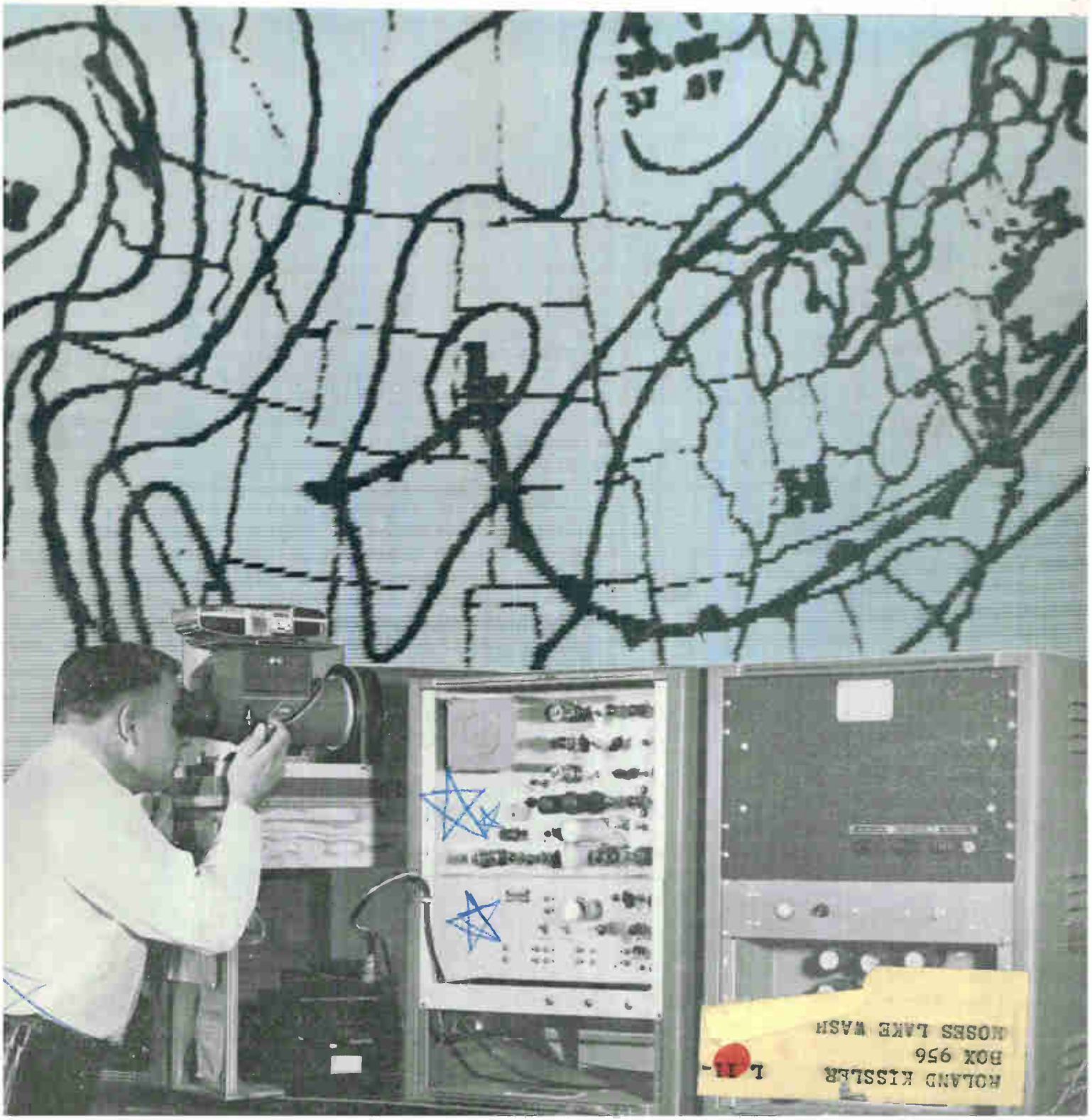
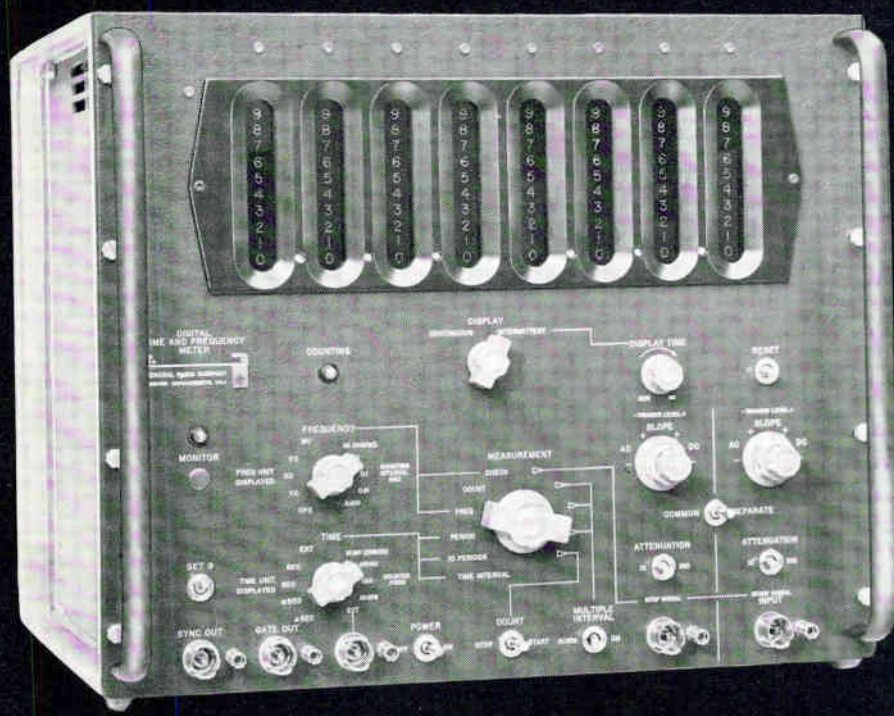
May 19, 1961

electronics

Facsimile equipment, below, uses meteor-burst propagation to transmit data such as weather map shown in background, p 85
Practical design techniques for thin-film networks, p 90

A McGraw-Hill Publication 75 Cents





the Counter with a Memory

Continuous Readout to 10 Megacycles

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

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

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

Unsurpassed reliability is achieved by:

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

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

SENSITIVITY:
0.25v rms

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

ACCURACY:
±1 count ± time-base oscillator stability

AVAILABLE WITH SEVERAL PLUG-IN TIME-BASE OSCILLATORS

Buy the Time-Base Stability You Need

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

For Digital Recording

1132-A Data Printer . . . $1450.
Records 8 digits from counter plus 4 digits from clock or other source, at speeds to 3 prints per sec . . . no modification of counter is required

For Graphic Recording

1134-A Digital-to-Analog Converter . . . $595
Makes possible low-cost, ALL-ELECTRONIC graphic strip-chart recording (no data printer needed) . . . high accuracy of 0.1%

For Measurements to 500 Mc

Frequency conversion units are under development

Write for Complete Information

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WEST CONCORD, MASSACHUSETTS

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May 19, 1961

electronics

A McGraw-Hill Publication *75 Cents*

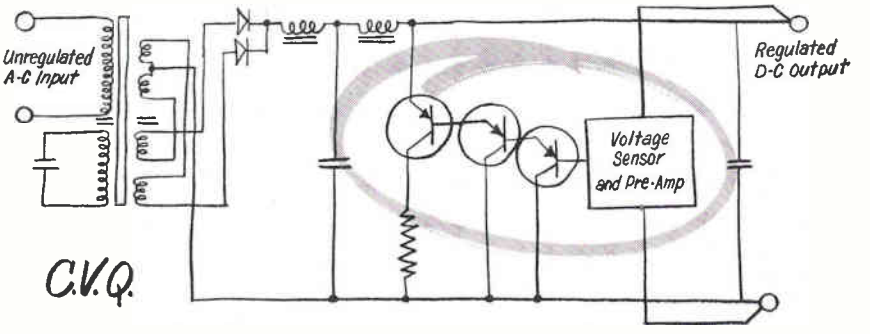
W. W. MacDONALD, Editor

BUSINESS

ENGINEERING

DEPARTMENTS

SOLA writes this new Rx for reliable d-c power



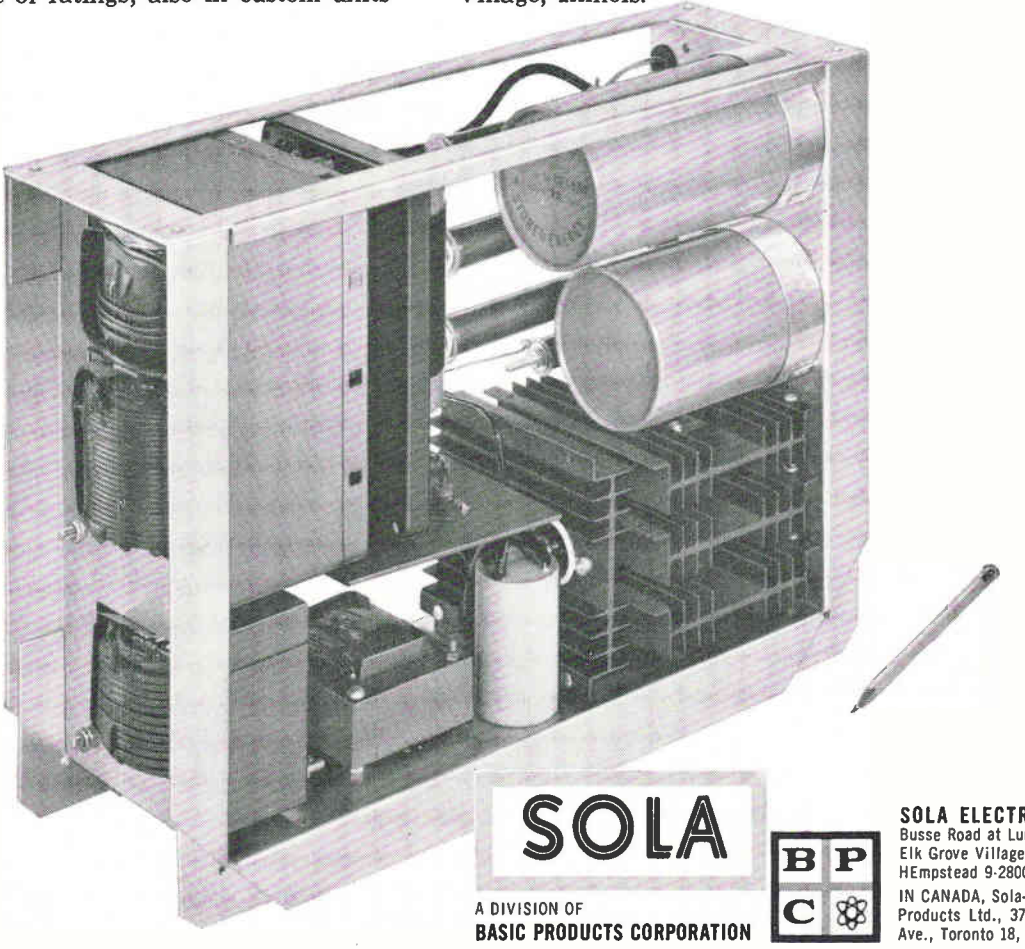
This schematic tells "CVQ's" secret at a glance . . . how SOLA's remarkably reliable new power supply achieves d-c output ideal for computers and other voltage-sensitive equipment. "CVQ" integrates the advantages of shunt-circuit regulation with the *inherent* high stability of the SOLA static-magnetic transformer. And the result is transistorized voltage regulation *with split-cycle response!*

"CVQ" answers the demands of dynamic loading. Voltage variations are ironed out down to the last transient — even to the last ripple of the a-c source. And the SOLA static-magnetic transformer *automatically* prevents damage in event of a short circuit.

SOLA "CVQ" d-c power supplies are available *right now,* in a wide range of ratings; also in custom units built to your specific requirements. Advantages include:

- More watts per dollar.
- Continuous automatic protection without fuses, both for output short circuits, and for open circuits in the voltage-sensing circuitry.
- Output regulated within ±0.04% for line voltage variations ±15%; 0.2% static-load regulation, 0 to full load. Excellent response time.
- Standard models available in the 120-watt range for 5, 6, 10 and 12 volts d-c (100-130/181-235/200-260 volt input).
- Compact mechanical layout — only 12¼ x 5¼ x 19".

Get full facts by writing for new SOLA Catalog DCX-361A. Or telephone HEmpstead 9-2800, Elk Grove Village, Illinois.



SOLA

A DIVISION OF
BASIC PRODUCTS CORPORATION

B P C

SOLA ELECTRIC CO.
Busse Road at Lunt,
Elk Grove Village, Ill.
HEmpstead 9-2800
IN CANADA, Sola-Basic Products Ltd., 377 Evans Ave., Toronto 18, Ontario

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Arnold offers you the widest range of shapes and sizes of iron powder cores on the market.

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The net result is extra advantage and assurance for you. No matter what shapes or sizes of iron powder cores your designs require, you can get them from a single source of supply—with undivided responsibility and a single standard of known quality. And Arnold's superior facilities for manufacture and test assure you of dependably uniform cores, not only in magnetic properties but also in high mechanical strength and dimensional accuracy.

● For more information on Arnold iron powder cores, write for a copy of our new 36-page Bulletin PC-109A. *The Arnold Engineering Company, Main Office and Plant, Marengo, Illinois.*

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2541

electronics
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CROSSTALK

ORGANIC SEMICONDUCTORS. The Inter-Industry Conference on Organic Semiconductors, co-sponsored by ELECTRONICS and Armour Research Foundation in mid-April, was a success. The technical quality of the papers presented was high, the sizable audience was serious and attentive. It represented a highly-placed, significant cross-section of the electronics and chemical industrial community.

We greatly enjoyed this experience. We heard portents of great significance to our industry and others in the technical dissertations. But we derived no big story from this conference. No new electronic devices have as yet been fabricated utilizing organic technology. Indeed, any references to plastic transistors or organic photocells must be relegated to that class of devices wryly referred to by W. O. Baker of Bell Labs as "journalistors," compounded of blue sky and printer's ink. But some day the real devices will come. Of that we are convinced.

Baker, speaking at a Conference luncheon, touched upon another intriguing aspect of organic semiconductor research. He speculated that complete understanding of the conduction process in organic compounds would lead to knowledge of the control and signaling processes in living organisms with untold applications in computer and communication fields. It might eventually lead to synthesis of the mechanism of the life process itself. Indeed, one scientist told ELECTRONICS that a better comprehension of organic semiconductors might stem from biology rather than from physics. Whichever approach is the right one, it is apparent that the two disciplines are now inextricably linked. ELECTRONICS intends to follow this exciting field carefully, and as developments unfold, they will be reported to our readers.

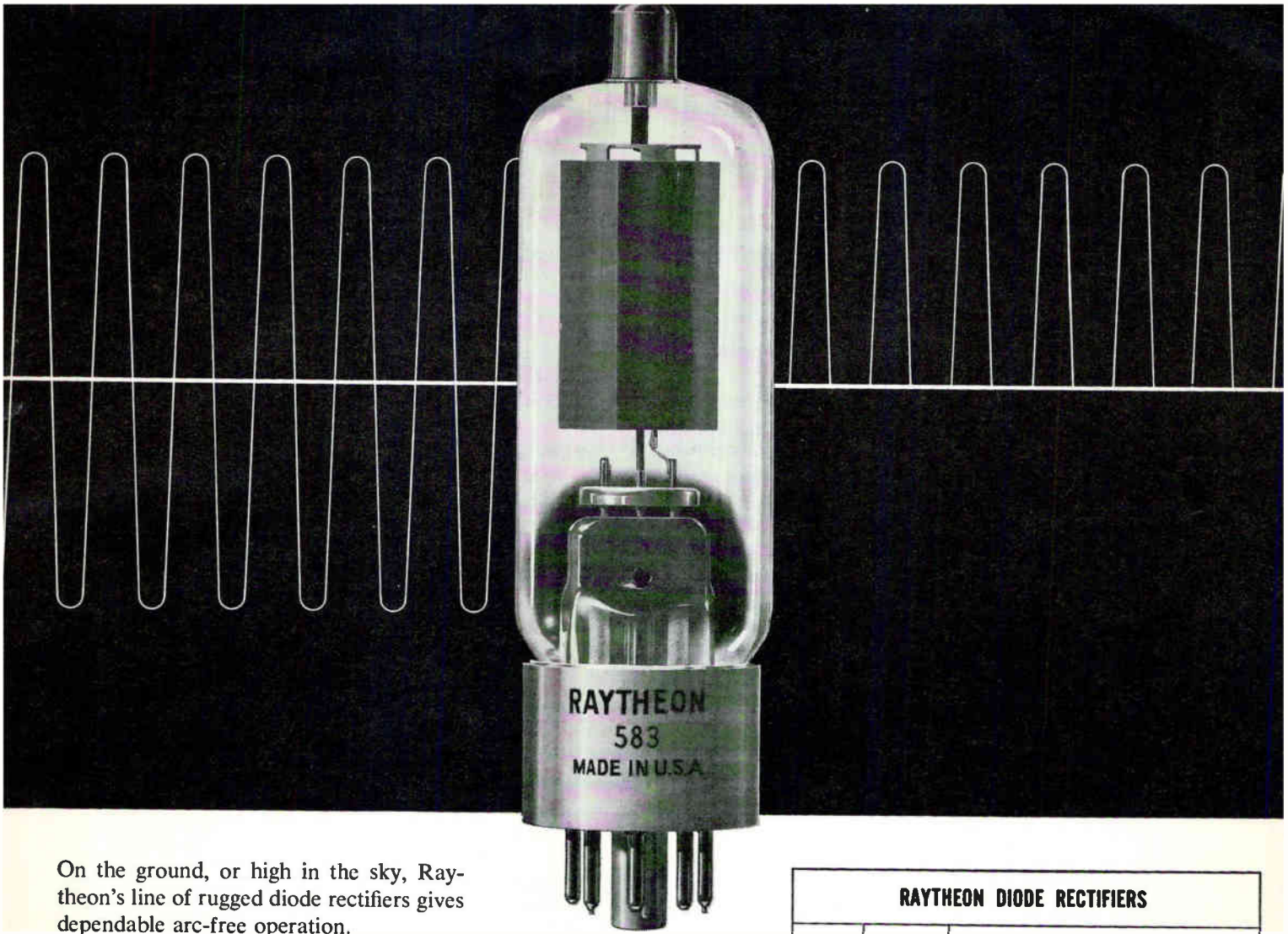
Coming In Our May 26 Issue

AIR-TRAFFIC CONTROL. As reported recently in ELECTRONICS (p 26, Feb. 10), the FAA believes the ultimate approach to the problem of midair collision is to keep flights of all aircraft continuously under surveillance by ground control centers. A step in this direction is the ground-based system for controlling high-density traffic at air terminals described in our next issue by R. Meuleman and S. D. Moxley, Jr. of Avco Corp. of Cincinnati. Aircraft can be controlled out to 80 miles and 18 arrivals and six departures governed simultaneously. System automatically computes instructions for the pilot and controls landing time with a precision of ± 9 seconds.

UV DETECTION. Reliable ultraviolet radiation detector tubes have many applications in systems where uv radiation is the independent variable either by nature or design. Typical applications include fire detection, explosion detection and communication between satellites.

Next week, D. H. Howling and R. C. Roxberry of McGraw-Edison Co. describe a gas-filled uv detector tube that exhibits a power gain of 110 db. Counting rate approaching 3 Mc is expected to allow unambiguous detection of explosions in a few microseconds.

FURTHERMORE. A variety of interesting feature material to appear next week includes: a transistor amplifier that controls remote appliances by Midwest Editor Wiley; a carrier phase reversal system for transmitting digital data over telephone lines by J. R. Masek of The Hallicrafters Co.; interstage design for stagger-loaded amplifiers by L. A. Beattie of the University of Idaho; and a survey of transmission media by J. H. Vogelman of Capehart Corp.



GET PEAK POWER WITH RAYTHEON RUGGED, ARC-FREE DIODE RECTIFIERS

On the ground, or high in the sky, Raytheon's line of rugged diode rectifiers gives dependable arc-free operation.

Example: Raytheon 583, one of six Raytheon half-wave rectifier types. Operating as a clipper diode at altitudes to 36,000 feet, maximum ratings are 15,000 volts PiV, 8 amperes peak plate current. Arc-free clipping action makes sure a magnetron can be fired once *without* re-firing automatically or uncontrollably!

The reliability of Raytheon diode rectifiers is the result of exceptional care in design and manufacture . . . with no compromise in quality control. Gold-plated plates and zirconium coatings assure reliable operation at high voltages. Cathodes are heliarc welded. Higher exhaust temperatures mean less gas and longer life. For more information on Raytheon's growing line of dependable diode rectifiers, please write: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

RAYTHEON DIODE RECTIFIERS

TYPE	SERVICE	HEATER VOLTS	HEATER AMPS	MAX. PLATE RATINGS PEAK INVERSE (VOLTS)	MAX. PLATE RATINGS PEAK CURRENT (AMPERES)	MAX. PLATE RATINGS AVERAGE CURRENT (AMPERES)
583*	H. W. RECT. (to 36,000 ft.)	2.5	4.9	17,000	0.250	0.065
	CLIPPER DIODE (to 36,000 ft.)	2.5	4.9	15,000	8.0	0.240
3B24W 3B24WA*	H. W. RECT. (HALF FIL.)	2.5	3.0	20,000	0.150	0.030
	(FULL FIL.)	5.0	3.0	20,000	0.300	0.060
3B26	CLIPPER DIODE	2.5	4.75	15,000	8.0	0.020
3B29	H. V. RECT. (OP. 1)	2.5	4.9	16,000	0.250	0.065
	(OP. 2)			7,700	0.300	0.080
	(OP. 3)			5,000	0.300	0.095
	CLIPPER DIODE	2.5	4.9	10,000	8.0	0.018
4B31*	H. W. RECT.	5.0	5.0	16,000	0.470	0.150
	CLIPPER DIODE	5.0	5.0	16,000	12.0	0.060

*Mil-Std-200E Preferred Type

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RAYTHEON

COMMENT

Medical Electronics

Re.: your articles on medical electronics (p 49, Jan. 20; p 46, Feb. 3; p 54, Feb. 20) . . .

The Burnham Beeches unit here is the Australian division of the Nicholas Institute for Medical Veterinary Research. This Institute is the basic research organization of the Nicholas group of companies and has another division at Slough, Buckinghamshire, in England. The work at Burnham Beeches is about equally divided into veterinary and medical pharmacological research aimed at producing new drugs and information about new drugs. The medical pharmacology group contains a small neurophysiology unit which is investigating the effect of analgesic drugs on the central nervous system.

The equipment of the neurophysiology unit is probably of interest to you. Electrodes are inserted into the brains of dogs using standard stereotaxic methods and the electrical activity of the site at the electrode needle tip is led off to a Tetroniks 122 preamplifier, thence to a main amplifier of an electroencephalograph unit and recorded by both pen recorder and cathode-ray oscilloscope. We have the standard Grass Instrument equipment, stimulators, cro photocamera, photic stimulator for this work. The whole system is a four-channel one and in this respect is unusual—it is based on the use of a 20th Century (English) crt which has four separate guns. We have a visual monitor and a paralleled crt for photographing. The timebase and trigger circuitry is orthodox and was made here in Melbourne.

The eeg unit, of which four main amplifiers are used in the four recording channels, is also unusual. It was made to our specifications in Adelaide and, although suffering from the usual drawbacks of an experimental model, has been on the whole very successful. The eight channels of amplifiers, both preamps and main amplifiers, have a frequency response from 0.1 to 10 Kc, and two of the main amps have a response from d-c to 10 Kc. The gains attainable are also higher than usual, and five microvolts can be recorded satisfactorily. We do a good deal of straight eeg recording from dogs, especially from chronically implanted electrodes . . .

N. R. BEECHY
NICHOLAS INSTITUTE
BURNHAM BEECHES, VICTORIA
AUSTRALIA

Help Wanted

I am writing in the hope that one of your readers may be able to help me. In connection with some research that I am conducting on human leukemia, I have been trying, without success, to obtain 18 in. each of 5- to 10-mil platinum and silver wire with an insulated coat capable of withstanding 200 C; the final dimension of the insulated wire should not exceed 15 mils.

I wonder whether any of your readers can help me locate this wire; I will be most grateful for any assistance in this matter . . .

JOHN A. SYKES, M. D.
TEXAS MEDICAL CENTER
HOUSTON, TEXAS

Our local contacts in the wire-specialty field were unable to help Dr. Sykes. Can anybody else?

Character Counter

The prompt appearance in your Apr. 28 issue (p 120) of my short article "Character Counter Aids Teletypewriter Routing" was indeed gratifying. Unfortunately an error in the published diagram would prevent the device from functioning as described. Further, the relay K_1 in the original drawing was described as a Sigma series 72 polar relay and was schematically shown as a polar relay . . .

ROY E. PAFENBERG
ARLINGTON, VA.

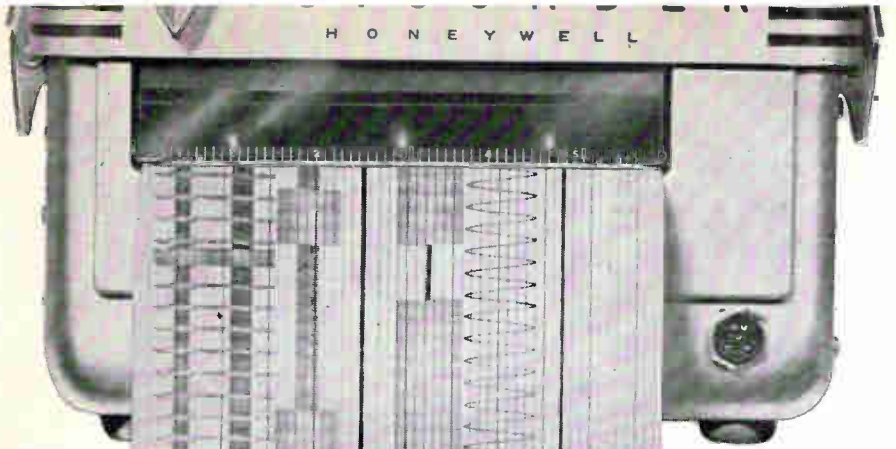
The bottom winding of K_1 is shown returned to the anode of 0B2; it should have been returned to the bottom of capacitor C_1 so that that capacitor shunts the lower winding of the relay.

To the Editator

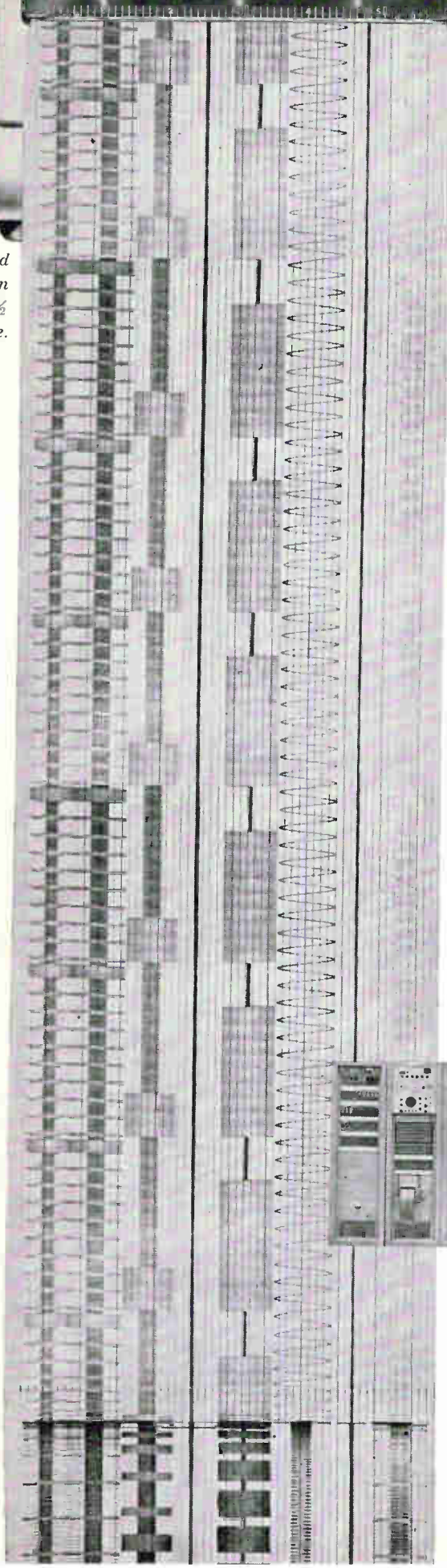
Concerning the "Birdbanding" item on p 10 of the Apr. 14 issue (Electronics Newsletter): your *editator* must be slipping.

GEORGE LANGER
DENVER, COLO.

The headline calls a capacitor a capacitator. *Oh well . . .*



isicorder and record shown approx. ½ actual size.



Record speed changed during recording.

"MASTER CLOCK"

for the missile range uses 15 Honeywell Visicorder oscillographs

The Timing Operations Center designed and built by Epsco-West for the Navy's Pacific Missile Range is now in use at Point Mugu, California. It makes use of 15 Honeywell Visicorders to read out (as shown on the unretouched record at left) the modulated timing codes distributed as balanced outputs to the Center's "customers."

The solid-state Epsco-West TOC generates up to 11 separate timing signals, one or all of which may be delivered to any of 36 users.

The 906B Visicorder also performs a supplementary function as a monitor on the timing and test-patch panel, and as permanent "record-keeper" for the built-in indicators and test oscilloscopes. Visicorders were selected for their jobs with the TOC because of their versatility, reliability, low cost, and compact size ((10" x 10" x 15½"; weight, 37 lbs.).

Pioneer and acknowledged standard in the field of high frequency direct-recording oscillography, the Visicorder is available in several models, from 6 to 36 channels, DC to 5000 cps response, up to 50,000"/sec writing speed. Honeywell engineering is at your service through 120 field offices for help in applying one Visicorder or a full system to your data acquisition program; or a quantity of Visicorders for OEM application in your products.

Call your local Honeywell office now or write today for Catalogs HC906B, 1012, 1108, and 1406 to Minneapolis-Honeywell, Heiland Division, 5200 East Evans Avenue, Denver 22, Colorado. Our telephone is SKyline 6-3681, Area Code 303.

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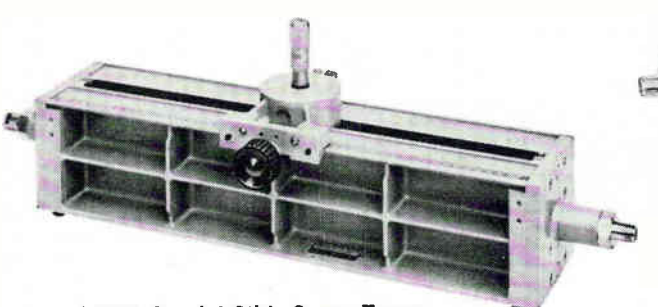
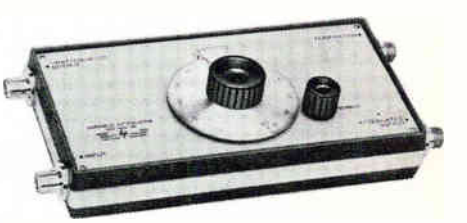
536A Coaxial Frequency Meter



872A Coaxial Slide-Screw Tuner



393A/394A Variable Attenuators

906A Coaxial Load

760D/761D Dual Directional Couplers

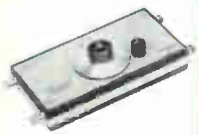
Here are seven new hp coaxial instruments to simplify your microwave work and give you greater measuring flexibility in the important 1-to-4 GC frequency range. Look at the increased versatility of measurements possible with these instruments, each carrying the assurance of quality, versatility, dependability and value which make Hewlett-Packard's one of the world's most widely used lines of microwave instrumentation.

hp 536A Coaxial Frequency Meter

For lab or production use this general-purpose frequency meter is a high resolution, broadband, direct reading instrument. Frequency is read directly in GC with high accuracy over a wide range of environmental conditions. Readability is increased by a long spiral scale calibrated in small frequency increments. The tuning plunger is spring-loaded to eliminate backlash. Smooth tuning and long life result from use of a non-contacting plunger.

Specifications

Frequency Range:	1 to 4 GC
Overall Accuracy:	0.14%
Dial Calibration Accuracy:	0.10%
Max. Temp. Coefficient/° C:	0.0016%
Connectors:	Type N
Dimensions:	9⅛" high x 6" long x 6" deep. 13 pounds
Price:	hp 536A, $500.00



hp 393A/394A Variable Attenuators

Accurate attenuation in high power coaxial systems are provided by these direct-reading, multi-purpose instruments, the hp 393A, 0.5 to 1 GC, and hp 394A, 1 to 2 GC. They are variable attenuators, variable directional couplers and local oscillator mixers. The direct-reading feature eliminates the need for calibration curves, and the attenuators handle up to 200 watts average, depending on line terminations. Two hp 908A low-power coaxial loads (furnished) permit the instruments to attenuate at levels up to 0.5 watt average power.

Specifications

Frequency Range:	hp 393A, 0.5 to 1 GC; hp 394A, 1 to 2 GC
Attenuation or Coupling:	hp 393A, 5 to 120 db, hp 394A, 6 to 120 db; both continuously variable
Absolute Accuracy:	Within ± 1 db or 1% of dial (hp 393A), ± 1.25 db or 2% of dial (hp 394A), whichever is greater. (With matched generator and load)
Nominal Impedance:	50 ohms
SWR:	< 2.5:1, 5 - 10 db attenuation; < 1.5:1, 10 - 30 db; < 1.2:1, 30 - 120 db (hp 393A); < 1.4:1, 30 - 120 db (hp 394A)
Directivity:	Greater than 15 db (hp 393A), or 10 db (hp 394A), 10 to 40 db attenuation with loads of less than 1.05:1 SWR
Maximum Voltage:	500 v peak
Connectors:	Type N
Dimensions:	5½" x 12" x 2¾"
Price:	hp 393A, $420.00; hp 394A, $420.00

hp 872A Coaxial Slide-Screw Tuner

With the hp 872A Coaxial Slide-Screw Tuner, insertion of the precision probe carriage into a specially developed slab line is quickly and easily varied with a micrometer drive, and position along the line may be read directly on a recessed scale. Probe travel is at least ½ wavelength at 0.5 GC so that any phase reflection may be compensated. Logging penetration and position of the probe makes repetition of settings simple, and the probe can be withdrawn so that no correction is applied.

Specifications

Frequency Range:	0.5 to 4 GC
Correctable SWR:	10
Insertion Loss at Max. Correctable SWR:	1 db or less
Characteristic Impedance:	50 ohms
Connectors:	Type N
Dimensions:	27" x 6" x 5"
Price:	hp 872A, $525.00

hp 906A Coaxial Load

This sliding coaxial termination is a movable, low reflection load for terminating 50-ohm systems in their characteristic impedance. The load moves at least ½ wavelength at its lowest rated frequency. It features a movable center conductor which insures proper seating in the mating conductor. Included are adapters for Type N connectors, plus storage case.

Specifications

Frequency Range:	1 to 12.4 GC
Load SWR:	Less than 1.05
Power Rating:	1 watt
Travel:	Greater than ½ wavelength at 1 GC
Dimensions:	31" long. 2 lbs.
Price:	hp 906A, $250.00

hp 760D/761D Dual Directional Couplers

New hp 760D/761D Dual Directional Couplers, two-octave vhf-uhf instruments, are especially useful for power monitoring, mixing and power sampling with tightly controlled coupling. High directivity and flat frequency response make them ideal for reflectometer systems. Power capacity is 50 watts cw and 10 kw peak.

Specifications

	Model 760D	Model 761D
Frequency Range:	250 - 1000 MC	1 - 4 GC
Mean Coupling:	20 ± ½ db	20 ± ½ db
Coupling Variation:	± ½ db	± ½ db
Directivity (Minimum):	35 db	30 db
Primary SWR (Maximum):	1.20	1.25
Secondary SWR (Maximum):	1.25	1.30
Connectors:	Type N	Type N
Price:	$200.00	$185.00

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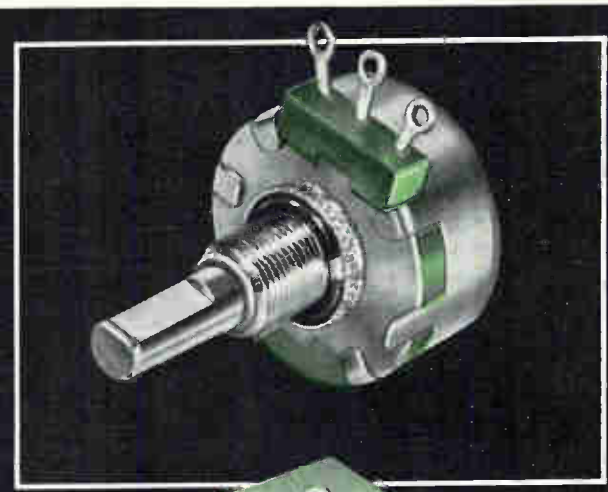
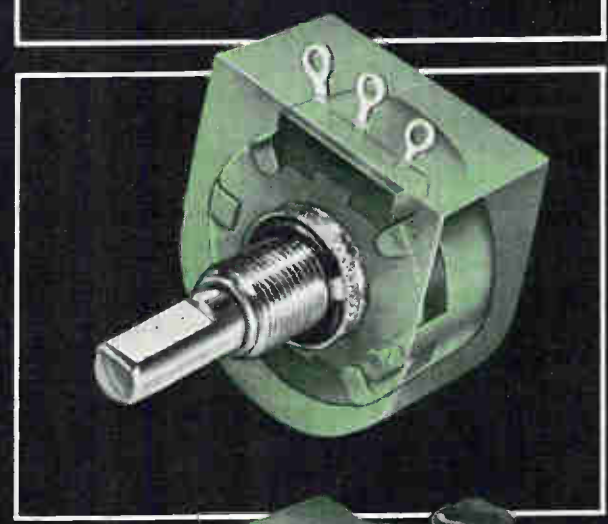
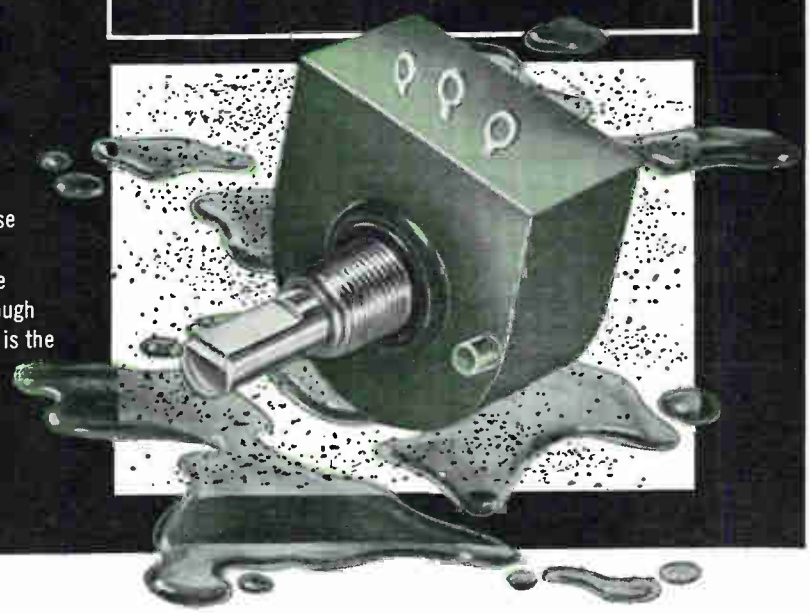
New **performance reliability** under the most adverse moisture, sand, dust, corrosive and explosive atmospheres, temperature cycling, low temperature storage and operating conditions, is sealed in through the Clarostat PotPot encapsulation technique. This is the answer for maximum reliability of potentiometers, switches, and other components, or combination assemblies. Potpot encapsulation meets MIL-E-52 specification.







The exclusive Clarostat PotPot encapsulation technique is available for standard Clarostat potentiometers and switches. It consists of a pre-sealing operation with a moisture test before encapsulation in a high density compound of desirable electrical and mechanical properties. Shaft and bushing assemblies are completely sealed.

Write for complete technical information... see for yourself how performance reliability increases through the PotPot technique...

CLAROSTAT®

CLAROSTAT MFG. CO., INC.

DOVER, NEW HAMPSHIRE

ELECTRONICS NEWSLETTER

Power Sources Conference Discusses Energy Converters

IMPROVED TECHNIQUES for thermal and solar energy conversion, and progress in fuel cells and batteries, drew the attention of some 1,000 engineers at the 15th Power Sources Conference in Atlantic City, N. J., last week.

Cryogenic fueled thermoelectric generators were discussed by J. Angello of U. S. Army Signal R&D Labs. Experiments with a single-stage bismuth-telluride converter using liquid nitrogen yielded a maximum power of 875 milliwatts at a temperature difference of 126 C and a cold-junction temperature of −191 C. Technique may yield conversion efficiency of 20 percent.

Increase in thermoelectric efficiency by impeding heat flow by structural means was described by R. C. Evans of Johns Hopkins. His report on isthmus effect experiments covered the construction of welded and sheared barrier generators. Experiments with chromel-constantin thermocouples showed an efficiency of 1.3 percent for two welded barriers per leg compared with 0.2 percent with no barriers.

In surveying recent advances in thermal energy conversion, D. C. White of MIT postulated the possibility of achieving 35-percent efficiencies by using the photovoltaic effect for conversion. An incandescent surface would supply photons to a *pin* photocell for conversion to electrical energy.

Increasing the power density and efficiency of thermionic converters by using cesium plasma triode converters was discussed separately by A. O. Jensen of GE and W. B. Hall of RCA. According to Jensen, a device now under development may achieve power density of four watts per square centimeter and efficiency of 20 percent at cathode temperature of 1,300 C.

Methods of reducing cost of solar-cell systems and increasing their resistance to radiation were discussed by several speakers. A. Herchakowski of Army Signal Labs described concentrator configurations for increasing power output per unit cell area; J. F. Elliott of GE reported on work aimed at increasing yield and efficiency by constructing large-area thin-film photovoltaic cells. P. Berman of Transitron and J. Mendelkorn of USASRDL both presented data indicating that resistance to radiation is increased with *n* or *p*-type cells.

Seek Optical Maser To Use Solar Power

AIR RESEARCH & Development Command has awarded a research contract to American Optical Co. to develop a sun-powered optical maser for satellite and space use. The proposed device would be a ruby maser fed from a solar collector instead of being powered by flash tubes. AO chief physicist E. Snitzer figures that a large solar collector would be able to produce enough of the necessary green and blue light to cause the ruby rod to go into continuous oscillation. Project is aided by the fact that sun power falling on an earth satellite is much more intense than the solar energy reaching the earth's surface.

Defense Spending Rise Seen Paced to GNP

ECONOMIC FORECASTS being bruited about Washington these days indicate that Department of Defense expenditures will rise at a rate equivalent to the increase in the gross national product. Rapidly growing resources of the Sino-Soviet bloc are being allocated to military forces; planners in Washington figure that U. S. preparedness must at least keep pace. Average increase being forecast—privately and without administration publicity—is around 5 or 7 percent annually, about $2 billion or more. Present budget is about $45 billion; 1970's may be near $80 billion. Research and development expenditures will continue to take about 10 percent of this figure. Even if an effective plan for disarmament can be adopted, the R&D expenditure will continue high since detection devices will require more R&D than the weapons they replace.

In other defense developments last week: Bendix received $12 million in contracts to equip aircraft of the North Atlantic Treaty Organization (NATO) with advanced electronic navigation systems. Air Force awarded a $35.8-million contract to Philco for continuation of work begun in 1957 in development of command and control subsystems for space and satellite programs. Another Air Force contract, for $10 million, was awarded to GE for ICBM target vehicles to test the Nike-Zeus countermissile; the target vehicles will be flown in place of operational ICBM nose cones.

Develops Small, Cheap Negative-Ion Generator

COMPACT INEXPENSIVE generator for producing negative ions was put on the market in England last week by Winston Electronics, an associate of Dynamics Corp. of America. Ion generator is 14 × 6 × 7¾ inches, consumes about 75 w, handles about 4,000 cu ft of air. Cost is about $52. DCA, which developed the basic generator of which the Winston model is an improvement, is expected to manufacture the improved version.

Unit consists of a fine filter to trap dust particles, four ultraviolet lamps to generate negative ions at the rate of about 4,000 per cubic centimeter, and a negative-ion multiplier—a metallic mesh from which electrons are ejected by secondary emission—to increase the ion content to about 100,000 per cubic centimeter. A small fan forces air through the unit.

Air Agency Prohibits F-M Radios in Aircraft

FEDERAL AVIATION AGENCY last week prohibited the use of portable f-m radios on U. S. civil aircraft. The ruling results from an investigation of interference from electrical and electronic devices on aircraft

instruments. The investigation disclosed that local oscillators in f-m radios affect the vhf navigation systems, causing the appearance of the "red flag" which indicates to the pilot that the instrument is not working properly. The red flag warns the pilot not to trust the reading of the instrument, and prevents the instrument from giving a faulty indication.

"Next-Hour" Facsimile Delivery Proposed to Post Office

SUBCOMMITTEE on the Post Office & Treasury of the Senate Appropriations Committee last week heard Alden Electronic & Impulse Recording Equipment Co.'s proposal of a next-hour delivery system using facsimile techniques. Alden proposes to pay the Post Office Department for a franchise to install high-speed facsimile equipment in local postoffices for use by the commercial and other mailers who need a high-priority mail delivery service. Alden fax equipment would be able to send two letterheads per minute; copy arriving at the destination postoffice would be automatically wrapped, and a clerk would put it in the regular postoffice box of the addressee.

Aerospace-Electronics Show Favors Data-Handling Gear

AUTOMATIC devices for tape preparation, digital guidance and control computer, power-spectrum analyzer and fiber-optics scrambler were among newer products introduced by 70 firms who filled the booths at last week's National Aerospace-Electronics Conference in Dayton, O.

McDonnell Aircraft showed tape preparation equipment for automatic checkout and machine control. Logic circuits in the unit analyze word groups and numerical keyboard commands, convert them to complete coded programs. A digital guidance and control computer, still under development by McDonnell, will feature nondestructive wired-rope core memory of passive elements which allows a 16-bit word to be read from a single core. Scratchpad memory will store 64 16-bit words.

Incremental power-spectrum analyzer for countermeasures was demonstrated by Hallicrafters. It will substitute continuous display of microwave power in 125 10-Mc increments for point-by-point plotting; unit covers the 2.4-3.6 Gc range.

Security for codes and secret messages is provided by fiber-optics scrambler device developed by Chicago Aerial Industries. More than 300,000 glass fibers are packed in an area whose cross-section is a little more than a square inch; scrambling the fibers scrambles the message. Transmitter and receiver are equipped with the scrambler devices to maintain communications security.

Granite Being Tested for Underground R-F Transmission

DEEP-ROCK transmission of r-f energy is being investigated by Raytheon in an abandoned dry well in Concord, Vt. Under an Air Force contract, Raytheon is working with l-f and vlf energy, sending to receivers in a granite quarry nearly 20 miles away. The company reports results at Globecom in Chicago this week.

Prior investigations have used potash and salt strata; granite seems a better medium, both because of its lower conductivity and also because granitic strata can be found all over the continental land mass.

Jamproof character of deep-strata electromagnetic transmission is attractive to the military planners, particularly for short-range communications between missile silos and underground command-control centers in the event that surface communications are disrupted by possible enemy attack.

Sales And Imports Of Radio-Tv Rise

JAPAN's Ministry of Finance last week released figures on February exports of electronic products to the U. S., indicating that all categories increased over the January level.

Exports of transistor radios with more than three transistors jumped from 157,447 units valued at nearly $2 million in January to 251,725 units worth $3.2 million. Tube radios went from 56,639 units worth $398,000 to 105,168 units worth $722,000; toy transistor radios (containing one or two transistors) from 177,188 units worth $520,000 to 196,665 units worth $601,000. Exports of tv sets with 21-in. screens or larger jumped from 1,935 units worth $97,000 to 2,677 units worth $132,000, and tape-recorder shipments went from 25,374 units worth $525,000 to 30,787 units worth $802,000. Ministry of International Trade & Industry figures that some 3 million toy radios (one or two transistors) will be produced in fiscal 1961, of which most will probably be exported to North America. The toy units are exempt from Japan's quota regulations.

In the U. S., Electronic Industries Association announced last week that retail sales and production of radio and tv sets continued to rise in March, but that cumulative totals remained below the totals for the first three months of 1960 in all categories excepting radio sales. March tv sales totaled 530,105 units, an increase of 77,823 over February. Radio retail sales totaled 853,821, up 187,593 over February's figure.

British Companies Wary Of Space Agency Contracts

ELECTRONICS and control-equipment manufacturers in Great Britain are expressing wariness about accepting contracts from National Aeronautics & Space Administration because of NASA's patent terms. British companies have asked their government for advice on their rights to inventions made under contracts placed by the space agency or to which the agency contributes financial aid. Some firms are afraid that the NASA patent terms might be interpreted as retroactive, since the wording of the law defines the making of an invention as "a conception or first actual reduction to practice;" if a contractor files for an invention which is first used in a subsequent NASA contract, the U. S. government may be able to lay claim to the patent rights.

Microdot Expands Telemetry Capability

South Pasadena – Microdot Inc. has recently acquired Spectralab Instrument Co. of Monrovia, California. The acquisition provides Microdot's Instrumentation Division with outstanding capabilities in the field of VHF and UHF cavities and related instrumentation. Spectralab has been widely noted for its recent scientific breakthrough in the new UHF telemetry field with the first operational UHF telemetry transmitter, and for its high power transmitter designed for the Pioneer V satellite. Spectralab instruments have also flown in the Redstone, Jupiter, Atlas and Pershing missiles.

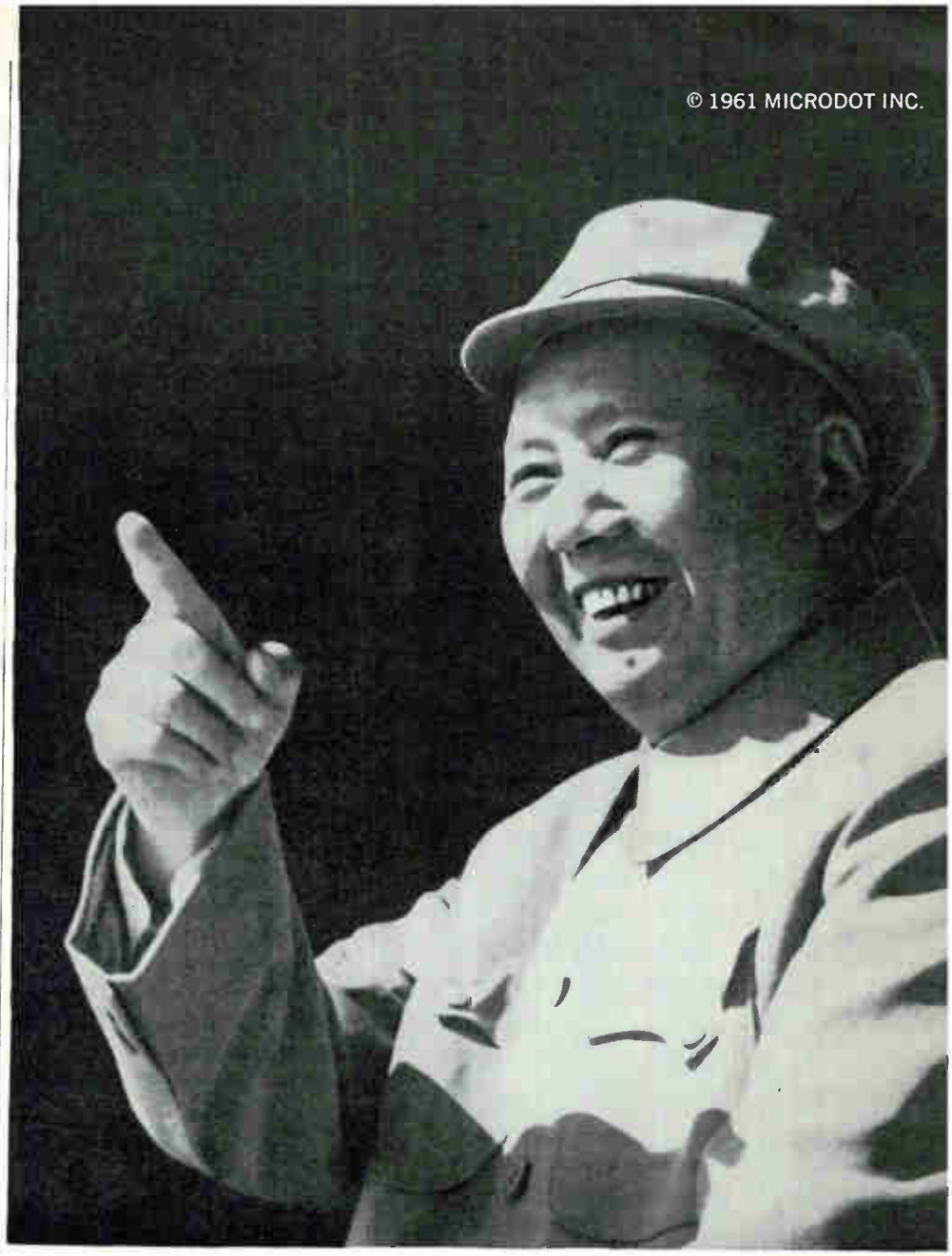
The Pioneer V transmitter shown above is typical of the sophisticated instrumentation now offered by Microdot. This miniaturized unit features an output of 150 watts, ease of adjustment, and proven outer space reliability.

With the Spectralab acquisition, Microdot's telemetry capability now includes a broad product line ranging from sensing devices through transmitters. As a single source for instrumentation, Microdot can provide weldable strain gages, load cells, temperature probes, thermocouples, amplifiers, power supplies, signal conditioning equipment, power amplifiers, frequency doublers, oscillators and transmitters.

MICRODOT INC.

220 Pasadena Avenue
South Pasadena, California

CIRCLE 13 ON READER SERVICE CARD



"MAKE A NOISE IN THE EAST, BUT STRIKE IN THE WEST"

Mao-Tse-Tung's arsenal is impressive: 700-million expendable people. And soon, nuclear capability.

To those of us in the defense business the prospect is worthy of sober consideration. We cannot match Red China in expendable human lives. Instead we must rely upon the effectiveness of our defense capabilities to keep fingers off buttons.

The responsibility is clear. The real business of the defense business is survival.

WASHINGTON OUTLOOK

ELECTRONICS INDUSTRY competition for a place in the commercial communications satellite field was dramatically played up during the House Space Committee's inquiry into the program.

The hearings pointed up the basic disagreements within the industry. The sharpest dispute is over the division of ownership in a space communications system. Generally, it's accepted that the government will prevent any single company from getting a dominant position.

The real in-fighting, therefore, shifts to what combination of companies should be allowed to pool their efforts. One bloc of companies wants ownership confined to firms already in international communications. Another group wants to include domestic communications companies—not only those already in the business but others that might crop up. General Telephone & Electronics Corp., for example, favors this.

Still another camp wants to pull in producers of aerospace equipment as well as common-carrier communications firms. GE backs this idea. The company recently formed a subsidiary, Communications Satellites, Inc., with ownership open to all interested firms with a miximum 10 percent equity ceiling stipulated.

There's also a divergence of technical opinion. One group of firms wants a system of synchronous satellites that would be placed some 22,300 miles out in space and appear to remain in a stationary position. This would require only three or four satellites to provide worldwide coverage. Other companies, however, are plumping for a system of 50 or more satellites in 3,000 to 5,000-mile high orbits.

NASA, meanwhile, is not content to allow industry to pace development of a space communications system. While the shapeup in industrial ownership goes on, the Agency is pushing for development of a system under Project Relay. The government-developed system will undoubtedly have a dominant role in any commerical system that eventually evolves.

Seven proposals, including three joint ventures, were submitted to NASA in March to develop Project Relay. A contract is due soon.

A TIP-OFF on administration views on electronic imports may be apparent in President Kennedy's first major policy decision on foreign trade. Only textiles are immediately covered in the new decision, but it could be applied to products such as electronic parts.

Kennedy has ruled against imposition of country-by-country import controls on textiles, as the domestic industry urged. Instead, he wants to work for an international voluntary agreement under which some other major industrial nations, such as West Germany, would take more textiles from the under-developed nations which produce them.

The President has ordered a series of steps aimed to help the industry at home. The State Dept. will begin negotiations with textile-producing and major consuming countries this month. If the efforts prove successful, the idea of an international voluntary agreement may be tried for other light-manufactured products—electronics, for example.

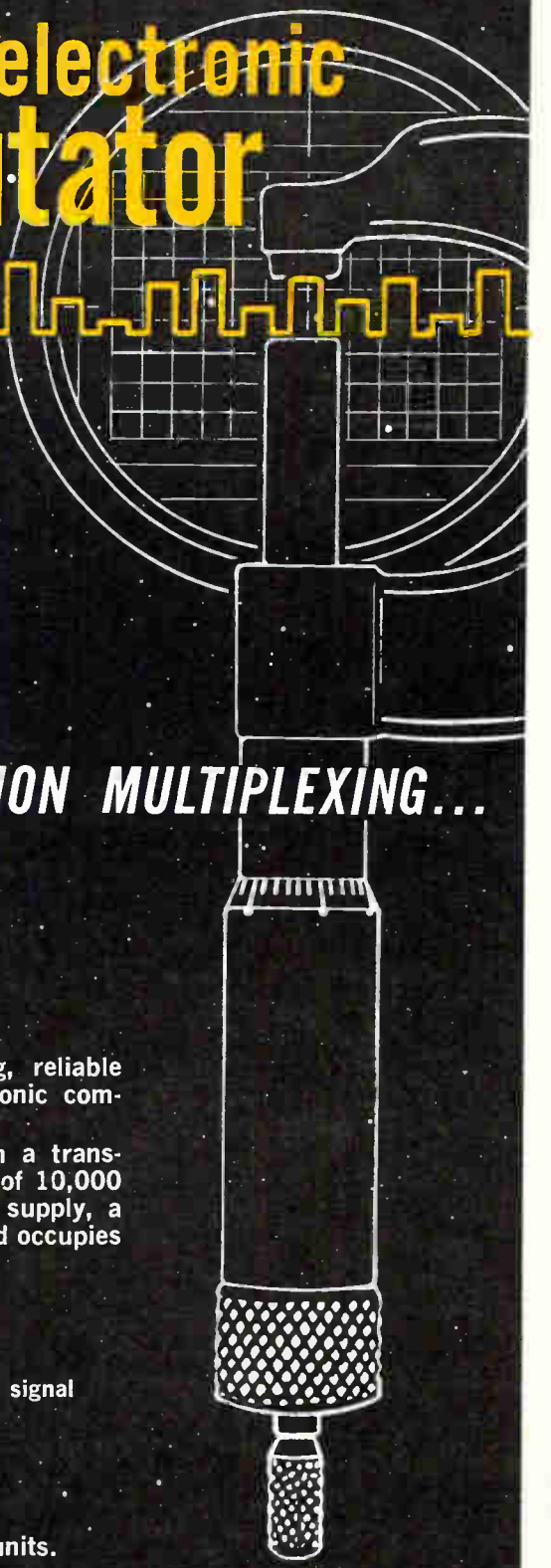
PENTAGON efforts to minimize over-pricing on major weapon contracts are being accelerated. Officials appearing before a congressional committee have spelled out what's being done:

Competition is being expanded by increasing the number of potential sources in negotiating contracts for which advertised bidding is not practical. Internal audit of cost estimates and price proposals from contractors is being substantially broadened. Purchasing techniques, cost estimating procedures, and financial cost controls "have been improved."

In addition, excessive inventories are being slashed, more effective controls are being clamped on overhead expenses, "more effective" subcontract management has been instituted, the "quality of negotiations have been improved," and the use of value engineering to trim costs is being encouraged.

CE-12 low level electronic commutator

60-POSITION
DOUBLE-POLE UNIT HALF SIZE



PRECISION MULTIPLEXING...

Unprecedented accuracy, high speed switching, and long, reliable service life characterize this revolutionary low level electronic commutator.

The CE-12 achieves a direct electrical connection between a transducer and load during "make," and open circuit resistance of 10,000 megohms at all other times. Containing an internal power supply, a standard 60-channel unit requires only 4.2 watts of power and occupies 50 cubic inches of space.

Typical Performance Specifications include:

- Linearity: 0.0001% from best straight line
- Common Mode Rejection: 120 db
- Accuracy: 1% with 20 millivolt signal; 0.004% with 5 volt signal
- Cross Talk: Less than 0.001%
- Series Contact Resistance: 12 ohms
- Back Current: Less than 0.001 microamperes
- Temperature: −35°C to +125°C

Available in standard 15, 30, 45 or 60-position double-pole units.

UED's soundly-conceived and solidly-built systems and components can help solve your design problems. Data sheets, test reports and technical consultation on request. Write or call:

United ElectroDynamics, Inc.

200 Allendale Road Pasadena, California

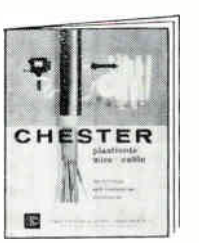
MU 2-1134 SY 9-7161

Set the date you need any standard type coaxial cable on the job, and Chester will meet it . . . with from-stock shipments of one of the country's most complete lines of coaxial cable.

With Chester cable you can make a quick selection of exactly the right cable for each specific application. From micro-waves to missles . . . in conformance with military or commercial specifications . . . for military or commercial applications . . . there's a Chester cable tailored to **your** design and requirement.

For special cable problems, you can depend on Chester to custom-engineer the correct cable to meet your specifications. Select the type conductor, insulation, jacket, and armor which your requirements demand. But, be sure **you select Chester** for the cable "job-tailored" for you.

NEW, Chester's fact-packed coaxial cable selection guide. Write for your free copy.



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SPECIFY CHESTER WIRE AND CABLE FOR ALL YOUR ELECTRONIC EQUIPMENT NEEDS
Coaxial Cables • Hook-Up Wire • Multi-Conductor Cable • Appliance Wire • Audio Wire • Miniature Wire and Cable • High Voltage Wires • High Frequency Wires • Antenna Loop Wire • Annunciator Wire • Telephone Wires and Cables • Television Transmission Lines

CIRCLE 16 ON READER SERVICE CARD

CIRCLE 17 ON READER SERVICE CARD→

this is the Brush Mark II . . .

anyone can plug it in put it in writing anywhere

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Ink or electric writing models. Immediate shipment from stock.

brush INSTRUMENTS
DIVISION OF
CLEVITE CORPORATION
37TH AND PERKINS CLEVELAND 14, OHIO

Response-ability!

plus reduced size and weight

ACTUAL SIZE
(versus ordinary commercial servo-type motor)

EAD 60 CYCLE MINIATURE SIZE 15 SERVOMOTORS

Design *instant response* into your recording instruments and, at the same time, miniaturize your "package" with substantial cost-reductions. EAD 60 cycle, size 15 miniature servomotors are engineered for RESPONSE-*ability* . . . the ability to produce rapid acceleration and reversing without over-power and over-size.

