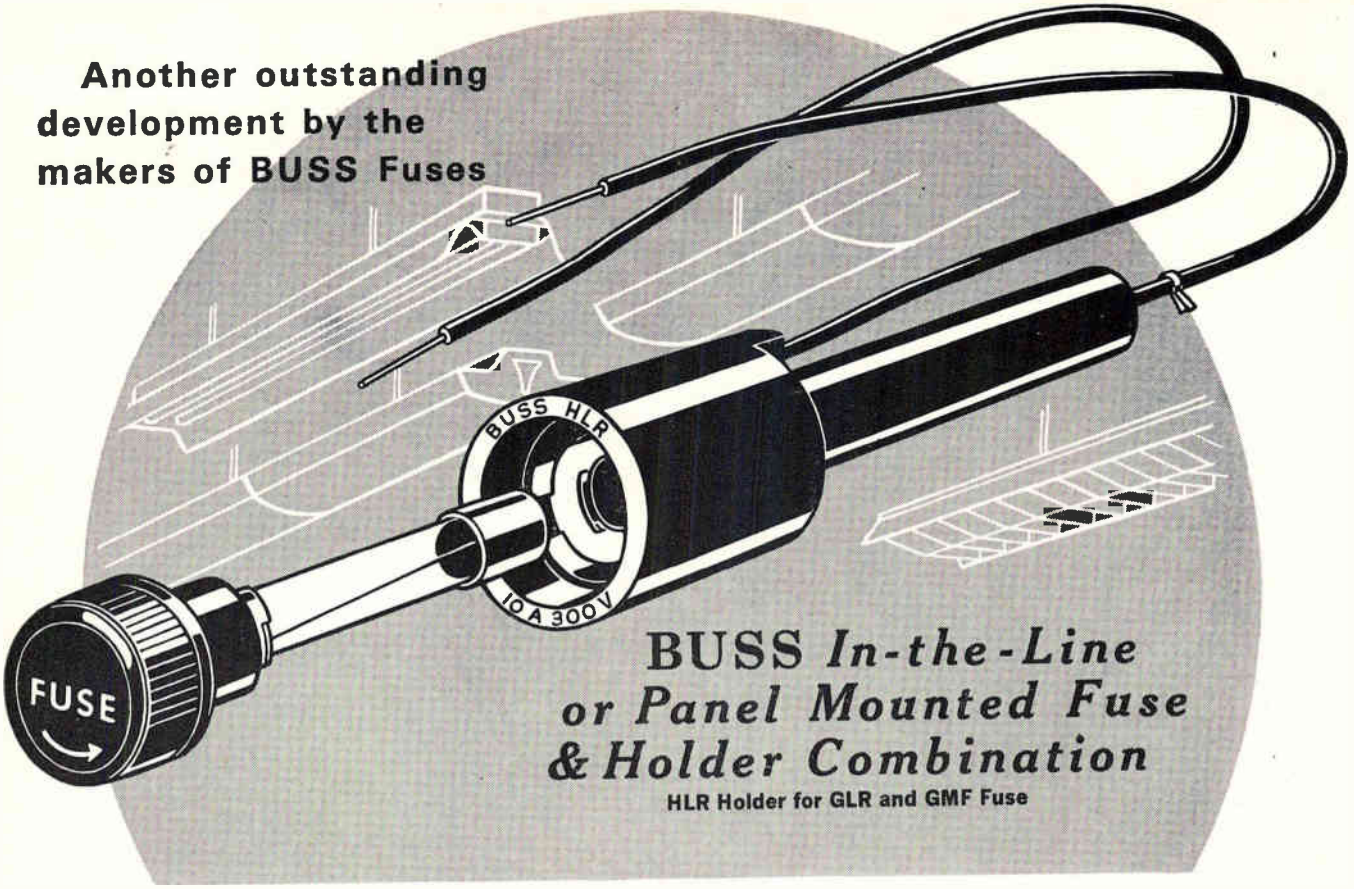
Visit Raytheon Semiconductor Division Booth 2606-2608 at the IRE SHOW

SEMICONDUCTOR DIVISION

Lowell, Massachusetts

RAYTHEON

Another outstanding development by the makers of BUSS Fuses



BUSS *In-the-Line or Panel Mounted Fuse & Holder Combination*

HLR Holder for GLR and GMF Fuse

For the Protection of Fluorescent Fixtures *or Other* Equipment . . . *300 Volts or less*

These BUSS Fuse & Holder combinations make it especially simple to protect fluorescent fixtures. They are also being used in a wide variety of other applications to protect any device or equipment on circuits of 300 volts or less.

BUSS GLR *fast-acting* type fuses or BUSS GMF *slow-blowing* type fuses are used in combination with BUSS HLR fuseholders. Fuseholder can be installed in-the-line or panel mounted.

Fuse and knob of fuseholder are in one piece. When a fuse blows, the entire fuse knob assembly is replaced. Cap of holder is insulated to protect user against possibility of shock.

Why safety demands that fluorescent fixtures be protected.

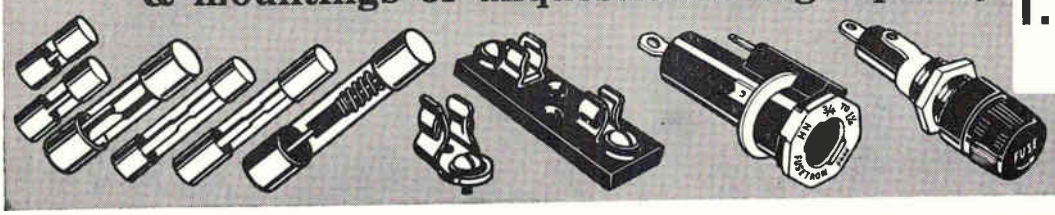
Trouble in fluorescent fixtures generally starts when the insulation in the ballast breaks down. This causes a short which develops heat, and can result in:

Molten compound dripping on people, equipment and merchandise . . . Gases forming and exploding, injuring personnel or damaging stock and equipment . . . Fires starting in ceiling or walls near fixture . . . Short continuing until branch circuit fuse blows and cuts off all lights on circuit.

All these dangers can be minimized by proper BUSS GLR or GMF fuse protection.

To get the full story, write for BUSS bulletin SFH-6.

BUSS–The complete line of fuses & mountings of unquestioned high quality



See us at the I.R.E. Show

Booth 2740

BUSSMANN MFG. DIVISION
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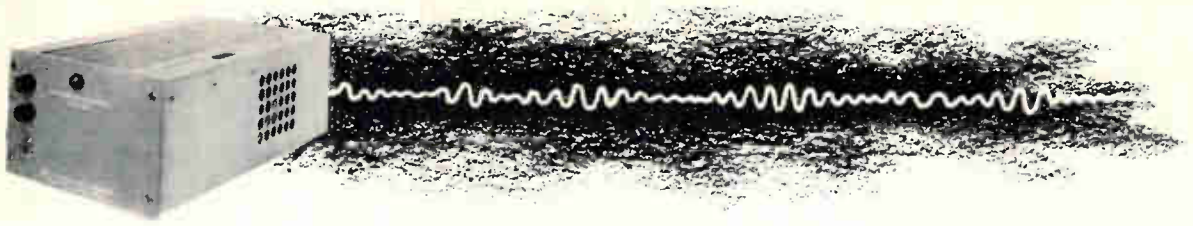


This is the MULTICOUPLER so small that needs only 12 watts power in all to route incoming signals to many a station while keeping them clean with high isolation that's compact and modular and miniaturized that's 80% cooler and transistorized that came from the house -that TRAK built

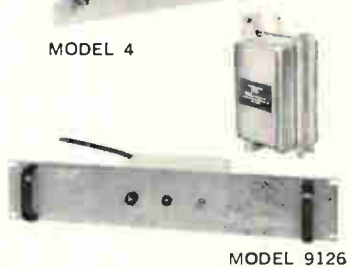
TRAK ANTENNA MULTICOUPLER MODEL 108
For hf direction finding and communications systems. Miniaturized—Transistorized. Noise figure: less than 8 db. Output isolation: 40 db. Dissipates 80% less heat than vacuum tube units. 2-32 MC. IM Distortion: 60 db below .25 V. Size: < ½ cu. ft. 8 outputs.

MODEL 108

TRAK ANTENNA MULTICOUPLER MODEL 4
Noise figure: less than 6 db. Insertion gain: 3 db. Output isolation: greater than 50 db. 2-32 MC. 10 outputs.

MODEL 4

TRAK ANTENNA AMPLIFIER/COUPLER MODEL 9126
Amplifies signal allowing 4000 ft. lead-in from antenna to receiver. 10 db of gain from 2-40 MC. Noise figure: less than 4.8 db.



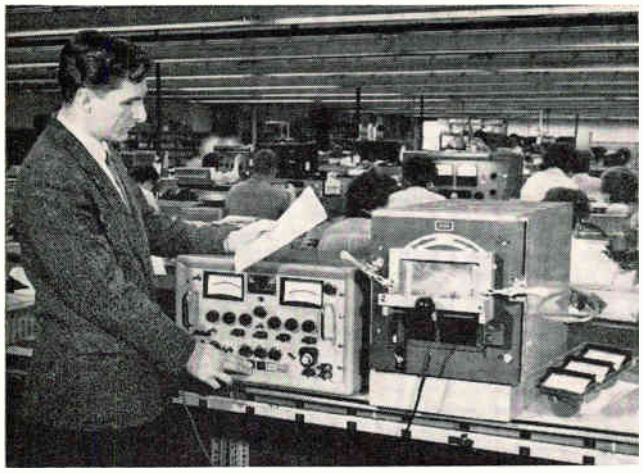
MODEL 9126

The Communications and Reconnaissance Dept. of Trak Electronics designs and manufactures on quantity or individual basis completely within their own plant. This permits "package cost" quotation at your design conception stage. Our engineering dept. will be glad to offer any design and specification assistance.

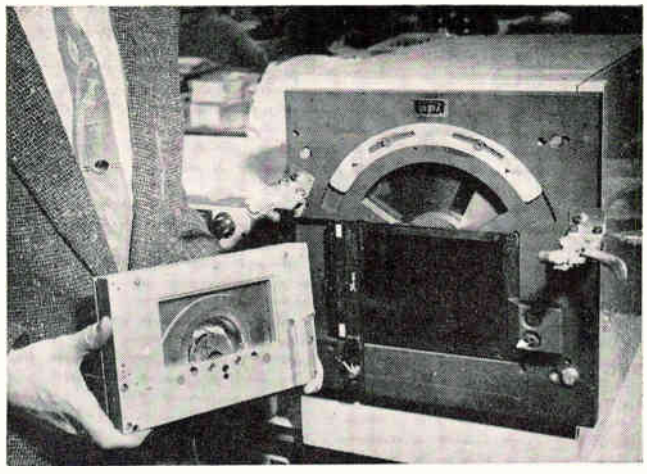
Simply write 59 Danbury Road or telephone POrter 2-5521.

TRAK

COMMUNICATIONS & RECONNAISSANCE DEPT., TRAK ELECTRONICS COMPANY, INC., WILTON, CONN.



Meter movement is in place and automatic equipment is calibrating a dial for it photographically. Completed meters with individually calibrated dials at right



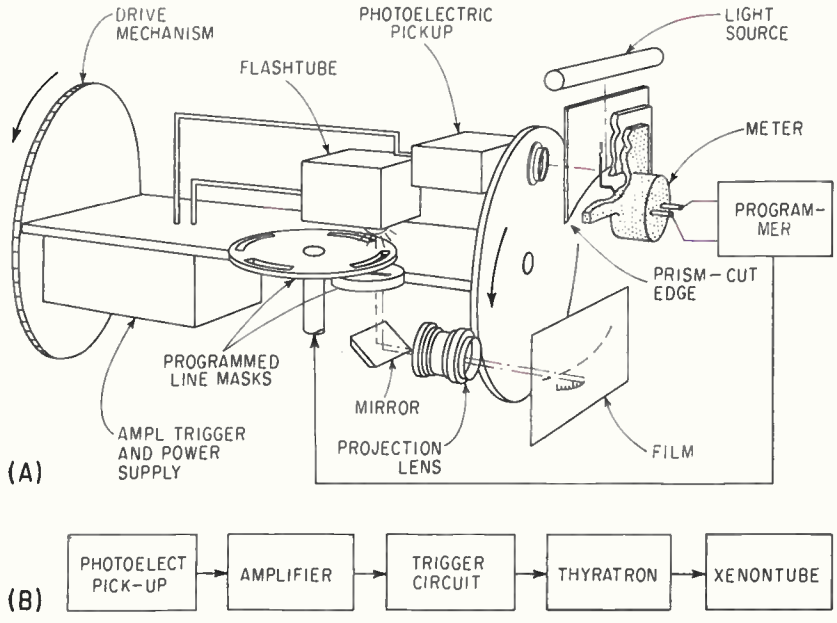
Special fixture holds meter movement in position as rotating scanner translates the actual position of pointer to mylar film

50TH ANNIVERSARY OF THE INTERNATIONAL IRE • ire • SPECIAL

Meter Dials Calibrated Automatically

PANEL METERS with high accuracy and linearity are being manufactured on a production line basis by Assembly Products, Inc., Chesterland, Ohio, and will be on display at IRE. The excellent performance of the meters is the result of two factors: first, friction and hysteresis are essentially eliminated by taut band suspension; second, the meters are individually calibrated by an automatic dial marking machine.

Linearity, or tracking, of ±0.5 percent is guaranteed in meters produced by the new methods, in contrast to the 2 or 3 percent linearity typical of meters not specially calibrated. When special care is taken to preserve the physical properties of meter materials, absolute accuracy as fine as ±0.5 percent also can be obtained.



Rotating scanner is illuminated and armed over the arc through which the pointer moves. When the pointer blocks the light, the resulting signal triggers the flash tube and the position of the pointer is transferred to sensitized mylar film

The dial printing machine automatically divides the full-scale current drawn by the meter into units that correspond to the dial divisions required. Each point is printed by an automatic photographic process on the actual dial that is later attached to the meter. First step in the dial printing process is placing an otherwise complete meter in a fixture that is clamped on the front of the machine. Meter terminals are connected to a console where programming adjustments are made in accordance with the number and type of scale divisions specified for the dial. At present the minimum practical number of divisions is 30—although as few as 10 have been printed experimentally—while the maximum is 180.

The full-scale signal of the meter is also set in on the console; the pro-

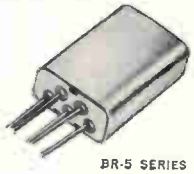
NEW BR-5 RELAY COMPLEMENTS OTHER BABCOCK SERIES

The new BR-5 is smallest of the precision relays that Babcock manufactures. Despite its small size, it features the same rugged dependability and operating versatility that distinguish all Babcock products.

Most airborne, undersea or ground support requirements can be satisfied by Babcock's standard line of relays, while other requirements are met by special variations. The following relay series show typical performance characteristics of Babcock's standard product line.

BR-5 MICRO/MICROMINIATURE DRY CIRCUIT TO 1 AMP SERIES

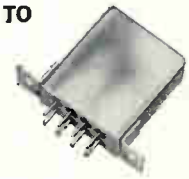
Contact Rating: 1 amp res. @ 32V DC, .050 Ω max. • **Contact Arrangement:** SPDT • **Vibration:** 30g, 40 to 3000 cps; 0.4" DA, 10-40 cps • **Shock:** 125g, 11 millisec. • **Life:** 100,000 operations min. @ 1 amp, 125°C. • **Military Specification:** meets MIL-R-5757D.



BR-5 SERIES

BR-7 SUBMINIATURE DRY CIRCUIT TO POWER SWITCHING SERIES

Contact Rating: 2, 5 and 10 amp res. @ 28V DC or 110V AC, 400 cps • **Contact Arrangement:** SPDT, DPDT • **Min. Pull-in Power:** 80 mw/pole, derated to 50 mw • **Header Styles:** plug-in terminals, solder hooks, 3" printed circuit leads.



BR-7 SERIES

BR-8 MICROMINIATURE CRYSTAL CAN SERIES

Contact Rating: 2 amp res. @ 32V DC or 115V AC, 400 cps; 1 amp inductive @ 32V DC • **Contact Arrangement:** SPDT or DPDT • **Dry Circuit:** 1μa @ 1 mv, 100 Ω max. contact resistance • **Size:** .360" x .790" x .870" high (current sensitive, 1.190" high).

BR-8 SERIES

BR-9 SUBMINIATURE MAGNETIC LATCHING SERIES

Contact Rating: 5 and 10 amp res. @ 28V DC or 110V AC, 400 cps • **Contact Arrangement:** DPDT • **Header Styles:** 10 pin or 8 pin polarized • **Holding Coils:** separate or series operation.

BR-9 SERIES

BR-12 MICROMINIATURE ULTRASENSITIVE SERIES

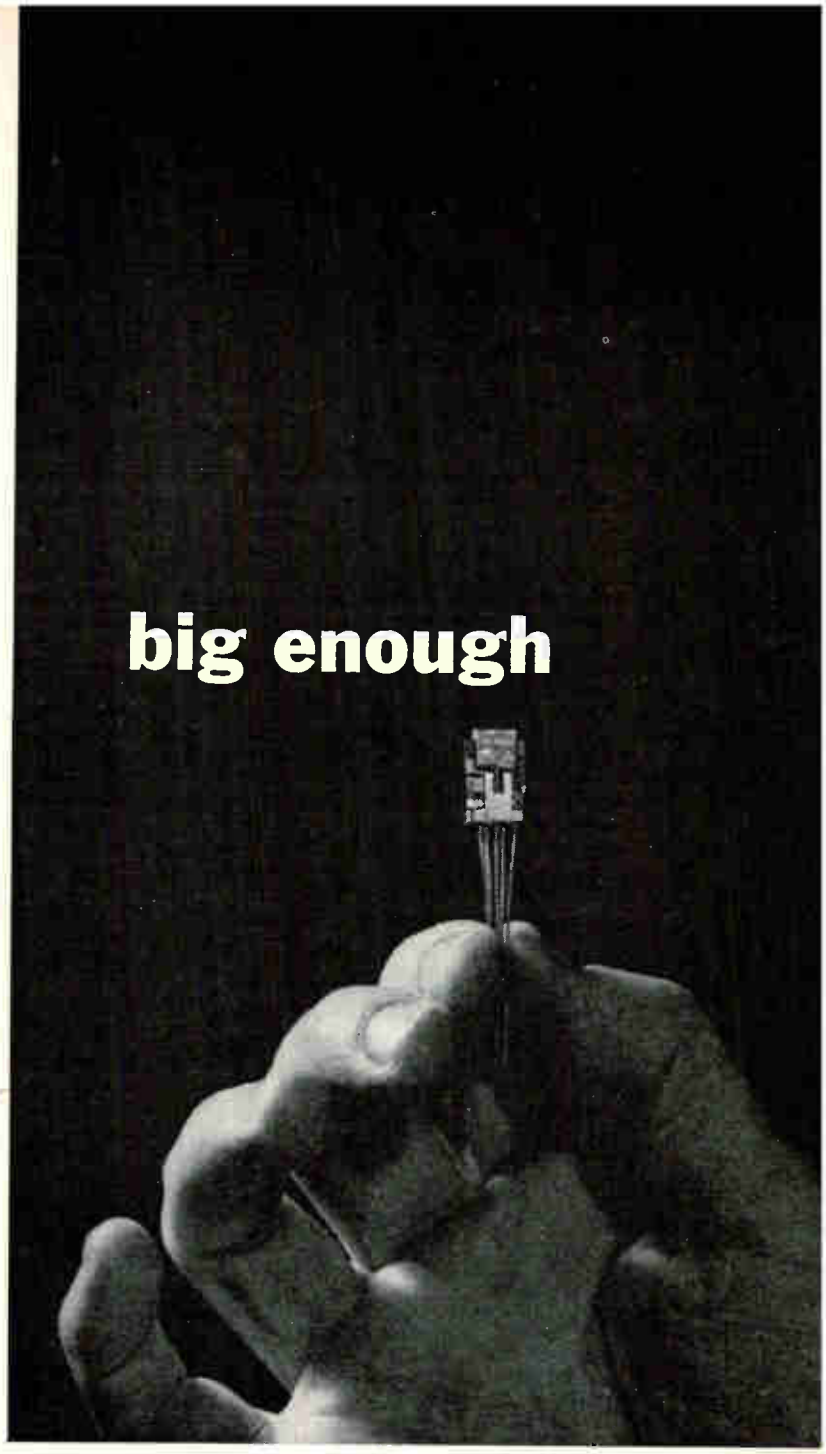
Relay Types: standard, high sensitivity, max. sensitivity and centepede "lie down" printed circuit versions • **Contact Rating:** 2 and 3 amp res. @ 32V DC or 115V AC, 400 cps; 1 amp inductive @ 32V DC (max. sensitivity unit 2 amp res. @ 28V DC) • **Contact Arrangement:** SPDT or DPDT • **Coil Power** (max. sensitivity unit): 25 mw SPDT, 40 mw DPDT.

BR-12 SERIES
BR-12P SHOWN

BR-14 SUBMINIATURE FOUR POLE, DOUBLE THROW SERIES

Contact Rating: (@ 28V DC or 115V, 400 cps): 10 amp res., 3.5 amp inductive; 7.5 amp res., 2.5 amp inductive; 5 amp res., 2 amp inductive • **Contact Arrangement:** 4PDT (4 form C) • **Size:** 1.000" x 1.075" x 1.300" • **Weight:** 3.0 oz. max.

BR-14 SERIES



Dry circuit to 1 amp switching in a rugged 1/10th oz. hermetically sealed relay

Babcock's dependable new BR-5 SPDT relay easily handles any load to 1 full amp at 32V DC. The transistor can-sized package is only as large as it needs to be, measuring 0.2" x 0.4" x 0.6". A special magnetic circuit is responsible for its high sensitivity, generally a limiting factor in relay miniaturization. Exceptionally rugged, the BR-5 is built to withstand 125g shock and 30g vibration at 3000 cps. Selective utilization of materials enables −65°C to +125°C operation, ideal for missile and space probe environments. Available in various mounting styles with printed circuit leads. Interested designers should contact their Babcock representative or write direct for Bulletin BR 617.

Babcock Relays

A Division of Babcock Electronics Corporation
1645 Babcock Avenue, Costa Mesa, Calif.

CIRCLE 127 ON READER SERVICE CARD

SPEEDS up to 800 steps/second

TORQUES from 50 to 350 gm.-cm.

SIZES as small as 0.94 cu. inch

COSTS as low as $15 per motor

Wide design choice

IN FAST, ACCURATE, QUIET AND LONG-LIVED

Cyclonome® Non-Mechanical* Stepping Motors

Converting pulses or current reversals into precise 18° angular rotations or shaft positions without "misses" or overshoot — **and without ratchets, escapements, solenoids or stand-by power* — is the basic job done by every one of these Cyclonome® motors. Stepping is accomplished *magnetically* — and the only moving part is the rotor.

But to get enough torque to drive punched paper tape, magnetic tape, movie film or various machine tool and process control instrumentation loads, a motor with substantial torque output is necessary. With a torque output of 350 gm.-cm., the "Series 9AG" Cyclonome can handle many of these jobs. Or say you're designing a traffic counter, electric impulse clock, telemetry pulse translator, recorder chart drive mechanism or some other piece of equipment of commercial quality. The practical economics of the situation (and perhaps lower speed and life requirements as well) may make the low-cost 9AB Series Cyclonomes particularly useful. If precise *and* very *high speed* stepping or positioning is your main problem, the 9AE Cyclonomes will faithfully and discretely follow seven or eight-hundred commands a second; this could let you feed information into a computer, for example, run a "sampling switch" or read information out of other devices in a very efficient manner.

The same "high-speed" Cyclonome also occupies less than a cubic inch; if you're working with high density packages, or need an inch-ounce of torque to operate a digital display in a minimum of panel space, this little Cyclonome can be very handy. (The fact that no power is needed by any Cyclonome to maintain "holding torque" also has obvious advantages in simpler drive circuits and cooler equipment operation.)

To each of these particular abilities should be added the over-all virtue of more reliable equipment operation a Cyclonome motor can often provide—partly because it has no mechanical ratchets or escapements to slip, clatter or wear out, and partly because it may let you simplify other parts of your design. The table below shows the basic choices now offered in Cyclonomes: if it gives you some ideas, we'd enjoy talking them over with you — either by phone or letter or at the IRE Show in New York, Booth 2628-2630.

	"STANDARD"		HIGH TORQUE	MINIATURE	LOW COST
Max. torque (gm.-cm.)	Unidirec. 80	Bidirec. 120	350	80	50
Max. speed** (steps/sec.)	300	300	450	600-800	60
Approx. size	1-5/8 x 1-27/32 x 1-13/32	1-5/8 x 1-27/32 x 2-5/32	2-9/16 x 1-1/2 x 1-13/16	1-1/2 x 5/8 x 1	2-7/16 x 1-1/2 x 1-13/16

**Motors will run synchronously at much higher speeds, but will stop and start instantly only within stated stepping speed range.

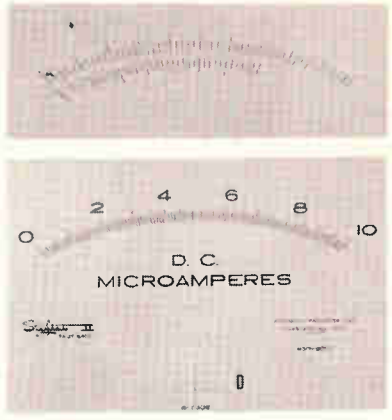
SIGMA

SIGMA INSTRUMENTS, INC.

62 PEARL ST., SO. BRAINTREE 85, MASS.

grammer then breaks down the total signal into the number of divisions required. The console then supplies the meter with current increments, beginning at zero, that correspond with those to be printed on the dial. A rotating lens (see sketch) continuously scans a section of a back-lighted prism in front of which the meter pointer steps for each current increment.

As the photoelectric pickup rotates through the lighted arc of interest, the black image of the pointer causes a photomultiplier tube to put out a negative voltage



Partially finished dial showing calibration marks, and complete dial

pulse whose timing is a function of pointer displacement. The pulse is amplified and then fires a stationary zenon flash tube whose light goes through a series of lenses and a slit, strikes a mirror, and then passes through two back-to-back lenses with long focal length; these lenses focus the beam on a sensitized film of mylar. Length of the mark—minor, submajor or major—is determined by a programmed mask that changes the size of the slit through which the light passes. Other necessary information such as trademarks, unit names and numbers, are then photographically printed on the dial; after further processing the dial is fitted to the particular meter movement it was processed with.

At present, the rate of printing speed is determined by the response time of the meter, since the pointer must move to a new position and be stationary before a dial mark is made. The average dial is printed in less than two minutes. The programmer can be used to produce

linear or logarithmic scales.

Assembly Products is currently using the new machine to print dials for its Stylist II five-inch meters and its Model 661 six-inch meters. The technique will be extended later to 4½-inch rectangular meters.

Machine Generates Tape for PC Board Drilling

AUTOMATIC machinery for short-run production of complex printed wiring boards has been developed by General Electric Company's HMED, Syracuse, and Edlund Machinery Co., Cortland, N. Y. The automatic equipment consists of two separate units that can be used independently: a drawing-to-tape converter that generates a completely programmed eight-channel punched tape directly from a dimensionless drawing; and a sixteen-spindle, tape-controlled drill press capable of automatically drilling 12 boards simultaneously. The operator generates the punch tape by positioning a stylus to ±0.04 inches of the hole centers on the drawing.

Only the drawing-to-tape converter is shown above; the drilling machine consists of four drilling stations, each equipped with four drill units. The combination machine requires approximately ten minutes from production drawing to completed board.

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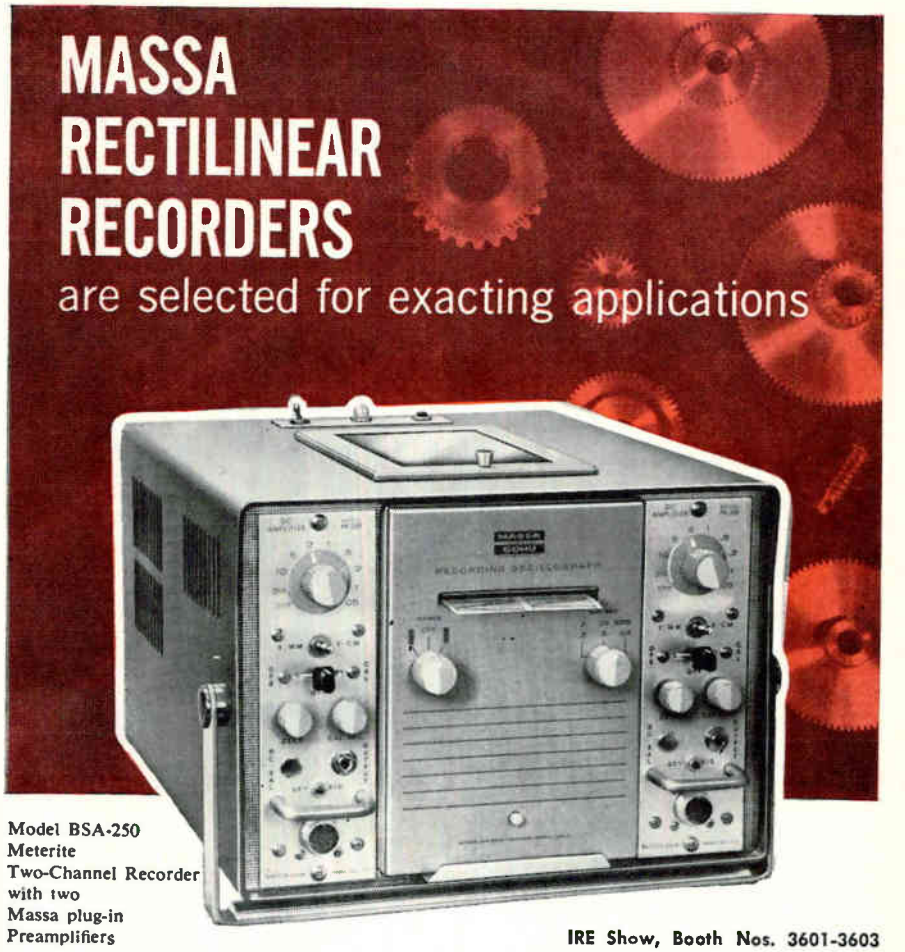

Model BSA-250 Meterite Two-Channel Recorder with two Massa plug-in Preamplifiers

IRE Show, Booth Nos. 3601-3603

Quality Control Measurements

The Massa rectilinear writing Meterite two-channel strip chart recorder improves quality control and provides valuable clues for better production techniques. A typical example is in the manufacture of precision gears, ball bearings, etc., where the unit under test is compared, dynamically, to a standard. Any runout is picked up by a sensitive transducer and converted to an electrical signal which is amplified by a Massa Carrier Preamplifier (Model PR-401) plugged into the Meterite, Model BSA-250. Direct ink writing permits the recording of continuous production testing to be performed most inexpensively.

The Meterite, equipped with preamplifiers, Model PR-401, permits recordings of magnitude and profile runouts as low as 20 to 30 microinches. Rectilinear writing produces undistorted waveforms which are identical to those at the transducer output, thereby eliminating the need for complex interpretation techniques.

Massa Division of Cohu Electronics, Inc., manufactures ink or electric rectilinear writing recorders from basic pen motors to complete recording systems with 2, 4, 6, 8, and 12 channels plus a complete line of interchangeable plug-in preamplifiers.

Write for Recorder Technical Bulletins.

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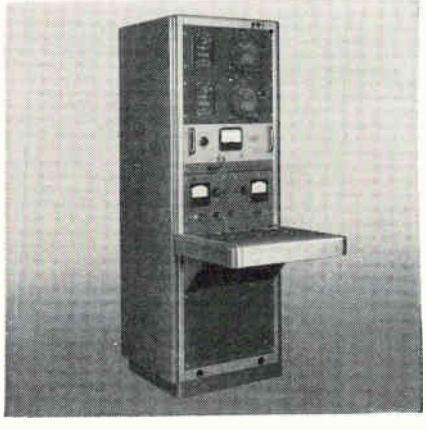
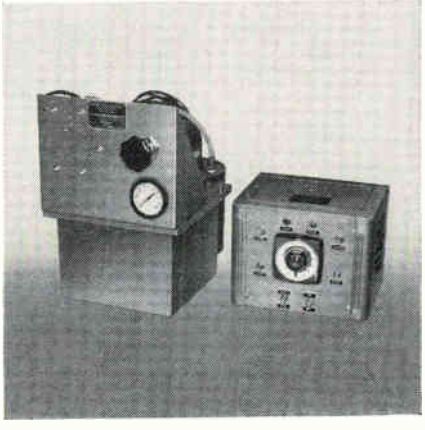


NEW PHILCO h_{fe} TESTER

A new low-cost way to check transistor current gain. Tester is continuously tuned to process 50kc to over 200mc transistors.



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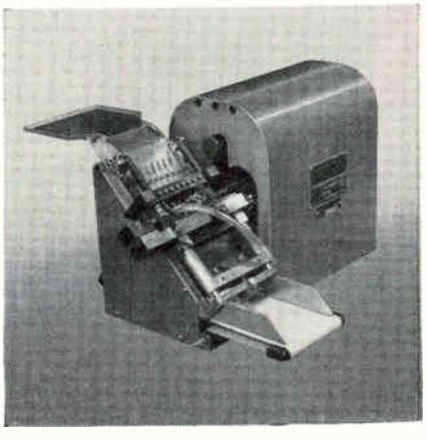
Philco proved-in-use equipment dispenses metered quantities of highly corrosive etchants, with rapid cycling, low pressure and clean cut-off. Philco equipment, complete with chemical pump, assures critically uniform clean-up etching of all components.



PHILCO DICE SCRIBER

The increasingly popular Philco dice scriber, shown in photo, processes 600-1200 semiconductor blanks, or 500-800 strips, per hour—with industry's lowest material waste rate.

New MESA SCRIBER offers fast and precise scribing of new mesa and planar semiconductor blanks. Scribes blanks as small as 0.010". Wafers are held with vacuum instead of wax. Scribing dimensions are programmable with the scriber's solid-state circuit controls.

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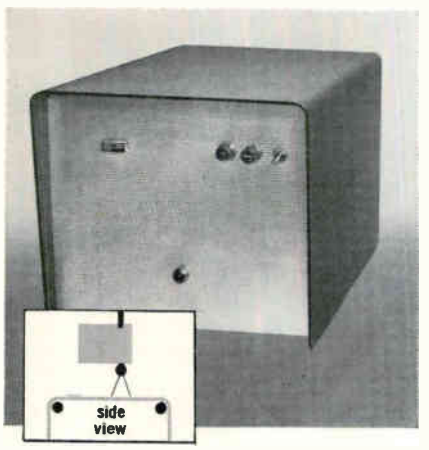
Inspects Incoming Transistors Automatically

Philco *Single-Position Automatic Tester, shown in photo, enables you to plug-in 10 different parameter tests. Can be programmed to test 10 different transistor types—simultaneously. Protects transistors from outside electrical influences during tests. Contains Philco-designed-and-built solid state comparator.

...REMARKABLE PHILCO MACHINES THAT MAKE YOUR PRODUCTS EVEN BETTER



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For facts on Philco production and testing equipment, and capabilities for custom equipment, telephone (collect) UL 5-4681 (area code 215). Ask for Mr. E. J. Greenholt. Or write Dept. E3962E.

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Over 60 years' successful experience has established Leach & Garner as a leader in the production of clad and solid alloys for a wide range of industries. Now a program, carefully developed by unique owner-management, has created a completely new, clean, **and separate** department where this experience is applied to bonding, rolling and fabrication of **clad semiconductor materials.**

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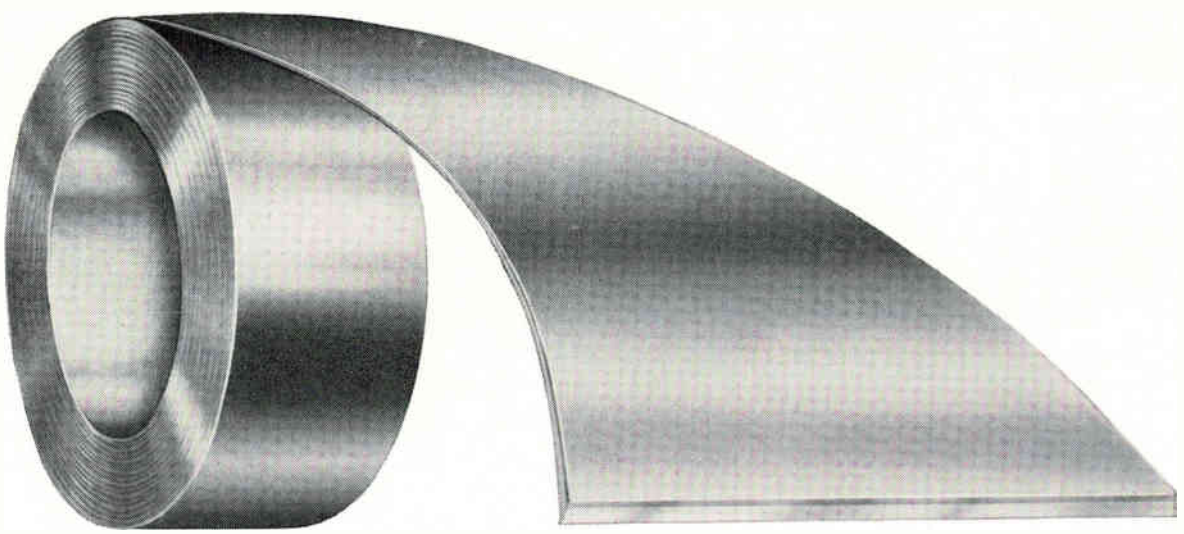
Specialized experience through production of countless miniature precision parts for the electronic industry is now combined with the most modern facilities to offer **semiconductor manufacturers** the service needed to meet the most demanding requirements at low cost with absolute assurance of complete conformity.



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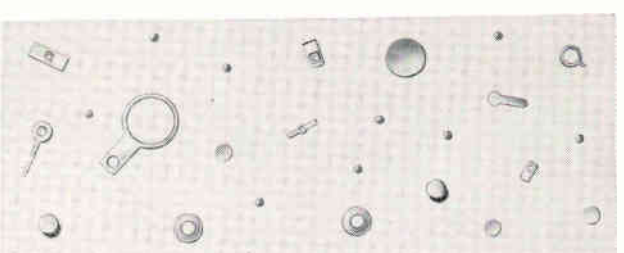

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Accelerated aging eliminates 98% of possible component failures in the new **Eitronic** digital instruments

Records show that 98% of all component failures occur during the first 100 hours of operation. To assure maximum reliability in the new Eitronic Series, all instruments undergo an extensive accelerated aging program equivalent to 100 hours of actual operation. Instruments are placed in a heat chamber and subjected to 125°F. and 90% humidity while operating under continuously varying voltages. This permits questionable components to be replaced *before* shipment, resulting in unequalled field reliability. One user with five Eitronic 850, four-digit AC/DC voltmeters reported a mean-time-between-failures of 2000 hours.

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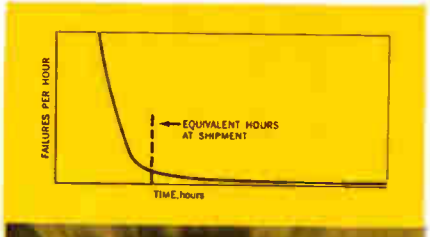
Your EI sales engineer will be pleased to demonstrate any of the six Eitronic models for you: DC, AC, DC ratio and resistance measurements, singly or in combination and in 4 or 5 digit models. Call him today.



