OCTOBER 9, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 41 PRICE SEVENTY-FIVE CENTS

Food Processing By Irradiation

Ohmic Heating Circuits

FILTERS FOR ALL APPLICATIONS FROM STOCK

HERMETICALLY SEALED TO MIL-T-27A & MIL-F-18327 SPECS.

Write For NEW Catalog

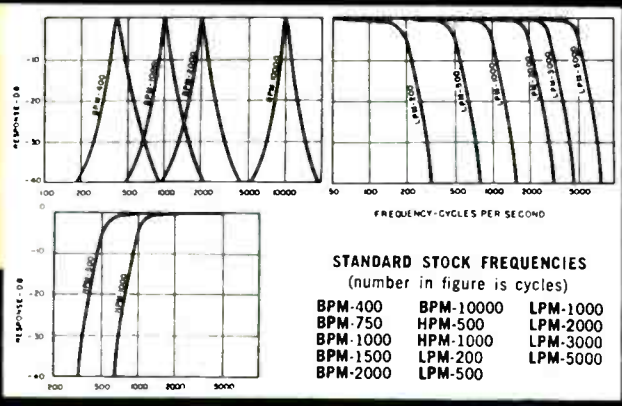
MINIFILTERS

New Minifilters provide almost the same characteristics (with attenuation only slightly less) as the industry's standard interstage and line filters immediately below.

BPM band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db ±3% from center frequency, then 35 db per octave.

HPM high pass units; loss of less than 6 db at cut-off frequency; attenuation of 30 db at .67 cut-off frequency, 40 db at .6 cut-off frequency. Input and output 10K.

LPM low pass units; loss of less than 6 db at cut-off frequency; attenuation of 30 db at 1.5 cut-off frequency, 40 db at 1.65 cut-off frequency. Input and output 10K.



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

BPM-400	BPM-10000	LPM-1000
BPM-750	HPM-500	LPM-2000
BPM-1000	HPM-1000	LPM-3000
BPM-1500	LPM-200	LPM-5000
BPM-2000	LPM-500	

BPM case (MIL AF)
¾ x ¾ x 1⅛"
Weight....1 oz.

HPM and LPM case (MIL AG)
1 x 1 x 1¾"
Weight....2¼ oz.

INTERSTAGE & LINE

These six basic types cover most popular filter applications and frequencies.

BMI band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

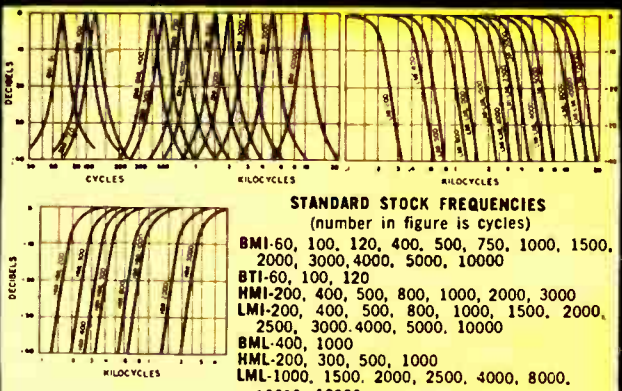
HMI high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

LMI low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

HML high pass filters are same as HMI but 500/600 ohms in and out.

LML low pass filters are same as LMI but 500/600 ohms in and out.

BML band pass units are same as BMI but 500/600 ohms input, output to grid, 9:1 gain.



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

BMI-60, 100, 120, 400, 500, 750, 1000, 1500, 2000, 3000, 4000, 5000, 10000
BTI-60, 100, 120
HMI-200, 400, 500, 800, 1000, 2000, 3000
LMI-200, 400, 500, 800, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 10000
BML-400, 1000
HML-200, 300, 500, 1000
LML-1000, 1500, 2000, 2500, 4000, 8000, 10000, 12000

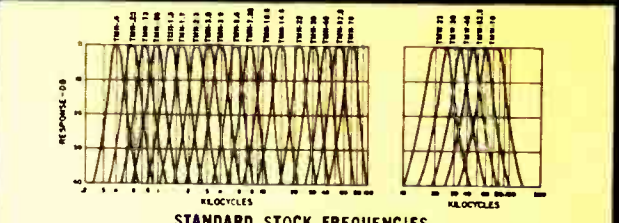
Base ..... 1¾ x 1⅛"
Height, BMI, LMI, BML ..... 1⅝"
Height, HMI, HML, LML ..... 2⅛"
Weight ..... 6 oz. and 9 oz.

TELEMETERING BAND PASS

UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, 4 pin header for small Winchester socket.

TMN units are within 3 db at ± 7.5% of center frequency . . . down more than 18 db at ± 25% . . . more than 40 db beyond 1.75 and .58 center frequency.