These 60 cycle, size 15 servomotors, now available for commercial applications, have the same precision RESPONSE-*ability* as EAD's military versions...your assurance of high performance and reliability.

TYPICAL PERFORMANCE DATA

MODEL	VOLTAGE	FREQUENCY	STALL POWER/ PHASE	STALL CURRENT/ PHASE	TIME CONSTANT	REVERSING TIME	ROTOR INERTIA	NO LOAD SPEED	STALL TORQUE
S2HBZ7-*	115 volts	60 cycles	6.0 watts	70 MA	.0052 Sec.	.0089 Sec.	4.0 gm cm²	1500 RPM	1.7 oz-in
S2HAX7-*	115 volts	60 cycles	6.0 watts	70 MA	.00915 Sec.	.0155 Sec.	3.3 gm cm²	3000 RPM	1.6 oz-in

*Basic models. Mechanical modificatians available to customer requirements.

If your responsibility is improved recorder design, look first to EAD for the servomotor line that meets all your RESPONSE-*ability* requirements. Call your nearest EAD representative or write about your specific needs.

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EASTERN AIR DEVICES, Inc.

A SUBSIDIARY OF NORBUTE CORPORATION

385 CENTRAL AVE., DOVER, NEW HAMPSHIRE

A Tinnerman T-Marked Original...

Dual SPEED NUTS® open door to 20% savings on as-assembled cost

Gibson refrigerator door hinges are held in place with new cost-cutting, time-saving twin-type SPEED NUTS. They replace 3/16" plate hinge retainers which had to be drilled and tapped for machine screws.

Gibson Refrigerator analysts estimate that special twin-type SPEED NUTS save 14% on the cost of each hinge retainer assembly, 20.5% on the as-assembled cost. Labor is reduced by half. Former problems with cross-threading and stripping are eliminated . . . SPEED NUTS and A-type screws go together naturally every time—and faster!

The T-mark of quality and dependability identifies the more than 10,000 variations of SPEED NUT brand fasteners. From this unlimited selection come many saving opportunities for you. Ask your Tinnerman representative to arrange for a free FASTENING ANALYSIS of your product. An engineering service that may produce similar savings for you.

You'll find Tinnerman under Fasteners in your SWEET'S Product Design File and in the "Yellow Pages." *Tinnerman Products, Inc., Dept. 12, Box 6688, Cleveland 1, Ohio.*

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Speed Nuts®
Look for the Tinnerman "T"

OTHER T-MARKED SPECIALS

SPECIAL "J" SPEED NUT cuts production time in half for a major gas range manufacturer. Simplified right-angle panel or brace attachments for a variety of appliance, cabinet, and instrument applications. Live-spring tension means a vibration-proof grip.

SNAP-IN FIXTURE FASTENER developed specially for Imperial Lighting Products Co., trimmed 80% off lighting fixture assembly time. Once fastened to the ceramic socket, this unique SPEED NUT snaps quickly into the fixture base...replaces three parts.

PUSH-ON SPEED NUT anchors latching bars on steel desks, reduces material and assembly costs by 50%. Push-on SPEED NUTS can be attached on studs, rivets, or tubing in a split second, and eliminates need for threaded parts . . . saves time and money.

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Simmonds GMBH, Heidelberg.

FINANCIAL

Earnings Go Up In First Quarter

FIRST QUARTER reports and annual statements being issued this month shown an upturn in sales and earnings for many electronics companies.

HOFFMAN ELECTRONICS, Los Angeles, reported 1961 first quarter sales of $16,098,315 were the highest in any quarter in company history and resulted in a net profit after taxes of $256,668, or 16 cents a share. The sales volume for the quarter compares with $10,215,897 in the same period of 1960, when the after-tax profit was $2,530. The increase is attributed to sales rises for the military products and semiconductor divisions of the company.

FAIRCHILD CAMERA AND INSTRUMENT, Syosset, N. Y., reports 1961 first quarter net earnings after taxes of $877,000, or 71 cents a share. This is an increase of 9.5 percent over first quarter 1960 earnings of $801,000 or 65 cents a share. John Carter, company president, says this year's first quarter earnings are the best in company history. Sales during the period were $20,655,000, a 49-percent increase over sales of $13,838,000 in the first quarter of 1960. New orders this year, during the first quarter, were up 58 percent over 1960's first quarter, while backlog rose 75 percent.

ELECTRONIC SPECIALTY CO., Los Angeles, reports 1961 first quarter sales more than double those of 1960 for the same period. This year the figure is $6.1 million as compared with $2.5 million in 1960. Profits for the January-March period this year were at an all-time high of $185,000, or 21 cents a share. Backlog at the end of this year's first quarter exceeded $20 million as against the $4.2 million on Mar. 31, 1960.

BOWMAR INSTRUMENT CORP., Ft. Wayne, Ind., reports record sales for the six months ended Mar. 31, 1961, first half of the company's fiscal year. Earnings after taxes were $187,285, making this the seventh consecutive year the company has shown increases in sales and earnings. Sales rose from $2,724,896 for the same period a year ago to $3,122,837 for the six-month first half of this fiscal year. Pretax earnings rose from $302,749 to $378,285. Per-share earnings after taxes were up from 20 cents to 24 cents.

GENERAL PRECISION EQUIPMENT CORP., Tarrytown, N. Y., reports preliminary figures for the first quarter of this year show a net income of 87 cents per common share. This is a 12.9-percent rise over net income of 77 cents per share in the same period a year ago. Net income for the period this year was $1,334,000 after taxes, up from $1,224,000 in the first quarter of 1960. In addition to this, a 51-cent per share special gain was realized from the sale of the company's downtown Manhattan headquarters building. Preliminary figures for the first quarter of this year show sales of $62,897,000, up 13 percent from 1960's first quarter.

THE MARTIN COMPANY, Baltimore, Md., reports a rise of 40 percent in sales and earnings for the first quarter of this year as compared with the same period of 1960. Net earnings of $4,914,690 on sales of $198,248,575 this year exceed the net of $3,488,122 on $140,839,907 of sales in the first quarter of 1960. This year's per-share earnings are equal to 79 cents net as against a 57-cent figure a year ago.

SIEGLER CORPORATION, Los Angeles, announces earnings of $553,363 on sales of $24,592,863 for the three-month period ended Mar. 31 this year. Earnings per share were 25 cents on 2,214,363 shares outstanding. Earnings in the first nine

months of the company's fiscal year were $2,330,228 or $1.05 per share on sales of $73,646,826. Because of a merger with Jack & Heintz, Cleveland, O., in February of this year, company spokesmen say there is no basis of comparison with last year's figures.

GLASS-TITE INDUSTRIES, Providence, R. I., reports sales and earnings for 1960 to be the highest in company history. Sales in 1960 were $3,636,454 against $1,899,446 in 1959. Net income rose to $263,436, equivalent to 26 cents per share as against $139,015, or 20 cents a share in 1959. The order backlog at the end of last year was in excess of $3 million.

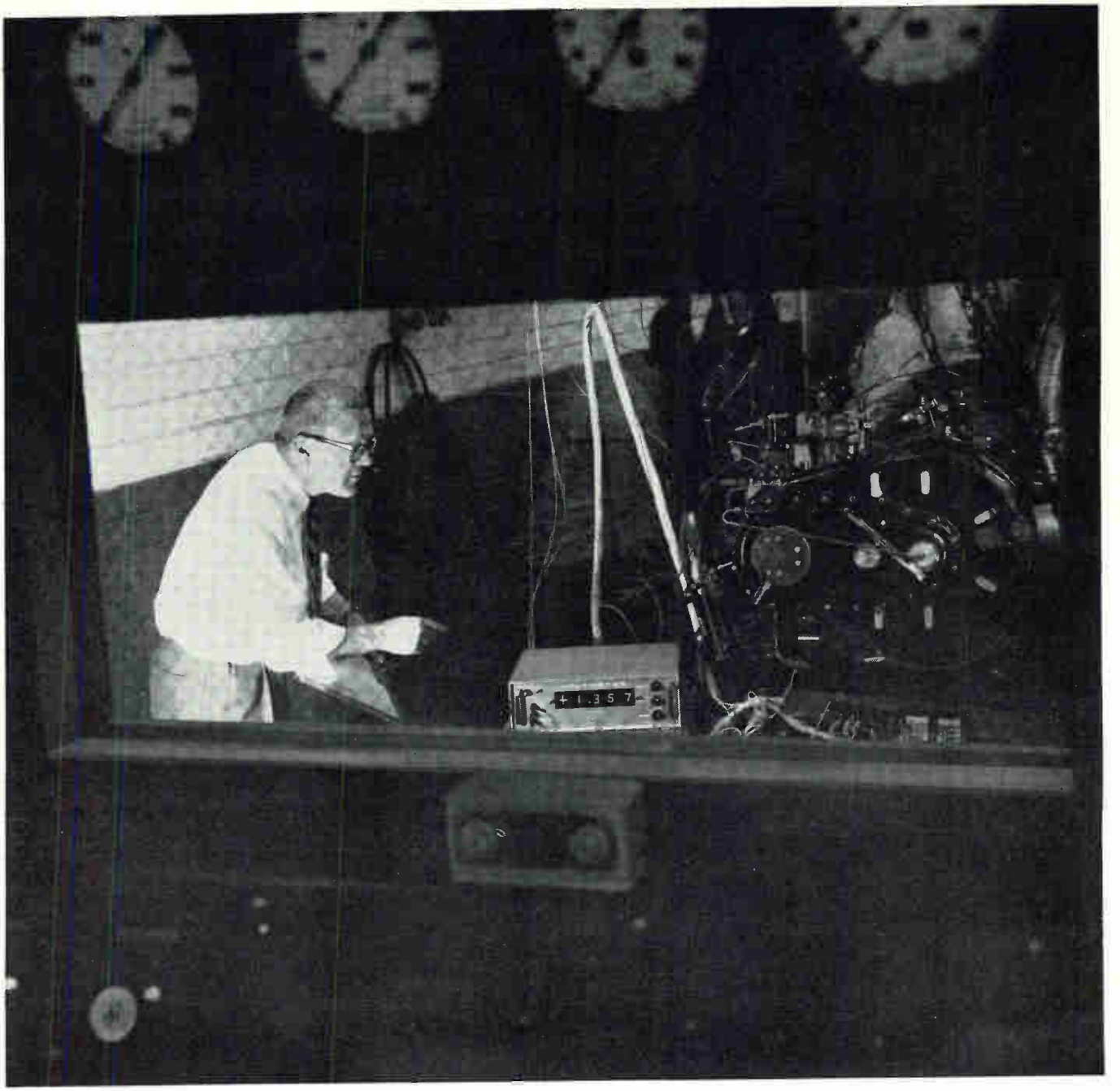
CONTROLS COMPANY OF AMERICA, Schiller Park, Ill., announces first quarter sales of $10,535,076, a drop from the $13,158,316 recorded a year ago. Net earnings after taxes for the first three months of this year were $283,605, equal to 22 cents a share, compared with $437,338, or 35 cents a share in the same period a year earlier. Louis Putze, company president, said cost reduction measures taken in the past year will result in improved performance during the remainder of 1961.

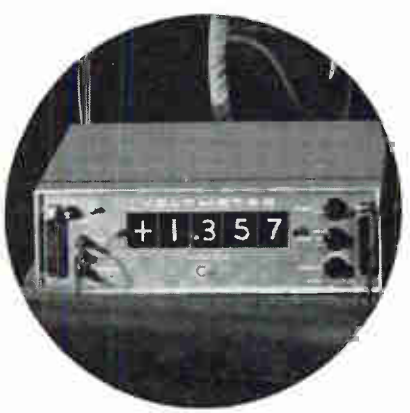
25 MOST ACTIVE STOCKS

WEEK ENDING MAY 5, 1961

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avnet Elec	2,512	60¾	46½	60¾
Avco Corp	2,173	20⅝	19⅜	19¾
Dynamic Corp of Am	2,128	17⅞	12⅝	16⅞
General Electric	1,847	66½	60½	66⅛
General Tel & Elec	1,669	29	28⅜	28⅛
Universal Controls	1,513	15½	14¼	14⅜
Sperry	1,496	33½	30⅝	32½
Martin Company	1,467	39½	37½	37⅝
Nuclear Corp of Am	1,410	6¼	5⅛	6
Nycon	1,340	5¾	4⅞	5⅝
Westinghouse	1,305	45	40	44¾
Ampex	1,293	25¾	24⅜	24⅞
Victoreen Inst	1,248	17½	14½	17½
Waltham Precision	1,243	4⅛	3⅝	4⅛
Standard Kollsman	1,126	48⅜	40½	46¾
Sterling Precision	1,103	3½	3⅛	3½
Ling Teinco Elec	934	36½	31¾	36¼
Rheem Mfg	918	21⅞	18¼	21⅞
Lear Inc	884	24¾	21⅛	23⅞
RCA	870	63⅝	56⅞	63⅜
Lockheed	855	42⅜	39¾	40⅛
Burroughs	786	35⅝	32⅝	32¾
General Dynamics	729	39⅞	36¾	39⅛
Rep Aviation	713	50½	47	47⅛
Terminal Hudson Elec	693	15¾	10⅜	14⅝

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.





NO STEPPING SWITCHES IN THIS ULTRA-RELIABLE DVM: Cubic announces a new digital voltmeter design that eliminates stepping switches and, with them, the need for periodic maintenance. The new Cubic V-70 uses the same ultra-reliable reed relays developed for submarine cables. These reed relays are sealed in glass and have practically unlimited life. They are noiseless and completely unaffected by operating position.

Accurate: The V-70 reads any d-c voltage from 0.001 to 999.9 volts with an absolute accuracy of 0.01% plus or minus 1 digit. The Cubic V-70 Digital Voltmeter provides these and other premium features at a cost of only $1,580. For details, write to Dept. E-104, Industrial Division, Cubic Corporation, San Diego 11, Calif. (in Europe: Cubic Europa S.p.A., Via Archimede 185, Rome).

Cubic manufactures a complete line of quality digital instruments, including a-c and d-c voltmeters, ohmmeters, ratiometers, scanners and printer controls.

cubic
CORPORATION
INDUSTRIAL DIVISION
SAN DIEGO, CALIF., U.S.A. ROME, ITALY

Now—A High-Performance Potentiometer For As Little As $3

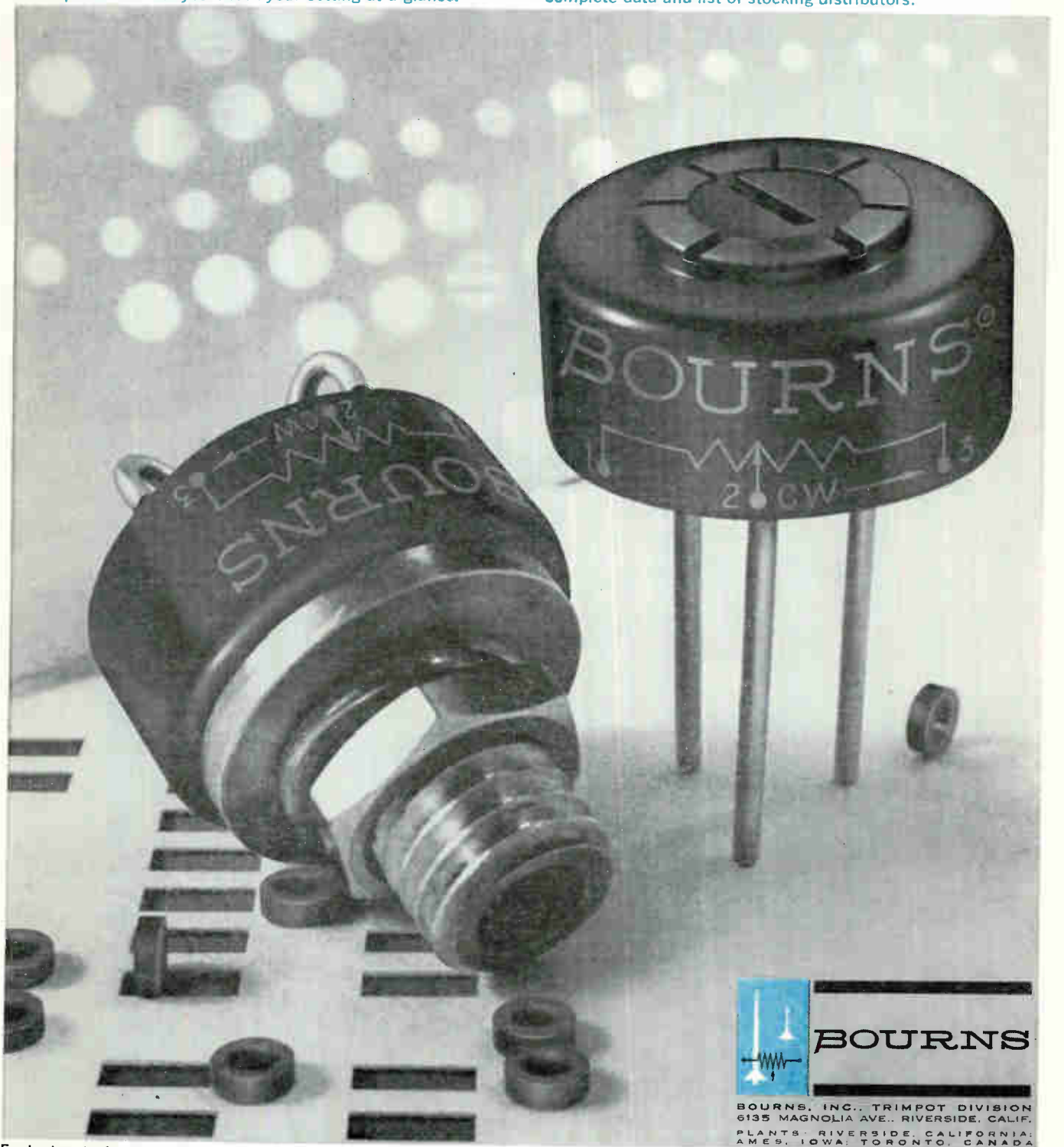
NUMBER 15—NEW PRODUCT SERIES

Never before could you find a low price tag on this kind of potentiometer performance. Now—for as little as $3 a unit in quantity orders—you can buy a single-turn ½" wirewound rotary that meets the highest standards for computer and industrial control applications.

Weighing in at a scant .05 ounce, the ½" dia. Trimpot® Model 3367 dissipates 0.5 watt, operates in 105° C heat, and holds residual end-setting resistance from 0 to 1.0%. It meets requirements for steady-state humidity and Mil Specs for sand, dust, salt spray and fungus. Designed for convenience, too, it has index points that let you check your setting at a glance.

Reliability well beyond the expected is made possible by the exclusive Bourns Silverweld® termination. Alloyed with multiple turns of the resistance wire, Silverweld eliminates vulnerable single-wire terminations, is virtually indestructible under thermal or mechanical stress. Units are 100% inspected, and subjected to the rigid double-check of the Bourns Reliability Assurance Program.

Model 3367 is available immediately from factory and distributor stocks with resistances of 100Ω to 20K. Your choice of printed circuit pins (spaced for interchangeability with more expensive devices) or solder lugs with bushing mount. Write for complete data and list of stocking distributors.



Exclusive designers and manufacturers of Trimpot® potentiometers. Pioneers in transducers for position, pressure and acceleration.

Fresh Look At Space Communications

CHICAGO—Space communications will be in spotlight of Fifth National Symposium on Global Communications sponsored by AIEE and IRE here at the Hotel Sherman next week (May 22-24), monopolizing three of 18 sessions and 15 of 88 technical papers.

More than 1,000 engineers, scientists and managers are expected to attend. Three simultaneous sessions will be held each morning and afternoon with topics ranging from space communications down to sharing earth radiation spectrum, through switching, data handling and transmission to compression methods for packing more meaning into speech transmissions.

George Mueller, vice president of Space Technology Labs, Los Angeles, will address the Tuesday luncheon session. Two dozen manufacturing and engineering firms will display communications equipment, processes and technical advances on first floor of symposium headquarters.

Saturation of present intercontinental message facilities points up need for symposium's study of communication problems, currently assigned top priority in offices and labs of government, industry and universities, says William L. Firestone, general chairman.

Ultraviolet communication system extending range of one watt of radiation to 20 million miles will be described by J. W. Ogland, Westinghouse, Baltimore, Md. Video information may be transmitted with same power at shorter, lunar distance ranges. Beam focused down to two minutes of arc provides antenna gain of about 50 million or 77 db.

Ultraviolet, infrared, visible light, x-ray and other exotic means of space communication will also be explored in a paper by L. R. Bittman, Martin Co., Baltimore, Md., with goal the attainment of enormous additional channel capacities.

Antenna of strip steel prestressed into tubular shape, stored on drum, then unfurled in orbit to form two-dipole system 150 and 75 ft between tips to cover one to 15 mc range will be displayed and discussed by Richardson and Molozzi, of the Canada Defense Research Telecommunication Establishment, Ottawa.

High antenna gain without need for attitude control of vehicle—through use of active Van Atta arrays positioned over multiple faces of satellite—will be explained by R. C. Hansen, Aerospace, Los Angeles.

Comparison of satellite communication with rural party line—allowing two or more party use for interconnection of any two points on globe—will be presented by Walker, Campbell and Glomb of Hoffman and ITT, N. J.

Restriction of deep space communication systems band to 1.2-10 Gc by strong influence of atmospheric and galactic noise will be discussed by Breese and Sferrazza, Sperry Gyro, Great Neck, L. I.

Incremental delay problem effecting data transmission and transit delay problem limiting orbit height of satellites for telecommunication without impairing conversation quality through hybrid echo effect will be discussed by Vadasz and Haviland, GE, Lynchburg, Va.

Performance estimates of delayed time satellite repeater system will be discussed by J. Dressner, Army Signal Research and Development Lab., Ft. Monmouth, N. J., and study of orbital patterns providing most efficient coverage of globe by Hight and Kreer, Bell Labs, Whippany, N. J.

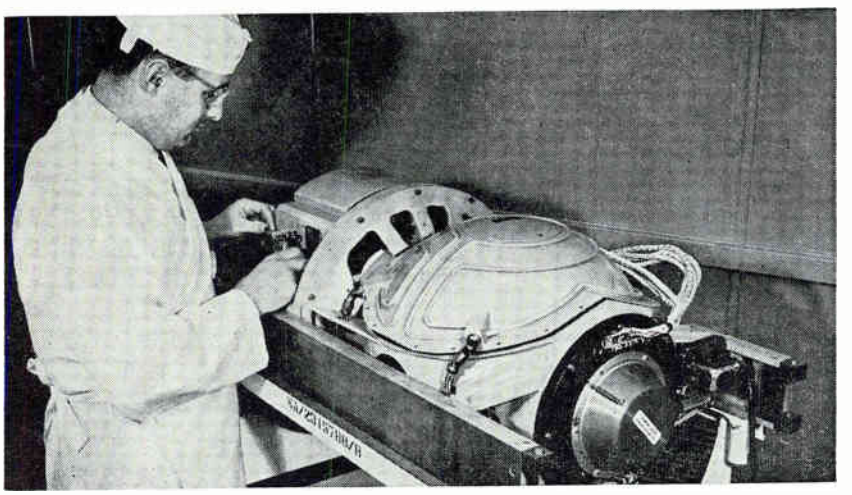
Near-infinite channel capacity, capable of simultaneous transmission of several tv and hundreds of voice channels will be discussed by T. Hafner, Surface Conduction, Inc., N. Y.

Digitized transmission of speech at 1,000 bits per second will be discussed by Campanella, Coulter and Irons, Melpar, Falls Church, Va., through derivation of seven parameters digitized into a 23-bit code word sampled 43.5 cps to provide 1,000 bit serial digital stream. Receiving end of system decodes and converts stream to synthetic speech.

Automatic message handling system to be installed in downtown Manhattan in 1962 for worldwide communications net linking 68 countries will be described by Becken and Andres, RCA, N. Y.

G. I. Carlson, Motorola, Chicago, will discuss microwave communications system in which transistors substitute for all but one vacuum tube, solid state logic and switching circuitry may be used instead of solenoids and meter relays and harmonic generator supplants local oscillator to reduce size from four standard seven-ft racks to single unit, while increasing transmitter stability four to 10 times.

Buttoning Up Polaris Guidance System



Polaris Mark I inertial guidance by GE Ordnance and MIT is smallest in any U.S. ballistic missile. Same team is working on 2,500-mi Mark II

Stereo's Impact and Collins' Program Highlight Broadcasting Convention

WASHINGTON—Impact of the Federal Communications Commission's recent approval of the multiplex system of f-m stereo broadcasting dominated the 39th annual convention of the National Association of Broadcasters here last week. In all, 3,000 persons attended.

Exhibitors, anticipating the surge of interest, displayed new equipment that had been hurriedly prepared for the convention after the decision was announced.

Equipment makers showed lines along two fronts, for the broadcasting stations and the listeners. Orders, particularly for new broadcasting units, were being placed at a fast pace.

Fisher Radio and Scott were showing new f-m stereo adapters that can be used by the listener. Prices on the adapters ranged from around $45 to $90 for self-powered units. Units that take their power from the set won't be so expensive, but no units were demonstrated and manufacturers shied away from predicting a price.

The big showing on home adapters is expected to come in September at the New York hi-fi show. Then, it is expected that virtually all manufacturers of f-m tuners will be exhibiting their own lines of adapters.

Manufacturers don't see any mass movement to dump existing f-m equipment dealers have on the shelf. Reason is, for the past couple of years most manufacturers have been providing space in f-m tuners for the adapters needed in anticipation of FCC approval of stereo broadcasting.

Buoyed by the FCC decision, National Association of Broadcasters' president Leroy Collins bluntly told the convention he wanted support for a new program he has laid out for the industry.

"If you do not approve of the course I have outlined for NAB," Collins told the broadcasting industry, "I want you to say so. If you do approve, I want your support—your active support, not just your acquiescence."

Keyed to this tone, Collins then laid out this program:

- For the broadcasting industry to become the initiator, rather than the defender, of legislative proposals relating to the industry.
- The establishment and operation of an NAB research center.
- For the broadcasting industry to begin an imaginative and energetic public-relations program.

Collins lashed out at pay-tv and warned that its acceptance could mean the ultimate elimination of free television with the public the ultimate loser.

The networks, Collins continued, should provide more quality programs and the advertisers should support them.

Federal Communications Commission Chairman Newton N. Minow backed up Collins in calling for advertiser support for quality programs.

The FCC chairman told the industry:

"We need imagination in programming, not sterility; creativity, not imitation; experimentation, not conformity; and excellence, not mediocrity.

Klystron Tester Crackles

Lightning-like bolts test klystron tubes used in radar. Sperry facility can deliver 100 million watts of peak power

Controls German Planes

German air traffic control digital computer TR4 (Telefunken) is part of new system installed in Frankfurt

British Output Rises 25% In Five Years

BRITAIN'S electronics industry output, excluding telecommunications equipment, now exceeds $700 million a year.

This is an increase of 25 percent in five years and exceeds the prewar figure 10 times.

About half of present output consists of consumer electronics, mainly radio and television receivers. Electronic capital goods account for about $140 million. British authorities estimate 2,000 different products are being placed on the market.

The electronics labor force, which has doubled in the past decade, now totals around 230,000 and equals the number of people making electrical machinery in the British Isles.

Over seven percent of United Kingdom scientists and engineers working in industry are employed in electronics, according to a British Treasury report, and two-thirds of these are involved in research and development.

A recent British study found that 12 percent of electronics industry output is now being spent on research.

This, for England, exceeds the percentage spent by any other industry except aircraft.

HOW DO YOU RATE AS A VENDOR?

By ROY J. BRUUN,
Assistant Editor

TODAY potential customers are taking a long hard look inside their prospective vendors' factories before signing contracts. Object is to spot potential trouble with deliveries or quality before it occurs. Afterwards, when the contract is in force, representatives of the customer's purchasing department keep up their vigilance. If things slip, they may move in with you.

Here is how a medium-sized firm, large firm and smaller firm rate their prospective vendors before letting contracts and how they follow up after contracts are let:

At Arma division of American Bosch Arma, members of the internal liaison staff complete source questionnaires to evaluate capabilities of possible bidders. Answers are based on visits to vendors.

The source questionnaires cover: adequacy of technical library; amount of vibration-test equipment; vintage of model shop equipment; whether firm is engaged in work of equal complexity; plant efficiency; plant morale; cooperation displayed; test techniques; assembly and wiring capability; variety of work; type and amount of test instruments; caliber of lab people; computational facilities.

At a conference attended by bidders selected on the basis of the completed questionnaires, the product design specification data are reviewed, technical and programming requirements outlined, terms and conditions stated, hardware demonstrated, Arma's policies are highlighted and all questions pertaining to the bid answered.

After the conference, purchasing releases to the bidders a request for proposal which in addition to information discussed at the conference includes schedules and form of contract, cost-plus-fixed-fee (CPFF), fixed-price-redeterminable or other.

A price-analyst from purchasing's support section summarizes the bid-pricing data and prepares an abstract of each bidder's proposal. He is assisted by engineers and other specialists from various Arma departments.

Proposal abstracts permit comparison among bidders of required man hours, hourly rates, burden rates, general and administrative rates, profit and conformity to schedule requirements.

The internal liaison staff reviews the abstracts and the technical proposals and rates bidders on experience, personnel and facility to do the work, engineering approach and technical concept, production methods and reliability control, cost and pricing structure, overall program plan, and effective management.

On the basis of rating, purchasing recommends a vendor to top management for approval.

During the contract, the internal liaison staff will visit the vendor's plant unannounced in an effort to check if he is either maintaining or improving his original capabilities.

If it looks as if delivery dates may be missed because of significant design changes, expedited delivery requirements, and other emergencies, Arma's management support team physically moves into the subcontractor's plant to assist in a recovery effort.

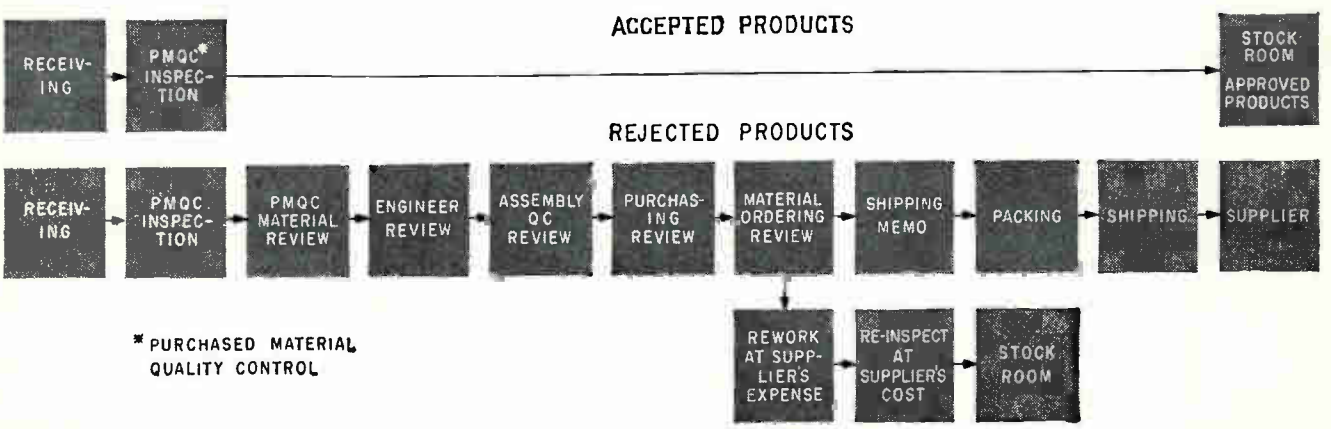
Headed by a purchasing man, the team has members from engineering, manufacturing, product reliability and the program manager's office. The team reports to the purchasing manager.

Careful and elaborate sizing-up of potential suppliers is done by RCA's Industrial Electronics Products activity. Performed by value analysts from purchasing, the size-up is guided by a vendor survey report. Among questions posed: is the potential vendor now producing products requiring government quality and specification standards? Do production and engineering capabilities appear adequate to do work up to missile standards?

These questions do not mean IEP is going into the missile business; they do emphasize its interest in high quality parts for industrial products in the face of an increasingly competitive climate.

Under employees and labor relations, the forms asks: shop union? Office union? Their names? Expiration dates of union agreements? Previous strike experience? Copies of union agreements and contracts?

Also wanted: information on number of graduate engineers, an



RCA processing diagram shows expense and inconvenience to vendor and customer caused by rejected products

appraisal of management's experience and capabilities, firm's position in case of mobilization, a copy of the potential vendor's quality-control manual.

The form also asks: how many shift hours are being worked in the first, second and third shifts? Are adequate production records maintained? Is the procurement system adequate? How much of available equipment is company owed?

Purchasing also wants to know if the supplier is capable of performing in the field of endeavor without extensive subcontract support.

In addition to IEP's initial evaluation of vendors, the quarterly vendor rating report is maintained by purchasing's follow-up personnel. These people are in day-to-day contact with suppliers. The report indicates the number of lots inspected and the number of lots found to be defective.

A vendor rated as A would have

ARE SEPARATE DEPARTMENTS WITH SKILLED PERSONNEL AVAILABLE FOR THE FOLLOWING ?

	Seporote Dept.	
	Yes	No
Procurement		
"Order Follow-Up"		
Personnel		
Field Service		
Mointenonce		
Security		
Finance		
Cost Control		
Sales		
Contract Adminstration		
Operations Control		
Planning & Scheduling		
Production		
Testing		
Quality Control		
Engineering		
Research & Development		
Traffic		

Excerpt from a vendor survey report form used by RCA's Industrial Electronics Products activity. The form runs into several pages

Vendor . . .

between 0 and 3 percent defective material. He is classified as a satisfactory supplier. Rating B indicates 3.1 to 10 percent defective lots and that improvement is required. The vendor receiving a C would have rejects at the rate of 10.1 percent and over, and is considered to be unsatisfactory.

Delivery ratings are also given. The ratings 1, 2 and 3 indicate satisfactory, improvement required and unsatisfactory.

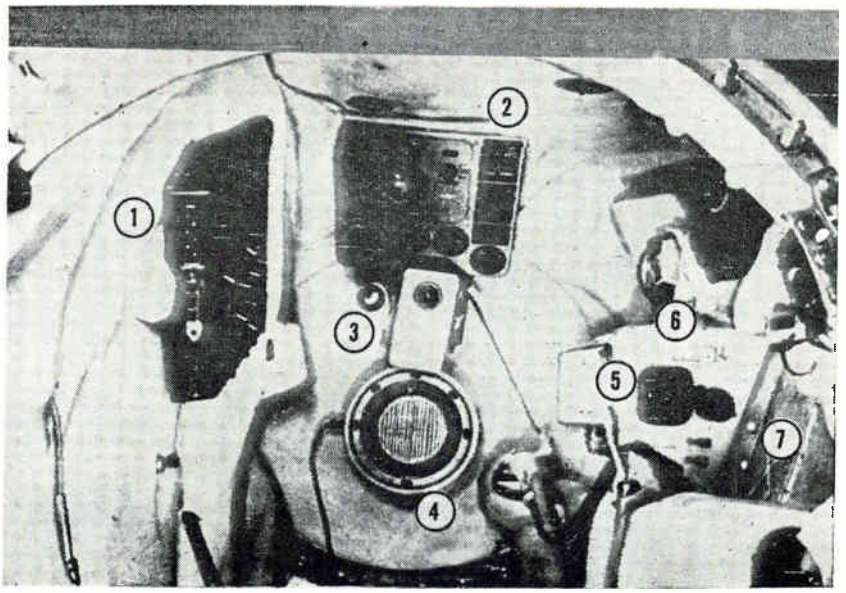
IEP's experience has indicated that quality and delivery go hand in hand so that if a supplier is unsatisfactory in quality, he is usually unsatisfactory in delivery. The reports are mailed out to all suppliers, and those who are unsatisfactory are called in far further discussion. Every vendor is given every opportunity to improve his rating, but if he is unsatisfactory for three successive quarters, he is dropped.

Huyck Systems' purchasing department relies on a vendor survey quality control rating sheet. Items such as the following are checked: condition of equipment (is there a program of maintenance and calibration?); does quality control or inspection report to production? (no—100 points, yes—0 points); is there a quality control manual?; are formal inspection records maintained and are they adequate?; is equipment government approved?

A vendor performing special processes such a welding, X-ray, plating, anodizing, magnetic particle inspection is automatically disqualified if he does not have government-approved equipment.

In obtaining conventional components, Huyck limits itself mainly to three suppliers bidding on individual orders. With some components such as transformers it will have the winner of a previous three-bidder competition bid with another set of two suppliers, and will continue this to keep active with a number of vendors to reap the benefits of new designs as well as gaining price and quality advantages.

Once a vendor has had an inspection visit, Huyck will make other visits only in response to deteriorating performance. Afterwards, if the vendor does not improve his performance, he is dropped.



Soviet Cosmonaut's Cabin Instruments

INTERIOR of Soviet Union spaceship's cabin (photo) shows controls and instruments used by Yuri Gagarin in his recent orbital flight. Visible are:

(1) Pilot's dashboard for control of cabin temperature, radiotelephone systems, and the switching in of manual control for functions such as engine retardation. Two sets of flight instruments for manually controlled descent are provided. Beneath a band extending from forty to sixty kilometers above the earth, conventional aerodynamic controls are used. Above this band inertial controls are employed.

(2) Instrument panel with mounted clock. Also present is a globe which revolves in synchronism with the vehicle's motion in orbit, to aid the pilot in determining his position in flight.

(3) Television camera. Two images of the pilot are transmitted back to earth. (Second lens not identified.)

(4) Optical instrument (not otherwise identified) and illuminator.

(5) Handle for manual control of ship orientation. Automatic orientation in descent and landing is accomplished by an optical and gyroscopic sensing system which feeds signals to an electronic coverter for transformation into commands. When the vehicle is properly oriented, the retarding engine is fired. Commands for switching on the orientation system, retro engine and other systems are issued by an electronic programming control.

(6) Radio receiver and (7) container with food.

The spaceship carries a radiometer for orbital measurements, and telemetry system for transmission of this information to earth.

A radio transmitting system provides tracking assistance and sends other telemetry information on 19.55 Mc.

Communication with earth is performed on a two-way radiotelephone which operates on 9.019 Mc, 20.006 Mc and 143.625 Mc. The pilot also has a telegraph key for c-w operation.

Contact with the Soviet Union could be carried out during most of the orbit. A tape recorder transcribes the pilot's voice in flight for subsequent transmission over ground receiving stations if desired.

Ninth Czech Tv Station Begins Operations

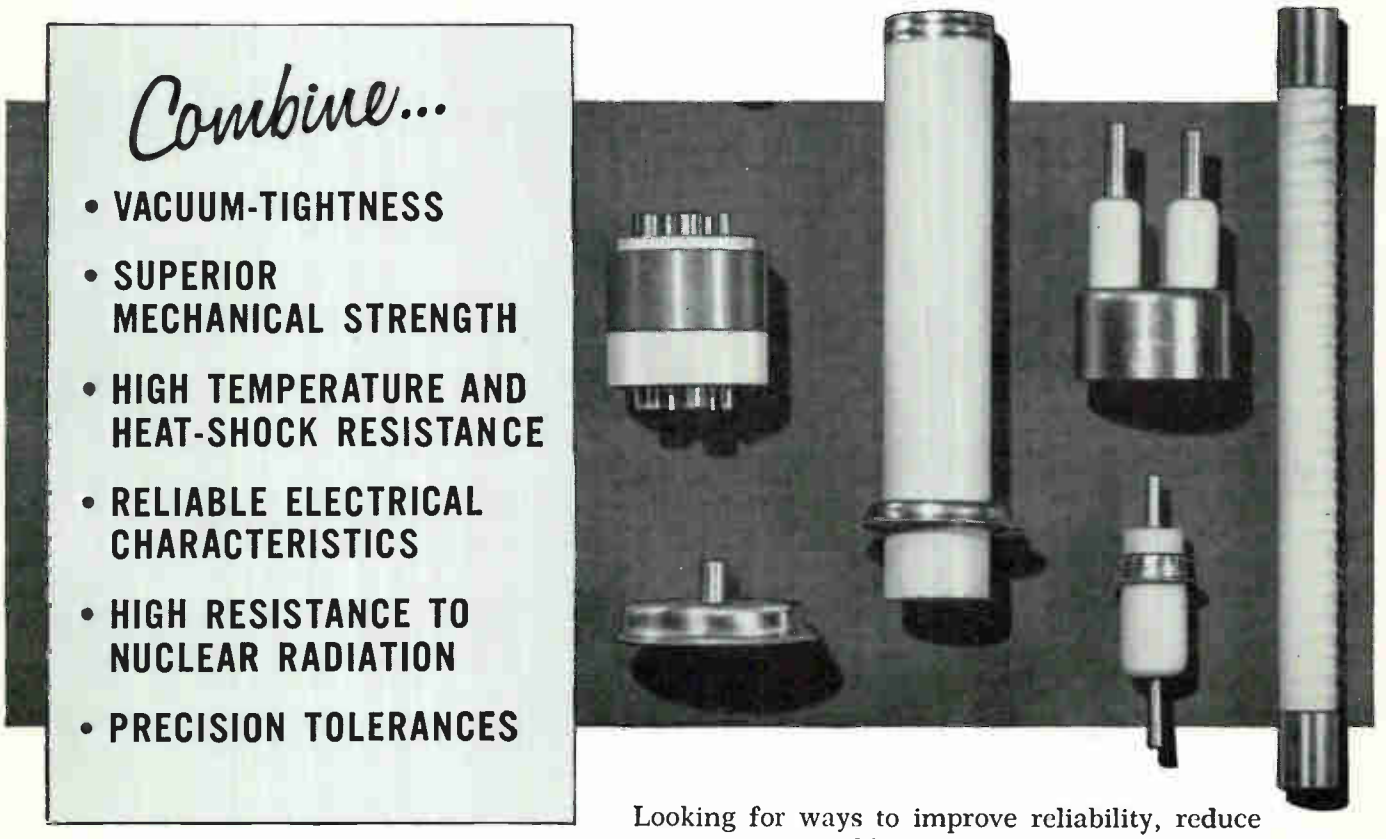
PRAGUE—Czechoslovakia's ninth television transmitter went into operation recently in the community of Dubnik near Presov.

Location of the station in eastern Czechoslovakia indicates the equipment may be used as a relay station between this country and the Soviet Union.

ALITE® HIGH-ALUMINA HERMETIC SEALS AND BUSHINGS

Combine...

- VACUUM-TIGHTNESS
- SUPERIOR MECHANICAL STRENGTH
- HIGH TEMPERATURE AND HEAT-SHOCK RESISTANCE
- RELIABLE ELECTRICAL CHARACTERISTICS
- HIGH RESISTANCE TO NUCLEAR RADIATION
- PRECISION TOLERANCES



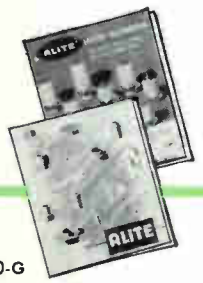
Looking for ways to improve reliability, reduce maintenance problems? The unique advantages of Alite high-alumina ceramic-to-metal seals may be just what you need!

With maximum working temperatures in the range 1300°-1600°C., Alite can be metallized and brazed to metal parts to form rugged, vacuum-tight seals which, in turn, can be welded into final assemblies.

From design to finished part, every manufacturing step — including formulating, firing, metallizing and testing — is handled within our own plant and carefully supervised to assure strict adherence to specifications, utmost uniformity and reliability.

Over 100 standard sizes of Alite bushings in a range of types are available to simplify design problems and speed delivery. However, when special units are called for to meet unusual requirements, a team of Alite engineers stands ready to help you take advantage of Alite's superior properties.

Write for FREE Helpful Bulletins



Bulletin A-7R provides detailed description and specifications of Alite. Bulletin A-40 describes Alite facilities and complete line of standard bushings.

410-G

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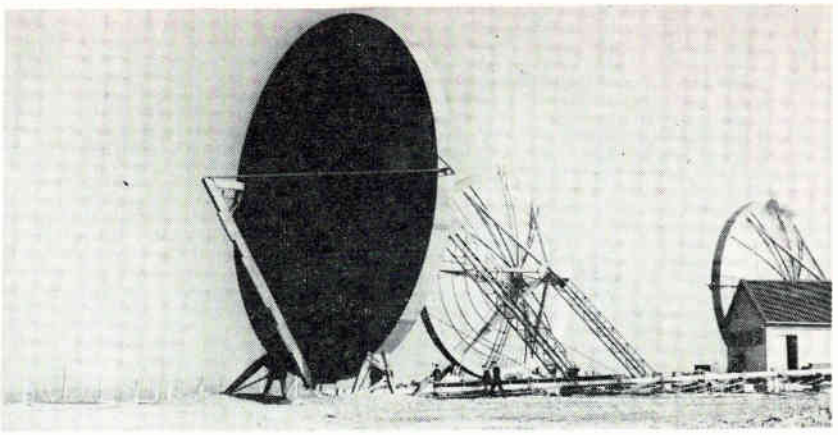


One of two antennas pointing toward London from Paris North Station, 40 miles northwest of French capital

Tropo Net Employs All-Steel Dishes

ALL-STEEL 60-ft parabolic reflectors built in West Germany by Krupp are being installed at 44 station links in the world's longest tropo scatter communications network, from northern Norway to eastern Turkey.

Project Ace High will collect and disseminate vital NATO defense information (ELECTRONICS, p 38, April 29, 1960). Operational date is undisclosed, but picture above of Paris North Station indicates equipment installation is nearing completion at principal sites.

The military network will give SHAPE a communications link with radar outposts and information centers in a 5,000-mile arc through Norway, Sweden, Denmark, Belgium, West Germany, France, Britain, Italy, Greece and Turkey. It will be operated by SHAPE personnel from 15 nations.

Ace High will also be part of an intercontinental communications system joining Western Europe with North American continent (ELECTRONICS, p 27, Sept. 4, 1959).

The galvanized-steel antennas chosen for Ace High have a reflecting skin fabricated of steel plate 2 mm thick and also steel support structures. Stress techniques based on aeronautical principles were designed into the antennas to withstand wind and weather conditions in varied climates.

Systems contractor is International Standard Engineering, Inc., a subsidiary of ITT. Itek Laboratories of Cambridge, Mass., formerly Hermes Electronic Co., is engineering consultant charged with system design and equipment specification responsibility.

For high-reliability operation over a range of climates from the Arctic Circle to the Mediterranean, redundancy and conservatism were designed into Ace High, with substantial amounts of reserve power and system gain. To insure operation even under unfavorable propagation conditions, two complete and parallel systems will be in operation at all times. The "operating spare" approach instead of idle standbys is expected to prevent communications failure even if equipment outages cause some circuit degradation. System will operate in band between 400 and 1,000 Mc, employing quadruple diversity in space and frequency.

Although some commercial power lines will be used, each station will have two diesel generators to supply power when needed.

Main route of the system will have 36 voice channels, with some equipped to handle telegraph service.

Line-of-sight microwave circuits, and in some instances low-power tropo, will connect the main route with spur lines and with information centers.

With parametric amplifiers, system designers say, it might be possible to get the receivers' 7½-db effective noise figure down to 3 or 3½ db, but the system was designed before parametric amplifiers had been proven. Also, increased receiver sensitivity and correspond-

ingly lower transmitter power might make the receivers susceptible to ignition interference and jamming.

Urges More Research For New Components

SAN FRANCISCO—Keynoting the 1961 Electronic Components Conference here earlier this month, James Bridges, director of electronics, Office of Director of Defense Research and Engineering, spoke out for curbing the weapons-system concept and for more applied research to develop radically new components and concepts. About 500 attended the three-day meeting.

"I think the weapons-system pendulum has swung a little too far," said Bridges, who believes research and development management has become too strongly systems oriented. The result, he says: a lot of money spent to achieve marginal improvements over existing weapons systems and too little spent on applied research to develop radically new concepts.

Bridges placed most, but not all, of the blame for this situation at the doorstep of government. "The government has created in the defense electronics industry a competitive and profit—or lack of profit—situation that makes a very extensive involvement in applied research appear unattractive to most companies," he said.

Bridges proposed two fundamental changes in fiscal policy and management organization to foster what he called "more thought given to weapons of the future."

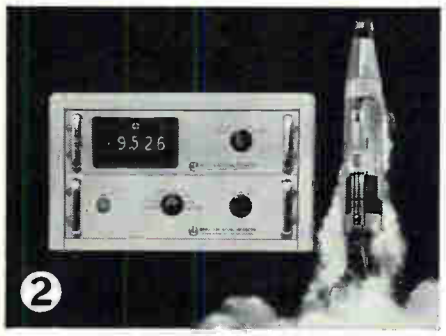
One change would be establishment of a separate budget category for applied research, and "building a fence around that money" so that it may not be diverted for systems.

Bridges suggested the possibility of combining applied research funds with basic research funds, since the latter are already well established in most levels of the military.

The second suggested change is to establish in each military service a management organization for applied research and component development "that will remove the planning and direction of these important R&D areas from influence of weapons-system managers."

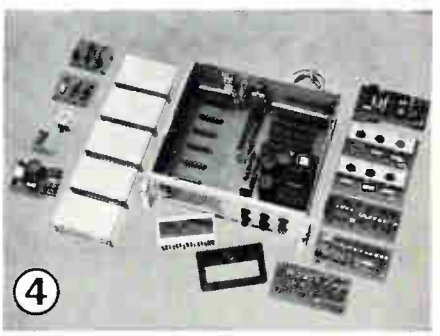
When does it pay to pay more for a digital voltmeter?

WHEN RELIABILITY is of uncompromising importance, consider NLS Series 20 instruments with advanced transistorized logic and mercury-wetted relays. The M24, above, which measures DC voltage, DC voltage ratio or resistance in ⅓ second, has been selected by major missile manufacturers after thousands of hours of competitive life testing.



WHEN SPEED, in the order of 200 measurements per second, is required, specify the NLS V44 All-Electronic DVM. Here is an instrument specifically designed to solve the special problems encountered in high-speed measuring and data logging.

WHEN ACCURACY—full five-digit accuracy—is demanded by your application, use the NLS V35A. This instrument features resolution of 0.001% over the entire range, a result of mathematically perfect "No-Needless-Nines" logic.



WHEN EASE OF SERVICING is of vital concern, you will find it in any NLS premium instrument. The higher-priced V44, M24, V24, R24 or the medium-priced V35A and V34A (shown above)—all feature 99% plug-in modular construction for spotting and correcting malfunctions in minutes instead of hours or days.

Originator of the Digital Voltmeter

non-linear systems inc.

DEL MAR, CALIFORNIA

Dataspeed, high-speed paper tape transmission system by AT&T, sends 750 bits a second over regular telephone lines. Photo shows teletypewriter with tape reader and punch attachments (left), Dataspeed tape punch or receiver (center), and tape reader or transmitter

Data System Uses Regular Phone Lines

AN ASSORTMENT of equipment using solid-state circuits unveiled recently by the Bell System will make telephone lines more useful for businessmen and engineers.

Dataspeed, a high-speed teletypewriter tape transmission system, exceeds present equipment speeds by a factor of ten. This means a 5,000-word message can be sent using regular telephone lines in about five minutes instead of fifty, with a proportionate cost saving. The system uses five-level punched paper tape, will be available late this year.

Data-Phone uses telephone lines to link data-processing equipment at speeds up to 1,600 words per minute. It will handle any type of data in any machine language, including handwriting and diagrams.

The digital information is converted to audio frequencies for telephone-line transmission and reconverted at the receiving end.

The equipment comes in four sizes, according to information handling capacity and speed. Series 100 is suitable for banks or airline ticket offices, with two-way communication. Series 200, with 1,600 wpm, will fit the speed of most business data processing systems now in use. Series 400, with a relatively slow (20 wpm) speed is designed for one-way data gathering systems such as branch inventories, sales orders or payrolls. Series 600 is suitable for transmitting handwritten messages or drawings, using devices such as Comptometer's Electrowriter.

For the general telephone user there are three automatic dialing systems that speed up calling often-dialed numbers and reduce dialing errors. A card dialer, built integrally with a telephone set, has plastic cards, prepunched by the user for different numbers and kept in a small file. Inserting a card and pressing a button initiates the dialing process.

Dialaphone, a telephone attachment, uses a paper tape loop, again prepunched by the user, that will hold 850 different numbers. The user selects the name of the person and presses a button; the number is dialed automatically.

Rapidial, a third system, operates the same way but uses magnetic tape that can be preprogrammed, altered or erased. Its capacity is 290 telephone numbers.

MEETINGS AHEAD

May 22-24: Communications Symposium, (GLOBECOM V), PGCS of IRE, AIEE; Sherman Hotel, Chicago.

May 22-24: National Telemetering Conf., PGSET of IRE, AIEE, IAS, ARS, ISA; Sheraton Towers Hotel, Chicago.

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

May 23-25: Large Capacity Memory Techniques for Computing Systems, Office of Naval Research; Dept. of Interior Auditorium, Wash., D. C.

May 31-June 2: Frequency Control Symposium, U.S.A. Signal R&D Lab.; Shelbourne Hotel, Atlantic City, N. J.

May 31-June 2: Radar Symposium, Univ. of Michigan Inst. of Science & Technology; Ann Arbor, Mich.

June 6-8: Instrument-Automation Conf. & Exhibit, ISA; Royal York Hotel, Toronto, Ontario, Canada.

June 8-9: National Electrical Manufacturers Assoc., NEMA; Biltmore Hotel, Los Angeles.

June 12-17: Components & Materials Conf., Institution of Electrical Engineers; London.

June 14-15: Product Engineering & Production, PGPEP of IRE; Sheraton Hotel, Philadelphia.

June 15-16: Broadcast and Television Receivers, PGBTR of IRE, and Chicago Section; O'Hare Inn, Des Plaines, Ill.

Aug. 22-25: WESCON, L.A. & S.F. Sections of IRE, WCEMA; Cow Palace, San Francisco.

Sept. 11-15: Instrument Automation Conf. and Exhibit, ISA; Sports Arena, Los Angeles.

Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Intl. Amphitheatre, Chicago.

Nov. 14-16: Northeast Research & Engineering Meeting, NEREM; Commonwealth Armory and Somerset Hotel, Boston.

THIS remarkable plastic may trigger a new (or cost-saving) design idea for you

National Vulcanized Fibre is unique. It's a tough, cellulosic plastic—not mere paper or fiberboard. Vulcanized Fibre possesses an unusual combination of mechanical, electrical and thermal properties. For example . . .

It weighs one-half as much as aluminum, yet is one of the strongest materials known per unit of weight. It's tough, durable and cushions the shock of repeated blows.

Vulcanized Fibre has superior arc-resistance. It comes in standard and special grades, including a fire-resistant grade called "Pyronil." It can be machined, formed or deep-drawn into intricate shapes, and can be combined with other materials . . . aluminum, rubber, "Mylar," copper, laminated plastic, plywood, to name a few.

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Find out for yourself why National Vulcanized Fibre is "the plastic with a million uses." There's a free sample kit waiting for you at a nearby NVF sales office. Check Sweet's Product Design File 2b/Na for the one nearest you. Or write directly to Dept. P Wilmington, Delaware.

116 Choices: One Source This is the latest count of the different plastics and grades NVF can offer in your search for the *one best material*. Add to this total *the* one special grade that can be developed from scratch to meet your particular need. This full range of materials is backed by complete engineering services . . . from application assistance up to and including the delivery of 100% usable, precision-fabricated parts . . . in any quantity, on time!

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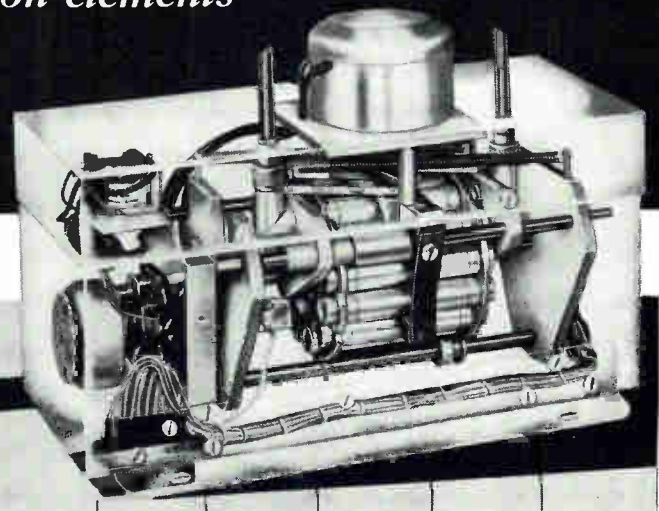

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A Quality Product requires ALLEN-BRADLEY Electronic Components

Ampex's Advanced Recorder/Reproducer, the FR-600 used for testing the Minuteman Missile.

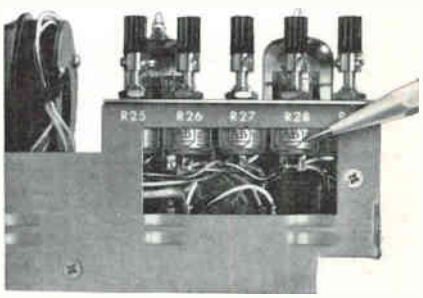
This shows a few of the A-B components in one of the Ampex recorder's modules.

In the design of the highly sophisticated circuitry for this advanced recorder, engineers at Ampex selected Allen-Bradley quality electronic components to meet the critical requirements for reliability, long life, and quiet operation. For example, the use of Allen-Bradley potentiometers—with their exclusive solid, hot molded resistance element—assures smooth control at all times. There are never any abrupt changes in resistance during adjustment as in wire-wound resistors. Also the "noise" factor is extremely low initially, and it decreases with use.

Allen-Bradley composition fixed resistors—also made by an *exclusive* hot molding process—are fantastically uniform. Their electrical characteristics are so consistent from resistor to resistor that performance over long periods of time can be accurately predicted. *And catastrophic failure is unheard of*—when you use Allen-Bradley composition resistors.

For the ultimate in reliability and performance, insist on Allen-Bradley *quality* electronic components. Send for Publication 6024 today.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



Portion of one of 14 CRT monitors, each containing 8 A-B Type G Potentiometers.

A-B QUALITY ELECTRONIC COMPONENTS USED IN AMPEX WIDE-RANGE RECORDER

Fixed Composition Resistors

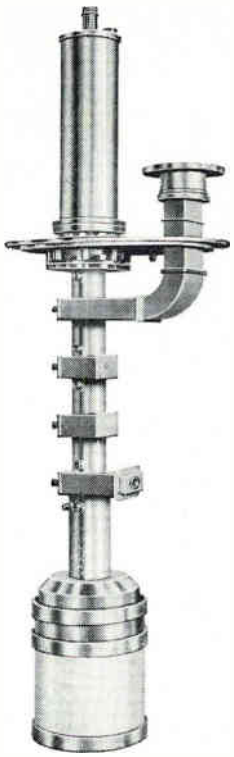
Adjustable Fixed Resistors

Type G Potentiometers

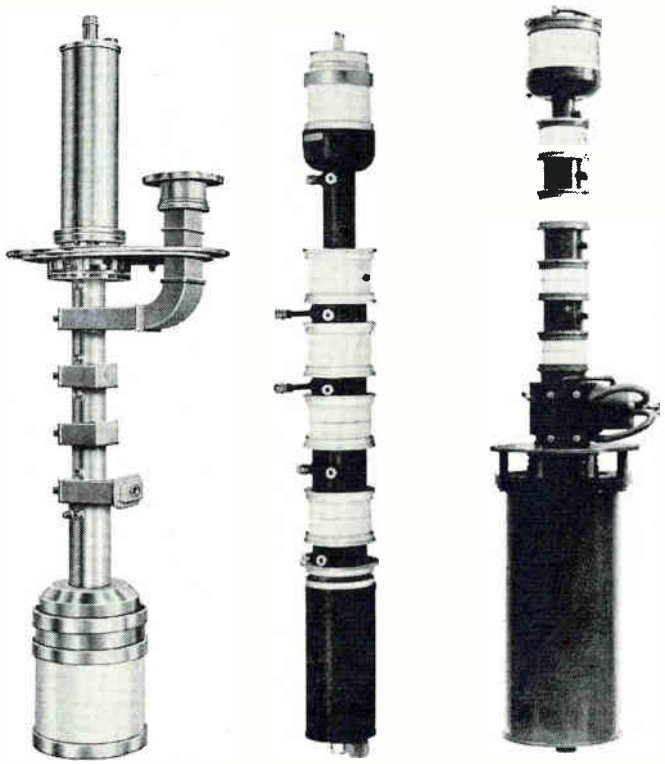
Type J Potentiometers

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS



Most companies think there's only one way to design a klystron.



But Eimac knows there are three.

Some rf ranges and requirements call for an internal cavity klystron. Others, an external one. For still others, a combined internal-and-external cavity is best. That's why Eimac designs klystrons *all three ways.* (And why it has more high power klystrons operating throughout the free world than all other makers combined.) Fact is, that's how Eimac designs *every* tube: to meet your specific needs.

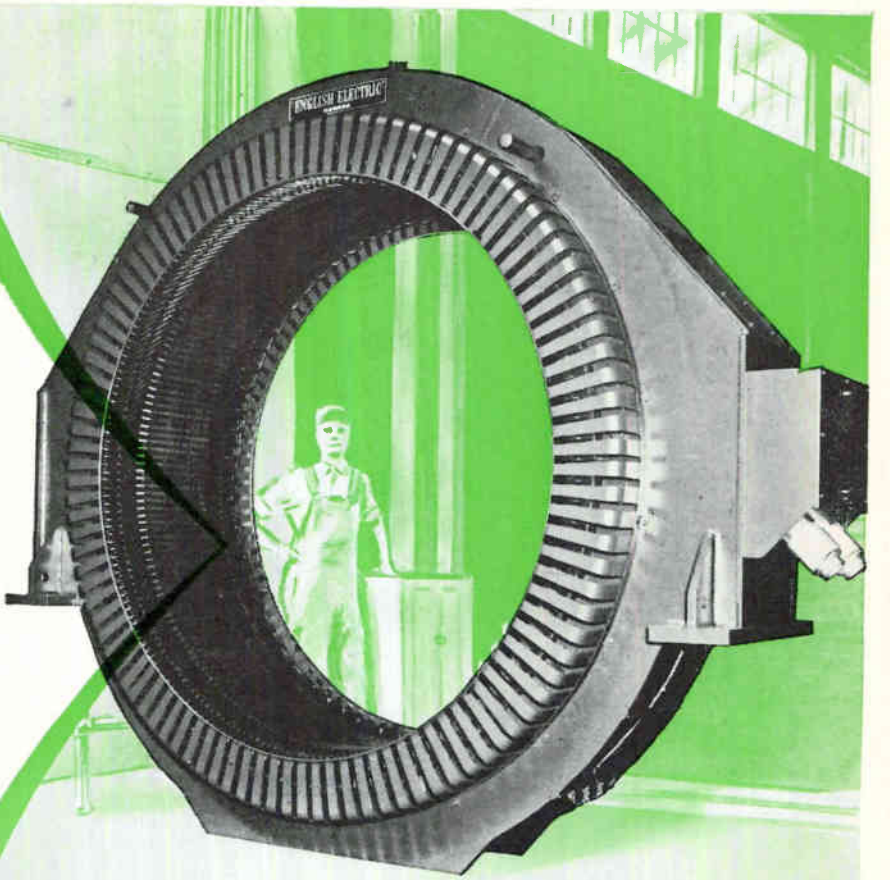
For data on Eimac klystrons shown above (4KP40,000SQ, internal cavity; 4K50,000LQ, external cavity; 5K210,000LQ, combined internal-and-external cavity) contact your Eimac representative or write: Power Klystron Division, Eitel-McCullough, Inc., San Carlos, Calif.