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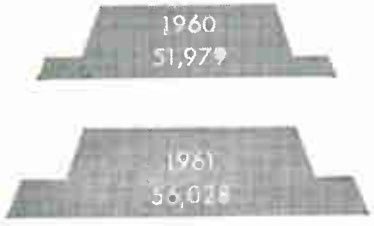
Engineers: Challenging opportunities now available. Contact Mr. Harvey Fleming.

Straits Tin Report

In 1961 a statistical short-fall of world production of tin under world consumption took place. Experts believe an actual physical shortage may occur in the 3rd quarter of 1962 because, in part, of production problems in the Congo, Indonesia and Bolivia.

Malaya, by far the world's largest tin producer, believes increased production to be the only sensible long-term answer to shortages. As a result, in 1961 its free-enterprise mining industry set an increased goal for itself and then proceeded to surpass it.

STRAITS TIN PRODUCTION
(long tons)



1961 production was 1028 tons over the promised increase and 4049 tons above the 1960 total.

This is the type of direct action and cooperation that U.S. industry and government can expect from Malaya's tin miners. Although operating, like American enterprise, on a profit-seeking basis, they recognize the need for steady market conditions and adequate supplies for consumers over the long term.

Write us today for a free subscription to Tin News—a monthly newsletter containing accurate information on world tin production, prices, marketing developments, and new uses and applications.

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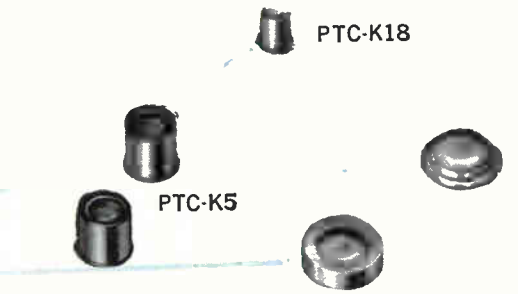
New! from — E-I



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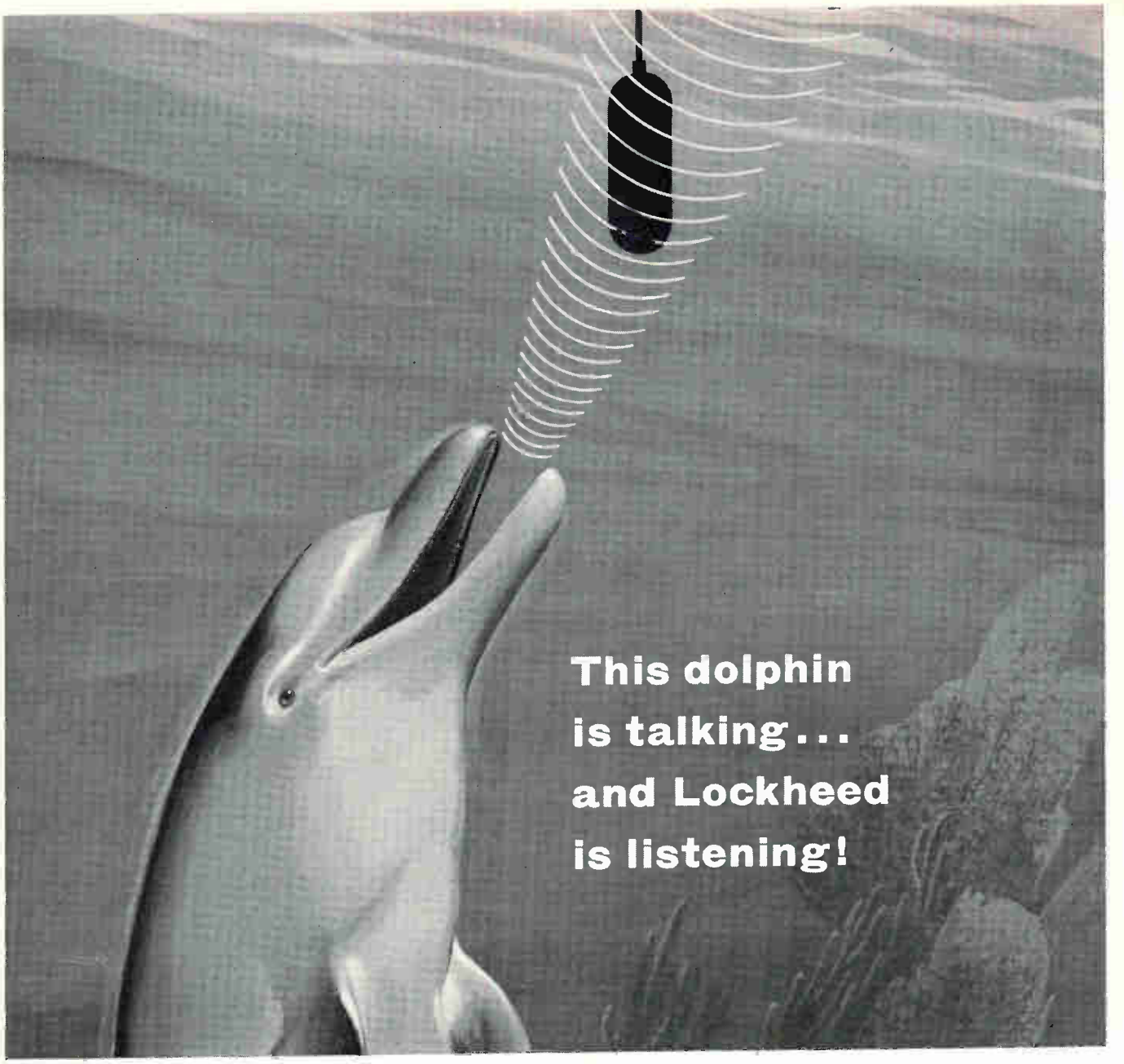

Yes, Lockheed oceanographers and marine scientists listen to "dolphin talk." Studying acoustical characteristics of underwater creatures is part of their daily work. Unraveling the mysteries of the sea is typical of the many research projects in which they are engaged—projects that constantly create new openings, fresh opportunities. Other fields now being probed: Internal waves; low-level marine meteorology; marine geology. Moreover, for its own use, Lockheed has adapted and commissioned the deep-sea research vessel *Sea Quest*—one of the few such ships owned by industry.

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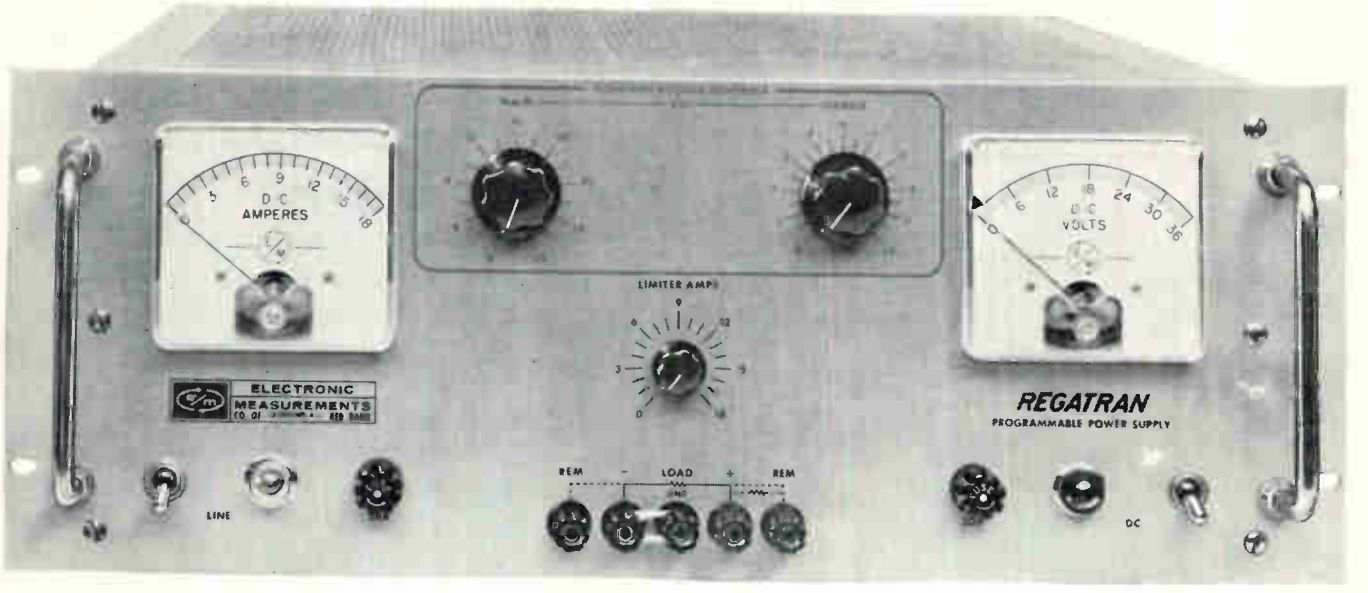

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BRIEF SPECIFICATIONS

BASIC MODEL NO.	DC OUTPUT		DIMENSIONS IN INCHES		
	VOLTS	AMPERES	PANEL HEIGHT	PANEL WIDTH	DEPTH BEHIND PANEL
PV32-5	0-32	0-5	3½	19	17¼
PV32-10	0-32	0-10	5¼	19	16½
PV32-15	0-32	0-15	7	19	15⅞
PV32-30	0-32	0-30	8¾	19	16¼
PV36-5	0-36	0-5	3½	19	17½
PV36-10	0-36	0-10	5¼	19	16½
PV36-15	0-36	0-15	7	19	15⅞
PV36-30	0-36	0-30	8¾	19	16¼
PV60-2.5	0-60	0-2.5	3½	19	17¼
PV60-5	0-60	0-5	5¼	19	16½
PV60-7.5	0-60	0-7.5	7	19	15⅞
PV60-15	0-60	0-15	8¾	19	16¼

- 0.01% or 2 millivolts regulation
- All solid-state with SCR input
- Programmable over the entire voltage and current range
- Long-line remote sensing
- Continuously variable current limiting
- Slaved series or parallel operation
- Up to 44% reduction in panel height

request specification sheet 2020

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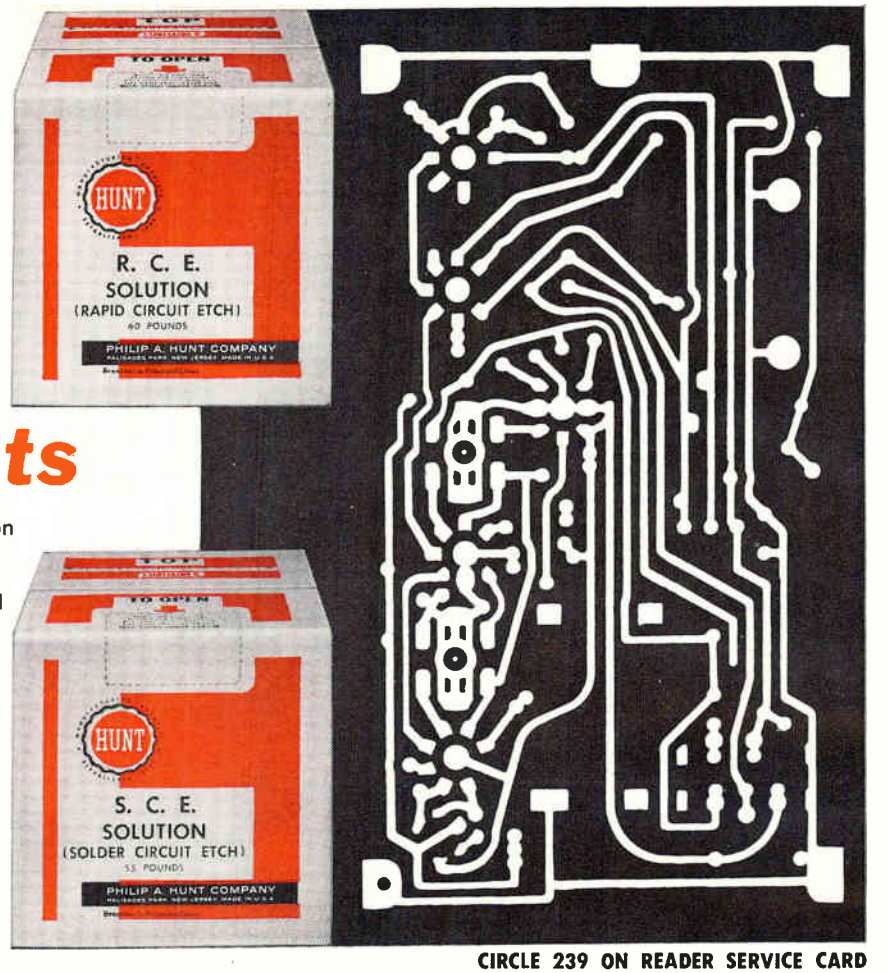

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HUNT S. C. E. (Solder Circuit Etch) is the only prepared product formulated to etch solder-plated boards at room temperature without attacking the solder.

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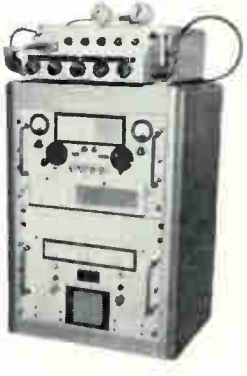
DEPARTMENT OF DEVELOPMENT
70 State Capitol **Denver 2, Colorado**

CIRCLE 260 ON READER SERVICE CARD

Faster, surer single sideband communications at vital Atlas, Titan, Minuteman missile sites

The United States Air Force is now taking delivery of SC-900 Series fully automatic 1KW single sideband transceivers developed and manufactured by General Dynamics/Electronics. This equipment will be installed at ATLAS, TITAN and MINUTEMAN missile sites and represents, in the truest sense, a real step ahead in the state of the art of communications. All tuning of the new General Dynamics/Electronics single sideband equipment is digital ■ The use of broadband techniques rather than a servo system results in faster tuning, simplicity and increased reliability ■ Emphasis on linearity, wide dynamic range and selectivity in the receiver RF circuits reduces interference from any



nearby communications equipment to an absolute minimum ■ Self-contained noise blanker eliminates interference from pulse type noise without the need for a separate noise sensing antenna ■ Functional modular construction offers the maximum in ease of maintenance ■ And in addition to all of these operating advantages, General Dynamics/Electronics single sideband equipment is extremely compact, ideal for a wide range of portable and stationary communications applications.

For SC-900 brochure, write:
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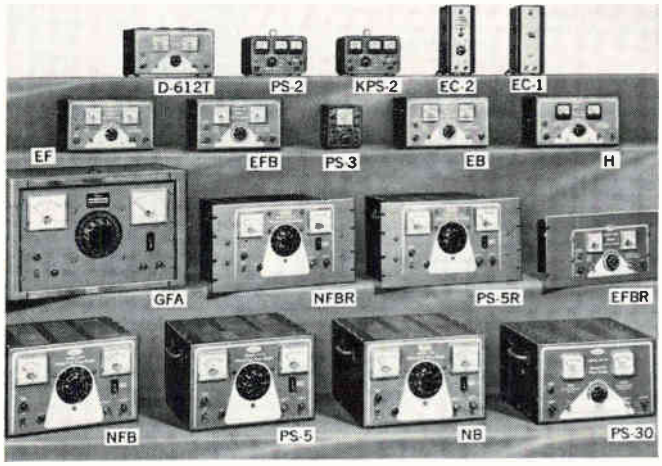
Recognized best in their price class



Model	Voltage Output	Amperage Output	Regulation (V/A)	Maximum Ripple (%)	Meters	Price (net)
GFA	0-125	0-10	1.6 to 10A*	1	0-150V, 0-20A	$575.00
PS-5	0-55	0-10	0.8 (0-10A)	0.5	0-75V, 0-10A	250.00
PS-5R	0-55	0-10	0.8 (0-10A)	0.5	0-75V, 0-10A	275.00
NFB	0-32	0-15	0.3 (0-15A)	0.75	0-50V, 0-25A	250.00
NFBR	0-32	0-15	0.3 (0-15A)	0.75	0-50V, 0-25A	275.00
NB	0-32	0-15	0.3 (0-15A)	5	0-50V, 0-25A	225.00
EFB	0-32 0-16	0-4 0-8	1.25 (0-4A) 1 (0-8A)	0.1	0-40/20V, 0-10A	140.00
EFBR	0-32 0-16	0-4 0-8	1.25 (0-4A) 1 (0-8A)	0.1	0-40/20V, 0-10A	160.00
EB	0-32 0-16	0-4 0-8	1.25 (0-4A) 1 (0-8A)	5	0-40/20V, 0-10A	115.00
EF	0-28 0-14	0-5 0-5	0.9 (1-5A) 0.6 (1-5A)	1	0-50V, 0-6A	98.00
PS-3	0-15 15-25	0-200MA 0-100MA	100MV	1MV	0-25V/100MA/ 200MA	79.50
PS-2	0-20 0-16	0-75MA 0-5A	1.6	0.15 0.5	0-20V, 0-10A & 0-75MA	56.00
KPS-2 (kit)	0-20 0-16	0-75MA 0-5A	1.6	0.15 0.5	0-20V, 0-10A & 0-75MA	44.95
D-612T	0-16 0-8	0-10 0-10	.44 (3-10A) .3 (3-10A)	0.5 @ 5A, 2 @ 10A	0-20V, 0-10A	59.95
EC-2	0-16	0-5	1.8	0.5	0-20V/10A	39.95
H	12** 6**	0-10 0-20	.23 (3-10A) .15 (3-20A)	5	0-20V, 0-30A	86.00
EC-1	12**	0-5	1.4	0.5	.....	29.95

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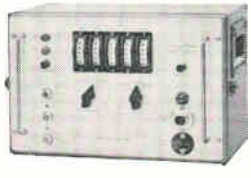

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Opportunities for:

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The Aerospace Vehicles Laboratory of the Space Systems Division has openings for nearly one hundred engineers who have experience in stress, structures, propulsion, mechanisms, control systems, equipment installation or heat transfer which can be applied to advanced aerospace weapons systems or vehicles. The Aerospace Laboratory is concerned, as a result of SURVEYOR and other contracts, with lunar and space exploration, air to air missiles and ICBM defense systems. The openings are for both junior and senior mechanical engineers, electronic engineers, physicists and aeronautical engineers. Some of the openings are described below:

Structures

Senior Dynamicist. Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

Loads Analyst. To establish structural design criteria for advanced missiles and spacecraft. Should be capable of determining external airload and inertial force distributions.

Reliability Analyst. To perform statistical analysis of structural loads and strength properties for the purpose of establishing structural reliability criteria on a probability basis.

Stress Analyst. To perform advanced stress analysis of complex and redundant missile and spacecraft structures. Will be required to solve special problems in elasticity, plasticity, short time creep and structural stability.

Design. Experience is required in preliminary and final structural engineering and design, including preliminary stress analysis. A knowledge of the effects of extreme temperature environment and hard vacuum, plus a background in materials is desired.

Heat Transfer

Space Vehicle Heat Transfer. Basic knowledge of radiation conduction and convection heat transfer with application to thermal control of space vehicles is required. Knowledge of spectrally-selective radiation coating, super-insulations and thermal vacuum testing is of particular value.

Aerothermodynamicist. Experience in hypersonic real gas dynamics, heat transfer, abalation; re-entry vehicle design, detection; shock layer, wake and rocket exhaust ionization; and anti-missile system requirements will be most useful.

Equipment Installation

Packaging and Installation Engineer. To perform optimum packaging and installation design for missile and or spacecraft units, considering amount and geometric shape of space available as well as weight and center of gravity distribution requirements. Must be capable of analyzing structural adequacy of unit under extreme environmental conditions.

Controls

Optical Devices. Design, development, procurement and test operations are involved. Considerable experience in the field of optical devices for space applications such as star, horizon, sun and moon trackers.

System Test. To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

Control System Analysis. Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

Circuit Design and Development. Experience in design and development of transistorized control system circuits, including various types of electronic switching and modulation techniques is required.

If you are a graduate mechanical engineer, electronic engineer, physicist or aeronautical engineer, with experience applicable to the above openings, please airmail your resume to: **Dr. F. P. Adler,** Manager, Space Systems Division, Hughes Aircraft Company, 11940 W. Jefferson Blvd., Culver City 71, California.

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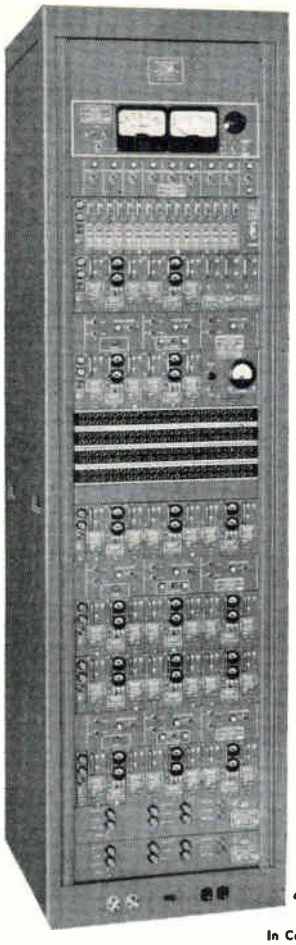

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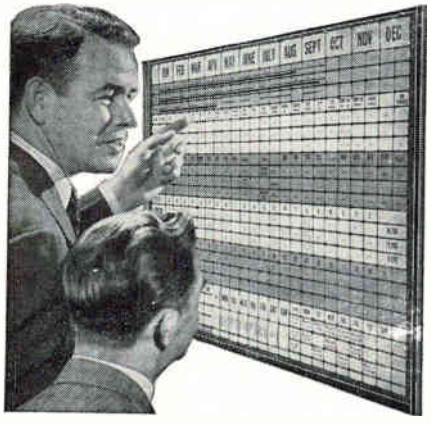

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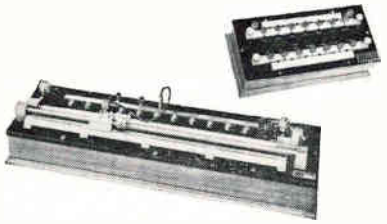

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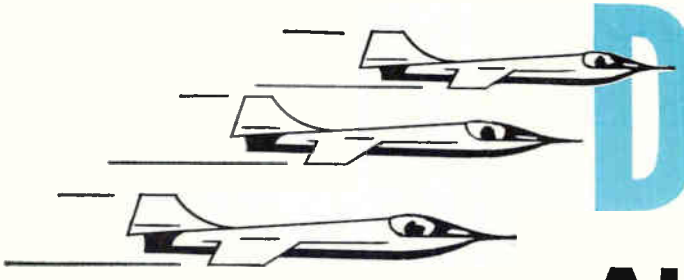

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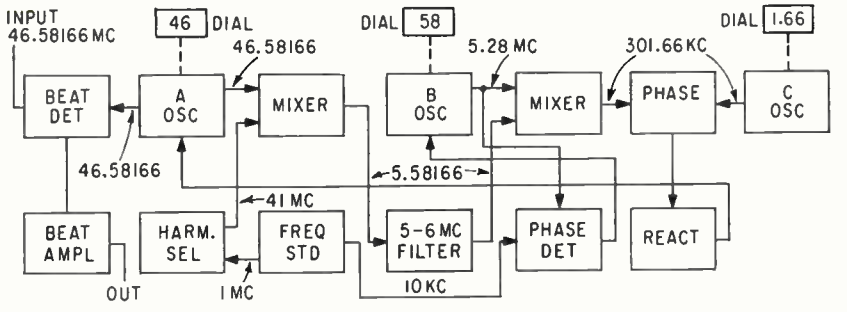
DESIGN AND APPLICATION

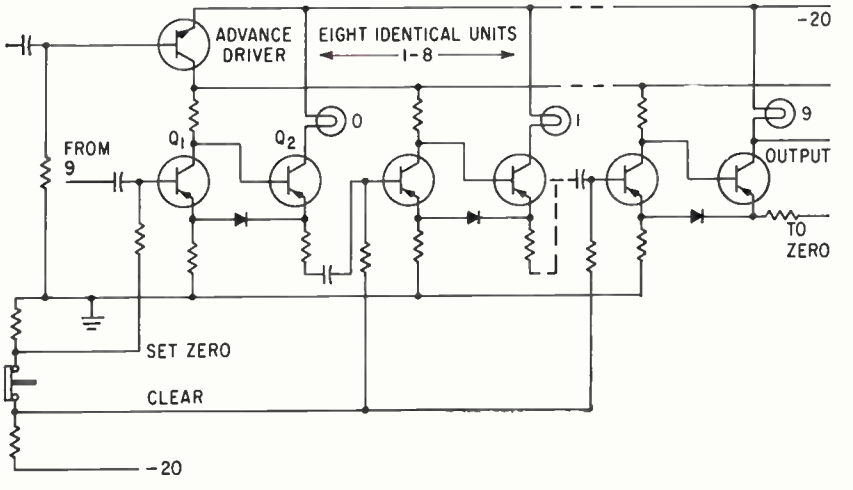


Frequency Meter

10 KC TO 3,000 MC

LAVOIE Laboratories, Inc., Morganville, New Jersey has recently announced their vhf frequency meter LA-70B that can be used between 10 Kc and 3,000 Mc with an accuracy of 0.001 percent between 20 and 3,000 Mc. It can also generate frequencies to 3,000 Mc with a stability of 0.001 percent with a resetability of 0.000025 percent. Internal 400 cps modulation is provided. Measured or generated frequency is provided by in-line readout of three dials reading in megacycles, hundreds and tens of kilocycles, and cycles. The block diagram shows this device used in the frequency-measuring mode, with an incoming frequency of 46.58166 Mc being measured. When the device is used as frequency generator, the dials are set to the desired frequency and a switch modifies the audio beat amplifier to provide 400 cps modulation if desired.

CIRCLE 401 ON READER SERVICE CARD

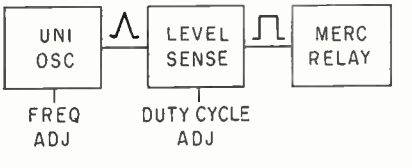


Digital Frequency Meter

USES RING-OF-TEN COUNTER

RECENTLY introduced by General Radio Co., 22 Baker Ave., West Concord, Massachusetts, is the type 1150-A digital frequency meter, a general purpose transistor digital counter using an in-line readout system with incandescent lamps. It has a maximum frequency of 220 Kc, sensitivity better than 1 v, display time adjustable from 0.5 to 5 seconds approximately, counting interval of 0.1, 1, 10 sec, or manual and a time base accuracy of 0.001 percent. This device uses a ring-of-ten counting system instead of the scale-of-ten derived from a scale-of-sixteen with feedback previously used. Although such ring circuits require ten binary flip-flops instead of four, the design is simpler and economical. Since the count proceeds around the ring, one flip-flop at a time, there is no time lost in feedback operations thus reducing delay. There is also no need to interlock d-c levels to maintain adequate margins for reliability. The sketch shows that each DCU consists of a ring of ten bistable circuits, each capable of driving its associated incandescent indicator lamp. In the sketch, the zero set system is shown as a switch. When opened, it returns the clear buss to −20 v causing all left-hand transistors to saturate and turning 1 through 9 lamp drivers off. Input transistor Q_1 will lose forward bias, desaturate, and permit Q_2 to go on thus turning the 0 lamp on. In practice a fast transistor is used to accomplish this zero setting.

CIRCLE 402 ON READER SERVICE CARD



Variable Pulser

TO 10 KC PER MINUTE

CONTROL Indicating Corp., 107 Turnpike Road, Windsor Locks, Connecticut announces and, is showing their solid state, variable-frequency pulser models VFP-100-A

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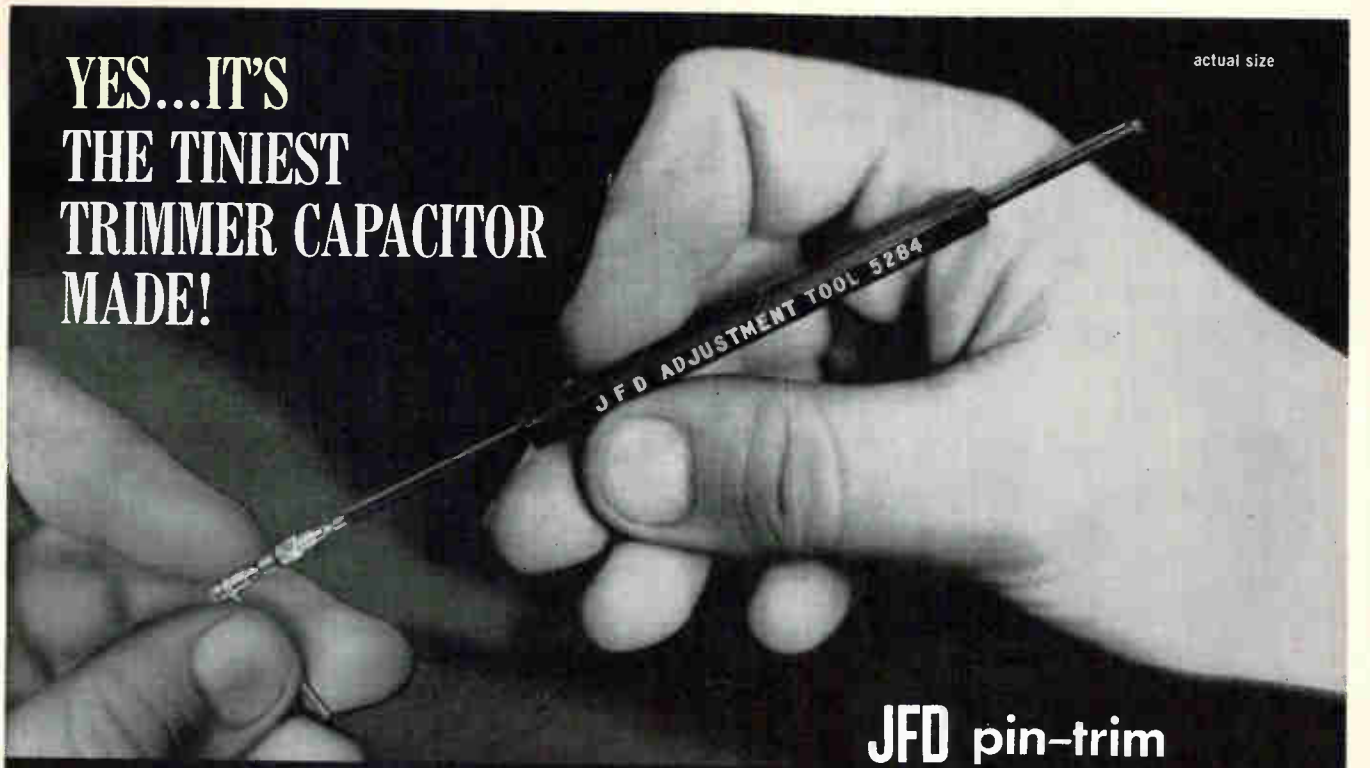

JFD pin-trim

If you are designing for missile environments or applications requiring more capacity in less space, look in to the Pin-Trim. It provides a practicable solution to the challenge of end-product miniaturization with high operational stability.

The new Pin-Trim delivers: (1) more capacitance per cubic centimeter than any other conventional piston trimmer; (2) 75 per cent less weight and 50 per cent less volume than JFD's own miniature trimmers; (3) greater sensitivity; (4) finer adjustment.

If you are looking for maximum compactness between stacked circuit boards, or less stray capacitance in a given area, check the JFD Pin-Trim specifications for your subminiature trimmer applications.

For further data, call your local JFD Field office or your JFD franchised Industrial Distributor.

- Overall diameter: 1/8 inch. Overall length above panel: 3/8 inch to 1 inch.
- Double the sensitivity of JFD standard trimmers. Special adjust mechanism provides 102 turns per inch for extra fine adjustment.
- Increased maximum to minimum capacitance ratio per unit (minimum: 0.5 pf.).
- Operating temperature −55° to +125°C.
- Low temperature coefficient of capacitance.
- Anti-backlash design for precise tuning resolution.
- Low inductance for high frequency use.
- Ultra linear tuning assures accurate alignment—absolute repeatability. Standard slotted end for screwdriver adjustment.
- Rugged shock and vibration resistance.
- 500 V. DC working voltage.
- 10^4 megohms insulation resistance.
- Q factor of 500 (measured as per JFD #5178).
- 0.5 inch ounce tuning torque.
- Meet or exceed applicable performance requirements of MIL-C-14409A.

JFD Adjustment Tool No. 5284 (illustrated) available at 85¢.

Model*	Capacitance Range MMF Measured Per JFD #5177 Min.	Capacitance Range MMF Measured Per JFD #5177 Max.	D.C. Working Volts	Dielectric Strength Measured For 5 Seconds at 50% R.H. at Max. Rated Cap.	Insulation Resistance Measured After One Minute at 500V. D.C. and 50% R.H.	Q Factor Measured Per JFD #5178	Unit Weight Grams	Dimen.** Max. ±1/32
PT901	0.5	2.0	500	1000	10^6 Megohms	500	0.62	3/8"
PT902	0.5	3.0	500	1000	10^6 Megohms	500	0.64	1/2"
PT903	0.5	5.0	500	1000	10^8 Megohms	500	0.79	3/4"
PT904	0.5	7.0	500	1000	10^5 Megohms	500	0.94	1"

* These units are also available in the same capacitance values for printed circuit boards in models PT911, PT912, PT913 and PT914.
** Length front of panel.

U.S. Patent No: 2,922,093 Canadian Patent No: 404,810

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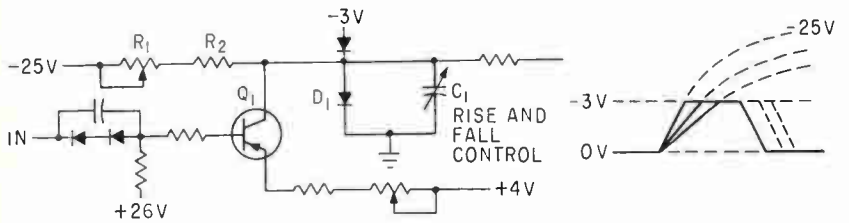
CIRCLE 145 ON READER SERVICE CARD 145

and -B. The frequency can be made adjustable between 1 and 10,000 cycles per minute with the duty cycle variable between 10 and 90 percent. There is no interaction between duty cycle and frequency. The output relay is a mercury-wetted type single-pole, single-throw contacts rated at better than a billion operations. The sketch shows operation of this device. It consists of a unijunction variable-frequency oscillator, a voltage level sensor and amplifier and the mercury-wetted relay. The voltage detector senses the level of the sawtooth generated by the oscillator, without loading the oscillator. The switching circuit does not go into conduction until the voltage level determined by the duty cycle control is exceeding. The square-wave output is amplified to drive the relay.

CIRCLE 403 ON READER SERVICE CARD



Pulse Generator

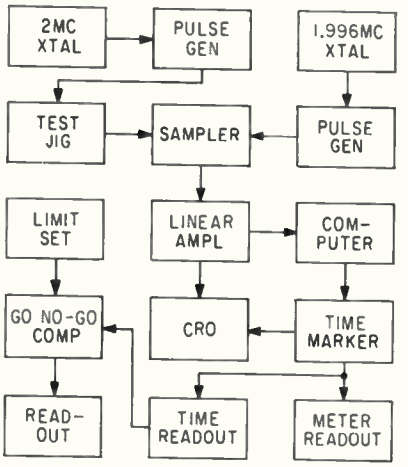
VARIABLE RISE AND FALL TIMES

RESE Engineering, Inc., A and Courtland Streets, Philadelphia 20, Pennsylvania, announce their model 203 pulse generator. This general-purpose, solid-state device generates pulses between 30 pps to 3 Mc from an internal clock and 0 pps to 3 Mc from an external trigger. The output pulse may be delayed from 50 nsec to 1,000 μsec with the pulse width continuously variable between 50 ns and 1,000 μsecs. The rise and fall times of the output pulses can be varied between 20 nsec and 2 μsec. As shown in the sketch, with no pulse input to transistor Q_1, the transistor normally conducts through diode D_1 to keep the collector at approximately zero volts. The 0.2 μsec input pulse cuts off Q_1 and the current flowing through R_1 and R_2 starts to charge variable capacitor C_1 until the voltage reaches -3 v and is then clamped by a diode. Since the change in charging current from -25 v to -22 v is not very great, R_1 and R_2 constitute a constant-current source and the charge of C_1 is very linear. By varying the value of C_1, the exponential slope of the capacitor charging curve is shifted, thus

NEW MULTI-PURPOSE

changing the rise and fall time of the output pulse.

CIRCLE 404 ON READER SERVICE CARD

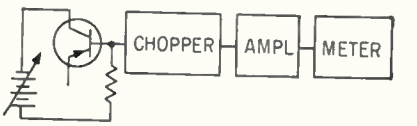


Diode Recovery Time Tester

AUTOMATIC 2 MC TESTS

WILTRON Company, 717 Loma Verde Avenue, Palo Alto, California, recently have announced their model 2051 automatic recovery time test set for use in checking fast computer diodes. This self-contained unit automatically measures diode recovery times from 1 to 50 nsec, or up to 300 nsec with external pulse source. As the sketch shows, a 2 Mc crystal synchronizes a pulse generator and a 1.996 Mc crystal synchronizes a strobe sampling pulser. The small frequency difference provides a time conversion of 5,000:1. After the sampling gate, the waveform is slow and easy to work with. The computer can be programmed for any desired recovery level. At desired level, the computer triggers the time marker generator providing basis for recovery time readout. A meter reads recovery time directly in nanoseconds. Automatic go/no-go circuits compare measured time to programmed limit and indicate on red or green light. High sampling rate makes trace appear continuous and there is a relative absence of ringing on recovery waveform. Microwave stripline test jig provides matched impedance to avoid ringing in most fast-recovery waveforms.

CIRCLE 405 ON READER SERVICE CARD



Dynamic Beta Tester

3 PERCENT ACCURACY

THE Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio, recently announced their model 1880 dynamic beta transistor tester. This completely transistorized unit measures a-c beta, d-c beta and leakage with 3-percent accuracy. Extremely sensitive leakage test is excellent for testing silicon transistors. Special tests include H parameters, input resistance output conductance, gm and $V_{CE(sat)}$. The sketch shows the method of testing leakage. Leakage voltage range is from

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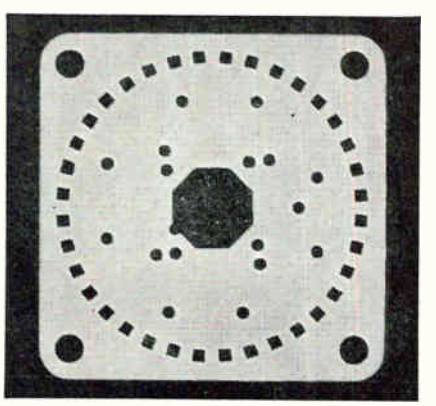

Fireban 1011 has a lengthwise flexural strength of 80,000 psi for 1/16 in. sheet and 76,000 for 1/8 in. Crosswise flexural strength is 70,000 and 65,000 psi respectively. It retains over 50% of its strength at 300 F. Sheets up to 1/16 in. may be cold punched at room temperature without haloing. Other important advantages are low moisture absorption, high chemical resistance, excellent electrical properties even after being subjected to severe humidity conditions.

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Technical data bulletins give complete information, including physical, mechanical and electrical properties on both types of Fireban 1011. Write for your copies today. Taylor Fibre Co., Norristown 40, Pa.