TMW are within 3 db at ± 15% of center frequency . . . down more than 20 db at ± 50% . . . more than 40 db beyond 2.5 and .4 center frequency.



STANDARD STOCK FREQUENCIES
(number in figure is KC)

TMN- .4	TMN-1.7	TMN- 5.4	TMN-30	TMW-22
TMN- .56	TMN-2.3	TMN- 7.35	TMN-40	TMW-30
TMN- .73	TMN-3.0	TMN-10.5	TMN-52.5	TMW-40
TMN- .96	TMN-3.9	TMN-14.5	TMN-70	TMW-52.5
TMN-1.3		TMN-22		TMW-70

TMN-2.3 thru TMW-70
23/32 x 23/32 x 1¾"
Weight....1.2 oz

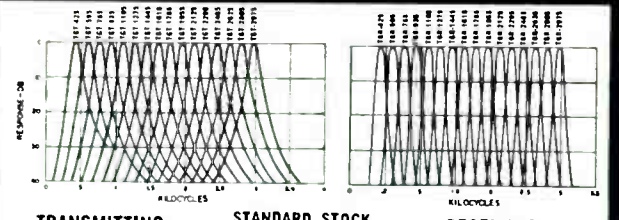
TMN-.4 thru TMN-1.7
1¼ x 1½ x 2"
Weight....3.5 oz.

TELEGRAPH TONE CHANNEL

These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

TGT transmitting filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 16 db at ± 170 cycles . . . down more than 7.5 db at adjacent channel cross-over.

TGR receiving filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 30 db at ± 170 cycles . . . down more than 15 db at adjacent channel cross-over.



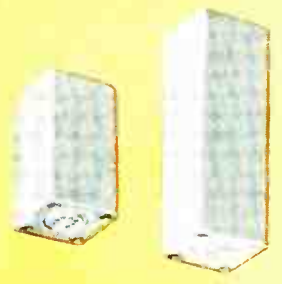
TRANSMITTING

TGT-425	TGT-1785
TGT-595	TGT-1955
TGT-765	TGT-2125
TGT-935	TGT-2295
TGT-1105	TGT-2465
TGT-1275	TGT-2635
TGT-1445	TGT-2805
TGT-1615	TGT-2975

STANDARD STOCK FREQUENCIES
(number in figure is cycles)

RECEIVING

TGR-425	TGR-1785
TGR-595	TGR-1955
TGR-765	TGR-2125
TGR-935	TGR-2295
TGR-1105	TGR-2465
TGR-1275	TGR-2635
TGR-1445	TGR-2805
TGR-1615	TGR-2975



TGT CASE
1⅓ x 1⅓ x 2½"
Weight....8 oz.

TGR CASE
1⅓ x 1⅓ x 4¼"
Weight....15 oz.

And Special Units to Your Specifications

UNITED TRANSFORMER CORP.
150 Varick Street, New York 13, N. Y.
PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