Eimac

ENGLISH ELECTRIC CANADA

USES NATVAR Teraglas®

TO TAPE STATOR COILS OF THIS 4500 HP MOTOR



This unit, one of four built by English Electric for export to Europe, is a 4500 HP, 6000 V, 3-phase, 50 cy. synchronous motor stator. Coil ends are taped with Natvar Teraglas, a new flexible insulating material comprising a base fabric woven from polyester (polyethylene terephthalate or "Dacron") warp yarns, and continuous filament glass filler yarns, coated with an improved varnish possessing exceptional dielectric strength under elongation.

English Electric Canada, Toronto, Ontario, Division of John Inglis Co. Ltd. manufacture electrical motors, controls, transformers and switchgear for use in important installations throughout the world.

They have found that Teraglas offers several distinct advantages over the thirsty cotton base tapes formerly used. At no advance in material cost, Teraglas is more readily applied to coils; the higher dielectric strength of Teraglas results in a better insulated coil; and better heat resistance provides a greater safety factor against high operating temperatures due to overloading.

If you are presently using conventional materials, it will pay you to consider the ease of use and extra protection of Teraglas. It is made in four standard thicknesses, .008", .010", .012" and .015", available in sheets, rolls or tapes in black and yellow.

Teraglas® U.S. Pat. Off. (Natvar Corp.)

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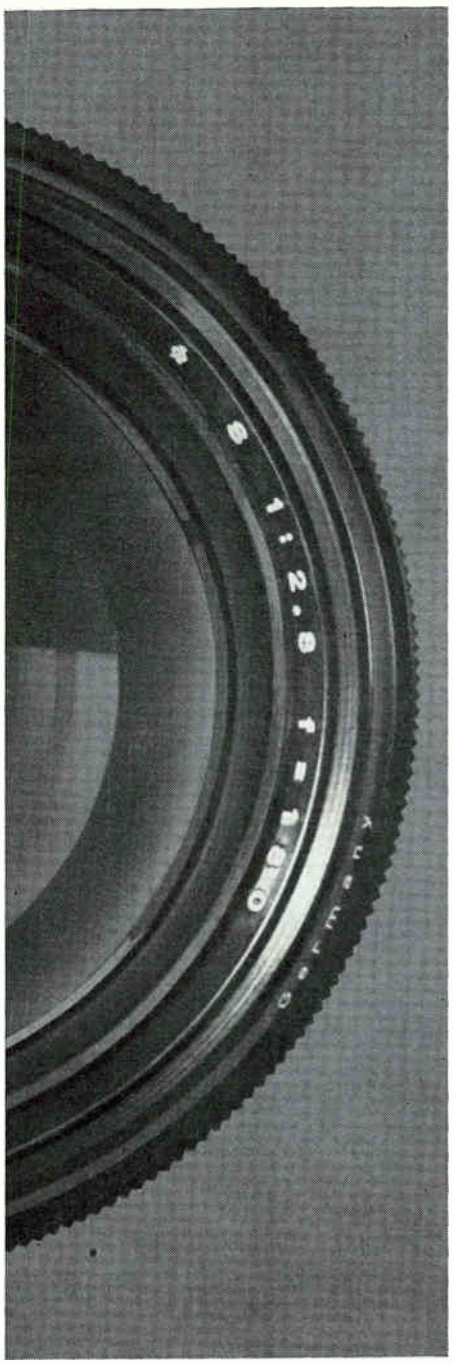
- Slot cell combinations, Aboglas®
- Teraglas®
- Isoglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated and silicone rubber coated Fiberglas tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

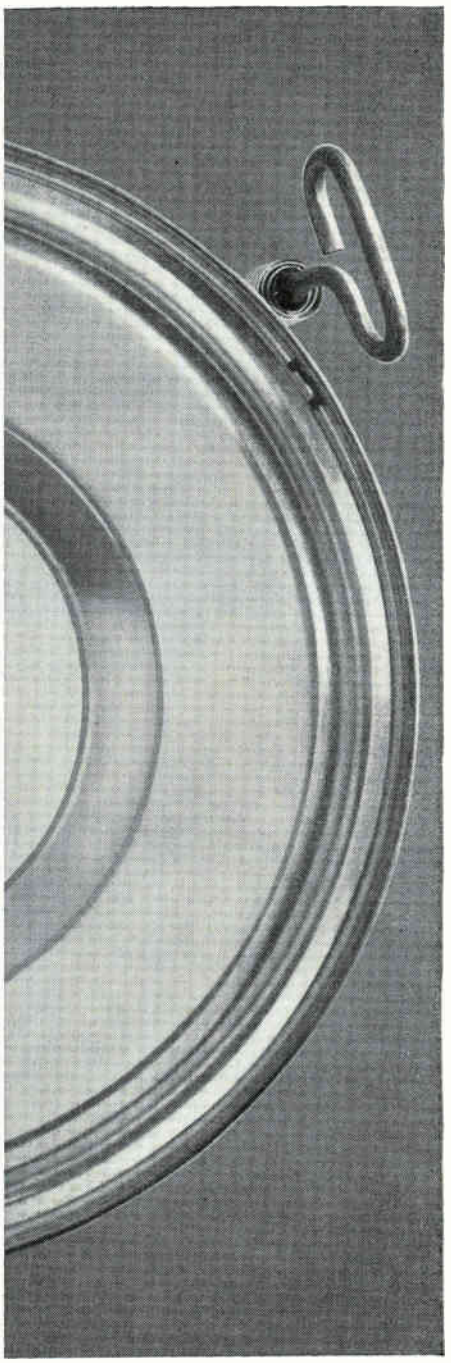
*TM (Reg. U.S. Pat. Off.) OCF Corp.

We will be very happy to supply information on any of our products on request.

Keeping tabs on the nickels, dimes, quarters that go into hundreds of vending machines—that's what Veeder-Root electrical and mechanical counters do with unfailing accuracy.



Special instrument counters play an important role on aerial cameras for many jobs such as locating plant sites, mineral prospecting and for general reconnaissance.

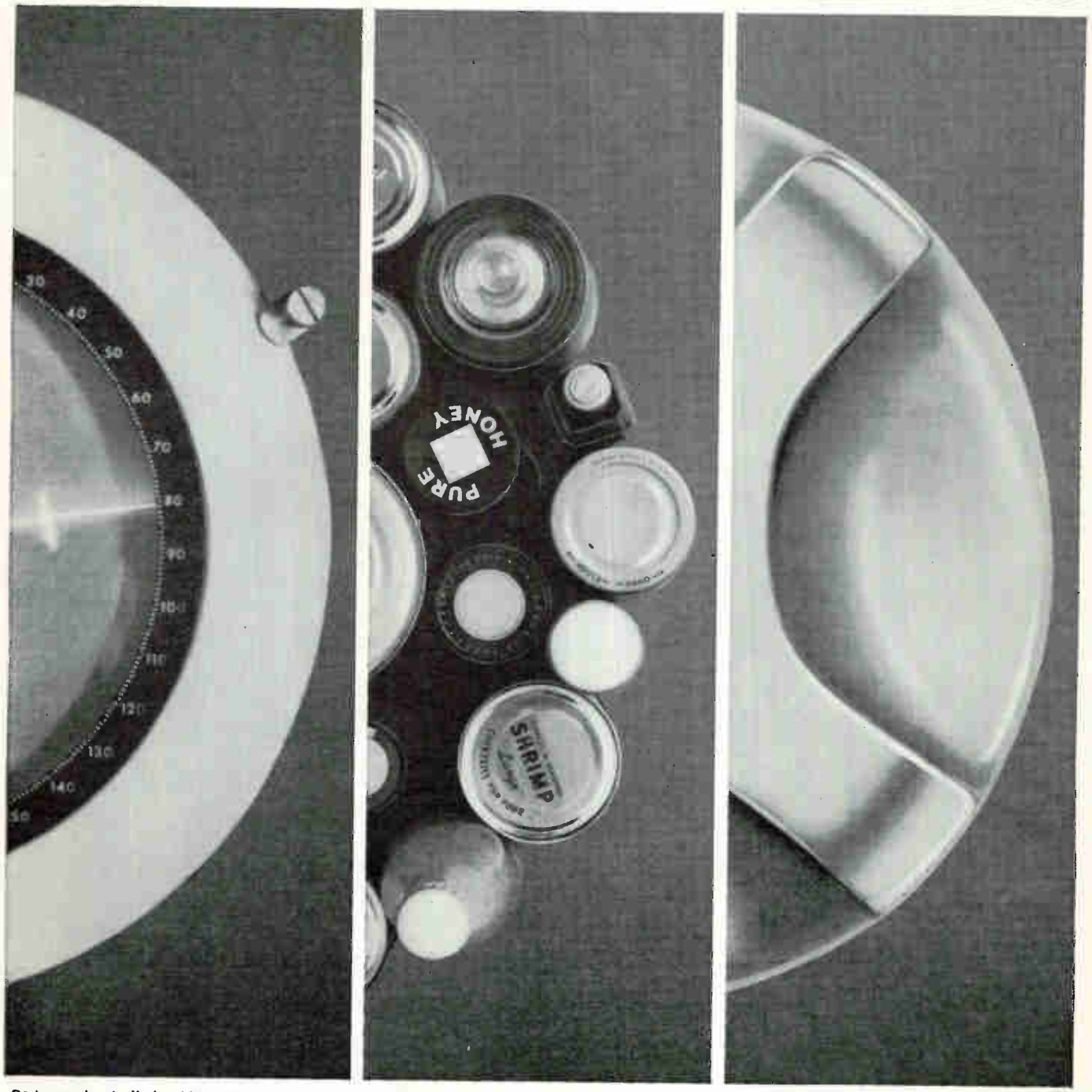


In making tin cans, and in packaging them, Veeder-Root electronic counters with photo electric input record production at speeds up to 300,000 units per minute.

Regulate, Actuate, Correlate with Veeder-Root Counters!

Here's a fast, low-cost way for you to record facts... coordinate operations... automate your plant machinery. Whether you include these versatile counters in your new

Veeder-Root counting controls for industry, defense and space exploration



Radar and missile-tracking systems rely on the positive precision of Veeder-Root instrument counters for instant read-out of range and azimuth or coordinate position.

Veeder-Root indicating and remote digital read-out counters help maintain inventory control of packaged and fluid goods, recording usage, balance on hand, re-ordering points.

Watchman for water. Another job for Veeder-Root counters. Installed on modern meters, these mechanical counters gauge flow... prevent waste of industry's precious raw material.

designs or add them to your present production line you increase equipment value and performance. Send for details on the latest developments. Write Veeder-Root Inc., Hartford 2, Connecticut. count on Veeder-Root

FILM-COATED MAGNET WIRE FOR 220 C

Affords continuous high-temperature operation up to 250 C—resists heat shock up to 425 C

The exceptional heat stability of Anaconda ML Magnet Wire makes it ideal for electrical equipment operating at continuous high temperatures up to 250 C—such as high-temperature motors, relays and dry-type transformers. This same heat-resistant characteristic also makes ML Magnet Wire a valuable tool in miniaturization and in reducing the size of larger equipment.

Tremendous overload resistance (as demonstrated by thermo-plastic flow above 500 C and heat shock resistance over 400 C) makes ML Magnet Wire particularly suitable for portable tool armatures and other applications where "stall" conditions or unusual overloads may be experienced.

Essentially zero weight loss to 200 C makes it possible to use ML Magnet Wire for relays that will operate at temperatures up to 250 C with low space factor and comparatively low cost. Using ML Magnet Wire in sealed relays practically eliminates contact contamination due to "outgassing" of wire insulation.

Other ML Magnet Wire advantages: high burn-out resistance and cut-through level; dry dielectric strength over 3,000 V/Mil; excellent flexibility; good windability and scrape resistance.

ML Magnet Wire is coated with a solution of ML Polymer, a new chemical development by duPont that represents a tremendous improvement in heat resistance over organic coatings. ML Magnet Wire can be used as a replacement for most film-coated magnet wires, except solderable types, and many glass and glass Dacron wires. Where the positive inorganic spacing of glass is required, the combination of ML film and glass serving offers outstanding properties. ML Magnet Wire's combination of high temperature rating, excellent winding characteristics and space factor permits its use in many applications which formerly required the use of much more expensive combinations of ceramics and fluorocarbons.

ML Magnet Wire is available in all sizes of round, square and rectangular. Film additions are single, heavy, triple or quadruple thicknesses, all conforming with NEMA specifications. ML also meets all requirements of Spec. MIL-W-583B for Class 180 Types H, H2, H3, and H4, and Class 200 Types K, K2, K3, and K4. For prices, technical data and applications engineering information, contact Department EFL-1-E, Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

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Transitron

SILICON CONTROLLED RECTIFIERS

augmenting the industry's broadest line

With the addition of the 50-Amp Silicon Controlled Rectifier, Transitron now offers the industry the broadest line of Controlled Rectifiers available on the market today.

Research and development efforts during the past year have already produced an impressive array of types which include the following series:

TSW31S SERIES (TO-18 package).....operating current range to 200mA
TCR251 SERIES (TO-5 package).....operating current range to 1 amp
2N1595 SERIES (TO-5 package).....operating current range to 1 amp
2N1600 SERIES (7/16" hex package)...operating current range to 3 amps
TCR505 SERIES (7/16" hex package)...operating current range to 5 amps
TCR510 SERIES (11/16" hex package) operating current range to 10 amps
TCR520 SERIES (11/16" hex package) operating current range to 20 amps

NOW AVAILABLE — NEW 50-AMP CONTROLLED RECTIFIER

The latest addition to the Transitron line — the 50 Amp Silicon Controlled Rectifier — is a three-terminal, four-layer device designed to control very large load currents with small gate current signals. A mechanically rugged and electrically stable device, the new Controlled Rectifier is provided in the 1 1/16" hex base stud-mounted package and is hermetically sealed. Wherever high power handling ability is required, the 50-Amp Silicon Controlled Rectifier will find wide application ranging from frequency changing to welding control.

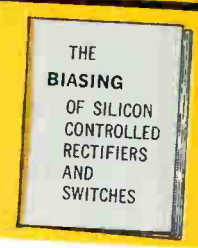
TCR550 SERIES (1 1/16" hex package)
operating current range to 50 amps

Type	Min. Peak Reverse Volt. and Min. Forward Breakover Volt. (volts)	Max. Average Forward Current at 90°C case (amps)	Package Configuration
TCR4050	400	50	1 1/16" hex
TCR3050	300	50	1 1/16" hex
TCR2050	200	50	1 1/16" hex
TCR1050	100	50	1 1/16" hex
TCR550	50	50	1 1/16" hex

Requires 50mA to turn on 50 Amp

For information on any or all of Transitron's line of Controlled Rectifiers, call or write today for Bulletin TE-1356.

WHY BIAS CONTROLLED RECTIFIERS?



Pioneering in *new* application techniques, Transitron application engineers have assembled information which demonstrates how "gate biasing" will improve the circuit reliability of the SCR. This informative booklet, entitled "The Biasing of Silicon Controlled Rectifiers and Switches," deals individually with *each* of Transitron's Controlled Rectifiers and Switches. It is an indispensable aid to the design engineer seeking *longer life* and *greater stability* in higher temperature applications . . . It's yours for the asking.

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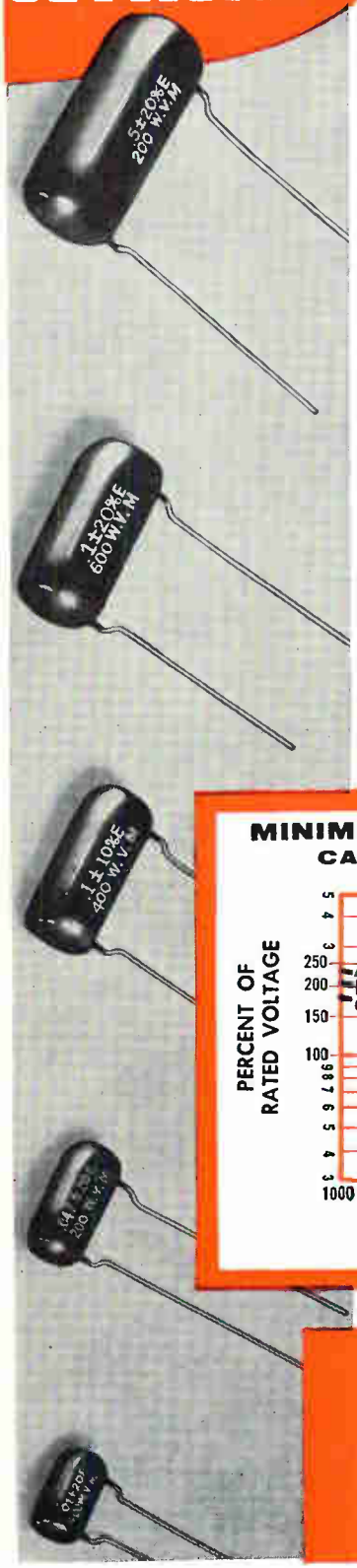
El-Menco

*MYLAR-PAPER DIPPED CAPACITORS

TYPE MPD



ASSURE A LOW FAILURE RATE OF

Only 1 Failure in ~~7,168,000~~ 14,336,000 Unit-Hours for 0.1 MFD Capacitors★

Setting A New High Standard Of Performance!

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

CAPACITANCE AND VOLTAGE CHART

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

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

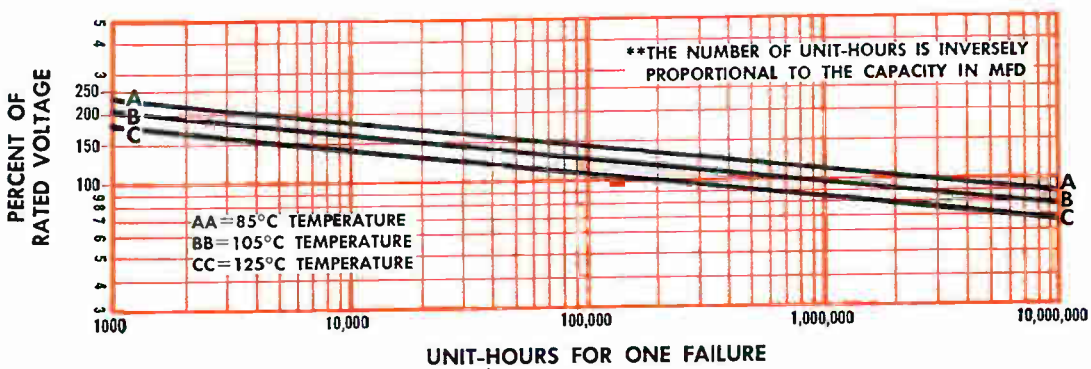
SPECIFICATIONS

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

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

Write for Technical Brochure

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



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THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

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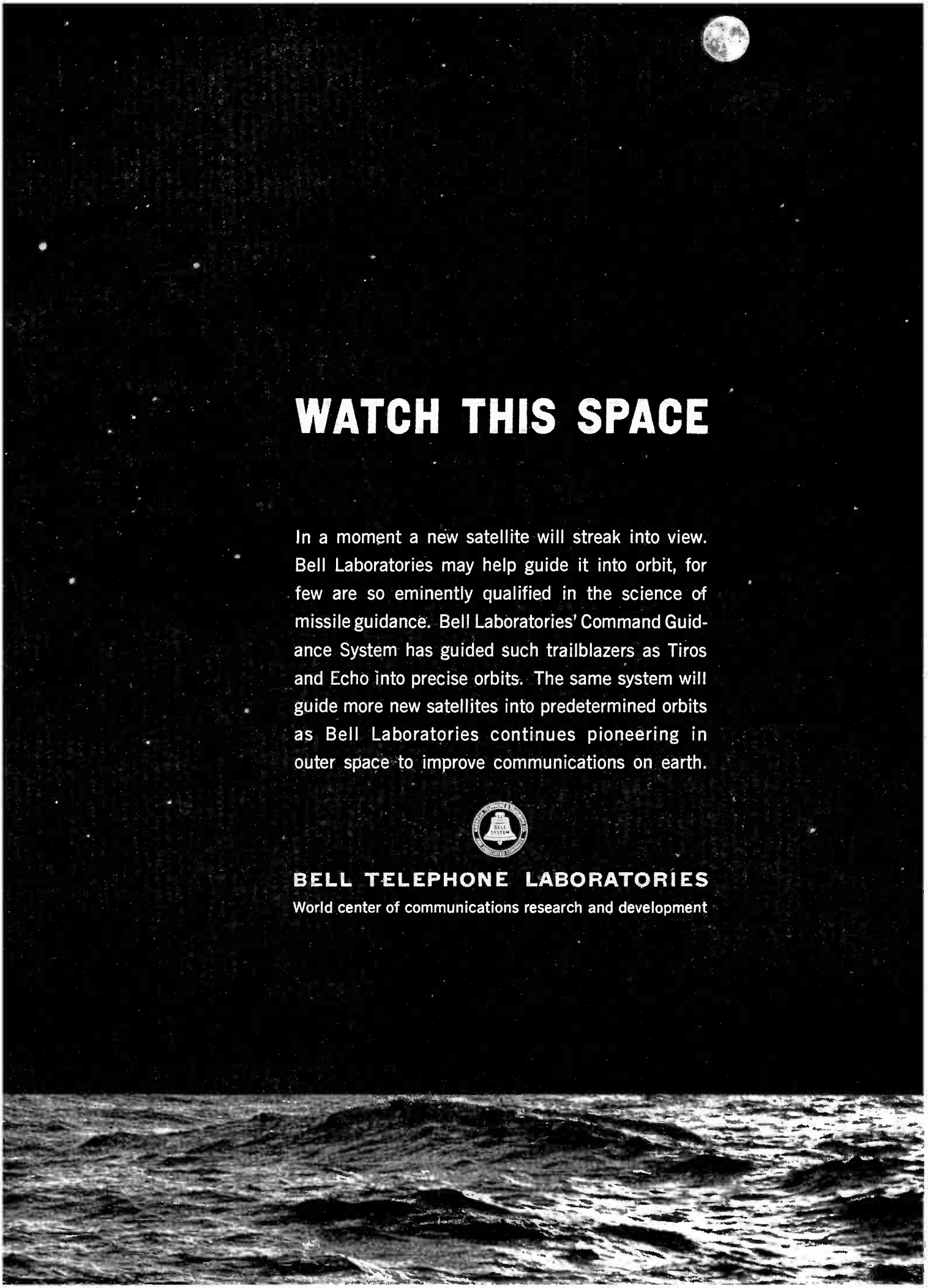
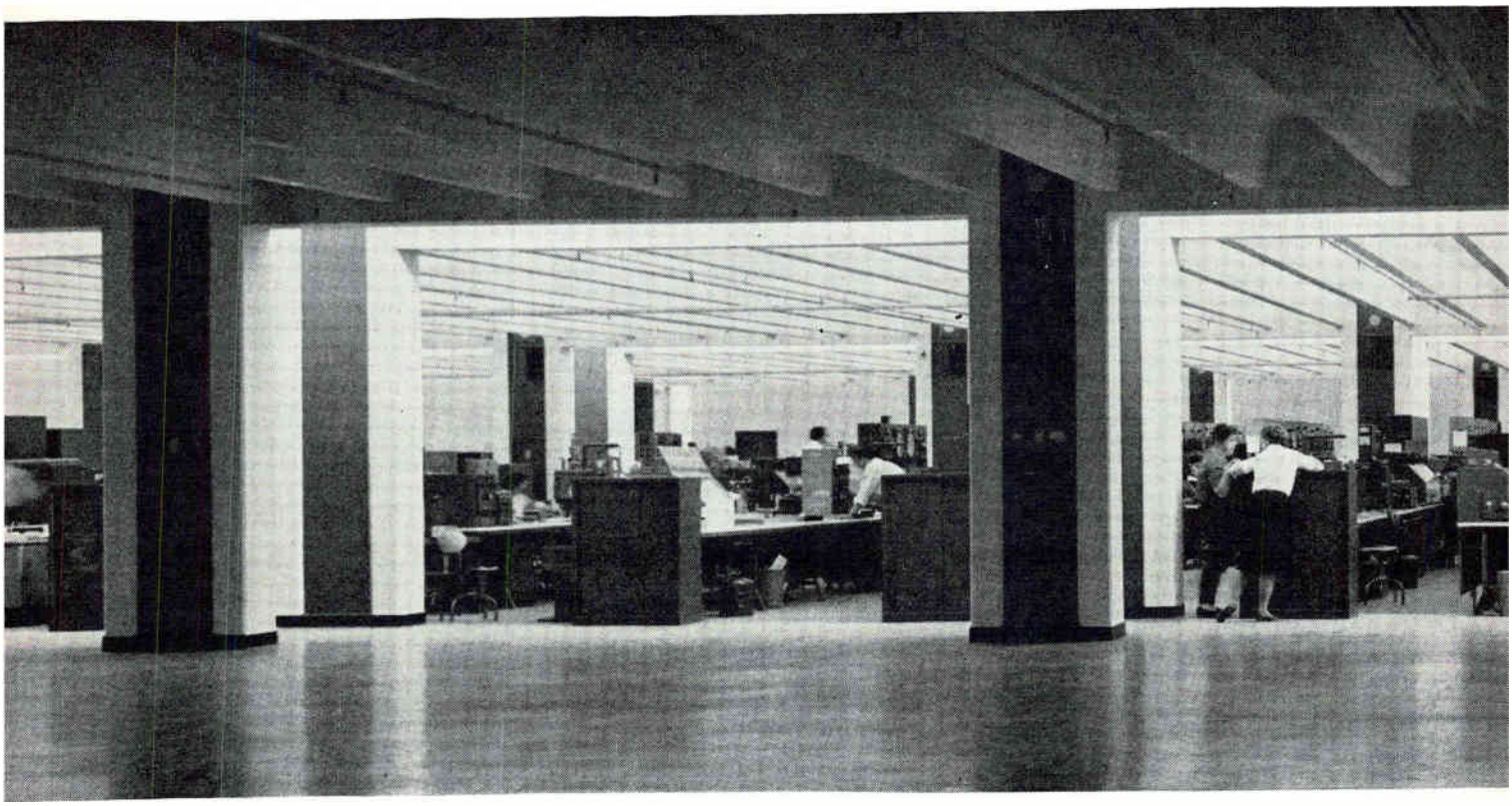

WATCH THIS SPACE
In a moment a new satellite will streak into view. Bell Laboratories may help guide it into orbit, for few are so eminently qualified in the science of missile guidance. Bell Laboratories' Command Guidance System has guided such trailblazers as Tiros and Echo into precise orbits. The same system will guide more new satellites into predetermined orbits as Bell Laboratories continues pioneering in outer space to improve communications on earth.
BELL TELEPHONE LABORATORIES
World center of communications research and development

New MADT & Epitaxial Planar



CBS Electronics Opens $5 Million Engineering and Production Facility

Diffusion Furnaces *shown here process thin epitaxial layers of high-resistivity material for CBS planar transistors.*

In modern architecture, form follows function.

This concept is dramatically demonstrated by the new CBS Lowell Progress Center which specializes in semiconductors for computer circuitry. This most modern engineering and production facility is designed to advance immediate and long-range developments in solid state technology and processes.

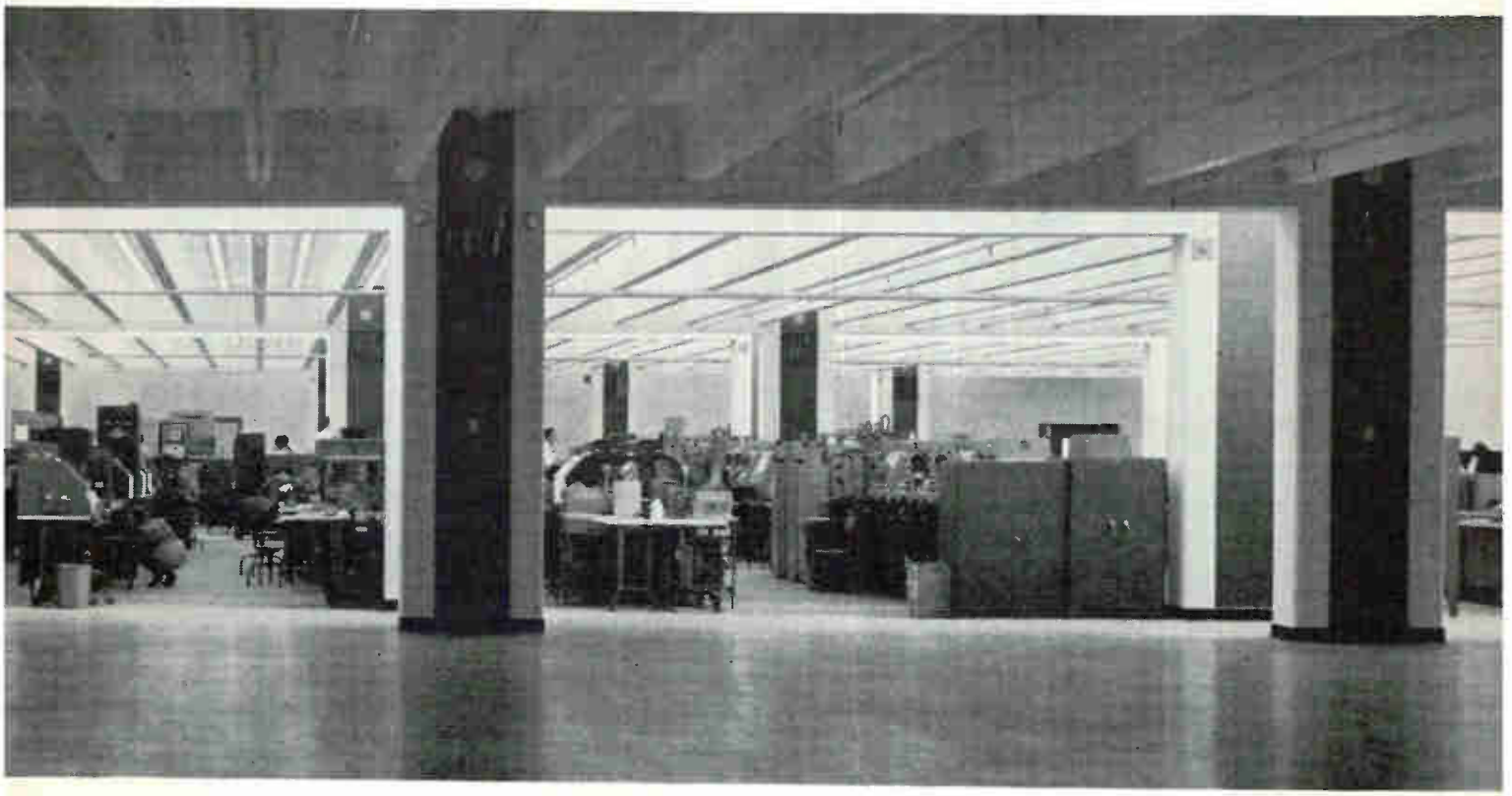
The Lowell Progress Center is currently supplying industry with a broad line of rugged and reliable semiconductors: *MADT, *MAT and *SBT switching transistors—PNP and NPN germanium high-power transistors—gold-bonded and point-contact diodes. An advanced line of CBS epitaxial-planar silicon transistors will soon be available in production quantities.

Close cooperation between CBS Electronics and CBS Laboratories is helping to shape the future of solid-state technology through the CBS microelectronics program. Under way for the past two years, this program concentrates on basic approaches to thin-film deposition on inert substrates. It stresses also the development of microminiature devices featuring increased packing densities and reduced power levels for use in compact computers.

Learn about present and future semiconductor advances coming from the Lowell Progress Center. Investigate how the broad capabilities of CBS Electronics can help you achieve your solid-state objectives. Write today to CBS Electronics, Semiconductor Operations, Lowell, Massachusetts.

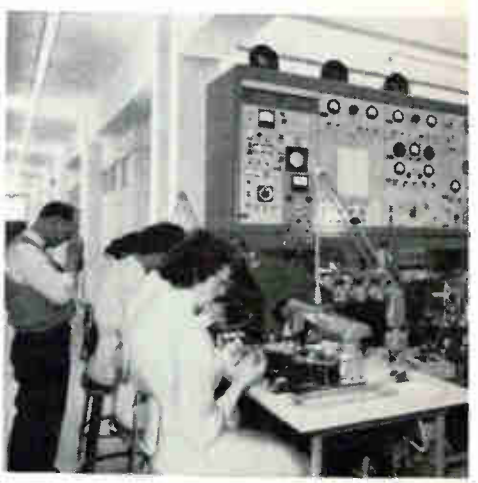
*MADT: Micro Alloy Diffused-base Transistor, *MAT: Micro Alloy Transistor, *SBT: Surface Barrier Transistor, Trade-marks of Philco Corp.

Semiconductor Progress Center



Lowell Progress Center *concentrates on the engineering and production of CBS semiconductors for computer circuitry. Functional design gives the 200,000 square feet of plant space built-in flexibility to help in achieving highest standards of quality and reliability. Close cooperation with CBS Laboratories promises new and exciting solid-state developments for the future.*

Mass Production *of MADT high-speed switching transistors is accomplished on the most up-to-date equipment in the semiconductor industry. Exceptional reliability and uniformity are assured by automatic in-line production permitting 100% in-process quality control of each transistor.*



CBS® **semiconductors**

More Reliable Products through Advanced Engineering

CBS ELECTRONICS, Semiconductor Operations, Lowell, Massachusetts

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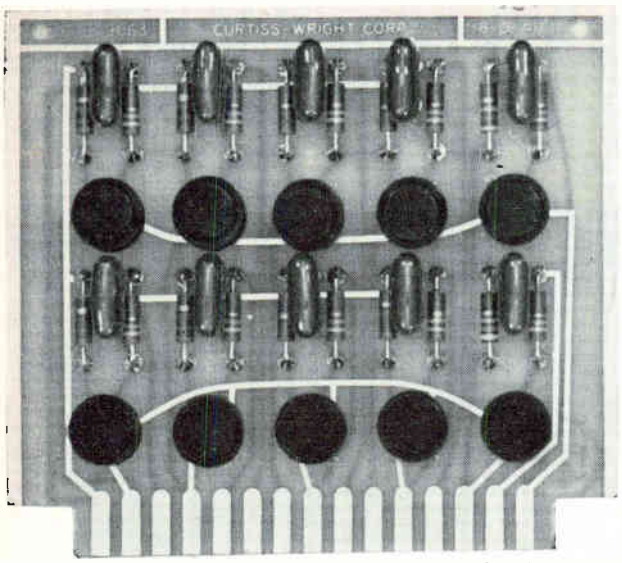
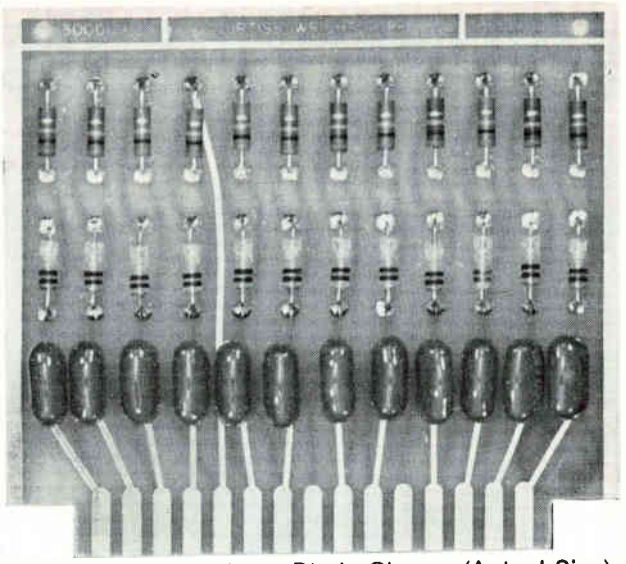
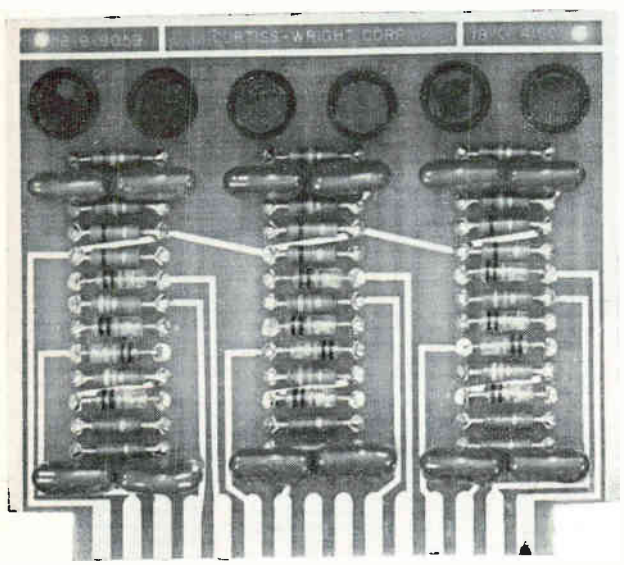


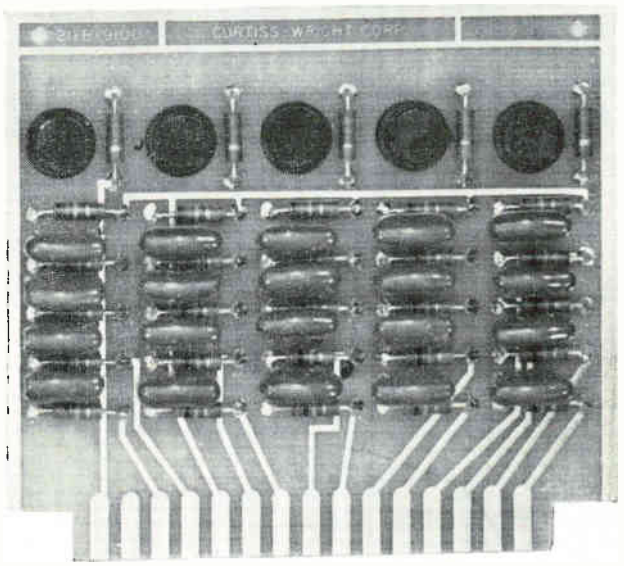
Two 4-Bit Transfer Gates (Actual Size)



Twelve Capacitor Input Diode Clamps (Actual Size)



Three Binary Circuits with Set-Reset Gates (Actual Size)



Five 4-Input NOR Gates (Actual Size)

An example of Intermountain Solid State Circuit design capability...

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Electronics Division
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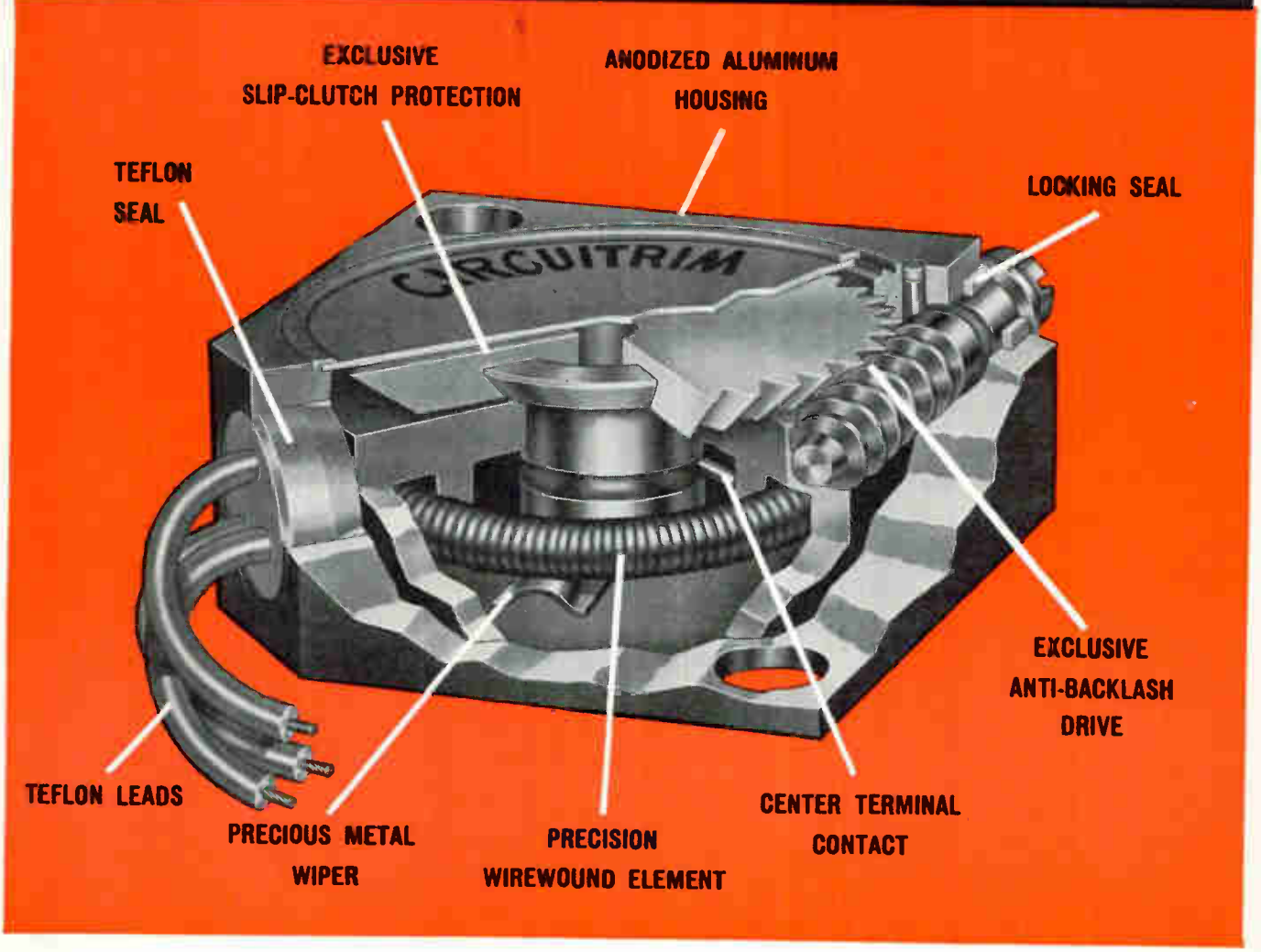
For circuits, instruments and systems . . . the Intermountain Branch of the Curtiss-Wright Electronics Division will utilize its highly developed solid state circuit design techniques to design and process Standard or High Density Miniaturized Solid State Printed Circuit Cards, comparable to the high quality units shown above. Proven reliable in operational Intermountain instruments and systems, these precision built Solid State printed circuit cards can be tailored to your specifications and requirements — meet exacting standards of quality, reliability and performance over a wide range of operating conditions. Write today for information or a quotation on your Solid State Printed Circuit requirements.

In PRECISION POTENTIOMETERS : if it's news, expect it first from IRC



EXPOSED... a reliable square trimmer design set it... forget it

Superior shock and vibration characteristics . . . made possible by an exclusive self-locking, anti-backlash gear. Once you set IRC's new ½" square Circuitrim, forget it. The square trimmer remains at its set position even under conditions as severe as MIL-E-5272A, Procedure 1 vibration and MIL Standard 202 Method 202 shock test.

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A NEW TRIMMER WITH INCREASED RELIABILITY ACHIEVED THROUGH SIMPLIFIED DESIGN.

Possesses the same quality electrical assembly as the ½" square Circuitrim. This unique design has eliminated the complex mechanical linkage used for adjustment, thereby giving a quality reliable trimmer for your highly competitive applications. 10 ohms to 50K ohms, 1 watt. ½" diameter.

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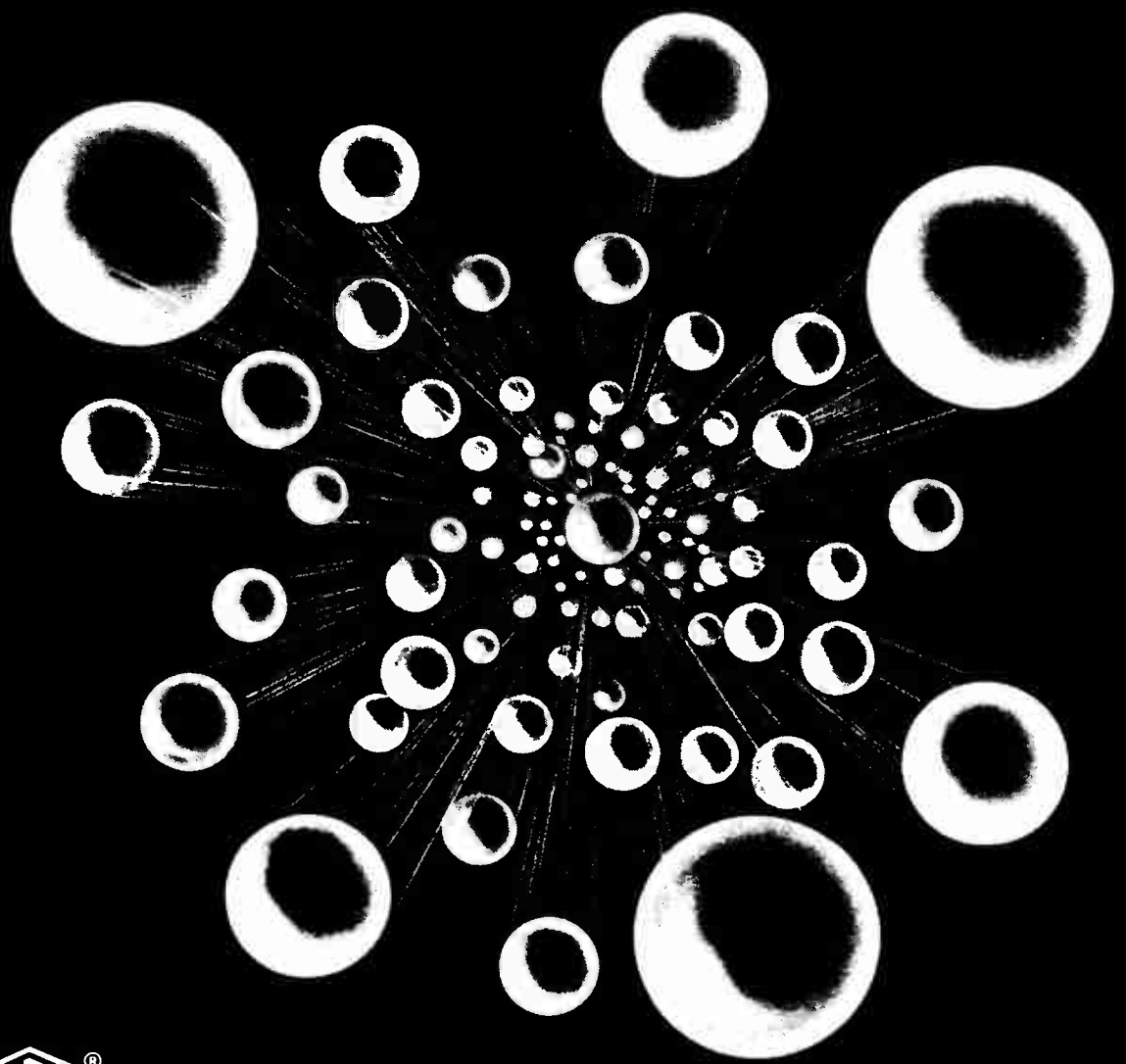

Universal Time, denoted A-1, was established by the United States Naval Observatory through the use of National's Atomichron.* National Company has applied the internal resonance of the cesium atom in producing a device which is the world's first truly primary standard of time and frequency.

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100 lbs.

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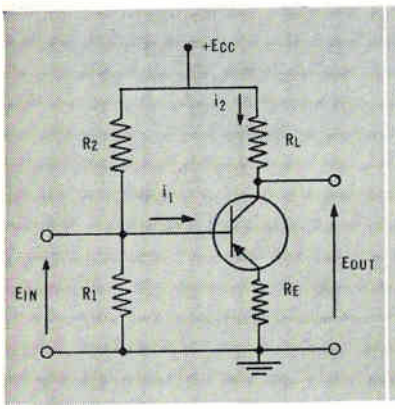
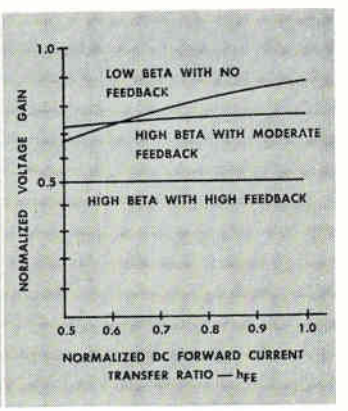
←CIRCLE 50 ON READER SERVICE CARD

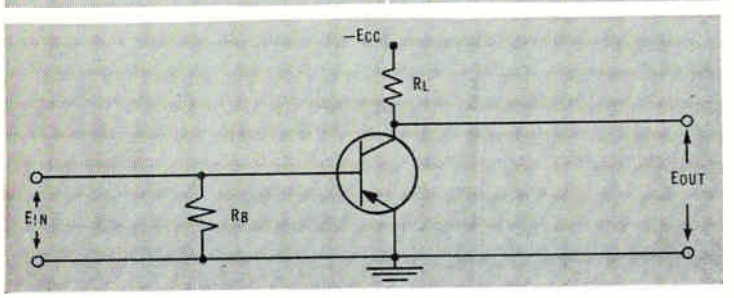
CIRCLE 51 ON READER SERVICE CARD

WHAT TI's 50-100h_{FE} @

IN AMPLIFIER CIRCUITS







In a common emitter amplifier, with emitter feedback, *high-beta* transistors offer the following advantages:

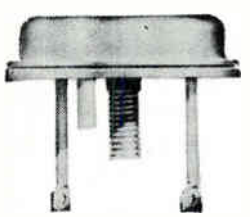
1. Comparing high and low beta transistors in an identical operating circuit with typical beta spreads of 2 to 1, the use of high-beta transistors provides reduced loading on the bias network thereby reducing the shift in the DC operating point.
2. The voltage gain of the circuit is: $A_v = -\frac{i_2 R_L}{E_{IN}}$
$$\cong + \frac{R_L}{\frac{r_b + r_e + R_E}{\beta} + r_e + R_E}$$
dependent on beta as beta is increased: $A_v \cong -\frac{R_L}{r_e + R_E}$.
3. The input impedance, R_{IN}, excluding the bias network is $R_{IN} = \frac{E_{IN}}{i_L} \cong r_b + (r_e + R_E)(1 + \beta)$. Thus, the input impedance is much higher if *high-beta* transistors are utilized.

IN SWITCHING CIRCUITS

Higher h_{FE} offers the following switching circuit advantages:

1. Less power required from the driver circuit. Eliminates one driver circuit stage or gives a much greater design margin.
2. Shorter rise time if high h_{FE} unit is substituted for low h_{FE} in identical circuits.

TEXAS INSTRUMENTS 2N1980



ACTUAL SIZE

Now get maximum circuit economy with Texas Instruments 2N1980 series *high-beta* germanium power transistors. Increased power gain gives you: fewer components for same circuit results; or equal components for better circuit results — either way, your circuits give increased performance at *less cost.*

With TI 2N1980, 2N1981, 2N1982 *high-beta* power transistors you get more power gain than any standard TO-36 device available today. You also get industry's lowest profile TO-36 package for more compact designs. TI's exclusive 2N1980 series manufacturing process assures you *constant — predictable — guaranteed* high beta performance.

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Send today for your personal copy of the new TI 2N1980 Application Note, "Circulation Stabilization Using High Beta Transistors."

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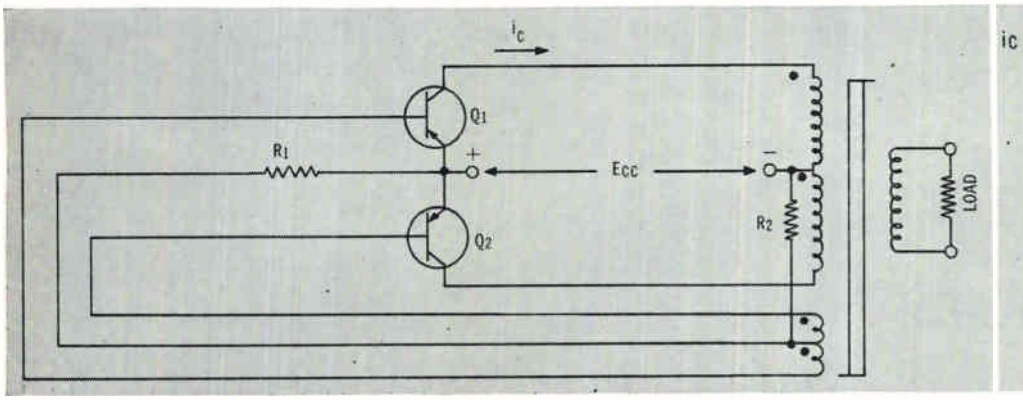
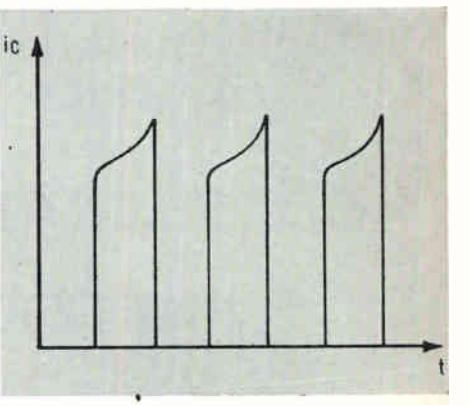
IN SQUARE CORE OSCILLATORS





The starting bias depends on the voltage divider R_1 and R_2. With a typical V_{BE} of 0.4 volts to start oscillations, appreciable power is lost in R_2 when R_1 is small. For low beta transistors R_1 must be small to provide enough feedback current to guarantee collector saturation. This results in high bias power loss in R_2. By using high-beta transistors, R_1 and R_2 may be increased in value — resulting in lower signal and bias power losses.

The peak collector current (shown in the above figure) in a square core oscillator can vary with a change of V_{BE}. For a given spread of transistors, V_{BE} can vary as much as 1.0 volt. High beta transistors may be used to reduce the effect of changes in V_{BE} on peak collector current. The maximum current spike for a given spread of transistors occurs in the highest beta units under conditions of peak base current.

Peak base current and peak collector current vary inversely with V_{BE}. Therefore, by using high-beta transistors, R_1 and the base winding voltage may be increased, minimizing the effects of V_{BB}.

GERMANIUM POWER SERIES

Immediate Circuit Improvement . . . with TI 2N1980 Series

	I_{CBO}	$V_{CE(sat)}$ @ 5 amp	h_{FE} @ 5 amp	BV_{CBO}	BV_{CEO}	I_C
2N1980	6 ma @ 50V	0.5V	50—100	50	30	15A
2N1981	6 ma @ 70V	0.5V	50—100	70	40	15A
2N1982	6 ma @ 90V	0.5V	50—100	90	50	15A

TEXAS INSTRUMENTS
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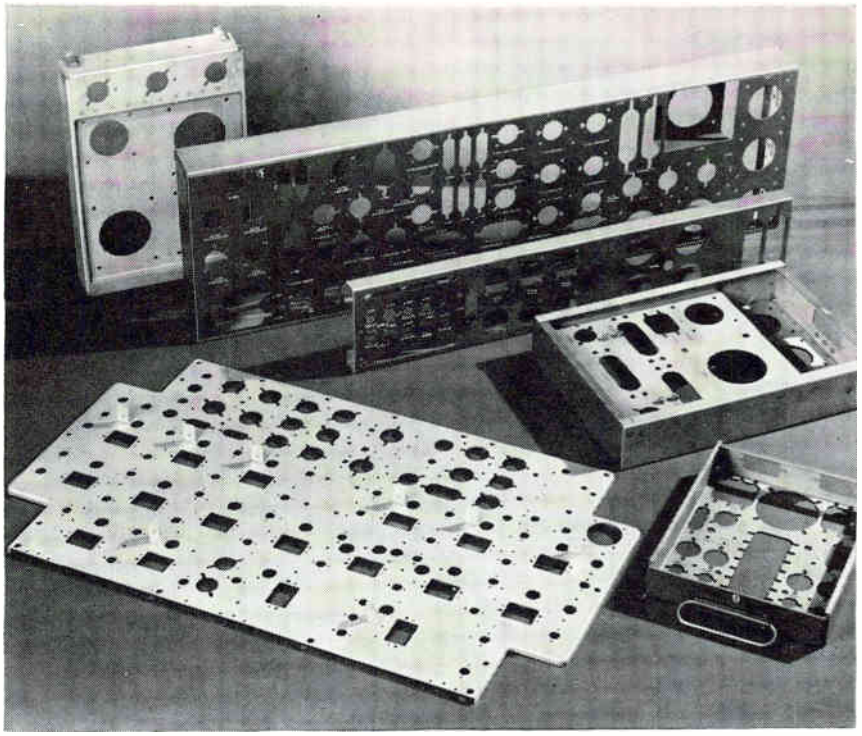
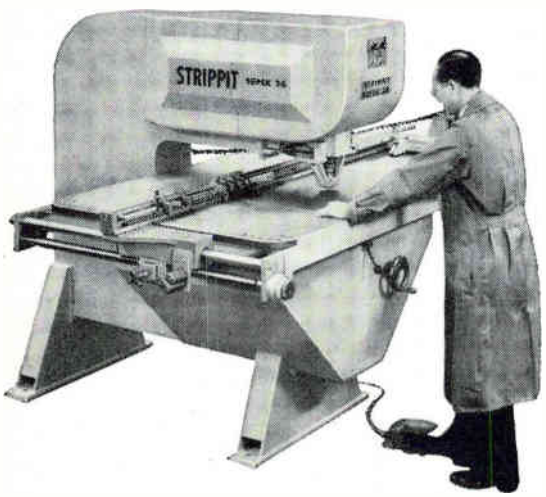
CIRCLE 53 ON READER SERVICE CARD

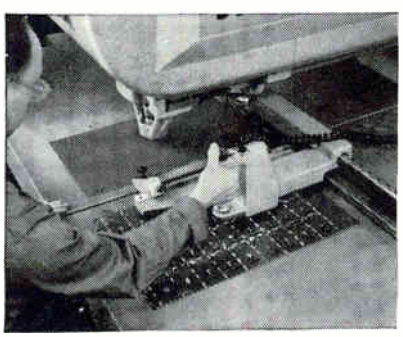


PUNCH COMPLICATED PATTERNS FAST WITH STRIPPIT FABRICATORS



SUPER 30. Handles flat or formed workpieces 60" wide...any length. Both the Super 30 and the 15A punch round and shaped holes up to 3½" diameter, to ¼" thick material...notch 90° corners—rectangular, radii, vee and special shape edge notches —up to ⅛" capacity...nibble straight line or contour shear up to 38" diameter circle, at 165 strokes a minute in ⅛" material.

STRIPPIT DUPLICATOR
For low cost production runs on the Super 30 or 15A, the STRIPPIT Duplicator functions like a pantograph to reproduce any hole pattern from a drilled or punched template. No custom dies needed to turn out precision sheet metal parts.



NEW 15A. Designed for workpieces up to 30" wide...any length...the new 15A Fabricator offers all the speed and accuracy of the Super 30. Each machine, with its own universal tool holder, makes it possible to interchange standard and special tools in seconds to minimize down-time. Flat punched parts produced require no deburring. Multi-stop micrometric gaging system positions work rapidly to exact layout specifications.