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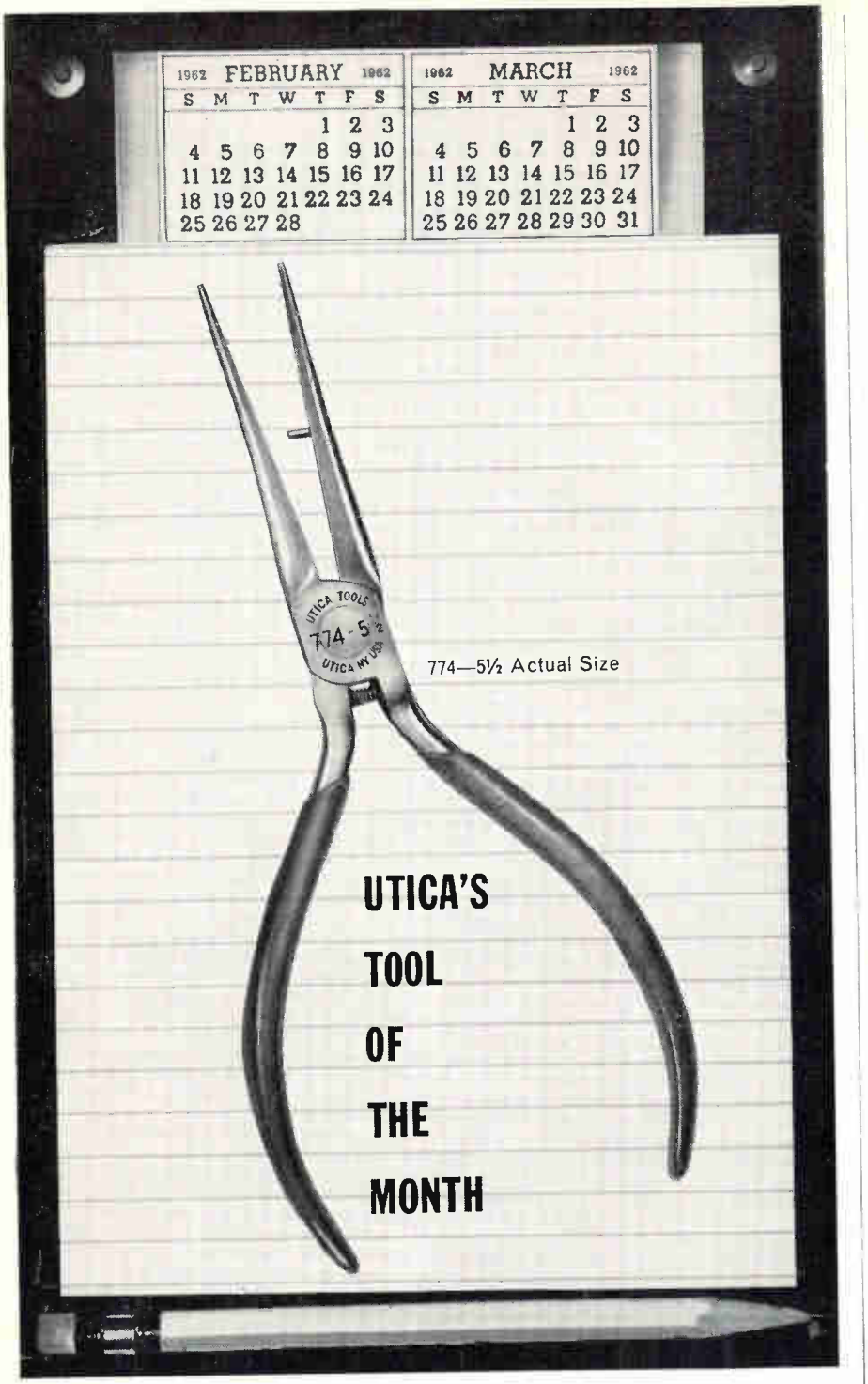
LAMINATED PLASTICS VULCANIZED FIBRE

CIRCLE 147 ON READER SERVICE CARD



Utica does it again with a special tool-of-the-month designed to meet the increasingly demanding needs of the electronic industry. The 774-5½ Electronic Pick-up and Wiring Plier features a dowel pin located in the jaws to assure perfect alignment and positive gripping control for looping, twisting and bending. And the finely tapered nose . . . only 1/16" at the tip . . . will pick-up and hold the finest wire used in electronic production work. Covering a wide range of wiring applications, this new plier is especially useful in handling delicate work in restricted work areas. The Bauer-type grip release spring and heavy plastisol grips offer ease of handling . . . increased production line efficiency.

UTICA TOOLS • DIVISION OF KELSEY-HAYES COMPANY, UTICA 4, NEW YORK

UTICA

148 CIRCLE 148 ON READER SERVICE CARD

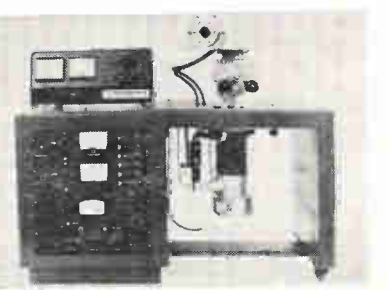
0 to 100 v in regulated 1-v steps. Seven leakage currents from 0-0.05 μa to 0-25 ma are available. Reverse voltage is applied between the two elements being tested and the current caused by this voltage is measured. On the low current ranges; 0-0.05 μa, 0-0.5 μa, and 0-5 μa, the voltage generated across a resistor is applied to a chopper. The square-wave signal is applied to an amplifier and rectified with a bridge circuit. The amplifier gain without feedback is approximately 10^6 and approximately 80 db of feedback is used. Output of the bridge activates the meter. The chopper and amplifier are not used on the higher current ranges. In this case, the voltage is applied directly to the meter.

CIRCLE 406 ON READER SERVICE CARD

Wire Insulation
FEATURES TOUGHNESS

W. L. GORE & ASSOCIATES, INC., 555 Paper Mill Road, Newark, Del., announces Milene, a laminated insulation compounded from Mylar polyester film and polyethylene. It is possible to get 534 22-gage thin wall Milene insulated wires in a 1 in. diameter circle. Only 300 22-gage wires with 10 mils of insulation can be put in the same area. UL results on the 100 C cut-through test show that with the 1,000 gram weight, 10 mils of PVC insulation cuts through instantly while 3 mils of Milene lasts over the 1 hr test limit.

CIRCLE 407 ON READER SERVICE CARD



Vapor Deposition Unit
USES ELECTRON BEAM

MRC MFG. CORP., Orangeburg, N. Y. Model EVD-96 is designed to vapor deposit in high vacuum thin films of high temperature materials such

NEW FROM SORENSEN

QM 48 VOLT SERIES

COMPACT, TRANSISTORIZED DC SUPPLIES
±0.05% REGULATION (LINE AND LOAD)

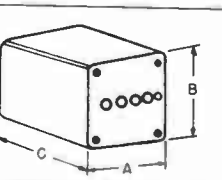
QM miniaturized DC supplies combine excellent regulation and extremely low ripple (less than 1MV RMS) with maximum reliability. These completely transistorized units are ideal for use with semiconductor circuitry.

Rugged QM supplies, recommended for a wide variety of "built-in" applications, are designed to resist damage from momentary overloads or output shorts. Intermediate voltages and power levels are available. Consult factory or local representative for complete specifications.

STANDARD RATINGS AND SIZES

Nominal Watts	2		4		8		15		30	
Nominal Output Volts	Amp.	Size	Amp.	Size	Amp.	Size	Amp.	Size	Amp.	Size
3.0	0.66	1	1.3	2	2.6	3	5.0	5	. . .	.
4.4	0.45	1	0.9	2	1.8	3	3.5	5	. . .	.
6.3	0.32	1	0.64	2	1.28	3	2.4	4	4.00	5
9.0	0.22	1	0.44	2	0.88	3	1.7	4	3.00	5
12.0	0.16	1	0.32	2	0.64	3	1.25	4	2.56	5
16.0	0.13	1	0.25	2	0.50	3	0.94	4	1.87	5
21.0	0.10	1	0.19	2	0.38	3	0.71	4	1.43	5
28.0	0.07	1	0.14	2	0.28	3	0.53	4	1.07	5
36.0	0.06	1	0.11	2	0.22	3	0.43	4	0.83	5
48.0	0.04	1	0.08	2	0.16	3	0.31	4	0.62	5

Size	A	B	C	Approx. Weight
1	3 9/32	3 3/32	5	3 lbs.
2	4 5/16	3 11/16	5 1/16	5 lbs.
3	4 11/16	4	6 1/8	6 lbs.
4	4 11/16	4	6 1/8	7 lbs.
5	5 3/32	4 11/32	6 15/16	10 lbs.



IRE SHOW BOOTHS; 2602-2604

Sorensen — A UNIT OF RAYTHEON COMPANY

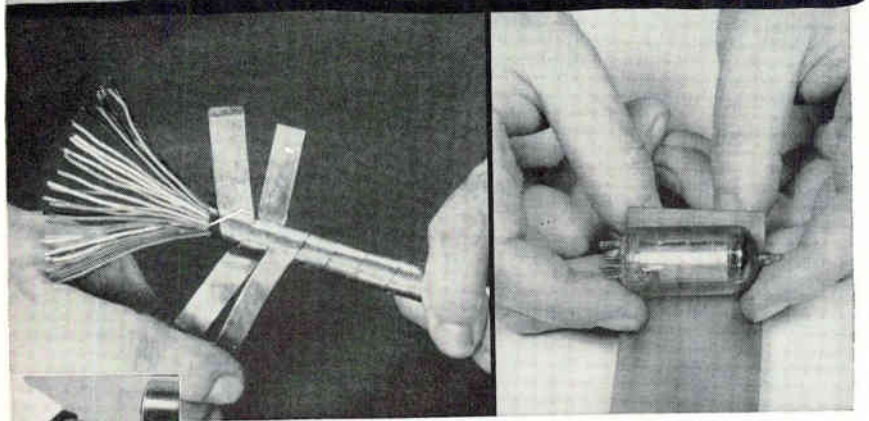
RICHARDS AVENUE • SOUTH NORWALK • CONNECTICUT

March 9, 1962

CIRCLE 149 ON READER SERVICE CARD

WRAP-AROUND MAGNETIC SHIELDS

APPLIED IN SECONDS



Cuts readily with ordinary scissors. Economical CO-NETIC and NETIC Magnetic Shielding Foils are for any size or shape components. Available in continuous lengths on rolls up to 15" wide . . . for human production line or to fit automated existing reels of your tape serving machinery. Furnished in final annealed state ready for your operation.

HOW YOU SAVE SPACE, WEIGHT, TIME, MONEY

Minimum weight and displacement shielding designs are possible due to the magnetic shielding effectiveness of Co-Netic and Netic foils . . . foils can be supplied FROM .002", even thinner if you desire. Ordinary scissors cut foil easily to exact contour and size required. Foil can be wrapped quickly around hard-to-get-at components, saving valuable time, minimizing tooling costs.

HOW TO INCREASE RELIABILITY

Guard against performance degradation from unpredictable magnetic field conditions to which your equipment may be exposed. Eliminate such failure or erratic performance possibilities with dependable Co-Netic and Netic protection . . . assuring *performance repeatability* for your device over a *wider range* of magnetic field conditions.

Co-Netic and Netic alloys are not affected significantly by dropping, vibration or shock. They are characterized by low magnetic retention and do not require periodic annealing. When grounded, they effectively shield electrostatic as well as magnetic fields over a wide range of intensities.

Every satellite and virtually all guidance devices increase reliability with Netic and Co-Netic magnetic shielding alloys. Use these highly adaptable foils for saving valuable space, weight, time and money . . . in solving your magnetic shielding problems for military, commercial and laboratory applications.

PHONE YOUR NEAREST SALES OFFICE TODAY:

MERIDEN, CONNECTICUT, BEverly 7-9232
UNION CITY, NEW JERSEY, UNion 4-9577
BALTIMORE, MARYLAND, HOpkins 7-3766
DECATUR, GEORGIA, 378-7516
CORAL GABLES, FLORIDA, HIghlands 3-7439
MAITLAND, FLORIDA, MIdway 7-7830
ST. PETERSBURG, FLORIDA, WAverly 1-9735
DALLAS, TEXAS, FLeetwood 1-1615
HOUSTON, TEXAS, HOmestead 5-7780
ALBUQUERQUE, NEW MEXICO, AMherst 8-6797
PHOENIX, ARIZONA, AMhurst 4-4934
SAN DIEGO, CALIFORNIA, BRowning 8-6230
LOS ANGELES, CALIFORNIA, WEbster 1-1041
PALO ALTO, CALIFORNIA, DAvenport 1-5064
SEATTLE, WASHINGTON, EA 3-8545
MONTREAL, QUEBEC, WEllington 7-1167

MAGNETIC SHIELD DIVISION

Perfection Mica Company / EVerglade 4-2122

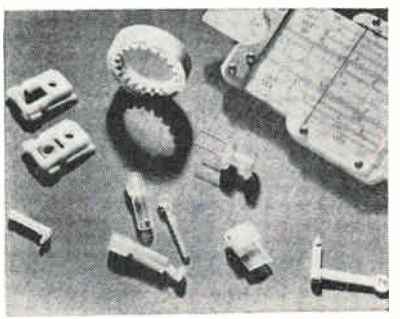
1322 N. ELSTON AVENUE, CHICAGO 22, ILLINOIS

ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING

150 CIRCLE 150 ON READER SERVICE CARD

as tungsten, tantalum and molybdenum and is equally capable of handling all other metals. With a suitable choice of substrates and masks, resistor, connector and capacitor films can be readily deposited for the production of electronic devices. The electron beam heating source consists of an annular gun and focusing shields. The gun, in conjunction with the cold mold materials holder, helps to retain the bulk properties of the material deposited.

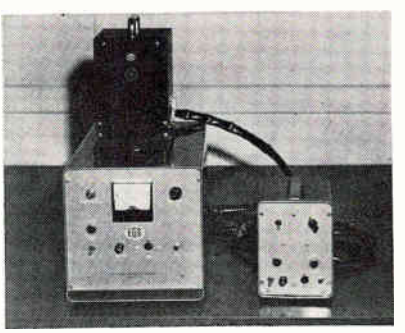
CIRCLE 408 ON READER SERVICE CARD



Precision Parts
PLASTIC MOLDED

GRIES REPRODUCER CORP., 400 Beechwood Ave., New Rochelle, N. Y. Each of the tiny parts illustrated was molded by the company in the engineering thermoplastic that best fulfilled the application specifications. For example, Delrin was chosen for its rigidity, Cycolac for high impact strength, and Kel-F 81 for high heat resistance and zero water absorption. Specifications for GRC plastic moldings are: maximum size and weight—1¾ in., 0.05 oz; no minimum size.

CIRCLE 409 ON READER SERVICE CARD

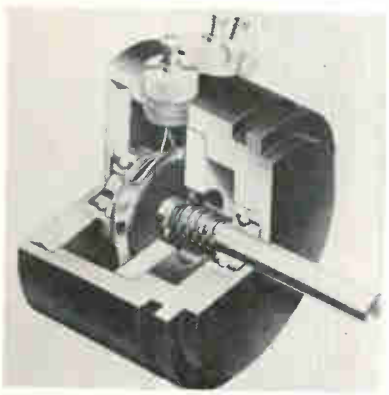


Pulsed Power Systems
FOR LASER STUDIES

EDGERTON, GERMESHAUSEN & GRIER, INC., 160 Brookline Ave., Boston 15,

Mass. Two compact, low-cost pulsed power systems were designed for driving flash tubes for motion studies, cloud chamber physics, laser stimulation, flash catalysis, and other applications. Model 530 has an output of 100 w-sec (260 μf at 900 v) selectable at 25, 50 and 100 percent full power. Output of model 531 is 400 w-sec (1,050 μf at 900 v). Input for both is 115 v 60 cycle a-c.

CIRCLE 410 ON READER SERVICE CARD

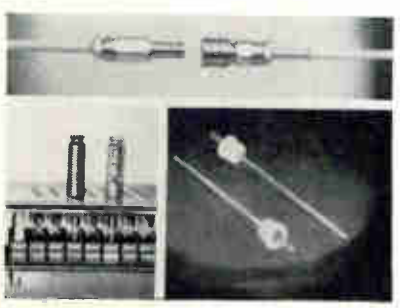


Precision Pot

ROTARY UNIT

HELIPOT DIVISION of Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif. Model 6200 is a single-turn rotary unit having a Cermet resistance element. Cermet is completely stable in ambients from −55 to +175 C, it is totally impervious to the effects of humidity, and life is estimated conservatively at 3 million turns. Resistance ranges are from 100 ohms to 50,000 ohms, and power ratings to 3 w are handled with ease.

CIRCLE 411 ON READER SERVICE CARD



Connectors, Terminals

& PROGRAM BOARDS

SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y. The ConheX

Itek

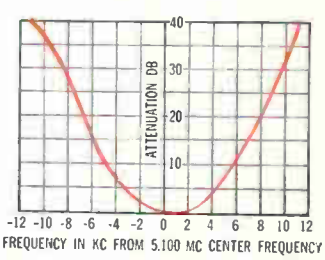
Crystal Filters do Wonderful Things

Booth 3934
IRE SHOW

A toast to Itek for a wonderful thing . . . Itek Crystal Filter 968B, with a near-Gaussian attenuation characteristic makes possible a 10,000 channel receiver! In antenna circuits, this 5 MC Filter optimizes pulse response, minimizes overshoot, and eliminates adjacent channel interference.

Perhaps you don't need a Gaussian crystal filter. But could you use the ingenuity that built one? Could Itek technical leadership help you?

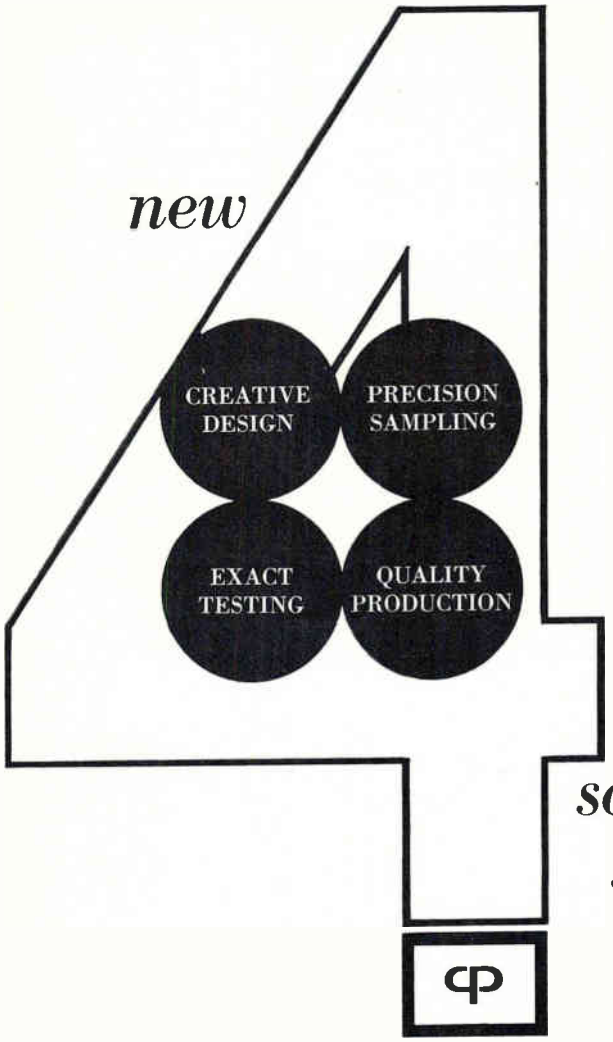
Of course, the world's largest and most complete selection of stock filters is available, too. Choose from more than 3,000 Itek-Hermes designs.



Write for free Brochure "WEESKACFAACP" or, What Every Engineer Should Know About Crystal Filters At A Cocktail Party. You'll enjoy it.

Itek Electro-Products Company

75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASS. A DIVISION OF Itek



CP Electronics specialists provide a 4-phase service for electromagnetic component design, engineering and manufacturing. Specialized service in new product development is the key to achieving the full capabilities of your end products or sub-assemblies. Electromagnetic components must be custom-designed and produced to meet your individual specifications. At CP, years of experience in the development of power and audio amplification components have led to close engineering that converts design into high-quality components with specific tolerances. The all-new CP Electronics Research and Development Laboratory at West Lafayette, Indiana stands ready to serve you, as do CP's complete testing and production facilities. For the custom components you require . . . for greater depth in new product, new technique engineering . . . investigate CP's 4-phase problem-solving service soon!

Write for actual examples of how CP's 4-phase problem-solving service has worked for others. For example, each year CP's facilities account for large-scale manufacturing of laminated iron-cored transformers and inductors with open, encapsulated or hermetically sealed construction and insulation allowing temperature ratings to 130° C. These are utilized at both power and audio frequencies with versions available for pulse transformer applications where pulse widths are in the microsecond range and PRF in the audio range.

CP ELECTRONICS, INC.
(FORMERLY COLUMBUS PROCESS COMPANY, INC.)
COLUMBUS, INDIANA • PHONE 812-372-4471
Manufacturers of Electro-Magnetic Components for Audio Amplification • Telemetering • Radio, TV, HiFi, Stereo • Civilian Broadcast Equipment • Specialty Power Supplies

152 CIRCLE 152 ON READER SERVICE CARD

subminiature r-f connectors feature closed entry design that results in better contact, more efficient power transfer, and greater dependability through elimination of receptacle distortion in use. New Press-Fit terminal designs include a series of long pigtail lead models that permit a direct conductor path to a component or termination without the need of a second soldering operation. The cordless Sealectoboard is used as a programming, switching, and central control device.

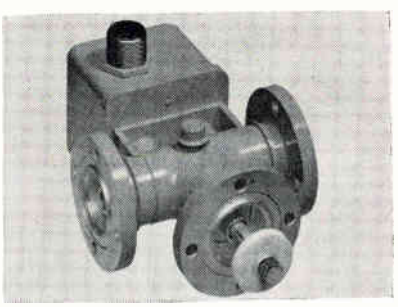
CIRCLE 412 ON READER SERVICE CARD

Phase Angle Voltmeter

VERSATILE UNIT

GERTSCH PRODUCTS, INC., 3211 S. La-Cienega Blvd., Los Angeles 16, Calif. Model PAV-1 combines the capabilities of a standard a-c vtvm, and a phase-sensitive vtvm, into a single unit. Available plug-in units provide operation as a phase angle voltmeter for 1, 2, or 3 different frequencies, variable ±5 percent. In addition to standard vtvm full scale ranges, a variable attenuator in the instrument allows any voltage from 0.001 to 300 v to be set as full scale deflection.

CIRCLE 413 ON READER SERVICE CARD



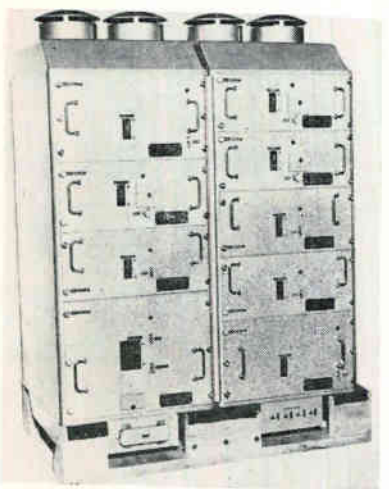
Vacuum Coax Relay

SPDT DEVICE

JENNINGS RADIO MFG. CORP., P.O. Box 1278, San Jose 8, Calif., announces the RC6 vacuum coax relay. Vacuum dielectric maintains a low unchanging contact resistance and there is no change in electrical characteristics during long periods

of storage or use. No damage occurs to the contacts if the relay is accidentally switched hot. Also, the vacuum enclosed contacts never require maintenance. Relay employs a newly designed electromagnetic type actuating mechanism. Positive latching is assured with powerful permanent magnets.

CIRCLE 414 ON READER SERVICE CARD

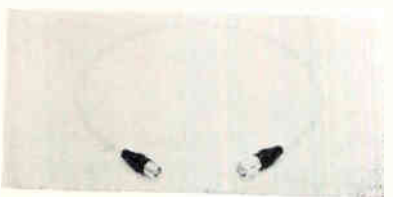


Static Inverter System

HIGH POWER RATING

VARO INC., 2201 Walnut St., Garland, Texas. Model 4350 is a modular-constructed 40-Kw static inverter system operating from 200 v d-c input. It provides both single-phase and three-phase output power at fixed frequencies of 60 and 400 cps. Smallest module has an output of 1 Kw. System contains 3-Kw, 5-Kw, and 10-Kw inverters. It may be used for both ground and shipborne installations. Features: low noise, small size and weight, low magnetic properties, and maintenance-free operation.

CIRCLE 415 ON READER SERVICE CARD

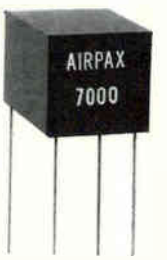


R-F Coaxial Plugs

FOR MINIATURE CABLES

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, Calif. The Crimp-Imp, designed for miniature cables, is installed using crimp

AIRPAX TRANSISTOR CHOPPER TYPE 7000



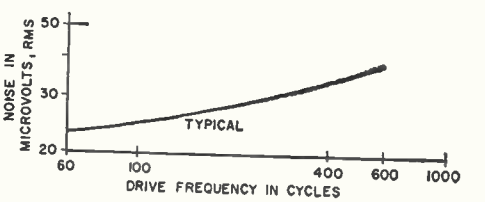
Low noise, high reliability and wide operating range are achieved in this all new transistor chopper. Welded circuitry and micro-miniature components permit high density packaging and ultra reliability. Complete isolation is obtained between drive and switching circuits without the use of a drive transformer.

RATINGS

Signal Input Voltage . . . ± 7 volts DC or peak
Signal Current . . . 1 ma maximum
Drive Frequency . . . 0 - 2KC
Drive Voltage . . . 5.5 to 10 volts DC, peak pulse or sq. wv.
Temp. Range: —30° C to +100° C operating; —55° C to +125° C storage
Noise . . . 35 uv RMS
Shock . . . 100 G in any plane Vibration . . . 10 - 2000 CPS at 20 G
Size . . . 0.4 Cubic inch

NOISE vs. FREQUENCY

BANDWIDTH: 20 CPS - 1500 CPS
DRIVE: 6 VOLTS, SQUARE WAVE
TEMPERATURE: 25° C.
INPUT AND OUTPUT
IMPEDANCE: 10 K OHMS



CD-11

AIRPAX ELECTRONICS INCORPORATED

PHONE 228-4600 TWX CAMB MD 545-U

CAMBRIDGE DIVISION • CAMBRIDGE, MARYLAND

METOHM precision resistors in handy protective "pop-out" package of ten.

NOW!

Ward Leonard precision metal films too!

"METOHMS" OUTDO MIL-R-10509D

Now Ward Leonard offers you the same uncompromising quality, the same superlative reliability in a metal-film precision resistor that you've come to know and expect in Ward Leonard power resistors.

Ward Leonard METOHM molded metal-film precision resistors exceed the requirements of MIL-R-10509D, characteristics B, C, and E. Standard METOHM resistance tolerances are ±1%; tolerances to ±0.05% on special order.

METOHMS exceed wire-wound precision resistors in high-frequency performance yet are smaller and lighter weight. And, they far excel other types of precision film resistors in low, and controllable, temperature coefficient of resistivity. Moreover, these low TC's apply over the entire range of resistance values. 2.9

METOHM TYPE	MIL EQUIVALENT	RATED WATTS	OHMIC VALUES		MAX. VOLTAGE RATING
			MIN.	MAX.	
WL 60	RN 60	⅛	30	500K	250 V.
WL 65	RN 65	¼	50	1 meg.	300 V.
WL 70	RN 70	½	50	1.5 meg.	350 V.

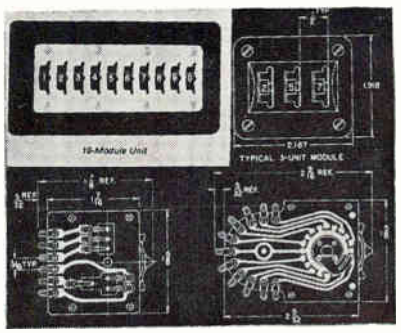
You'll find full data on METOHM resistors in Ward Leonard Catalog No. 50. Write for your copy and a list of distributors today. Ward Leonard Electric Co., 30 South Street, Mount Vernon, New York.

RESULT-ENGINEERED CONTROLS
WARD LEONARD ELECTRIC CO. MOUNT VERNON NEW YORK
RESISTORS • RHEOSTATS • RELAYS • CONTROLS • DIMMERS

Come visit us at Booth 2231 at the IRE Show.

techniques for both the cable center conductor and the cable braid. Plugs have matched impedance and exhibit a vswr of not greater than 1.18:1 over a frequency range of 100 Mc to 2 Gc. The internal mating area of the plugs is environmentally sealed when the plugs are mated, and the junction where cable and plug meet is sealed by a rubber boot.

CIRCLE 416 ON READER SERVICE CARD

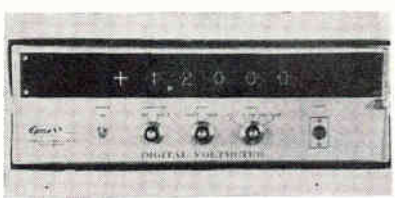


Thumbwheel Switches

DIGITAL AND BINARY

CHICAGO DYNAMIC INDUSTRIES, INC., 1725 Diversey Blvd., Chicago 14, Ill. Line of miniature modular tab type digital (series MTTSD) and binary (series MTTSB 4-bit code) p-c thumbwheel switches are 1⅝ in. high and mount on ½ in. centers. They can be supplied in 8, 10 or 12 positions and to meet MIL-S-22710. Modular assemblies are available in 1 to 36 switch combinations. Price range $2.90 to $4.95 for digital and $9.30 to $11.95 for binary type depending on quantity.

CIRCLE 417 ON READER SERVICE CARD



Digital Voltmeter

ALL SOLID STATE

EPSCO INC., 275 Massachusetts Ave., Cambridge, Mass., has developed a universal voltmeter-analog to digital converter (VAD). The low-cost high speed, 4-digit digital voltmeter with floating differential input is designed for both high and low speed data conversion requirements. The VAD features 1000 megohm input impedance, 0.01 per-

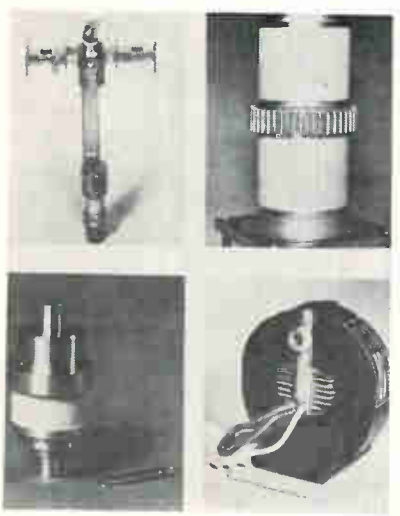
cent accuracy, auto polarity, auto ranging, 100 μsec conversion, a 500 v common mode rejection range, and easy to read Nixie display.

CIRCLE 418 ON READER SERVICE CARD

Waveguide Castings

ARWOOD CORP., 321 W. 44th St., New York 36, N. Y., announces premium waveguide castings with 63 rms finish, as well as thin wall and high temperature magnesium castings, and compact heat sink type castings.

CIRCLE 419 ON READER SERVICE CARD



Power Tubes
WIDE VARIETY

GENERAL ELECTRIC CO., Schenectady 5, N. Y., offers a variety of power tubes including: KU-band twt Z-5184 (top left, without solenoid) with nominal peak power output of more than 1 Kw; ZT-7000 hydrogen thyratron (top right) with an average power capability of 100 Kw; ZP-1025 metal-ceramic triode (bottom left) which delivers a typical peak power output of 2 Kw under 0.01 duty cycle at 1,100 Mc; Z-5424 typical voltage-tunable magnetron, a power oscillator with a minimum c-w output of 50 w in the 2.9-3.2 Gc range and efficiency of 50 percent minimum.

CIRCLE 420 ON READER SERVICE CARD

Tape Reader
AND SPOOLER

POTTER INSTRUMENT CO., INC., Sunnyside Blvd., Plainview, N. Y., announces the PTR-50 perforated

OPTICAL SHAFT POSITION ENCODER

Continuous Or Pulsed DATA

10 Seconds of Arc

RESOLUTION

Type RD17 Digisyn® Encoder
10" diameter x 4¾" high

To take full advantage of the pointing accuracy of today's tracking radars, digital encoders with high resolution and interrogation rates are essential. A typical application of the Wayne-George 17 digit DIGISYN provides continuous digital output to describe target positions with resolution of 10 seconds of arc. DIGISYN encoders are available with linear, sine-cosine and other non-linear functions of rotation. Codes include cyclic binary and binary coded decimal. All electronics including power supply and amplifiers are self-contained plug-in units.

Wayne-George's experience in the design and production of 22 encoder types for a wide variety of applications is available to meet your special requirements.

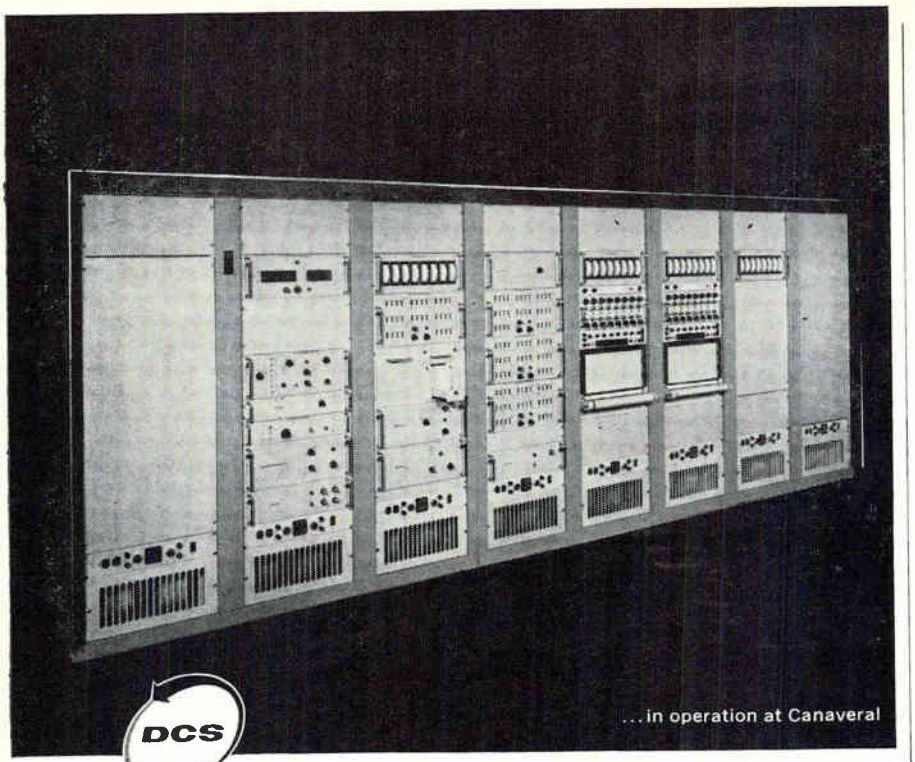
Write for Technical Literature

WAYNE-GEORGE CORPORATION

322 Needham Street, Newton 64, Mass.

IRE Show Booth No. 3237

CIRCLE 155 ON READER SERVICE CARD



Can you use these unique features of DCS PCM Digital Data Systems?

If you are considering PCM telemetry ground stations or any digital data system, you will be interested to learn what's available from DCS. Designed to the same standards of reliability which have built DCS's reputation in FM analog data systems, DCS digital data systems offer these unique features:

- a signal generator capable of simulating several signal modes and operating conditions
- a pulse synchronizer which optimally recovers data in the presence of severe noise and reconstitutes the pulse train
- automatic synchronization under conditions of gross time base perturbations
- provisions for conventional or majority logic for sync recognition
- a digital-to-analog converter featuring thumb-wheel selection of channel to be presented in analog form

These are only a few of the exclusive features of DCS digital data systems. We'd be pleased to assist you in adapting these proved capabilities and equipments to meet your specific requirements. Call your nearest DCS field office, or write us at Dept. E-1-9.

DCS

DATA-CONTROL SYSTEMS, INC.

Instrumentation for Research

Los Angeles • Santa Clara • Wash., D. C. • Cape Canaveral
Home Office: E. Liberty St., Danbury. Conn. • Pioneer 3-9241

CIRCLE 156 ON READER SERVICE CARD

tape reader and its companion PTS-50 spooler. Using photoelectric sensing for two-way high-speed read capability, the PTR-50 introduces the Monobrake tape stop system, a device that eliminates tape bounce and buckling at the read station. The pinch-roller design simplifies alignment. The PTR-50 and PTS-50 combination accommodates tape widths of $\frac{1}{4}$ in., $\frac{1}{2}$ in., or 1 in., with changeover accomplished by repositioning the tape guide posts.

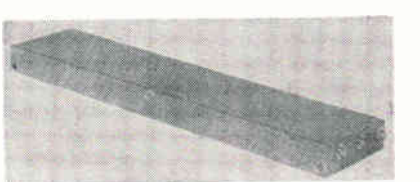
CIRCLE 421 ON READER SERVICE CARD

Coil Winding Machine

AUTOMATED

LEESONA CORP., 333 Strawberry Field Rd., Warwick, R. I. The No. 116, a rotary unit of from 6 to 12 winder heads, was designed to reduce labor costs while increasing bobbin coil production. It will wind from 400 to 1,000 coils per hr in Awg 16 to 50 and finer. Its individually-powered heads will wind all sizes of coils up to 3 in. in diameter by $2\frac{3}{4}$ in. in length, and will wind, simultaneously, two or more different coils. Machine will support and wind from 100 lb wire containers.

CIRCLE 422 ON READER SERVICE CARD



Delay Lines

ELECTRICALLY VARIABLE

COLUMBIA TECHNICAL CORP., Woodside 77, N. Y. Type 1460 can provide continuously variable delays

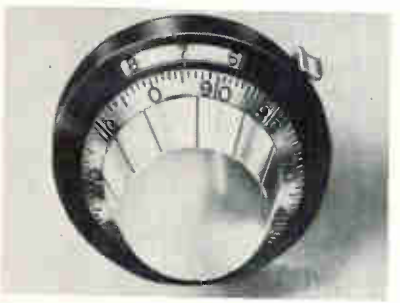
from minus to plus 10 percent of nominal value, with infinite resolution, by varying a d-c potential superimposed on the input signal, without appreciable performance degradation. It is rated 0.2 μsec delay at 95 ohm impedance, and displays high fidelity frequency response with a rollover at 60 Mc.

CIRCLE 423 ON READER SERVICE CARD

Noise Analyzers

QUAN-TECH LABORATORIES, INC., Boonton, N. J., has available model 310 transistor noise analyzer, model 311 low-current transistor noise analyzer, model 315 resistor noise test set, model 303 noise and wave spectrum analyzer and other accessory noise equipment.

CIRCLE 424 ON READER SERVICE CARD



Turns Counting Dial

SIMPLE TO INSTALL

VEMALINE PRODUCTS CO., Franklin Lakes, N. J. The Vem-A-Dial turns counting dial fits precision potentiometers and other multiturn devices. It is well constructed for long life, low in cost, meets applicable MIL Specs, counts up to 15 revolutions, is calibrated in 100th of a turn increments.

CIRCLE 425 ON READER SERVICE CARD

Servo Assembly

IN IN-LINE FORM

DAYSTROM, INC., Transicoil Division, Worcester, Pa. In-line servo package includes a motor generator coupled through appropriate gearing to a control transformer. Signal in-

NEW

DC driven CHOPPERS

What... No AC?

In transistorized d-c amplifiers, the use of a d-c driven Chopper instead of the usual a-c drive, removes an additional source of stray a-c signals from the critical chassis wiring. The 94 cycle chopping rate also eliminates the null off-sets resulting from the use of a 60 cycle chopping rate.