electronics

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Vol. 32 No. 41

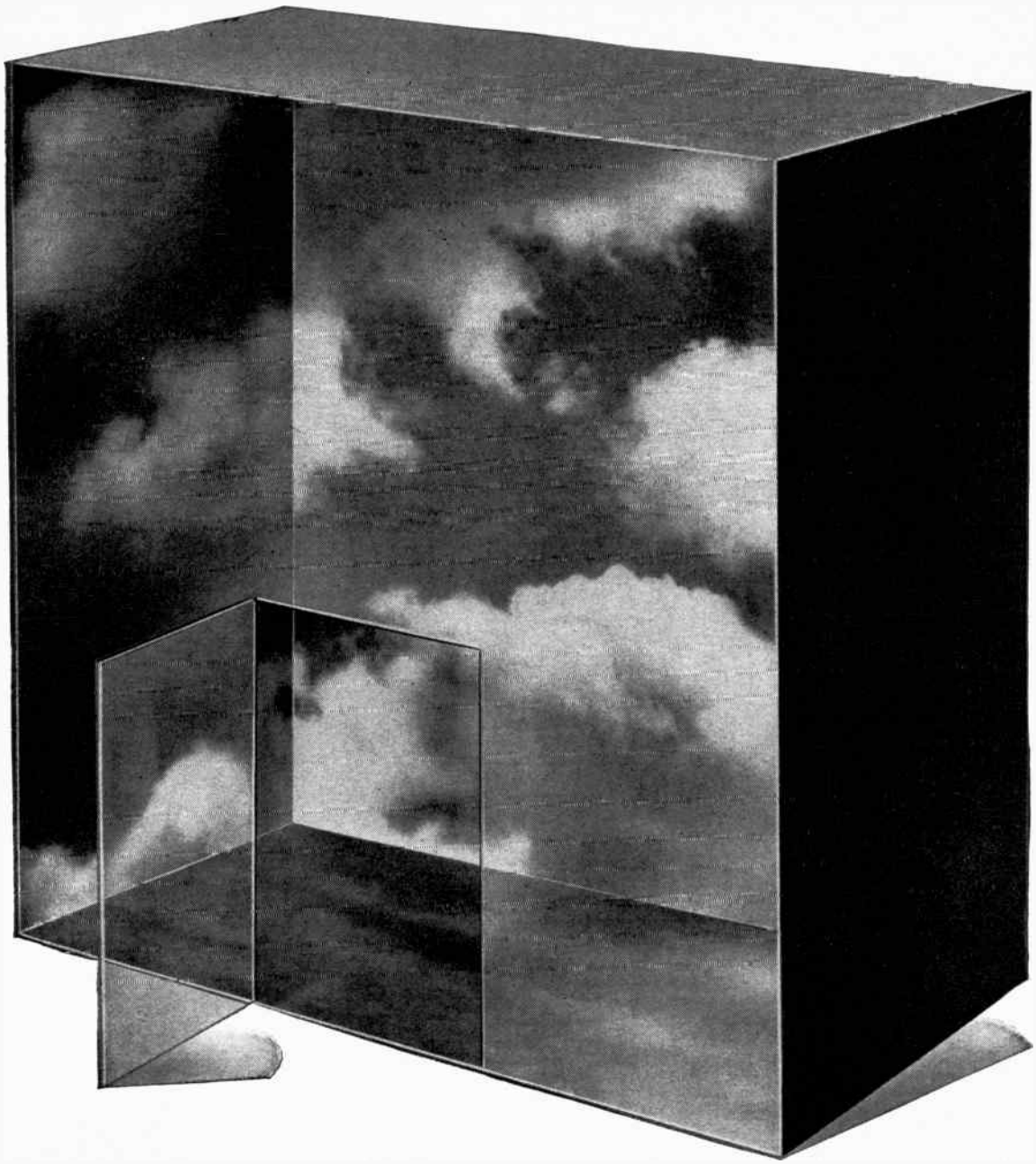
Issue at a Glance

Business

Engineering

Departments

B.F.Goodrich



Bring the wild blue yonder indoors...

If you have to figure what happens up there... you'll come considerably closer by testing with B.F.Goodrich Microwave Absorbents. The specifications and details are many. Sufficient to say—*all* the information is in a comprehensive new booklet. Write to The B.F.Goodrich Company, 586 Derby Place, Shelton, Connecticut.

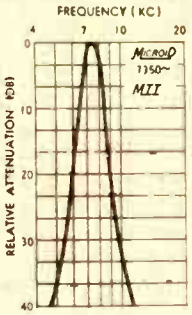
B.F.Goodrich ***microwave absorbents***

SPACE SHRINKERS

MICROIDS AND MONKEYS — Burnell & Co. welcomes the assistance of their simian friends in the task of gathering data vital to space shrinking. By shrinking toroids, filters and related networks for guidance and communication systems, Burnell helps space vehicles carry bigger payloads — more instrumentation, animals — eventually man. Typical of our accomplishments is the MTT MICROID® telemetering band pass filter. Significantly, the combined weight of 23 MICROIDS — plus the monkey — is less than the single non-miniaturized telemetering band pass filter pictured here. MICROID band width is 15% at 3 db + 60% —40% at 40 db. Frequency coverage is from .4 kcs to 70 kcs.

Sizes	
Channels 1-6	2x27/32x1/2
Channels 7-10	1-5/16x11/16x11/16
Channels 11-18	15/16x19/32x1/2
Alternates A-E	15/16x19/32x1/2

Write for Filter Bulletin MTT 23.



2/3 actual size

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
DEPT. E-25
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TELETYPE PELHAM 3633

PACIFIC DIVISION
DEPT. E-25
720 MISSION ST.
SOUTH PASADENA, CAL.
RYAN 1-2841
TELETYPE: PASACAL 7578

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Member ABP and ABC

SHOPTALK . . . editorial

THE ELECTRONICS INDUSTRY. Nearly thirty years ago, this magazine gave its name to an infant industry. Today, the electronics industry encompasses more than 4,000 plants that employ nearly 2 million workers. And people still ask: "What is electronics?"

Electronics is an art and a science and an industry concerned with the motion of charged particles. This motion is ordered and put to work in electron devices such as tubes, transistors, magnetic amplifiers, masers, and a host of other solid, liquid or gaseous contrivances.

The development, manufacture and use of electron devices, the equipment in which they are used, the components and hardware that are used with them, and special materials from which these things are made are all part of the electronics industry.

In many plants electronic equipment, materials or components make up almost all the output. In other plants electronic products make up less than all the output: a machine shop punches out chassis, an airframe manufacturer makes inertial guidance systems, a chemical manufacturer rolls printed-circuit board stock. These too are part of the electronics industry to the extent that they are manufacturing electronic equipment, components or materials.