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825 SERIES ACTUAL SIZE

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TEMPERATURE CHARACTERISTIC		CAPACITANCE RANGE (MMF)	
CRL	MIL LETTER	CRL	MIL NUMBER
NP0	A	1.5-7	070
N300	B	3-12	120
N500	C	3-13	130
N650	D	5-20	200
		4.5-25	250
		4-30	300
		7-45	450

MICRO-MINIATURE ACTUAL SIZE

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

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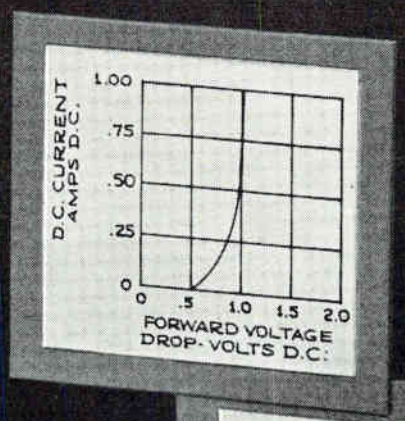

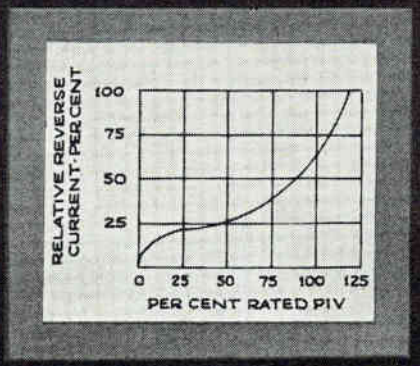

Tarzian Type	Amps. DC	PIV	Max. RMS Volts	Max. Amps. Recurrent Peak	Max. Amps. Surge (4MS)
2F4	.20	400	260	2.0	20
F-2	.75	200	140	7.5	75
F-4	.75	400	280	7.5	75
F-6	.75	600	420	7.5	75

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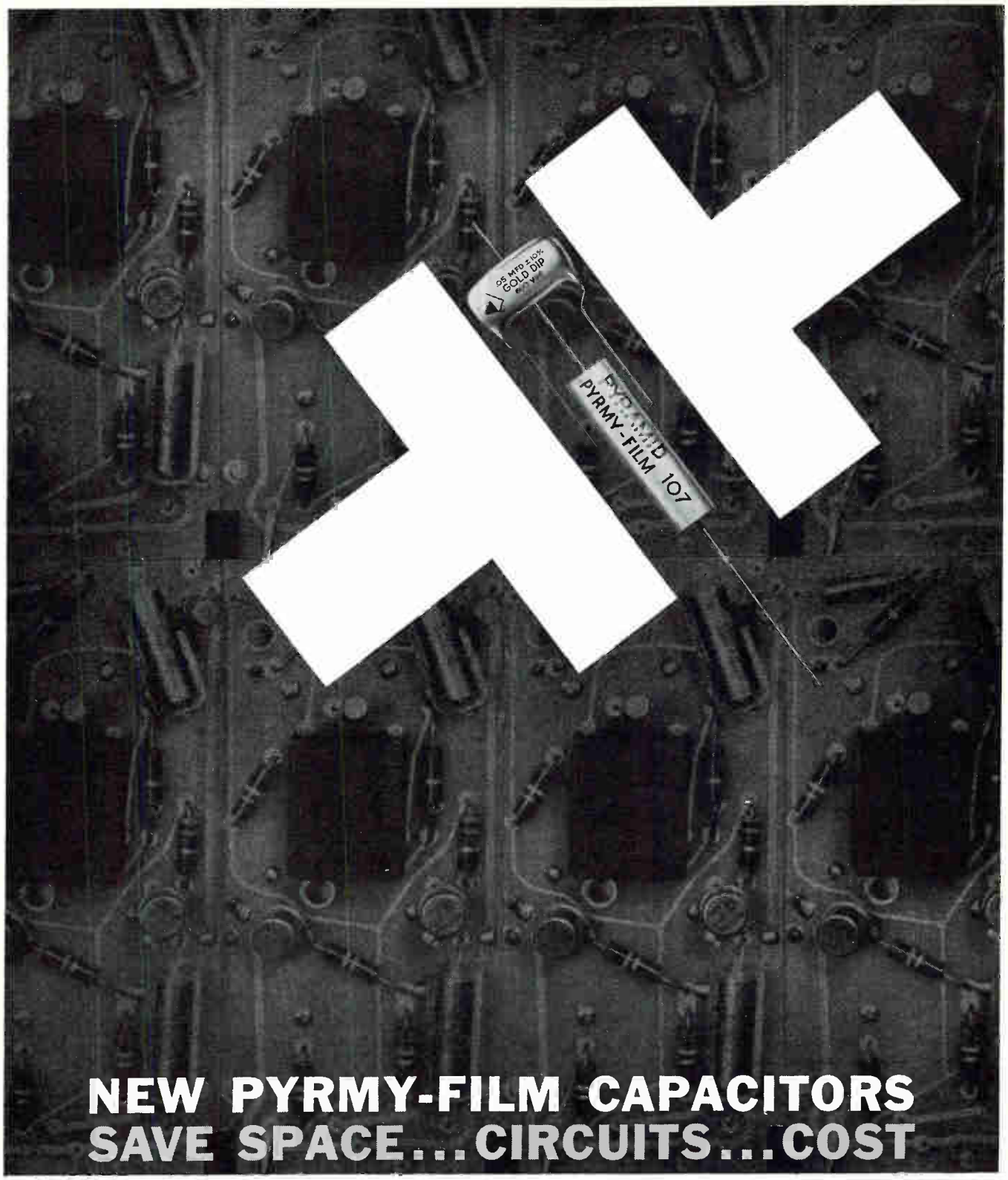

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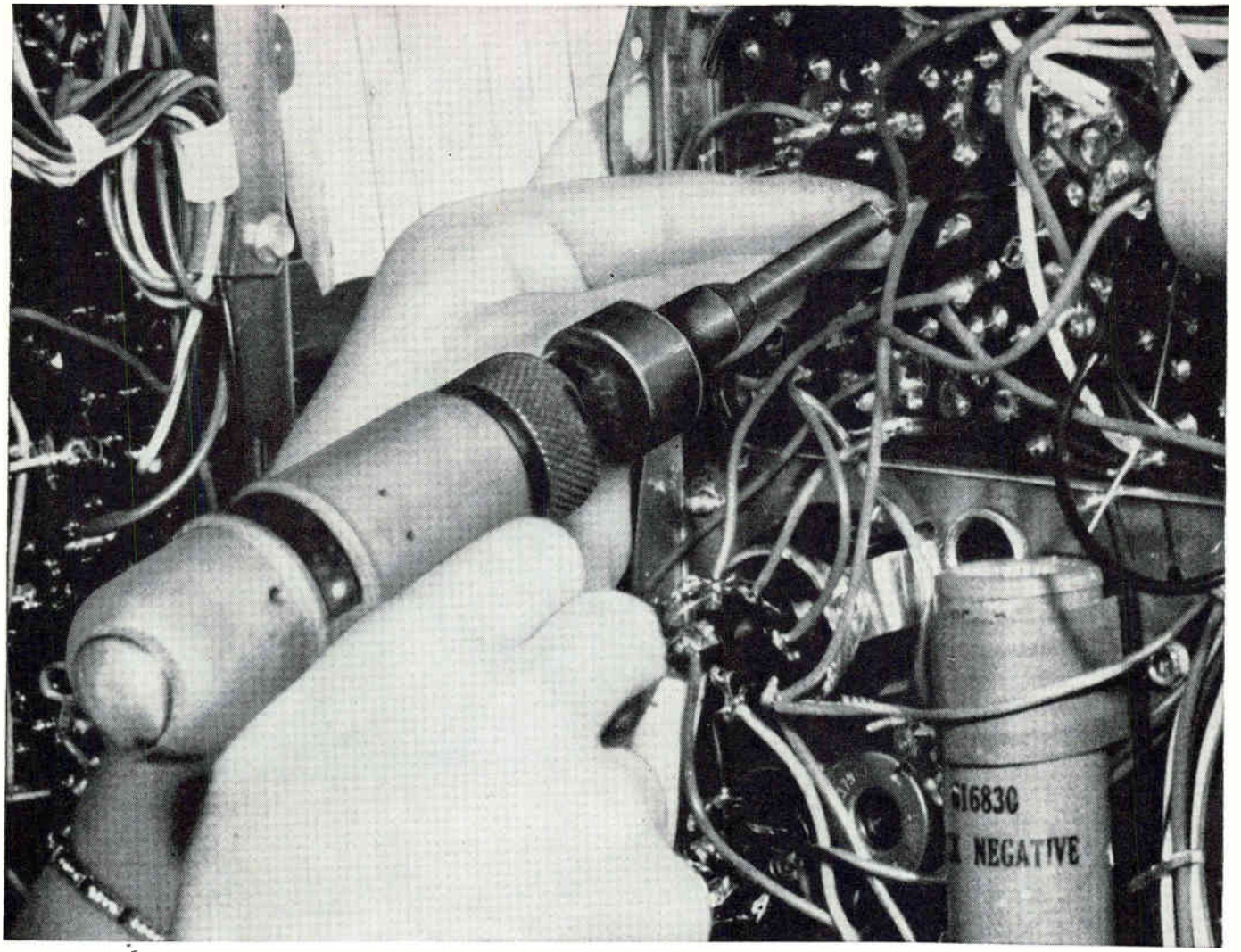

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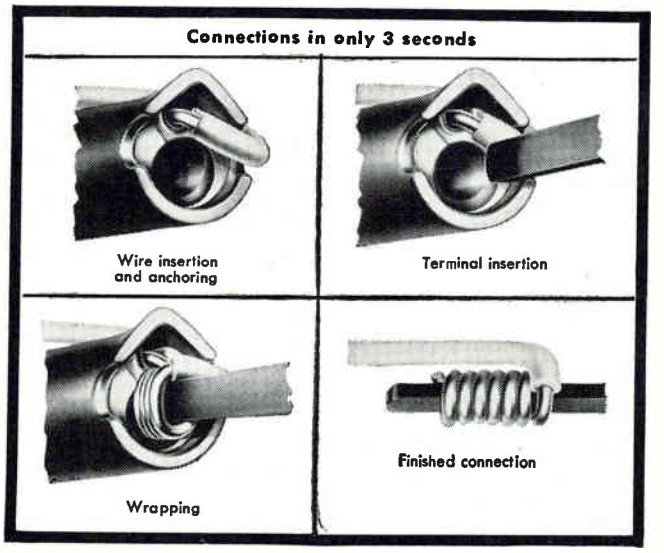

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Power Consumption is less than 17 Watts for 2 Watts Output.

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

Model TR-20–225-260 mc.

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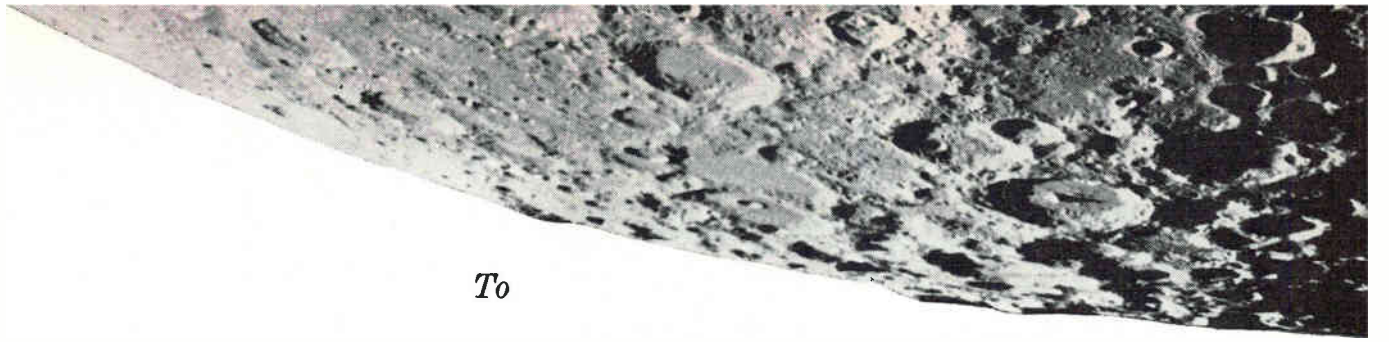


To

pinpoint

a NASA

payload

on

the

moon...

requires

Motorola

systems

reliability

CALTECH'S JPL RANGER, to carry research instrument packages to the moon, will rely upon precision design, construction, testing and performance of Motorola electronic equipment. Comprehensive measurements of operational and navigational data aboard will be assembled for transmission by its Flight Data Encoder. An all solid state Transponder generates the telemetry carrier, receives ground commands, and translates carrier frequencies for two-way Doppler velocity measurements. ☆ In laboratories and at launch site, Payload Test Sets will check out the spacecraft RF communications system. At NASA's transmitter and receiver sites, Calibration Beacons will check command transmitter performance and radiate precise signals to test telemetry receivers. ☆ Motorola's participation in Ranger lunar probes demonstrates its space communications capabilities for frontier programs.

Military Electronics Division **MOTOROLA**

Qualified technical personnel are invited to apply

CHICAGO 51, Illinois, 1450 North Cicero Avenue
SCOTTSDALE, Arizona, 8201 East McDowell Road
RIVERSIDE, California, 8330 Indiana Avenue

CIRCLE 64 ON READER SERVICE CARD

a new concept in ***compactness***

SANGAMO 460-SERIES MAGNETIC TAPE INSTRUMENTATION

The Sangamo 460-Series is not just another tape transport, but a magnetic tape recorder/reproducer so compact that it can contain a complete 14 track record-reproduce system in one standard 19″ w. x 71″ h. cabinet. All its read, write, speed control, and power supply circuits are transistorized and grouped into modules on individual, plug-in circuit boards. It is designed for reel-to-reel or loop operation in direct analog, FM, PDM, and PCM modes.

In the 460-Series transport, record and reproduce circuit boards are located directly above the control panel at eye level to permit easy access for signal level adjustment and monitoring without interfering with system operation. All DC power for the transport and record-reproduce electronics is provided by a modular sub-assembly mounted at the bottom of the cabinet. The complete power supply is mounted on drawer slides.

- Magnetic tape instrumentation system accuracies heretofore considered unattainable have been achieved by Sangamo as a result of reduced instantaneous and long-term record-playback speed deviations. The 460-Series Recorder/Reproducer accomplishes this by combining a very low inertia DC capstan drive with a high-response, tape-speed, servo control system.

- A unique vacuum tension/cleaning pad located immediately in front of the recording or reproducing head provides gentle, but firm and precise, tape tension. The head in turn is mounted almost in contact with the drive capstan. This arrangement results in a very short span of tape that requires controlled positioning. The combination of these features results in minimum skew, less flutter, and fewer dropouts.

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

SANGAMO 460-SERIES PERFORMANCE and CHARACTERISTICS

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

Stop Time: 0.2 seconds from 60 ips.

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

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

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

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

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

Tape Widths: Standard sizes from ¼ to 2″.

Reel Sizes: 14″ or smaller.

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

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

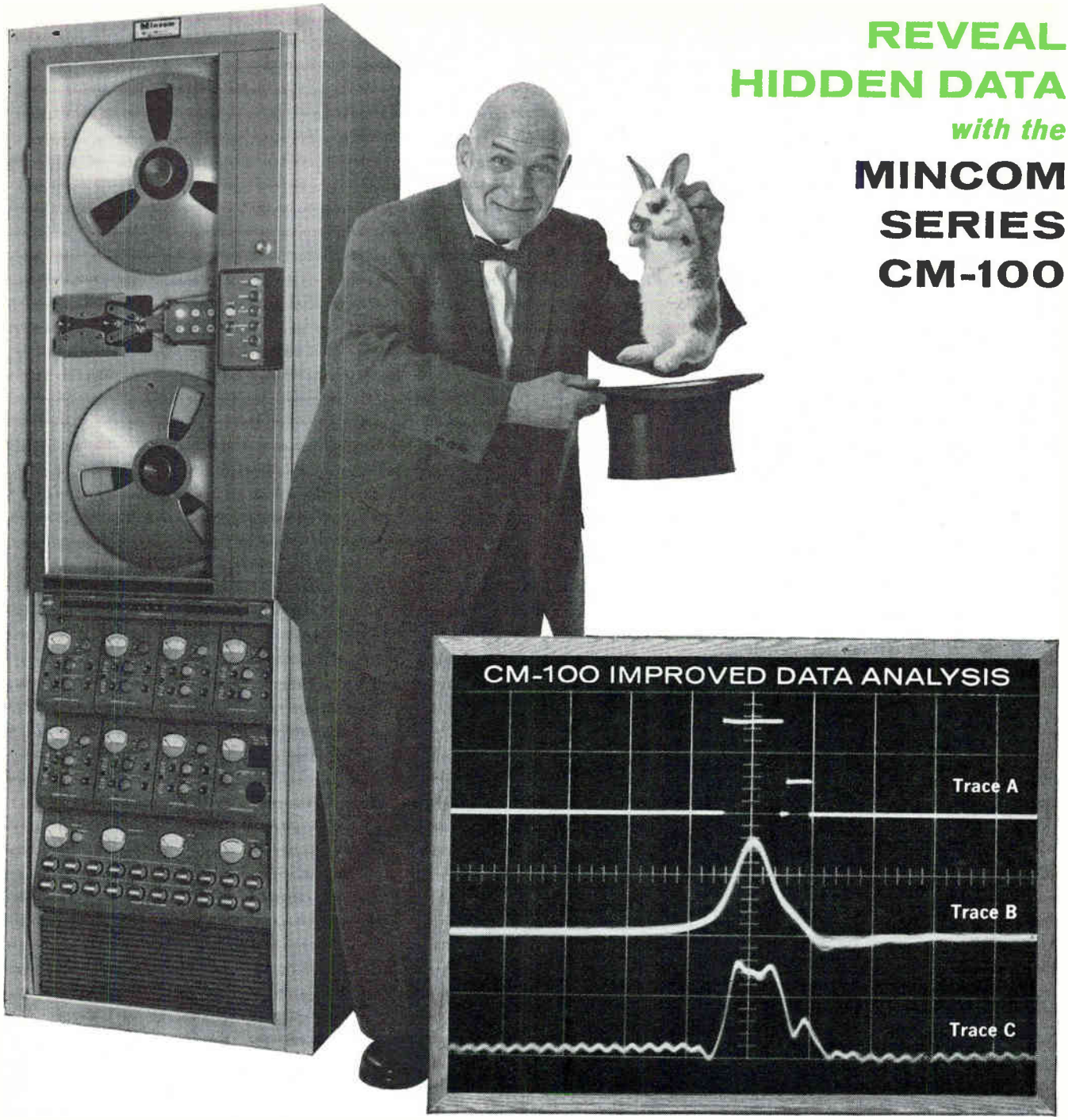
Weight: Approximately 500 pounds for 14 track system.

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

ES61-3

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



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

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

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

MINCOM DIVISION MINNESOTA MINING AND MANUFACTURING COMPANY

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Rx how to cure traveling wave tube headaches

If you have TWT headaches—finding a microwave amplifier *now*—which produces high gain and wide bandwidth *with* high average and peak powers—Hughes may have just the prescription for you. Hughes TWT's provide all these desirable features with built-in long life, ruggedness and dependability. They fully exploit the advantages of permanent magnet periodic focusing in both glass and metal-ceramic structures, and many are available in either gridded or ungridded versions.

CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
MICROWAVE TUBE DIVISION

typical twt's available now:

311H 2.0-4.0 KMC Gridded 1 KW minimum peak power output, 1% duty, 36db small signal gain @ 50 mw input. Weight 13 lbs. Length 17-7/16".

312H 2.0-4.0 KMC Gridded 1 KW minimum peak power output, 1/2% duty, 36db small signal gain @ 50 mw input. Weight: 11 lbs. Length: 15-3/8".

304H 2.0-4.0 KMC Ungridded, 1 KW minimum peak power output, 1% duty, 37db small signal gain @ 1 mw input. Weight: 12-1/2 lbs. Length: 17-31/32".

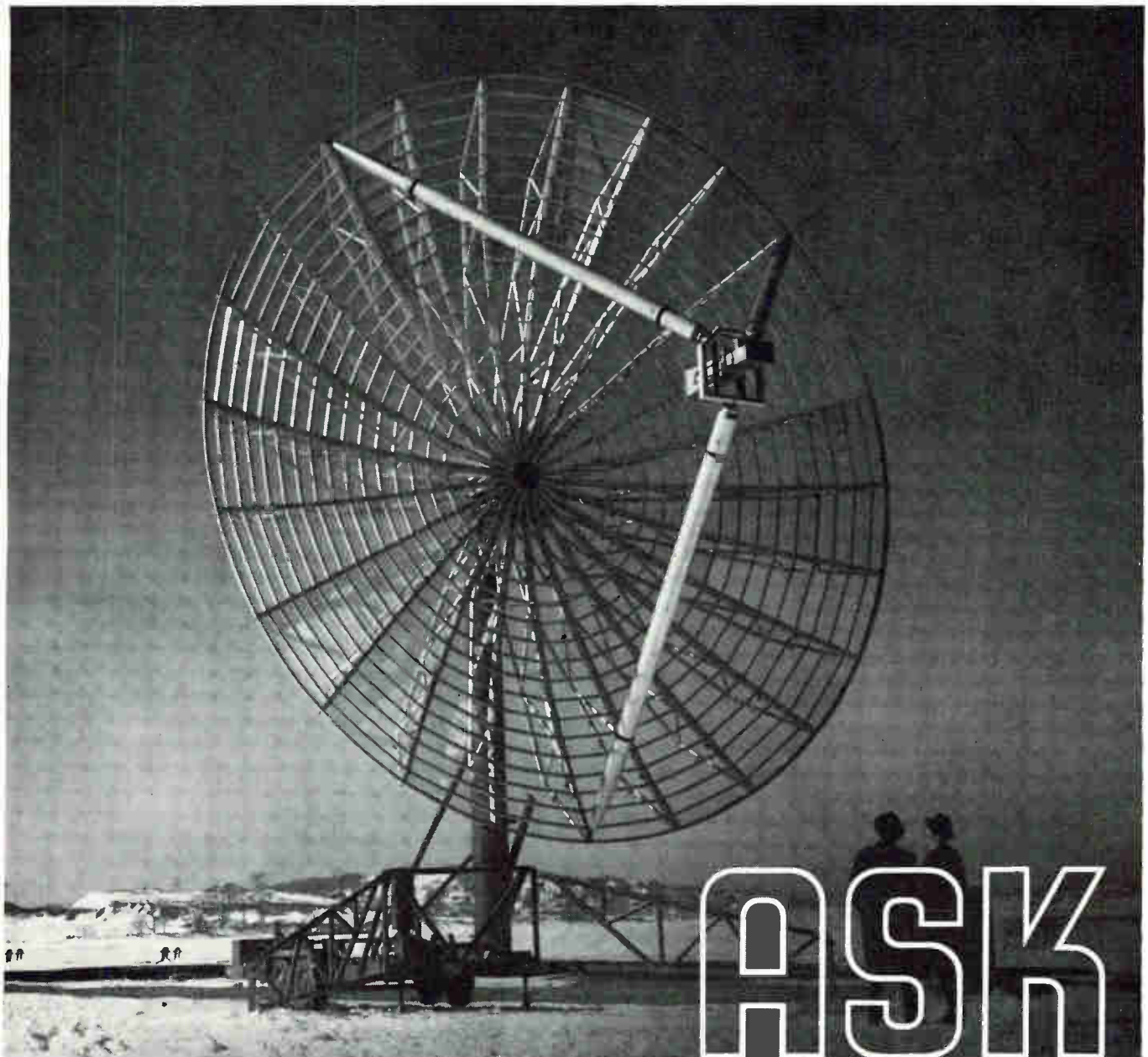
307H 8.5-9.5 KMC 50 KW minimum peak power output (500 watt average), metal-ceramic construction, 54db saturation gain, 1% maximum duty cycle, beam voltage = 38 kv. Wt. 21 lbs. Length: 24".

Hughes also has a complete line of K_u-band backward-wave oscillators for commercial and military applications.
Write or telephone today for full information or a catalogue concerning the broad line of Hughes TWT's available in L, S, C & X bands.
Hughes Microwave Tube Division, P. O. Box 90427, Los Angeles 45, California.

The antenna completely packed and ready for transit.

The antenna assembled but not erected.

The antenna partially erected.



ASK ASI!

30-foot MOBILE ANTENNA offers the solution to tactical communication problems . . . This is the new Model 111 — a 30′ mobile scatter antenna by Antenna Systems, Inc. designed for tactical applications in scatter links.

In transit, this lightweight, self-contained unit, complete with 30′ mesh reflector, torque tube support, and all associated hardware nests snugly and securely on a steel flat bed trailer. On location, the antenna can be rapidly assembled. A winch or a hydraulic lifting device, mounted on the trailer, provides for quick erection into operating position.

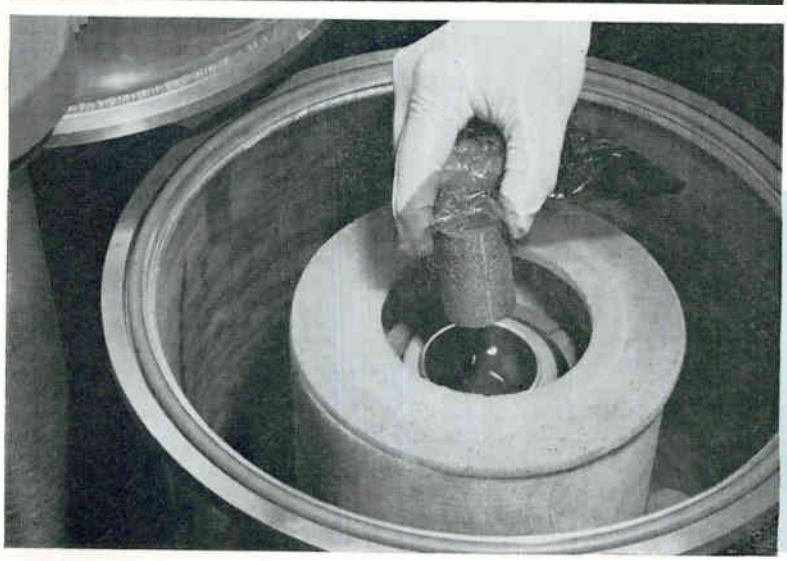
ASI is fully capable of modifying this mobile and versatile package to meet individual requirements . . . to support smaller or larger antennas or pedestals for el-az tracking. For full information, write:

ANTENNA SYSTEMS INC.
HINGHAM, MASSACHUSETTS

FOR ANSWERS TO PROBLEMS IN THE DESIGN, FABRICATION AND INSTALLATION OF ANTENNA SYSTEMS, ASK ASI!

The Untouchables (Part 4)

Specify Crucible Charges of Deposited Hyper-Pure Silicon



Pre-packaged single piece crucible charges . . . in sizes and weights to meet the exact requirements of your Czochralski crystal growing equipment . . . are now available from Dow Corning.

Accurately Pre-weighed, these single piece crucible charges assure easy handling . . . smallest surface area . . . highest purity . . . an exceptionally clean melt and a savings in crucible costs.

High Quality is inherent in Dow Corning crucible charges. The *deposited* polycrystalline silicon in these charges has never touched a mold. Result — highest purity.

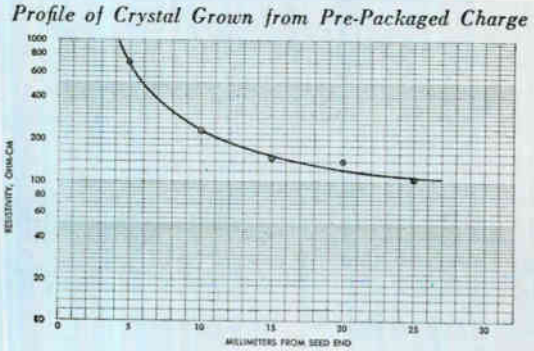
This High Purity means consistently higher quality crystals — simplifies doping procedures — increases device yield. Typical resistivity of N-type crystals grown from Dow Corning prepackaged crucible charges is greater than 100-ohms centimeter for 80% of the crystal; maximum boron content, 0.3 parts per billion atoms; maximum donor impurity, 2.0 parts per billion.

Now You Specify the Weight and Diameter, up to 38 mm (about 1½″), best suited for each crucible of your Czochralski crystal growing machines. Your crucible charges will be supplied in the appropriate length to provide the exact weight you require in just one piece.

Protective Packaging guards initial *deposited* purity right through crucible charging. Charges are individually wrapped in special cellophane, and sealed in airtight polyethylene envelopes to assure untouchable purity.

Whatever your need — deposited silicon crucible charges; polycrystalline rod or chunk; high resistivity P-type single crystal rod; single crystal rod doped to your specifications — Dow Corning should lead your list of sources.

Profile of Crystal Grown from Pre-Packaged Charge



Free brochure — "Hyper-Pure Silicon for Semiconductor Devices." Write Dept. 3517.

HYPER-PURE SILICON DIVISION
Address: HEMLOCK, MICHIGAN

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CIRCLE 71 ON READER SERVICE CARD →
CIRCLE 69 ON READER SERVICE CARD 69

Sonobuoy picks up ocean's noises—
including the sound of
marine life, waves and surface
ships—which may mask
the signal of a distant sub

In ASW aircraft, new signal processing equipment will extract sub's signal out of the noise

Sifting sounds from the sea

Lockheed Electronics signal processing equipment to aid airborne sub-hunters

Detecting sound from a distant submarine out of the noise of the sea is as tough as hearing a bumblebee above the roar of a jet engine. The sub can lurk within range of a listening sonobuoy, yet still not be discovered by the ASW aircraft. The general noise level of the restless sea – the motion of waves, the rumble of ships or the squeal of porpoises, for instance – may mask the faint target signal.

To lift the target signal out of the noise, Lockheed Electronics is developing airborne detection and locating equipment utilizing advanced signal processing techniques. These techniques hinge on modern information theory and noise theory–disciplines employed in optimizing the design of filters, detectors, time integrators and computers to gain improved signal-to-noise ratios.

Lockheed Aircraft, LEC's parent company, has a notable record of achievement in ASW systems. These capabilities are now augmented by the talents of Lockheed Electronics, applied to underseas warfare components and systems.

MINDING THE FUTURE

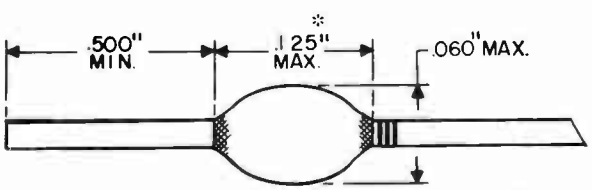
LOCKHEED ELECTRONICS COMPANY

Plainfield, New Jersey

A MAJOR BREAKTHROUGH – ALL-GLASS MICROMINIATURE COMPUTER DIODES FOR NANOSECOND SWITCHING.

HIGHEST RELIABILITY • LOWEST LEAKAGE • HERMETIC SEAL

micro glass silicon mesa computer diodes provide optimum miniaturization and highest reliability. Direct fusion of hard-glass to junction, and use of bonded contacts produces mechanically rugged diodes with exceptionally stable electrical characteristics. Excellent reverse current characteristics are combined with switching speeds of typically 2 nanoseconds. Higher allowable junction temperature of 200°C — true hermetic seal (kovar to hard-glass) — and solid mass-of-glass construction, recommend these diodes for all military-severe applications.



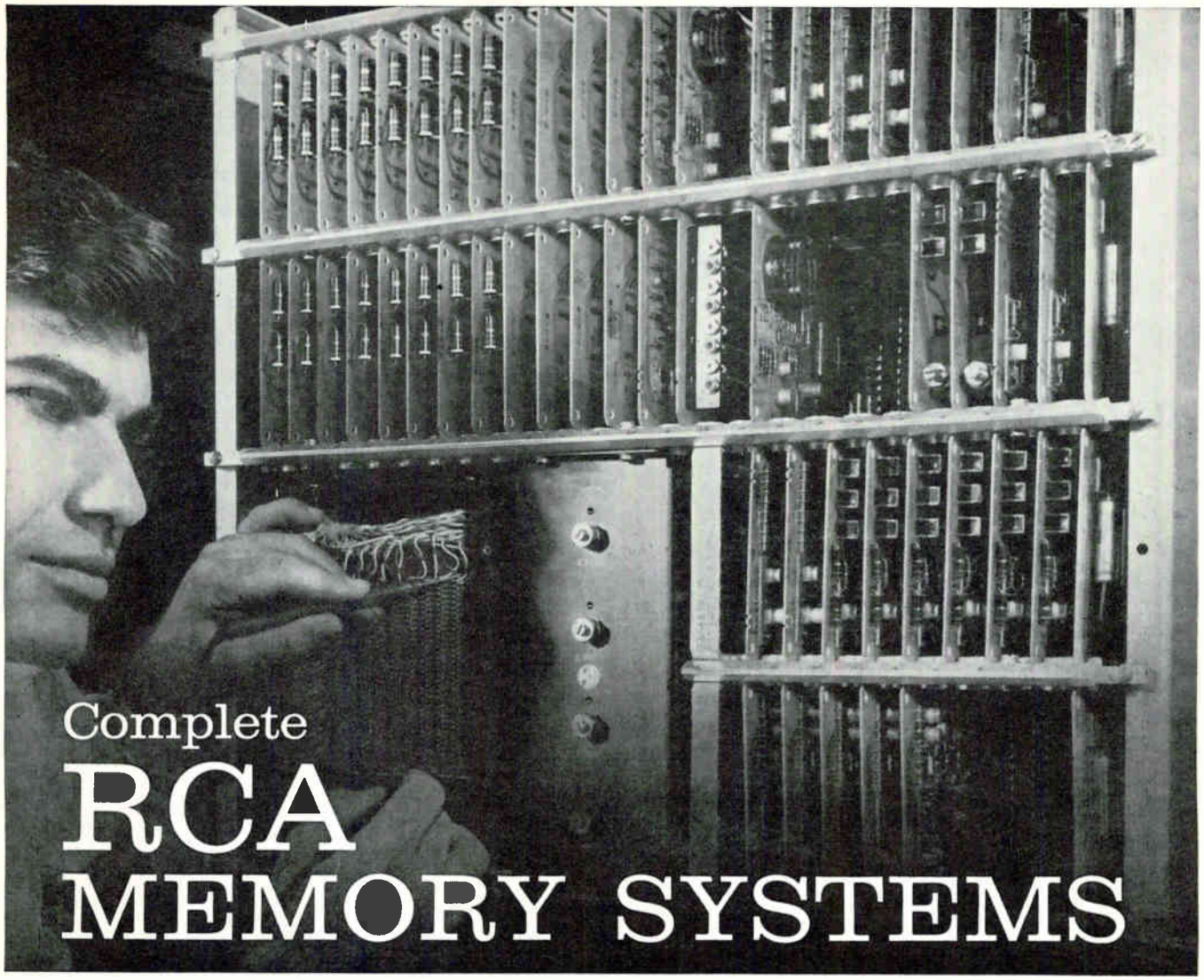
*Available also in .090" with slightly less power dissipation.

ALL *micro glass* DIODES MEET ENVIRONMENTAL REQUIREMENTS OF MIL-S 19500B

TYPE	FORWARD CURRENT @ 1 V DC (mA)	BREAKDOWN VOLTAGE @100μA (volts)	CAPACITANCE (max.) (μμf)	REVERSE CURRENT (μA) 25°C	REVERSE CURRENT (μA) 150°C	REVERSE RECOVERY max. (nanosec.)	POWER DISSIPATION (mW)
MA-4303	10.0	50.0	1.5 @ — 6v	.025 @ — 40v	25.0 @ — 40v	4.0	125
MA-4304	10.0	50.0	1.5 @ — 6v	.025 @ — 40v	25.0 @ — 40v	4.0	200
MA-4305	10.0	50.0	1.5 @ — 6v	.025 @ — 20v	25.0 @ — 20v	4.0	125
MA-4306	10.0	50.0	1.5 @ — 6v	.025 @ — 20v	25.0 @ — 20v	4.0	200
MA-4307	30.0	100.0	2.0 @ 0v	.050 @ — 75v	50.0 @ — 75v	4.0	125
MA-4308	30.0	100.0	2.0 @ 0v	.050 @ — 75v	50.0 @ — 75v	4.0	200

MICROWAVE ASSOCIATES, INC.
SEMICONDUCTOR DIVISION
Burlington, Massachusetts, BRowning 2-3000
Western Union FAX • TWX Burlington, Mass. 942

EXPORT SALES: MICROWAVE INTERNATIONAL CORP., 36 W. 44TH ST., N.Y.C., N.Y., U.S.A. CABLE: MICROKEN



with specified extra wide safety margins

Standard or custom systems, incorporating RCA ferrite and semiconductor devices, are designed, built, and tested by memory-circuit specialists—at RCA's newly expanded memory products operation in Needham, Mass.

Here is the new answer to memory-system design and production, offering new latitude to the computer engineer, new solutions to your system production problems—complete RCA Memory Systems. Designed and produced by RCA from ferrite cores to entire packaged systems, these precision units are pre-tested to broad operating limits and are delivered ready for immediate use in computer designs.

Here are some of the outstanding features of complete RCA Memory Systems:

- **Specified Wider Margins of Operations** ...Up to 8 percent...to cope with broad variations in power levels.
- **Custom Design Service...** RCA's engineering staff will custom-design a memory system to your specifications.
- **Superior Reliability...** Components and circuits proved by the long, dependable service of over 100 systems now in use.
- **Complete Information Retention...** even in case of full power loss.
- **Wide Temperature Range...** 0°C to 50°C.

For Systems Engineering Service—Call your RCA Office. *For technical information* write RCA Semiconductor and Materials Division, Commercial Engineering, Section E-19-NN-3, Somerville, N. J.

RECENT RCA MEMORY SYSTEM SHIPMENT	
Capacity	4096 words, 18 bits per word.
Speed	Complete Read-Write cycle time of 5 usec.
Modes of Operation	Read-Regenerate/Read-Modify/Write-Only.
Reliability	Acceptance tests made with all power supply voltages varied both plus and minus 5 percent from their nominal values while the system is being temperature cycled.

STANDARD RCA MEMORY SYSTEMS	
Capacity	512 to 4096 words; 6 to 32 bits per word.
Speed	Complete Read-Write cycles times 5 to 12 usec.
Modes of Operation	Read-Regenerate/Read-Modify/Write-Only.
Reliability	Acceptance tests made with all power supply voltages varied both plus and minus 8 percent from their nominal values while the system is being temperature cycled.

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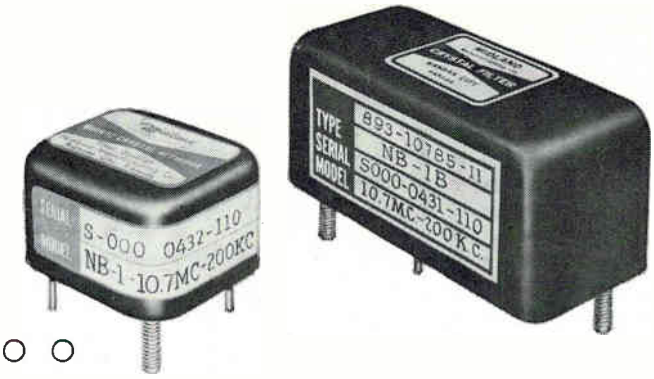
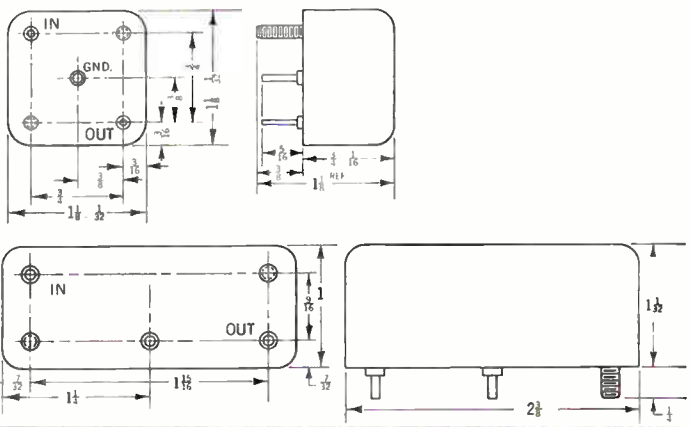


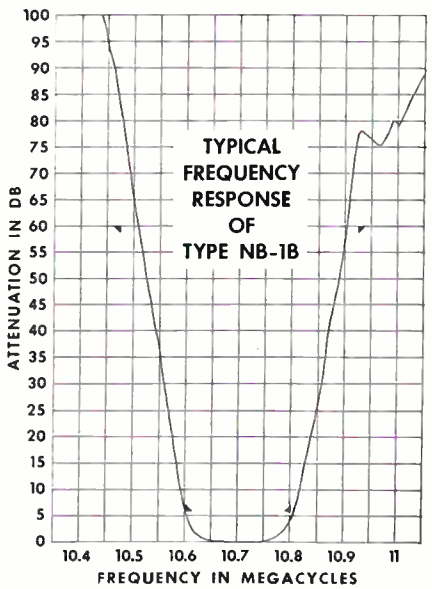
Now...

stability and reliability are realized in practical large percentage bandwidth crystal filters

With Midland type NB Miniature 1.8% wide band pass 10.7 MC crystal filters

The Types NB-1 and NB-1B are four-crystal networks contained in a hermetically sealed package with a volume less than 1 cu. in. and 2.5 cu. in. respectively. The center frequency of both types is 10.7 MC ± 3KC with a 6db bandwidth of 200KC + 10KC, — 0 KC and an ultimate minimum rejection of 100db. Singly used they exhibit a maximum 60db/6db bandwidth ratio of 2.25:1. Because they are small in size, two of the same type can be used in cascade with an active network between filters to produce an 80db/6db bandwidth ratio of better than 1.7:1, with an ultimate rejection of over 120db. Small quantities for engineering evaluation are available *immediately* from stock. Midland invites consultation at any time for potential crystal filter users.





CRYSTAL FILTER SPECIFICATIONS

	TYPE NB-1	TYPE NB-1B
Center Frequency	10.7MC ± 3KC	10.7MC ± 3KC
Bandwidth @ 6db	200KC + 10KC, — 0 KC	200KC + 10KC, — 0 KC
Bandwidth @ 60db	450KC Max.	450KC Max.
Bandwidth Ratio	2.25:1 Max.	2.25:1 Max.
Ultimate Rejection	90db Min.	100db Min.
Insertion Loss	12db Max.	*8db Max.
Required Source/Load Resistance	50 ohms ± 5%	50 ohms ± 5%
Inband Ripple	1db Max.	*1.5db Max.
Inband Ripple at Temperature Extremes	1.5db Max.	*2.0db Max.
Operating Temperature	—55° C to +90° C	—55° C to +90° C
Shock	100 g	100 g
Vibration	15 g to 2KC	15 g to 2KC

*The Type NB-1B can also be provided with an insertion loss of 12db max.; inband ripple of .5db max.; and inband ripple at temperature extremes of 1db max. When ordering, specify required insertion loss and ripple.

Midland

MANUFACTURING COMPANY, Kansas City 15, Kansas
WORLD'S LARGEST PRODUCERS OF QUARTZ CRYSTALS
DIVISION, PACIFIC INDUSTRIES, INCORPORATED

MID 2-61

get the size, specs and mobility you need with

SANBORN RECORDERS

2 Channels . . . 35" high mobile cart . . . choice of 4 plug-in preamps

Interchangeable plug-in "850" type preamplifiers in Carrier, DC Coupling, Phase Sensitive Demodulator and Low Level types, for inputs ranging from microvolts to hundreds of volts . . . internal MOPA available when carrier or chopper excitation is required . . . heated stylus, rectangular coordinate recording on 50 mm wide channels . . . transistorized circuits . . . frequency response to 125 cps within 3 db, at 10 mm peak-to-peak. Model 297 can also be used in optional portable case or rack mounted in 10½" of panel space.

Two 50 mm wide channels . . . separate floating input DC amplifiers. . . . 4 chart speeds . . . mv or volt inputs

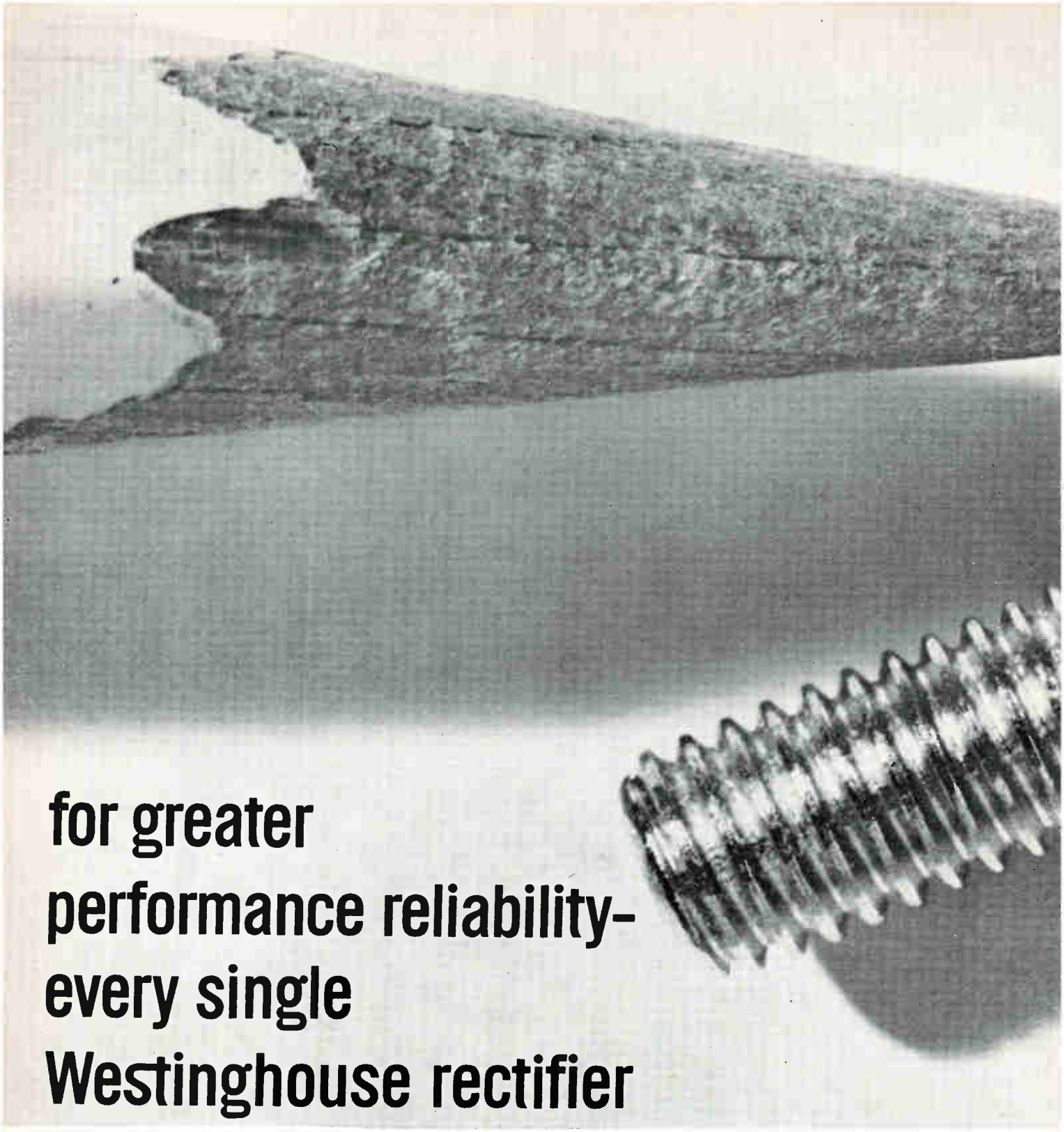
Operate this 1-cubic-foot recorder vertically, horizontally, or tilted at a 20° angle on carrying handle. Inputs are floating and guarded . . . 12 sensitivities from 0.5 mv/mm to 20 v/cm . . . response DC to 125 cps within 3 db, at 10 div peak-to-peak . . . max. nonlinearity 0.25 mm . . . common mode rejection 140 db min. DC . . . built-in 10 mv calibration signal and electrical limiting . . . internal 1 sec. timer . . . monitor output connectors for each channel. Galvanometers are rugged, low impedance type with velocity feedback damping; most circuitry for each channel is mounted on a single, easily serviced card.

1 Channel . . . 20 lbs., briefcase size . . . 10 mv/div DC Model . . . 10 uv rms/div AC strain gage Model

Extremely compact, highly versatile recorders for general purpose DC inputs (Model 299) and AC strain gage recording (Model 301). Two chart speeds: 5 and 50 mm/sec . . . inkless, rectangular coordinate recording . . . response from DC to 100 cps within 3 db, at 10 div peak-to-peak . . . gain stability better than 1% to 50°C and for line voltage variation from 103 to 127 volts. Model 299 has balanced to ground input, 10 switch-selected sensitivities, calibrated zero suppression. Model 301 has wide sensitivity ranges, can be used with strain gages and inductive transducers, provides excitation voltage of approximately 4.5 volts rms at 2400 cps, and has uncalibrated zero suppression.

For complete details contact your nearest Sanborn Sales-Engineering representative. Sales representatives are located in major cities throughout the United States, Canada and foreign countries.

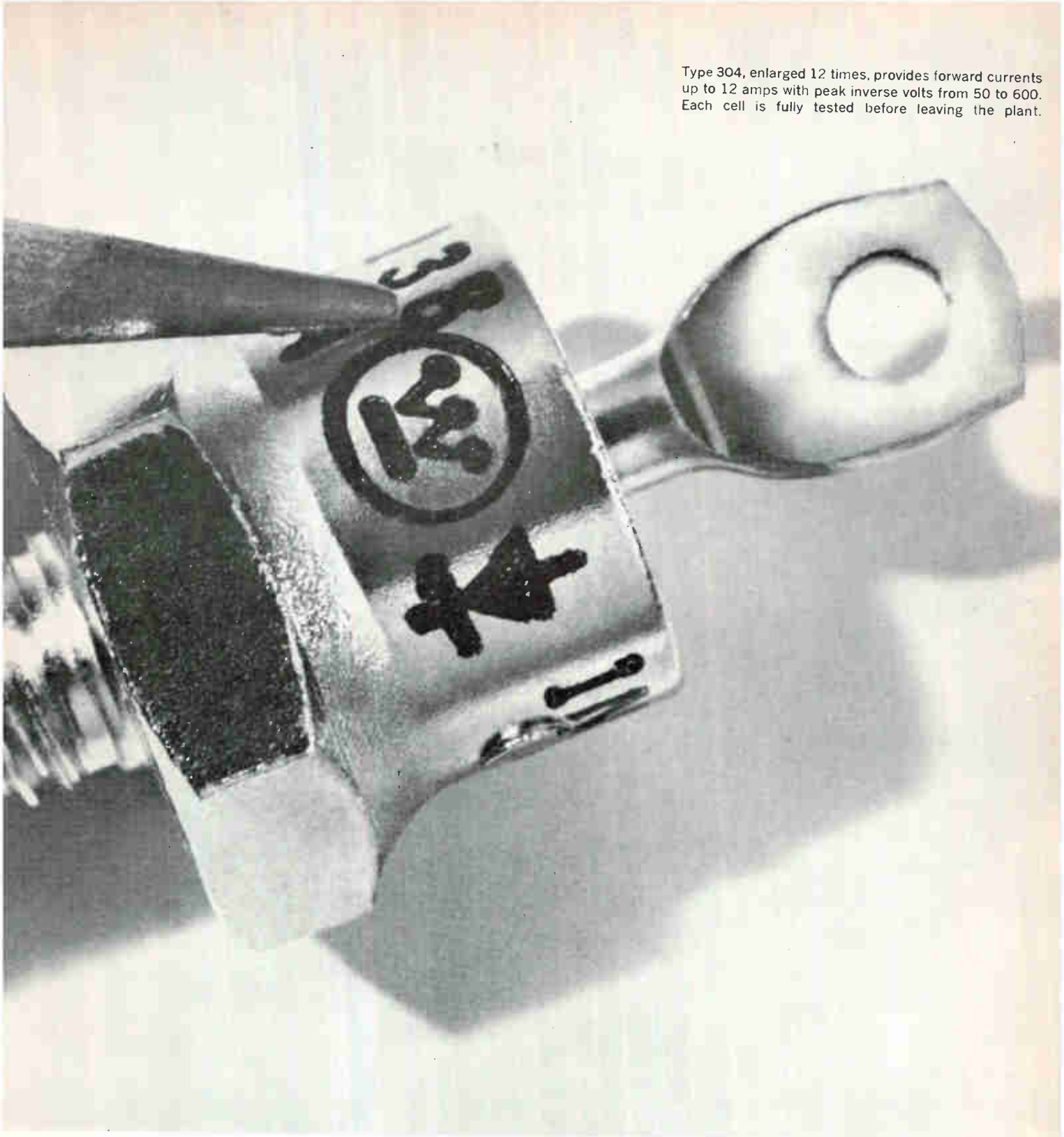
SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts



for greater performance reliability- every single Westinghouse rectifier is 100% power tested

Test proved—100% power testing means each Westinghouse Silicon Rectifier Cell is completely tested before leaving the plant. Tests are conducted with the rectifier running hot—as it would under actual service. Then peak overload current is applied—followed immediately by full-rated reverse voltage. This kind of full-power testing, under the worst combination of current, voltage, and temperature—exclusive with Westinghouse—is your assurance of the highest reliability.

Performance proved—In high voltage stacks Westinghouse rectifier cells have given more than 20 million stack-hours of failure-free operation. Proof the pay-off from 100% power testing is unprecedented reliability.



Type 304, enlarged 12 times, provides forward currents up to 12 amps with peak inverse volts from 50 to 600. Each cell is fully tested before leaving the plant.

Complete medium power line includes 34 silicon rectifier types ranging from 6 amps to 35 amps, from 50 to 600 PIV. For complete reliability make sure the semiconductors you buy are fully power-tested. You can be sure . . . if it's Westinghouse. For full details on Westinghouse 100% power testing, write for booklet, "New Dimensions in Semiconductor Reliability," Westinghouse Electric Corp., Semiconductor Department, Youngwood, Penna. SC-1037

Westinghouse

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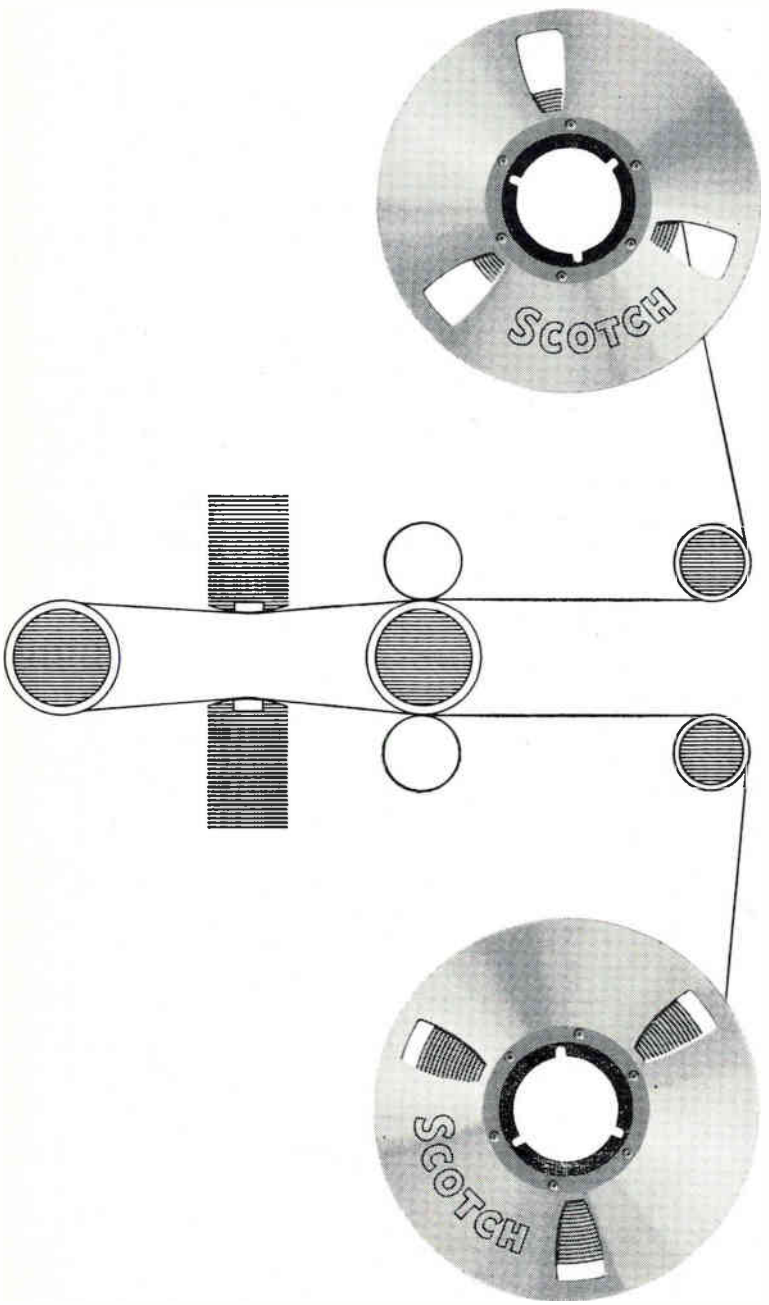
BEST SHORT WAVE LENGTH RESPONSE

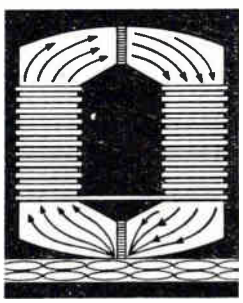
SCOTCH® BRAND High Resolution Tapes offer superior high frequency results



IN INSTRUMENTATION Tapes, a good *bit* may well depend on the character of the magnetic coating—and the uniformity with which it is applied. At short wave lengths, the head responds only to the flux nearest it—thus, the thinner the coating, the more it concentrates flux in that narrow region next to the gap where the head can use it best.

"SCOTCH" BRAND High Resolution Tapes 457, 458 and 459 testify to the great skill "SCOTCH" BRAND experts have in laying down a thin uniform coating that results in intimate head-to-tape contact, as shown in the diagram. This famous trio of tapes reproduces the critical short wave lengths, offers the superior response and resolution that lets you pack more information to the inch.

Much of their fine performance at high frequencies rests with the famed "SCOTCH" BRAND high potency oxides and their higher magnetic retentivity. At optimum bias settings, the coating is about 50% more sensitive to short wave lengths than ordinary coatings.



These tapes give you three great bases on which to build toward miniaturization. No. 458, with a 1.5 mil polyester base, offers standard recording time and maximum strength. No. 459, with a 1.0 mil polyester base, gives 50% extra recording time. No. 457, with a .65 mil base of tensilized polyester, delivers twice the standard recording time. One of the key factors in the consistent performance of the "SCOTCH" BRAND High Resolution Tapes is their uniformity—from reel to reel and within the reel. All three tapes offer a uniformity in magnetic coating and base that goes far to eliminate errors in performance.

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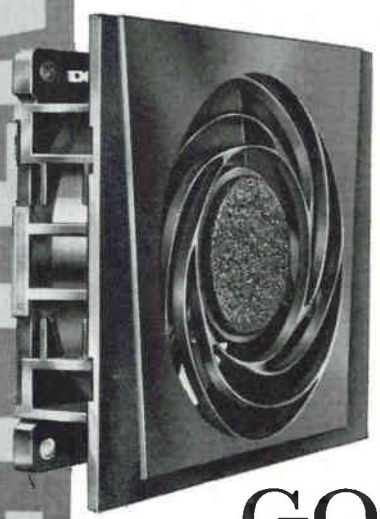

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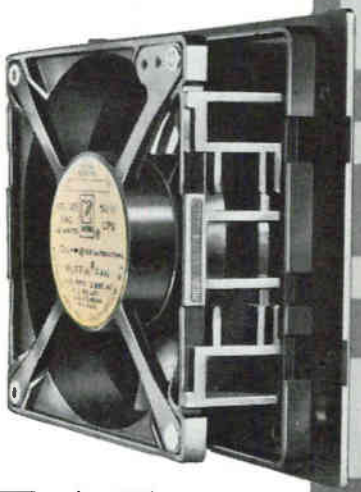

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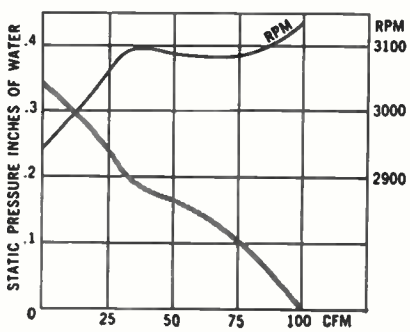

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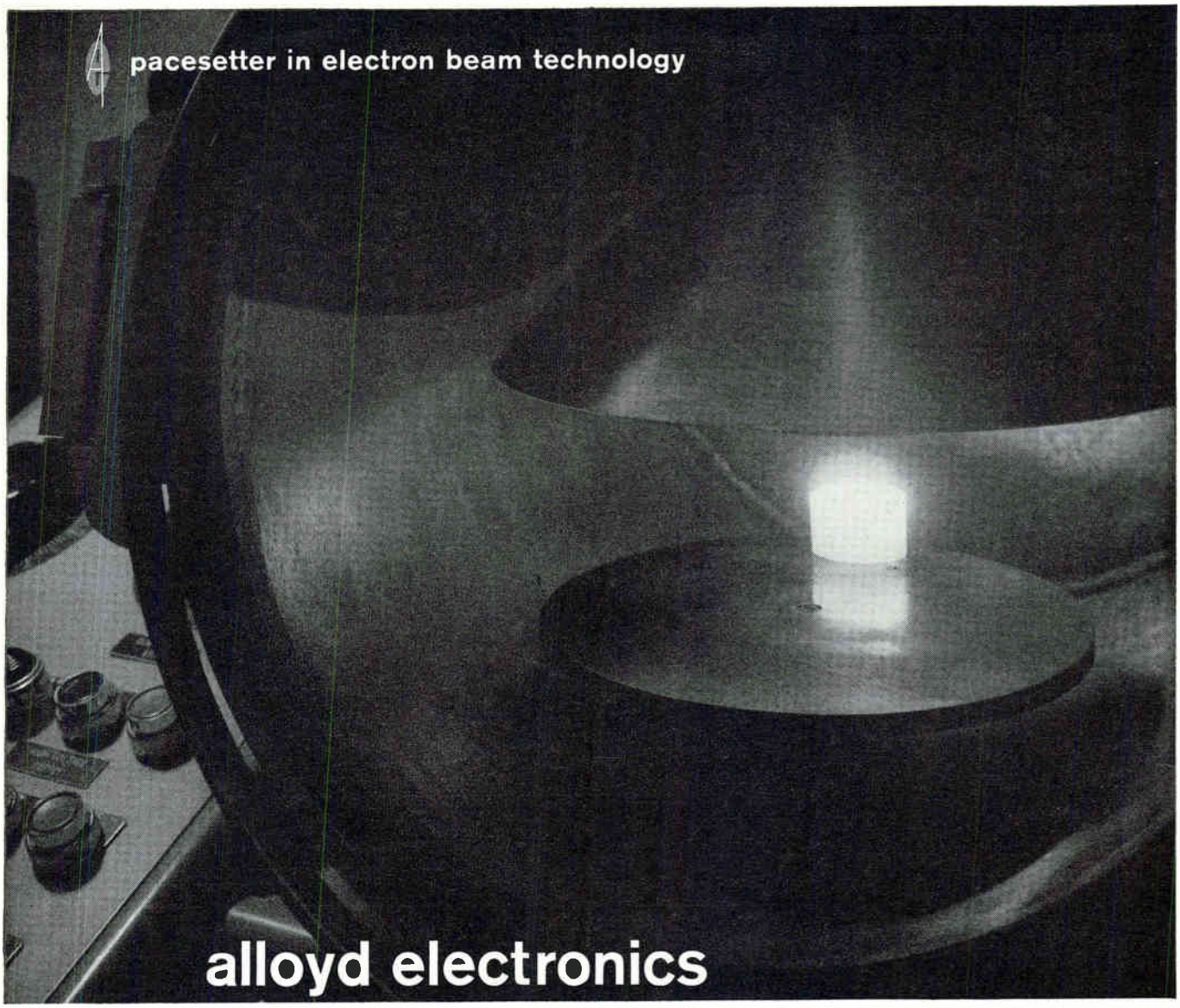

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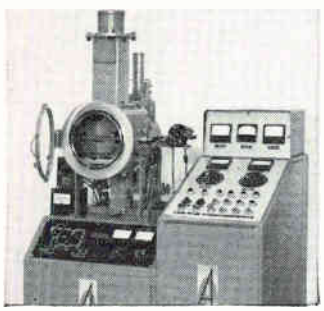

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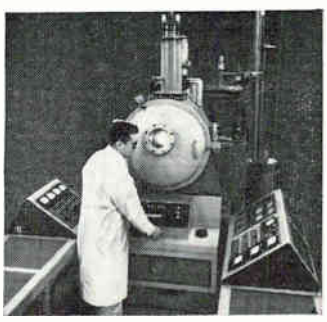
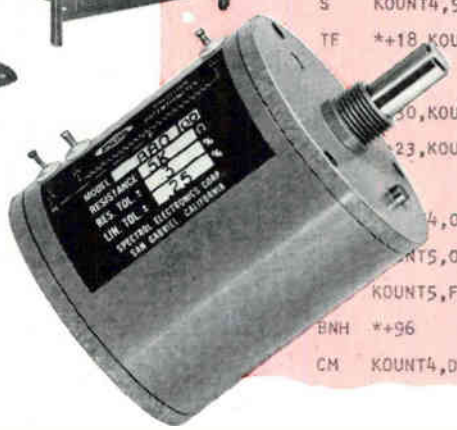


SPECTROL SOLVES EQUATIONS LIKE THIS...

$$\theta = A\tan^{-1} B\left[\left(1+0.2\left[C+D\frac{e_o}{E_i}\right]^2\right)^{7/2}-1\right]$$

to design non-linear potentiometers –faster, more accurately



```
          AM     FPN-8,01,10          03366 11 03129 00001
          TF     *+18,KOUNT4          03378 26 03396 03952
          TFM    ,70,10               03390 16 00000 00070
          B      NEGK                 03402 49 03318 00000
EQUALK    AM     KOUNT4,02,10         03414 11 03952 00002
          TF     *+18,KOUNT4          03426 26 03444 03952
          TFM    ,70,10               03438 16 00000 00070
          TF     *+30,KOUNT4          03450 26 03480 03952
          TF     *+23,KOUNT5          03462 26 03485 03957
          TD     ,                    03474 25 00000 00000
          AM     KOUNT5,01,10         03486 11 03957 00001
          CM     KOUNT5,FPN,7         03498 14 03957 03137
          BNH    EQUALK               03510 47 03414 01100
FLAGK     BNF    *+24,FPN             03522 44 03546 03137
          TDM    DECK+21,2,10         03534 15 03876 00002
          BB                          03546 42 00000 00000
POSK      MM     FPN-8,02,10          03558 13 03129 00002
          S      KOUNT4,99            03570 22 03952 00099
          TF     *+18,KOUNT4          03582 26 03600 03952
                                      03594 16 00000 00070
                 0,KOUNT4             03606 26 03636 03952
                 23,KOUNT5            03618 26 03641 03957
                                      03630 25 00000 00000
                 4,02,10              03642 11 03952 00002
                 NT5,01,10            03654 11 03957 00001
                 KOUNT5,FPN,7         03666 14 03957 03137
          BNH    *+96                 03678 47 03774 01100
          CM     KOUNT4,DECK,7        03690 14 03952 03855
```

The above equation is the mathematical expression for the non-linear function required of a precision pot to relate voltage ratio $\frac{e_o}{E_i}$ to potentiometer shaft position θ.