In portable d-c amplifiers, the advantages of low level operation plus a 94 cycle chopping rate are now available, using a 12, or 24 volt battery as the chopper drive source.

Write for Catalog 554.

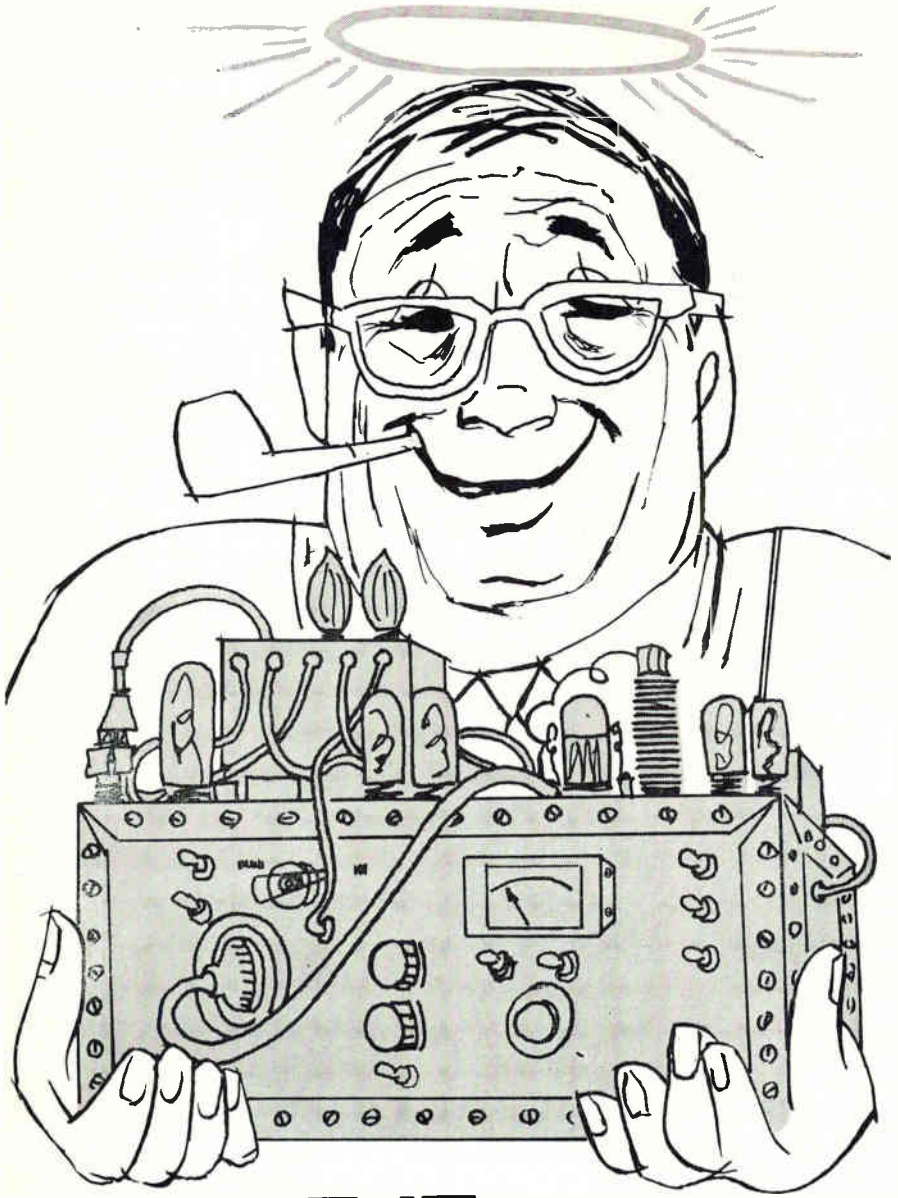
STEVENS INCORPORATED ARNOLD

QUALITY SINCE 1943

7 ELKINS ST., SOUTH BOSTON 27, MASS.

S/A-20-2/3

"Visit us at IRE Show—Booth #2920"



I MADE IT ALL MYSELF!

We have to admire the purism of a hobbyist and the personal satisfaction he gets from doing every part of a job himself. But we know that you, as a professional engineer, don't have time for such luxuries. Your purpose is to get results **now**. That's why you make some things and buy others.

When it comes to digital circuits, you can't afford to make your own. Why? Because proven EECo digital modules are immediately available ...at prices you can't hope to match by "do-it-yourself" methods.

Write today on your company letterhead for complete technical data and price information on any of our more than 200 proven catalogued digital circuits.

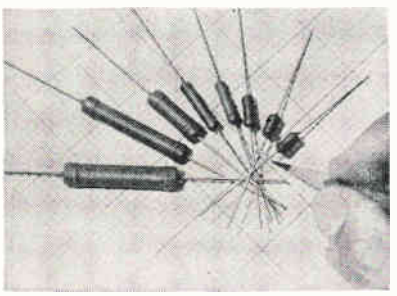
ENGINEERED ELECTRONICS Company

ENGINEERED ELECTRONICS Company

1441 EAST CHESTNUT AVENUE • SANTA ANA, CALIFORNIA
KIMBERLY 7-5651 CABLE ADDRESS: ENGELEX

put to the device is three wire synchro data applied to the control transformer stator. When the rotor is continuously driven to null in a feedback loop, the output of the rate generator represents the first derivative of the three wire data. This computation finds frequent usage in navigational computers.

CIRCLE 426 ON READER SERVICE CARD



Silicone Resistor

WIRE WOUND

WARD LEONARD ELECTRIC CO., Mount Vernon, N. Y. The Syl-Ohm miniature power resistors feature: (1) Low T. C. resistance wire (to 20 ppm/deg C max) uniformly wound on tough miniature ceramic cores. (2) Sturdy axial leads designed for improved solderability. (3) A specially formulated silicone embedding coating for maximum protection against moisture, thermal shock, salt spray and other adverse operating conditions. They are available in 8 sizes from 1 to 12.5 w.

CIRCLE 427 ON READER SERVICE CARD

Pulse Transformer

PCA ELECTRONICS INC., 16799 Schoenborn St., Sepulveda, Calif., announces availability of a 10 Kv dual purpose pulse transformer.

CIRCLE 428 ON READER SERVICE CARD

Reflex Klystron

RUGGEDIZED

WESTINGHOUSE ELECTRONIC TUBE DIVISION, BOX 284, Elmira, N. Y. The WL-6781 has an integral cavity. It

is suited for use as a local oscillator in airborne radars, and as a lab signal source. Tunable over a 8.5- to 10-Gc range by means of a tuning screw, the tube is designed to give high performance at beam voltages as low as 200 v. It has molded leads and a viking 5-pin connector.

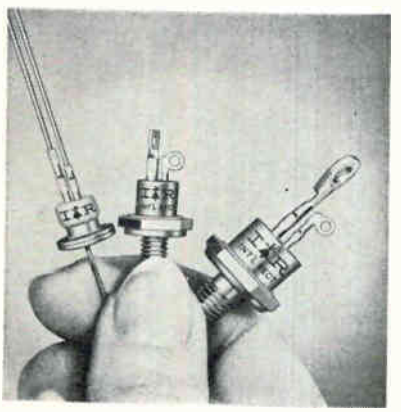
CIRCLE 429 ON READER SERVICE CARD

Power Supply Tube

HIGH-PERVEANCE

RAYTHEON CO., 55 Chapel St., Newton 58, Mass. High-perveance beam tube features low tube drop and high plate resistance for maximum circuit efficiency. Applications of the CK6216 includes series pass in regulated power supplies, a power switch to drive d-c wire lines, a screen grid clamper to protect Class C beam pentodes, a magnetic control tube, and many others.

CIRCLE 430 ON READER SERVICE CARD

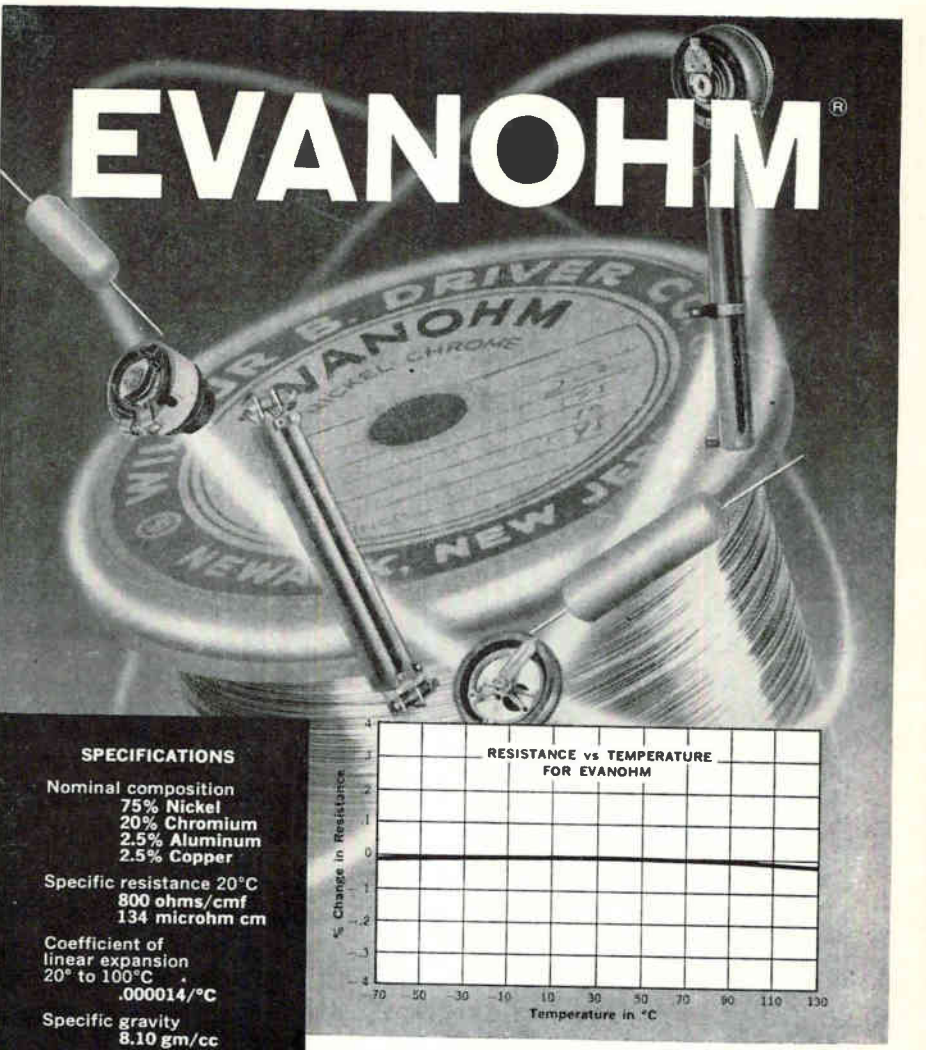


Controlled Rectifiers

FAST TURN-OFF

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Three series of scr's are de-

Time-tested Standard of the Resistor Industry!



SPECIFICATIONS

Nominal composition
75% Nickel
20% Chromium
2.5% Aluminum
2.5% Copper

Specific resistance 20°C
800 ohms/cmf
134 microhm cm

Coefficient of linear expansion 20° to 100°C
.000014/°C

Specific gravity
8.10 gm/cc

Pounds per cubic inch
.293

Magnetic attraction
None

Average tensile strength
180,000 psi

Thermal conductivity
0.152 W/cm/°C

Mean thermal EMF vs copper 0°C to 100°C
1 μv/°C

Specify EVANOHM for exceptional stability over wide temperature ranges. This WBD precision resistance alloy provides high specific resistance, low temperature coefficient and low thermal EMF to copper. It is especially recommended for high reliability applications . . . resistors, precision instruments, missiles and critical equipment. Available in bare wire, enameled or insulated.

FINE WIRE ALLOYS IN A FULL RANGE OF RESISTIVITIES

ALLOY	Nominal Composition	Resistivity (ohms/cmf)	T.C. of Resistance (ohms/ohm/°C, 20-100°C)	Specific Gravity gms/cc
Evanohm®	75 Ni-20 Cr-2.5 Al-2.5 Cu	800	±.000005† (−65° to 125° C.)	8.10
Tophet A®	80 Ni-20 Cr	650	.000085	8.412
Tophet® C	61 Ni-15 Cr-bal. Fe	675	.00013	8.247
Cupron® (Constantan)	55-Cu-45 Ni	294	±.000020	8.90
Balco®	70 Ni-30 Fe	120	.0045	8.46
Ballast® (Pure Nickel)	99.7 Ni	48	.0060	8.90
30,60,90,180 Alloys	Cu-Ni	30-180	.00130 -.00018	8.90

† .002" and finer

Call or write for EVANOHM brochure to—

WILBUR B. DRIVER COMPANY

NEWARK 4, NEW JERSEY — Telephone: HUmboldt 2-5550

In Canada: Canadian Wilbur B. Driver Co., Ltd., 50 Ronson Drive, Rexdale (Toronto)

PRECISION RESISTANCE, ELECTRONIC AND MECHANICAL ALLOYS FOR ALL REQUIREMENTS

VISIT OUR EXHIBIT—BOOTHS 4301-A—4301-B, I.R.E. SHOW

JENNINGS VACUUM CAPACITORS | OVER 300 TYPES

TO MEET HIGH VOLTAGE CIRCUIT DESIGN PROBLEMS

Of course this unusually large selection didn't just happen overnight. It represents the accumulation of twenty years experience in the manufacture of vacuum capacitors. During this time Jennings has developed exclusive vacuum processing techniques. Examine the representative types shown below, all of them proven successful in thousands of applications.

HIGH VOLTAGE

Type	VMMHHC
Capacitance Range	25 to 200 mmfd
Peak Voltage	120 kv
RF Current	125 amps RMS
Length	20¼ inches

HIGH CURRENT

Type	VMMHCW
Capacitance Range	50 to 400 mmfd
Peak Voltage	55 kv
RF Current	500 amps RMS
Length	17 inches

HIGH RATIO OF CAPACITANCE CHANGE

Type	UCSL
Capacitance Range	7 to 1000 mmfd
Peak Voltage	5 kv
RF Current	42 amps RMS
Length	7-9/16 inches

SMALL SIZE

Type	ECS
Capacitance Range	3 to 30 mmfd
Peak Voltage	15 kv
RF Current	20 amps RMS
Length	4⅛ inches

Our radio frequency laboratory with 12 functioning transmitters ranging from 17 KC to 600 MC and up to 100 KW CW power is at your service to test our products under your particular circuit conditions.

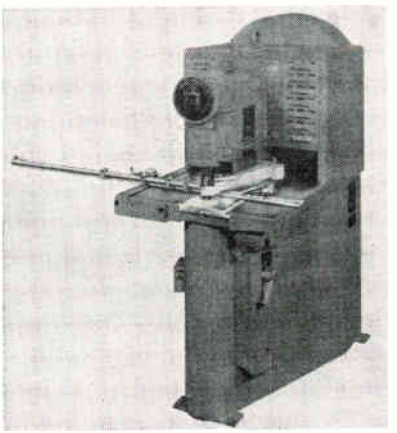
Write for our special brochure describing our complete line of vacuum capacitors.

RELIABILITY MEANS VACUUM / VACUUM MEANS Jennings®

JENNINGS RADIO MFG. CORP., 970 McLAUGHLIN AVE., SAN JOSE 8, CALIF., PHONE CYpress 2-4025

signed for inverters and other d-c switching applications, where a maximum limit on turn-off time provides greater predictability of rectifying device performance and increased economy in the selection of associated circuit components. Available in current ranges of 1.1 amp, 4.7 amp and 16 amp. All have peak reverse voltage ranges from 50 through 300 v.

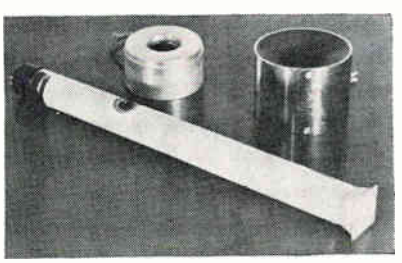
CIRCLE 431 ON READER SERVICE CARD



Quick Change Holder
WITH GAGING SYSTEM

WALES STRIPPIT INC., South Buell Road, Akron, N. Y., announces the 1¼ in. quick change holder with microbar gaging system for use on the Strippit 15A fabricator. System allows any operator to make back and end gage settings directly to thousandths in a matter of seconds. Features that allow for such fast and accurate gage settings are dial indicator assemblies and microbars which are mounted directly to the holder base and the back gage bar.

CIRCLE 432 ON READER SERVICE CARD



Fiber Optic CRT
HIGH RESOLUTION

LITTON INDUSTRIES, Electron Tube Division, 960 Industrial Road, San Carlos, Calif. The E2A16 is a 17¾ in. long crt with a 1½ in. square face panel composed of a bunched

array of fiber optic light pipes. The individual light pipes are coated on the vacuum side with phosphor, which is excited by an electron beam emanating from a precision, high intensity, high definition, electron gun within the tube. A variety of phosphors are available.

CIRCLE 433 ON READER SERVICE CARD

Control Panel
AND BLOWER

MCLEAN ENGINEERING LABORATORIES, P.O. Box 228, Princeton, N. J., announces a full MIL-Spec blower-control panel combination. The control panel section includes airflow indicator pilot lights, circuit breakers, relay switches and a fused double outlet. The blower features two large centrifugal blower wheels that quietly deliver 800 cfm at slow speed. Blowers measure 10½ in. high by 19 in. wide with control panel adding 3½ in. to the height.

CIRCLE 434 ON READER SERVICE CARD

Photoconductive Cells
EXPANDED LINE

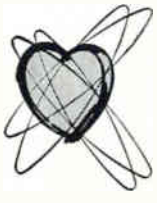
CLAIREX CORP., 8 W. 30th St., New York, N. Y., has expanded its line of standard photoconductive cells from 3 to 5 series. The two new series will be produced in hermetically sealed metal packages with

HILL ELECTRONICS
specializing in solving problems of
FREQUENCY CONTROL
with emphasis on
RELIABILITY

Hill designs and produces precision oscillators, crystal and L-C filters to provide optimum reliability within the diverse technical and economic requirements of the customer. Its concentration on frequency control and its unique organization of talents and facilities enable Hill not only to design and manufacture devices which often exceed the state of the art, but those having less exacting requirements where economy is a major consideration.

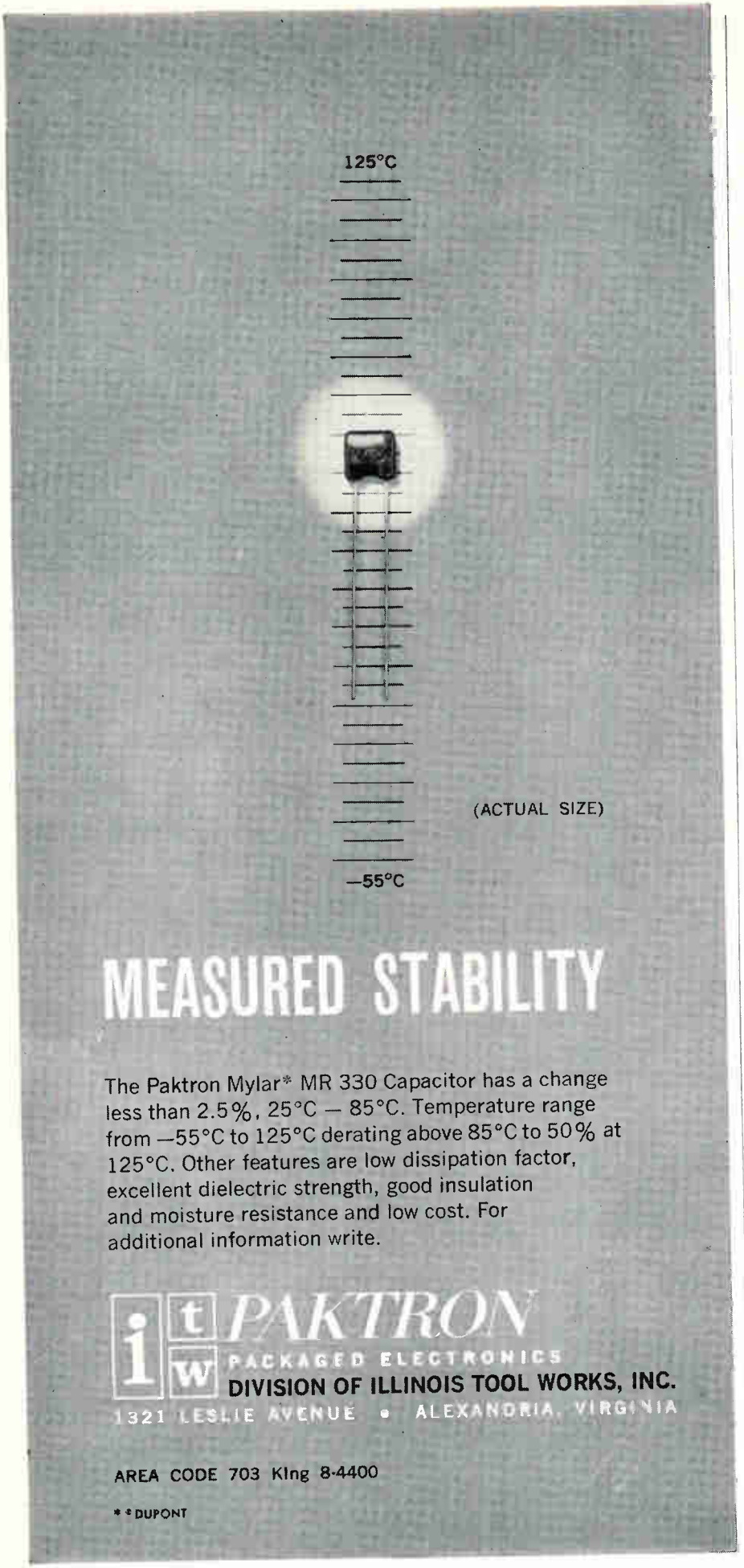
Development has been completed on a primary frequency standard with stability better than 5 parts in 10^{11} per day. This standard utilizes a 5th mode, 2½ MC crystal of Hill manufacture. Standards will be available commercially by mid-summer. In conjunction with this ultra-stable, highly reliable standard, Hill has developed comparing and distributing equipment to form a completely integrated system that generates a very high precision reference signal. This signal is continually phase-compared against any standard frequency transmission such as NBA or NAA, the deviation is recorded, and provision is made for utilizing either the generated or corrected signal throughout your plant.

For further information concerning this new standard and the complete self-contained frequency reference system, or any frequency control problem, visit **BOOTH 1219, I.R.E. Show.**



HILL ELECTRONICS, INC.
MECHANICSBURG, PENNSYLVANIA

CIRCLE 161 ON READER SERVICE CARD



MEASURED STABILITY

The Paktron Mylar* MR 330 Capacitor has a change less than 2.5%, 25°C — 85°C. Temperature range from —55°C to 125°C derating above 85°C to 50% at 125°C. Other features are low dissipation factor, excellent dielectric strength, good insulation and moisture resistance and low cost. For additional information write.

i t w PAKTRON
PACKAGED ELECTRONICS
DIVISION OF ILLINOIS TOOL WORKS, INC.
1321 LESLIE AVENUE • ALEXANDRIA, VIRGINIA

AREA CODE 703 KIng 8-4400

* ® DUPONT

several types ranging up to a few watts in power dissipation characteristics; the balance of the line will continue to be hermetically sealed in glass.

CIRCLE 435 ON READER SERVICE CARD

Servo Motors

MINIATURE UNITS

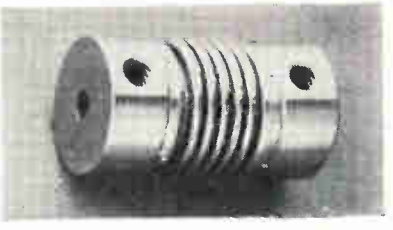
SANGAMO ELECTRIC CO., Springfield, Ill., announces size 5 (0.5 in. dia.) and size 8 (0.75 in. dia.) servo motors available as control motors, motor generators and synchronous motors. They are designed for 400 cps excitation and are enclosed in corrosion-resistant stainless steel cases.

CIRCLE 436 ON READER SERVICE CARD

Tunable Magnetron

METCOM INC., Salem, Mass., announces the MXM-28, a waveguide output 2 Kw X-band tunable magnetron designed to withstand missile-type environmental conditions.

CIRCLE 437 ON READER SERVICE CARD



Couplings

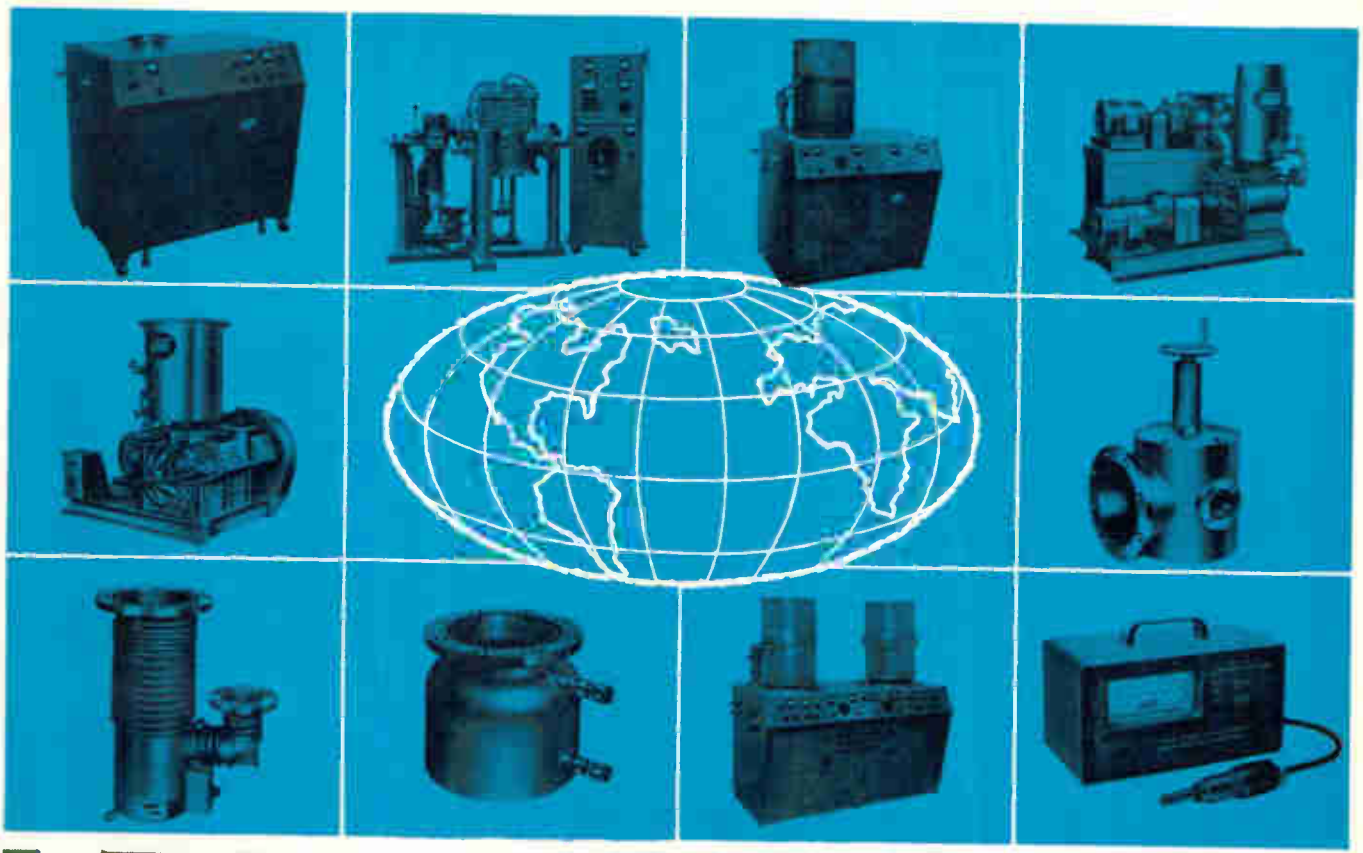
PRECISION DEVICES

TECH-OHM ELECTRONICS, INC., 36-11 33rd St., Long Island City 6, N. Y., announces a line of standard stock miniature precision bellows, Oldham and precision sleeve couplings. Line is designed for ground support, computer and servo applications.

CIRCLE 438 ON READER SERVICE CARD

Deviation Bridge

INDUSTRIAL INSTRUMENTS, INC., 89 Commerce Road, Cedar Grove, New



LEADERSHIP

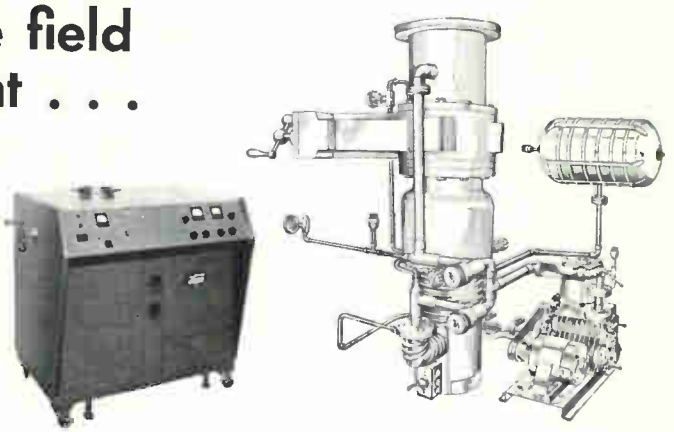
with a forward look in the field of high vacuum equipment . . .

Kinney Vacuum, the accepted leader in the manufacture of vacuum pumps is acknowledged foremost in research and development in the high vacuum industry.

This leadership is carefully guarded by constant and extensive research and development that produces the ultimate in mechanical pumps, diffusion pumps, valves, baffles, gauges, vacuum furnaces, space chambers, and complete vacuum systems.

The resources of the New York Air Brake Company and all of its divisions guarantee every Kinney Vacuum product to be efficient in operation, most modern in design, and constructed to give the maximum in service.

- PROVEN STABILITY
- EXTENSIVE RESOURCES
- DYNAMIC DEVELOPMENT



HIGH VACUUM PUMPING SYSTEM . . . KPW-6
Attractive cabinet design requires less floor space, cabinet and frames are of unitized construction with formica work surface. Accurate pressure readings on ionization-thermocouple gauge at three positions. New line of components includes high speed oil diffusion pump mated with dual-coolant ultra-high vacuum drum baffle. These components allow straight through pumping resulting in rapid evacuation to below 1 x 10^{-6} torr., ultimate pressure less than 5 x 10^{-7} torr.

KINNEY VACUUM DIVISION THE NEW YORK AIR BRAKE COMPANY
3529 WASHINGTON STREET • BOSTON 30, MASS.

CIRCLE 163 ON READER SERVICE CARD 163

Do you solder ...THIN FILMS ... DOT MODULES ...MICROELECTRONICS ?

MODEL H10
12 Watts
115 Volts AC-DC

HEXACON HORNET
– is your iron!

- SMALLEST IRON — ONLY 5 7/8"
- SMALLEST TIP DIAMETER — 1/32"
- SHORTEST DISTANCE FROM WORK — 1 15/16"
- LOWEST WATTAGE — 12 WATTS
- HOT TIP GETS IN AND OUT FAST
- NO DAMAGE TO INSULATION
- FASTEST WORKING TEMPERATURE
- LIGHTWEIGHT

DUROTHERM Non-Freezing Long-Life Tips
1/32", 1/16", 1/8"

Gets into tight places. Plastic handle, cooled thru ventilated design and concave stainless steel which reflects heat away from hand.

HEXACON

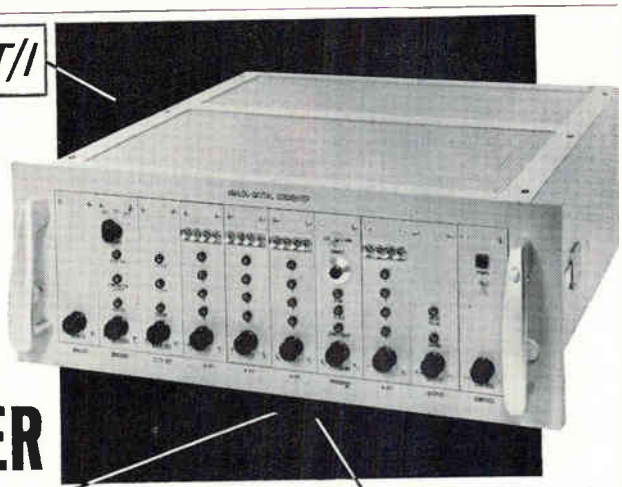
HEXACON ELECTRIC COMPANY
130 West Clay Avenue, Roselle Park, New Jersey

SERVING INDUSTRY AND CRAFTSMEN FOR OVER THIRTY YEARS

At the I.R.E. Show—Visit HEXACON Booth 4002
CIRCLE 244 ON READER SERVICE CARD

NEW FROM T/I

HIGH SPEED A-D CONVERTER



1.5 μ sec per bit

Automatic Zero Stabilization

Texas Instruments Model 834 Analog-Digital Converter is a versatile, all solid state instrument combining high speed with high accuracy. Basic speed is 25 microseconds per conversion (40,000 12 bit conversions per second); accuracy is ±0.05% of full scale, ±½ the least significant bit. The instrument provides full scale ranges of ±2.5, ±5.0, and ±10.0 volts with an input impedance of 200,000 ohms. Modular construction allows modification of output logic levels and digital code to suit various system requirements.

Write for complete information.

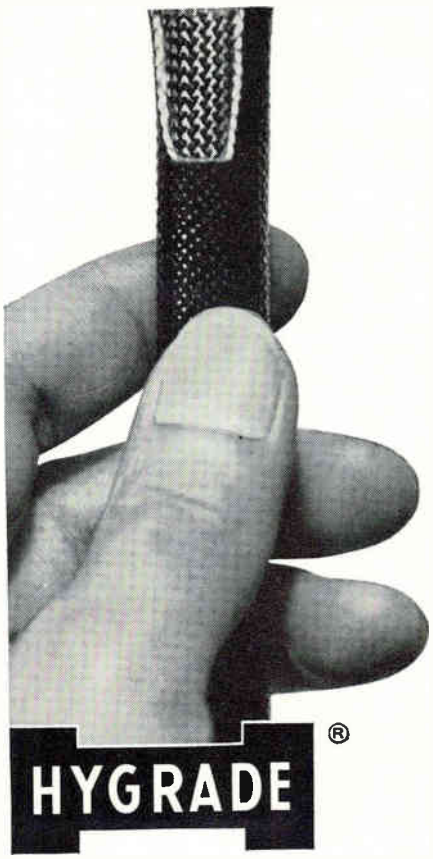
APPARATUS DIVISION
PLANTS IN HOUSTON AND DALLAS, TEXAS

TEXAS INSTRUMENTS
INCORPORATED
3609 BUFFALO SPEEDWAY
P. O. BOX 66027 HOUSTON 6, TEXAS

476

Test It!

It's silicone rubber on braided fiberglass



HYGRADE®

SR-398

A superior silicone rubber compound over fiberglass produces a tough and nearly glass-smooth surface for higher abrasion and cut-through resistance. It is tested to MIL-T-5438 specs. Tensile strength, 1000-1200 psi, yet it expands to slip over terminals, connections. High dielectric strength (8000v) maintained even after continuous use at rated 210°C. Write, phone, or wire for test samples.

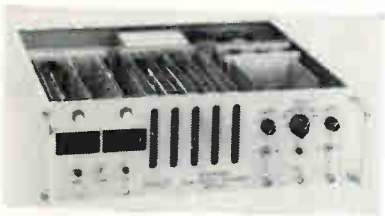
L. FRANK MARKEL & SONS

1 SOURCE *for* EXCELLENCE
Insulating Tubings and Sleevings
High Temperature Wire and Cable

NORRISTOWN, PENNSYLVANIA
CIRCLE 245 ON READER SERVICE CARD

Jersey. Model DB-1 deviation bridge can be operated as either a balanced or unbalanced Wheatstone bridge for rapid resistance comparisons. It has an accuracy of ±0.1 percent as a limit bridge and greater accuracy as a null device.

CIRCLE 439 ON READER SERVICE CARD



Reversing Counter
SOLID-STATE

BECKMAN INSTRUMENTS, INC., Berkeley Div., 2200 Wright Ave., Richmond 3, Calif. Model 3302/5 reversing dual preset counter can add as well as subtract pulses, and provide automatic output signals at certain preselected limits, while always indicating the true algebraic sum of plus and minus counts. Price is $1,945.

CIRCLE 440 ON READER SERVICE CARD

Paper Tape Punch
COMPACT UNIT

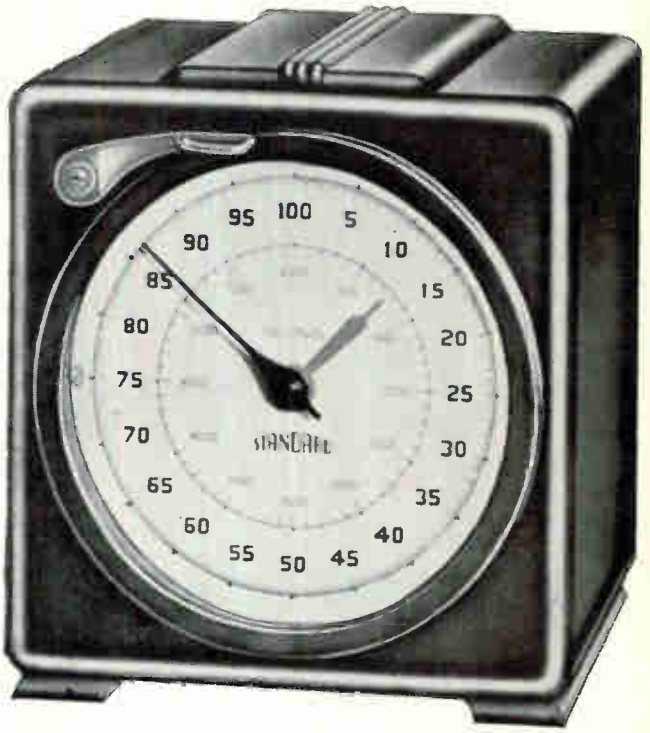
NAVIGATION COMPUTER CORP., Valley Forge Industrial Park, Norristown, Pa. Tape punch verifies the information it punches with printed letters and numbers along one side of the tape. Single compact unit contains a keyboard and the punch itself. It is intended for making up tapes to program digital equipment, such as digitally-controlled machine tools.

CIRCLE 441 ON READER SERVICE CARD

Wire Dispenser
FREE TURNING ROLLERS

EUBANKS ENGINEERING CO., P. O. Box 4158, Pasadena, Calif. Model 71 roller wire dispenser provides a

THE ONE TIMER WITH ALL THE FEATURES...



STANDARD TRADEMARK

Only in a STANDARD instrument do you get all the features "most wanted" in an interval timer:

UNEXCELLED PRECISION—Consistent, continuous accuracy over years of use. Accuracy to ±.001 second available in standard models.

INSTANTANEOUS ELECTRIC RESET—A "must" in many instrument complexes—a plus benefit for all other applications.

PROVEN MECHANISM—Synchronous motor driven—electric clutch operated. Proved reliably accurate and dependable by years of service.

CHOICE OF CONTROL—Start, stop and reset can be manual, by electric circuit or output of electronic tubes.

RANGE OF MODELS—Portable or panel mounting—in a wide selection of accuracies and ranges.

Request Catalog No. 198-B

THE STANDARD ELECTRIC TIME COMPANY
89 LOGAN ST., SPRINGFIELD, MASS.

CIRCLE 165 ON READER SERVICE CARD

ANTENNA CAPABILITIES

The advanced design and precision construction of Ainslie antenna systems and associated equipment bear testimony to nearly two decades of microwave communication, detection and identification experience. By virtue of complete design-to-delivery capabilities and facilities, Ainslie Corporation offers its customers not only comprehensive standard lines of mesh, spun and horn antennas, but also the flexibility required to develop custom designed prototypes for on-schedule delivery.

See us at the IRE Show—Booth 1620

Ainslie CORPORATION

531 Pond Street
Braintree 85, Massachusetts

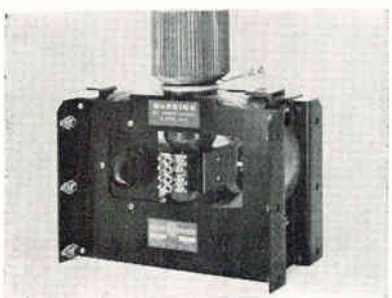
convenient method of handling wire reels during stripping, marking or other processing. A reel of wire is cradled between two free-turning steel rollers, which may be spaced to accommodate reels from 6 in. to 22 in. in diameter. Dimensions are 24 in. long by 18 in. wide by 4½ in. high. Price is $47.50.

CIRCLE 442 ON READER SERVICE CARD

Lapped Ruby Lasers

ADOLF MELLER CO., Providence, R. I., announces lapped ruby lasers with guaranteed flatness and parallelism to 1¼ sec of arc.

CIRCLE 443 ON READER SERVICE CARD

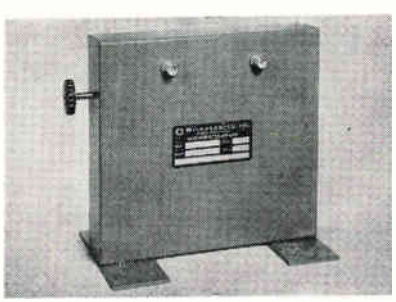


Klystron Amplifier

FEATURES LONG LIFE

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif. Model VA-861 klystron amplifier delivers 1 Kw at 5.9 to 6.4 Gc. Designed for transportable communication systems and c-w radar applications. Requires no adjustments except tuning. Features long life, simple operation, and reliable performance.

CIRCLE 444 ON READER SERVICE CARD

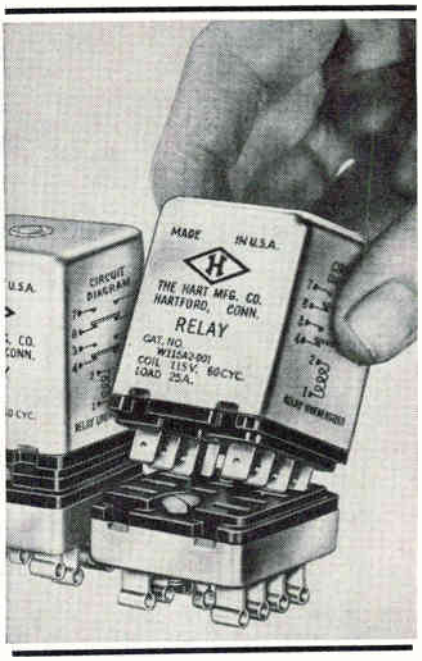


Quartz Delay Line

VARIABLE

MICROSONICS, INC., Hingham Industrial Center, Hingham, Mass. Continuously adjustable quartz delay lines have stepless adjustment in the range from 5 to 200 μsec, but

DEPENDABLE SWITCHING



of contact loads to 25 amps . . .

"Diamond H" Series W Relays—The simple, functional construction of this high-quality general-purpose relay assures long-time dependable switching. For a broad range of applications, specifying "Diamond H" Series W Relays makes good sense. Here are some reasons:

Reliable—Mechanical life in excess of 10,000,000 cycles.

Versatile—a-c or d-c units available with choice of eight different combinations.

Compact—Measures 1½ x 1½ x 1⅞ inches—weighs less than 10 oz.

High Contact Rating—Conservatively rated up to 25 amps, 240 v a-c or 28 v d-c.

Easy to mount—Plug-in design. Panel or side mounts also available.

Underwriters Laboratory Approval—U/L File 31481.

Cost-saving—Low in initial cost, the Series W is easy to install, saves space, and is easy to service.

Send for complete facts—in new 8-page Series W Relay Guide.

THE **HART**
MANUFACTURING COMPANY
202 Bartholomew Avenue, Hartford 1, Conn.
Phone JAckson 5-3491

CIRCLE 246 ON READER SERVICE CARD

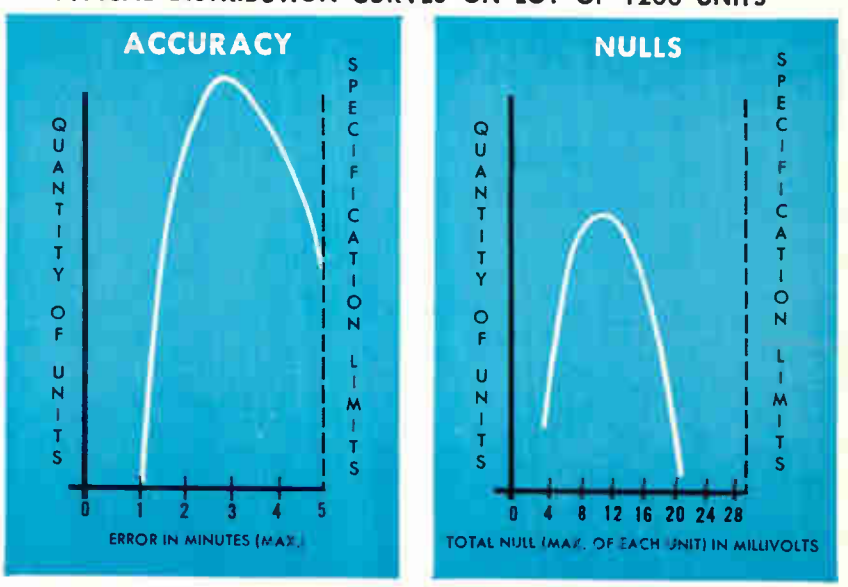
CLIFTON PRECISION OFFERS
SIZE 8 SYNCHROS
OF GUARANTEED
5′ (MAX. ERROR) ACCURACY

Extreme uniformity and thermal stability are maintained in these premium synchros in all electrical characteristics—and especially accuracy.

They are high temperature resistant units and retain their stable characteristics over a temperature range of —55°C to +125°C. Exposure to +150°C is feasible for short periods of time.

These are production line units—not selected. Delivery is in 45 days; prototype quantities immediately.

TYPICAL DISTRIBUTION CURVES ON LOT OF 1200 UNITS



ELECTRICAL CHARACTERISTICS

SYNCHRO FUNCTION	CPPC TYPE	ROTOR AS PRIMARY: Input Voltage (400~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	STATOR AS PRIMARY: Input Voltage (400~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	D.C. RESISTANCE: Rotor (Ohms)	Stator (Ohms)	IMPEDANCE: Zro (Ohms)	Zso (Ohms)	Zrss (Ohms)	Max. Null Voltage (MV)	ACCURACY: Max. Error (Min.)
Torque Transmitter	HGC-8-A-010	26	.120	.66	11.8	206	10.0	—	—	—	—	—	—	37	12	46+j210	11+j36.5	81.5+j24	30	5
Control Transformer	HTC-8-A-010	—	—	—	—	—	—	11.8	.039	.092	22.5	393	10.5	365	64	400+j1420	60+j254	590+j176	30	5

For additional information, call or write our Sales Department, 5050 State Road, Drexel Hill, Pennsylvania, MAdison 2-1000, TWX LNSDWN, PA. 1122(U)—or our Representatives.

CLIFTON PRECISION PRODUCTS CO., INC.

Clifton Heights, Pennsylvania

VISIT OUR HOSPITALITY SUITE during the IRE Convention
Barbizon Plaza Hotel, Park Suite East, 3 to 10 PM, New York City, March 26-29, 1962

SEE THE MACHINE THAT DOES IT!

The first public showing of an automatic Gardner-Denver "Wire-Wrap"® machine will be at the IRE Show March 26 through 29. This machine automates wiring of complicated computer panels—adds new reliability to connections—because they're solderless wrapped connections.

IRE SHOW

BOOTHS 4524-4526

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER DENVER

Gardner-Denver Company, Gardner Expressway, Quincy, Illinois

other areas of delay time are possible with design modifications. Multiple variable outputs can also be obtained, each of them adjustable together or separately. Lines are normally produced for operation in the range from 20 to 60 μsec with bandwidths from 8 to 20 μsec and spurious signals down to 30 or 50 db.

CIRCLE 445 ON READER SERVICE CARD

Flag Indicator

MONITORS CIRCUITRY

ELECTRO-MECHANICAL INSTRUMENT CO., Perkasie, Pa., offers model 801 miniature flag indicator to monitor all types of electronic circuitry and to sell in quantity in the low-price range. It has a max power requirement of 1 mw, and has wide application on computers, automatic control devices, monitoring of switch-gear circuits, transistor and relay circuits where reliability of constant circuit monitoring at low power consumption is desirable.

CIRCLE 446 ON READER SERVICE CARD

Oscillator

WIDE RANGE

MARCONI INSTRUMENTS, 111 Cedar Lane, Englewood, N. J. Using a modified Wien Bridge circuit, the company has produced a low distortion RC oscillator, model 1370, which tunes 10 cps to 10 Mc. Out-

if

YOUR PRODUCTS NEED PROTECTION

YOU NEED HumiSeal® PROTECTIVE COATINGS

There's a HumiSeal Protective Coating for virtually every electronic use.

Write today for complete data on the HumiSeal line of coatings so you can select coatings best suited for your application.

COLUMBIA TECHNICAL CORPORATION

Woodside 77, N.Y. • YE 2-0800

VISIT US AT BOOTH #1116 AT IRE SHOW

CIRCLE 247 ON READER SERVICE CARD

put impedance may be selected at 75, 100 and 600 ohms to suit the needs of the tv, telephone and audio industry. Unit contains a built-in voltmeter and precision attenuator; max output is 31.6 v; distortion is less than 0.4 percent in audio range.

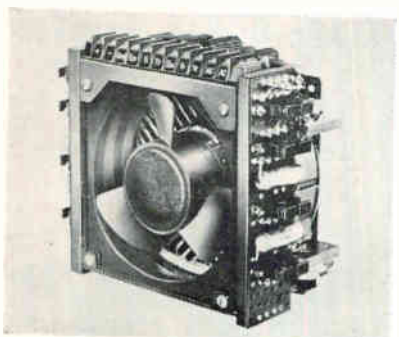
CIRCLE 447 ON READER SERVICE CARD

Test Table

LINEAR ACCELERATION

MICRO GEE PRODUCTS, INC., 6319 W. Slauson Ave., Culver City, Calif. Linear acceleration table features an air bearing suspension and is designed to provide single axis motion. Model 70B is useful for evaluating dynamic performance, threshold characteristics, cross-axis and g sensitivity of accelerometers, gyroscopes and other flight transducers. Test specimens up to 10 lb can be accelerated up to 5 g's with a max linear displacement of 2 in. (double amplitude).

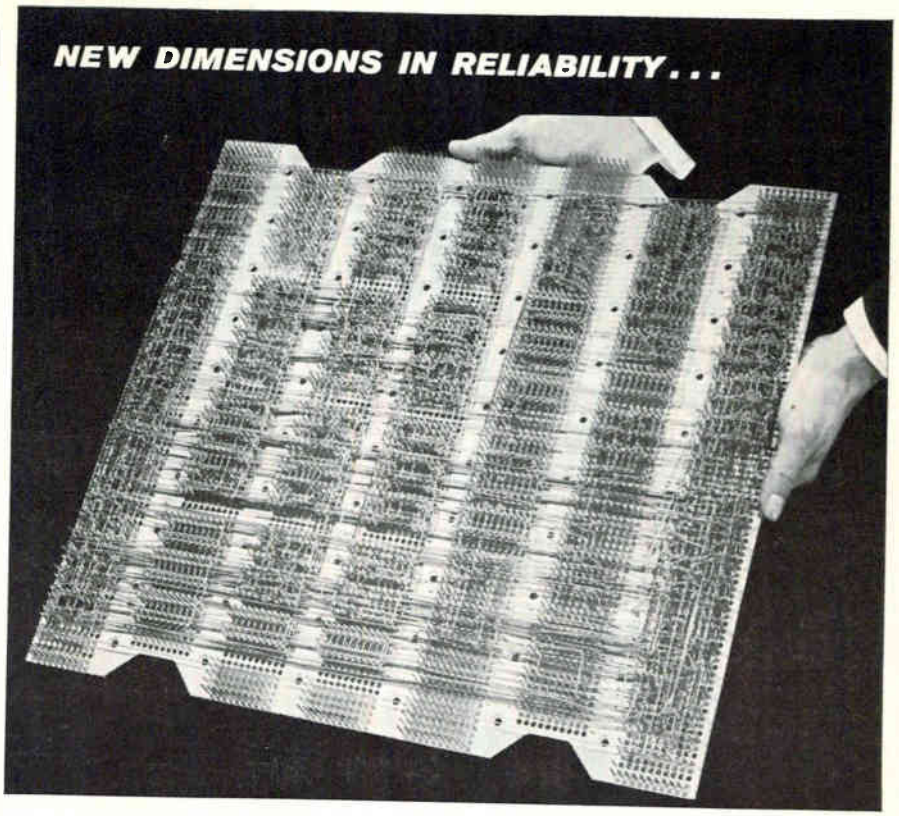
CIRCLE 448 ON READER SERVICE CARD



Display Driver

SOLID STATE

CELCO-CONSTANTINE ENGINEERING LABORATORIES CO., Mahwah, N. J. This unit, a deflection amplifier, uses high power, high frequency transistors to drive a magnetic deflection yoke. Unit produces excellent step function response. Input voltage versus yoke current linearity to ½ percent is achieved. Features include true push-pull per-



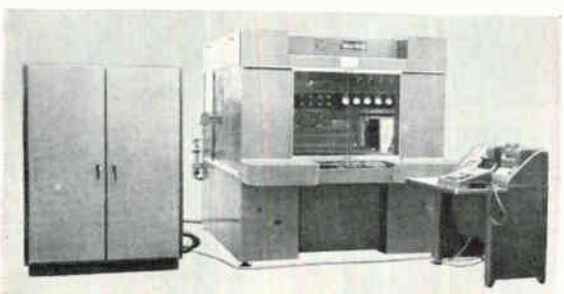
Complex computer boards wired automatically by Wire-Wrap® machines

2480 wires and 4960 connections are contained in this complicated back panel—automatically wired by a Gardner-Denver "Wire-Wrap" machine.

This is typical of how Gardner-Denver brings new dimensions to the reliability of complex electrical connections. This machine, with its punched card control system, wires complicated modular panels fast—in just about any conceivable pattern . . . makes literally thousands of connections in a small space.

And these connections are the most reliable in the world—because they're solderless wrapped connections. Just how good are they? Over a billion without reported failure.

If you're looking for ways to make lasting, trouble-free connections, fast—consult one of our engineers, or write for bulletin 14-121.



See this machine in action at IRE show BOOTHS 4524-4526

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Gardner Expressway, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

CIRCLE 169 ON READER SERVICE CARD

DREXEL

CARD READER

A high reliability programming device of

COMPACT LIGHT-WEIGHT DESIGN

DREXAMATIC
SERIES 754

FEATURES:

- Utmost reliability for critical applications
- Compact light weight design
- Flexibility
- Ease of operation
- Economy

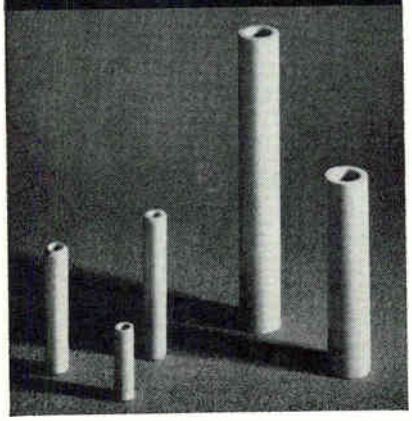
The DREXAMATIC Card Reader is a static memory. All information on a punched card is presented simultaneously in the form of switch closures. Changing cards requires only seconds, and once set, the memory status is independent of power failure, or severe environmental conditions. Complete flexibility permits application to any system. Both terminals of each switch element are terminated on the back plane. Individual switch elements can be either normally open or normally closed. Sound basic design and quality control in manufacture provide the utmost reliability for critical applications. True wiping action is a design characteristic. Rhodium and gold contacts are standard.

DREXEL DYNAMICS CORPORATION
Horsham, Pennsylvania
WAverly 7-6200

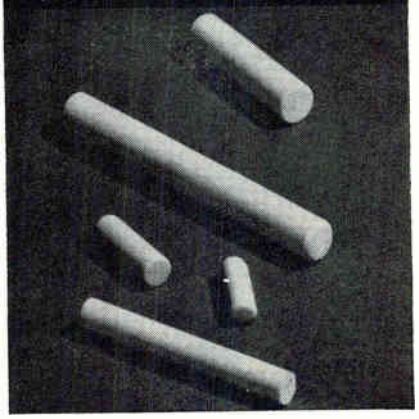
CIRCLE 248 ON READER SERVICE CARD

DU-CO

RESISTOR TUBES



CORES FOR AXIAL LEAD RESISTORS



FOR WIREWOUND RESISTORS with VITREOUS ENAMEL, CEMENT or SILICON COATING

These ceramic forms are furnished in quantities accurately notched, slotted, turned, tapped or machined to specifications.

These Du-Co parts are produced to close dimensional tolerances—hold to the thermal expansion required to meet the proper enamel fit.

Du-Co steatite porcelain is extremely smooth, low-water absorptive to pass humidity tests.

Facilities for Centerless grinding to hold diameter ±.0005".

Standard sizes are stocked for immediate delivery!

Ask for additional literature on your letterhead.

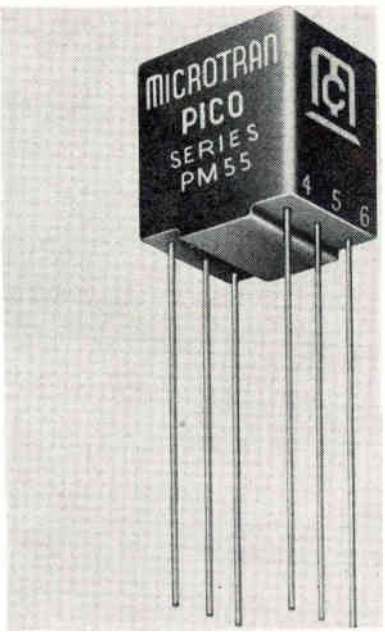
DU-CO steatite and technical ceramics

"Proud to Serve You"

DU-CO CERAMICS CO.
203 Main Street Saxonburg, Pa.

formance into single ended yoke for highest efficiency. A built-in power supply with X and Y channels are included in the compact component.

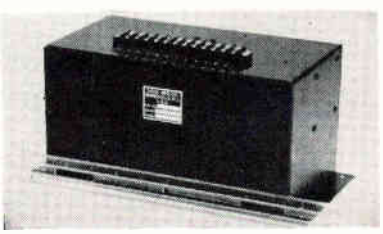
CIRCLE 449 ON READER SERVICE CARD



Transformers
MINIATURIZED

MICROTRAN CO., INC., Valley Stream, N. Y. The PICO series with leads on 0.1 in. grids is only $\frac{5}{16}$ in. by $\frac{13}{32}$ in. by $\frac{13}{32}$ in. high and weighs only 0.1 oz. Gold-plated, high-strength nickel alloy leads permit both reliable soldered joints and high-density welded packaging. Epoxy molded construction per MIL-T-27, grade 5, class R, 10,000 hr life. The 20 different items in the series are available in impedance ratings from 3.2 ohms to 200,000 ohms.

CIRCLE 450 ON READER SERVICE CARD



Servo Amplifier
SOLID STATE

DIEHL MFG. CO., Somerville, N. J. Model XA-500 will drive both phases of 115/115 v, 60 cycle servomotors with outputs from 25 to 100 w. It utilizes scr's in conjunction with saturable reactors. By control-

ling both phases of the motor, it eliminates the need for constantly energizing a reference phase. Four inputs, two a-c and two d-c, are provided. They may be used in any combination. Prices are from $250 to $375 each, depending on quantity.

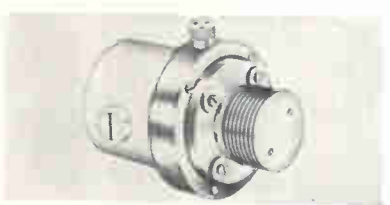
CIRCLE 451 ON READER SERVICE CARD

Cup Core Assemblies

FOR FILTER NETWORKS

INDIANA GENERAL CORP., Electronics Div., Keasbey, N. J. Temperature compensated cup core assemblies utilize a new Ferramic material. Available in 7 physical sizes, with the TC-2 material in them applicable over a frequency range of 1 Kc to 1.5 Mc. Q values of 800 are obtainable, and gapped inductance values range from 40 to 1,000 mh per 1,000 turns. Complete core assembly is comprised of a matched pair of cup cores, a trimmer assembly, a bobbin and a bracket with base plate.

CIRCLE 452 ON READER SERVICE CARD

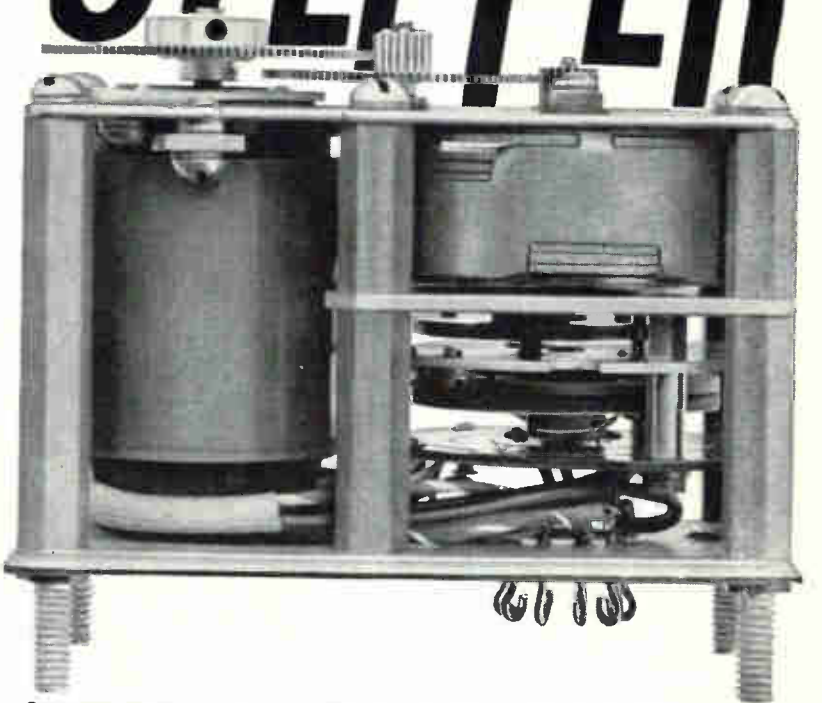


C-W Oscillator

AND AMPLIFIER

TRAK MICROWAVE CORP., Tampa, Fla., announces a miniature, high power, microwave c-w oscillator, type 2975 CW. A c-w amplifier, type 2975A, with the same specs and dimensions has also been devel-

FANCY STEPPER



Stepping devices from A. W. Haydon Co. can do wonderful things to pulses ...with pulses...and for pulses. For instance, one precision gated stepping switch acts as a pulse divider for a random or variable pulse source—or as a frequency divider if the pulse source is constant. Another works in conjunction with pulses, supplying single or multiple switch closures with an accuracy virtually equal to that of the pulse source itself. Still a third will count a predetermined number of pulses, rotate a stepper switch, return the counter to 000, and cut off the pulse source. ■ The remote positioning device illustrated is but one of A. W. Haydon Company's fancy steppers. Here a precision gated stepper switch has been coupled to a synchro transformer. Similarly, precise angular positioning of rotary components such as potentiometers, dials and indicators can be controlled. Based only on the number of pulses received (not incremental changes in voltage or phase angle), it will hold a set position whether power is on or off, and will home the synchro to the zero reference on demand—ready to accept another setting. ■ All A. W. Haydon Co. stepper motors are all-electric—no ratchets, linkage, contacts or other mechanical crutches are used. Their power consumption is low, accuracy is extremely high. ■ Send for technical brochure SP9-1 and find out more about pulse driven steppers and their application.

THE AWH HAYDON COMPANY

235 North Elm Street, Waterbury 20, Connecticut

CIRCLE 171 ON READER SERVICE CARD

NEW

WIDE RANGE R-C OSCILLATOR

TUNES 10 CPS TO 10MC

•

BUILT-IN VOLTMETER AND ATTENUATOR CONTROLS OUTPUT, 1MV TO 3.16V

•

SOURCE IMPEDANCE SWITCH SELECTED, 75, 100, 600 Ω

•

HIGH OUTPUT TO 31.6V (BELOW 100KC)

•

PLUS FEATURE: SQUAREWAVES TO 100KC

•

PRICE: $770

New RC Oscillator Model 1370 tests AF/Video Amplifiers, wide band systems, networks, and telephone circuits with ease. Output impedance may be set at 75, 100 and 600 ohms (or 5 ohms using accessory pad TM6454) to exactly suit the system under test. Six decade bands effectively expand the tuning dial to 105 inches; dual ratio drive enables any frequency to be set with precision.

A modified Wien Bridge circuit gives exceptional stability and low, low distortion. Circuit also generates squarewaves to 100Kc for transient analysis and rapid bandwith determination.

Write For Complete Technical Literature

MARCONI INSTRUMENTS

DIVISION OF ENGLISH ELECTRIC CORPORATION

111 CEDAR LANE • ENGLEWOOD • NEW JERSEY

Main Plant: St. Albans, England

See us at IRE Booth 3401-5

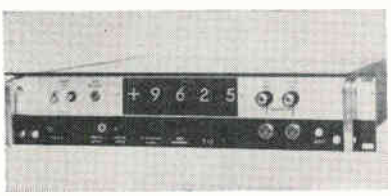
oped. Typical usage is for beacons, transponders and microwave communications. Frequency, 2 Gc, tunable ±20 Mc; power output, 15 w c-w; power supply requirements, 900 v at 90 ma and 6.3 v a-c at 1.05 amp; size, 3½ in. long by 2½ in. in diameter.

CIRCLE 453 ON READER SERVICE CARD

Resistor

FERROXCUBE CORP. OF AMERICA, Saugerties, N. Y., announces the new PTC (positive temperature coefficient) resistor. It varies in resistance as the ambient temperature changes.

CIRCLE 454 ON READER SERVICE CARD

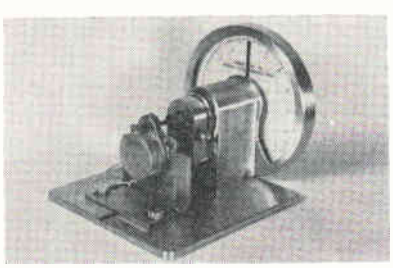


Bidirectional Counter

SOLID STATE

ERIE-PACIFIC, Div. of Erie Resistor Corp., 12932 S. Weber Way, Hawthorne, Calif. Model 510 provides a convenient concept of digital control in industrial and military systems. This is accomplished through the ability of the counter to count either forward or backward—so that it at all times records the net + or − input supplied by a directional transducer, or the net difference between the inputs of two transducers, where one may provide command data and the other feedback.

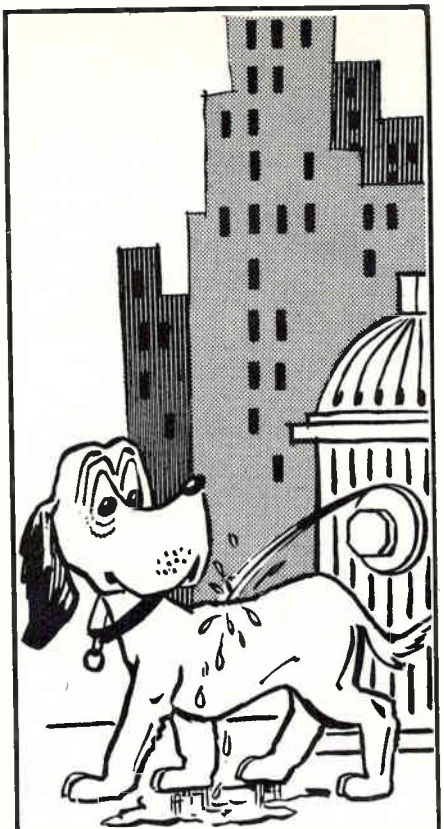
CIRCLE 455 ON READER SERVICE CARD



Torque Tester

SELF-CONTAINED

GENERAL THERMODYNAMICS CORP., 211 Concord Turnpike, Cambridge 40, Mass. The dynamic torque test-



A New Twist!

We like people with ideas! If you have suggestions for cartoons, send them on to us...**A PRIZE FOR EVERY ENTRANT!** You'll get a credit line too...if you give permission.

Cartoon above suggested by S. Malin, Fresh Meadows, New York.

We aren't really cartoonists... secretly, we manufacture

HEXSEALS* SEELSKREWS*
SEELBOLTS* SEELRIVITS*
RUBRGLAS* SILICORINGS*

Modular Self-Sealing Nuts, Screws and Hardware for use on all types of Switches, Panels and Boxes.

OUR PRODUCTS MEET ALL APPLICABLE MIL SPECS

Our modular seals may be new to you; let us send you our Catalog 359B. *Trade Mark

Write or call: **MISS RIVA SOLINS**

APM-HEXSEAL CORPORATION

41 Honeck St., Englewood, N. J.

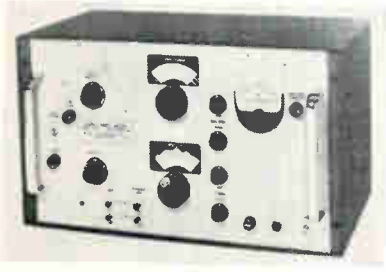
LOwell 9-5700

VISIT OUR BOOTH 2835 AT THE IRE SHOW

CIRCLE 249 ON READER SERVICE CARD

ing machine is a mechanical torque measuring device that requires no support equipment. A patented mechanical system measures the deflection of a rotating torsion bar and indicates torque on a dial. Clockwise or counter-clockwise rotation as well as static measurements can be made. Torque ranges covered, from 0-1 to 0-200 oz-in.

CIRCLE 456 ON READER SERVICE CARD



Capacitance Bridge

HIGH STABILITY

BOONTON ELECTRONICS CORP., 738 Speedwell Ave., Morris Plains, N. J. Model 75B, a three-terminal device, is designed to extend capacitance measurement capabilities at 1 Mc. Capacitance range is 0.00002 to 1,000 pf. Parallel resistance range is 1.000 ohms to 100 megohms. Differential capacitance measurements to 0.00002 pf are practical. Price is $1,375.

CIRCLE 457 ON READER SERVICE CARD

Diffusion Furnace

CONSOLE-TYPE BASE

HEVI-DUTY ELECTRIC CO., 304 Hart St., Watertown, Wisc. Diffusion furnace enables semiconductor manufacturers to obtain repeatable temperature uniformity of ±½ C. Both the diffusion furnace and a split tube source furnace are mounted on a single console base that can contain the controls and

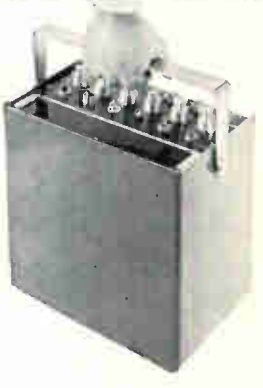
ERIE *Instrumation* MODEL 925
. . . the counter that remembers!!

SOLID STATE
20 MC
UNIVERSAL COUNTER-TIMER

All new . . . the rugged, compact Model 925 is designed to offer the ultimate in reliable counting of periodic or random electrical events and precise measurement of Frequency, Period and Time Intervals. *Built-in memory* provides readout storage, continuous display while counting, more frequent sampling and less operator eye fatigue. Modular construction.

OUTSTANDING FEATURES:

- IN-LINE NIXIE READOUT
- 8 DIGIT MEMORY — No Blinking
- SENSITIVITY — .1V RMS — All 3 Channels
- THREE DC AMPLIFIERS
- HIGH INPUT IMPEDANCE
- AUTOMATIC DECIMAL POINT
- ONLY 3½" RACK SPACE (Model 925-R)
- DECADE TIME BASE — No Adjustments
- STABILITY — 1 Part In 10^8/Day; 5 Parts in 10^8/Week



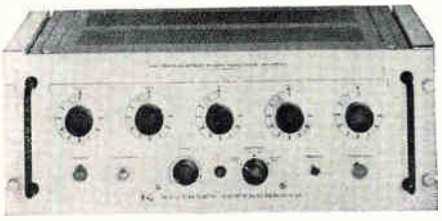
ONE HAND PORTABILITY

Write today for complete specifications on the Model 925 or Model 925-R (Rack Model) — the ideal instrument for laboratory or industrial applications.

Quality Where It Counts
ERIE *Instrumation*
ERIE-PACIFIC, DIVISION OF ERIE RESISTOR CORPORATION
12932 South Weber Way, Hawthorne, Calif. • ORegon 8-5418 • TWX HAW CAL 4006

dial any output from 0-1000 volts!

Keithley Regulated DC Supplies provide the stability, ease and accuracy necessary for a wide range of laboratory tests. Typical applications include calibration of meters and dc amplifiers; testing insulation, diode, and capacitor leakage resistances; or furnishing potentials for photo-multiplier tubes and ionization chambers.



MODEL 241—*0.05% accuracy*

A dc secondary standard featuring a long-life photo-chopper and zener reference. It is immune to shock and vibration, and offers long-term calibration stability.

- **Accuracy:** 0.05% or 1 millivolt.
- **DC Output Voltage:** 0-1000 volts—plus, minus or floating, with 5 calibrated dials and 100 μv resolution.
- **Output Current:** 20 milliamperes max.
- **Stability:** 0.005% short term.
- **Ripple:** less than 1 mv RMS.
- **Overload Protection:** fast-acting relay circuit.
- **Price: $800.00**

MODEL 240—*1.0% accuracy*

A general-purpose version of the Model 241 available at lower cost.

- **Accuracy:** 1.0% or 100 millivolts.
- **DC Output Voltage:** 0-1000 volts—plus or minus, with 3 calibrated dials and 10 mv resolution.
- **Output Current:** 10 milliamperes max.
- **Stability:** 0.05% per eight hours.
- **Ripple:** less than 3 mv RMS above 5 cps.
- **Overload Protection:** Fast-acting relay circuit.
- **Price: $345.00**

full details in latest catalog

KEITHLEY INSTRUMENTS

12415 Euclid Avenue • Cleveland 6, Ohio

power supplies specified by the customer. However, the diffusion furnaces also are available as single units, or they can be mounted atop each other to save valuable floor space.

CIRCLE 458 ON READER SERVICE CARD

Discriminator

SOLID-STATE

PRECISION INSTRUMENT CO., 1011 Commercial St., San Carlos, Calif. Subcarrier discriminator contains 9 IRIG discriminator channels with output meter for each in only 7 in. of rack space. Linearity is ±0.4 percent, stability of zero, 0.15 percent. Subcarrier amplitudes from 10 mv to 10 v rms are accommodated. Two output ranges are available: ±0.4 ma into 300 ohms and ±5.0 ma into 1,000 ohms. Frequency response is flat to within ±0.5 db from d-c to IRIG cut-off frequency.

CIRCLE 459 ON READER SERVICE CARD

Test Equipments

DOUGLAS MICROWAVE CO., INC., Mount Vernon, N. Y., has available a standing-wave indicator set and a bidirectional power monitor.

CIRCLE 460 ON READER SERVICE CARD

Digital Encoder

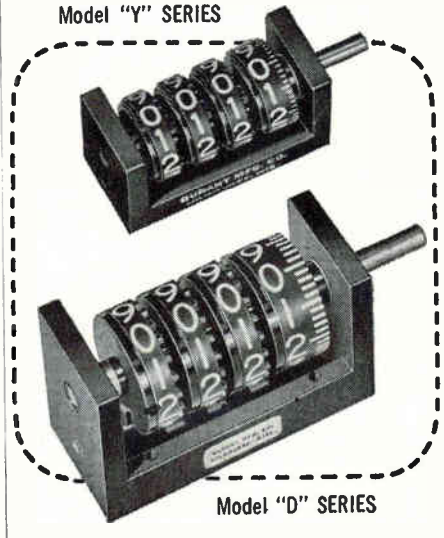
MANUAL-INPUT

GUIDANCE CONTROLS CORP., Engineers Hill, Plainview, N. Y. Detented 7-bit, 128-position encoder permits manual insertion of coded signals into digital data systems, computers, automatic test equipment and numerical machine tool

DURANT

DIGITAL READ-OUT COUNTERS

Model "Y" SERIES



Model "D" SERIES

for MISSILE TRACKING, RADAR CONTROLS, COMPUTERS, NAVIGATION INSTRUMENTS, GAUGING INSTRUMENTS, and ANY other indicator applications.

- Meets military specifications.
- High speeds, lower torque, lower moment of inertia for long life.
- Nylon wheels with legible figures, nylatron pinions.
- Single, 1½, or double width wheels.
- One-piece aluminum die cast frame.
- Base mounting. Threaded mounting holes may be in frame top or ends.
- Right or left hand drive, clockwise or anti-clockwise rotation.
- "Y" Series, single or dual bank types.
- Component parts can be purchased separately to meet design requirements.

Your answer to an infinite number of variable demands for PRECISION CONTROLS.

Send for Catalog No. 400

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CIRCLE 250 ON READER SERVICE CARD

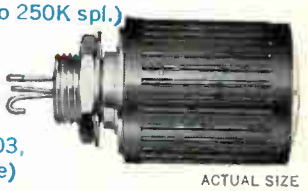
New Bourns Knobpot*—Precision Potentiometer, Dial and Knob—All in Front of the Panel!

With the new Bourns Knobpot, nothing is behind the panel but the solder hooks and the bushing. Everything else is out in front, integrated into a single, compact unit. (Just ¾" in diameter by 1" long, the easy-to-mount 10-turn Model 3600 Knobpot is shorter by ½" than comparable potentiometers alone—to say nothing of the space it saves by incorporating its own turns-counting dial.)