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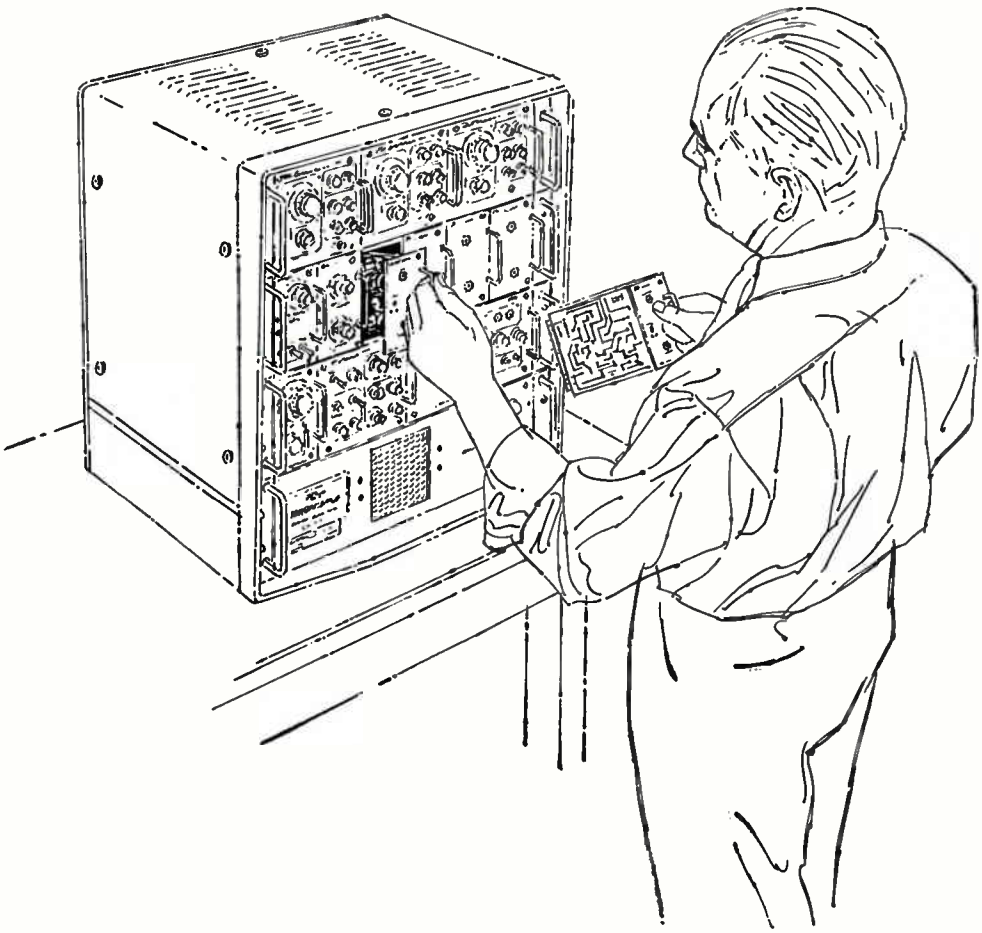

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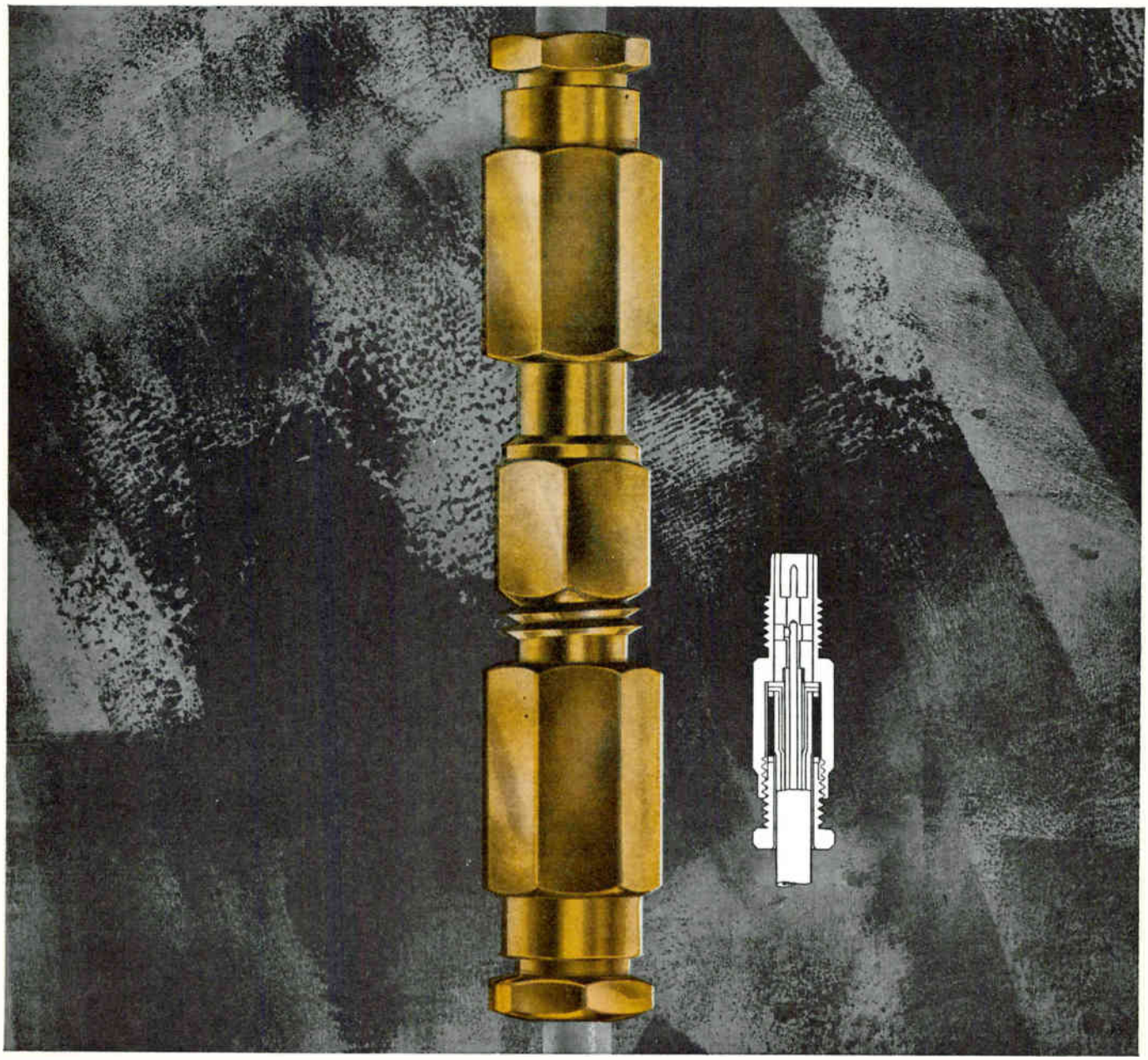

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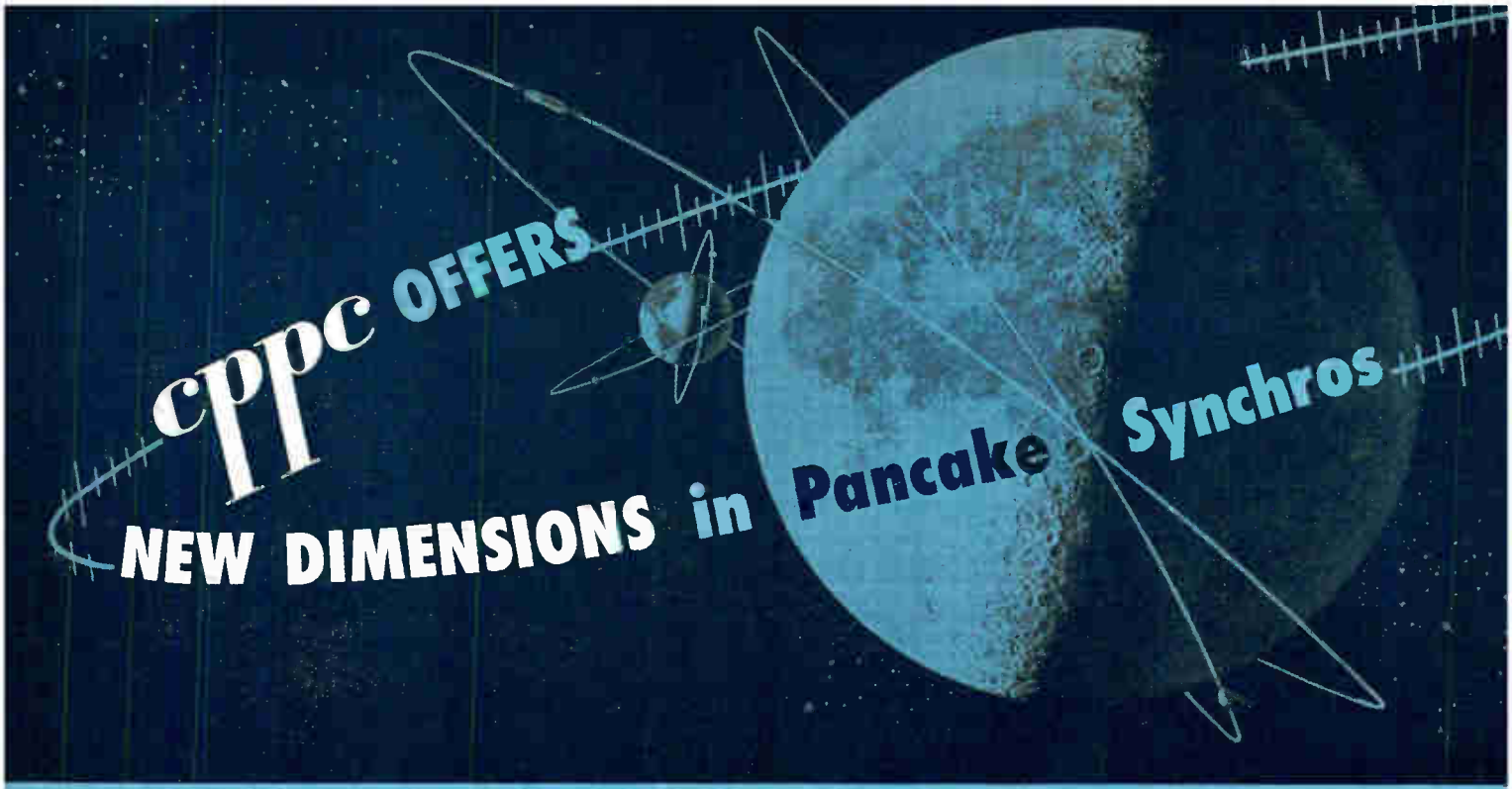

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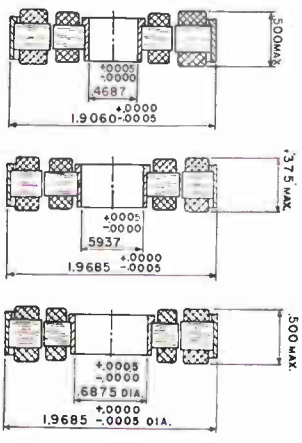

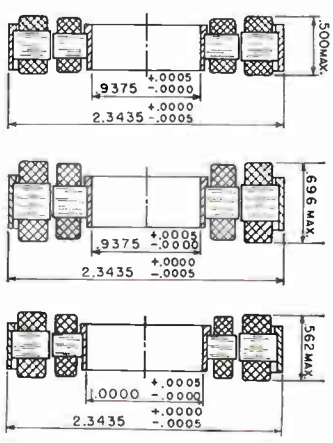

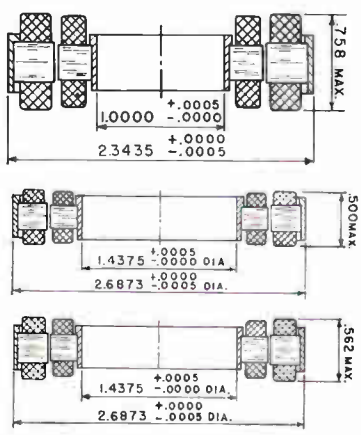

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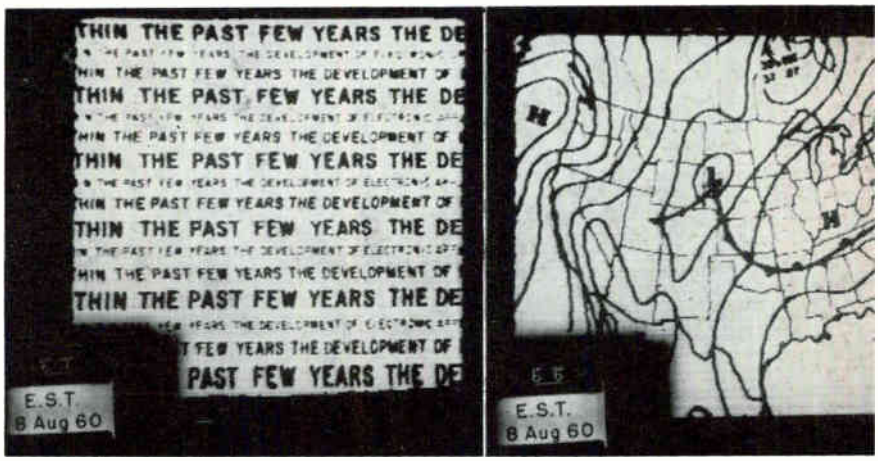

Photos are for r-f BW of 220 Kc, scan time of 0.5 sec; transmitter and receiver frames coincide

Transmitting Facsimile Messages Over Meteor-Burst Paths

By BENEDICT F. GEDAMINSKI
WILLIAM G. GRIFFIN, Jr.,
Electronics Research Dictorate,
Air Force Cambridge Research
Laboratories, Bedford, Mass.

THE METEORFAX SYSTEM transmits pictures up to distances of about 1,000 miles over meteor trails. These trails are formed in the E region by the multitude of tiny meteors that enter the atmosphere daily and burn up, leaving in their wake ionization columns. Capable of reflecting vhf signals, the ionization columns are random with respect to time, orientation and location. Thus, special techniques are required for a forward-scatter meteor-burst communication link. The communication circuit is momentarily closed when a favorably oriented meteor trail is formed and the signal at the receiver exceeds a predetermined threshold level. Hence, storage devices and appropriate circuits are needed to hold and then quickly release information when a closed path is recognized simultaneously by the sender and receiver.

Prior techniques[1] have used magnetic or tape storage devices to store teletypewriter, digital and voice signals. However, studies at AFCRL showed that it would be feasible to transmit high-information graphics over meteor trails with available transmitter powers during the short lifetimes of the meteor signals; these lifetimes range from 0.1 to 1.0 second. The system uses a high-speed electronic facsimile, to transmit in real time directly from printed page or photograph.

Instrumentation was developed[2] and the relationships of bandwidth, system gain, duty cycle and picture quality evaluated on an experimental link operated between NBS station WWI at Longbranch, Illinois and the RCA station at Riverhead, New York (see photos).

Meteor-trail signals have been classified as either underdense or overdense, depending on the initial electron densities in the trail and the concomitant scattering mechanism. Signals reflected from underdense trails, which have initial electron densities of less than 10^{14} electrons per meter, exhibit a sharp signal rise followed by an exponential decay; underdense trails have highly directional characteristics. Although the trail electrons are considered to be independent scatterers, the trail behaves somewhat as a metallic reflector when the initial densities exceed 10^{14} electrons per meter; such signals are identified as overdense. This type of signal rises to full amplitude more slowly and remains near peak amplitude for a much longer period before falling off sharply. These signals are more frequently distorted by atmospheric winds, which produce random strong fading of the signal, increase of single-trail multipath and loss in signal directivity.

Design of facsimile systems transmitting over meteor trails involves considerations such as the power available at the receiver from a forward-scattered signal, the meteor-burst detection rate at a specified receiver-threshold level, and the signal-duration distribution at this level. These factors contribute to establishment of the duty cycle — percentage of on-time — which determines the average information rate of the circuit.

Duty cycle of the propagation medium is about[1].

$$DC \leqq K_1 (P_t/B\,W\,L)^{1/2} \times \lambda^{2.35} (P^1 \sec^2 \phi) \sec^{3/2} \phi \qquad (1)$$

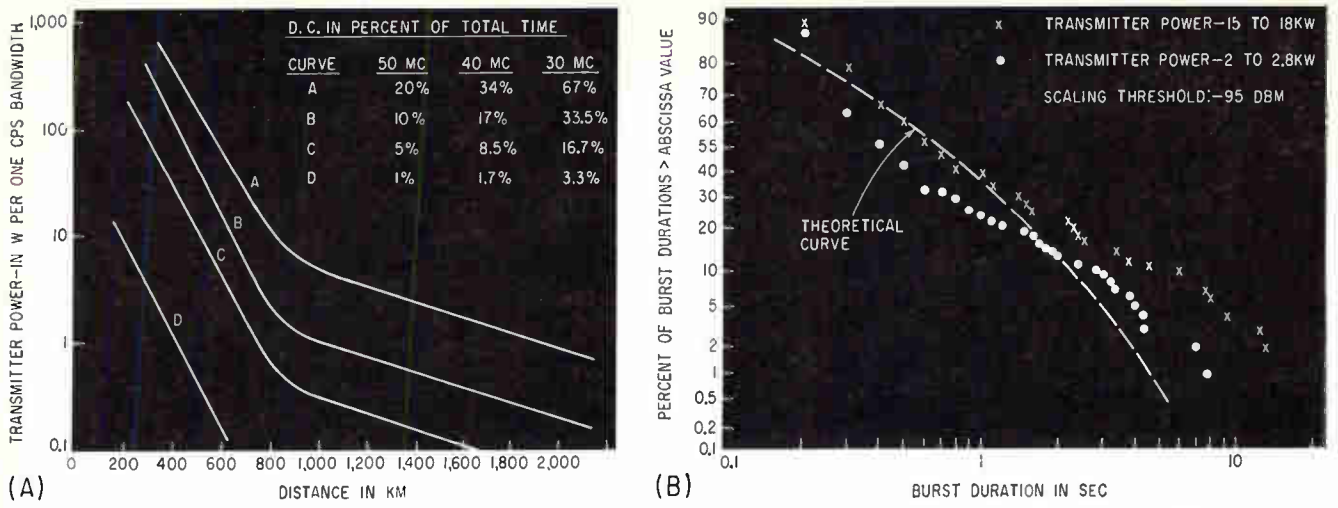

FIG 1—Power as a function of distance, frequency and duty cycle (A). Signal duration distributions (B)

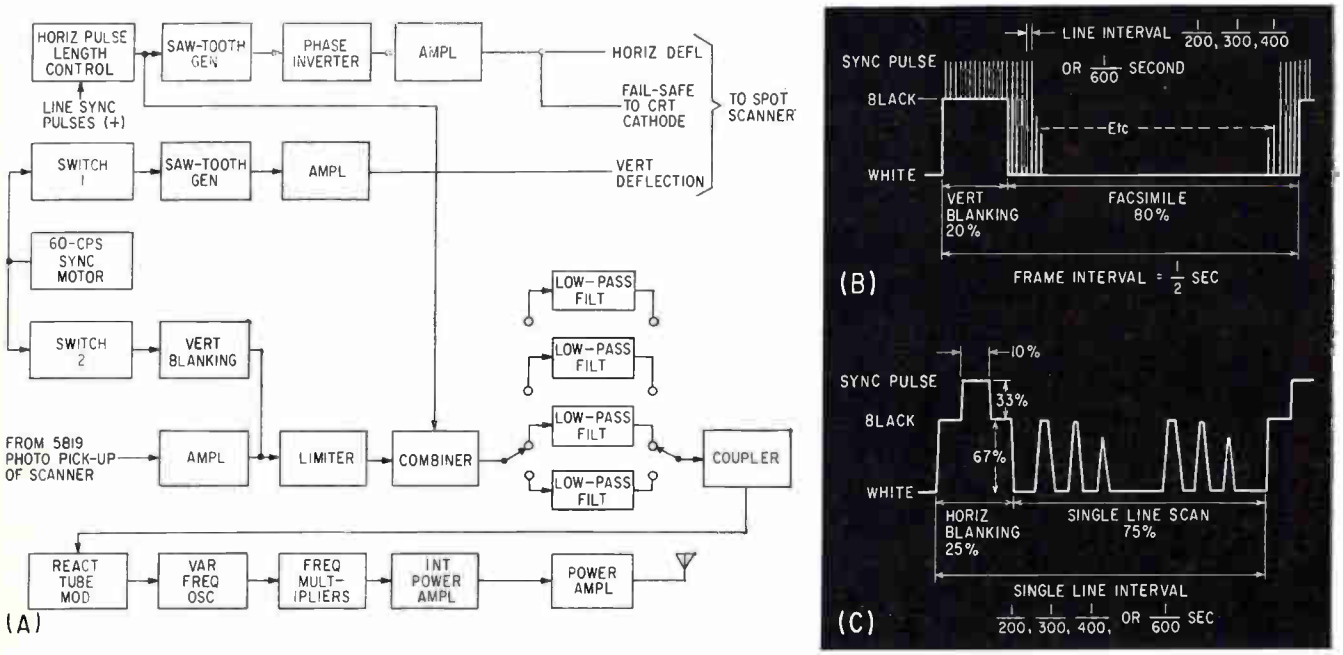

FIG. 2—Transmitter circuit blocks of (A) control flying-spot scanner (not shown), and receive, amplify and transmit signal from scanner. Expansion of (B), which is frame interval, into single-line interval is shown in (C)

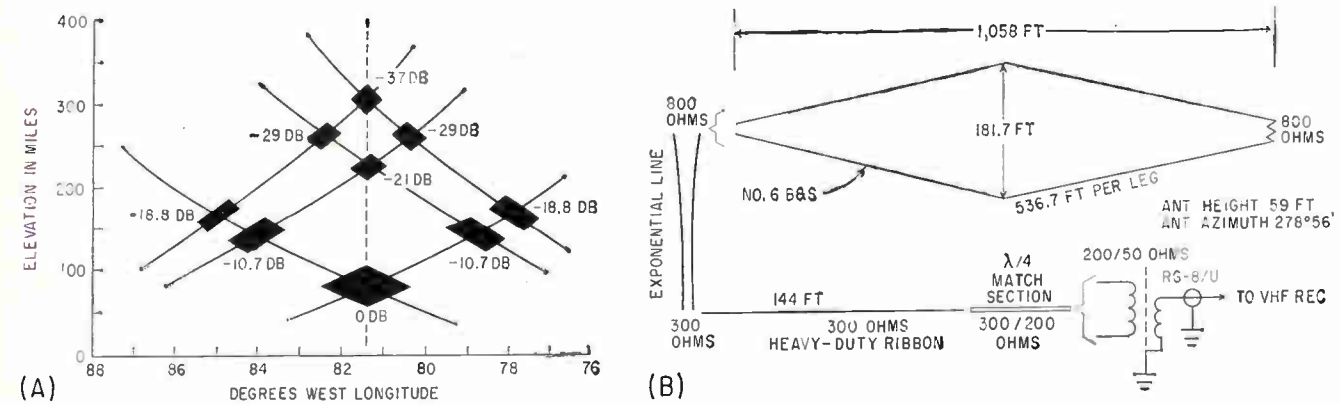

FIG. 3—Common volumes shared by transmitting and receiving antennas and relative gains of these volumes (A). Receiving station antenna (B)

where P_t = transmitted power, BW = bandwidth, L = power threshold level above cosmic noise, ($P^4 \sec^2 \phi$) = probability duration factor, 2ϕ = forward scattering angle, λ = wavelength, and DC = duty cycle.

Available experimental data from National Bureau of Standards and Stanford meteor-burst circuits were applied to Eq. 1 to obtain an estimate of the power requirements for the meteorfax system as a function of DC distance and bandwidth. The experimental data showed that power-bandwidth products of 1 watt/cps were not unreasonable over long paths. Results are shown in Fig. 1A where the value and relative contribution of each parameter to the power available at the receiver is illustrated.

A complete picture per burst requirement was initially set up and picture information was experimentally varied within a preselected fixed frame time. The selection of a frame time was contingent on the usable meteor signal durations to be expected over a path. Meteor-signal durations are influenced by wavelengths, scatter angles, meteor size and diffusion coefficients, thus making it difficult to determine, both theoretically and experimentally, the signal-duration distribution of all usable meteor signals. However, it was shown[3] that for the underdense trails, the signal-duration distribution is independent of the receiver decision level and is

$$P(t > t_o) = \exp(-mK_2 T_o) \qquad (2)$$

where: $P(t > t_o)$ is the probability of obtaining time t greater than time t_o, which is of arbitrary duration; K_2 is a function of wavelength, scattering angle and diffusion coefficient; m is an exponent expressing amplitude echo rate above an arbitrary peak amplitude. The theoretical and observed signal-duration distributions are shown in Fig. 1B. On the basis of the anticipated signal durations, a picture scanning time of 0.5 sec was chosen. A 0.6-sec experimental median on high power tests provided an appreciable percentage of time when a complete picture could be transmitted and received in a single burst.

A slowed-down television-scanning approach was used in the frame-per-burst system. This all-electronic system transmitted, in the brief duration of a meteor signal, picture intelligence at rates higher than conventional facsimile. At the transmitting station (Fig. 2A) the subject copy on 35-mm strip film was repeatedly scanned at 2 cps by a flying-spot scanner, and the resulting picture continuously transmitted over the air. No vertical sync pulses were transmitted. The vertical scan voltage was generated from a capacitor whose charge-discharge cycle was controlled by a limit switch actuated by a motor.

An improvement in picture quality was made by using stable frequency standards at each terminal to generate synchronized line sweeps. Picture legibility was improved by a more precise timing of the horizontal sweeps; picture quality could be maintained even when the signal-to-noise ratio was too marginal to recover transmitted sync. Maintaining horizontal sweeps during momentary fades of the signal below threshold allowed quick recovery of the text in relation to the rest of the picture. A 67-elment-per-inch vertical and horizontal resolution was used with three sizes (widths) of letters or lines so that the information rate becomes proportional to the scanned area with constant resolution and scanning time. This provided a variety of picture information rates within the 0.5-sec frametime to establish experimentally the meteor-trail-bandwidth capabilities.

The picture-modulated light from the flying-spot scanner goes to a multiplier phototube that produces an electrical output. This output is amplified, limited and combined with the blanking and sync pulses to form the composite video of Fig. 2B and 2C. The composite signal after frequency limiting by the low-pass filter, which determines the upper picture frequency, frequency modulates the transmitter with three discrete levels of frequency shift corresponding to white level, black level and horizontal sync pulse level. The use of f-m eliminates the amplitude-variation effects of the meteor signal on picture quality. A grid reactance modulator (Fig. 2A) controls a Collins 70E-15 variable frequency oscillator whose frequency-multiplied output of 49.72 Mc is the carrier frequency. This output goes to the intermediate power amplifier, which drives a Collins 205G-1 having a 20 Kw peak envelope power output.

The signal was radiated at Longbranch, Illinois from a rhombic antenna 536.7 feet long in each leg, with half side angles of 80.25 deg. Antenna height above ground placed the main lobe in the vertical plane at 4.6 degrees. Gain of the antenna was 18 db above a half-wave dipole. Antenna beam width was 6 deg at the half-power points. The azimithal direction was 75 deg and 11 minutes, thus placing the beam 6.2 deg north of the great-circle path to Riverhead, N. Y.

Transmissions were generally made in the morning because the meteor rate is higher during the morning hours. The common antenna volumes shown in Fig. 3A were produced with a similar antenna (Fig. 3B) at Riverhead oriented to Longbranch, Ill.

The one-way facsimile transmissions from Longbranch were monitored at the Riverhead station (Fig. 4A) by a fixed-tuned single-conversion superheterodyne receiver (Fig. 4B). The first oscillator is crystal controlled and the i-f is 13 Mc. The i-f amplifiers had 27, 55, 110 and 220 Kc bandwidths to test the capabilities of the meteor propagation circuit to carry pictures at various information rates. Receiver noise figure was about 4 db. The picture was retrieved from the f-m components of the signal while the simultaneous recovery of the a-m components provided the means to trigger the picture-recording camera, and concurrently to describe on strip charts the amplitude-time characteristics of the meteor-burst signal.

The picture-recording mechanism at Riverhead was cocked in anticipation of an acceptable meteor-burst signal from Longbranch by holding the crt blanked and the camera shutter open, both under the control of the facsimile recorder and camera control unit (Fig. 4C). This unit evaluated the signal output from the receiver and the transmitted horizontal sync preventing false triggering by random and ambiguous signals, static crashes and interfering stations. The above-threshold signal must be accompanied by over-the-air sync before the recording mechanism is actuated. Recognition produces a pulse which

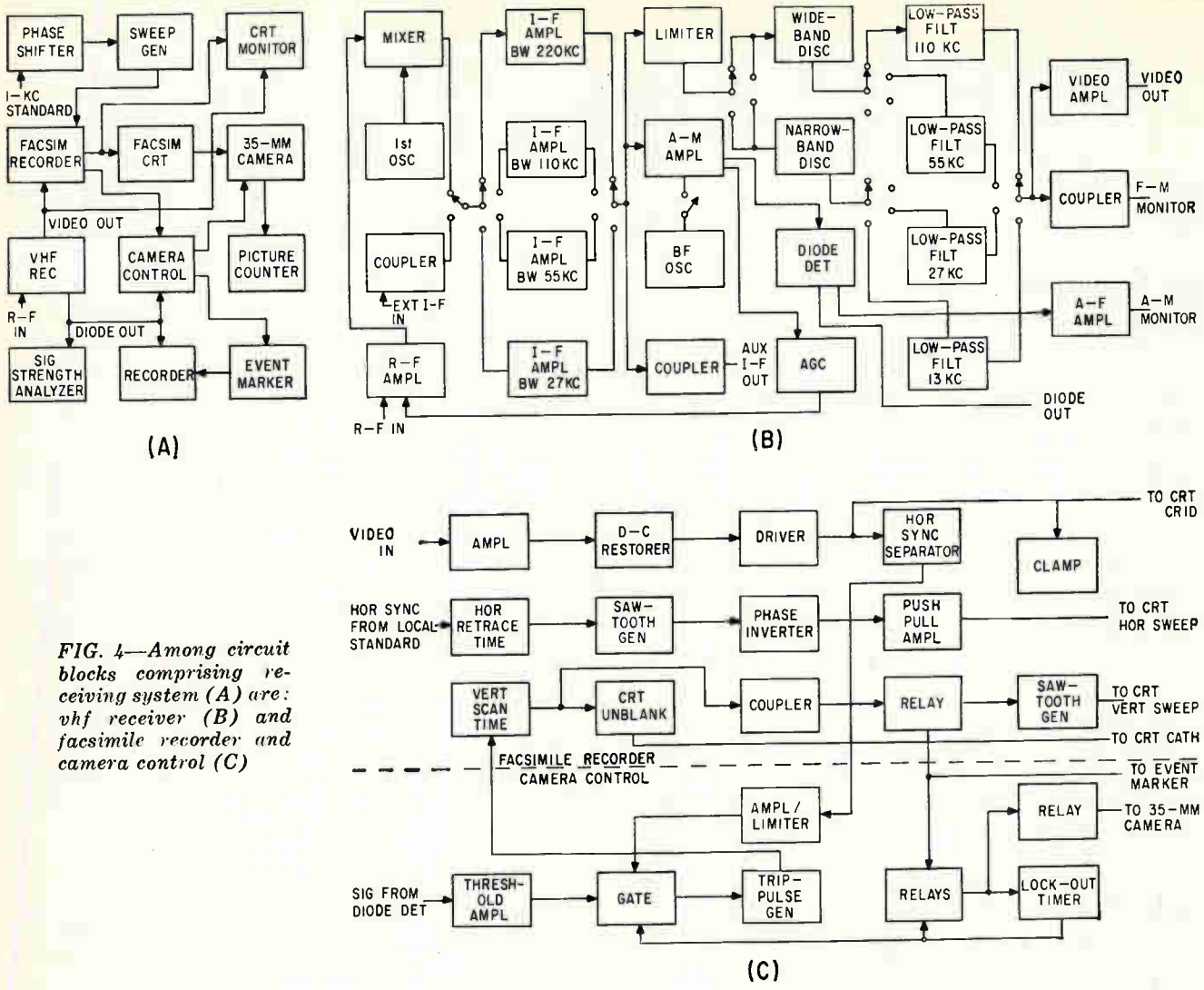

FIG. 4—Among circuit blocks comprising receiving system (A) are: vhf receiver (B) and facsimile recorder and camera control (C)

unblanks the crt and starts the vertical scan. The received picture copy was randomly framed since no frame synchronization was attempted. Horizontal-line sweeps of 200, 300, 400 or 600 cps to match the transmitter sweeps were derived from a local stable frequency standard. The relative phase between the transmitter and receiver line sweeps was manually adjusted and synchronized by using a dual-beam scope to monitor a line of incoming video and the local line sweep generated by the frequency standard.

Video picture information intensity modulated the crt, with line-by-line scanning performed in 0.5 sec. The picture was reconstructed on film in either a fast-print camera for quick inspection and equipment adjustment or in the 34-mm automatic camera. The record mechanism and shutter remained open for 0.5 sec under the control of a relay system. At the end of that time the shutter closed, the electronics reset, the film advanced, the automatic camera shutter reopened and everything again was ready for another meteor burst signal at the end of a 1.5-sec recycle period.

Meteor-bursts are detected at a random rate influenced by time of day, season and the geographical location of the terminals on the earth's surface. Therefore, meteor-burst propagation is an on-off intermittent circuit requiring that an average percentage of useful on time or duty cycle over some period of time be established, depending to a degree on the number and average duration of signal bursts observed over a path.

The average information passed over a discontinuous circuit, such as meteor burst, is the instantaneous rate times the path duty cycle. By assuming the instantaneous rate is proportional to bandwidth

$$I_{AV} \propto BW \times DC \qquad (3$$

There is no simple approximation to a complicated *DC-BW* relationship for optimum information transfer. However, for a qualitative approach some value is obtained by a further simplification of Eq. 1 to

$$DC \propto L^{-M} P_t^N f^{-B} \qquad (4)$$

where f = frequency, and M, N and B are experimentally determined.

Empirical measurements of duty cycle, favoring early morning rates, as a function of threshold power level were made on this circuit at threshold ranges of -75 dbm to -85 dbm and from -85 dbm to -95 dbm. Exponent M was evaluated as a slope of the duty cycle versus threshold curve. Average half hour values versus time of day obtained are shown in Fig. 5A. A median range from 0.5 to 0.85 was established from a cumulative distribu-

tion of the exponent M taken with a combination of transmitted power and threshold values.

Exponent M then can be used to anticipate the direction that system bandwidth must go to maximize information transfer. From Eq. 3 and 4

$$I_{AV} \propto 1/L^M \qquad (5)$$

for constant signal-to-noise ratio. Thus information rate is influenced by the slope of the duty cycle versus threshold curve.

As bandwidth is raised to increase the instantaneous rate, the threshold level is also raised to maintain a constant signal to noise ratio. Where the slope of M in Eq. 5 is greater than unity, the information rate decreases. Under these circumstances, the average information rate would be higher by trading off bandwidth for duty cycle; that is, going to a narrow-band system. However, if the slope is less than unity, a gain in path information can be made by operating a wide-band system because duty cycle decreases slower than bandwidth noise and the increase in threshold level.

Wide-band operations and high instaneous picture rates were justified over the Longbranch-Riverhead circuit to obtain maximum information transfer over a period of time. This advantage was most pronounced in the early morning hours, using a combination of high transmitter power and low receiver-threshold settings; M was less than unity 97 percent of the time in the early morning. In other combinations of power and threshold, wide band ($M < 1$) operations was favored somewhat over 50 percent of the time.

To make a further comparison of the system's information rate, a facsimile bit rate was established for 110-Kc and 220-Kc bandwidth transmission. Three sizes of letters and lines were transmitted in each test bandwidth, with each line or letter size corresponding to a different bit rate. The intermediate-size letters corresponded to 96.9 thousand bits per second in the 110 Kc bandwidth and 218 thousand bits per second in the 220-Kc bandwidth transmissions. These are the bit rates used in the following estimates of the propagation circuit performance. The received information (bit) rates were estimated over half-hour operating periods. A percentage of the 0.5-sec frame-time was assigned to each frame in proportion to the readable text that was without error. A summation of values for the individual frames provided the total operating time. All test transmission data, which was taken at threshold values from -81 dbm to -92 dbm, was normalized to a -88 dbm threshold and a value of 0.75 was assigned to exponent M in Eq. 4.

On this basis an average of 1,000 bits-per-second received over this circuit represents sufficient information to keep twenty-two 60-wpm printers running continuously. Theoretically, a decrease in threshold should increase the average information rate. For example, the estimated bits-per-second would be increased by a factor of 3.8 if a -96 dbm threshold is assumed with 0.75 retained for M. Then, the minimum information rate for the 220-Kc bandwidth with 18 Kw of transmitter power would be sufficient to keep about 33 printers operating continuously under the worst conditions of evening operation, when meteor activity is lowest and with antennas oriented for best operation at other times of day.

An evaluation of the power exponent N (Fig. 5B) was made by directly measuring the duty cycle at threshold levels of -95 dbm, -85 dbm and -75 dbm, with transmitter powers of about 18 Kw and 2.5 Kw alternated at half-hour intervals. The morning median values ranged from 0.8 at threshold of -95 dbm and 1.2 at 85 dbm. The values were higher than a theoretical value of 0.5 under idealized conditions. However, no other experimental data was available to compare the results. No evaluation of exponent B was attempted.

The feasibility of sending pictures over ionized meteor trails was firmly established. The results exceeded the program objectives and saturated the top limit of the capability of the experimental equipment. System frequency response and horizontal-sweep stability limited the maximum picture information to approximately 200,000 bits per sec. However, picture rates in excess of 300,000 bits per sec were achieved by operating the equipment at optimum adjustment above the theoretical limit. Average information-handling capability for this circuit, over half-hour periods, was 2,300 bits per sec on 220 Kc bandwidth and 1,400 bits per sec 110 Kc bandwidth. The meteor propagation medium may not be the limiting factor in achieving higher transmission rates. Single burst multipath time delays measured on this circuit, up to the equipment resolution, was about 1.5 μsec. Distances up to about 1,000 miles appear feasible with more sophisticated devices.

Philip Newman and Joseph Casey conceived the Meteorfax technique.

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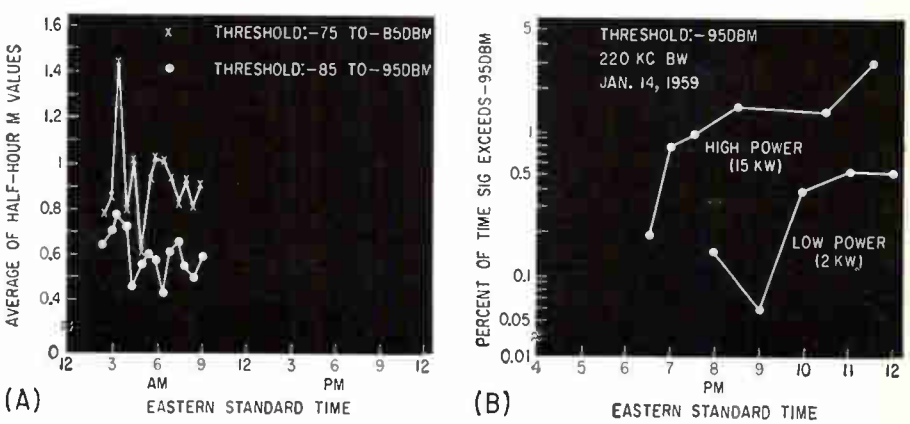

FIG. 5—Averages of M, the threshold exponent (A). Exponent N was evaluated from such data as in (B), which shows duty cycle as function of transmitter power

Step-by-Step Design Techniques for

Thin-film passive networks and interconnections can reduce size and weight of electronic assemblies without appreciably increasing costs. Results of a study program are described

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THE LONG-RANGE objective of this thin-film network program is a circuit fabrication method, which with interconnection techniques, will enable the reduction in size of electronic equipment by several orders of magnitude. Before this long-range objective could be achieved, it was necessary to determine the feasibility of multilayered thin-film circuits and to fabricate a range of circuit functions and analyze their performance. Using these films in a multilayered configuration would make possible reductions in size and weight. However, the number of layers that could be used, the materials employed and the methods of fabrication had to be determined. To determine operational performance, a range of circuit functions employing multilayered films to form the passive element networks were fabricated and compared to circuits fabricated by conventional component techniques.

Six different circuit functions, encompassing a range of switching and communication applications, were selected for fabrication and evaluation. The topological layout of each circuit was designed to fit within a substrate area of 0.3 × 0.3 inch and to be compatible with the electrical characteristics of the films. The OR NOT circuit consisted of two grounded-emitter transistors having a common collector load resistor. The TRL (transistor-resistor logic) circuit provided for a fan in and fan out of 3. The astable multivibrator was designed for 500-Kc operation and 10-volt signal swings. The audio amplifier required an 0.11-μf input capacitor to obtain a lower cut-off frequency of 500 cps. The i-f amplifier was designed for 4.5 Mc and r-f amplifier for 18 Mc.

Glass 0.020 in. thick was used as the substrate material on which the passive elements and interconnections were deposited. Aluminum was chosen for conductors, nichrome for resistors and silicon monoxide for dielectrics and insulation material. The aluminum conductors were deposited to a thickness of 5,000 Å and a minimum line width of 0.015 in. to obtain conductors having essentially the resistance per inch of bulk aluminum.

To obtain resistive films with good stability, nichrome was deposited to a maximum of 200 ohms per square. The tolerance limitations of masks limited the minimum line widths to 10 mils. At 200 ohms per square, the thickness of the resistor films was 150 Å and 5 watts per square inch was allowed for power dissipation. Interlayer shorts were minimized by depositing silicon monoxide to a thickness at 10,000 Å. Although the dielectric constant of silicon monoxide varies slightly with deposition pressures and operating frequencies, an average dielectric constant of 6 was suitable for the design of capacitors. With 10,000 Å of silicon monoxide as a dielectric, capacitances of 33,000 pf per square inch were attained. This value was sufficient to design, within the 0.3 × 0.3 inch substrate area, capacitances up to 2,000 pf. To avoid paralleling many layers for capacitor values over 2,000 pf, cerium fluoride was used as the dielectric. Experimental data obtained from an advanced thin-film component development program indicated that dielectric constants of 200 or more could be attained with cerium fluoride when deposited under optimized conditions.

As an example of the method used in circuit fabrication, the topological layout of the free-running multivibrator is shown in Fig. 1. This figure also contains the schematic and shows the position of the circuit on the substrate. During this program, an overall 0.6 × 0.6 inch glass substrate was used. However, all passive elements were deposited within the 0.3 × 0.3 inch area. Each 0.6 × 0.6 inch substrate was optically checked for flaws or scratches and processed through several cleaning stages to remove dust, dirt and grease.

The evaporation process was initiated by depositing, 500 Å of chrome through an interconnection mask onto the substrate to obtain good adhesion of the films to the glass. This film was further built up to 5,000 Å by evaporating aluminum on top of the chrome. The aluminum, in a vacuum of approximately 6×10^{-6} mm of mercury, was allowed to achieve a rate of 75 Å per second before the shutter was opened and the evaporant began to deposit on the substrate. At this rate, 5,000 Å was deposited on the substrate in approximately 1½ minutes. During this process, the substrate was held at 150 C.

The first circuit layer was a silicon monoxide undercoat which was placed over the area where the circuit was to be fabricated to smooth out the substrate and reduce the possibility of interlayer shorts in the succeeding layers. The silicon monoxide was evaporated from a crucible by a resistance heater un-

Multilayer Thin-Film Networks

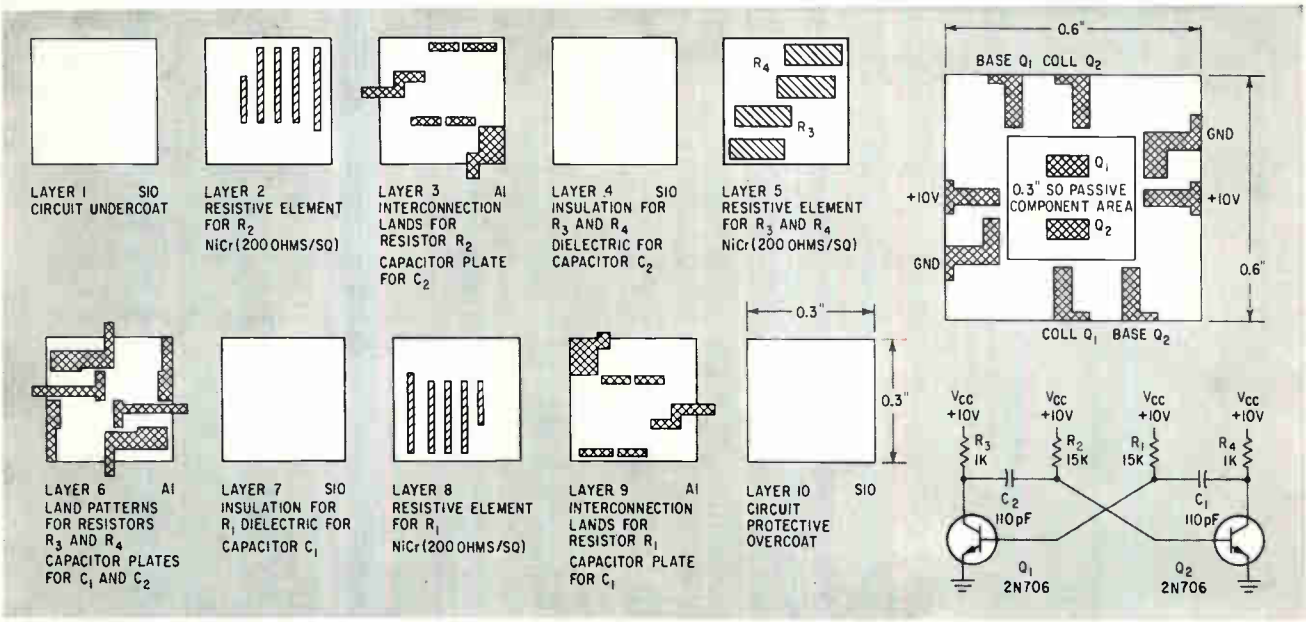


FIG. 1—Topological layout of a multilayer thin-film, free-running multivibrator showing method of fabrication

der a pressure of 5×10^{-6} mm of mercury. The substrate was maintained at 300 C and a rate of 50 Å per second was obtained before the shutter was opened. Approximately 3.3 minutes were required to deposit 10,000 Å.

The rate of evaporation was determined by monitoring the change in frequency of a crystal placed in the stream of the evaporant. Prior calibration experiments had established the change in frequency of the crystal required for the thickness desired.

The second step was to place the material on the substrate for the first evaporation of resistors. The mask was positioned and the nichrome was sublimated from a 60 mil, 80-20-percent nickel-chromium wire at a rate of ½ Å per second at a pressure of 4×10^{-6} mm of Hg. The evaporant is deposited on the circuit being fabricated and on a monitor slide adjacent to it. An ohmmeter connected across the monitor indicated when the design value of 200 ohms per square was obtained. The nichrome material was evaporated in a vacuum of 4×10^{-6} mm of Hg. During this step the substrate was maintained at 300 C. Approximately 4 minutes were required to obtain the desired 200 ohms per square. The resistor being deposited in this step was one of the 15,000-ohm timing resistors and dissipated 12.5 mw in operation. The physical dimensions of the resistors were dictated by the ohms per square and the power dissipation. To stabilize the resistors, they were given a vacuum anneal at 300 C for 1 hour.

The third layer was aluminum which connected the resistor, provided the connection points and also provided the lower plate of C_1, one of the timing capacitors.

The fourth layer was silicon monoxide and it provided the layer-to-layer insulation and the dielectric for timing capacitor C_1.

The fifth step was to deposit nichrome to form the two 1,000-ohm collector resistors.

The sixth layer, aluminum, was evaporated to connect the resistor and provide the necessary layer-to-layer connections. It also formed the top plate for capacitor C_1 and the lower plate for timing capacitor C_2. The seventh layer, silicon monoxide, was deposited to insulate and provide the dielectric of capacitor C_2.

The eighth step was the evaporation of nichrome for the other timing resistor, followed by the ninth layer, an aluminum evaporation to connect the resistor and complete capacitance C_2. The tenth circuit layer was an overcoat evaporation of silicon monoxide.

A total of eleven layers, ten circuit layers and an interconnection layer, was used for this circuit and the maximum build up of films was 50,000 Å. In the 18 layer OR NOT circuit, a maximum of 100,000 Å was achieved.

Four different systems were considered to fabricate the experimental models. The system used to fabricate the majority of the circuits used three separate evaporators, one for each of the materials. Since each evaporator deposited only one material, it was optimized for that material. The substrates were manually changed from one evaporator to the other until the circuit was completed. Eight substrates were handled in each evaporator, and only one evaporation was performed for each pumpdown.

Before the circuits could be tested, they were placed in a holder and had wire leads thermocompression bonded to the film-inter-

connection tabs. This method of connecting to evaporate thin films was found to be superior to soldering, conducting adhesive pastes or pressure contacts. Experiments showed that ohmic contacts were obtained with thermocompression bonds. The bonds were made by applying approximately 180 grams pressure at a temperature of 200 C to an 8 mil radius chisel. The wire bonded was 3 mil gold. Transistors and diodes were affixed to the film networks in the same manner. The units used were uncased 2N706 silicon transistors and PD101 silicon microdiodes. The units were glued on top of the film area and their wires were thermocompression bonded to the film interconnection tab. While extensive research is being conducted to develop active elements more compatible with the film fabrication process, the aims of this program of evaluating multilayered thin films could be achieved by using the uncased transistors.

A detailed investigation into the problem of the inductors required for the i-f and r-f amplifiers evaluated several different film inductor configurations, and it was concluded that a flat square spiral would have the fewest circuit and fabrication problems.

This film inductor required 46 turns of 2-mil copper conductor spaced on 4 mil centers, and produced an inductance of 10 μh. While this configuration could yield inductances of 5 to 20 μh, a d-c resistance of the order of 20 ohms reduced the Q to low values. In addition, it was necessary to use an 0.6-in. square area for the component. Considerably improved performance was attained with bobbin-wound, air-core microinductors. These chip inductors mounted in an 0.1 × 0.1-in. area, and exhibited inductances of 15 μh with a Q of approximately 20 at 2 Mc. This investigation revealed that at the present microminiature inductors could best be attained through conventional techniques.

Miniaturizing electronic functions necessitated thermal studies. Studies of the thermal problems associated with miniaturizing electronic functions determined the temperature distribution and heat transfer paths within the circuits as the result of the heat dissipated by resistors and transistors. The circuit layouts were evaluated by a numerical relaxation method based on the calculus of finite differences. The solution for the steady-state temperature within the substrate assumes constant heat flow with time. An IBM 704 data processing system was used to solve a group of simultaneous equations in matrix form, which described the heat flow balance at each point in the substrate. Figure 2 shows the results of the relaxation method applied to the OR circuit which dissipated 87 mw. The isothermal lines plotted for each 2 F increment indicated that the single substrate having the OR-NOT circuit did not exceed a 65 F rise over ambient. With an ambient of 140 F, the maximum film temperature of 205 F was well below the 257 F limit determined by the semiconductors.

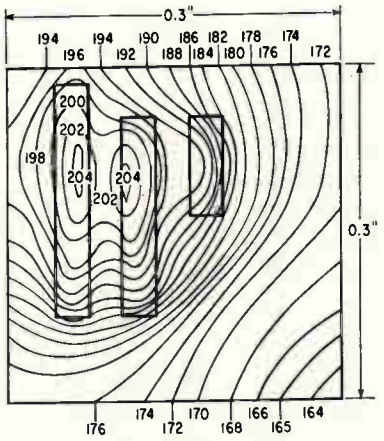


FIG 2—Isothermal distribution for an OR circuit assuming a still air ambient of 140 F

These studies also proved that film-to-film thermal gradients were so small that the high heat dissipating resistors could be placed on any layer without affecting the overall package temperature.

The electrical performance of each of the six multilayered circuit types fabricated was carefully analyzed. A minimum of five operational circuits of each type were evaluated. The TRL-NOR circuit exhibited operational performance equivalent to a similar circuit built with conventional components. Initially, the five other circuit types had some departures from conventional circuit performances. The initial OR NOT circuits had distortion in the output waveforms, and had a maximum operating frequency less than the design limit of 1 Mc. Increasing the insulating layers from 10,000 Å to 30,000 Å reduced the feedback capacitance causing this effect, and enabled the circuit to meet the design goals.

The i-f and r-f amplifiers were found to contain feedback paths that produced sustained oscillations. By eliminating the feedback path, the film circuits were found to operate similarly to conventional-component versions. The audio amplifier's lower cutoff frequency was higher than the design goals. It was found that the value of the input capacitor was lower than the design value of 0.11 μf. Cerium fluoride rather than silicon monoxide was used for the dielectric of this component in an attempt to obtain the desired capacitance. While experimental data obtained in the laboratory had indicated that dielectric constants as high as 250 could be attained with cerium fluoride, the vacuum systems used in this circuit feasibility study were not optimized for this material; hence much lower values were obtained. For the same area capacitor, an order of magnitude increase over silicon monoxide was attained.

The astable multivibrator is described in detail to present a clearer picture of the analysis performed on each film circuit. This circuit had a design frequency between 400 and 600 Kc, depending on component tolerances. However, the actual frequency of thin-film versions of the multivibrator was between 0.75 and 1.5 Mc.

An analysis of the film-circuit layout established that interlayer feedback from the collector resistor of one stage to the base resistor of the same stage shunted each deposited base timing resistor with a resistance and capacitance distributed network. This resulted in lower effective timing resistance, thus reducing the time constant of the circuit and increasing the pulse repetition rate. The value of the timing capacitor for each stage of the multivibrator was not altered by the component placement of the films. Interlayer feedback was responsible in this case, and in all other instances where deviations in circuit performance had been ob-

served. This feedback is a direct function of the component placement in the circuit layout. To predict the performance of the multilayered film circuits before fabrication, it was necessary to simulate the feedback paths within the film network. The three-dimensional nature of the films complicated any attempt to synthesize an exact equivalent of the film circuit. However, a layer-by-layer physical inspection of the topological design was used to determine an approximate equivalent for each circuit. Only feedback paths that primarily affected circuit operations were included in these representations. Conventional-component models of these approximated circuits were fabricated and dynamically compared to the corresponding film-circuit version.

Figure 3 shows the approximate equivalent circuit derived from the film layout of the multivibrator. This schematic shows the network of feedback paths connecting the collector and base resistors of each transistor. Figure 4A and B shows the waveforms obtained from the film circuit and the approximated equivalent circuit. The identically shaped waveforms and operating frequency prove the validity of the circuit simulation. By using the approximate equivalent circuit to simulate the film version, the performance can be predicted before the circuit fabrication.

From the experience in the fabrication of the six circuit types, an optimized version of the identical multivibrator was designed. This design considered the film structure as an integrated circuit network to achieve the desired output function. To establish the reproducibility of the process, a series of 160 starts was made of this circuit. No departures from anticipated circuit performance were expected since the approximate equivalent circuit, derived from the new film layout, indicated that the performance goals would be achieved. The circuits would exhibit symmetrical operation in the 400 to 600 Kc range if the component design tolerances were held to within ± 10 percent. Figure 4C and D shows the output waveforms of one of these circuits compared to a conventional component version of the multivibrator.

A 90-percent yield of operational circuits was obtained and the data showed that the passive elements could be held at ±10-percent.

Several hundred circuits using nichrome resistors and aluminum conductors have been subjected to environmental tests. These tests include temperature, humidity, temperature cycling and load life and were designed to determine the limits to which film networks could be stressed without using protective coatings. The tests showed that when humidity was kept below 50 percent, the circuit components were stable within 1 percent over wide variations in temperature and power dissipations. The temperature range was between −55 and +100 C, while the power dissipation was varied from 0 to 200 percent of rated power. Originally, film samples containing nichrome resistors and aluminum conductors subjected to 1,000-hour combinations of power, high temperature (80 C) and high humidity (95 percent), exhibited some film deterioration due to electrolysis. However, other metallic film combinations such as NiCr/CrAu have been developed and exhibit high stability and immunity to corrosion.

The use of these newer materials along with a protective coating will enhance the use of thin films in the production of reliable electronic systems.

During the fabrication of the multivibrators, eight circuits were produced simultaneously within an area of 15 sq in. An analysis of the resistor distribution over the deposition area revealed that a maximum of ±6-percent deviation in resistor value was maintained for each evaporation. A closer examination of the masks used in the fabrication indicated that ±2 percent of this deviation was a result of mask tolerances. These results indicate that with only minor improvements to the fabrication process, simultaneous deposition of as many as fifty or more circuits can be successfully achieved on a single substrate.

This article was derived partly from studies and research performed with United States Army Signal Corps and United States Air Force support. The authors acknowledge the assistance of their colleagues.

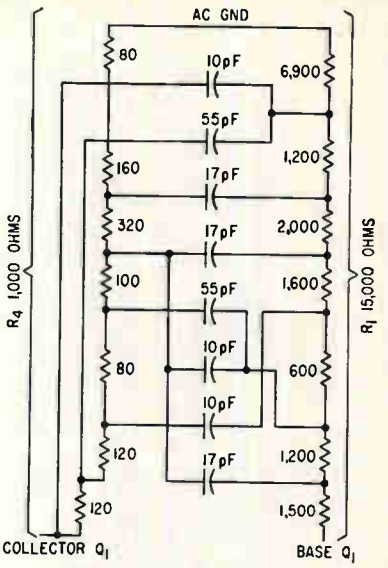


FIG. 3—Approximate equivalent circuit of an astable multivibrator

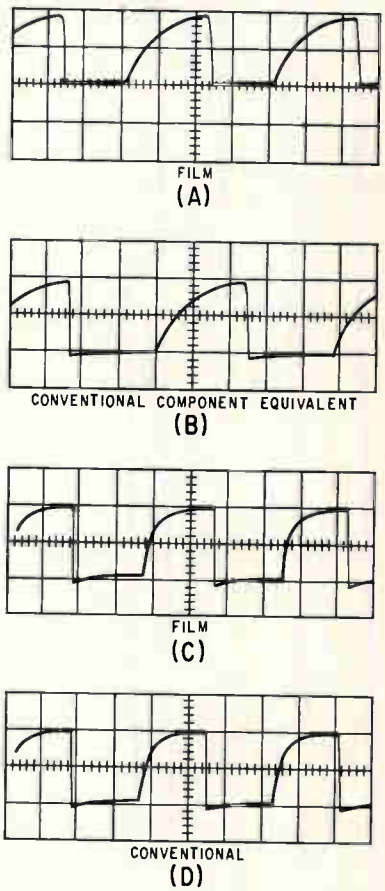
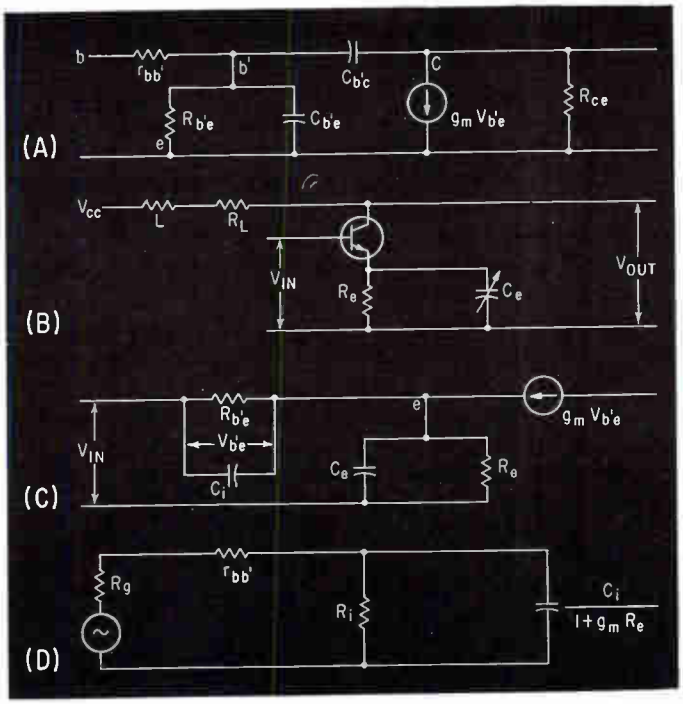


FIG. 4—Collector waveform for film astable multivibrator (A) and conventional component equivalent (B). Optimized circuit waveform (C) with conventional equivalent (D)



Simplified hybrid-pi equivalent (A) of basic video amplifier (B). Equivalent input circuit (C) and input circuit with generator resistance (D)

Emitter Peaking

Emitter peaking improves response, linearity and stability of transistor video amplifier as well as minimizing effects of varying or different transistor internal parameters. Design equations for this circuit are presented

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DESIGN of transistor common-emitter video amplifiers is complicated by the low input impedance of transistors and the frequency dependence of this imped nce. The response of a typical high-frequency transistor amplifier is more dependent upon input parameters than output; therefore, any peaking or high-frequency compensation should be concerned with the base-to-emitter circuit rather than the collector circuit.