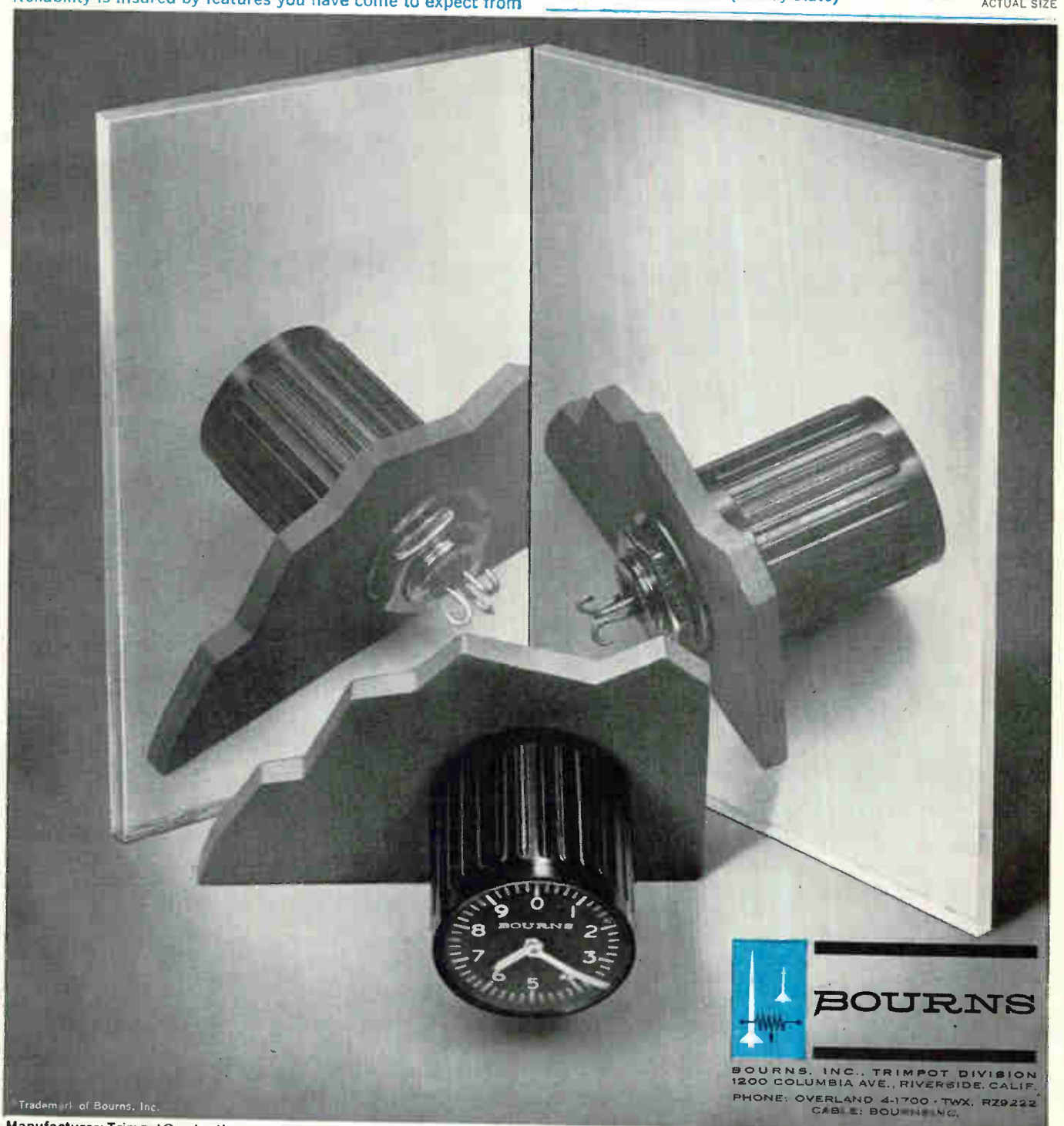
Settings are easy to make and permanent. The clear-reading dial lets you adjust to 0.5% of the unit's total resistance value, and the knob's self-locking feature keeps your adjustment steady even under 10G vibration or 50G shock.

Reliability is insured by features you have come to expect from Bourns: exclusive, indestructible Silverweld® multi-wire termination; 100% in-process and final inspections; Bourns' Reliability Assurance Program—the most extensive in the industry. Write for complete data.

Resistances: 1000Ω to 100K std. (to 250K spl.)
Linearity: ±0.5%
Power rating: 1.5W @ 25°C
Max. operating temp.: +85°C
Mech. life: 200,000 revolutions
Humidity: MIL-STD-202, Method 103, Condition B (steady state)



ACTUAL SIZE



Trademark of Bourns, Inc.

BOURNS, INC., TRIMPOT DIVISION
1200 COLUMBIA AVE., RIVERSIDE, CALIF.
PHONE: OVERLAND 4-1700 · TWX: RZ9222
CABLE: BOURNSINC.

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

CIRCLE 175 ON READER SERVICE CARD 175

DON'T MISS REEVES-HOFFMAN'S

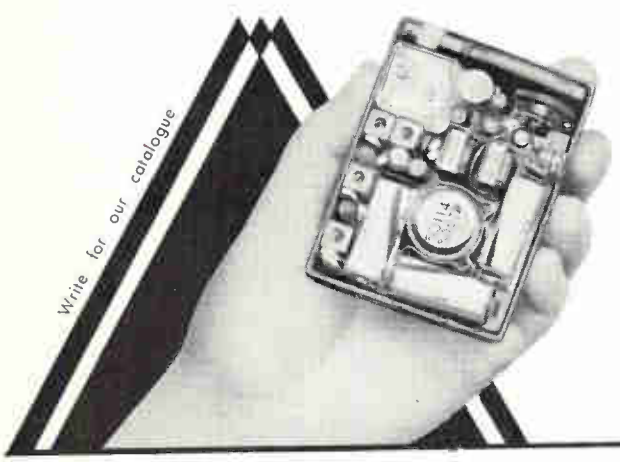
NEW, ULTRA-STABLE CRYSTAL-CONTROLLED 5-MEGACYCLE FREQUENCY STANDARD

REEVES-HOFFMAN

DIVISION OF
DYNAMICS CORPORATION
OF AMERICA, CARLISLE, PENNSYLVANIA

at I.R.E. BOOTH 1309

CIRCLE 267 ON READER SERVICE CARD



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Intermediate Frequency Transformer IFT

POLYVARICON Variable Capacitor

The high standards of MITSUMI electronic components are insured by a fully-automated assembly system, and double-checked by rigid quality controls. Mitsumi Electric Company is Japan's largest manufacturer of components for radio, television and communicotions equipment.

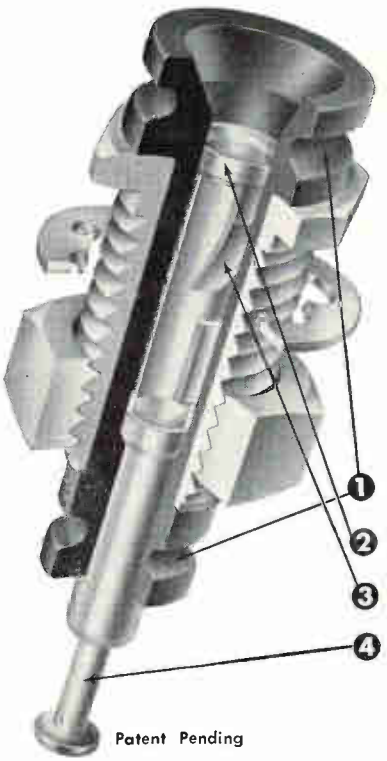
MITSUMI PARTS

MITSUMI ELECTRIC CO., LTD.
Komae, Kitatama, Tokyo

AUGAT TEST JACKS

for .080 diameter prods

Meeting Requirements of MS16108 (Ships)



Patent Pending

Look at these features . . .

1. Front and rear barriers for additional voltage breakdown
2. Closed entry contact design
3. Heat treated beryllium copper contact
4. Choice of three terminal styles

WIRE WRAP* for No. 20, 22, 24 or 26 wire

EYELET Hot tin dipped

TURRET Hot tin dipped

Plus ten brilliant Nylon** colors (also available in Teflon**).

Write today for Data Sheet 162 describing Augat Test Jacks in detail.

*Gardner-Denver Company trademark
**DuPont trademark

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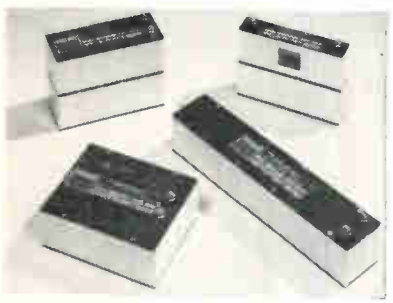
AUGAT INC.

30 Perry Avenue, Attleboro, Mass.

CIRCLE 252 ON READER SERVICE CARD

controls. Unit works (1) with common signal input lead and 7 parallel output leads for straight binary counting from 0 to 127, or (2) with 7 parallel signal input leads and common output for generating composite signals from inputs of different frequencies or pulse widths.

CIRCLE 461 ON READER SERVICE CARD



Modular Battery

LONGER CELL LIFE

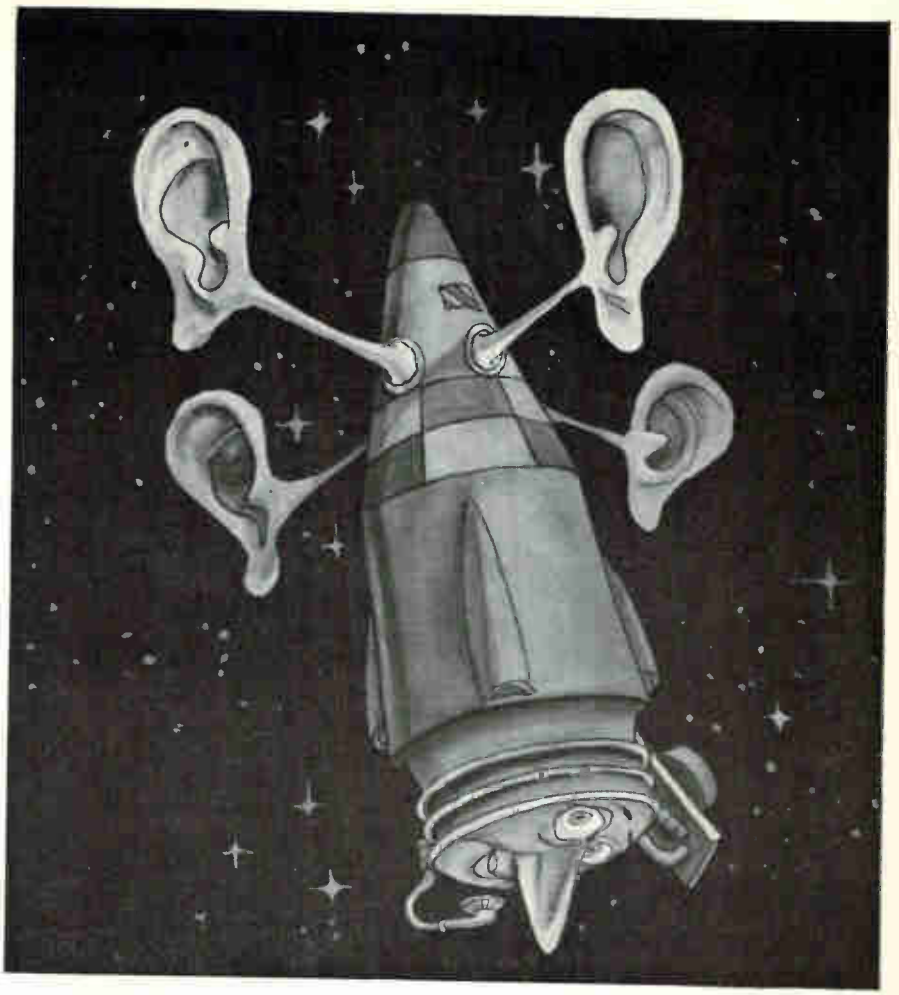
GOULD-NATIONAL BATTERIES, INC., E-1200 1st National Bank Building, St. Paul 1, Minn. The modular construction consists of a battery case for use in fabricating cells of different voltages and capacities through the combination of a number of batteries of standard size or predetermined size and shape. Battery case consists of an elongated rectangle having a row of cell pockets fabricated from a dielectric material. Modular concept provides batteries that can be fabricated to fit allotted space, yet deliver specified capacity.

CIRCLE 462 ON READER SERVICE CARD

Teraohmmeter

FULLY LINE-OPERATED

ROHDE & SCHWARZ, 111 Lexington Ave., Passaic, N. J. Type N teraohmmeter is designed for measurement of extremely high insulation resistance. It has fixed test voltages



NEMS-CLARKE® Surveillance... the Ears of the World

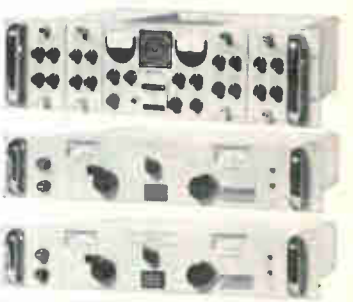
Multiple demodulation of any signal from 30-1000 mc is possible through this new receiving system. It is applicable to both communications and surveillance.

The units, AMD 21-4 Amplifier Demodulator, RFT 30-260 Frequency Tuner and RFT 250-1000 Frequency Tuner, allow reception of any signals in this frequency range and the demodulation of those signals simultaneously in four IF bandwidths either AM or FM. For increased flexibility, these units can receive four different frequencies simultaneously, one frequency in each of the following bands 30-110, 90-260, 250-500, 495-1000 mc.

Write for Data Sheet 777.
Vitro Electronics, 919 Jesup-Blair Dr.
Silver Spring, Maryland
A Division of Vitro Corp. of America

VISIT VITRO AT I.R.E. SHOW
BOOTH 3821-3823

Vitro ELECTRONICS

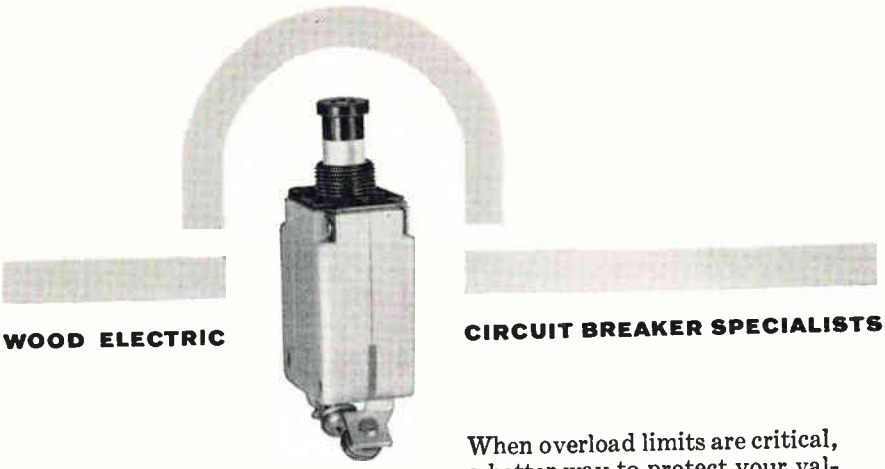


AMD 21-4 UNIT
Accepts 1, 2, 4 inputs.
Input Impedance 50 ohms.
VSWR better than 1.5: 1.
Modules: Bandwidths available 4 Omc; 2 Omc.
500 kc; 50 kc; 15 kc.

RFT 30-260 UNIT
TUNING RANGE.....In Two Bands: 30-110 mc; 90-260 mc.
AVERAGE NOISE FIGURE
30-110 mc, 5 db;
90-260 mc, 6 db

RFT 250-1000 UNIT
TUNING RANGE.....In Two Bands: 250-500 mc; 495-1000 mc.
AVERAGE NOISE FIGURE
250-500 mc, 9 db;
495-1000 mc, 12 db.

COMMON TO BOTH RFT UNITS
INPUT IMPEDANCE..50 Ohms Nominal.
TYPE RECEPTION.....AM. FM. CW.
IMAGE REJECTION.....56 db.
RACK SPACE.....3½" by 19".
POWER.....115/230 v—50-400 cycles.



WOOD ELECTRIC **CIRCUIT BREAKER SPECIALISTS**

MINIATURE

Only 1.5 cu. in., 2100 Series thermal breaker with double contacts; meets MIL-E-5272A on vibration, corrosion, sand and dust, explosion; trip-free, push-pull operation. Ratings 5 to 50 amperes. Size 1¾ x ¾ x 1 inch.

When overload limits are critical, a better way to protect your valuable electronic equipment is with Wood Electric magnetic and thermal circuit breakers — types for airplane electrical systems, computers, general electronic equipment. All are built for dependability and precisely calibrated for critical applications by specialists in this field. For catalog write Dept. D

Circuit breakers for critical applications

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HIGH TEMPERATURE
WIRE and CABLE

FOR QUALITY ASSURANCE

it's **Super-Temp**

AIRFRAME WIRES • HOOK-UP WIRES • MAGNET WIRES
SINGLE & MULTICONDUCTOR CABLES • COAXIAL CABLES
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Super-Temp serves the electronic, missile and aircraft industries with dependable high temp specialized wires and cables. Extensive laboratory quality controls insure wide margins of dependable performance. Quality certification program with lot control and bonded area available for military programs. Write for samples and price quotations on specific needs. Address Dept. E-23.

AMERICAN SUPER-TEMPERATURE WIRES, INC.
A Subsidiary of Haveg Industries, Inc.
8 West Canal Street, Winooski, Vt.
13151 Sherman Way, N. Hollywood, Cal.

of 10 and 100 v, a total range of 0.1 megohm to 50 T ohms, and is completely line operated with highly stabilized power supplies. It is excellent for testing insulation of components, capacitors, transformers, cables, wires and the like.

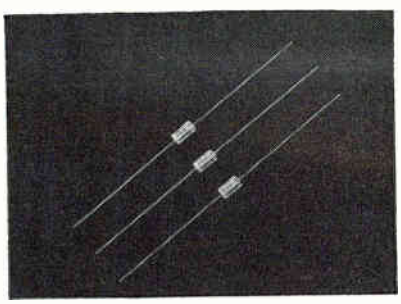
CIRCLE 463 ON READER SERVICE CARD

Soldering Furnace

FOR GLASS DIODES

C. I. HAYES, INC., Cranston, R. I., Model FED includes furnace, combination conveyor and work holding system, and stepless power controls. It is used to solder germanium wafers, leads, and glass sleeves into a glass diode assembly. Furnace readily lends itself to integration into an automated production line.

CIRCLE 464 ON READER SERVICE CARD

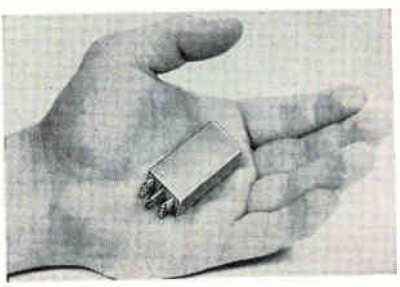


Metal Film Resistors

ULTRA RELIABLE

ELECTRA MFG. CO., 4051 Broadway, Kansas City 11, Mo., announces a line of ultrahigh reliability deposited metal film resistors. The HRM series is available for critical industrial and military applications. Currently available in ½ w sizes and common resistance values.

CIRCLE 465 ON READER SERVICE CARD



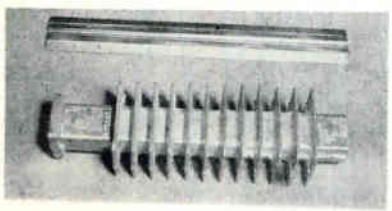
Miniature Relay

GENERAL PURPOSE

NORTH ELECTRIC CO., Galion, Ohio. Type CC dpdt relay (2 Form C) can be obtained with operating

speeds as fast as 3 millisec. It has a minimum life of 100 million operations at rated loads. Measuring ⅜ in. by ⅛ in. by 1⅛ in. above mounting surface, it has silver contacts with an average contact resistance of 30 milliohms. Insulation resistance between all mutually insulated parts is 100,000 megohms minimum at 500 v d-c, 25 C at 20 percent relative humidity.

CIRCLE 466 ON READER SERVICE CARD



Metal Castings

BY SHAW PROCESS

AVNET-SHAW CORP., Plainview, N. Y. Illustrated are waveguides cast in aluminum alloy by Shaw Process precision ceramic-mold casting technique. They have parallel walls cast to 30/40 microinch surface finish. Shaw Process can reproduce the most complex shapes with high accuracy and at low cost. The process uses any castable metal, ferrous or non-ferrous.

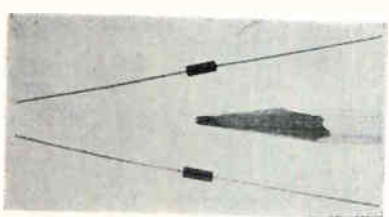
CIRCLE 467 ON READER SERVICE CARD

Data Recorder

AND ENCODER

PERKIN-ELMER CORP., Norwalk, Conn., announces a new high-speed digital data recorder and a low torque, one-brush shaft encoder.

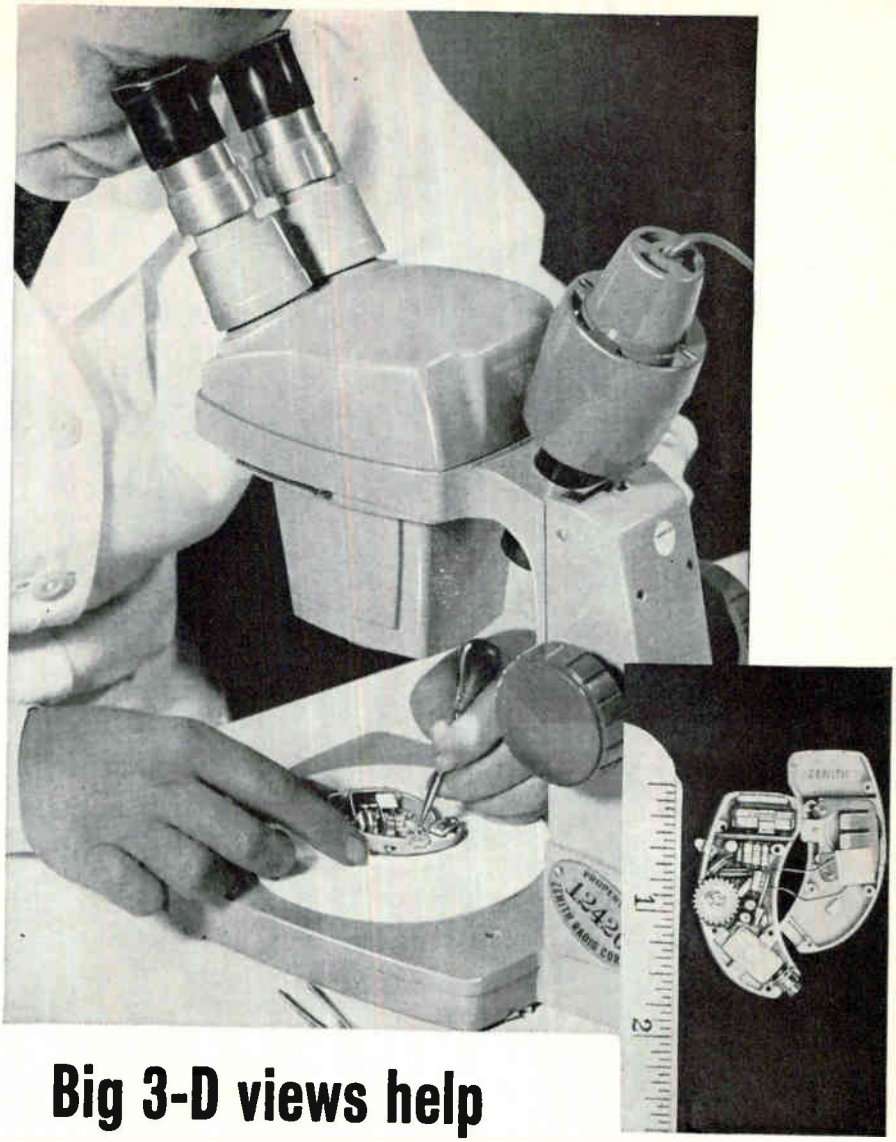
CIRCLE 468 ON READER SERVICE CARD



Wirewound Resistors

WITH MOLDED COATING

DALE ELECTRON, INC., Columbus, Neb., announces bobbin resistors available in two physical sizes and power ratings: MWA-8, 1/10 w, and MWA-10, ⅛ w. Operating tem-



Big 3-D views help Zenith assemble tiny hearing aid

Zenith's new "Signet" hearing aid packs wider response and greater gain than before into a package so tiny that it takes Bausch & Lomb StereoZoom® Microscopes to manufacture, assemble and inspect it.

Zenith chose StereoZoom Microscopes for vivid views of tiny parts, magnified in natural 3-D . . . for all-day viewing without eye fatigue . . . for 7 inches of unobstructed working distance for hands and tools.

Put B&L StereoZoom Microscopes to work on *your* precision operations. Choose from the most complete line of industrial microscopes, including zoom models for scanning or critical study throughout the entire range of 3.5× to 120×!

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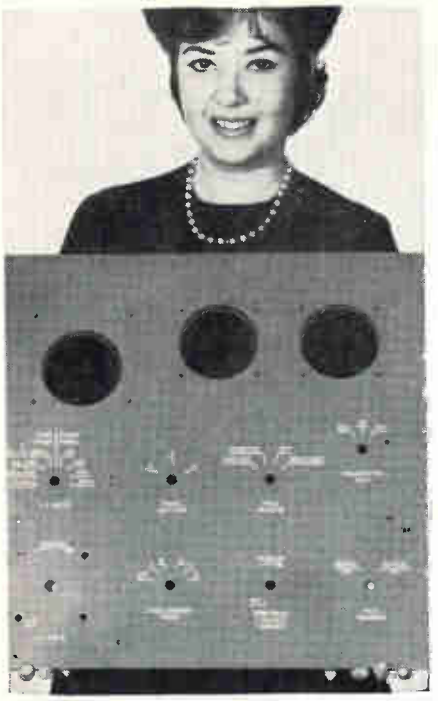
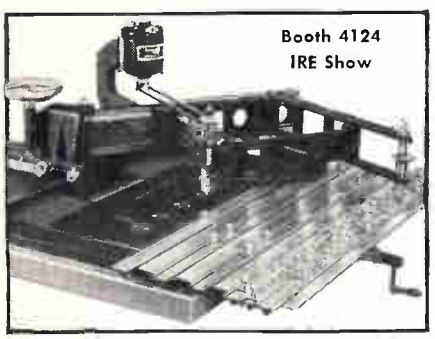


ANY SIZE
panels
or nameplates
ANY TIME
you need them
with
tracer-guided
ENGRAVOGRAPH



Write for catalogue ZR-5

new hermes
ENGRAVING MACHINE CORP.
154 W. 14TH, ST., NEW YORK 11, N.Y.
Chicago • Los Angeles • Montreal

perature range is from −55C to 145C. Max working voltage of MWA-8 is 27 v d-c or rms; of the MWA-10, 37 v d-c or rms. Resistance range is from 10 ohms to 160,000 ohms, depending on type and tolerance. Tolerances: 0.5 percent, 1 percent. Temperature coefficient 20 ppm/deg C.

CIRCLE 469 ON READER SERVICE CARD

Servo Motor Tach
HIGH PRECISION

WRIGHT DIV. OF SPERRY RAND CORP., Durham, N. C., announces a size 11 servo motor tachometer. A temperature compensating thermistor-resistor network stabilizes the speed sensitive voltage to within 0.5 percent and the phase shift to within 1 deg throughout the ambient temperature range of 0 C to 85 C. The tachometer linearity from 0 to 3,600 rpm over the temperature range is 0.07 percent.

CIRCLE 470 ON READER SERVICE CARD

Switch Module
SMALL-SIZED

NORTH ATLANTIC INDUSTRIES, INC., Plainview, N. Y. The SM-150 switch module measures 2 in. by $\frac{11}{16}$ in. by $1\frac{3}{8}$ in. Side by side stacking permits build-up of any desired number of digits for use in system input application and test instrumentation. Design uses two internal conven-

ENGINEERED
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OF
SHELLS
EYELETS & STAMPINGS

Cly-Del is a major supplier of drawn metal components used in every conceivable product from cosmetic cases to computers.

From its beginning, nearly 25-years ago, Cly-Del has been a company of undivided responsibility.

Offering complete help... planning, engineering, designing, development, tool and diemaking, production, secondaries, inspection, packaging and delivery.

The big move four years ago put all Cly-Del facilities and abilities in a new, one-level, fireproof, 80-thousand square-foot building. Stand-by auxiliary heating and compressor systems and a 17-thousand square-foot warehousing area for strip stock assures Cly-Del customers of deliveries when they need them.

Up-dating equipment is a constant, continuing responsibility of Cly-Del management. As a result, Cly-Del is always a modern, efficient, high-volume, quality producer of shells, eyelets, stampings.

You are invited to ask for estimates of cost and delivery for parts you require. Your inquiries will receive prompt, accurate attention.

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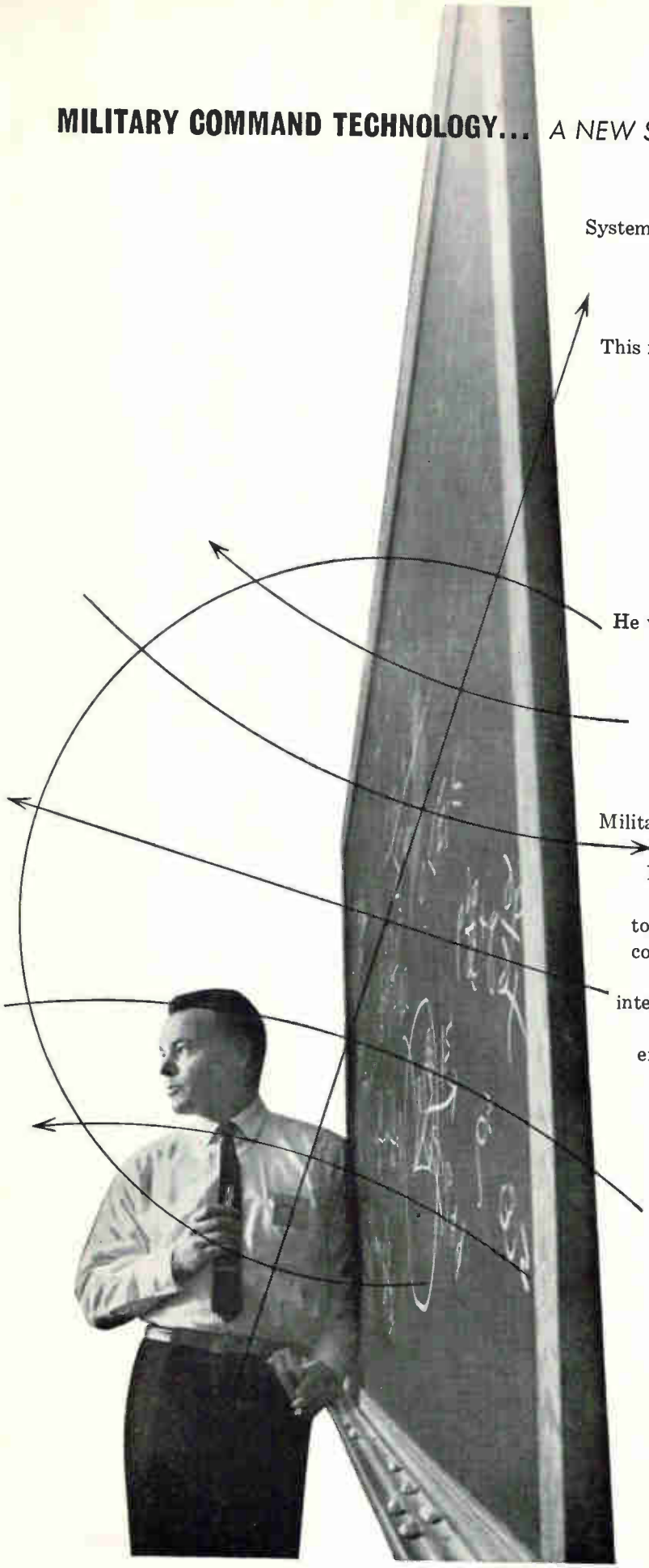
WATERBURY 20, CONNECTICUT

CIRCLE 252 ON READER SERVICE CARD

MILITARY COMMAND TECHNOLOGY... *A NEW SCIENCE FOR NATIONAL DEFENSE*



Systems that instantly provide the military Commander with the information necessary for decision. Systems to enable the Commander to control all his forces under any conditions.

This is the purpose of Military Command Technology. It is the work carried out at MITRE. It includes command systems, control systems, intelligence systems, warning systems, and support systems. It encompasses a vast network of interrelated, constantly evolving systems that protect our country.

The designer of these systems must be able to visualize how war would be fought. He will work closely with the nation's top policy makers. He will help solve the problems of military command — nature, deployment, and use of weapons; war-plans; control of forces; missions; logistics; support and intelligence operations. But, most important — he must be able to apply existing and predictable technology to the abstract problems of future military command.

Military Command Technology, in short, is a systems engineering task of overwhelming importance. MITRE has men who can get the job done. And there is room at MITRE for more such men — top professionals who feel they want to serve their country in a vital area. There are key assignments available in system analysis and planning; intersystem integration; general system engineering; initial system design; and research and experimentation. Facilities are at Bedford, Mass.; Washington, D. C.; Colorado Springs.

If you feel you can advance this new science, you are urged to write in confidence to Vice President — Technical Operations, The MITRE Corporation, Box 208, Dept. W217, Bedford, Mass.

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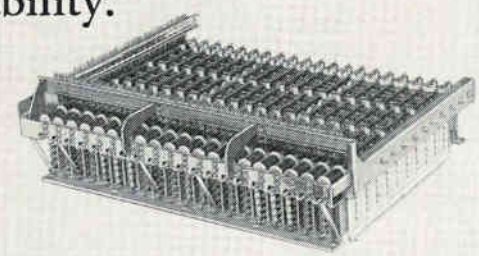
CIRCLE 301 ON READER SERVICE CARD

This Fast, Flexible Crossbar, The Simplest Memory Matrix Available, Implements Complex Logic with Minimum Electronics & Maximum Reliability.



Blessed with refreshingly straightforward logic, this versatile, high-density device awaits your ingenuity. Apply its unique* reliability (20 million operations/crosspoint, minimum) and "pre-wired" simplicity to storage, format conversion, buffering, programming, and logical manipulation. The Crossbar is the logical improvement on stepping switches and relay matrices.

Write us for *why* and *how*.

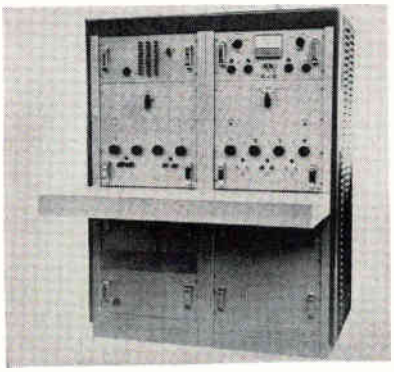
**An adjective fully justified by exclusive U.S. and Foreign Patents.*

Cunningham
ESTABLISHED 1936
SOPHISTICATED SWITCHING SYSTEMS
BOX 516, ROCHESTER 2, NEW YORK

Plant & Offices:
Honeoye Falls, N. Y.
Phone: Honeoye Falls 485
TWX RO 572-U

tional switch wafers, providing longer life and lower capacitance than p-c types. Modules are available with wide range characteristics up to 4 pole 12 position, with stops. Interwafer shielding is also available.

CIRCLE 471 ON READER SERVICE CARD

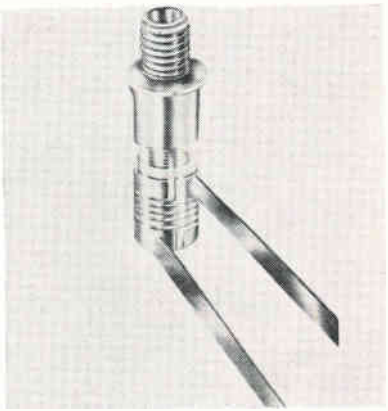


A-C Calibrator

HIGH ACCURACY

WESTON INSTRUMENTS DIVISION, Daystrom, Inc., 614 Frelinghuysen Ave., Newark 14, N. J. Model 172 audio frequency a-c calibrator provides a regulated and adjustable sine wave output voltage of 0.1000 to 1099.9 v in 4 decade ranges from 50 cps to 10 Kc. Four dials are provided—the first indicating from 0 to 10 and the second, third, and fourth from 0 to 9, for a reading of up to five digits. Rated accuracy is ± 0.05 percent of indicated value at 10 percent to 100 percent of each decade range from 50 cps to 2,500 cps.

CIRCLE 472 ON READER SERVICE CARD



Variable Inductor

METALIZED

JFD ELECTRONICS CORP., 6101 Sixteenth Ave., Brooklyn 4, N. Y. Series of variable inductors covers

inductance values from 0.03 mh to 1.5 mh, in overlapping ranges. Adjustment range is ±10 percent from nominal value; typical minimum Q values, 100. Construction is of metalized glass, with precision brass tuning mechanism for extremely stable performance over a wide operating temperature range.

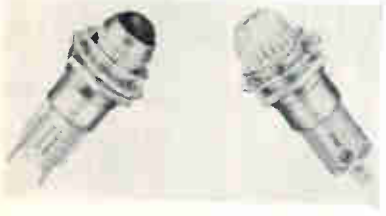
CIRCLE 473 ON READER SERVICE CARD

Optical Radar Set

USES RUBY LASER

MARTIN MARIETTA CORP., Orlando, Fla. Optical radar set employs a ruby laser. The prototype laser device consists of a complete transmitting and receiving system packaged in a suitcase occupying only 1.6 cu ft of space. The Suitcase laser transmits and receives a concentrated beam of light, much like a radar, and is believed to have considerable value in military applications. Commercial uses include surveying, where distances can be accurately measured without triangulation.

CIRCLE 474 ON READER SERVICE CARD

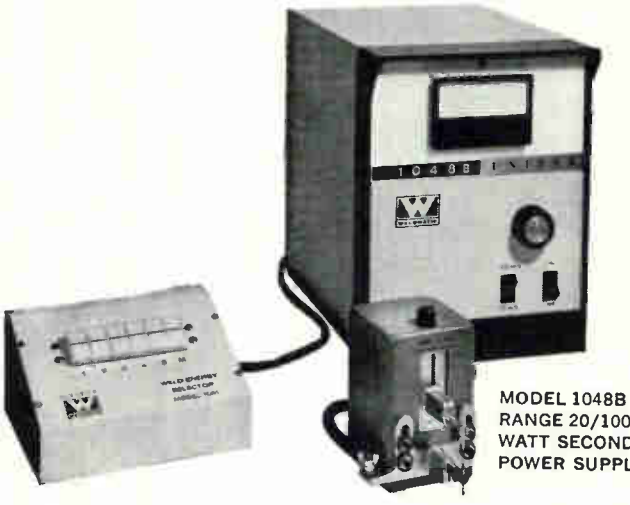


Indicator Light

WIDE APPLICATION

DRAKE MFG. CO., 4626 North Olcott Ave., Chicago 31, Ill. The E'lite type 5200 features simplified construc-

NOW FROM WELDMATIC!



MODEL 1048B DUAL RANGE 20/100 WATT SECOND POWER SUPPLY

MODEL 1061 5-SETTING WELD ENERGY SELECTOR

MODEL 1032 WELDING HEAD

A NEW WELD STATION CONCEPT

A weld station designed for the maximum in *weld repeatability; higher productivity* with less chance of operator error; *wide latitude of heat selections.* The power supply is the new Weldmatic 1048B with dual range full-switching circuits of .1 to 20 and 0.5 to 100 watt seconds. Voltage regulation of ± 1%, and high resolution mirror-backed meter insure precise heat settings. The new Weld Energy Selector Model 1061 allows independent selection of any of five present energy settings. A sixth button shifts heat control back to the power supply. Model 1032 welding head with its absolute linear electrode movement, true force firing and fastest follow-up, is without equal in delivering repeatable welds. If desired, dual heads may be used.

For details on this new concept in electronic welding, call your Weldmatic representative or write Weldmatic Division/Unitek, 950 Royal Oaks Drive, Monrovia, Calif.