Emitter peaking improves the response of the input network as well as the linearity and stability of the amplifier. It also minimizes the effects of varying or different transistor internal parameters on the characteristics of the circuit. Although the improvement in response is accompanied by an almost proportional loss in gain, the loss is not serious because of the high gain or transconductance inherent in the transistor.

The following analysis is based on the familiar hybrid-pi[1] equivalent network shown in Fig. 1A and applies to the amplifier shown in Fig. 1B. The analysis consists of calculation of an equivalent input network, calculation of an output network and combination of these two calculations to provide useful design equations.

If it is assumed that the equivalent base resistance $r_{bb'}$ shown in Fig. 1A is part of the generator impedance, the input circuit can be represented by the equivalent circuit shown in Fig. 1C. At low frequencies, neglecting C_e, the input impedance appears as a parallel total input resistance R_{in} and equivalent input capacitance C_i having the values

$$C_i = C_{in} / (1 + g_m R_e)$$
$$R_{in} = R_{b'e} (1 + g_m R_e)$$

The value of C_{in} is given by

$$C_{in} = C_{b'e} + C_{b'c} g_m R_L$$

To determine the time constant and loss of the input network, the effects of $r_{bb'}$ and the generator resistance must be included as shown in Fig. 1D. Equivalent input resistance R_i is the parallel combination of R_{in} and $R_g + r_{bb'}$ as

$$R_i = [R_{in} (r_{bb'} + R_g)]/[R_{in} + r_{bb'} + R_g]$$

where R_g is the internal resistance of the signal source. If emitter capacitance C_e is neglected, the input time constant is

$$T_{in} = R_i C_i$$

There is a small signal loss ($A_{bb'}$) in the input network as a result of $r_{bb'}$

$$A_{bb'} = R_{in}/(R_{in} + r_{bb'})$$

Analysis of the collector at low frequency involves the parameters shown in Fig. 1C. Output voltage V_{out} is

$$V_{out} = g_m V_{b'e} R_L$$

Input voltage V_{in} is

$$V_{in} = V_{b'e} + g_m V_{b'e} R_e$$

Internal gain from base to collector $A_{b'c}$ may be computed as

$$A_{b'c} = V_{out}/V_{in} = (g_m V_{b'e} R_L)/(V_{b'e} + g_m V_{b'e} R_e) = (g_m R_L) / (1 + g_m R_e)$$

Total gain A is

$$A = A_{bb'} A_{b'c} = [R_i/(R_i + r_{bb'})] [g_m R_L / (1 + g_m R_e)] = g_m R_L R_{b'e}/ [R_{b'e} (1 + g_m R_e) + r_{bb'}]$$

The value of g_m at 25 C is approx-

Improves Video Amplifier Response

imately $g_m = 0.38\ I_e$ (in ma). Time constant of the collector is defined as $T_{out} = R_L\ C_o$ where $C_o = C_{ob} + C_{wiring} + C_{load}$.

This time constant may be improved by shunt or series inductance peaking. More complex peaking generally will not produce an appreciable improvement in the response of the entire amplifier because the peak network imposes bandwidth restrictions.

Shunt peaking may be used with an allowable overshoot of 2.5 percent. Bandwidth improvement of 1.7 may be realized in the collector with the output time constant reduced by a factor of 1.7 as[3]

$$T_{out} = R_L\ C_o/1.7$$

For such shunt peaking of an amplifier, a small inductor L, is placed in series with the collector load resistance R_L. This inductor has the value[3]

$$L = m\ R_L^2\ C_o$$

where m is 0.4 for a bandwidth improvement of 1.7 and an overshoot of 2.5 percent. If $r_{bb'}$ is neglected, the low-frequency voltage gain of the amplifier A' is given by

$$A' = g_m\ R_L\ /\ (1 + g_m\ R_e)$$

The gain of the amplifier is reduced by the factor $(1 + g_m\ R_e)$ compared to that of an equivalent amplifier having either no emitter resistance or a well-bypassed emitter resistance. Because the time constant or bandwidth is improved by exactly the same ratio, the gain-bandwidth product remains constant.

The emitter resistance and capacitance perform to some extent as a frequency-compensated attenuator to the signal being amplified. The flattest response is achieved when the emitter-circuit time constant T_e equals the time constant of its parameters

$$R_e\ C_e = [(T_{in})^2 + (T_{out})^2]^{1/2} = T_e$$

The upper cutoff frequency of the amplifier $f_{3\,db}$ for the maximally flat condition is given by

$$f_{3\,db} = 1/2\ \pi\ T_e$$

If some overshoot or undershoot is desired or can be tolerated, an approximate expression for the upper cutoff frequency may be used

$$f_{3\,db} = 1\ /\ |2\pi\ T_e\ C_e|(C_e + \Delta\ C)]$$

Over a small range ΔC is the amount of capacitance added to or subtracted from the capacitance across the emitter resistance. The 10-percent to 90-percent rise time T_r is then approximately

$$T_r = 2.2\ T_e$$

The gain-bandwidth product remains approximately the same for small changes in R_e or R_L as long as the emitter current is constant. For example, the germanium drift-field transistor 2N384 provides a gain-bandwidth product of approximately 200 Mc at an emitter current of 5 ma, whereas the 2N1491 silicon-mesa type transistor has a gain-bandwidth product greater than 500 Mc at an emitter current of 25 ma.

As an example of design procedure, assume a pulse amplifier similar to that shown in Fig. 1B required to have the following characteristics: voltage gain A of 20, input impedance R_{in} is from a 75-ohm cable, load capacitance C_{load} of 10 pf and a maximum temperature T_{max} of 75 C.

Free-air dissipation P_c of the 2N1491 is 0.25 watt at an ambient temperature of 75 C. Assuming V_{cc} of 28 volts and maximum dissipation capabilities

$I_e = P_c/(V_{cc}/2) = (0.25)/(28/2) =$ 17.8 ma

$R_L = (V_{cc}/2)/I_e = 785$ ohms (750 ohms is used)

The gain of the amplifier is

$$A = (g_m\ R_L\ R_{b'e})\ /\ [R_{b'e}\ (1 + g_m\ R_e) + r_{bb'}]$$

where $A = 20$, $r_{bb'} = 30$ ohms, $R_{b'e} = 60$ ohms and $g_m = 0.38\ I_e = (0.038)\ (17.8) = 0.675$ mho.

Substituting these values in the gain equation yields a value of approximately 33 ohms for R_e.

$C_{in} = C_{b'e} + C_{b'c}\ g_m\ R_L =$
$450 + 2(0.675)\ (750) = 1{,}462$ pf

$R_{in} = R_{b'e}\ (1 + g_m\ R_e) =$
$60\ [1 + (0.675)\ (33)] = 1{,}396$ ohms

$R_i = [R_{in}\ (r_{bb'} + R_g)]/[R_{in} + r_{bb'} + R_g] =$
$[1{,}396\ (30 + 75)]/1{,}396 + 30 + 75 =$ 97.6 ohms.

$T_{in} = R_i\ C_i = R_i\ C_{in}/(1 + g_m\ R_e) =$ 6.15 nanoseconds

Output capacitative loading C_{out} is given by

$C_{out} = C_{ob} + C_{wiring} + C_{load} =$
$5 + 3 + 10 = 18$ pf

Assume the $R_e\ C_e$ product equal to the $R_L\ C_L$ product. The output time constant T_{out} with shunt peaking is then given by

$T_{out} = R_L\ C_{out}/1.7 =$
$(750)\ (18)\ (10^{-12})/1.7 =$
7.95 nanoseconds

The value of C_e may be determined as

$R_e\ C_e = (T_{in}^2 + T_{out}^2)^{1/2} =$
$[(6.15)^2 + (7.95)^2]^{1/2} = 10$ nanoseconds

$C_e = T_e/R_e = 10/33 = 303$ pf.

Upper cutoff frequency is given by

$$f_{3db} = 1/2\ \pi\ 10 \times 10^{-9} = 15.9\ \text{Mc}$$

The gain-bandwidth product of the amplifier is 15.9 × 20 or 318. This product remains approximately the same at this emitter current for small changes in R_e or R_L and may be used as a guide for amplifiers requiring a different gain or bandwidth from that shown in the example.

The author thanks R. Minton, H. Lee, W. Williams and C. F. Wheatley for their technical assistance.

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Voltage-Variable Capacitors

Series-resonant circuits using voltage-variable capacitors can be interconnected to form a square-wave oscillator with a controllable frequency range between 15 cps and 1.5 Kc; r-f energy is used as the power source

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AMONG recent electronic devices using semiconductor material is the voltage variable capacitance diode. This semiconductor is a unidirectional element and has a voltage-variable junction capacitance. For a-c voltage components that are small in comparison with the reversed bias voltage across the junction, the diode operates as a variable capacitor and the magnitude of its capacitance is a function of the d-c reverse bias voltage[1].

In the circuit of Fig. 1A, assume a signal input of amplitude E across matching impedance R_m. The positive half cycle of the signal will flow through diode C_r charging tank RC. Due to diode action, the negative half cycle cannot flow. If R is sufficiently large so that time constant RC is large with respect to the period of the input signal, the charge on C will remain almost constant and there will be a d-c voltage output V_{out}. This d-c output voltage appears across diode C_r as a reverse bias voltage that determines the capacitance of C_r.

As the amplitude of the input signal is increased, voltage V_{out} increases and the value of C_r varies. Characteristic curves show that the capacitance value of C_r decreases with an increasing reversed bias voltage[2]. For a certain value of input voltage, C_r will be such that the series elements L and C_r will have a resonant frequency equal to the input signal frequency. At this point V_{out} will be maximum.

When the natural frequency of the tuned circuit is below the input frequency, and the input voltage is small in amplitude, the small self bias causes a large capacitance value and an under-resonant series circuit.

As the input signal is increased in magnitude, the circuit resonant frequency value approaches that of the input and a regenerative effect of increasing bias causes a switching action at the output voltage V_{out}[3]. Thus, V_{out} reaches a maximum value and a large reverse bias voltage is established across diode C_r. Since the magnitude of the bias voltage is large compared with the magnitude of the a-c voltage component across the C_r, variation in the actual capacitance C_r will be so small it can be considered constant.

Rectification of this small a-c component will compensate the d-c losses of C discharging through R and a constant d-c voltage will exist across the tank RC.

If the bias voltage can be changed in magnitude (decreasing the input amplitude so that there is not sufficient compensation for d-c losses of the tank), then V_{out} will decrease in magnitude and C_r will increase its value.

Continuing decrease of the input signal magnitude, a second critical value of C_r is reached at which a negative regenerative action starts and the output voltage is switched to a low-voltage level. Therefore, the circuit has two stable states.

It is possible to set input amplitude E so that there is no actual compensation for the d-c losses of the tank circuit and there is an internal triggering down to the low level. This corresponds to the quasistable operation.

If fast changes of bias voltage can be produced across the diode, then the output level can be made to jump from one to the other output level of voltage, and oscillations will occur across the tank.

The series circuit can be tuned to a given input frequency by varying inductance L. The higher the Q of the circuit, the larger the output voltage jumps will be. For Q's below a certain value no sudden level changes will occur.

Two series-resonant circuits can be connected in parallel across the output of an r-f generator with a common matching impedance Z (see Fig. 1B). The two circuits are identical in that the nominal values of the circuit components are the same. It is possible to tune both circuits for resonance at the common input frequency value.

As the input voltage is increased across impedance Z, the d-c output voltages across tanks R_1 C_1 and R_2 C_2 will increase until the component values of one of the series circuits will be such that regenerative action will occur and the voltage across that branch (for example V_1 across R_1 C_1) will jump to its upper level, while V_2 will remain at its low level[4].

If a perturbation can be produced in V_1, the effective value of C_{r1} will change. Thus, this series circuit will no longer be at resonance, its impedance will increase and the current through the other branch will increase varying the value of C_{r2} and forcing the second series circuit into resonance. The output voltage values will be inter-

OUTPUT SIGNAL LEVELS

	State 1	State 2
V_{in}	0.95 v rms	1.10 v rms
V_1	0.14 v d-c	16.50 v d-c
V_2	16.50 v d-c	0.14 v d-c

Make a Relaxation Oscillator

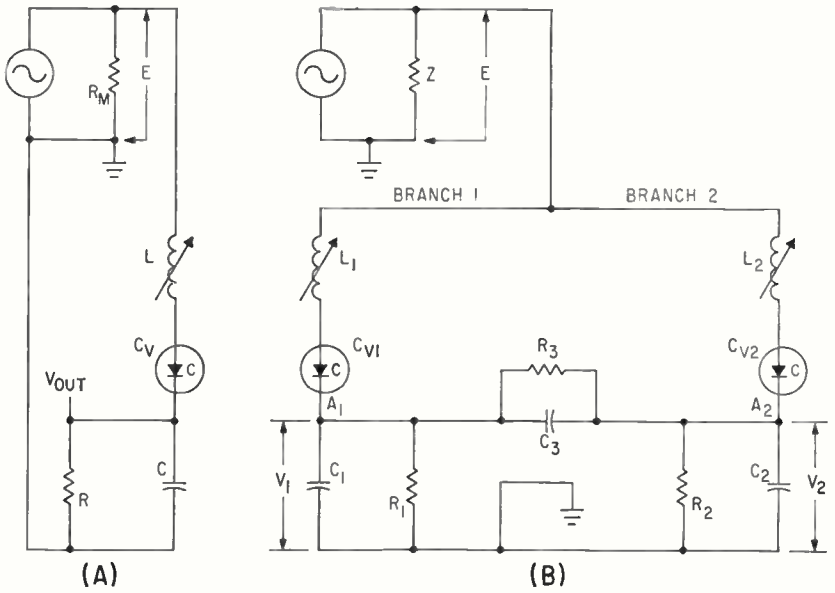

FIG. 1—Single series-resonant circuit (A) can be modified to a double-branch circuit (B) capable of acting as a relaxation oscillator

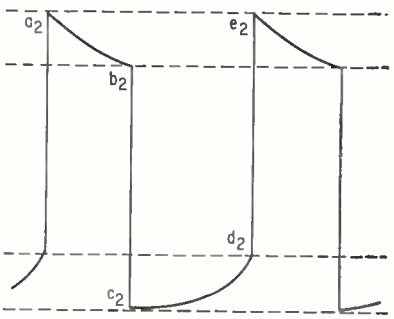

FIG. 2—Waveshape of relaxation oscillator corresponding to output voltage V_2

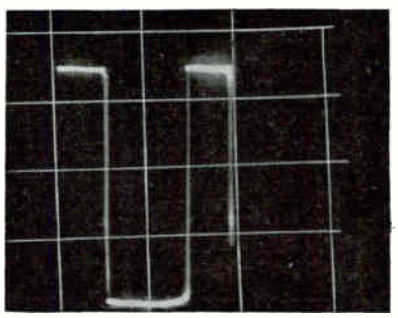

FIG. 3—Waveshape: V_1 = 3.6 v d-c, f = 71 cps, C_3 = 0.3 μf and R_3 = 150,000 ohms

changed with V_2 at the upper level and V_1 at the lower level. The circuit then has two stable states and can be triggered from one to the other.

With input frequency of 4 Mc, Z of 600 ohms, L_1 and L_2 adjustable high Q coils of 42 to 100 μh inductance, C_{v1} and C_{v2} of 22 pf at −4 v d-c (PC-113-22), C_1 and C_2 of 300 pf mica capacitors and R_1 and R_2 of 1 megohm, and setting inductors L_1 and L_2 at 80 μh, the input amplitude was varied until the largest possible difference was obtained between the two output levels. The table shows the results.

Variation in input amplitude is due to slight differences between L_1 and L_2. The two series circuits should not be identical for optimum operation in this mode.

Relaxation oscillations are characterized by a sudden change, or relaxation, from one state of operation to another. When both states of operation are states of equilibrium the operation is known as a bistable mode. If one of the states is a stable equilibrium for only a certain period of time determined by coupling time-constants and bias so that the circuit switches itself back to the initial state, the operation is known as a quasistable mode.

In an RLC circuit, with a small L or a large C, especially if one of the elements is nonlinear or even discontinuous, nonlinear oscillations are possible[5].

If the two series resonant branches of Fig. 1B are interconnected with the parallel combination of R_3 C_3, the circuit forms a relaxation oscillator when operated under the proper conditions.

Assume that branch 1 (L_1 C_{v1} R_1 C_1) is tuned to resonance at the input frequency of the rf generator and that branch 2 (L_2 C_{v2} R_2 C_2) is slightly unbalanced or untuned with respect to the input frequency. Under these conditions the circuit will tend to switch back to the situation where V_1 is at its high output level once a perturbation has taken place and a momentary change of states has occurred.

When interconnection tank R_3 C_3 is introduced into the quasistable trigger-pair circuit, the two output voltages tend to balance.

A potential difference will appear across C_3 and C_2, with a larger voltage on C_2 since C_3 has a larger capacitance (within a range of 1 μf to 0.01 μf). The larger potential across C_2 becomes a reverse bias for C_{v2}. When V_2 has reached a threshold value, a disturbance occurs that switches branch 2 into resonance. As a consequence, V_2 reaches a high output level with the interconnection of R_3 C_3.

At the same time, high level V_2 is proportionally divided between C_3 and C_1, increasing V_1 and if the input amplitude is sufficiently large, output V_1 will also reach a high level. Branch 1 is tuned to resonance for the input frequency while branch 2 is untuned. The high output level of V_1 will be larger than the high output level of V_2 and a new potential difference will exist across C_3. Figure 2 shows output voltage V_2. High level of branch 2 (a_2) is an unstable state as it corresponds to the quasistable situation. Therefore, branch 2 will try to move out of it as C_2 discharges. This is delayed by discharge of C_3 across the paral-

lel combination of R_3 and R_1 R_2 in series.

At a certain value of V_2, point b_2 in Fig. 2, the output voltage of branch 2 is switched to its low level output c_2. Since C_3 cannot discharge instantaneously and the voltage at point A_2 of the circuit (Fig. 1B) has decreased instantaneously, it is necessary for the voltage at point A_1 to decrease by the same amount. Consequently V_1 is practically switched to its low level at the same time that V_2 drops. Now branch 1 is in a quasistable state.

The discharge of C_3 continues during the low-level period and the voltage across C_2 increases. At the same time, since the input amplitude has not been varied and is large, branch currents flow thus increasing the reverse bias of the diodes exponentially from c_2 to d_2.

At d_2, the critical bias voltage is reached for C_{r2} and V_2 is switched to its high level. Thus V_1 is also switched to its high output level and a complete cycle of relaxation is obtained. Since the changes of state must occur at the same time for both output voltages, due to the location of C_3 in the circuit, both oscillations are in phase.

Slight changes in the amplitude and frequency of the input voltage varies the amplitude of output voltage V_2 without affecting the relaxation oscillations. An optimum value of V_2 can be found where the voltages of branch 1 are precisely those needed for no overdriven operation, and V_1 is close in shape to a square wave. For Fig. 1B, Z is 630 ohms, f_{in} is 2.9 Mc, V_{in} is 1.35 v rms, L_1 is 141 μh, L_2 is 131 μh, C_{r1} and C_{r2} are both 22 pf diodes, C_1 and C_2 are 240 pf, R_1 and R_2 are 750,000 ohms, C_3 is a capacitor decade between 0.01 and 1 μf and R_3 is a variable resistance between 15,000 ohms and 10 megohms. The square wave is shown in Fig. 3.

The d-c levels of both outputs were measured with a vtvm and were found to be 13.25 v for V_1 and 12.25 v for V_2. Graphical measurements lead to the approximate values of 15.5 v d-c and 11.90 v d-c for V_1 high and low values respectively and 14.75 to 14.25 v d-c and 10.65 to 11.15 v d-c for V_2 high and low values respectively.

Current was difficult to measure directly since insertion of a microammeter tends to stop oscillation. However, 40 μa is a good approximation. If both branches of Fig. 1B are operated separately as series-resonant circuits for the same input frequency and the d-c output voltage is plotted against the rms input amplitude, jumps of 7 v d-c and 5.5 v d-c will be obtained for V_1 and V_2 respectively.

The jumps of relaxation oscillations are only 3.6 d-c volts in amplitude. The jumps of branch 2 are smaller than the jumps of branch 1 because branch 2 is untuned for the input frequency, a forced condition to operate the whole circuit as a quasistable oscillator. Less change in bias is needed to trigger the circuit of branch 2 and hence it is this circuit that first moves out of one of the end states. The amplitude of the jump in the oscillator circuit is the same for both branches; however, since branch 2 jumps first or starts the jump first, the relaxation oscillations can be considered to be driven by the operation of branch 2. The amplitude of the oscillations will not be larger than the amplitude of the jump given by the static curve of branch 2 when operated as a single series resonant circuit.

In all cases, the jump from low to high level is a clean line indicating that the switching is obtained without any ringing and at a speed of approximately 300 μsec. A thicker switching line indicates the presence of ringing. This ringing limits the range of the relaxation oscillations as the values of the R_3 C_3 tank are varied. For the experimental values given for the circuit of Fig. 1B, the range of the square wave oscillations were found to be 50 cps to 1 Kc.

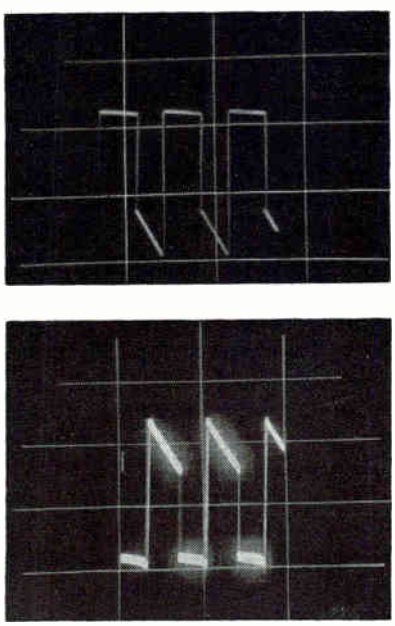

FIG. 4—With V_1 and V_2 at 6 v d-c, top shows f = 130 cps and C_3 = 0.1 μf. Bottom shows f = 140 cps with C_3 = 0.08 μf

The series combination of R_1 and R_2 in parallel with C_3 could constitute the interconnection tank R_3 C_3. Therefore, R_3 is not essential for oscillations and may be removed from the circuit of Fig. 1B. If branch 2 is detuned to a greater degree, the output waveforms can be changed in shape. When the detuning is too large, branch 2 will not have sudden jumps. Nevertheless, if a voltage variable-capacitance diode with a steeper capacitance-versus-bias slope is used in branch 2, it is possible to obtain a considerable change in current, although not a sudden one because this branch is never at resonance. The circuit is operated with branch 1 as a quasistable circuit and branch 2 with a ramp output.

For the circuit of Fig. 1B, with R_3 removed and f_{in} = 3 ±0.02 Mc, V_{in} = 1.6 v rms, L_1 = 139 μh, L_2 = 36.5 μh and C_{r2} = 47 pf at −4 v d-c, the waveforms shown in Fig. 4 are generated at V_1 and V_2.

From the values of C_3 shown in Fig. 4, note that the output frequency is inversely proportional to the time constant of tank C_3 − (R_1 + R_2). Varying C_3 causes the output frequency to range from 15 cps to 1.5 Kc. The measured d-c levels are 14 v and 7 v for V_1 and V_2 respectively. Circuit current is approximately 22 μa.

The authors thank Pacific Semiconductors Inc. for semiconductor diodes and technical data charts.

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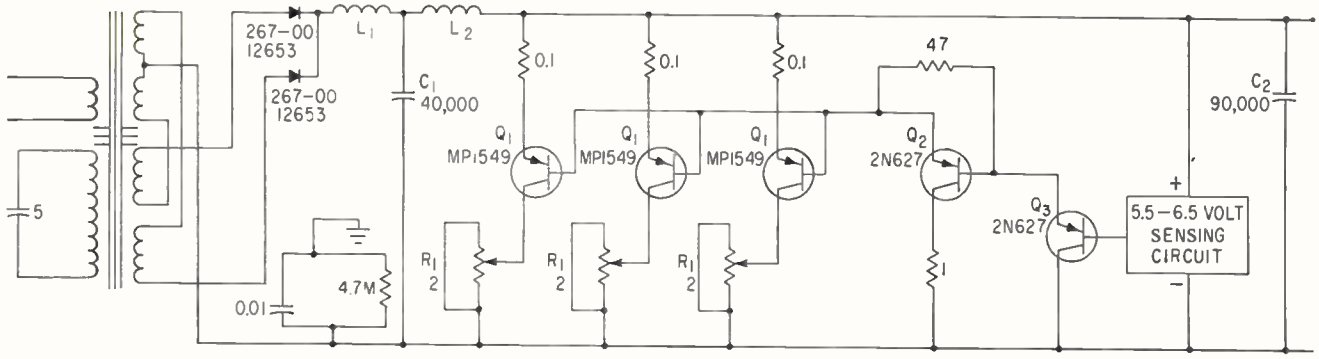

FIG. 1—Constant voltage transformer feeds rectifiers and shunt regulator. Sensing circuit feeds back correcting signal, causing transformer to collapse to hold desired output

Transformer and Shunt Transistors Regulate D-C Power Supply

Constant voltage transformer and shunt-transistor regulator control a d-c power supply. Feedback-sensitive circuit uses Zener diode as reference

By J. T. KEEFE,
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CONSTANT VOLTAGE ferroresonant transformers can be used in d-c power supplies to provide a high degree of regulation. When used with silicon rectifiers and high capacitance, etched foil, telephone-grade electrolytics, a circuit is available suitable for many applications. Transformers are designed to deliver only about 150 percent of rated current, thus protecting the rectifiers against initial charging surges and the load from short circuit.

However, the series impedance of the power supply, while low, causes a regulation problem when load current is high, as it can be in circuits using many transistors. A shunt regulating circuit, which is a-c in principle and depends on the leakage reactance of the constant voltage transformer, has been developed to produce well-regulated d-c at high efficiency. Operation of the constant voltage ferroresonant transformer is explained in the editorial box; the feedback controlled, shunt regulating circuit is shown in Fig. 1.

The photograph shows a typical shunt-regulated supply

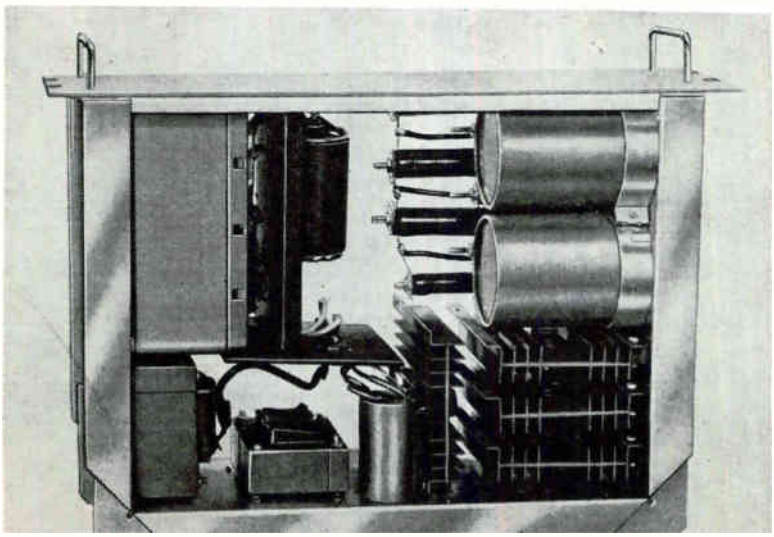


Figure 1 shows a ferroresonant supply using full wave center-tapped rectifier, choke-input pi-section filter, shunt transistors and sensing circuit. The power supply without shunt regulator is adjusted to a nominal output voltage that is always above rated voltage under the worst conditions of line, load, ripple and temperature.

The shunt transistors produce regulation by increasing the voltage drop through the leakage reactance of the constant voltage transformer (CV). Current through the shunt circuit adds to the load current so that the total keeps the output of the CV (after filtering) at rated output voltage. Resistor R_1, in series with each power transistor, dissipates the additional watts beyond the capability of the transistor. If the watts to be dissipated exceeds the rating of one transistor—resistor, parallel elements are added.

Transistor Q_1 is controlled by Q_2 and Q_3, which are driven by the voltage sensing circuit. A temperature-compensated Zener diode cir-

cuit, adjusted to give rated output from the supply, is used in the voltage sensor. When output is too high, the voltage difference is amplified and applied to the base of Q_3, turning on Q_2 and in turn, Q_1.

Current flow through Q_1 continues until the output voltage has dropped to the reference level, at which point all transistors turn off. Since there always tends to be a voltage difference, the action repeats continuously at a high rate (approximately 1 Kc) and is more analogous to a switching circuit than to an amplifier. Because the transistor circuit responds almost instantly, 120-cps ripple is also attenuated and is lower than in the basic supply.

The shunt regulated circuit gives high performance at relatively low cost and minimum complexity. Regulation obtained from the CV costs less than a transistor circuit that would give the same results. However, as the power rating of the supply decreases, the CV eventually will not pay its way, and it is better to use an all-transistor supply. The cutoff point is probably between 20 and 30 watts.

The circuit has other advantages besides simplicity. It is inherently short-circuit proof due to the collapsing action of the CV transformer. In addition, no load current flows through the regulating transistors, thus they are unaffected by overloads or short circuits.

The regulating circuit is relatively fail-safe. For an open, the transistors would draw only leakage current but the CV transformer would still be effective. For a short, the output would collapse,

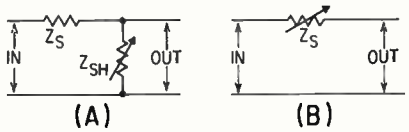


FIG. 2—Shunt regulator (A) and typical series regulator (B)

as with an external short. In no event would the load be subjected to a sudden substantial increase in voltage due to failure in the regulating circuit.

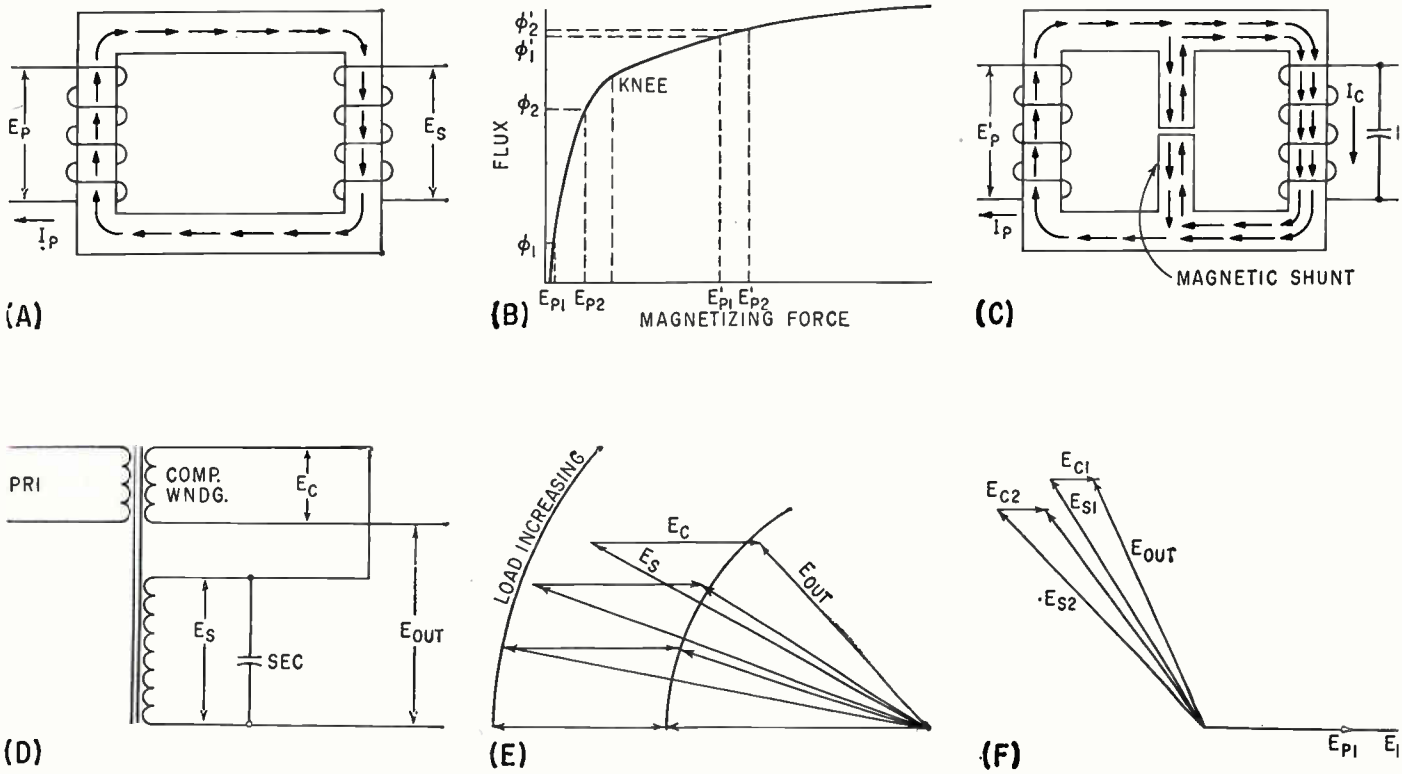
Figure 2A shows the shunt system of fixed series element and variable shunt element. Current through the variable element is adjusted so that the voltage drop across the series element varies enough to keep the output constant. In an a-c circuit, the elements can be impedances or resistances; in a d-c circuit, they can only be resistances.

The shunt principle is little used in d-c regulators because the fixed series element represents a continuous watts loss. In the d-c series regulator (Fig. 2B), the series resistance also dissipates some wattage but, since it varies only enough to provide regulation, the over-all power dissipation is less and the series system is more efficient.

In the design presented in this article, the parallel element is in effect a variable resistor but the series element is the leakage reactance of the CV transformer. Thus, effective regulation is obtained without incurring excessive dissipation.

The circuit shown in Fig. 1 uses three transistors in shunt and has rated output of 6 v d-c at 20 a. The primary of the CV typically is triple rated for 115/208/230 v a-c,

OPERATION OF CONSTANT-VOLTAGE TRANSFORME



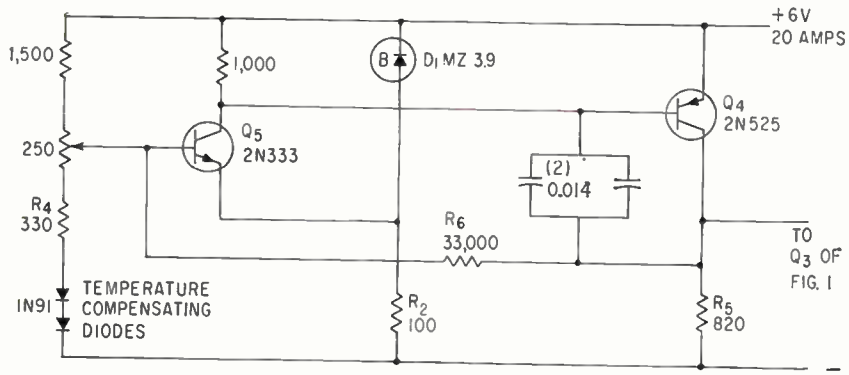


FIG. 3—Sensing circuit uses Zener diode as reference, develops error signal to control output of supply

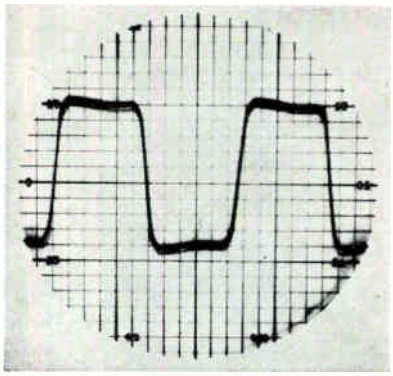


FIG. 4—Waveform from constant voltage transformer

±13 percent. The 0.1-ohm resistors in the emitters of the power transistors balance the current; the 47-ohm resistor paralleling Q_2 modifies the effect of leakage current.

The voltage sensor and preamplifier, Fig. 3, is connected normally to the power supply output terminals. However, it can be connected at the point of load. This is desirable in high current supplies since the voltage drop in distribution lines is then controlled. In the sensor, Fig. 3, a voltage proportional to output voltage is developed across R_1, R_4, temperature compensating diodes 1N91 and the potentiometer. The Zener diode conducts continuously and holds the supply voltage of Q_5 constant. However, the base-emitter voltage on Q_5 will vary with the output voltage. As the deviation (error) between output voltage and the Zener reference increases, the base-emitter voltage on Q_5 will decrease, turning Q_5 and Q_4 towards off. This causes the base current of Q_3 (Fig. 1) to increase, turning Q_3, Q_2 and Q_1 towards on. Thus the shunt current through Q_3 increases, causing output voltage to decrease. This decreases the error voltage and causes the base voltage on Q_5 to increase. Transistors Q_5 and Q_4 now turn towards on and Q_3, Q_2 and Q_1 towards off, reducing the shunt current. Thus the system maintains voltage equilibrium at the value determined by, but not equal to, the Zener diode voltage.

In a conventional transformer (A), primary voltage E_p sets up magnetizing current I_e. The flux set up by I_p, shown by arrows, is constant as long as E_p is constant.

A magnetization curve for typical transformer grade steel is shown at (B). In the area to the left at the knee of the flux changes in direct proportion to the magnetizing force. To the right of the knee, increase in magnetizing force has little effect on increasing flux.

In conventional transformers, rated input voltage occurs at a point such as E_{p1}. If the voltage is then increased to E_{p2}, the magnetizing force and flux increase, inducing E_s proportionally. Hence, for operation below the knee, output voltage is input voltage multiplied by the turns ratio, or $E_s = (N_2/N_1)\,E_p$.

With a magnetic shunt and a capacitor, shown in (C), current I_c flows in the capacitor and the secondary winding. Part of the flux produced by I_c flows in the shunt and does not link the primary. Thus, total flux under the secondary winding is higher than primary flux and is above the knee, corresponding to E_p'. As a result, variation in E_p' produces negligible change in the total secondary flux.

Since secondary flux is now relatively independent of primary voltage, secondary voltage is relatively constant. A compensating winding on the primary leg, connected in series opposition to the secondary, reduces variations further, as shown at (D). By proportioning, net output voltage is made nearly constant. Action of the compensating voltage for varying load and fixed input voltage, at (E), indicates the secondary voltage phase shift with increasing resistive load. The phase of the compensating voltage is unaffected and hence E_c progressively subtracts less, tending to compensate for load regulation effect. At fixed load and varying input voltage the change in magnitude of E_c provides the major compensating action although some phase shift still results. Vector relationships are shown at (F) for a 30-percent change in input voltage.

Capacitor current I_c has been shown to keep secondary flux relatively fixed for varying inputs. With a load, current in secondary is the sum of the load and capacitor current. If load current is resistive (unity power factor (pf)) there is a decreased secondary flux density and consequent lowering of output voltage. The poor load regulation can be partly corrected for by the compensating winding.

If load current is partly inductive (lagging pf), the effect of the capacitor is directly attenuated and output voltage will change with pf. This effect can often be compensated for on a-c applications.

If load current becomes too great, the effect of the capacitor is lost. Secondary flux now opposes primary flux, demagnetizing the secondary core leg. The output voltage collapses abruptly and limits the short-circuit current to 150 to 200 percent of full load.

Because the flux under the secondary winding is above the knee of the magnetization curve, output voltage, as shown in the oscillogram, Fig. 4, is not a true sine wave. This is an advantage in power supply applications, since it reduces the peak inverse voltage that the rectifying element must withstand

Vibrating Wire Probe Maps

Small single-loop probe vibrating at 14 Kc measures magnetic flux in small fields with 1-percent short-term accuracy

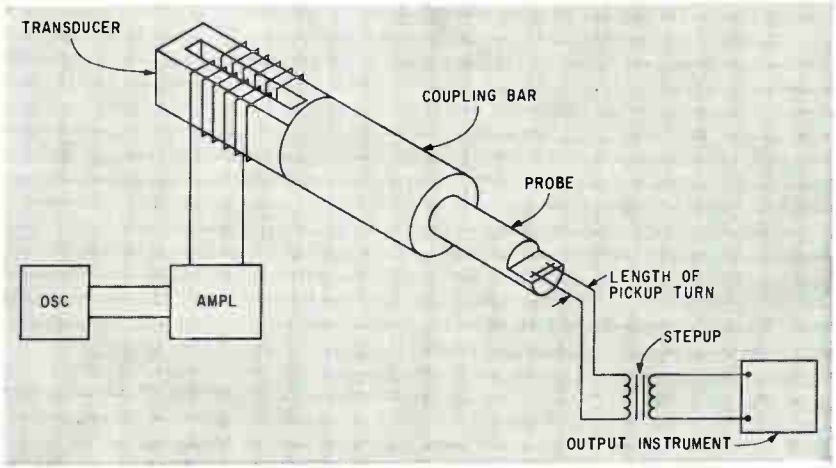


FIG. 1—Sketch shows original fluxmeter arrangement with 14-Kc magnetostrictive drive

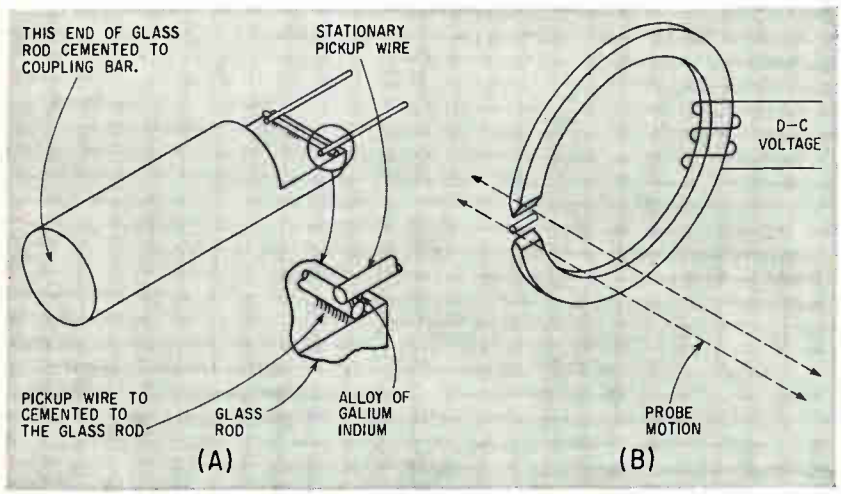


FIG. 2—Detail of modified pickup shows how pickup wires are attached to coupling glass rod, (A); laboratory setup used to check fidelity is shown in (B)

USES OF MAGNETIC MATERIALS in control and detection devices have greatly increased the need for micromeasurement of magnetic fields. Magnetic field plotting and microuniformity measurements have been conducted with rotating coil instruments, Hall generator devices and quartz crystal magnetometers.

The usefulness of each type of fluxmeter is determined by the thickness of the probe and its effective area. The thickness determines the minimum area for which accurate measurements can be made. Since the probe responds to the average of the flux densities within the sampling area, valid data can be obtained only when the flux density is uniform or when the gradient is known. The latter case does not occur frequently and will be ignored.

Let the sample magnetic field be nonuniform. The variation in flux density between any two points on a contour of this configuration is a function of the distance and the gradient between the points. When the distance between the points is decreased, the variation in flux density is decreased. The difference in flux density is decreased and becomes zero when the points share a location on the contour.

Useful data for field plotting or uniformity studies may be obtained for any external magnetic field if the sampling area is small enough. This assumes that the sensitivity of the measuring equipment is consistent with the magnitude of the magnetic field.

The equipment to be described has a sensitvity of 0.004 mv per gauss, a sampling area of 6.25×10^{-6} square inch, and an equivalent noise level of 10 gauss. The sampling area is generated by $\frac{1}{16}$ inch length wire as it is vibrated ± 0.0005 inch in a direction perpendicular to its length.

The vibration originates in a magnetostrictive transducer that operates at approximately 14 Kc. This 14-Kc vibration is transmitted to the pickup wire through a coupling bar. The pickup wire is cemented to a glass probe, cemented, in turn, to a bar of nonmagnetic stainless steel. The coupling bar is brazed to a magnetostrictive transducer. A sketch of this assembly is shown in Fig. 1.

The probe is designed to minimize extraneous pickup voltages. The vibration, which is necessary for producing the pickup voltage, is effectively isolated from all parts of the electrical circuit except the pickup turn. The isolation is accomplished by short, flexible electrical connection between the vibrating wire and the stationary brush wires. A sketch of the pickoff technique is shown in Fig. 2A. The base is a glass rod.

The pickup wire must be fastened to the probe base at a location that experiences maximum longitudinal motion. The effective length of the pickup turn is determined by the distance between the brush wire contacts. Contact between the pickup turn and the brush wire is made with an alloy of gallium and indium; this technique

Magnetic Flux Fields

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East Pittsburgh, Pennsylvania

provides good electrical contact with a frictionless mechanical coupling. The elimination of the transfer of mechanical energy from the pickup wire to the brush keeps vibration out of the brush wires.

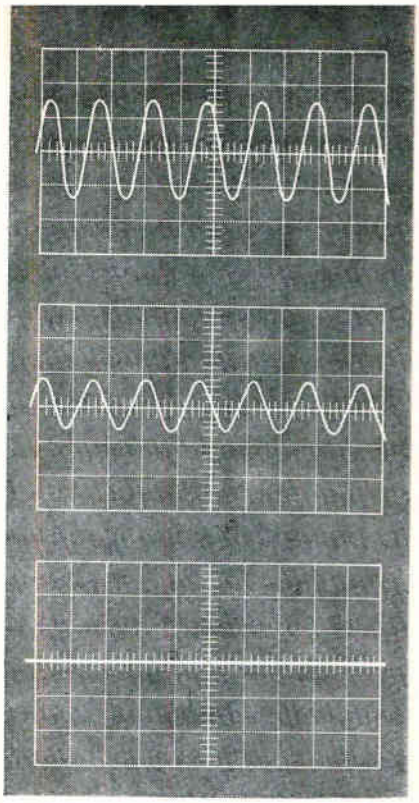
The voltage induced in the pickup wire is sinusoidal, at the same frequency as the vibration. An oscilloscope trace of the output voltage is shown. The top trace is at 5,000 gauss, the center at 2,500 gauss and the bottom at zero.

Proper adjustment of the gallium-indium contact will use a minimum quantity of the alloy. The distance between the pickup and brush wires should be kept to a minimum but they should not touch.

Several methods for checking the fidelity were tried. The more definitive data were obtained from a laboratory setup of the type shown in Fig. 2B. The core for this electromagnet was a single ring lamination with i.d. = 8 in., o.d. = 10 in. and 0.025 in. thick. The gap is $\frac{1}{16}$ in. long and the pole faces are pointed as shown. A plot of the output voltage against relative position of the pickup wire is shown in Fig. 3B. The symmetry about the peak ordinate indicates that only minor, if any, voltages are produced by the brush wires. There was no perceptible change in either the sinusoidal waveshape or phase during this test.

A more positive check of the fidelity using this ring sample will result if more precision is used in alignment between the pickup wire and the magnetic contour lines generated by the pole tips of the ring sample. The pole tips should trace parallel lines, lines that are parallel with the direction of vibration of the pickup wire.

A nominal accuracy for the equipment is ±3 percent. This includes variations in supply voltage and frequency, the nonlinearity of the step-up transformer and the accuracy of the indicating instrument. A Tektronix oscilloscope type 535 with a type-D preamp measured peak values of the output voltage. The rms value of the output voltage was measured with a Ballantine 320 electronic voltmeter. A plot of these two measurements against the excitation mmf of an electromagnet, Fig. 3A, shows that both outputs are linearly related to the flux density in the air gap of the electromagnet. This assumes that the air gap flux is a linear function of the excitation mmf. Since curves that are linearly related to some reference are also linearly related to each other, the form factor of the wave is constant. Hence, the shape of the wave may be assumed constant and the indicating instrument can be calibrated to read peak, average or rms values.



Fluxmeter probe in a field of 5,000 gauss (top), 2,500 gauss (center) and zero gauss (bottom)

Additional sources of error include variations in signal-to-noise ratio, variations in wave shape, and variations in effective length of pickup turn that result from changes in the geometry of the gallium-indium contacts. The measuring accuracy for general application is expected to be within ±3 percent, and for short-term measurements within ±1 percent.

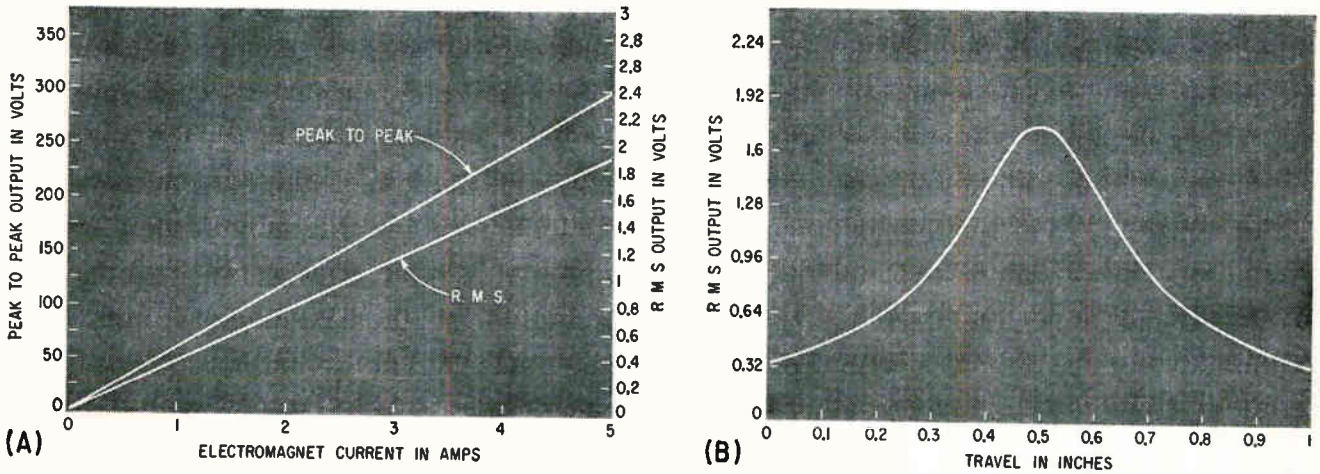
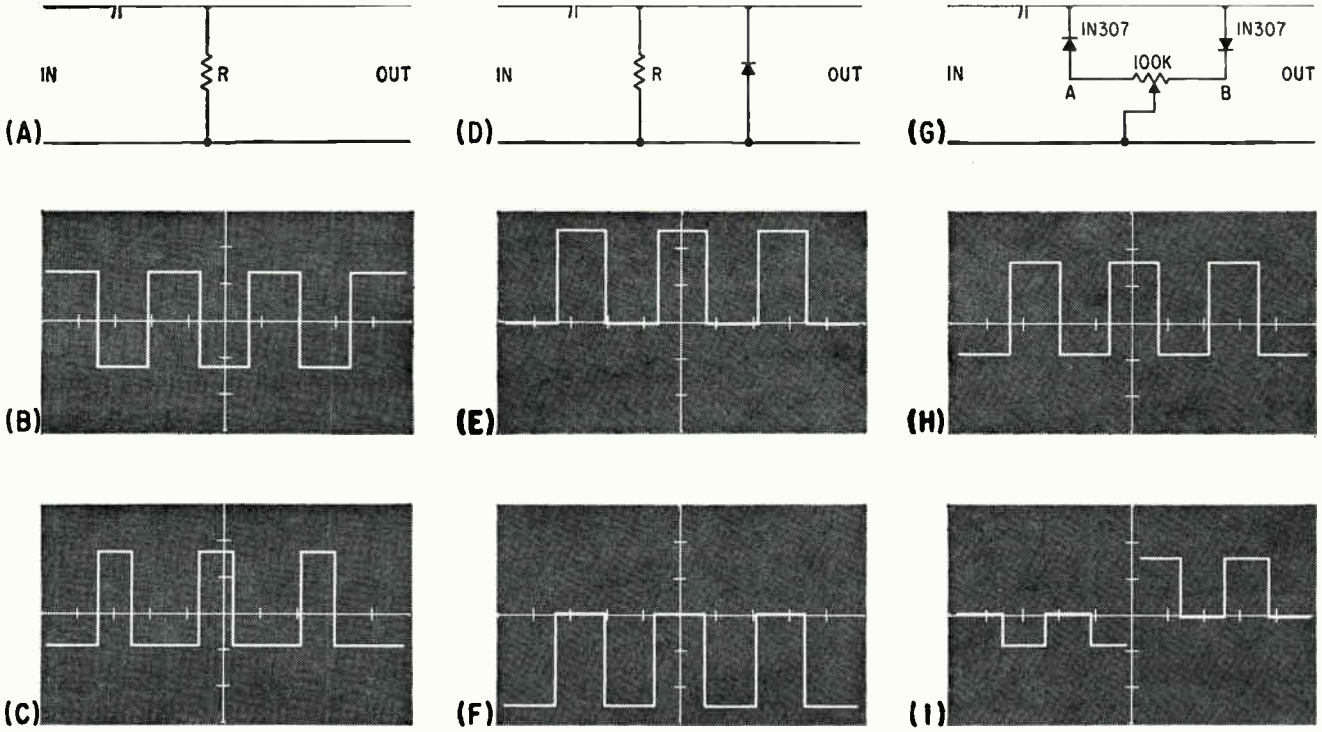


FIG. 3—Output of the vibrating wire fluxmeter is plotted against flux density (A); results of fidelity measurement using a setup of Fig. 2B are plotted as contour of flux density in (B)



Coupling capacitor circuit (A) places input waveform so that positive-voltage area equals negative-voltage area, whether wave is symmetrical (B) or asymmetrical (C); circuit shunted by diode (D) clamps input wave (E); reversing the diode has a negative-clamp effect (F). Adjustable clamp circuit (G) can be used to position any waveform between two extremes (H). It also serves as proportional rectifier, if output is taken from point A or B (I)

Adjustable Clamp Circuit

SHIFTS A-C SIGNAL LEVEL

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IF AN A-C SIGNAL is applied to a coupling capacitor loaded by a resistor (A), charge current flows from the second plate of the capacitor during positive excursions of the signal, and into the second plate during the negative excursions. The d-c level of the second plate of the capacitor must be such that the net change in charge is zero for a cycle. If the signal waveform is symmetrical, it must have equal positive and negative voltages (B); and if the signal is asymmetrical, it is shifted by an amount which makes areas under positive and negative parts of the signal equal (C).

In a conventional clamping circuit, the load resistor is shunted by a diode (D). This allows a heavy charging current to flow into the capacitor during the negative excursions of the signal, but becomes a high resistance during the positive excursions, so that discharge current can flow only through the resistor. The capacitor then takes on a net charge, and the d-c level of the signal is shifted positive (E).

If the diode is connected with the opposite polarity, the positive peaks of the signal are clamped to ground (F).

This description includes several assumptions, such as that the r-c time constant of the capacitor and resistor is much greater than the period of the signal[1].

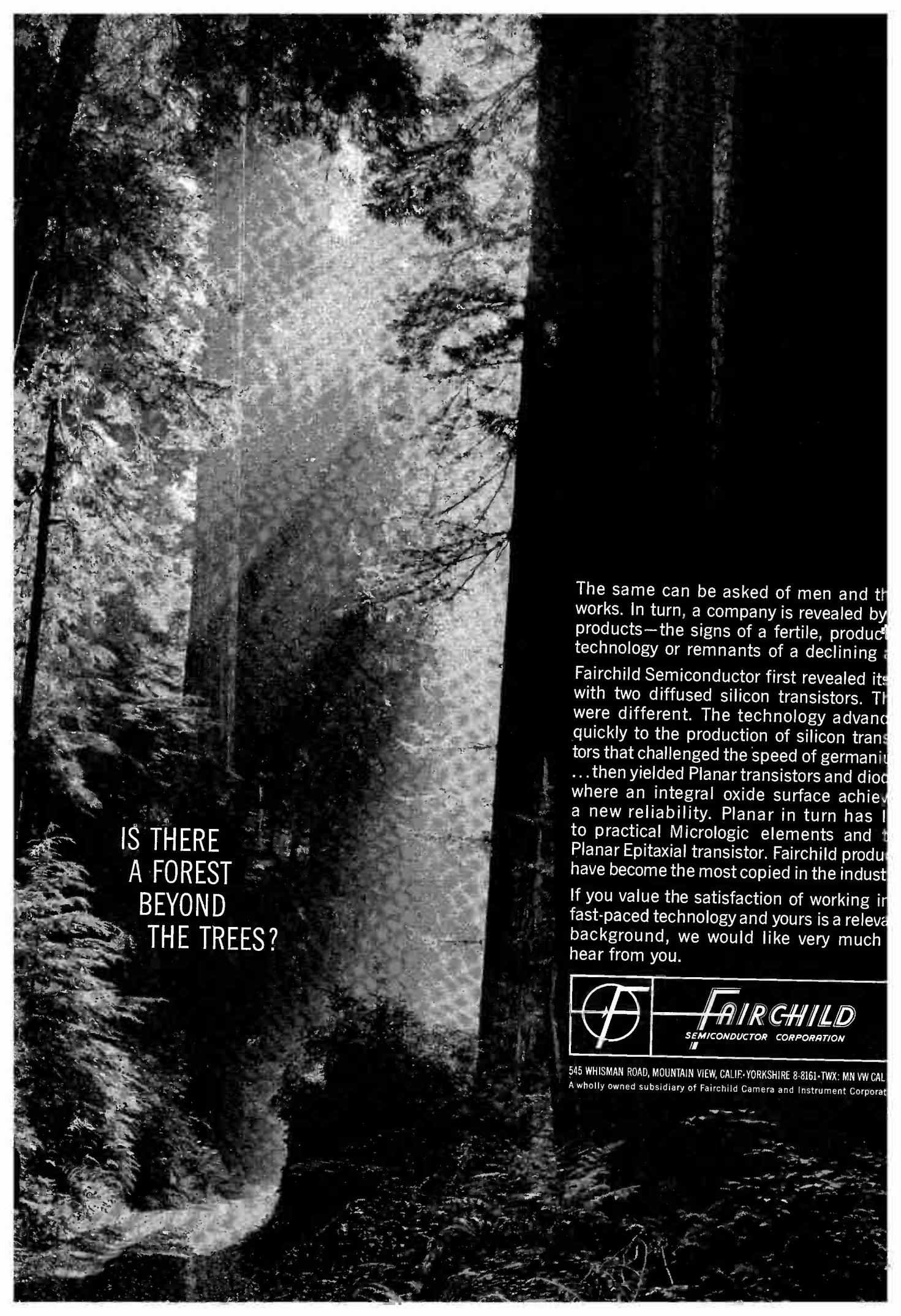
The d-c level of a signal may be shifted anywhere between the two limits of the full clamping circuits by a circuit with an adjustable ratio of the resistive loads for the positive and negative parts of the signal. A circuit is shown in (G). When the potentiometer is in its full clockwise position, the circuit is a full negative clamp (F). When the potentiometer is fully clockwise, the circuit is a full positive clamp (E). At midpoint, the loads for the positive and negative parts are equal, and the circuit is equivalent to (A).

For an intermediate setting, the signal takes up the corresponding intermediate level relative to ground. A symmetrical signal may be shifted by any desired ratio (H). An asymmetrical signal may be shifted to make the positive and negative peaks equal.

At points *A* and *B* of the adjustable clamp circuit (G) appear the rectified fractions of the signal that are negative and positive from ground (I). The circuit can also be considered as a proportional rectifier. For a constant-amplitude signal, it resembles a conventional clipping circuit,[2] however, the rectified fractions of the signal remain in constant proportion to the input signal.

REFERENCES

(1) J. Millman and H. Taub, "Pulse and Digital Circuits," McGraw-Hill Book Co., New York, Section 4-5, p 119, 1956.
(2) Ibid., Section 4-3, p 111.



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Broad-Based Research Produces Space Items

VARIABLE-BANDWITH communications system, plasma devices and thin-film elements are examples of development projects at a new research complex. The electronics laboratory, one of seven widely diversified facilities of the Paul Moore Research & Development Center, is responsible for the communications equipment. This flexible system is important for the Courier satellite program and for communications with moon bases.

The space-associated laboratory facilities also permit research in guidance and control systems, reentry simulation, material development, nuclear radiation, fluid systems, and space environment and life sciences. These Republic Aviation facilities including the electronics laboratory are supported by separately located transonic, supersonic and hypersonic wind tunnels. Efforts in any or all of the self-sustaining laboratories can be integrated into major space-related systems development.

The variable-bandwith communications system in Fig. 1 modifies performance in accordance with current propagation conditions. A design objective of the equipment is to maintain communications during fades. However when reception is good, the high signal-to-noise ratio is unnecessary. By trading receiver gain for bandwidth at these times, more information can be transmitted. In addition to the other applications, this principle is valuable for radar and electronic countermeasures systems.

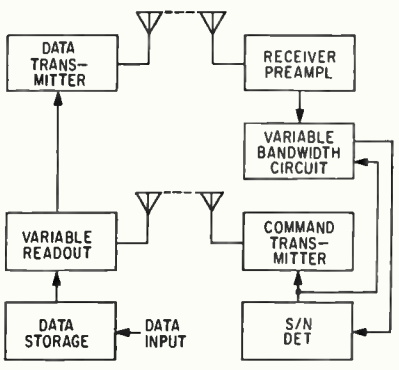

FIG. 1—Communications system selects optimum bandwidth in accordance with propagation conditions

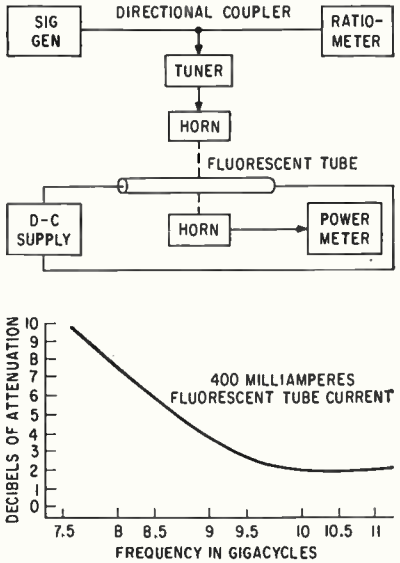

FIG. 2—Microwave frequencies propagated through fluorescent light with setup at top were attenuated as shown in plot

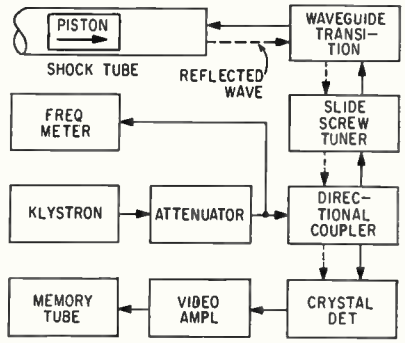

FIG. 3—Test arrangement uses microwaves to determine velocity history of shock tube piston

Plasmas, which normally have an adverse effect on propagation, can also aid signal transmission under certain conditions. In one experiment at the new installation, r-f was fed into d-c ionized fluorescent tubes. The tubes, with an electrically rather than a thermally created plasma, radiated the r-f signal like an antenna. This phenomenum could be significant if the re-entry plasma sheath from missiles could be made to act as an antenna.

Frequencies lower than plasma frequency that will propagate through the ionized sheath are being sought in other experiments. These windows have been created previously using magnetic fields.

Experiments at frequencies from 5.4 to 11 Gc were performed with the equipment in Fig. 2. Reflections in the system were tuned to minimum with the fluorescent light extinguished. With power switched on, the load was again matched. The difference in attenuation of the transmitted energy at different frequencies is shown in the figure. For future studies, a tube for generating an air plasma is planned having a size and shape more suitable for microwave experiments.

Microwave reflection techniques are being used for instrumentation of shock tube diagnositics. Microwaves reflected from the piston face in Fig. 3 can be used to determine complete velocity history of the piston. In preliminary experiments with a 14-mm shock tube, c-w microwave energy was used.

Output from a reflex klystron was directed through a rectangular-to-circular waveguide transition and a small circular hole plugged with teflon into the terminal end of the shock tube. The shock tube acted as a lossy waveguide and the piston as a movable short. Amplitude and relative phase is determined by comparing transmitted and reflected energy using a detector. This data was used to calculate piston position and velocity.

In the guidance and control systems laboratory, new techniques are being explored for possible use in detection, guidance and control of space vehicles. Active thin-film elements have been developed that operate at room temperature. Fabrication techniques are being investigated for microminiaturizing of such switching and storage devices as digital-to-binary converters and magnetic memory elements. In a laser project, the laboratory hopes to develop a compact high-intensity

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PR 80-2.5M	0-80	0-2.5	1.5	3½	19	13⅞	$325.00
PR 155-1M	0-155	0-1	1	3½	19	13⅞	$325.00
PR 310-0.6M	0-310	0-0.6	0.5	3½	19	13⅞	$345.00
PR 15-30M	0-15	0-30	4	7	19	13⅞	$495.00
PR 38-15M	0-38	0-15	2	7	19	13⅞	$475.00
PR 80-8M	0-80	0-8	1.5	7	19	13⅞	$450.00
PR 155-4M	0-155	0-4	1	7	19	13⅞	$430.00
PR 310-2M	0-310	0-2	0.5	7	19	13⅞	$430.00

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LOAD — *at maximum output voltage:*
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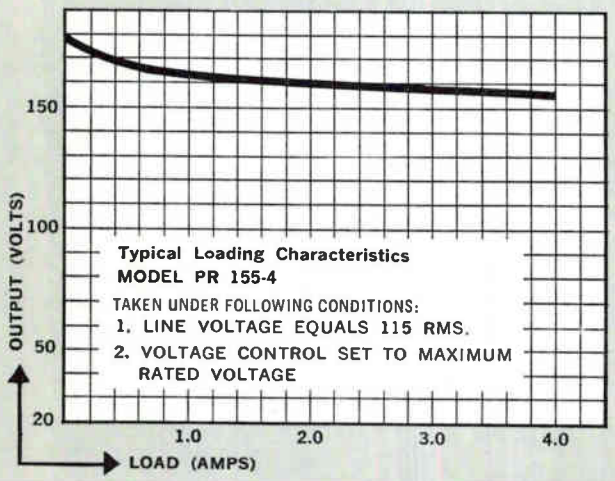
Less than 4% output voltage change for 25-100% load change (6% for PR 15-10M and PR 15-30M).
(See Graph below for typical load characteristics)

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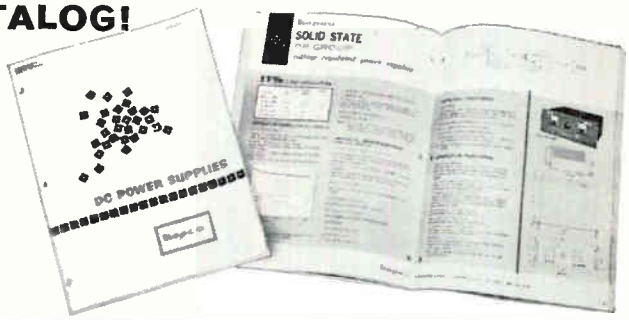

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coherent light source as a solution to some weapons systems problems.

Other projects include investigations of intermetallic compounds, cermets, structural plastics, pure crystal samples and operation of electronic equipment in the presence of nuclear radiation.

Low-Energy Technique Can Produce Neutrons

NEUTRONS are being produced in an energy range previously unobtainable with low-energy accelerators. The technique provides a laboratory source of neutrons that formerly were produced only with more costly high-energy accelerators. The process is also of interest in furthering knowledge of theoretical nuclear physics.

The method was described to the American Physical Society in a paper by William Imhof of the Missile and Space division of Lockheed. While performing studies for the Atomic Energy Commission, Lockheed physicists discovered how to produce neutrons in the range of 8 to 11 Mev using conventional low-energy generators.

The technique involves bombarding a radioactive target (carbon^{14}) with deutrons. These heavy hydrogen particles are accelerated with a conventional 3-Mev Van de Graaff generator. When a deutron collides with the target, the proton is stripped from the deutron leaving only the neutron. In this reaction, the neutron receives nearly 8 million volts of energy more than that of the incoming deutron.

Usefulness of the reaction as a source of neutrons was evaluated by measuring that rate at which neutrons were produced when the deutrons were accelerated at different energies. The neutrons were monitored with a plastic scintillator, and the light emitted when a neutron was detected was recorded with a multiplier phototube.

The reaction also produces lower energy neutrons in the target. It was therefore necessary to determine speed of each neutron counted to determine its energy. Time-of-flight for the neutrons to travel a known distance was measured. This approach permitted separate measurement of the yield of neu-

trons produced in the radioactive carbon target having different energies.

The C^{14} stripping reaction also provides clues about the internal forces of the nucleus. The distance from the C^{14} nucleus at which proton stripping occurs is related to the angle at which the neutron is likely to recoil. Thus measuring neutron intensity at different angles to the deutron beam provided data about the position at which stripping occurs.

These measurements revealed how often the final nucleus is left in an excited state, providing evidence of the nature of the forces inside the nucleus.

Remote Input-Output Device for Computers

DEVELOPMENT of an interrogator will enable direct communication with a remotely located computer. Detailed information can be sent and received by a device that looks like an electric typewriter with a small viewing screen.

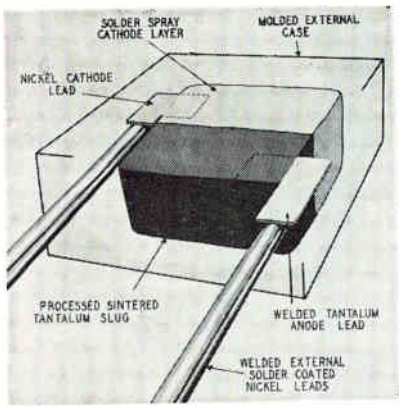
The unit, called the 2502 Interrogator, was developed by Information Products Corp. Data can be sent and received over direct wires or, with the firm's communications switching centers, over ordinary telephone lines.

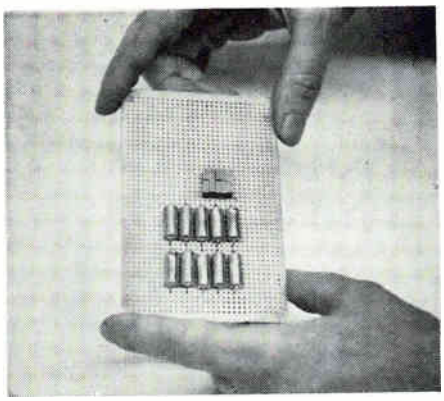
The system designed for operation by clerical personnel is expected to increase efficiency of routine operations such as credit checking, insurance investigation, banking, production and inventory control. Data appears on the crt a few seconds after interrogation.

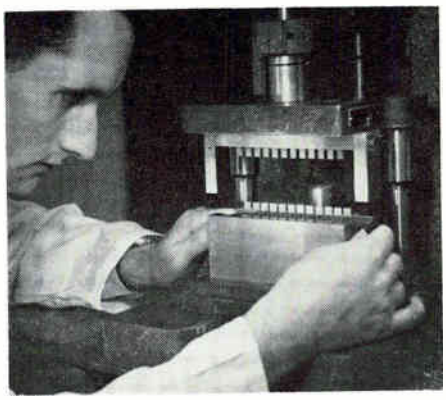
The keyboard contains 40 standard alpha-numeric keys with special keys for transmit, clear and reset. Any 6- or 7-bit code can be used, with a bit rate of 1 Mc. Characters are transmitted at a rate of 15,800 per second.

The crt display is 3 by 8 inches. It is positioned at an angle of 30 degrees from the plane of the base so that it can be viewed from either a sitting or standing position. It accommodates 10 lines of data with up to 72 characters per line.

The interrogator also can add, modify or update data stored in the computer. The information is entered by the keyboard with verification provided by the display.







Polarized electrolytic construction (left) obtains capacitors with volumetric efficiencies up to 20,000 microfarad volts per cu in. Same line is planned to offer efficiencies up to 120,000 microfarad volts per cu in. Flat, uniform shapes with paralled leads consolidate space on circuit board (center) where flat capacitors are compared to same number of larger equivalents. Technician (right) checks new units still seated in epoxy mold

Packing Microfarads in Limited Space

UNTIL RECENTLY, capacitor size has not kept pace with the pico developments of associated semiconductor components like the diode, and the small resistors and transistors. The problem involved in shrinking capacitors is how to pack a reliable unit of the highest volumetric efficiency into the least area. And circuit designers concerned with saving space are now asking how many microfarad volts can be packed into a specified size.

In the past, miniature-circuit designers have found it necessary to include large cylindrical capacitors in an otherwise tiny circuit. And the capacitor has loomed in size in comparison with its associated components. Consequently the capacitor has been a limiting factor in the over-all Lilliputian design of complete systems.

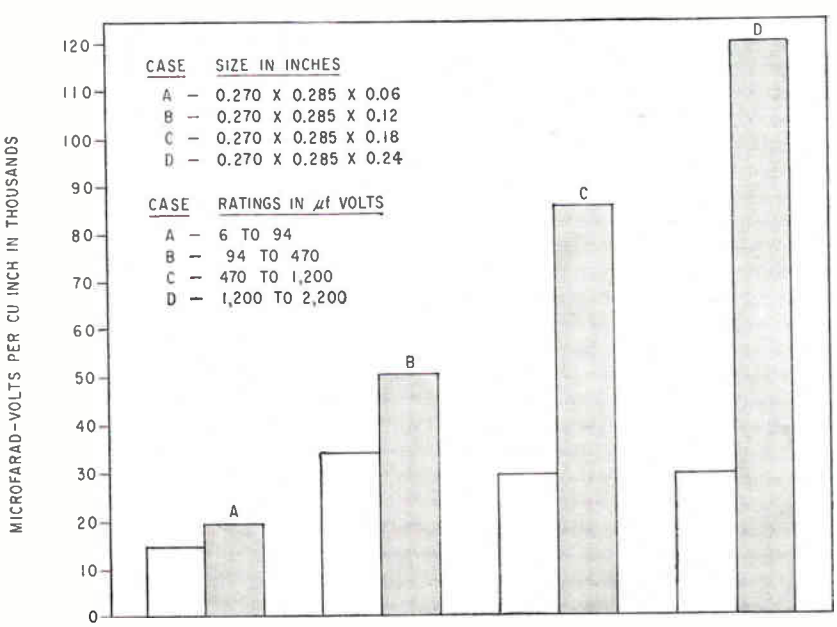
Research on this problem at RCA has resulted in the development of a new line of solid tantalum capacitors, now scheduled for commercial production[1].

Featuring flat, rectangular cases with parallel leads (see diagram), twenty-four of these capacitors can be mounted and stacked on a printed circuit board in an area the size of a postage stamp. These small units mark RCA's entry into the semiconductor passive component field, and are expected to find wide use in space vehicles, computers, data processing systems, communications and airborne equipment.

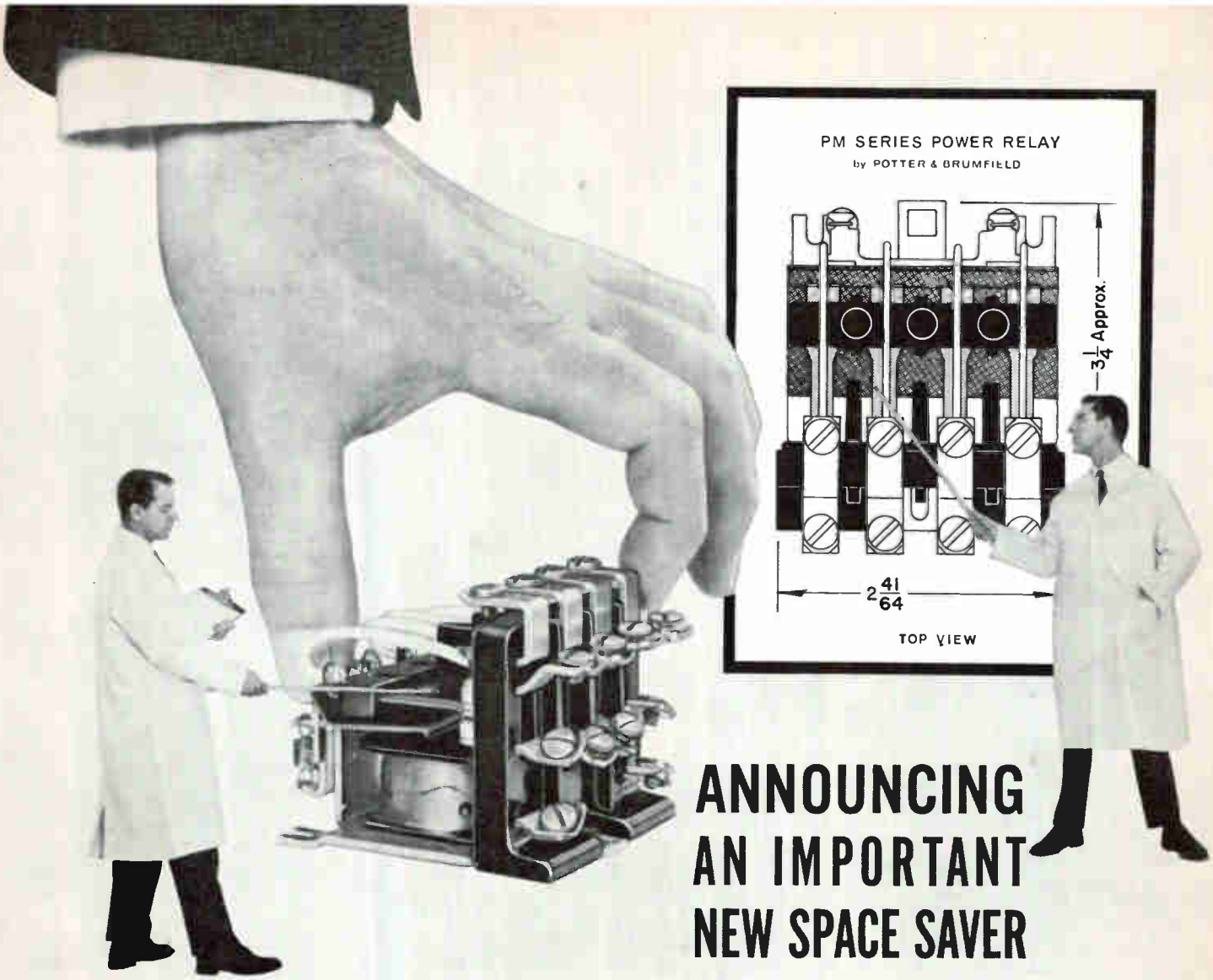
Computer designers, in particular, are showing interest in the hexahedral units for printed modules, since many thousands of these units, used in an average computer, can save a lot of space.

The accompanying graph gives the volumetric efficiencies of the new capacitors compared to conventional units having the same electrical characteristics. The flat capacitors have been planned in four case sizes, differing only in their electrical characteristics and thickness.

Case A is now commercially available. The B case will be ready this summer. Capacitors in the A case pack 94 microfarad volts, and the B cases obtain efficiencies of 470 microfarad volts. In laying out the circuit, it will be easy to stack



Volumetric efficiencies of RCA's new line of solid tantalum capacitors (cases A, B, C, D) compared to tantalum units having similar electrical characteristics. Highest rating given in each case size. Comparative units have insulating sleeves. The A cases, type CTA-2, are now available



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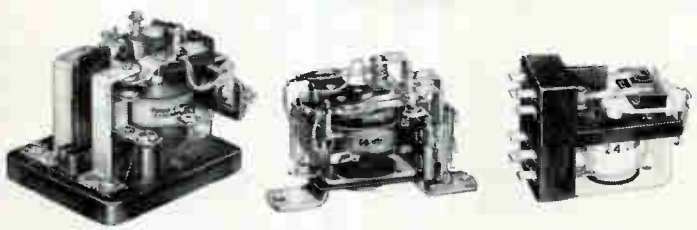

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Power: 14 volt-amps average at nominal voltage.
Duty: Continuous.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONICS PARTS DISTRIBUTORS

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

the different types because of their uniform sizes.

Construction is shown in the diagram. The capacitors are precision molded in epichlorohydrin bisphenol A to improve mechanical strength, eliminate need for insulating sleeves, and provide protection from adverse environmental conditions. The encapsulant has been run through moisture cycling tests three times, to make sure that this material meets moisture requirements. Two parallel, solder-coated leads are spaced 0.200-in. apart to facilitate mounting on printed circuit boards.

The encapsulant was especially formulated for low water vapor transmission rate.

In the manufacturing process, high purity, capacitor grade, powdered tantalum is pressed into square, flat pellets. These pellets are sintered in a high-vacuum furnace at around 2000 C to form a rigid, porous structure having a high surface-to-volume ratio and a continuity of electrical contact with an attached tantalum lead. This is the slug or anode.

The anode is immersed in an electrolytic or conductive bath and is made anodic in a d-c circuit, and d-c potential is applied. The d-c voltage determines the thickness of the tantalum oxide film formed on the surface of the tantalum anode by oxidation. The oxide films formed are from 200 to 2,000 Angstrom units thick. This thin-film anode holds the key to obtaining high capacitance.

A semiconductive solid electrolyte, manganese dioxide, is then deposited as a protective oxidizing layer over the entire surface of the formed dielectric. This material is completely free of moisture and is the prime reason for these capacitors being called solid types.

A layer of finely divided carbon is deposited on the surface of the electrolyte to provide a low resistance contact, and a metallic cathode envelope is added to allow attachment of the final cathode lead.

As seen in the diagram, the final external leads are connected to the capacitor terminals, and the structure is encased in its rigid, thermosetting encapsulant.

Life tests of over 2,000 hours have been made on the A and B units. These units, now in produc-

tion, meet the d-c leakage, dissipation, and life tests of MIL-C-26655/2. Operating temperature range is from 55 C to 125 C. The d-c leakage current is a maximum of 0.02 microampere per microfarad volt or 1 μa, whichever is greater at 25 C, measured in accordance with the spec. Dissipation factor is 6 percent maximum at 25 C measured at a frequency of 120 cps by a polarized bridge.

Starting this month, RCA is setting up an integrated system of tooling for the manufacture of the capacitors which will reduce the number of hand operations required to a minimum. This production technique will give higher yield, increase reliability and bring the cost down.

It is interesting to note that the transistor, formerly one of the smallest electronic components in microcircuit design, is now getting to be one of the largest components in miniature circuits.

REFERENCE

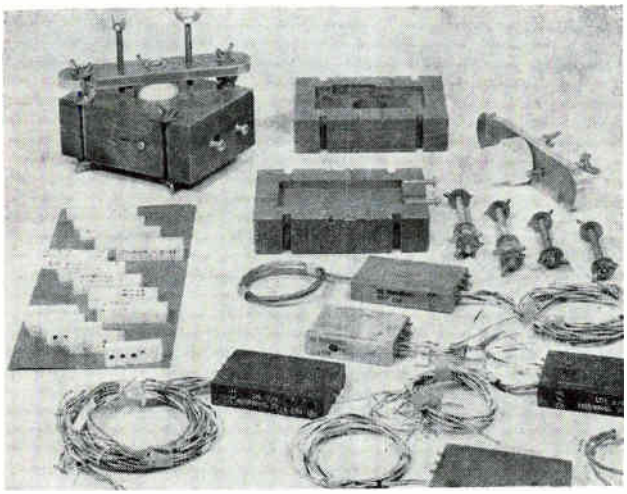
(1) Harold Velie, Product Planning Administrator, Microelectronics Dept., RCA Semiconductor and Materials Division, Somerville, New Jersey.

Firm Meets Demand For High-Purity Metals

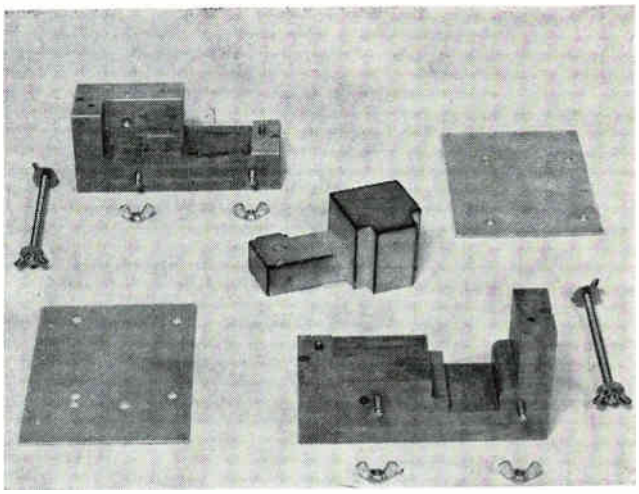
PRODUCTION of nine high purity metals—antimony, arsenic, bismuth, cadmium, gold, indium, selenium, silver and tellurium—has been increased and put on a commercial scale, American Smelting and Refining Company (Asarco) announced last week. This means that these metals, refined by a complex series of processes to more than 99.999 percent of purity, will now be available as off-the-shelf items to meet increasing industry needs. Until now they have been available only in laboratory quantities.

The decision to scale up production is a result of immediate demand by the electronics industry and for thermoelectric devices which are now starting to go into commercial production. Use of thermoelectric cooling devices for defense and consumer applications is expected to increase sharply.

In the high purity field, Asarco also produces copper, lead, sulphur, thallium and zinc for industrial research and development purposes.



Teflon blocks enable two molds produced from the same pattern to produce 12 different modules (left). Plugs stopper pour holes after foam is poured, core pieces mold



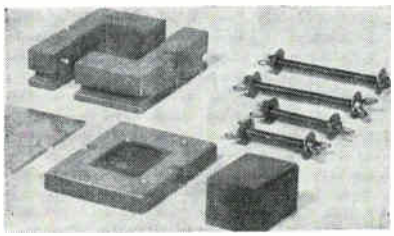
access holes for adjusting screws. Modules with a more intricate shape were made with the mold at right. The plaster pattern, center, can be made with the mold

Versatile Molds Encapsulate with Foam

By JOHN J. TALLENT,
General Electric Co.,
Light Military Electronics Dept., Utica, N.Y.

MODULES ENCAPSULATED in resinous foams are widely used in airborne and space electronics. They come in many shapes, from simple cubes to intricate, unsymmetrical forms. The spaces into which they must fit precisely are becoming smaller and smaller as missiles become more sophisticated.

Good design dictates that all edges and corners be rounded to prevent chipping of the edges or cuts in wire insulation and for appearance. To achieve odd configurations or radii by machining is time-consuming and costly. It is much quicker to incorporate the shape into a pattern and mold. The mold-making technique described is very useful for making engineering prototypes and one-of-a-kind modules.



Basic mold for cube module. Threaded studs fit in the side grooves. One plate is aluminum and the other molded epoxy

Aluminum-filled epoxy resins provide good patterns and easily-made, economical molds. The resins have high heat resistance (400 to 500 F), low shrinkage (0.001 inch per inch), are tough, have excellent heat transfer, high impact strength, are non-irritating, non-hygroscopic and can be easily machined. Changes or corrections in the pattern or mold can be made with aluminum-filled epoxy paste.

Molds of the type shown can be made with little investment in equipment. Only a drill press, band saw, lathe and oven are required. A five-gallon paint spray tank (for use as a pressure tank), a belt or disc sander, sheet metal shear and punches, and a vacuum chamber or oven are helpful but not indispensable.

If the pattern is intricate or has thin sections, it should be made of the same resin as the mold. If it has few contours or if only one mold is needed, molding plaster can be used. Since plaster is low in cost, it may be precast in blocks of various sizes ready to make into patterns. Flexible plastic trays or even cardboard boxes can be used for casting. A bubble-free, hard, dense block is obtained if the plaster is mixed to a thin, watery consistency, poured, placed in a pressure tank at 80 psi until the plaster has set and then dried thoroughly. Patterns may also be made from precast resin blocks, or cast as needed, using the same basic techniques.

Patterns are made approximately one-quarter inch higher, one-sixteenth inch wider and the same length as the specified finished dimensions. After the pattern is cut and finished, it is sprayed with a high-temperature mold release or with a thin film of RTV silicone rubber, available in aerosol cans.

The mold fixture shown in Fig. 1 can be adjusted to accommodate a range of pattern sizes. One or two

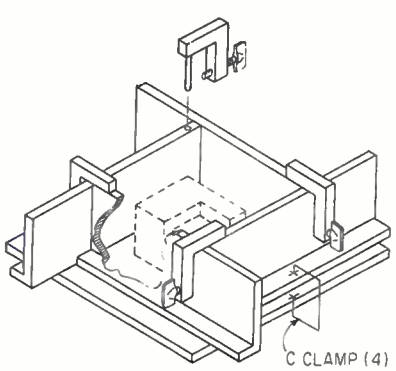


FIG. 1—Molding fixture is adjustable

PORTABLE KLYSTRON POWER SUPPLY 809-A

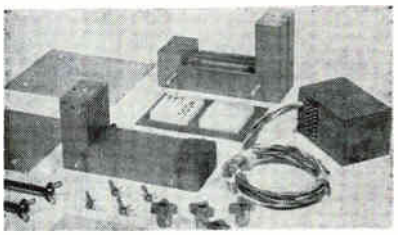
featuring: • New compact size: 8" x 12" x 15" • New low in reflector voltage ripple: less than 1 mv rms • New planetary gears to give finer adjustment of reflector voltage • New design including internal blower, built-in cabinet tilt stand, PRD expansion coil cord with polarized ac plug • Direct reading of beam voltage or current on front panel meter.

Regulated beam voltage 250 to 600 volts; regulated reflector voltage 0 to −900 volts; 6.3 volt ac filament supply. Reflector voltage available either unmodulated or internally modulated by square wave or sawtooth. Send for data! **PRD ELECTRONICS, INC.:** 202 Tillary St., Brooklyn 1, New York, ULster 2-6800; 1608 Centinela Ave., Inglewood, California, ORegon 8-9048. *A Subsidiary of Harris-Intertype Corporation.*

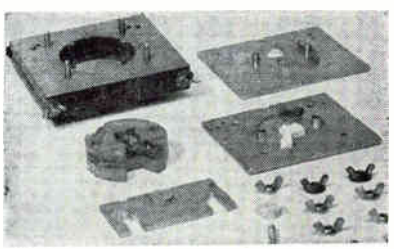
HARRIS INTERTYPE CORPORATION

New from PRD!

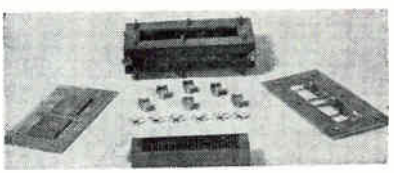
fixtures should take care of all normal requirements. If the outside of the resin mold is held to standard lengths and widths, core pieces can be positioned and held to the walls with double-backed adhesive tape. These core pieces form slots or grooves for threaded rods whose wing nuts hold the mold and the top and bottom plates together.



Interchangeable Teflon inserts mold right or left-hand modules. The large knobs do not have to be screwed on. Held at a slight angle, they pass freely over the thread and are locked or unlocked with a short turn



This mold would be hard to machine, but was easily made from a pattern. Note the cored slots around the edges



Header boards made this module difficult to encapsulate. Correct positioning required lacing and tieing in the mold

Identification numbers are embossed on aluminum-backed adhesive tapes, with a reverse embossing wheel. The tape is stuck on the inner walls so numbers will be depressed into the mold and read correctly.

The pattern is placed in the fixture and preheated in an oven to 125 F (the oven used is cam-programmed for various temperatures and times and shuts off automatically, to facilitate curing). Surfaces are coated with a high-temperature mold release. The aluminum-filled

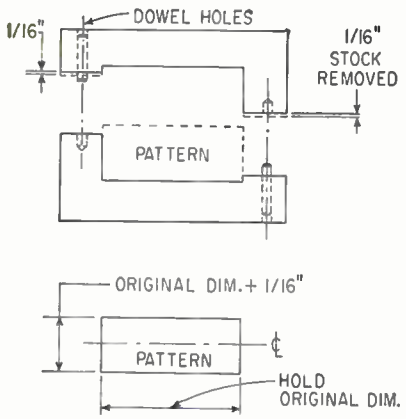


FIG. 2—Slitting returns mold to specified width

epoxy resin (preheated to 140 F) is mixed with the catalyst, and poured around the pattern to a height of one-sixteenth inch above the required dimension.

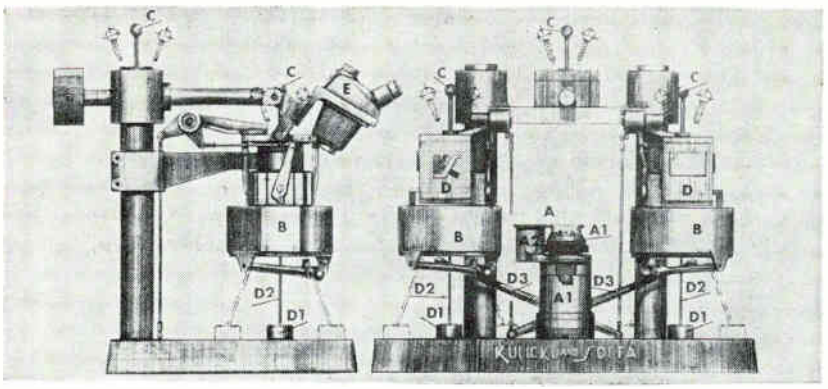
After the resin has cured and cooled, the mold is removed. Some 95 percent of the molds have been made with straight walls without draft, but have released from the fixtures without trouble. Holes are drilled to locate the dowels which align the mold halves. The mold is split with a one-sixteenth-inch splitting saw, as in Fig. 2. When the mold is joined together, the width is the specified dimension. The mold is assembled with the threaded rods and is machined to the correct thickness. Top and bottom plates or covers complete the molds.

This basically simple procedure can, with a little skill and ingenuity, produce many forms of encapsulation molds. A sampling of different molds made at General Electric LMED is given by the photographs.

Hardboard Blocks Cut Crystal Dicing Costs

HARDBOARD SQUARES are used as disposable semiconductor dicing blocks by Clevite Transistor Products, Waltham, Mass. The blocks are made of quarter-inch tempered Masonite sanded to a thickness of 0.23 inch ±0.005. Crystals are fixed to the blocks with hot wax. Cutting wheel wear and block cost are reported to be less than with ceramic blocks formerly used. Blocks are supplied by Masonite Fabricators, Elizabeth, N. J.

New On The Market



Microcircuit Production
ASSEMBLY AND TEST

EQUIPMENT will assemble and test microcircuits up to 1.25 inches square. A positively controlled heat column holds the blank circuit. Two turret-head indexing tool mounts each carry four tools. Both tool mounts and the microscope mount can be controlled for gross positioning by a joy-stick. Positioning to millionths of an inch is accomplished with two micropositioners. A stereo-zoom microscope is optional equipment. A wide variety of microcircuit tooling is available. Manufacturer is Kulicke and Soffa Co., 1234 Callowhill St., Phila 23, Pa., and delivery on the model 410 is 90 days.

CIRCLE 301 ON READER SERVICE CARD

Automatic Frequency Meter
3 TO 50 GC

SERIES AFM frequency meter is fully automatic and can be used with commonly available microwave instruments. The indicator is an aircraft-type, dual-meter movement with one pointer position a function of frequency and power level while the other pointer position is a function of power level.

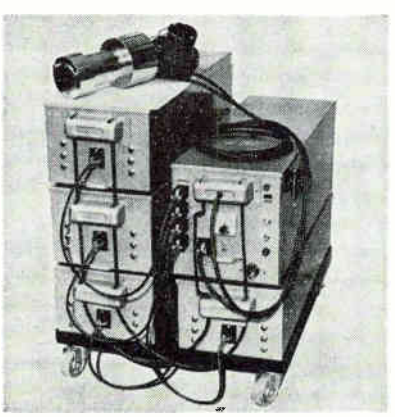
Minimum r-f power is 1.0 mw avg; accuracy is 0.1 percent; resetability is 10 Mc at 9,300 Mc. Price is $92, from Somerset Radiation Lab., Inc., 192 Central Ave., Stirling, N. J., with delivery in 30 days.

CIRCLE 302 ON READER SERVICE CARD

Power Supply
FOR OPTICAL MASERS

MODEL 275 optical maser power supply is designed for research. The 5,000-volt supply furnishes energy to 20,000 joules, from 1,000 to 5,000 v. Separate stabilized voltage supply triggers the flash-lamp source.

Ruby maser mounting accessories for various lengths and diameters



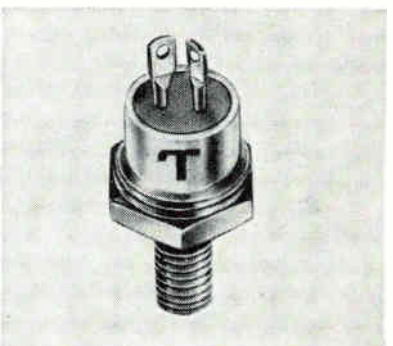
of crystals are available. Maximum peak light output can be obtained from type FT-524 or FT-623 flash tubes. Manufacturer is Electro Powerpacs, Inc., 5 Hadley St., Cambridge 40, Mass.

CIRCLE 303 ON READER SERVICE CARD

Power Transistors
HIGH VOLTAGE

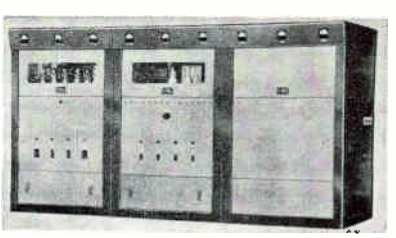
SERIES of four high-voltage intermediate-power transistors is announced by Transitron Electronic Corp., 168 Albion St., Wakefield, Mass.

The silicon diffused mesa transistors have 150 and 200-v max



rating, and sustaining voltages of 125 and 140 v. Maximum power dissipation at 25 C case temperature is 40 watts, 20 watts at 100 C. Operating current range is 50 ma to 2 amp. Delivery is three weeks, prices from $52 to $66.

CIRCLE 304 ON READER SERVICE CARD



Pulse Modulator
64 MW PEAK POWER

PULSE modulator is designed to test super-power klystrons, microwave devices, continuous duty radar transmitters and similar equipment. Peak power is 64 Mw continuous. Continuous adjustable pulse range is 75 Kv to 250 Kv, with pulse current of 260 amp at 250 Kv. Pulse length, at 96 percent of peak voltage, is plus or minus 2.75 μsec. Frequency is 30 to 360 pulses per

MIL-R-19365C

Across the Board!

OHMITE

"Dividohm®" Adjustable Resistors

HIGHLIGHTS OF MIL-R-19365C. This revised specification covers power-type, wire-wound, adjustable resistors from 1 to 15,000 ohms inclusive. Resistance tolerance is specified as ± 5% for all eight power ratings which are listed at right. The maximum continuous operating temperature is 350°C (Char. V).

MIL-R-19365C resistors are the tubular type with single-layer windings and lug-type terminals—two fixed and one adjustable.

Ohmite can supply all eight adjustable resistors to meet *every* requirement of MIL-R-19365C. Higher resistances using smaller wire sizes are available, also, to meet the performance requirements of this new MIL specification.

Write for Military Catalog 50B—the "Easy Way" to Order MIL Resistors.

STANDARD MIL-R-19365C ADJUSTABLE RESISTORS

STYLE	WATTS	DIMENSIONS		OHMS	
		LENGTH	DIA.	MIN.	MAX.*
RX29	11	1¾"	7/16"	1	470
RX32	17	2"	9/16"	1	910
RX33	26	3"	9/16"	1	1,500
RX35	55	4"	29/32"	1	3,600
RX36	78	4"	1 5/16"	1	5,100
RX37	113	6"	1 5/16"	1	8,200
RX38	159	8"	1 5/16"	1	11,000
RX47	210	10½"	1 5/16"	1	15,000

*0.004" Diameter wire.

Offering you complete availability of these MIL resistors so quickly is another indication of Ohmite's ability and desire to give industry the finest, most advanced resistance products with the best of service.

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois

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

OHMITE

second. Pulse height deviates from flatness ± 2 percent. Maximum time jitter, with respect to synchronizing pulses, is 0.05 μsec. The PM-87 supply is manufactured by Ling Electronics Div., Ling-Temco Corp., 1515 South Manchester Ave., Anaheim, Calif.

CIRCLE 305 ON READER SERVICE CARD

Desk-Size Computer
8,192 12-BIT WORDS

COMPUTER is packaged in an office desk, is priced at $90,000 or leased at $2,250 per month from Control Data Corp., 501 Park Ave., Minneapolis 15, Minn.

Basic 160-A computer has magnetic core memory of 8,192 12-bit computer words, buffered input and output, program interrupt, and a list of 91 instructions. The memory can be expanded in modules up to 32,768 words. Applications include data processing, engineering problem solving, off-line data conversion, real-time data acquisition/data reduction, and industrial control. Programming aids are available.

CIRCLE 306 ON READER SERVICE CARD

Photoelectric Keyboard
BINARY ENCODING

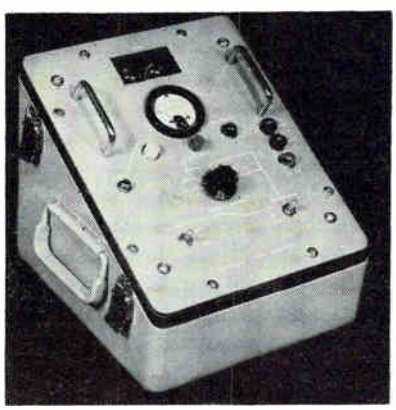
PHOTOELECTRIC binary-encoding keyboard has been announced by Invac Corp., 14 Huron Dr., Natick, Mass. Alphanumeric keyboard uses photoelectric encoding to generate 5, 6, 7 or 8 bit binary codes. Encoding matrices, contacts and switches are not used. The K-144 complete with amplifiers sells for $550.

Ten data channels are available.

CIRCLE 307 ON READER SERVICE CARD

Automatic Cable Tester
DIGITAL READOUT

AUTOMATION DYNAMICS CORP., 255 County Road, Tenafly, N. J. Model 50 quickly, accurately and automatically examines each wire individually for faults. Leakage and short



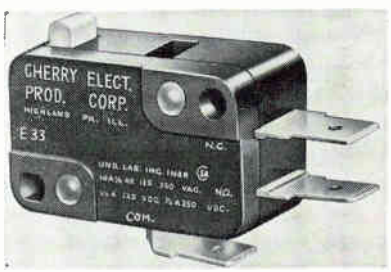
circuits between conductors resulting from defective insulators, improperly connected wires, cold solder joints or damaged wires are located. Deviations of resistance to 0.1 ohm for continuity and leakage up to 100 megohms are detected. Accepted or rejected wire is identified through a clear digital readout.

CIRCLE 308 ON READER SERVICE CARD

Miniature Toroid
0.01 TO 500 MILLIHENRY

MODEL TAS-125 toroid can be used from 0.5 to 20 Kc; it is available with inductance from 0.01 to 500 mh. The uncased unit has Q's to 60, is $\frac{3}{8}$ in. o-d by $\frac{1}{4}$ in. high. Units are available from stock, modified versions in two to three weeks. Prices upon request, from Torotron Corp., 256 East 3rd St., Mount Vernon, N. Y.

CIRCLE 309 ON READER SERVICE CARD



Small Switch
SNAP-ACTION

CHERRY ELECTRICAL PRODUCTS CORP., 1650 W. Deerfield Road, Highland Park, Ill. The E33-00A series feature standard mounting dimensions, terminal variations of screw, quick connect or solder lug, and case molded hinged pivot roller and roller leaf actuators. Flat switch case of $1\frac{3}{32}$ by $\frac{3}{8}$ by $\frac{13}{32}$ in. permits individual or gang assembly use for multiple cam operation. The Rock-Wipe contact action provides for accurate repeatability and precise tolerance adherence.

CIRCLE 310 ON READER SERVICE CARD

Transducer
ELECTRO-HUMIDITY TYPE

PHYS-CHEMICAL RESEARCH CORP., 40 E. 12th St., New York 3, N. Y. Electro-humidity transducer is an electric hygrometric circuit element which senses changes in rela-

Highly Reliable

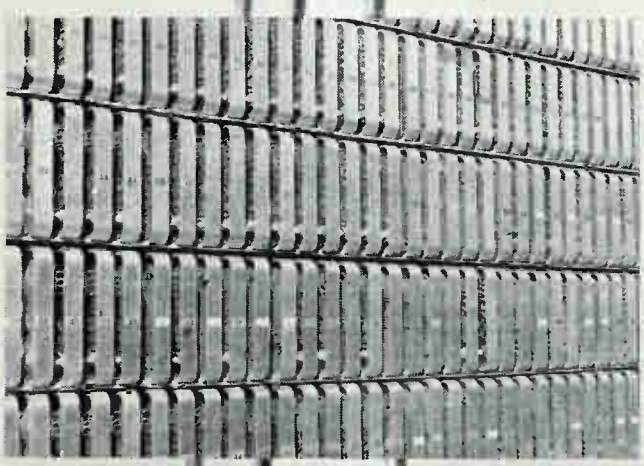
HITACHI "SEMI-CONDUCTORS"

For Industrial Use
Switching Transistors and Diodes

2SA18
2SA41
2SA42
2SA86
2SA208
2SA209
2SA210
2SB66
2SB67
2SB68
2SB81
2SB82
2SC89
2SC90
2SC91

1N34A
1N35
1N38A
1N56A
1N60
1S77
1S78
1S79
1S84

Hitachi semi-conductors provide the basis for the excellent capacity of the Hitachi Electronic Computer HITAC 103.



Back of HITAC 103.

Hitachi, Ltd.
Tokyo Japan

Cable Address: "HITACHY" TOKYO

tive humidity by changes in ohmic resistance. The transducer is a processed plastic wafer—a chemically treated styrene copolymer—which has an electrically conducting surface layer that is integral with the nonconducting substrate. Changes in relative humidity cause the surface resistivity to vary.

CIRCLE 311 ON READER SERVICE CARD

Pulse Generators
CLOCK TYPE

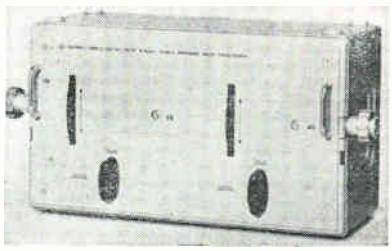
TEXAS INSTRUMENTS INC., P. O. Box 6027, Houston 6, Texas, announces clock pulse generators that include repetition rates of 3-25 Mc and 25-100 Mc; rise/fall times of less than 4 μsec; a pulse width of less than 8 μsec at one-half pulse height; 0-4 v amplitude, continuously variable; and output impedance of 93 ohms.

CIRCLE 312 ON READER SERVICE CARD

Cryogenic Thermometer

MALAKER LABORATORIES, INC., Mountainside, N. J. Electronic cryogenic thermometer measures temperatures in the range of 0.3 to 25 Kelvin.

CIRCLE 313 ON READER SERVICE CARD



Attenuator
D-C TO 3,000 MC

ROHDE & SCHWARZ, 111 Lexington Ave., Passaic, N. J. Type DPU precision attenuator covers the range from d-c to 3,000 Mc, with attenuation settings between 0 and 99 db

in steps of 1 db. A 10 db attenuation pad, an outside accessory, extends the range to 109 db. Electrical length of the attenuator is practically constant and corrections are given for both electrical length and propagation time for each attenuator position.

CIRCLE 314 ON READER SERVICE CARD

Cable Analyzer

MICRO BALANCING, INC., 191 Hericks Rd., Garden City Park, N. Y. Cable analyzer, transistorized and portable, double-tests 75 circuits in two seconds.

CIRCLE 315 ON READER SERVICE CARD

Spectrum Analyzer
WIDE BAND

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. Model WSA spectrum analyzer has a display of up to 4,000 Mc. It covers the frequency range from 10 Mc to 40,000 Mc in 20 bands which are contained in one unit. The wide band display can be used to simplify field intensity measurements by displaying the entire range of each frequency band, for testing r-f transmitters and signal generators for "holes" throughout their tuning range, and other applications.

CIRCLE 316 ON READER SERVICE CARD

Miniature Chopper
LOW-NOISE

JAMES ELECTRONICS INC., 4050 No. Rockwell, Chicago 18, Ill., announces low-noise dpdt miniature choppers for microvolt instrumentation applications. Nine pin plug-in and flange mount models are available. Frequency response is 1-500 cps at microvolt levels. Prices range from $30 to $45.

CIRCLE 317 ON READER SERVICE CARD

Stepping Motor
FOR SPACE AGE USE

LYTLE CORP., 1404 San Mateo S.E., Albuquerque, N. M. Inertial guidance, telemetry, industrial control, and research have need for a stepping motor possessing the characteristics of the Digistep motor. It is a reliable method of digital to analog conversion when used to drive a potentiometer or tape capstan. Key features are 500/sec stepping rate and reliable stepping with as much as 50 percent variation in voltage level.

CIRCLE 318 ON READER SERVICE CARD

Wire Tester

MARATHON SPECIALTY STEELS, INC., 375 Park Ave., New York 22, N. Y. Equipment for the ultrasonic testing of wire detects inclusions and cracks running in any direction at drawing speeds of up to 200 ft per minute.

CIRCLE 319 ON READER SERVICE CARD

S-Band Isolators
ULTRAMINIATURE

MELABS, 3300 Hillview Ave., Palo Alto, Calif. Model X-173 isolators are extremely useful in missile and satellite applications and in replacing resistive pads. Model X-173A, covering 2.6 to 3.3 Gc, has an isolation greater than 10 db with 18 db at band center. Model X-173B,

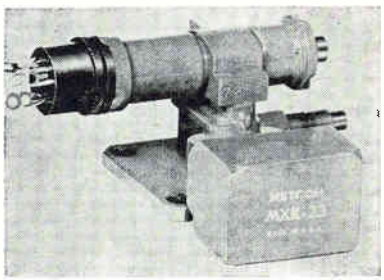
2.7 to 2.9 Gc, has an isolation greater than 14 db. Isolation of model X-173C (2.95 to 3.25 Gc) is also greater than 14 db.

CIRCLE 320 ON READER SERVICE CARD

Thermostats

STEVENS MANUFACTURING CO., INC., P. O. Box 1007, Mansfield, Ohio. Polypropylene boot enclosure, filled with epoxy resin, protects against moisture, fumes and dust.

CIRCLE 321 ON READER SERVICE CARD



Reflex Klystron
ELECTRICALLY TUNABLE

METCOM, INC., 76 Lafayette St., Salem, Mass. The MXK-23 is an electrically tunable reflex klystron with a tuning range greater than 400 Mc. It is for use in the X-band region, in radar equipment and test equipment, as local oscillator or as wide band sweep oscillator. It differs from standard tunable klystrons in that it is tuned in the conventional mechanical manner and is electrically tuned for 400 Mc from any mechanical setting.

CIRCLE 322 ON READER SERVICE CARD

Grid Board Kit
EASY TO USE

CORNING ELECTRONIC COMPONENTS, Bradford, Pa., offers a kit that

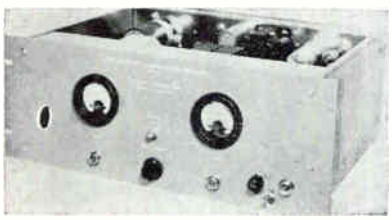
combines all materials to make high quality prototype printed circuits. Using the kit's copper-clad Fotoceram grid boards, resist materials to lay out circuit patterns, and etching materials to etch away copper beyond the circuit runs, a designer can produce a printed circuit on glass-ceramic substrate in 15 minutes, without leaving his desk.

CIRCLE 323 ON READER SERVICE CARD

Mobile Supports

TEKTRONIX, INC., P. O. Box 500, Beaverton, Ore. Scope-Mobile carts for Tektronix oscilloscopes or auxiliary equipment feature an adjustable tray which can be tilt-locked in nine positions.

CIRCLE 324 ON READER SERVICE CARD



Noise Generator
PRECISION UNIT

ELGENCO, INC., 1555 — 14th St., Santa Monica, Calif. Model 301 noise generator makes available a random voltage source with an ultrastable spectral density of approximately 4.0 v ^{2}/cps controlled to ± 0.1 db from 0 to 40 cps and a Gaussian amplitude distribution with an accuracy of better than 1 percent. Primary source of noise is a xenon-filled thyratron connected in a diode configuration and operated in a magnetic field.

CIRCLE 325 ON READER SERVICE CARD

Indicator Lights
TRANSISTOR CONTROLLED

TRANSISTOR ELECTRONICS CORP., 3357 Republic Ave., Minneapolis 26, Minn. Miniature indicator lights which combine a momentary action push button switch with transistor circuitry and complete neon indicator in a single unit are features of the Tec-Lite TBL series Button-Lite. Series was designed to solve space and circuitry prob-

lems in computers, data processing and industrial control systems.

CIRCLE 326 ON READER SERVICE CARD

Power Tetrode
COMPACT TUBE

PENTA LABORATORIES, INC., 312 N. Nopal St., Santa Barbara, Calif. The PL-4-65A, a 65-w power tetrode is suitable for use as an r-f amplifier and oscillator and as an a-f power amplifier and modulator. Its small size and quick heating filament make it useful for mobile communications applications. It can be operated with full input at frequencies up to 150 Mc.

CIRCLE 327 ON READER SERVICE CARD

Modular Units

MOLEX PRODUCTS CO., 9515 Southview Ave., Brookfield, Ill. Modular plug and receptacle offer multiple circuit connections from 3 to 60 circuits, priced as low as .014¢ per circuit.

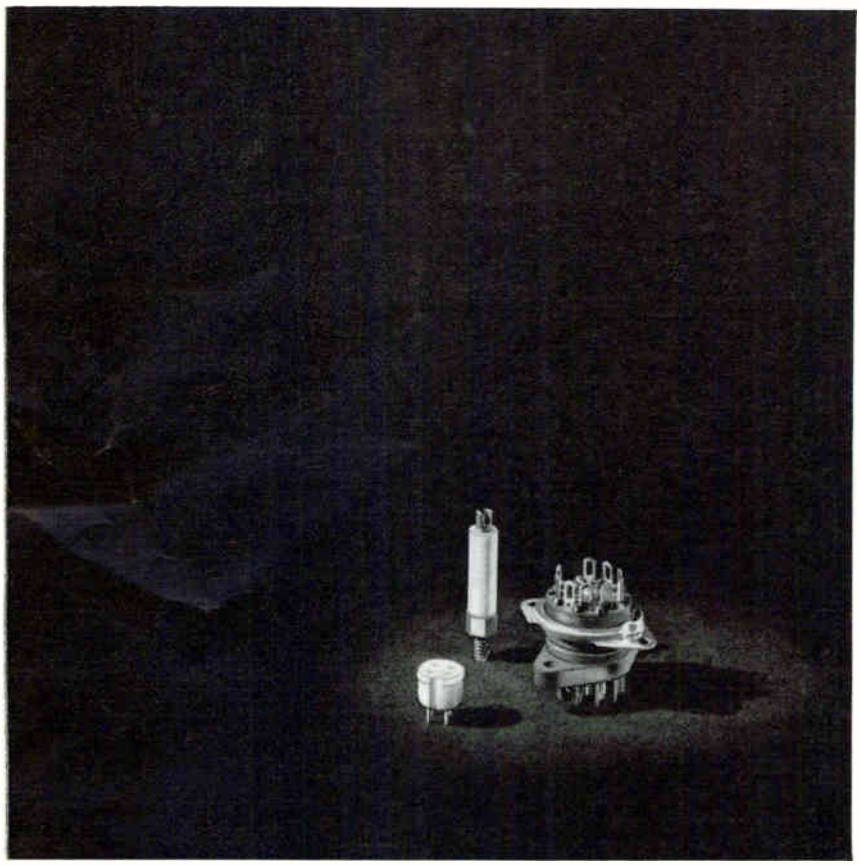
CIRCLE 328 ON READER SERVICE CARD

Trimmer Pot
SUBMINIATURE SIZE

ATOHM ELECTRONICS, 7648 San Fernando Road, Sun Valley, Calif. Combining subminiature size with an expanded resistance range to 100,000 ohms, type W5 trimmer po-

ENGINEERED COMPONENTS

for the Electronics Industry



As close at hand as your nearest authorized Garlock distributor—
CHEMELEC* Insulators, Subminiature Tube and Transistor Sockets, Connectors.

Availability as well as reliability are two reasons why it is smart to specify Garlock when buying components.
Through a new organization of authorized distributors, Garlock now offers immediate delivery of CHEMELEC Stand-off and Feed-Thru Insulators, Subminiature Tube and Transistor Sockets, Connectors, and other standard components.

As near as the telephone, your authorized Garlock Electronic Products Distributor offers prompt, courteous service. Call him at the nearest of these locations:

CALIF.
NEWARK ELECTRONICS CO.
4747 W. Century Blvd.
Inglewood, Calif.
SCHAD ELECTRONICS
499 S. Market St.
San Jose, Calif.
WESCO ELECTRONICS
1715 E. Colorado Blvd.
Pasadena, Calif.

COLORADO
INTER-STATE RADIO & SUPPLY CORP.
1200 Stout Street
Denver, Colorado

ILLINOIS
NEWARK ELECTRONICS CO.
223 West Madison St.
Chicago 6, Illinois

MARYLAND
ELECTRONIC ENTERPRISES, INC.
4902 Snader Avenue
Baltimore 15, Md.

MASS.
DE MAMBRO RADIO SUPPLY CO. INC.
1095 Commonwealth Ave.
Boston 15, Mass.

NEW YORK
ELECTRONIC CENTER INC.
160 5th Avenue
New York 10, New York
HARRISON RADIO CORP.
225 Greenwich St.
New York 7. New York

ONTARIO
LAKE ENGINEERING CO. LTD.
767 Warden Ave.
Scarborough, Ontario,
Canada

N. CAROLINA
DALTON-HEGE, INC.
938 Burke St.
Winston-Salem, N. C.

Take advantage of on-the-spot availability—specify these skillfully engineered Garlock electronic components. Reliable under the most severe conditions, they are ideal for high temperature, high voltage, high frequency service on missile guidance, fire control, tracking, and radar systems. Garlock has the technical personnel and modern facilities to produce components of all materials—Teflon† TFE and FEP, Nylon, Delrin†, C.T.F.E.‡—and a range of sizes, designs, and tolerances to fit your exact needs. At your disposal, too, for development of new electronic products, Garlock maintains complete electrical, chemical and physical laboratories staffed by top-flight engineers.

Remember, too, the newest of the Garlock electronic products—Flexible Printed Circuitry of Teflon FEP. For complete details on what Garlock has to offer, write for Catalogs AD-169, 171, and 188. Garlock Electronic Products, Garlock Inc., Camden 1, New Jersey.

GARLOCK

ELECTRONIC PRODUCTS

Canadian Div.: Garlock of Canada Ltd.
Plastics Div.: United States Gasket Company
Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*Registered Trademark
†DuPont Trademark
‡polychlorotrifluoroethylene

tentiometer has a 2 w rating to 70 C. Measuring only 0.210 by 0.312 by 0.890 in., and with mounting holes on 0.750 in. centers, the unit is designed to exceed all requirements of MIL-R-27208 (proposed).

CIRCLE 329 ON READER SERVICE CARD

Silicon Diodes

PACIFIC SEMICONDUCTORS, INC., 12955 Chadron Ave., Hawthorne, Calif. High conductance core driver laminar diode has a capacitance of 7 pf at 9 v reverse and a reverse recovery of less than 0.2 μsec.

CIRCLE 330 ON READER SERVICE CARD

Counter/Indicator

VARIABLE RADIX

ELECTRONIC CONTROL PRODUCTS, U. S. Highway 22, Dunellen, N. J. The G-100 variable radix counter/indicator is a versatile transistorized counter operating at rates up to 110 Kc. Unit is useful in such applications as data reduction, digital clocks, or any application where counting, display, binary output drive and memory are required.

CIRCLE 331 ON READER SERVICE CARD

Test Chamber

FIVE BATHS

CONRAD, INC., 141 Jefferson St., Holland, Mich. Model CAL-5-1-1 is equipped with five individually thermostatically controlled temperature baths. Ranges: –90F, –60F, –40F, –20F, +20F. Unit is self-contained with Freon 13 and Freon 22 cascade refrigeration system. It is applicable to many electronics

← **CIRCLE 128 ON READER SERVICE CARD**

testing applications such as thermometer calibration and the like.

CIRCLE 332 ON READER SERVICE CARD

Computer Relay

HIGH SPEED

JAMES ELECTRONICS INC., 4050 N. Rockwell St., Chicago 18, Ill., announces series of high speed computer relays for transistor circuits. Driving voltage is a nominal 20 v. Units will operate in less than 750 μsec and have polarized driving systems with center tapped driving coils. Switching circuits are for dry to 10 v levels with 100 million operations reliability. Prices range from $25 to $35.

CIRCLE 333 ON READER SERVICE CARD

Baking Ovens

F. J. STOKES CORP., 5500 Tabor Rd., Philadelphia 20, Pa. Designed for processing semiconductor devices, the ovens maintain 350 C concurrently with a vacuum of 10^{-5} mm Hg.

CIRCLE 334 ON READER SERVICE CARD

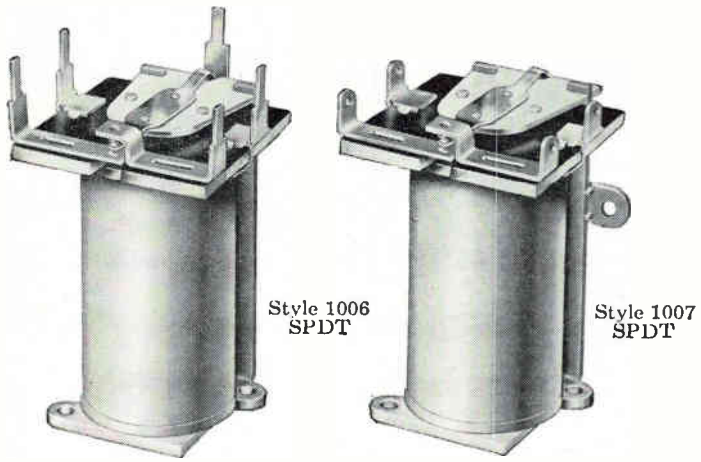
Pressure Transducer

FOR AIRBORNE USE

CONSOLIDATED ELECTRODYNAMICS CORP., 360 Sierra Madre Villa, Pas-

CIRCLE 129 ON READER SERVICE CARD→

Sensitive Relays at Sensible Prices



Price Electric Series 1000 Relays Now Feature . . .

Sensitive Operation • Solder or Printed Circuit Terminals
Open or Hermetically Sealed Styles • Low Cost

These versatile sensitive relays are designed for applications where available coil power is limited. They retain all the basic features, such as: small size, light weight and low cost, that make the Series 1000 General-Purpose Relays pace setters in their field.

Typical Applications

Remote TV tuning, control circuits for commercial appliances (including plate-circuit applications), auto headlight dimming, etc.

General Characteristics

Standard Operating Current:
1 to 7 milliamps DC at 20 milliwatt sensitivity

Maximum Coil Resistance: 16,000 ohms

Sensitivity:
20 milliwatts at standard contact rating; 75 milliwatts at maximum contact rating. Maximum coil power dissipation 1.5 watts.

Contact Combination: SPDT

Contact Ratings:
Standard 1 amp; optional ratings, with special construction, to 3 amps. Ratings apply to resistive loads to 26.5 VDC or 115 VAC.

Mechanical Life Expectancy:
30,000,000 operations minimum.

Dielectric Strength: 500 VRMS minimum.

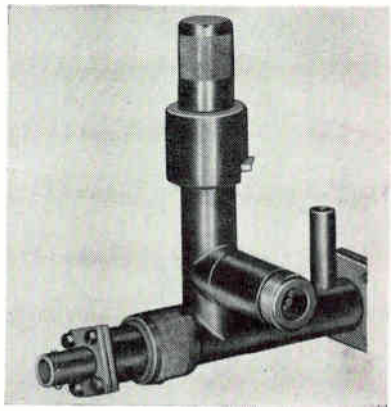
For Additional Information, contact:

PRICE ELECTRIC CORPORATION

306 Church Street • Frederick, Maryland
MOnument 3-5141 • TWX: Fred 565-U

adena, Calif. Type 4-329 utilizes a rated electrical excitation of 20 v d-c or a-c rms with a carrier frequency in the 0-20 Kc range. Sensitivity is 50 mv ± 0.25 mv through a 50,000 ohm load at rated excitation and 70 F. Input impedance is 700 ohms min; output impedance, 350 ohms ± 10 percent at 77 F.

CIRCLE 335 ON READER SERVICE CARD



Crystal Mixers

570-630 MEGACYCLES

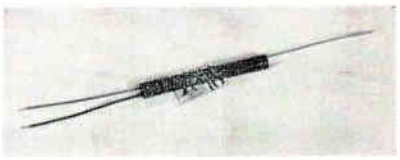
APPLIED MICROWAVE ELECTRONICS, 114 W. 25th St., Baltimore 18, Md. Model CM6 coaxial crystal diode mixers are particularly suitable for applications where maximum performance is desired over a reasonable bandwidth. Input is type N; vswr (signal and l-o) 1.5:1 max; adjustable l-o coupling. Unit price is $390.

CIRCLE 336 ON READER SERVICE CARD

Resistors

FI-OHM CO., 360 N. Michigan Ave., Chicago 1, Ill. Deposited-film resistor prices range from ½ cent for ⅛ w to 3 cents for 4 w units in production quantities.