WELDMATIC DIVISION / UNITEK

Lepel

High Frequency

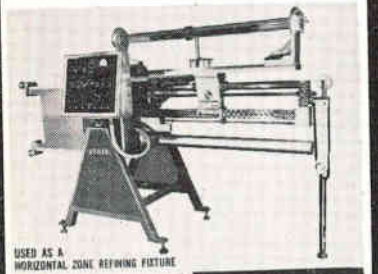
INDUCTION HEATING UNITS

HARDENING · ANNEALING
ZONE REFINING · CRYSTAL GROWING
SOLDERING · BRAZING

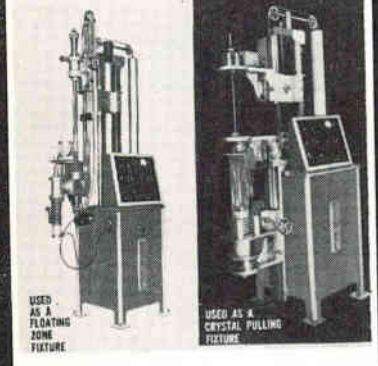
3 in 1 FIXTURE
for

- FLOATING ZONE REFINING AND CRYSTAL GROWING
- HORIZONTAL ZONE REFINING
- CRYSTAL PULLING

This Lepel 3 in 1 unit is designed for production work as well as for research and development laboratories doing experimental work on semiconductor materials, thermoelectric materials and ultra pure metals. This combination fixture provides facilities for horizontal zone refining, floating zone refining and crystal growing. All these facilities may not be required in a single program but the rapid progress in materials science emphasizes the need for just such versatile equipment.



USED AS A HORIZONTAL ZONE REFINING FIXTURE



USED AS A FLOATING ZONE FIXTURE

USED AS A CRYSTAL PULLING FIXTURE

This fixture consists of the three attachments and the basic unit which contains the traverse and programming mechanism. All three attachments and the generator can be operated from the control panel.

The change from floating zone operation to horizontal zone refining to crystal pulling require less than a half hour.

Our engineers will process your work samples and return the completed job with full data and recommendations without cost or obligation.

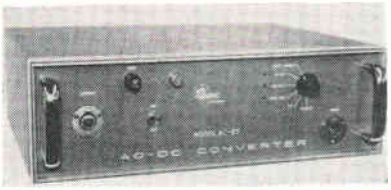
WRITE FOR LEPEL CATALOG

Lepel HIGH FREQUENCY LABORATORIES, INC.

55th ST. & 37th AVE., WOODSIDE 77, N. Y.
CHICAGO OFFICE: 6246 WEST NORTH AVE.

tion for increased durability and reliability. It measures 1 5/8 in. overall length, with a hole diameter of 11/16 in. Lampholder housing is molded of Glaskyd material for strength as well as economy. Wide choice of styles, shapes and colors of lenses available.

CIRCLE 475 ON READER SERVICE CARD

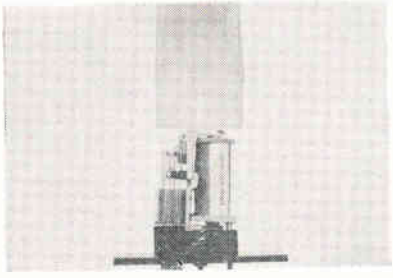


A-C/D-C Converter

SELF-POWERED

CUBIC CORP., San Diego 11, Calif. Model AC-85 provides means for making precision a-c measurements with d-c digital voltmeters, pen recorders and any d-c measuring device having full floating input. Converter features transistorized circuitry with a Nuvistor input for maximum stability. Input may be floated to 500 v d-c and input circuitry with full guard shielding provides common mode rejection in excess of 70 db at 60 cps. Price is $1,400.

CIRCLE 476 ON READER SERVICE CARD

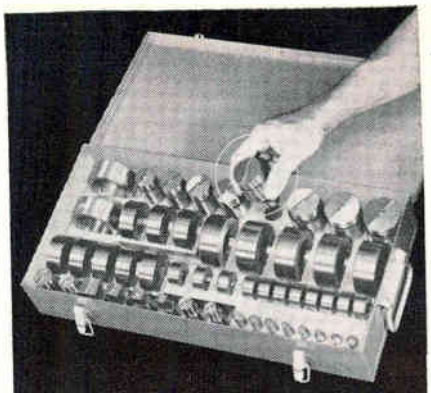


Miniature Relay

PLUG-IN UNIT

AUTOMATIC ELECTRIC CO., 400 N. Wolf Rd., Northlake, Ill. Series EIN is a Class E relay mounted to a plug and enclosed in a clear-plastic removable cover. Plug contacts are designed so the relay may be used with a flush-mounted socket or soldered directly into the circuit. This packaging allows easy assembly and maintenance, reduces damage in handling and in shock and vibration environments. Relay is available with operating voltages up to 220 v, d-c or a-c.

CIRCLE 477 ON READER SERVICE CARD



the right punch & die at your finger tips...

NEW DI-ACRO PUNCH PAKS

Punch Pak No. 1 - $139.50
Punch Pak No. 2 - $259.50

- Off the shelf delivery
- Adapters to fit any punch press

Di-Acro Punch-Paks save you money, cut production delays. No time lost looking for the right size or waiting for special orders. Cost is approximately 10 per cent less than individual punch and die sets—with the rugged, steel store-or-carry chest free. All Di-Acro Punches and Dies are precision made of quality tool steel.

PUNCH-PAK NO. 1 contains 30 sizes of round punches and dies from 3/64" to ½" in increments of 1/64".

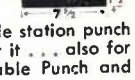
PUNCH-PAK NO. 2 contains round punches and dies from 1/16 to ½" in 1/16" increments, round sizes from ½" to 2" in ⅛" increments, squares in ½", ⅝", ¾" and 1" sizes, one die holder and two die adapters.

Die Adapter A-2 ¾" diameter—1¼" bore, Die Adapter B-2 ¾" diameter—2⅛" bore.

DIMENSION DATA

All Di-Acro Punches to ½" have ½" diameter shanks, 2 13/32" length.
All Di-Acro Punches from ½" to 2" have 1" diameter shanks, 3⅛" length.
All Di-Acro Dies to ¾" are 1¼" diameter, ⅝" high.
All Di-Acro Dies from ¾" to 1⅜" are 2⅛" diameter, ⅞" high.
All Di-Acro Dies from 1½" to 2" are 2¾" diameter, 15/32" high.

PUNCH AND DIE HOLDERS



which adapt Di-Acro Punches and Dies to any punch press are listed in literature on single station punch and die program. Ask for it . . . also for literature on new Adjustable Punch and Die program.

For full information consult Yellow Pages of your phone book under Machinery-Machine Tools for the name of your Di-Acro distributor or write us.

Pronounced die-ack-ro

di-acro PRECISION METALWORKING EQUIPMENT

DI-ACRO CORPORATION
433 Eighth Avenue
Lake City, Minnesota • U.S.A.

CIRCLE 254 ON READER SERVICE CARD

PRODUCT BRIEFS

MINIATURIZED POWER PACKS ultra low voltage. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J. (478)

MULTIHEAD WIRE WELDER adjustable table. Alphil Spot Welder Mfg. Corp., 1058 Pacific St., Brooklyn 38, N. Y. (479)

DIFFERENTIAL D-C AMPLIFIER wideband. Dynamics Instrumentation Co., 583 Monterey Pass Road. Monterey Park, Calif. (480)

PHOTOCONDUCTIVE CELLS four basic sizes. General Electric Co., Owensboro, Ky. (481)

METAL-FILM RESISTORS ¼, ½ and ½ w. Kidco Inc., P.O. Box 278, Medford, N. J. (482)

CONTINUOUSLY VARIABLE DELAY LINE operates up to 60 Mc. Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J. (483)

MEMORY CORE in plane and stack assemblies. Ferroxcube Corp. of America, Saugerties, N. Y. (484)

CAPACITANCE MEASURING SYSTEM extended range. Electro Scientific Industries, 7524 S.W. Macadam Ave., Portland 19, Ore. (485)

MEDICAL RADIATION ANALYZER transistorized. Franklin Systems, Inc., 2734 Hillsboro Road, West Palm Beach, Fla. (486)

TEMPERATURE INDICATORS solid or liquid, Alpha Wire Corp., 200 Varick St., New York, N. Y. (487)

INSTRUMENTATION CART priced at $14.95. Atlantis Electronics Corp., Box 451, Garland, Texas. (488)

HIGH-ENERGY BATTERIES power tv camera. Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y. (489)

ELECTRONIC COUNTER 10 cps to 10 Mc. Lavoie Laboratories, Inc., Morganville, N. J. (490)

SERVO AMPLIFIER for precise control. Photocircuits Corp., 31 Cliff Ave., Glen Cove, N. Y. (491)

HERMETICALLY SEALED CAPACITOR flat shape. Good-All Electric Mfg. Co., Ogallala, Neb. (492)

NEW WATTMETER-LOAD FOR RF OUTPUT TO 150 WATTS

The new BIRD Model 6150 TERMALINE RF Wattmeter is a termination type absorption instrument having selectable dual power ranges of 0-30/0-150 watts. Power values are read directly throughout the frequency range of 30-500 mc. The instrument is portable, simple to operate, and requires no calibration or auxiliary power.

Specifications:	BIRD Model 6150
Power scales:	0-30 and 0-150 watts
Impedance:	50 ohms nominal
Frequency Range:	30-500 mc
VSWR:	1.1 maximum
Accuracy:	±5% of full scale
Input Connector:	Female N
Weight:	8 pounds
Size:	3 15/16" x 6 3/8" x 12"
Price:	$225.00 F.O.B. Factory

other models available

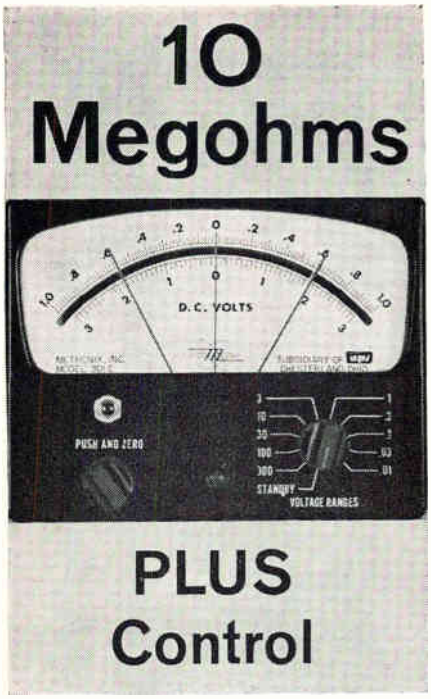
BIRD Model 611 (power scales 0-15 and 0-60 watts) and Model 612 (power scales 0-20 and 0-80 watts). Price, either model: $175.00. Model 61 with two compatible power scales as low as one watt and up to 80 watts. Price: $220.00. Frequency range of any model may be extended. Prices on request.

Contact BIRD for further information on these instruments and other BIRD products.

BIRD Model 6150
TERMALINE RF Wattmeter

BIRD ELECTRONIC CORPORATION
30303 Aurora Rd., Cleveland 39 (Solon), Ohio
CHurchill 8-1200 TWX CGN FS 679
Western Representative:
VAN GROOS COMPANY, Woodland Hills, Calif.

CIRCLE 185 ON READER SERVICE CARD 185



An electronic voltmeter with a meter-relay

This happy combination makes an extremely versatile and acute instrument.

It has critical measuring ability that goes with high input impedance, in space-saving panel-mounting style.

It also has the reliable, simple control of a locking contact meter-relay, with adjustable set points.

Many difficult functions can be easily controlled: conductivity cells, life testing of components or systems, production testing and sorting, automatic Go-No Go of missile circuits.

Ready When Needed

Metronix DC instruments such as Model 301-C-CMR (illustrated) have input resistances up to 10 megohms. AC input impedances go as high as 5 megohms. Like all Metronix panel-mounting electronic voltmeters (PMEV's), they are always connected—immediately available for continuous monitoring of critical parameters.

Send for data sheets describing Metronix PMEV's in single or multiple ranges, DC or AC, with either meter-relays or conventional indicating meters.

METRONIX
The Electronic Instrument Division of Assembly Products, Inc.
Chesterland, Ohio
Telephone: HAmilton 3-4440
Visit Us at Booth 3942, IRE

Literature of the Week

JUNCTION DIODES Sperry Semiconductor, Norwalk, Conn. Brochure SS-200 shows types of subminiature alloy junction silicon diodes. **(493)**

PREAMPLIFIER DeVar-Kinetics Division, C.E.C., 494 Glenbrook Road, Glenbrook, Conn. Bulletin IM-511 completely describes a versatile preamplifier. **(494)**

CONNECTOR PRODUCTS TMC Connector Products Div., The Technical Material Corp., P.O. Box 142, Mamaroneck, N.Y. A 16-page catalog describes connectors, patch panels, adapters, and connector mounting plates. **(495)**

TRANSFORMER CASES Kinetron Corp., Shrewsbury & Patterson Ave., Red Bank, N.J., offers a 2-page bulletin describing varied dimensions, materials, finishes, modifications and prices of its MIL-Standard cans. **(496)**

AUDIO-VISUAL SYSTEMS Applied Communication Systems division of Litton Systems, 335 N. Maple Drive, Beverly Hills, Calif. A description of audio-visual systems for industry is contained in an illustrated 8-page brochure. **(497)**

INDUSTRY INSTRUMENTS General Radio Co., West Concord, Mass. A folder describes such instruments as continuously adjustable autotransformers, sound and vibration measuring equipment. **(498)**

TRANSISTORS Tung-Sol Electric Inc., One Summer Ave., Newark 4, N.J. Form T-481 contains reference information on five lines of transistors. **(499)**

MICROWAVE MEASUREMENTS Polarad Electronics Corp., 43-20 34th St., L.I.C. 1, N. Y., has issued a revised and enlarged 4th edition of its booklet "Notes on Microwave Measurements." **(500)**

VHF-UHF NOISE GENERATOR PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y. Catalog sheet illustrates and describes model 904-A vhf-uhf noise generator. **(501)**

POWER TRANSISTORS Kearfott Semiconductor Corp., 437 Cherry St., West Newton, Mass. Three types of *pnp* germanium alloy junction power transistors are covered in a recent catalog sheet. **(502)**

VACUUM CAPACITORS Dolinko & Wilkens, Inc., 1907 Summit Ave., Union City, N. J. A catalog describes high voltage, high current fixed vacuum capacitors. **(503)**

PULSE GENERATOR Rese Engineering Inc., A & Courtland Sts., Philadelphia 20, Pa. Brochure covers pulse generator with controllable linear rise and fall time. **(504)**

CONTROLLER PROCESSOR Epsco, Inc., 275 Massachusetts Ave., Cambridge 39, Mass., offers a 30-page brochure of advance data sheets on 275 controller processor. **(505)**

SILICONE DIELECTRICS General Electric Co., Waterford, N. Y. Data book S-24 covers a family of silicone dielectric fluids and compounds. **(506)**

PLUGS Cannon Electric Co., 3208 Humboldt St., Los Angeles 31. Calif., has published an illustrated catalog supplement presenting its KM Mark 2 plugs. **(507)**

EPOXY RESINS John C. Dolph Co., Monmouth Junction, N. J., has available a new epoxy resin selection guide chart. **(508)**

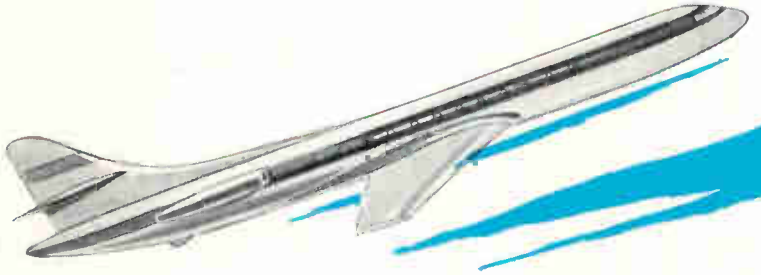
HEAT RADIATORS The Birtcher Corp., 745 S. Monterey Pass Rd., Monterey Park, Calif. Technical data sheet deals with series of heat radiators for mounting high-powered semiconductors. **(509)**

AMPLIFIER RACK MODULES Kin Tel Division of Cohu Electronics, Inc., 5725 Kearney Villa Road, San Diego 12, Calif. Data sheet 2-115 covers a line of amplifier rack modules with increased cooling efficiency. **(510)**

NUCLEAR POWER SOURCE Leesona Moos Laboratories, 90-28 VanWyck Expressway, Jamaica 18, N. Y., offers a technical data sheet on Raypak self-contained nuclear power source. **(511)**

AIR-DRY SILVER PREPARATIONS E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Del. Air-dry silver preparations that can be used for making conductive patterns, printed circuits, or shielding coatings are covered in a bulletin. **(512)**

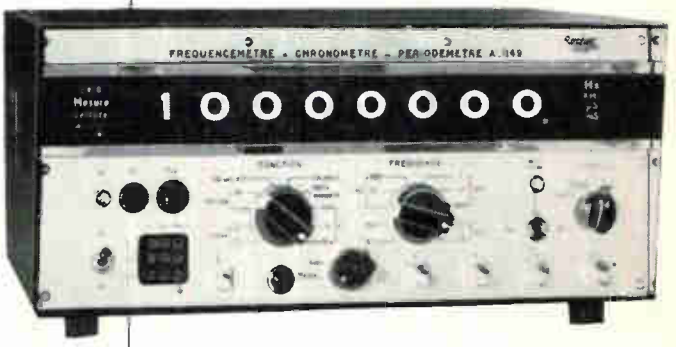
Rochar
électronique
France



an other french product

a new solid-state 10 MC counter

- ★ Count capacity : 99,999,999
- ★ Bright inline readout : 8 digits
- ★ Unit and point indication (displayed)
- ★ High inputs sensitivity: 50 mV to 100 V rms
- ★ Temperature range : 0 to 50° C (-10 to 60° C on test)
- ★ Gatetime : 0.1-1 and 10 seconds ($\pm 10^{-7}$) or any other value with external preset time base (optional)
- ★ Time interval measurements 0.1 μs to > 100 days
- ★ Pulse duration measurements (polarity+or-)
- ★ Period measurements
- ★ Ratio measurements
- ★ Chock and vibration tested



model A-1149

maximum counting rate > **15 MC**

with external aperiodic divider (optional) > **60 MC**

The latest model of digital instruments manufactured by.....
a SCHLUMBERGER LTD subsidiary
408, Bank of the South west Bldg
HOUSTON 2, TEXAS

Rochar
électronique
France

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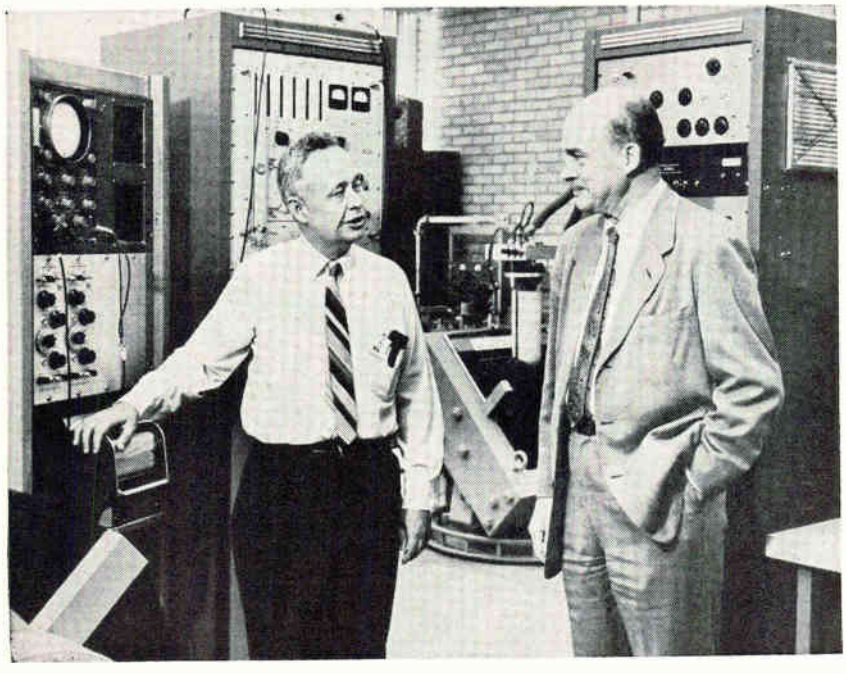
CIRCLE 187 ON READER SERVICE CARD



Haggerty: in favor of the merger . . .

PATRICK EUGENE HAGGERTY, who could be the last IRE president, used to work 10 hours a day, six days a week. Since January, he has averaged 12 hours a day, and often works Sundays, too, now. For a man to devote so much time to his work, he has to "enjoy it down to his very fibers."

This, Pat Haggerty (shown at left, with Eric Jonsson, TI board chairman), does.

He will be 48 on St. Patrick's Day. Of these years, he says the last 16 "have been the most fun." They represent the period in which he helped lead Texas Instruments to a top spot in the semiconductor industry. Now president of TI as well as IRE, the modest but fast-stepping and imaginative North Dakota native describes both jobs as sheer fun.

Even Haggerty, however, admits the IRE presidency this year is a difficult and time-consuming task, especially in view of the proposed consolidation with AIEE.

Haggerty is in favor of the merger, along lines preliminary discussions have covered so far. He believes the consolidation will provide a better overall professional society for individuals, and bring more unity to the profession. He also thinks a combined group will be more sound, financially.

The merger negotiations, however, have added extra work to the IRE president's job this year, and this is one reason Haggerty now works many Sundays.

In the past, he has tried to keep his Sundays free from business affairs. Until this year, Sundays were generally devoted to his family (five children, ranging in age from eight to 23) and personal affairs. Since he still considers he has a full-time commitment to TI, he had to find extra time for IRE, so feels justified this year in working a 7-day week. He estimates he spends about one-quarter of his working time on IRE matters, with Sundays devoted to writing letters and handling other IRE affairs.

If Haggerty is sold on the IRE-AIEE merger idea, he can be expected to put forth a dedicated zeal toward bringing it about. There haven't been many times in the past that Haggerty failed to sell others on an idea, either.

At TI, he is the one single individual given the most credit for first leading the company into the semiconductor field, and then pushing its sales up to around $235 million. TI people say Haggerty has blended his leadership abilities with a generally modest, polite type of personality. Some quickly add that this doesn't mean they don't know who is boss. "Haggerty can really sit down on you when he thinks it necessary."

TI people also view their president as "one of the best at getting to the heart of a complex problem, then making a decision."

"He has an engineering background (BSEE, Marquette Univ., 1936) but you wouldn't consider him a real technical person," says one. "At the same time, he has the ability to judge the significance of a development, and take action."

Haggerty, himself, believes the electronics industry is still "very much a growth industry." He believes its growth in the next decade will be as "absolute" as in the past, although not as great in percentage. "After all," he says, "we started from zero."

He believes the industry has come through its economic problems of 61-62 in good shape. Overall, it remains healthy despite "one of the worst pricing struggles" it has gone through up to now. This struggle isn't over yet, but because the rate of price decline now is not as great as it was last year he is encouraged.

There is only one hobby Pat Haggerty cares much about, and that is sailing. He gets in "little batches now and then," but his work schedule doesn't allow much time even for this. "I find time for it occasionally, because it is the only thing I've found that is as much fun as working here." Since

The 2N398 was good . . . The 2N398A was better . . .

BUT LOOK AT THESE NEW HIGH VOLTAGE MILLIWATT TRANSISTORS FROM MOTOROLA

Whether It Has Been Five Years or Five Days Since You Selected a Milliwatt Transistor, It Will Be Worth a Few Minutes of Your Time to Read This —

Motorola's two latest PNP germanium milliwatt transistor types – the 2N2042 and the 2N2043 – offer power dissipation of 200 milliwatts . . . four times that of the 50 mW 2N398 types.

Here are devices with a minimum collector voltage of 105 volts. Here are devices whose breakdown voltages immediately suggest the answer to low power converter applications where a safeguard in voltage is desirable.

And here, in this series, is a device in a TO-5 package that dissipates *1/5 W without a heat sink* . . . an ideal unit as a driver for Nixie tubes, for power output stages, or for other high voltage applications.

Another "plus benefit" of these new devices is their maximum junction temperature of 100° C, rather than the usual 85°C of most milliwatt germanium devices. This higher operating condition – or safety factor – meets the requirements of many military equipments, as well as commercial equipment, and quality industrial applications, where temperatures of this order may not be expected but where the designer can have this extra safeguard at no extra cost.

NEW MOTOROLA 2N2042 and 2N2043 AUDIO TRANSISTORS

- 105 Volts
- 200 mW power dissipation in free air
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other hobbies don't provide the "sheer fun" of his profession, he doesn't bother with them.

He doesn't even fool with ham radio now, although he built one of the first sets in his state while in high school. Visitors to his estate-type home in Dallas find it strange that it isn't filled with electronic gadgets to do various jobs. The house does contain, however, what one source describes as one of the finest modern art collections.

Abajian Joins AIL In Executive Post

HENRY B. ABAJIAN joins Airborne Instruments Laboratory, Deer Park, L. I., N. Y., as assistant to vice president, electronic systems and techniques division.

Abajian founded Westbury Electronics Corp. in 1952 and was the president of that company until 1959 when it merged with Intercontinental Electronics. He resigned from Intercontinental to accept the AIL post.

IBM Corp. Promotes Clarence Frizzell

CLARENCE E. FRIZZELL has been promoted to manager of manufacturing in the Data Systems division of IBM Corp., Poughkeepsie, N. Y.

Frizzell, who has been general

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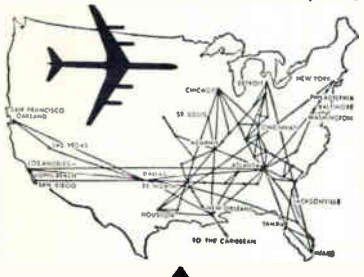

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manager of the division's Poughkeepsie plant, will now have responsibility for both DSD manufacturing there and at its manufacturing facility in Kingston, N. Y.

PEOPLE IN BRIEF

Systems engineering dept. of Adler Electronics Military Products div. adds five engineers: **Norman Courter** and **Robert McCollum** formerly with ITT-Kellogg; **Merle Miller** from The Franklin Co.; **Ralph Barbato** from General Dynamics Electronics; and **Thomas Delaney,** formerly with AT&T. **Abraham Berg** leaves Republic Aviation Corp. to become manufacturing mgr. at Aerotest Laboratories, Inc. **William J. McGowen,** ex-F. J. Stokes Corp., joins Kulicke and Soffa Mfg. Co. Inc. as mgr. of manufacturing. **Joseph L. Berkowitz,** previously with Paratron Corp., appointed quality control mgr. of the Eastern Div. of IMC Magnetics Corp. **Charles T. Zavales** from FXR Inc. to Del Electronics Corp. as v-p in charge of engineering of modulators, power supplies and transformers. **J. Alan Stewart,** g-m of the Sparton Electronics div., elected a v-p of Sparton Corp. **Paul Schild,** ex-Bendix Corp., named mgr. of manufacturing at PRD Electronics, Inc. **Chester J. Piott,** formerly with Hughes Aircraft Co., now Western region mgr. for Emertron, Inc. **Dan L. McGurk** promoted to g-m of TRW Computers Co.

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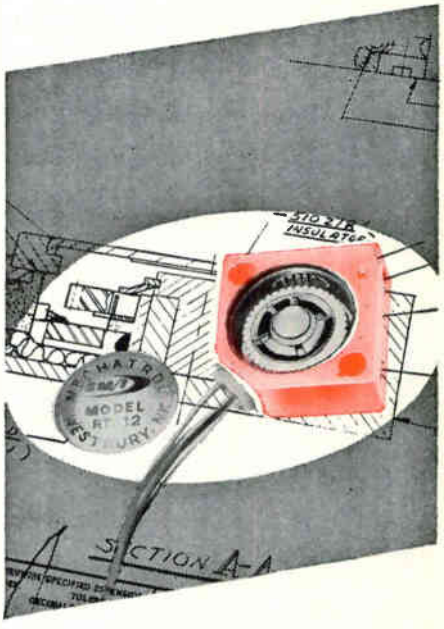

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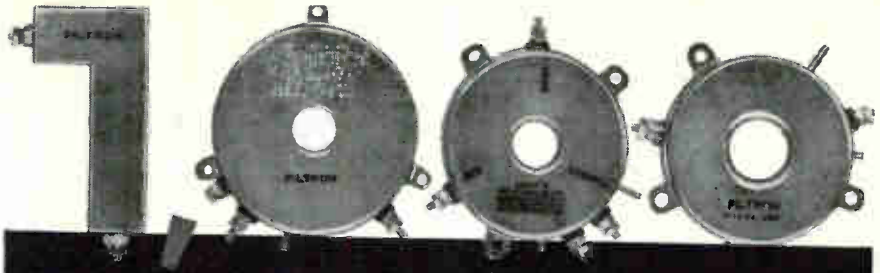

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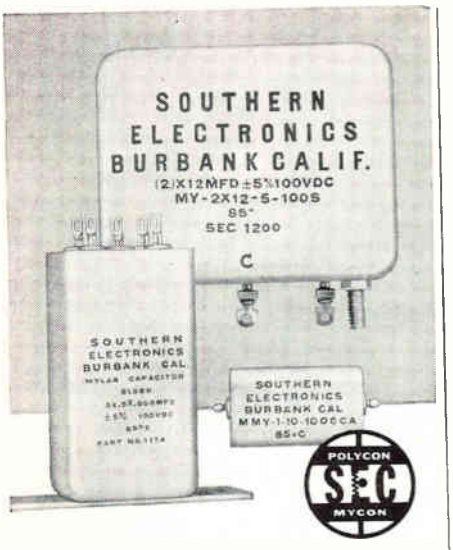

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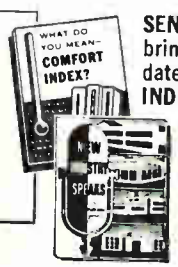
*COMFORT INDEX—One of many terms used to describe the exact point at which the climate of a particular area approaches an ideal combination of moderate temperature, low humidity.



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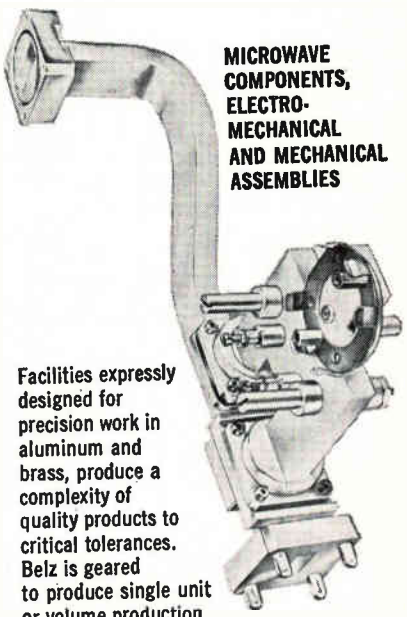

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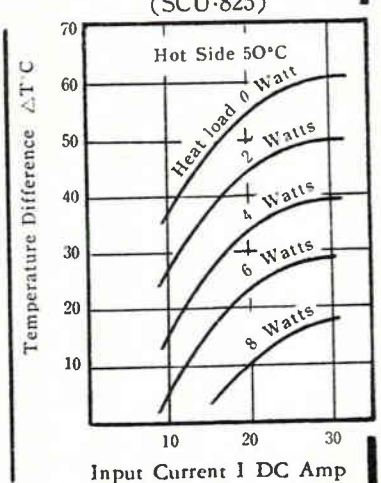

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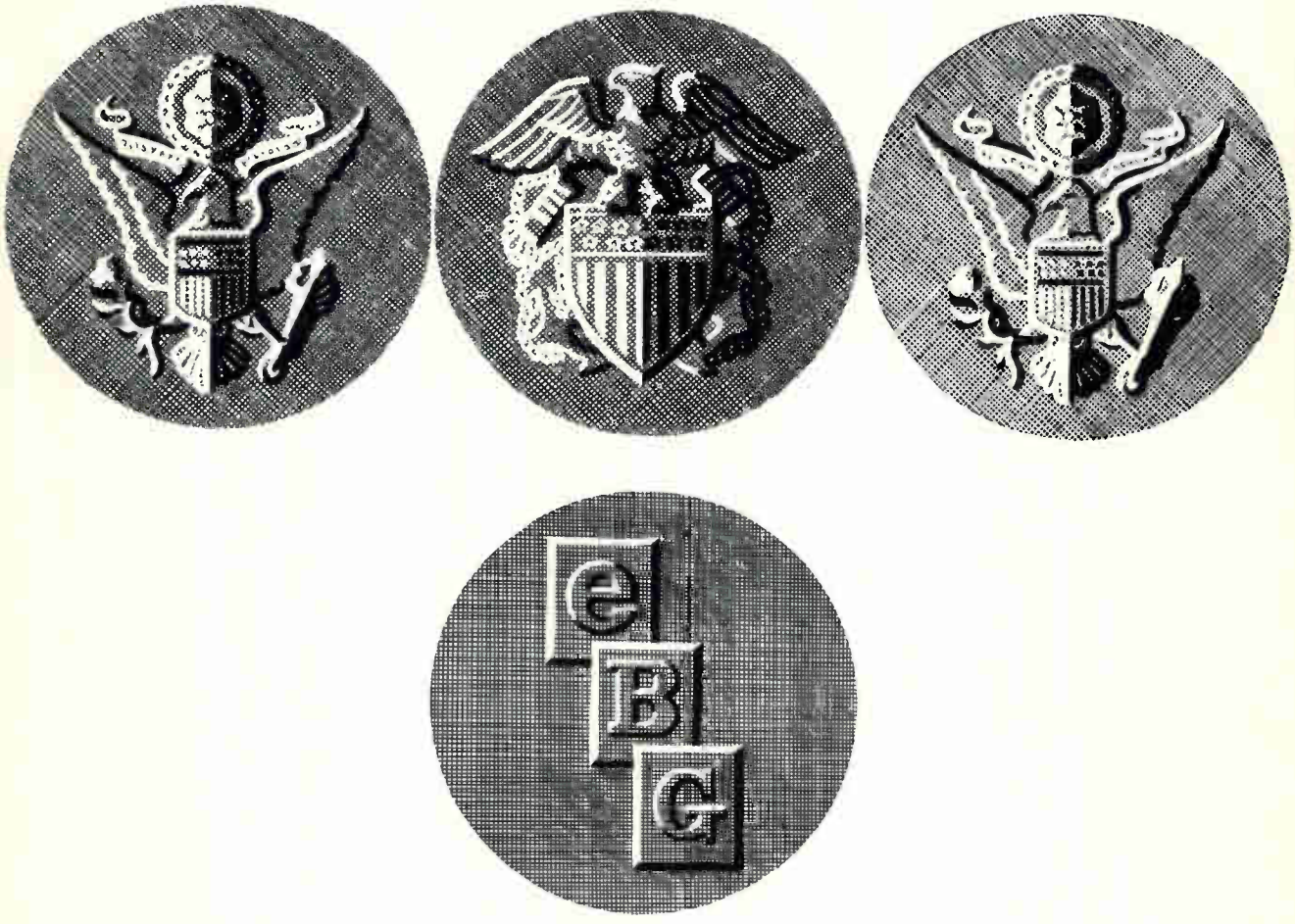

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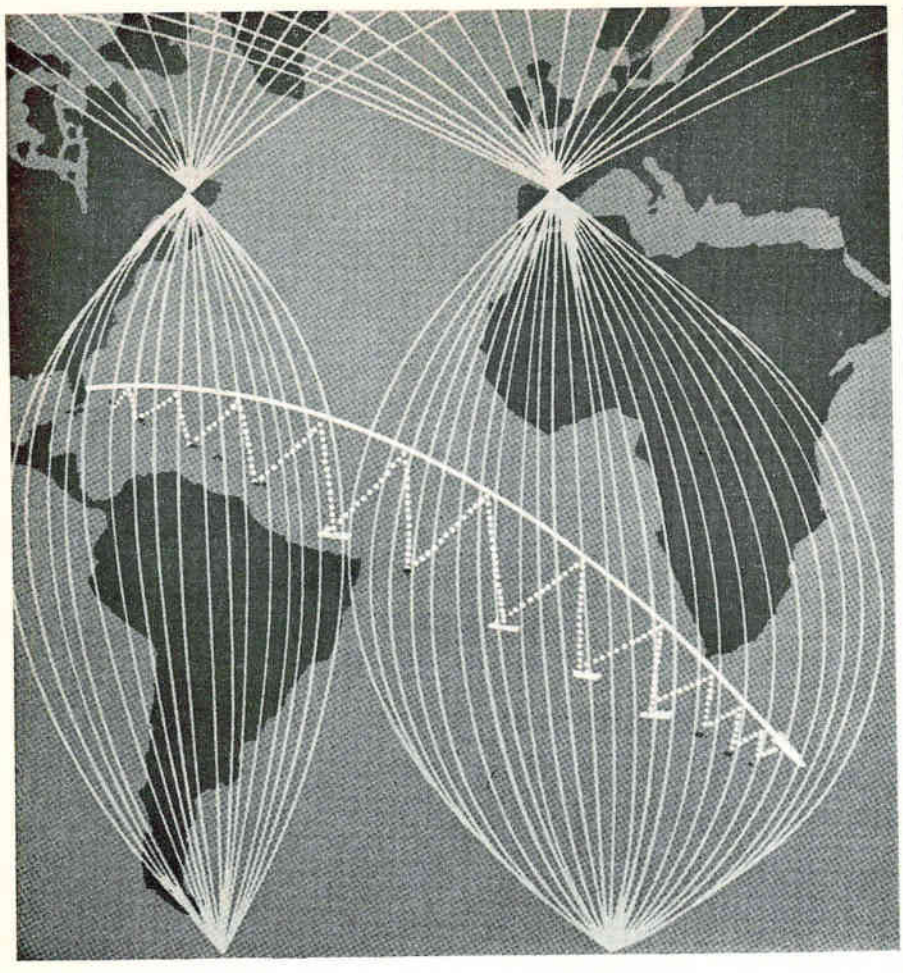

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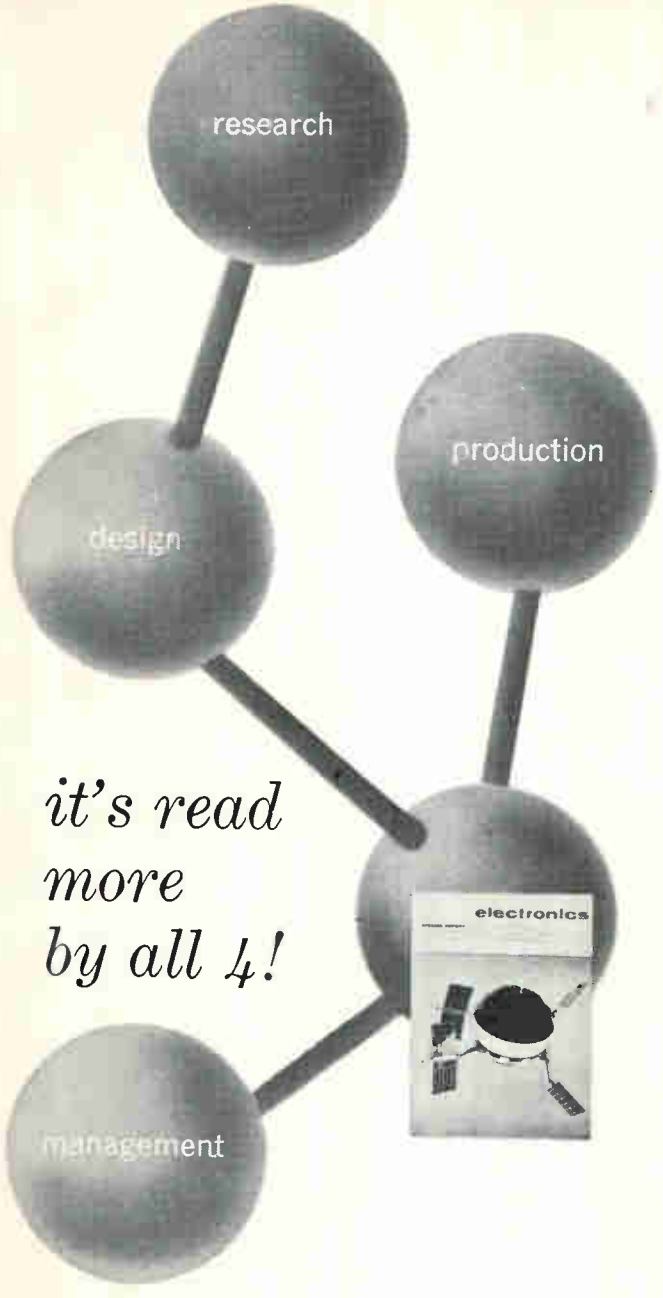

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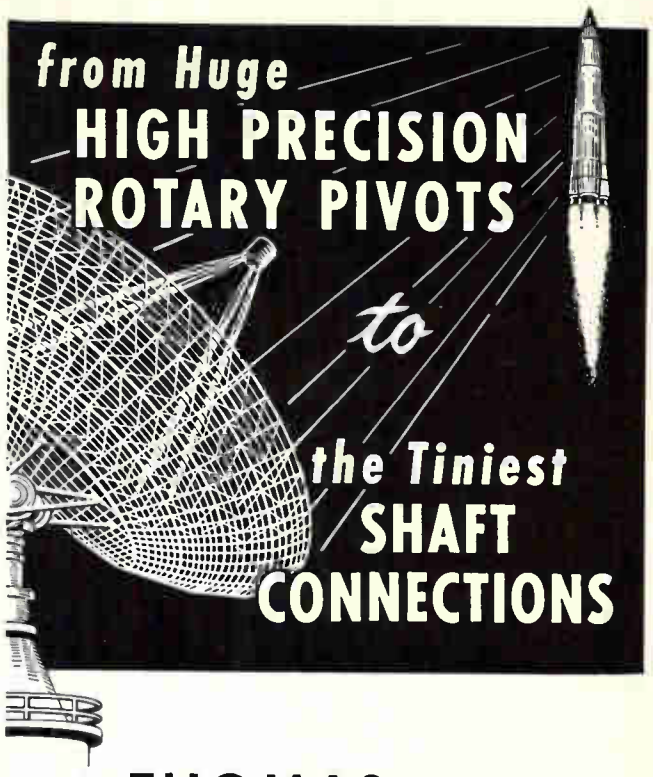

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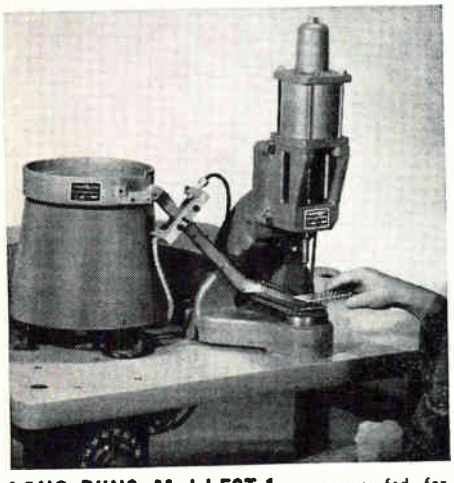

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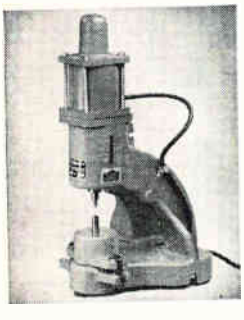

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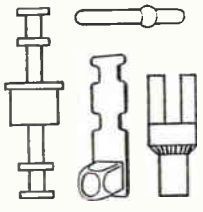

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READS AS LOW AS .05 GAUSS

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Full scope of 11 position range selector provides sensitivity as low as .05 gauss.