CIRCLE 337 ON READER SERVICE CARD

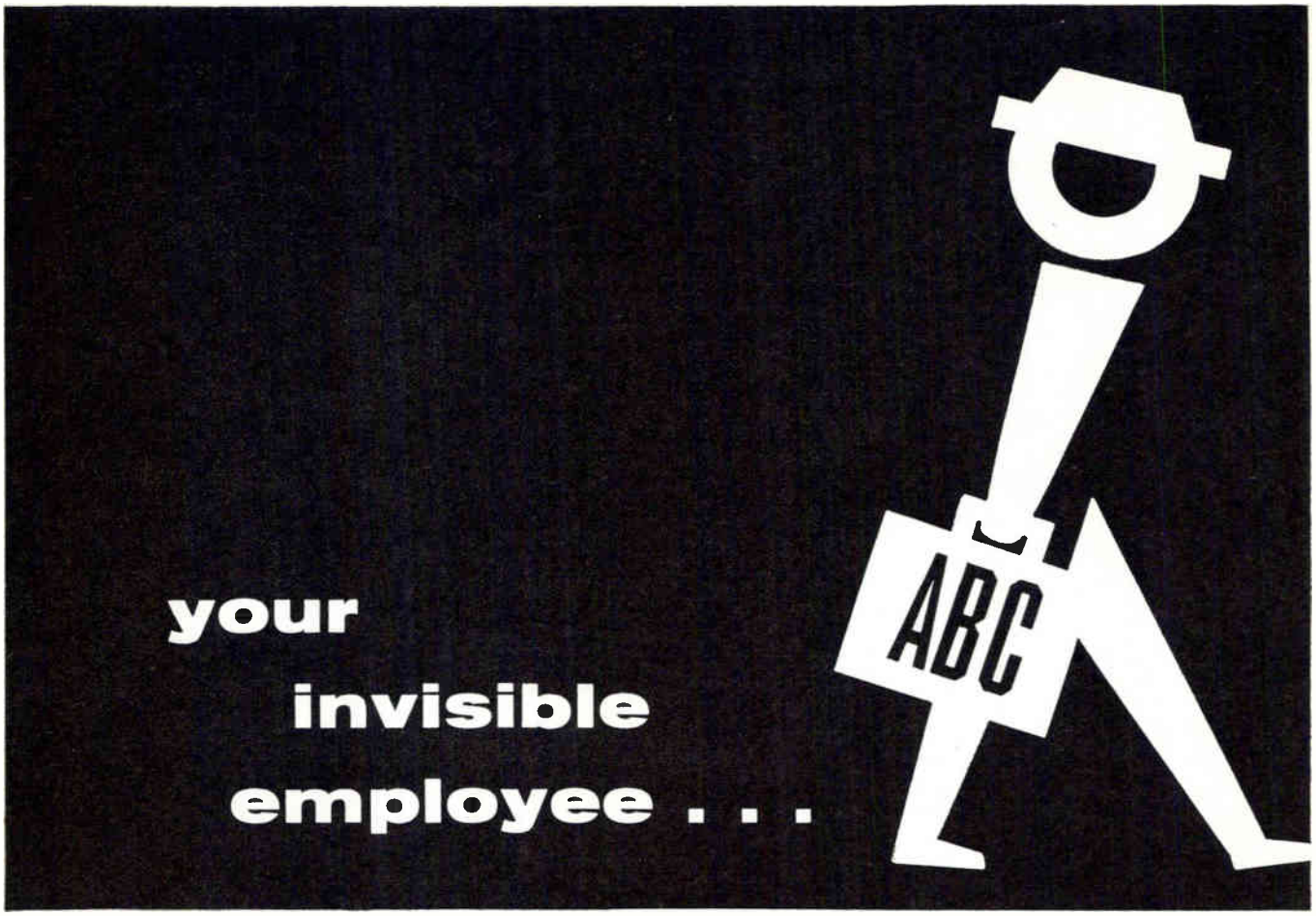


Delay Lines

DISTRIBUTED CONSTANT

RICHARD D. BREW AND CO., INC., 90 Airport Road, Concord, N. H. Distributed constant delay lines have an impedance of 500 ohms. They

CIRCLE 131 ON READER SERVICE CARD→



He's not on your payroll . . . he takes up no desk space in your office . . . and he doesn't hang around the water-cooler talking to your secretaries. But this man works for you — and for every other advertiser.

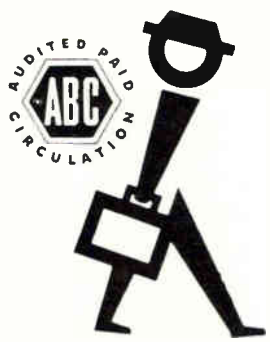
What does he do? He helps to safeguard your advertising investments in print media — by providing audited circulation facts and figures on 2,900 publication members of the Audit Bureau of Circulations*. Assuring an accurate accounting, he tells you how many people purchased the publication . . . where they live . . . how much they paid . . . and the answers to many other questions about the publications and your markets.

He gives you factual marketing information as the basis for your advertising investments. He walks into every ABC-member publication's office and audits its circulation — just as carefully and as objectively as a financial auditor might check your books.

When he is finished, the guesswork is gone! He gives you facts — no opinions, pleasant statistics, *maybe* projections, or fancy figures — just plain old fashioned circulation facts.

Who is he?

He is the ABC auditor — and he works for *you!*



electronics

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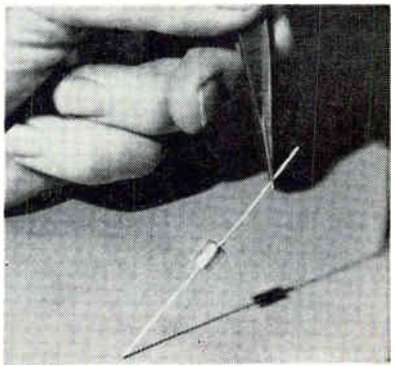
are encased in an epoxy tube 13/32 in. in diameter. Delay time ranges from 0.05 to 1.0 μsec. Maximum rise time for delays below 0.03 μsec is 50 μsec; for delay from 0.3 μsec to 0.75 μsec, 80 μsec; for delays between 0.8 to 1.0 μsec, rise time is 120 μsec.

CIRCLE 338 ON READER SERVICE CARD

Waveguide Adapter

GENERAL RF FITTINGS, INC., 702 Beacon St., Boston 15, Mass. Units adapt coaxial cable to waveguide. Models range from 3.2 to 10.8 Gc; impedance is 50 ohms.

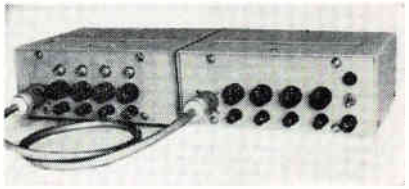
CIRCLE 339 ON READER SERVICE CARD



Silicon Rectifiers
NEED NO HEAT SINK

ELECTRONIC DEVICES, INC., New Rochelle, N. Y., offers a line of silicon rectifiers rated for 1 ma continuous duty from 400 to 1,000 piv. They are available in a silver-flashed metal and epoxy package or in a hermetically-sealed, flangeless glass to silver-flashed metal package. They can be supplied with single-ended leads for use in p-c boards or with standard axial type leads. Case measures ¼ in. by ⅜ in.

CIRCLE 340 ON READER SERVICE CARD



Pulse Generator
& SYNCHRONIZER

PHOTRONICS CORP., 134-08 36th Road, Flushing 54, N. Y. Triggering system designed for synchroni-

zing a number of cameras or for use in telemetering, fire control, precision computer time programming, automatic control, and aircraft and ship navigation. Accuracy is 1 part in 100,000. Output pulses from 8 or more per sec up to 1 pulse every 8 sec with individual system synchronization adjustable by delay up to 10 millisec.

CIRCLE 341 ON READER SERVICE CARD

Variable Transformer

20-AMPERE UNIT

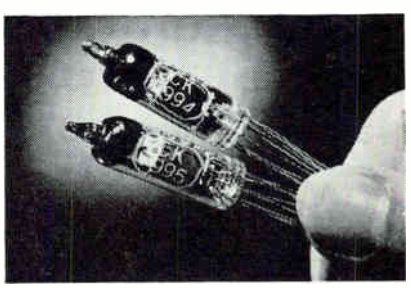
OHMITE MFG. CO., 3665 Howard St., Skokie, Ill. The VT20 is a 20 ampere variable transformer. Heavy radiator and base plates facilitate heat dissipation, and radiator plate is counterbalanced to compensate for weight of brush assembly. Shaft can be extended from either side of the unit as required for panel or horizontal surface mounting.

CIRCLE 342 ON READER SERVICE CARD

Transformer Kit

MICROTRAN CO., INC., 145 E. Mineola Ave., Valley Stream, N. Y. Kit of nine subminature transistor transformers saves time in optimizing breadboard circuitry.

CIRCLE 343 ON READER SERVICE CARD



Subminiature Tubes

FRAME GRID

RAYTHEON CO., 55 Chapel St., Newton 58, Mass. Type CK7994 and CK7995 frame grid subminiature

A NEW SERVICE

NOTICE TO READERS

FREE

REPRINT OF THE MONTH

Each month the editors of *electronics* are selecting a significant article and offering it in reprint form —FREE—to readers.

The May free reprint is an article from the May 5th issue. It is a two page article by Fred W. Kear—Digital Control Uses Unijunction Transistors.

The bistable characteristic of the unijunction transistor makes it a useful control device for digital circuits, replacing many components used in conventional transistor switching circuits, reducing packaging size and lessening maintenance problems. This article discusses the use of unijunction transistors in readout and control circuits.

Order your free copy now by checking the appropriate box on the Reader Service Card in this issue.

electronics

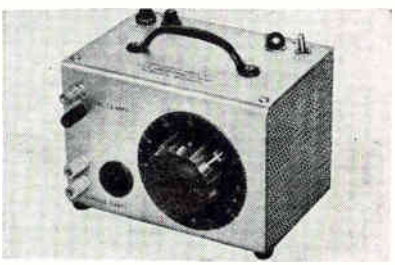
tubes feature a low feed-back capacitance, high transconductance-to-plate current ratio, low noise and low interelectrode capacitance. Both rated for high temperature environments up to 220 C, the tubes are enclosed in T-3 button envelopes with nominal o-d of 0.375 by 1.25 in.

CIRCLE 344 ON READER SERVICE CARD

Electronic Counters

RIDGEFIELD INSTRUMENT GROUP, division of Schlumberger Corp., Ridgefield, Conn. Instruments feature counting rates to 1 Mc and a preset count detection capability to 250 Kc.

CIRCLE 345 ON READER SERVICE CARD



A-C/D-C Supply
PORTABLE UNIT

EDER ENGINEERING CO., INC., 1568 S. First St., Milwaukee 4, Wisc. High current for portable work is available from model 4372 power supply. It offers simple dial selection of desired output voltages from 0 to 125 d-c or to 0 to 140 a-c at 2.5 or 3.0 amp respectively. The bridge rectifier is overload-protected against burnout. Price is $49.50.

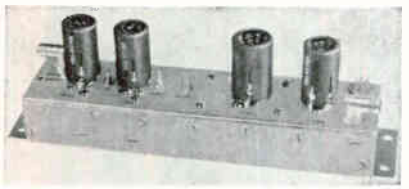
CIRCLE 346 ON READER SERVICE CARD

Linear Amplifier
WITH ANALYZER

HAMNER ELECTRONICS CO., INC., P. O. Box 531, Princeton, N. J. The N-328 amplifier with pulse-height analyzer features ultra-high speed, non-overload characteristics plus optional pickoff for 40 nsec range

coincidence. It has a gain of 7000, double delay-line pulse shaping and a choice of integral or differential discriminators.

CIRCLE 347 ON READER SERVICE CARD



AFC Unit
FOR KLYSTRON L-O

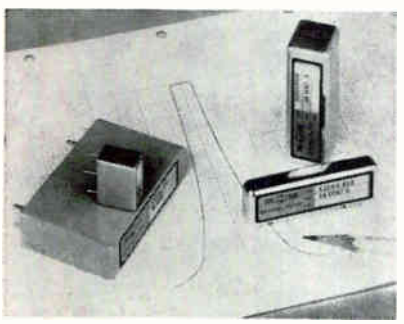
LEL, INC., 75 Akron St., Copiague, N. Y. Designed to control the frequency of a klystron local oscillator in pulse radar systems, the 1F42 afc unit, available at 30 or 60 Mc center frequencies, utilizes a diode-phantastron control circuit and has a sensitivity of 40 v per Mc.

CIRCLE 348 ON READER SERVICE CARD

Variable Capacitors

HAMMARLUND MANUFACTURING CO., INC., 460 W. 34th St., New York 1, N. Y. Forty-two variable capacitors which meet MIL-C-92, have working voltages of 500, 600, or 700 with capacitances from 4.0 to 143 $\mu\mu$f.

CIRCLE 349 ON READER SERVICE CARD



Crystal Filters
MANY APPLICATIONS

COLLINS RADIO CO., 19700 San Joaquin Road, Newport, Calif., announces crystal filters for a broad range of applications in ssb, telemetering, missile guidance, radar and navigation equipment and other communication and electronics uses. Filters over the 10 Kc to 30 Mc range are now being produced in quantities. One of the units is a 5 Mc filter in a thumb-size 3/8

cu in. case, less than half the package size previously available.

CIRCLE 350 ON READER SERVICE CARD

Demagnetizer
FOR RECORDING TAPE

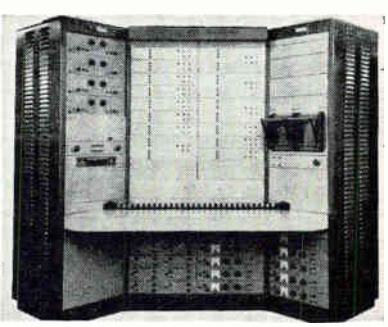
AMPLIFIER CORP. OF AMERICA, 398 Broadway, New York 13, N. Y. Demagnetizer for bulk sound recording tape serves dual purpose: completely erases tape on the reel, without rewinding; demagnetizes record-playback and erase heads. Even on severely overloaded tape, the background noise level is lowered 3 to 6 db below that of virgin, unused tape. Price of either of two models of the Magneraser is $18.

CIRCLE 351 ON READER SERVICE CARD

Time Code Generator

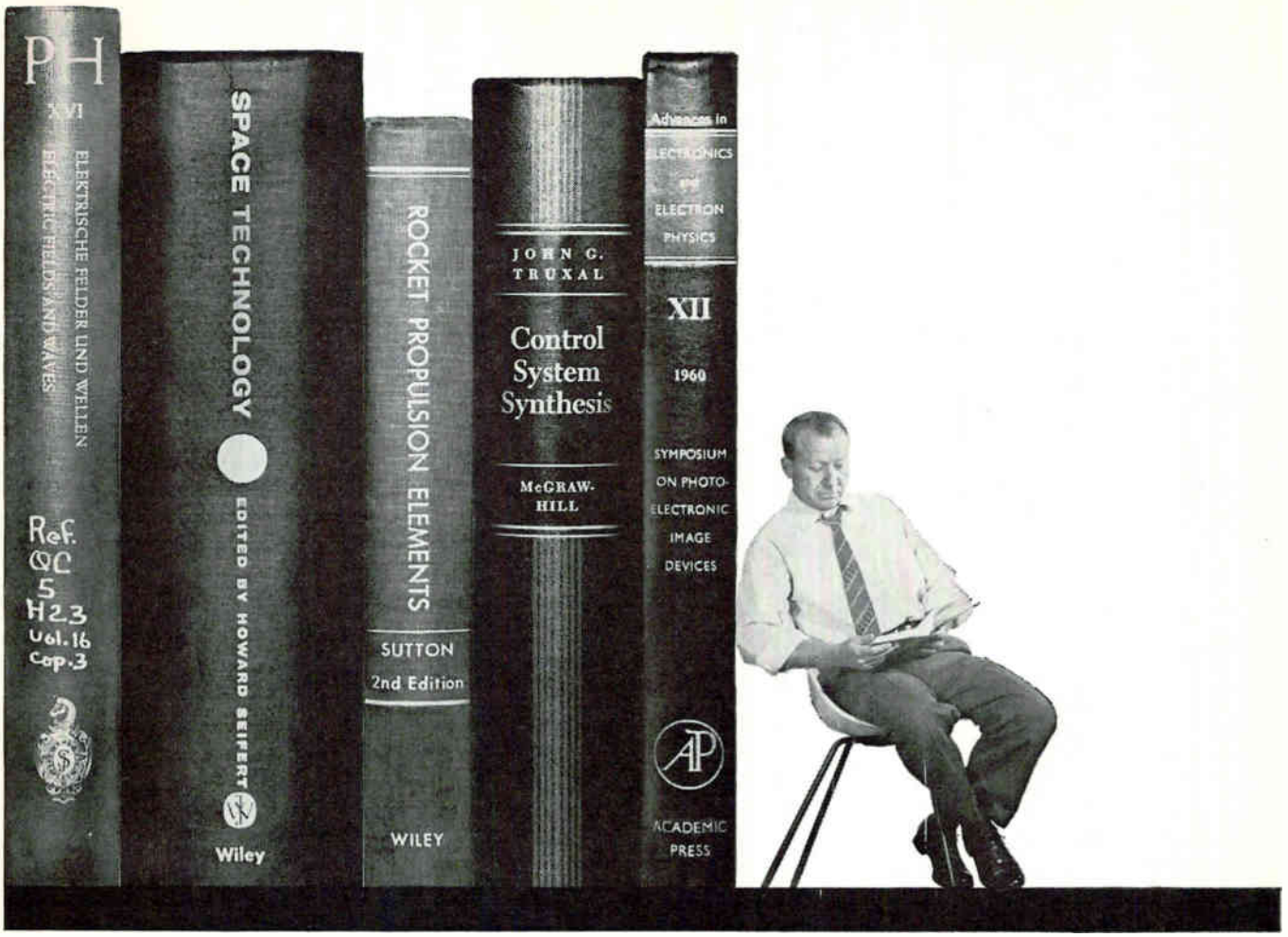
EPSCO-WEST, 240 East Palais Rd., Anaheim, Calif. Generates up to three time code formats of any family of time codes. Stability is 1 part in 10^8 per day.

CIRCLE 352 ON READER SERVICE CARD



Specification Tester
FOR TRANSISTORS

PHILCO CORP., Lansdale Div., Lansdale, Pa. Designed to rapidly test large quantities of transistors to a single, programmed specification, the versatile automatic specifica-



electronic and electromechanical engineers in a unique role

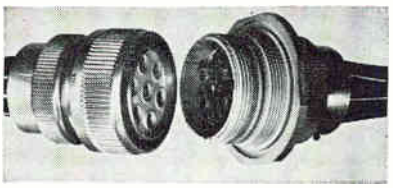
The engineers and scientists of Aerospace Corporation are in the forefront of a rapidly advancing state-of-the-art in sensing and information systems. Their unique role: a critical civilian link uniting government and the scientific-industrial team responsible for development of space systems and advanced ballistic missiles. In providing scientific and technical leadership to every element of this team, they are engaged in a broad spectrum of activities, from formulation of new concepts to technical review and supervision of hardware development by industry. Specific areas of interest include inertial and radio guidance, automatic control, communications, instrumentation, space- and ground-based computing, telemetering, tracking, auxiliary power, infrared, television, optics, and photography. Now more men of superior ability are needed; highly motivated engineers and scientists with demonstrated achievement, maturity, and judgment, beyond the norm. Such men are urged to write Mr. George Herndon, Aerospace Corporation, Room 110, P. O. Box 95081, Los Angeles 45, California.

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government.

AEROSPACE CORPORATION

tion tester (VAST I) is capable of 20-parameter go-no-go testing of 3,600 transistors per hr. The equipment accommodates three operators, though more than two will seldom be required.

CIRCLE 353 ON READER SERVICE CARD



Coaxial Connector
SEVEN-PIN

VIKING INDUSTRIES, INC., 21343 Roscoe Blvd., Canoga Park, Calif. Seven-pin coaxial connector meets MIL-C-26500 (USAF). It features individual coaxial, snap-in contacts that can be removed from the connector with an extraction tool. The contacts utilize a clamping mechanism to retain both the coaxial cable jacketing and the braid. Contact material is copper alloy, rhodium plated. Inner insulation of the coax contact is Teflon.

CIRCLE 354 ON READER SERVICE CARD

Sweep Generators

TELONIC INDUSTRIES, INC., Beech Grove, Ind. R-f sweep and signal generators provide up to 4 w power. User can select four different modes of operation.

CIRCLE 355 ON READER SERVICE CARD

Polarized Connectors
TNC AND TM

GENERAL RF FITTINGS, INC., 702 Beacon St., Boston 15, Mass. Polarized TNC and TM connectors are designed for use in systems where it is desired to eliminate the possibility of connecting mismatching cables. This is achieved by reversing the interior components of standard connectors thus making it

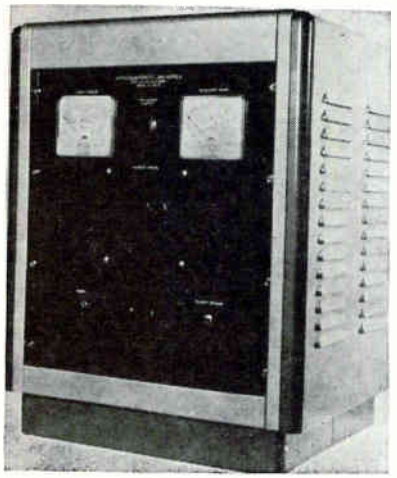
impossible to mate with a standard component. Neither exterior nor electrical characteristics change.

CIRCLE 356 ON READER SERVICE CARD

Cross Patch Cords

HERMAN H. SMITH INC., 2326 Nostrand Ave., Brooklyn 10, N. Y. Cords allow several connections from one terminal, and interconnect an unlimited number of multiple circuits.

CIRCLE 357 ON READER SERVICE CARD



Power Supply
TRANSISTORIZED

SPECTROMAGNETIC INDUSTRIES, P. O. Box 3306, Hayward, Calif. Model TC200-5 transistorized current-regulated power supply converts 110 v, 60 cps, single phase a-c to 200 v d-c with maximum current of 5, 10, or 15 amp. Precision controls give coarse and fine continuous adjustment from zero current to maximum, with regulation held to 0.1 percent.

CIRCLE 358 ON READER SERVICE CARD

Resistor
¼ WATT UNIT

DAYSTROM, INC., Weston Instruments Division, Newark, N. J., has added to its line of precision metal film resistors a ¼ w model Vamistor. It features Vamalloy, a low temper-

ature coefficient alloy, deposited and fixed to the inside glazed surface of a ceramic tube and helically grooved for resistance value. Fire-bonded silver conducting bands and epoxy resin encapsulation are added to make a resistor which is compact, highly accurate, and virtually impervious to weather.

CIRCLE 359 ON READER SERVICE CARD

Recorder Control

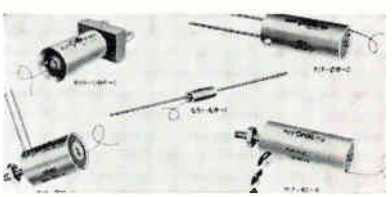
CAHN INSTRUMENT CO., 14511 Paramount Blvd., Paramount, Calif. Recorder control converts any fixed-span recorder to a universal multi-range recorder, with 15 voltage ranges and 15 current ranges.

CIRCLE 360 ON READER SERVICE CARD

Bandpass Filter
LIGHTWEIGHT UNIT

RANTEC CORP., Calabasas, Calif. Model FS-205 is for the 2,200 Mc to 2,300 Mc band. It is designed for rugged missile and satellite environments up to 20 g's from 25 to 3,000 cps. Insertion loss 0.25 db in passband and 50 db in stopband. Vswr is less than 1.2:1 and filter can handle 15 w of power c-w at any altitude without corona.

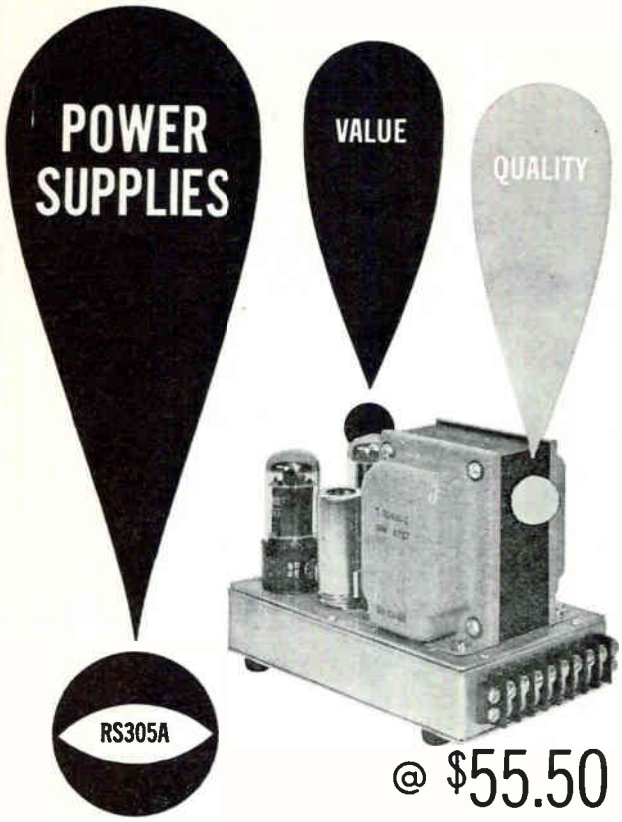
CIRCLE 361 ON READER SERVICE CARD



Precision Resistor
WIRE WOUND

ROTOHMETERS, INC., 46 Prospect St., Yonkers, N. Y. The Rotohmeter is a two terminal wire wound resistor with adjustment feature by which the user himself makes final adjustment to a desired resistance then seals the unit with epoxy or other sealant.

CIRCLE 362 ON READER SERVICE CARD



@ $55.50

For original use . . . For incorporation into laboratory equipment . . . In 55- to 400-cycle systems. The Trans Electronics Model RS305A Power Supply provides voltage regulation of .05% load and .05% line over the entire 225- to 325-volt range. Operating current range 0-50 ma, continuous duty, with filament output of 6.3 volts CT AC @ 3 amps. Units feature low ripple and noise (5 mv peak to peak); fast recovery time (25 to 50 microseconds). Three versions of Model RS305A offer, respectively, modular construction in package 5 x 4⅛ x 6½ inches; rack-mounting; and rack-mounted models with 3¼-inch meters, in case with 3½-inch panel height. Input is 105-125 volts AC.

SPECIFICATIONS

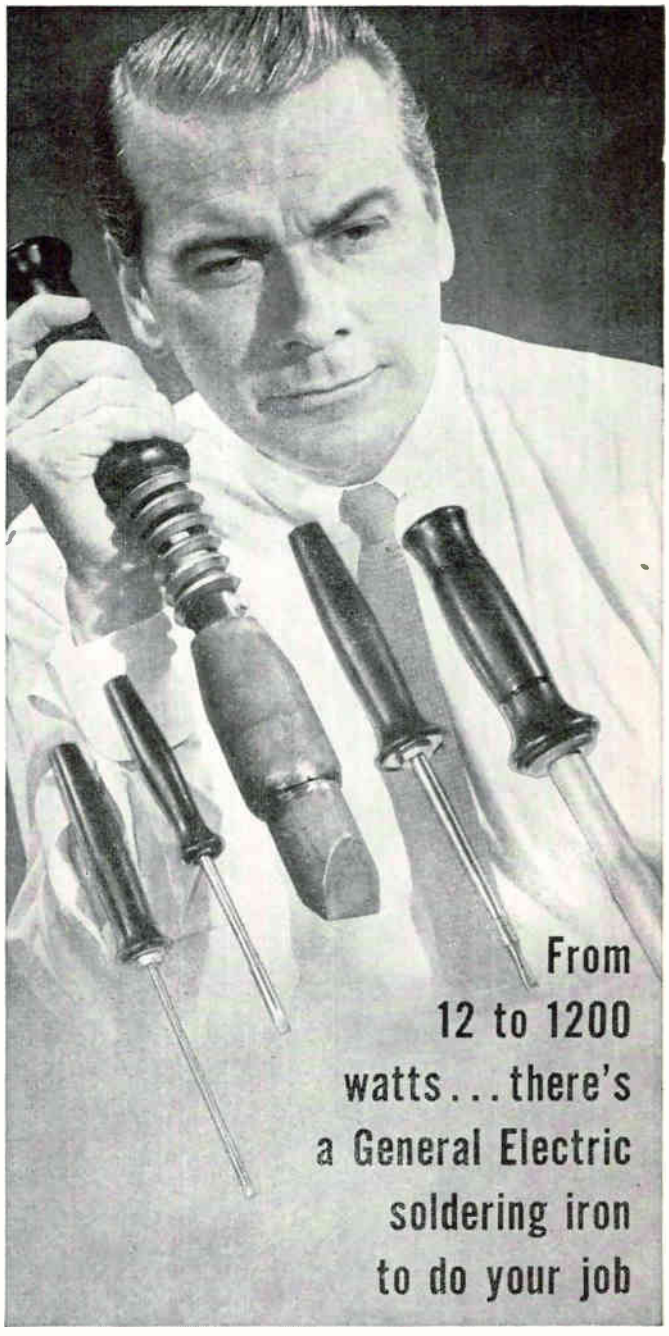
model*	voltage range	current ma	filament volts/amps	price
RS-110				$108.00
RR-110	0-100	6-100	6.3/3	133.00
RM-110				169.00
RS-205				55.50
RR-205	150-225	0-50	6.3/3	80.00
RM-205				115.00
RS-217A				87.50
RR-217A	150-225	0-175	6.3/8	112.50
RM-217A				147.50
RS-305				55.50
RR-305	225-325	0-50	6.3/3	80.00
RM-305				115.00
RS-317				87.50
RR-317	225-325	0-175	6.3/8	112.50
RM-317				147.50
RR-450	+300-400	0-50	6.3/2	155.50
RM-450			6.3/1.5	196.00
DUAL TRACKING	—300-400		6.3/1.5	
RR-473	+300-400	0-25	6.3/2	140.00
RM-473			6.3/1.5	175.00
DUAL TRACKING	—300-400		6.3/1.5	
RS-505				81.50
RR-505	300-5002	0-50	6.3/3	106.50
RM-505				141.50
RR-303	0-300	0-500	6.3/15	320.00
RS-303	0-300	0-500	6.3/15	360.00
RR-550	300-500	0-500	6.3/15	310.00
RM-550	300-500	0-500	6.3/15	350.00

TRANS ELECTRONICS, Inc.

7349 Canoga Avenue, Canoga Park, California

DIamond 0-3333

CIRCLE 206 ON READER SERVICE CARD



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Whatever your soldering requirements may be—from complex miniature electronic sub-assemblies to heavy-duty industrial uses—one of the high-speed soldering irons in General Electric's complete line will do the job. The G-E irons shown above include (left to right):

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MIDGET for pinpoint soldering of hard-to-reach joints.

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LIGHTWEIGHT for soldering of most electronic components.

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For expert assistance in choosing the *exact* iron you need, contact your General Electric distributor or local G-E Apparatus Sales Office; or write Section 758-03, General Electric Co., Schenectady 5, N. Y.

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CIRCLE 143 ON READER SERVICE CARD

NEW BOOKS

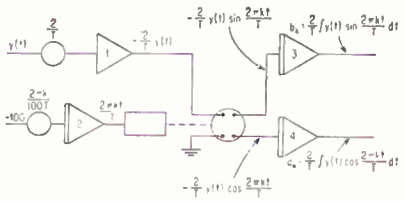

FIG. 25.1. Fourier analysis on the general-purpose computer.

Analogue Computation

By STANLEY FIFER

McGraw-Hill Book Co., Inc., New York, 1961, 1331 *p*, $39.50 (4 *vol*)

ALTHOUGH certainly of value to anyone in any way connected with the analog computing field, this set will be invaluable as a reference book and guide to those working in computer laboratories. It consolidates much information formerly available only in various papers and reports, as well as putting together in one well-indexed set information which previously could be gathered only from many different volumes.

These volumes present every aspect of analog computation: programming and check-out procedures, components and component design, error analysis, techniques for generating functions of two variables, methods of handling many types of mathematical configurations such as systems of linear algebraic equations, noise generation and the adjoint method of noise analysis, and solutions of partial differential equations. Although these volumes are oriented toward the use of a general purpose d-c computer, all other types of analog computers are discussed and, where possible, the merit of the application of the different types of computers to each problem is presented.

The chapters are arranged in such a way as to make this set valuable as a text book. Each chapter has an introduction, a summary, a set of sample problems and a very complete list of references. The illustrations and schematics are plentiful and concise. The level of mathematics and physics required is such that it would be most useful in graduate work.

Two chapters, containing the equations and computer set-ups for the dynamics of flight and flutter, will be of special interest to those who are not directly concerned with operation of a computer but who must set up the mathematical equations from physical situations.—LEONORE R. BUSHOR, *Computer Consultant, West Islip, N. Y.*

Dictionary of Automation, Computers, Control and Measuring

By W.E. CLASON

Elsevier Publishing Co., Amsterdam, The Netherlands (D. Van Nostrand Co., Inc., Princeton, N. J., Distributors), 1961, 856 *p*, $27.50.

THIS latest in the Elsevier series of multilingual dictionaries gives 3,390 words and phrases in English and the equivalents in French, Spanish, Italian, Dutch and German. When the British term differs from the American, both are given. Each term is defined in English and classified in one of a dozen categories, including machine translation and information theory. For each language other than English, there is an alphabetic list of terms, referring to the corresponding numbers in the basic table.

A valuable tool for the technical translator and for those who read foreign journals, this dictionary would be of even more interest if Russian were one of the six languages presented. However, Russian supplements have been published for several other Elsevier dictionaries, so it may be only a matter of time until it is done for this volume.

Although some terms in common use are not included, the omissions are more than made up for by the technical excellence and careful preparation of this handsome volume.—SBG

THUMBNAIL REVIEWS

Transistor Circuit Analysis and Design. By Franklin C. Fitchen, D. Van Nostrand Company Inc.,

Princeton, N. J., 356 p, $9. A practical introduction to transistor circuit design which is aimed at junior- and senior-level engineering students, this book deals in detail with the customary transistor physics and the basic equivalent circuits: the current-generator tee, the hybrid, and the hybrid-pi. Subsequent chapters stress actual design of different types of transistor amplifiers, receiver and transmitter circuits, and pulse circuits.

Professional Engineers Examination Questions and Answers. By W. S. LaLonde, Jr., McGraw-Hill Book Co., New York, N. Y., 589 p, $7.50. This volume offers a complete review course dealing with basic fundamentals and business economics as well as the major engineering subjects covered by state licensing examinations. The question and answer approach, dealing separately with each particular subject, allows the reader a method of educating through self checking. An excellent book for engineers wishing to brush up on little used areas.

Ceramics. By P. William Lee, Reinhold Publishing Corp., New York, 1961, 210 p, $5.95. This book surveys the basic materials used in all forms of ceramics, glass and cermets, and reviews ceramics chemistry, production methods, applications and developments. While it may satisfy persons seeking a general understanding of ceramics technology, its information on insulations, dielectrics, ferrites and transducer materials is sketchy and would be of little value to specialists in these fields.

Stereo 1881. By John Sunier, Gernsback Library, New York, N. Y. 160 p, $2.95. Relatively non-technical, this book is designed to acquaint audiophiles with the history and development of stereophonic sound from its earliest beginnings to the present day. Discusses stereo sound, old and new developments of stereo tapes and disks, and the various techniques used for experimental broadcasting.

NOTE: Our review of Welsby's THE THEORY AND DESIGN OF INDUCTANCE COILS (p 164, Apr. 28, 1961) gave the publisher as MacDonald of London and the price as $4.20. While this information is correct for editions distributed in England, the sole U. S. publisher is John Wiley & Sons, Inc., who are distributing the book at a price of $6.

Literature of the Week

WIRE DISPENSERS Products for Industry, Inc., 1704 Summer St., Stamford, Conn. Data sheet describes plastic dispensers for handling pre-cut wire used in harnesses, control panels and assemblies.

CIRCLE 363 ON READER SERVICE CARD

POTENTIOMETER Reon Resistor Corp., 155 Saw Mill River Rd., Yonkers, N. Y. Bulletin covers a composition variable resistor that is rated at 3 w for standard applications and 2 w for military specifications.

CIRCLE 364 ON READER SERVICE CARD

CROSSBAR James Cunningham, Son & Co., Inc., 33 Litchfield St., Rochester 8, N. Y. "High Performance Crossbars" reviews six basic crossbar types, performance data, actuation and control, and applications.

CIRCLE 365 ON READER SERVICE CARD

FACILITIES BROCHURE Loral Electronics Corp., 825 Bronx River Ave., New York 72, N. Y. Sixteen page brochure outlines the company's capabilities for defense electronics.

CIRCLE 366 ON READER SERVICE CARD

SIZE 5 COMPONENTS General Precision, Kearfott Div., Little Falls, N. J. Miniature servo system components are covered in a 4-page catalog.

CIRCLE 367 ON READER SERVICE CARD

SOLDER FOIL Accurate Specialties Co., Inc., 345 Lodi St., Hackensack, N. J. Data sheet gives solder foil specifications and lists standard alloys available as foil.

CIRCLE 368 ON READER SERVICE CARD

THERMOSTATS Stevens Manufacturing Co., Inc., P. O. Box 1007, Mansfield, Ohio. Brochure on thermostats covers both hermetically sealed and semienclosed styles.

CIRCLE 369 ON READER SERVICE CARD

TRANSISTOR RELAYS Bergen Laboratories Inc., 60 Spruce St.,

Paterson 1, N. J. Specifications and applications are given for two precision transistor relays and a transistor isolation amplifier in a 4-page brochure.
CIRCLE 370 ON READER SERVICE CARD

POWER SUPPLIES Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif. A 16-page catalog describes a line of compact, highly regulated d-c power supplies with 80 percent efficiency.
CIRCLE 371 ON READER SERVICE CARD

CAPACITORS General Electric Co., Schenectady 5, N. Y. Bulletin gives specifications on fixed plastic-dielectric tubular capacitors designed for filter bypass or blocking purposes in missiles, computers, etc.
CIRCLE 372 ON READER SERVICE CARD

TRANSFORMERS PCA Electronics Inc., 16799 Schoenborn St., Sepulveda, Calif. Eight-page catalog features the company's line of datapulse transformers.
CIRCLE 373 ON READER SERVICE CARD

CALIBRATION SERVICE Endevco Corp., Customer Service Dept., 161 East California Blvd., Pasadena, Calif. Brochure describes a calibration service which offers shock calibration to 15,000 g.
CIRCLE 374 ON READER SERVICE CARD

PLASTICS Synthane Corp., Oaks, Pa. Brochure covers copper-clad laminated plastics conforming to MIL-P-13949B.
CIRCLE 375 ON READER SERVICE CARD

RECEIVER MIXER Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. Application note tells how to adapt an X-band or H-band crystal detection mount for use as a mixer for a laboratory receiver.
CIRCLE 230 ON READER SERVICE CARD

TAPE PREPARATION McDonnell Electronic Equipment Div., Box 516, St. Louis 66, Mo. Bulletin describes punched tape preparation equipment for automatic checkout and machine control requirements.
CIRCLE 231 ON READER SERVICE CARD

ELECTRON TUBES Machlett Laboratories Inc., Springdale,

NEW DESIGN DATA ON MAGNETIC AMPLIFIERS

—latest ARNOLD folder enables you to design and build a unit to your exact needs.

Armed with the data in this folder, you can create an optimum design for a 12-watt magnetic amplifier . . . get the closest possible control over its design and construction . . . for control of servo motors, regulated power supplies, etc.

You build the amplifier around its basic component — the saturable reactor. Twenty-four ARNOLD saturable reactors are described in the folder. There's full information as to what associated components are necessary, and how to use the components in a proper magnetic amplifier circuit.

In buying just the saturable reactor, you get far more latitude than in buying a whole black box. And you won't have to prepare comprehensive specs., or depend on an outside source for the complicated designs.

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ARNOLD MAGNETICS CORP.
6050 W. Jefferson Blvd., Los Angeles 16, Calif.
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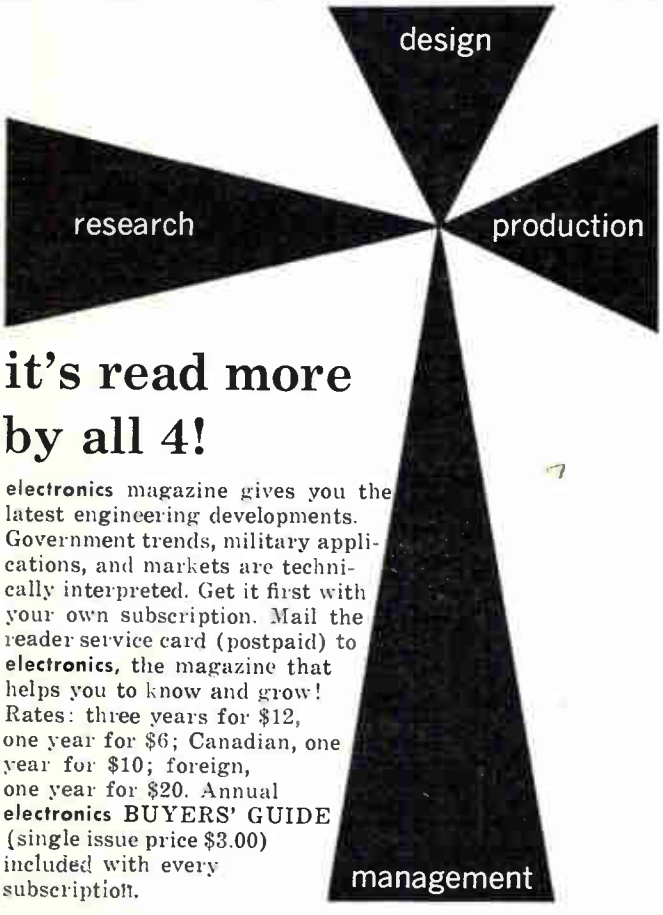
CIRCLE 211 ON READER SERVICE CARD



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Dependable Push Button Switches by Grayhill

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- Double Pole
- Lighted
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- Solderless
- Push-Pull
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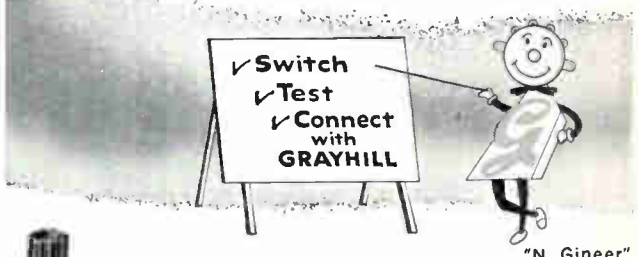
—Ratings from 1/10 ampere to 10 amperes—for commercial or military applications—custom engineered models for special applications. These top quality Push Button Switches are available with a wide variety of accessories, such as decorative mounting nuts, range of colored button caps, lockwashers, etc.

Special return springs, contacts and other variations of the standard model are available on special order.



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Grayhill offers a full line of Rotary Tap Switches, Push Button Switches, Test Clips, Binding Posts, and other miniature electrical and electronic components.
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Grayhill

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523 Hillgrove Ave., LaGrange, Illinois

Conn. Catalog provides a reference guide to types and condensed data on the company's tubes, including vapor-cooled triodes, hard-pulse tube modulators and the uhf planar group.

CIRCLE 232 ON READER SERVICE CARD

POWER SUPPLIES Technipower Inc., 18 Marshall St., South Norwalk, Conn. Bulletin covers miniature solid state d-c power supplies, including rack mounted versions with optional meters.

CIRCLE 233 ON READER SERVICE CARD

DELAY LINES Ad-Yu Electronics Lab., 249 Terhune Ave., Passaic, N. J. Two data sheets describe High-Z miniature delay lines with linear phase response and models which feature a rise time less than 3.5 percent of total possible delay.

CIRCLE 234 ON READER SERVICE CARD

MICROWAVE EQUIPMENT Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md. Catalog reviews the company's products, featuring their line of coaxial attenuators and terminations.

CIRCLE 235 ON READER SERVICE CARD

PRINTED CIRCUIT CLEANER National Ultrasonic Corp., Nutley, N. J. Data sheet covers a cleaning system which combines Freon agents with ultrasonic energy.

CIRCLE 236 ON READER SERVICE CARD

TV TRANSLATORS Electronics, Missiles & Communications, Inc., 262 E. Third St., Mt. Vernon, N. Y., has available a planning package for vhf tv rebroadcast translators.

CIRCLE 237 ON READER SERVICE CARD

ELECTRON TUBES Raytheon Co., Industrial Components Div., Newton, Mass. Twelve-page booklet covers industrial and military filamentary subminiature electron tube characteristics.

CIRCLE 238 ON READER SERVICE CARD

RECORDERS Curtiss Wright Corp., Princeton, N. J. Data sheet describes rectilinear recorders featuring 2 to 6 channels.

CIRCLE 239 ON READER SERVICE CARD

MICRO MANIPULATORS Brinkmann Instruments, Inc., 115 Cutter

Mill Rd., Great Neck, L. I., N. Y. Brochure covers manipulators with three dimensional movements for the positioning of micro tools.

CIRCLE 240 ON READER SERVICE CARD

ALLOYS Semi-Alloys Inc., 550 S. Fulton Ave., Mt. Vernon, N. Y. Four data sheets deal with the melting points of four basic alloys, aluminum, gold, indium and silver, for use in the semiconductor industry.

CIRCLE 241 ON READER SERVICE CARD

COOLING UNITS Wakefield Engineering, Inc., Wakefield, Mass. Booklet describes several models of Delta natural convection cooling units.

CIRCLE 242 ON READER SERVICE CARD

READOUT CELLS Hoffman Electronics Corp., 1001 N. Arden Dr., El Monte, Calif. Data sheet supplies engineering information on silicon solar readout cells which are basically light-to-electricity converters.

CIRCLE 243 ON READER SERVICE CARD

INDUCTIVE DEVICES Vanguard Electronics Co., 3384 Motor Ave., Los Angeles 34, Calif., has published a catalog presenting specifications and dimensional diagrams for inductive devices.

CIRCLE 244 ON READER SERVICE CARD

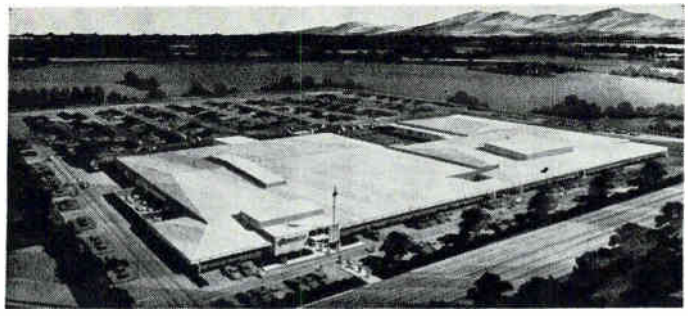
SERVOMOTOR GENERATOR Beckman Instruments Inc., Helipot Div., 2500 Fullerton Rd., Fullerton, Calif. A servomotor generator, wound for 115 v, 400 cycle excitation is described in a single data sheet.

CIRCLE 245 ON READER SERVICE CARD

COMPUTER RESOLVERS Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J., "Primer for Computing Resolvers" covers properties such as function and axis error and techniques of measurement.

CIRCLE 246 ON READER SERVICE CARD

MOTORS Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill. The construction and operation of several instrument motor models is discussed in a 28-page brochure. Please request copies on company letterheads.



Fairchild Adds to Mt. View Plant

FAIRCHILD SEMICONDUCTOR CORP. has begun construction on a new 40,000 sq ft addition (wing at right in sketch) to its transistor manufacturing and headquarters facility in Mountain View, Calif. Robert N. Noyce, vice president and general manager, said the addition would cost more than $500,000.

Scheduled for completion this fall, the new structure will bring Fairchild's total office and manufacturing space at 454 Whisman Road to 108,000 sq ft.

Julius Blank, Fairchild's manager of facilities, said the original building was completed in August 1959 and cost approximately $1 million. The company also has 56,000 sq ft of other plant space in the Mountain View-Palo Alto area and a 55,000 sq ft diode plant in San Rafael.

Noyce said the expansion was necessary because the firm had doubled its share of the semiconductor market last year and plans to double its product line this year.

In addition to manufacturing high-performance silicon transistors and diodes, the company has recently introduced a line of electronic building blocks called Micrologic elements for computers. It has also entered the industrial transistor market and the transistor test equipment market and now has a work force of 1,550.

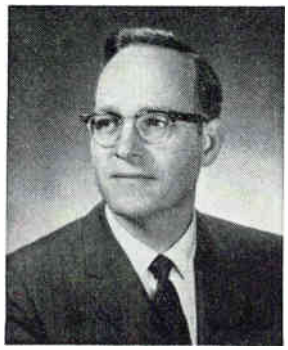
Fairchild is a wholly owned subsidiary of Fairchild Camera & Instrument Corp. of Syosett, L. I., N. Y.

Infrared Industries To Double Capacity

INFRARED INDUSTRIES, INC., has started construction of a 15,000 sq ft addition to its plant on Route 128, Waltham, Mass., which will double present plant capacity.

The new building, representing an investment of approximately $250,000, will provide additional laboratory facilities for expanded production and engineering programs in the company's Photoconductor Division, according to William E. Standring, general manager.

Approximately 50 new positions will be created following completion of the new facility on June 15, Standring said.



G-D/Electronics Promotes Jacque

APPOINTMENT of Raymond F. Jacque as manager of quality assurance in the military products division of General Dynamics/Electronics, Rochester, N. Y., is announced. Prior to this assignment he was assistant manager of quality control in the division for seven years.

Giannini Tabs Two For Promotion

PROMOTION of two men to positions of division management was recently announced by Neil Curry, manager of Giannini Controls Corp.'s servo component division.

Russell Reid, former contracts administrator, becomes operations manager. Neil Saldinger, former project engineer, moves up to assistant chief engineer.

Copolymer Corporation Elects Carpenter

COPOLYMER CORP., Los Angeles, Calif., reinforced plastics firm, recently elected Carey Carpenter executive vice president.

Active in reinforced plastics since 1953, Copolymer will broaden its research and development effort under the former Swedlow Inc. technical manager to bid for an increased part in the field of ablative and structural missile and space components.

Adler Electronics Fills New Posts

GORDON S. JONES has been appointed manufacturing engineering supervisor in the operations division of Adler Electronics, New Rochelle, N. Y. He was formerly with DuMont Laboratories, Clifton, N. J.

Also announced was the promotion of Lester Kowalsky to group

Recording 1200 Megawatt Impulse Measurements

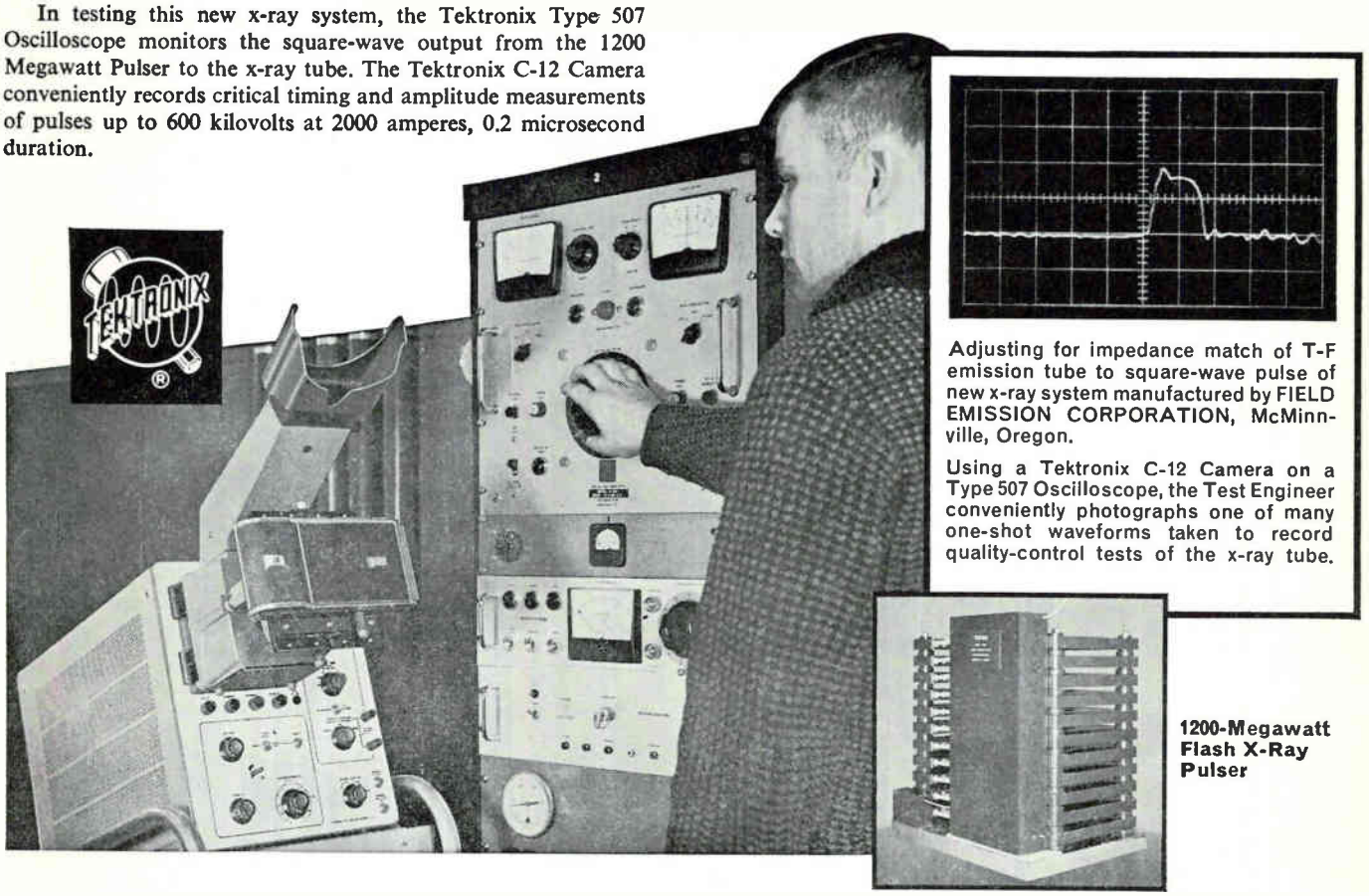
with Tektronix Camera and Surge-Testing Oscilloscope . . . in Monitoring Flash X-Ray System

New Flash X-Ray System manufactured by FIELD EMISSION CORPORATION utilizes an x-ray tube with a newly-developed T-F emission cathode—which increases the current density by a factor of one million over that of a thermal emitter.

Applying square-wave pulse techniques to this high-current T-F emission tube enables the x-ray system to provide stop-motion pictures of high-speed events at velocities up to 30,000 feet per second.

In testing this new x-ray system, the Tektronix Type 507 Oscilloscope monitors the square-wave output from the 1200 Megawatt Pulser to the x-ray tube. The Tektronix C-12 Camera conveniently records critical timing and amplitude measurements of pulses up to 600 kilovolts at 2000 amperes, 0.2 microsecond duration.

For your own high-voltage and high-current applications, consider a C-12 Camera on a Type 507 Oscilloscope. Together, these Tektronix Instruments enable you to obtain and keep an accurate waveform record of power-surge measurements—such as high-voltage breakdown tests of power transformers, insulators, allied components . . . pinch-effect studies . . . other experiments in plasma research.



Adjusting for impedance match of T-F emission tube to square-wave pulse of new x-ray system manufactured by FIELD EMISSION CORPORATION, McMinnville, Oregon.

Using a Tektronix C-12 Camera on a Type 507 Oscilloscope, the Test Engineer conveniently photographs one of many one-shot waveforms taken to record quality-control tests of the x-ray tube.

1200-Megawatt Flash X-Ray Pulser

Type 507 Oscilloscope

Tektronix CRT—new 5-inch CRT at 24-KV accelerating potential provides bright trace on 6-cm by 10-cm viewing area.

Vertical Sensitivity—50 v/cm to 500 v/cm.

Risetime—10 nanoseconds.

Sweep Range—20 nsec/cm to 50 μsec/cm.

Single Sweeps—RESET button arms the sweep circuit for triggering internally, manually, or by an external signal.

Internal Time Markers.

High-Voltage Trip Pulse.

Electronically-Regulated Power Supplies.

Type 507 Oscilloscope **$3000**

Includes Scope-Mobile and separate Power Supply.

(prices f.o.b. factory)

C-12 Camera

- **Undistorted Viewing.**
- **Direct Recording.**
- **One-Hand Portability.**
- **Lift-On Mounting.**
- **Swing-Away Hinging.**
- **Comfortable Viewing**—with or without glasses.

C-12 Camera **$500**

Includes f/1.9 lens with 1:0.9 (object-to-image ratio) complete with cable release, Focusing Back, Polaroid® Back.

® by Polaroid Corporation.

For a demonstration of a Tektronix Camera on a Surge-Testing Oscilloscope, please call your Tektronix Field Engineer.

Also, ask him to place your name on the request list for the technical report "Impulse Tests and Measuring Errors"—which will be available soon.

Tektronix, Inc.

P. O. Box 500 • Beaverton, Oregon • Phone Mitchell 4-0161 • TWX—BEAV 311 • Cable: TEKTRONIX

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

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

In Europe please write Tektronix Inc., Victoria Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country.

leader, manufacturing engineering. He was formerly a senior mechanical engineer.

The Adler operations division is responsible for the production of communications systems and equipment for the military and industrial markets.

El-Tronics Appoints Melvin Salveson

EL-TRONICS, INC., Warren, Pa., has named Melvin E. Salveson as president of its Alwac Division, at Hawthorne, Calif. This division manufactures digital computers for scientific calculations.

Salveson was systems research manager and consultant in operations research for the General Electric Co. for several years, and has headed up his own consultant firm since 1957.

Burnell Names Lurie Chief Engineer

WILLIAM B. LURIE, former senior project engineer and program director of General Precision Laboratories, Inc., has joined Burnell & Co., Inc., Pelham, N. Y., manufacturer of electronic filters and delay lines, as chief engineer. He will be in charge of design and engineering administration, and will also coordinate engineering and re-

search of the company's subsidiaries and its Guillemin Research Laboratory.

Hennessey Joins Dalmo Victor

FRANK HENNESSEY, radar antenna design engineer, has joined Dalmo Victor Co., division of Textron Inc., Belmont, Calif., as a senior engineer. He will serve as group leader of the microwave antenna research group.

Hennessey previously was associated with Lockheed Missile Systems Division as a research scientist on antennas for space vehicle applications.

Philco Names D. G. Fink V-P for Research

DONALD G. FINK has been appointed vice president for research of Philco Corp., Philadelphia, Pa. He was formerly director of research and general manager of the research division.

Before joining Philco in 1952, Fink was editor of ELECTRONICS.

Sheingold Accepts Government Post

LEONARD S. SHEINGOLD, director of the Applied Research Laboratory

of Sylvania Electric Products Inc., Waltham, Mass., has been named chief scientist of the U. S. Air Force. He succeeds Alesander H. Flax, who will return to his former position as vice president and technical advisor of Cornell Aeronautical Laboratory at Syracuse, N. Y.

As chief scientist, Sheingold will have responsibility for providing technical advice on Air Force plans, programs and requirements. Appointment of a chief scientist is made for a one-year period.

Daystrom-Pacific Names V-P & G-M

KENNETH M. MILLER, formerly vice president of Motorola Aviation Electronics, has been named vice president and general manager of Daystrom-Pacific, Los Angeles, Calif., a division of Daystrom, Inc.

Miller previously served as general manager and earlier as chief engineer of the Lear Cal Division of Lear, Inc.

Goodyear Aircraft Hires Frank Fehn

FRANK P. FEHN has joined Goodyear Aircraft Corp., Akron, O., as a senior development engineer in the firm's guidance and computer engineering department. Prior to his association with the company, he

had spent nine years with the E. W. Bliss Co. of Canton, O., as a senior electronic specialist and assistant chief engineer.

Allegri-Tech Opens West Coast Facility

ALLEGRI-TECH, INC., Nutley, N. J., has announced the opening of a new 20,000 sq ft plant in Burlingame, Calif.

Company manufactures printed circuit configurations and modules used in military applications such as the ground support equipment of Polaris and Nike-Zeus and the reconnaissance satellites.

PEOPLE IN BRIEF

Victor Met transfers from General Electric to Kane Engineering Labs as manager of the waveguide components research and development group. **Thomas D. Kegelman** promoted to chief of the television and infrared group of United Aircraft Corp.'s Norden Div. **Norman E. Wunderlich** named staff consultant of Intercontinental Electronics Corp. **William C. Hennings** and **Hugh L. Gottfried** of Melabs move up to manager of the space systems branch and manager of the reconnaissance systems branch, respectively. **William O. Puro** leaves Melpar to join Emertron Inc. as director of microwave development. **Joseph J. Houghton**, formerly president of Electrodynamic Instrument Corp., chosen director of engineering and manufacturing by Infotronics Inc. **Ben Wright** advances at Kaar Engineering Corp. to chief engineer. **Herbert Rosenberg** transfers from Space Technology Labs to Marshall Labs as manager of the digital circuits dept. **Leon Davidson** promoted to manager of the programming section of Teleregister Corp.'s engineering dept. **Samuel Todd Huey**, previously with RCA, joins the engineering staff of Lynch Communication Systems. **George F. Houlroyd** of Foto-Video Electronics moves up to vice-president of manufacturing. **John J. Davis** leaves Summers Gyroscope to join Rutherford Electronics as project engineer.

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CITY..... ZONE..... STATE.....

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MAJOR(S) .....

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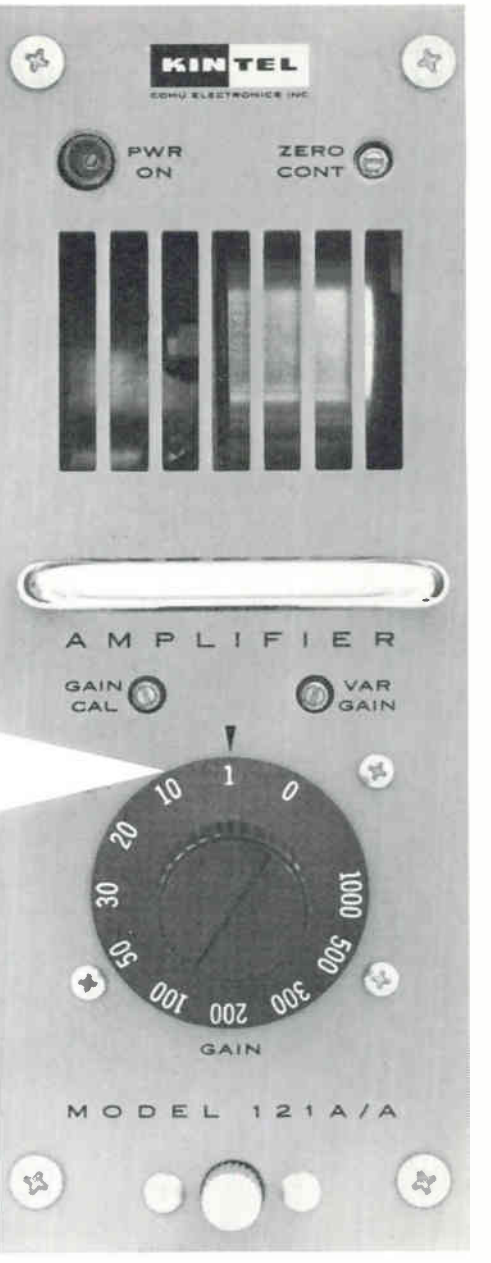

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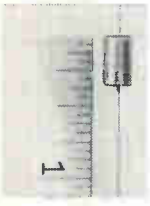

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1N3194	400 v	750 ma	6 amp.	1.2 v	10 μa
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