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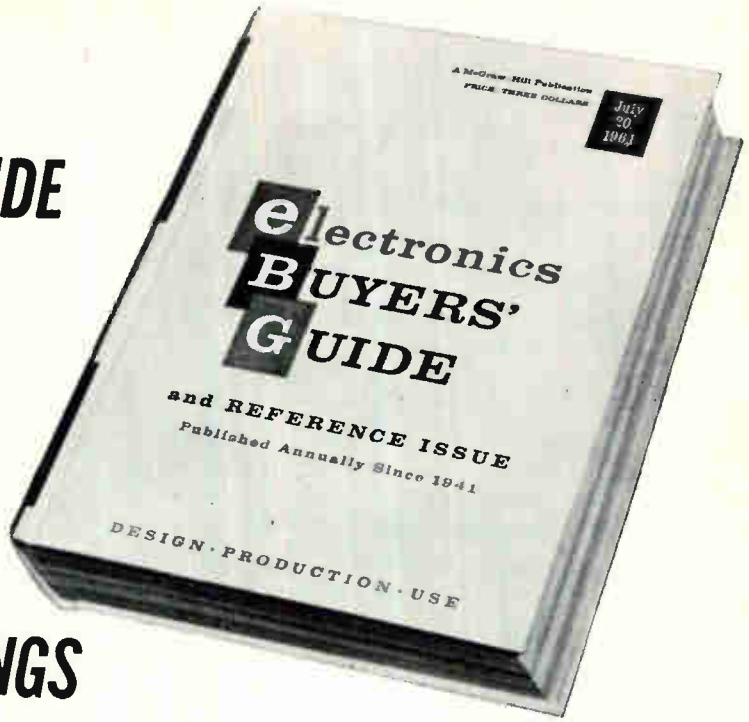
1962 BUYERS' GUIDE TAKES THE FIRST BIG STEP TO INCORPORATE SIC* NUMBERS IN PRODUCT LISTINGS



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Users of the BUYERS' GUIDE have come to expect pioneer service during its more than 20 years of existence. Editorial initiative keeps the BUYERS' GUIDE up to date on the products, materials and services of the entire industry; who makes what and where to buy it.

For the first time anywhere the 1962-63 **electronics** BUYERS' GUIDE and Reference Issue will include SIC numbers for those products which are clearly defined by the SIC. Statistics for marketing based on census figures are available only on products that can be precisely coded by SIC.

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ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

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1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

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ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pennsylvania	213	10
ESQUIRE PERSONNEL SERVICE INC. Chicago, Illinois	208	11
FAIRCHILD STRATOS Aircraft Missiles Div. Hagerstown, Maryland	198, 199	12
GENERAL COMMUNICATION CO. Boston, Massachusetts	207	13
GENERAL DYNAMICS/ELECTRONICS A Div. of General Dynamics Corp. Rochester, New York	210	14
HOLLNBERGER-BURCHELL ASSOCIATES West Islip, New York	208	15
KOLLSMAN INSTRUMENT CORP. Sub. of Standard Kollsman Industries Inc. Elmhurst, New York	217	16

CONTINUED ON PAGE 210

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME .....

HOME ADDRESS .....

CITY .....ZONE.....STATE.....

HOME TELEPHONE .....

Education

PROFESSIONAL DEGREE(S) .....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

FIELDS OF EXPERIENCE (Please Check)

3-9-62

- ☐ Aerospace
- ☐ Antennas
- ☐ ASW
- ☐ Circuits
- ☐ Communications
- ☐ Components
- ☐ Computers
- ☐ ECM
- ☐ Electron Tubes
- ☐ Engineering Writing
- ☐ Fire Control
- ☐ Human Factors
- ☐ Infrared
- ☐ Instrumentation
- ☐ Medicine
- ☐ Microwave
- ☐ Navigation
- ☐ Operations Research
- ☐ Optics
- ☐ Packaging
- ☐ Radar
- ☐ Radio—TV
- ☐ Simulators
- ☐ Solid State
- ☐ Telemetry
- ☐ Transformers
- ☐ Other .....
- ☐ .....
- ☐ .....
- ☐ .....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	.....	.....
RESEARCH (Applied)	.....	.....
SYSTEMS (New Concepts)	.....	.....
DEVELOPMENT (Model)	.....	.....
DESIGN (Product)	.....	.....
MANUFACTURING (Product)	.....	.....
FIELD (Service)	.....	.....
SALES (Proposals & Products)	.....	.....

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39

EMPLOYMENT OPPORTUNITY

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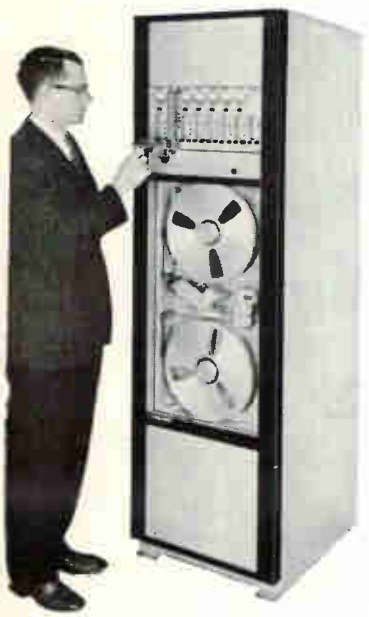

EDUCATION AND EXPERIENCE: Requires B.S. degree in Engineering plus three to five years of applicable experience in transistor circuitry design and development.

NOTE: If you are interested in this employment opportunity, please send your resume to W. J. Mullaney, Training Director, Sangamo Electric Company, Springfield, Illinois. A note describing your employment objectives is always appreciated and a recent snapshot of yourself, if available, most helpful.

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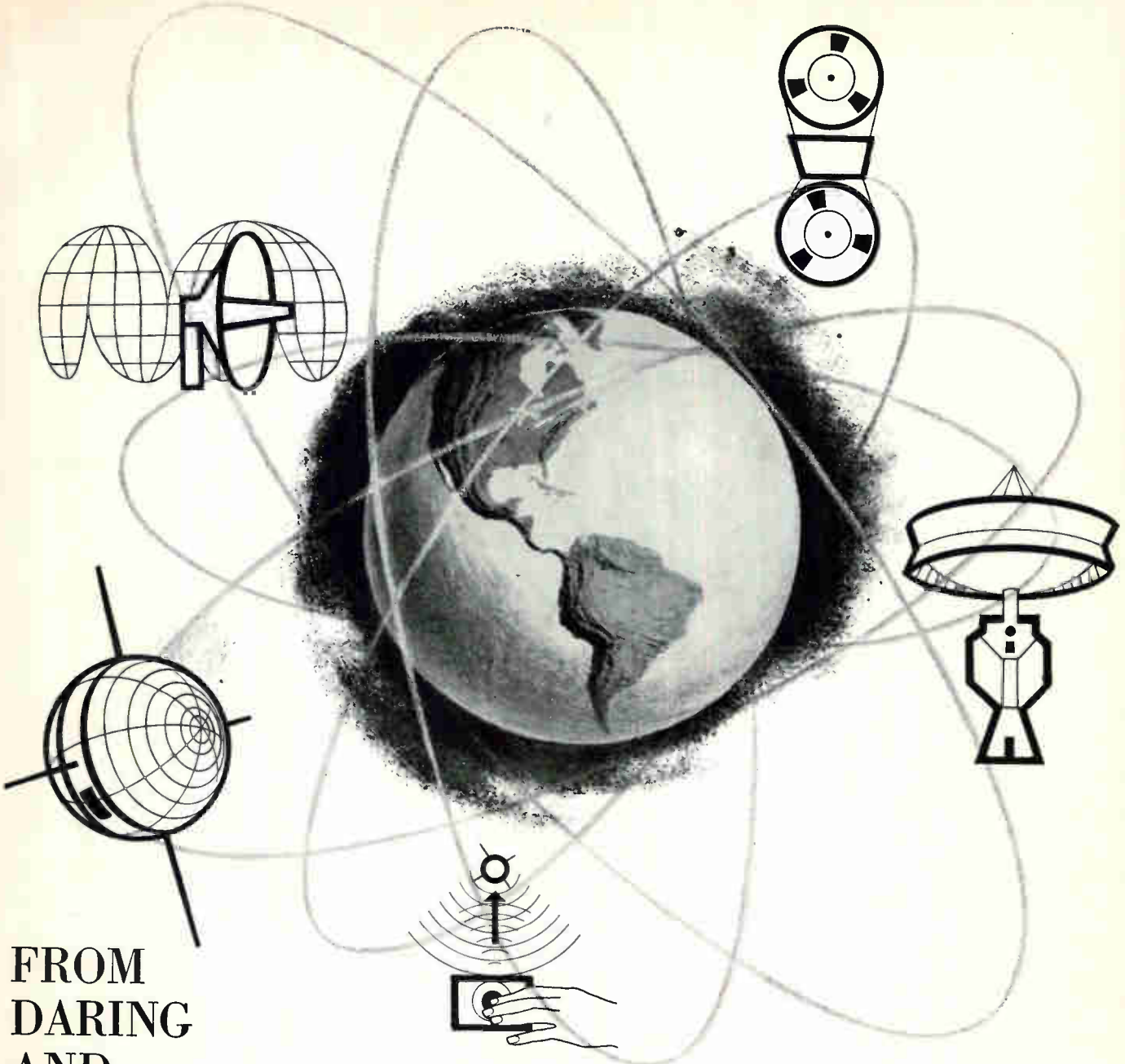

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IN

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GD

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electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from Page 206)

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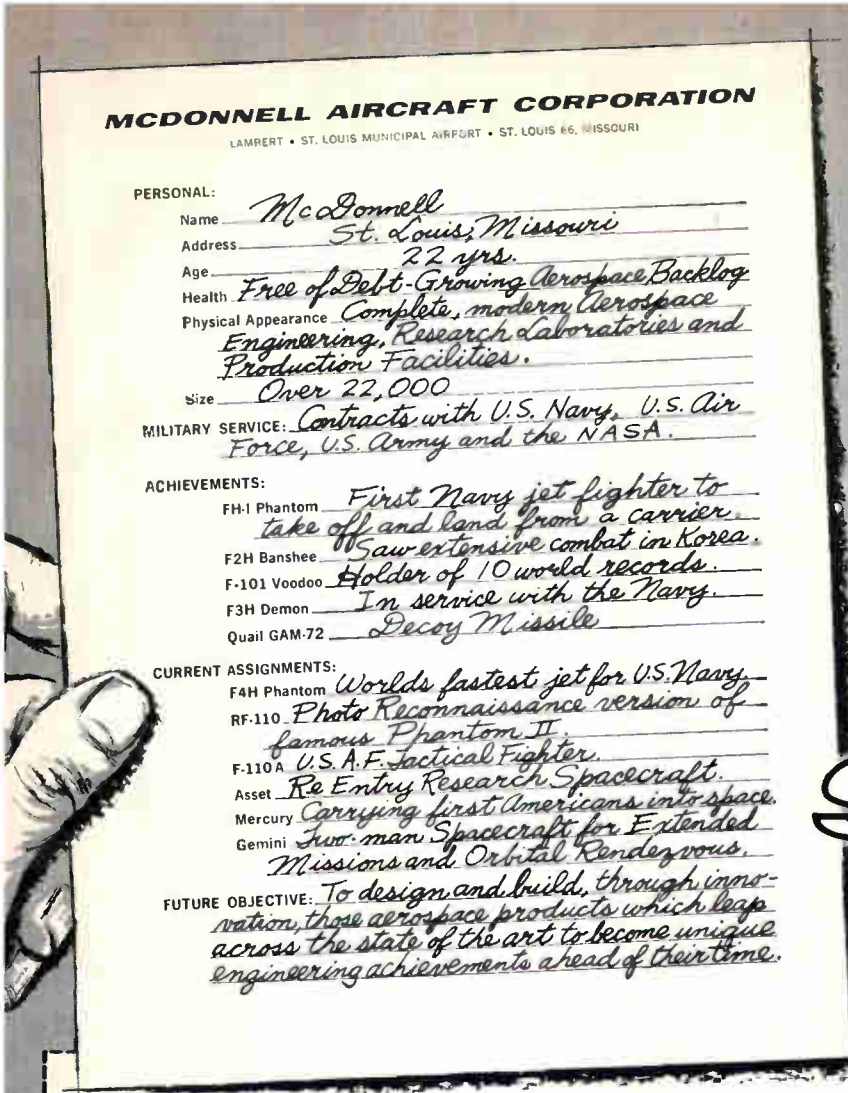

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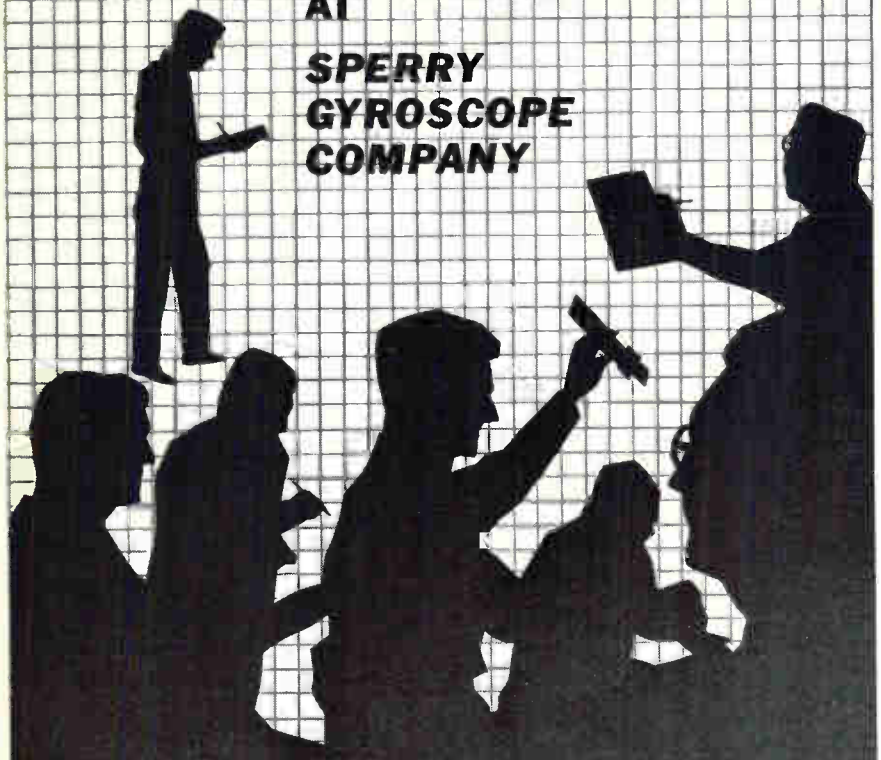

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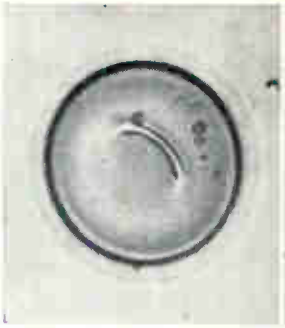

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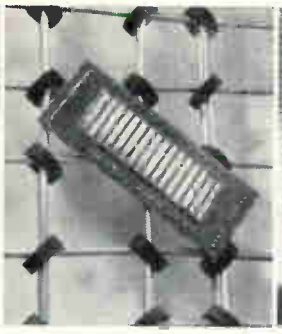

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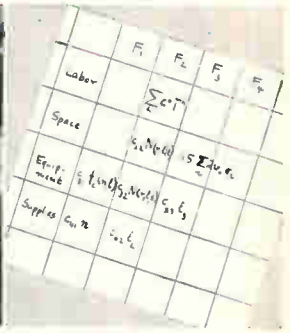

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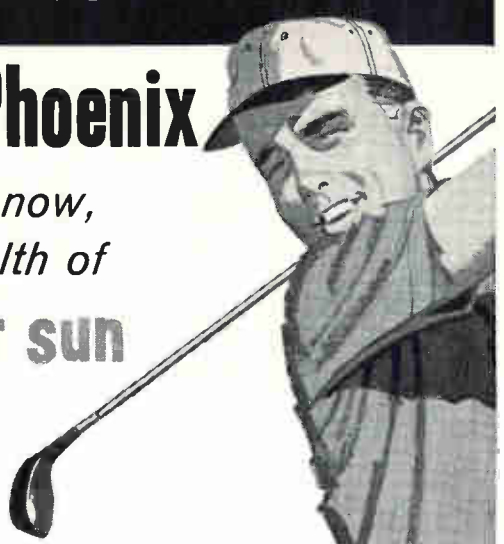

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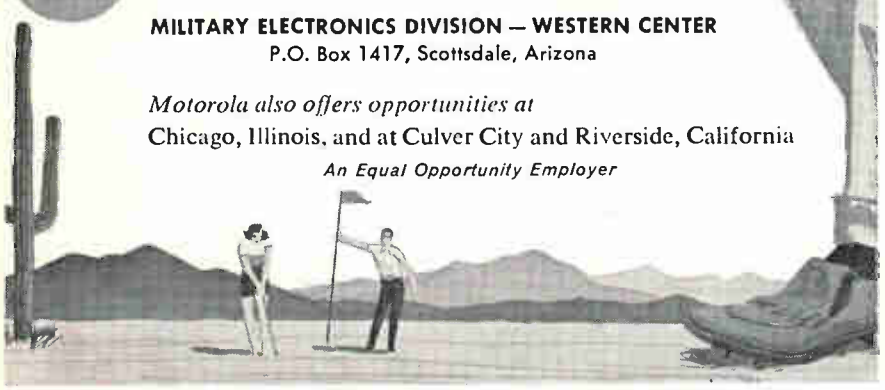

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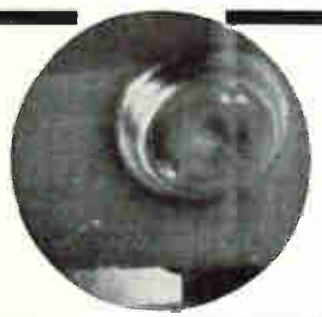
QUIZ PIC # 2



WHAT IN THE WORLD
(of electronics)
IS THIS?

This is our idea of a little fun and recreation. Examine the magnified portion of this photograph . . . and see if you can identify this "tool of the industry." If you can't . . . turn to PAGE ELECTRONICS ad on page 219 for the answer.

CLUE: Brushing after every meal won't help . . . this needs cavities!

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Higher Quality—Lower Costs
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Advertisement

INTERESTING TO NOTE . . .

NEW YORK, N. Y. Feb. 1962:—

Universal Relay Corp.. 42 White St., New York 13, N. Y. announces the publication of their 52 page Spring 1962 catalog. With publication of the catalog, they inform their customers that "normal inventory includes over 1,500,000 relays in approximately 30,000 types. In most cases stock is sufficient to give immediate delivery of production quantities.

This catalog is, therefore, not just a listing of items available 'on order' but, by and large, it is an indication of in-stock items (either as complete units or as ready to assembly components).

The average shipment is made within 48 hours. Where coils and frames require assembly, or relays require special testing or adjustment, shipments are made within one week to ten days.

Universal is completely equipped to assemble, adjust and thoroughly test any type of relay. Assembly and test facilities have been imitated by some relay manufacturers.

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The catalog is full of items to fill everyday relay requirements".

Catalog E-162 may be obtained by writing directly to:

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ANTENNA PEDESTAL SCR 584-MP 61B

Full azimuth and elevation sweeps 360 degrees in azimuth. 210 degrees in elevation. Accurate to 1 mil. or better over system. Complete for full tracking response. Angle acceleration rate: AZ, 9 degrees per second squared EL, 4 degrees per second squared. Angle slewing rate: AZ 20 degrees per sec. EL. 10 degrees per sec. Can mount up to a 20 ft. dish. Angle tracking rate: 10 degrees per sec. Includes pedestal drives, selsyns, potentiometers, drive motors, control ampildynes. Excellent condition. Quantity in stock for immediate shipment. Ideal for missile & satellite tracking, antenna pattern ranges, radar system, radio astronomy, any project requiring accurate response in elevation and azimuth.
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3 CM & 10 CM. Our 584s in like new condition, ready to go, and in stock for immediate delivery. Ideal for telemetry, research and development, missile tracking, satellite tracking, balloon tracking, weather forecasting, anti-aircraft defense tractical air support used on Atlantic Missile Range, Pacific Missile Range, NASA Wallaps Island, A.B.M.A. Write us. Fully Desc. MIT Rad. Lab. Series, Vol. 1, pps 207-210, 228, 284-286.

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500 kw. 1220-1359 mcs. 160 nautical mile search range P.P.I. and A. Scopes, MTI. thratron mod. 5J26 magnetron. Complete system.

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Airborne radar. 50uw output using 725A magnetron. Model 3 pulser. 30 in. parabola stabilized antenna. PPI and "A" scope. Complete system. $1200 each. New.

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Complete RF head including transmitter, receiver, modulator. Uses 2J42 magnetron. Fully described in MIT Rad. Lab. Series Vol. 1, pps. 616-625 and Vol. II, pps. 171-185 $375. Complete Radar System $750.

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Output pulse power 25 KV at 40 amp. Max. duty ratio: 002. Uses 6C21 pulse tube. Pulse duration .25 to 2 microsec. Input 115 volts 60 cycles AC. Includes power supply in separate cabinet and driver. Fully guaranteed as new condition. Full Desc. MIT. Rad. Lab. Series "Pulse Generators."

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6 or more units..$19.95 each FOB—NYC Warehouse

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rms/piv	rms/piv	rms/piv	rms/piv	AC & DC
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.09	.17	.22	.31	
rms/piv	rms/piv	rms/piv	rms/piv	&
280/400	350/500	420/600	490/700	L
.38	.50	.63	.77	O
rms/piv	rms/piv	rms/piv	rms/piv	A
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Operation Up to 125°C Case Temp.

D.C. Amps	50Piv 35Rms	100Piv 70Rms	150Piv 105Rms	200Piv 140Rms
2	.25	.35	.45	.55
3	.60	.85	1.00	1.25
6	.70	1.00	1.25	1.50
12	.85	1.20	1.50	1.70
35	1.80	2.15	2.50	2.90
70	3.75	4.25	4.80	5.60
240	4.50	5.70	6.90	8.40

D.C. Amps	300Piv 210Rms	400Piv 280Rms	500Piv 350Rms	600Piv 420Rms
2	.80	1.00	1.50	1.95
3	1.50	1.80	2.10	2.65
6	1.75	2.00	3.70	5.20
12	2.00	2.20	3.90	5.70
35	4.95	6.10	FOR QUANTITY	
70	10.80	15.30	Export & User Prices	
240	19.60	29.75	Write on Company	

*°Derate 20% for Battery or Capacitive Load or D.C. Blocking! *Stud mounted on Heat-sink*

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12VDC to 500VDC up to 200MA
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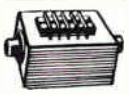

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1N1354	1N1369	1N1808	1N2500
1N1355	1N1370	1N1809	1N2974
1N1356	1N1371	1N1811	1N2979
1N1357	1N1372	1N1812	1N2980
1N1358	1N1373	1N1813	1N2990
1N1359	1N1374	1N1815	1N2991
1N1360	1N1375	1N1816	1N2997
1N1361	1N1603	1N1822	1N3004
1N1362	1N1604	1N1834	1N3007
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†.25	15KV	15.95	3	20KV	125.00
†.25	20KV	22.50	4	10KV	67.50
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†.5	25KV	29.50	9	10KV	115.00
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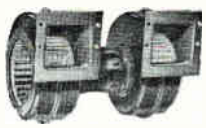

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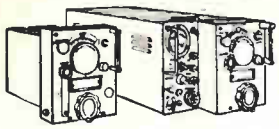

Checked Out TEST EQUIPMENT
for your Laboratory and Radar needs

PIB I	Pulse Impedance Bridge, Cleg Labs	400.00
608 A	Hewlett Packard Signal Generator	695.00
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400 A	Hewlett Packard VTVM	125.00
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TS125	S Band Power Meter	195.00
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TS147B	Wide Band X-Band Signal Generator	795.00
TS147D	Wide Band X-Band Signal Generator	1,695.00
TS148	X-Band Spectrum Analyzer	1,695.00
TS155	S Band Signal Generator	125.00
TS155C	S Band Signal Generator	595.00
TS173	Frequency Meter	225.00
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TS175	Frequency Meter	195.00
TS175C	Frequency Meter	225.00
TS182	VHF Oscillator & Power Meter	45.00
TS183	Battery Tester	35.00
TS226	Frequency Meter	45.00
TS239	Oscilloscope	895.00
TS251	Range Calibrator	175.00
TS270	Echo Box	175.00
TS270A	Echo Box	175.00
TS270B	Echo Box	225.00
TS403	S Band Signal Generator	1,250.00
TS419	L Band Signal Generator	895.00
TS488A	Echo Box X Band New	495.00
TS545	L Band Echo Box	95.00
TS577	Telephone Test Set	295.00
TS666	Calibrator	125.00
EPUT554	Berkley Instruments Frequency Meter	395.00
RCAMI-7519E	Distortion & Noise Analyzer	150.00

UPM 4, 6, 7, 8, 10, 11, 11A, 30, 33, 42, 44,
URM 12, 23, 25, 26, 43, 64

Radar Test Sets.....Prices on Request
Tektronix Oscilloscope Model 511A.....450.00
Model 84.....750.00
General Radio Signal Generator 605B.....295.00
Power Supplies
Radar Pulsers to test Magnetrons.....695.00 up

New...250KW X-Band RF Generator

Uses 4J50 Magnetron with dummy load and directional coupler. Variable repetition rates and power output. Power input 115V, 50-1000 cycles. Unit size: 30"48"x28"—mounted on casters.
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2K23	25.00	2K54	24.00
2K25	12.00	2K55	35.00
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2K42-4	170.00	5721	110.00
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and others

MAGNETRONS

2J21	12.50	2 SGA	66.00
2J30	37.50	2J61-62	35.00
2J31	12.50	2J61A-62A	75.00
2J32-34	17.50	3J21	50.00
2J36	17.50	3J31	60.00
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2J42	55.00	4J52	45.00
2J48/50	25.00	4J57-9	135.00
2J51	55.00	4J60-62	135.00
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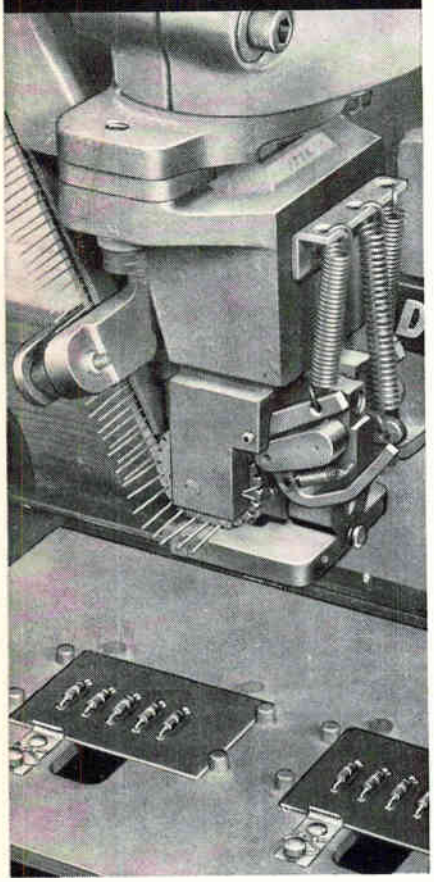

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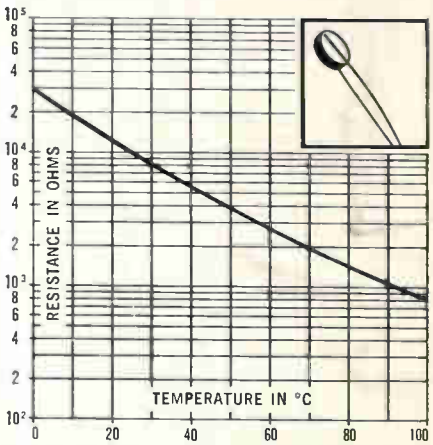

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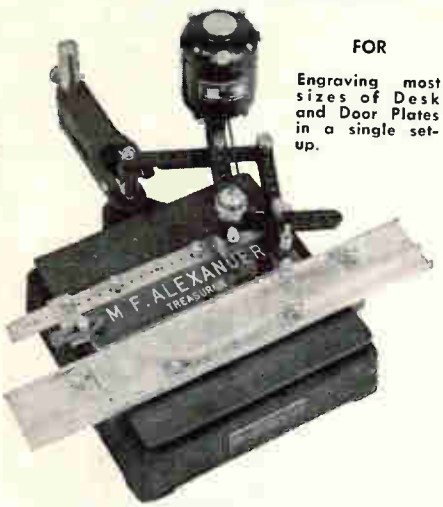

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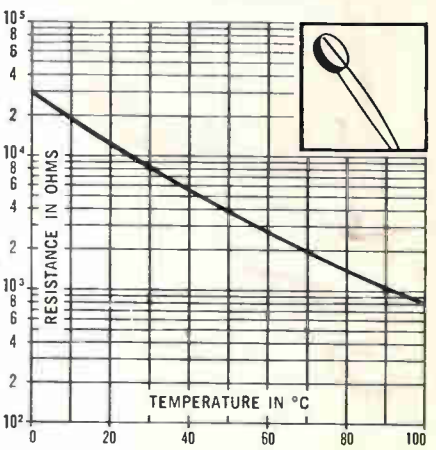

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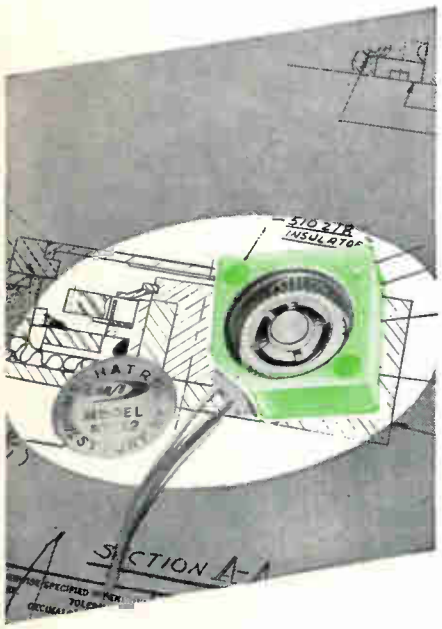

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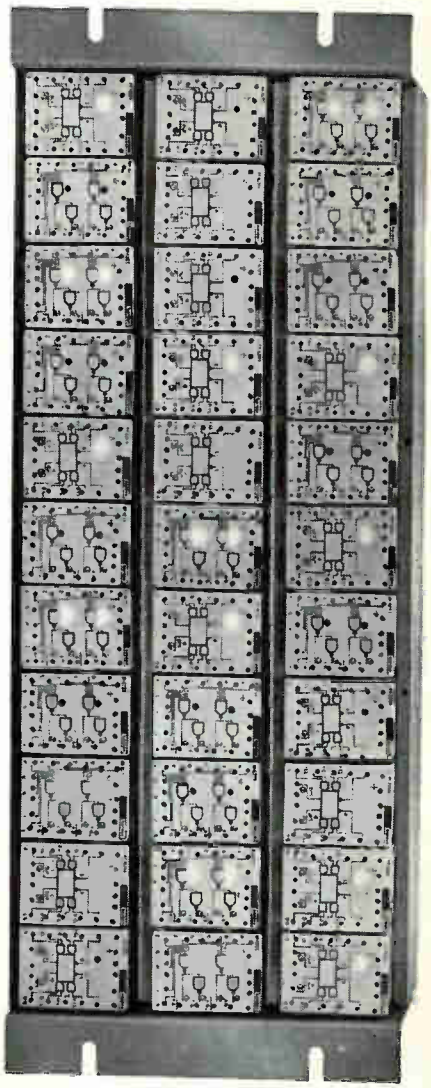

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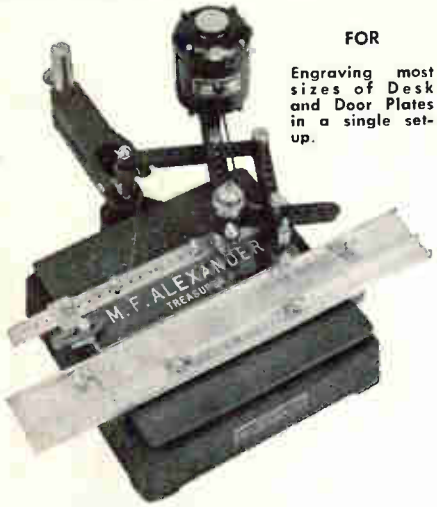

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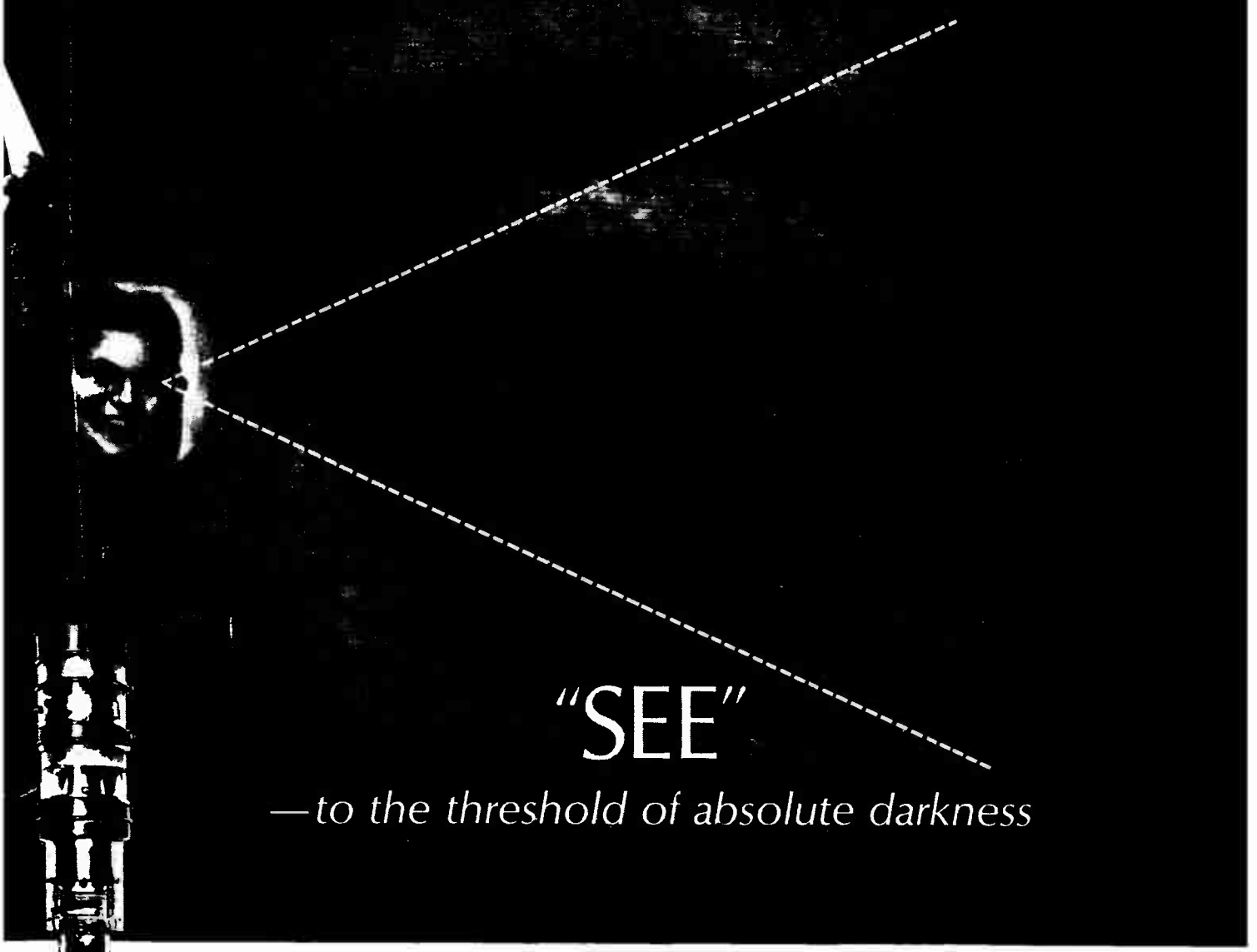

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