The degree of specialization varies. Some airframe manufacturers may realize 50 to 60 percent of their gross sales in electronic equipment and parts. An automobile manufacturer may be 5 to 10 percent in electronics. Few large firms are exclusively in electronics.

ELECTRONICS, interest in its industry transcends classifications based on major product of any manufacturer. Where people are designing, making or using electronic materials, components or equipment, there is our industry and our editorial interest.

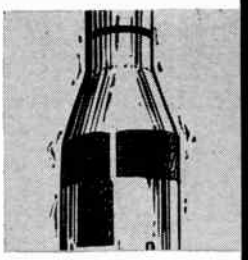
W W MacDonald

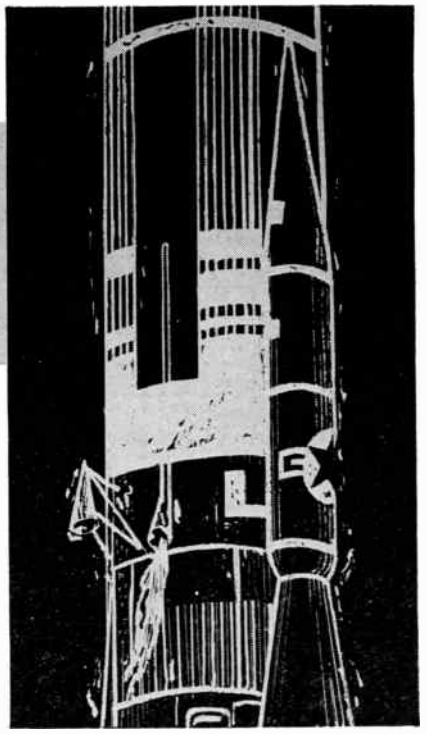
Editor

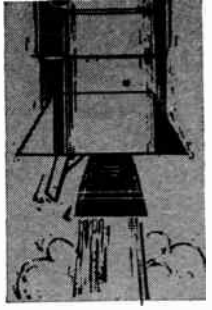
Coming In Our October 16 Issue . . .

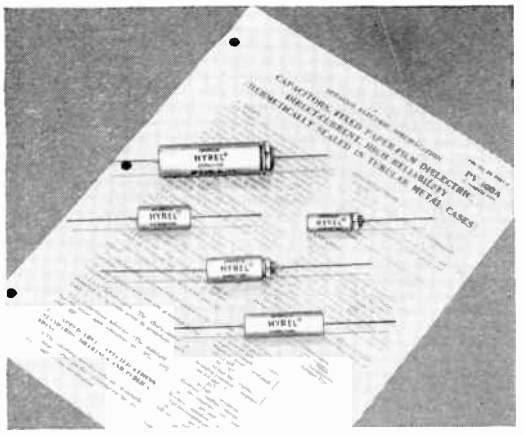
INSTRUMENTING HUMAN PAYLOADS. A capsule shaped like the one designed to carry a human cargo for Project Mercury was recently recovered intact after a successful flight down the Atlantic Range. This is another significant step toward the inevitable first human space flight. When this epochal event does take place, how will scientists on earth monitor the physical wellbeing of the first astronaut? The problems of instrumentation for determining the physiological data under conditions of space flight are indeed complex and require new and ingenious transducer design. Next week, M. Traite, W. Welkowitz, J. Kilduff and C. Purporo of the medical instruments department of Gulton Industries, Metuchen, N. J., describe both the transducers and associated circuitry for determining the respiration, electrocardiogram, temperature, blood pressure and other physical parameters of men, in space.

PRECISION ANGLE ENCODER. Accurate, automatic measurement of angular position is needed for optically guided missile-tracking instruments. A special angle transducer of unusual design and construction has recently been developed which allows real-time digital recording of shaft position of special radars and optical tracking instruments. L. G. DeBey of Aberdeen Proving Ground, D. Comstock of the Norden division of United Aircraft, and S. B. Peterson and R. C. Webb of Colorado Research Corp. have teamed up to describe this new transducer and associated electronics. The vernier element introduces a new principle into analog-to-digital conversion: quantization by radio interferometry.









MISSILE-READY CAPACITORS

—thanks to Sprague's PV-100A

It has been more than three years since Sprague originated Specification PV-100–*the first high reliability capacitor specification for missiles and other critical applications.* This specification and a later revision, PV-100A, have proved so comprehensive and so successful in providing "the highest order of reliability known to the capacitor industry" that their provisions are currently reflected in *every* military specification covering high reliability capacitors. This is a distinction shared by no other capacitor manufacturer.

The capacitors manufactured by Sprague to PV-100 and PV-100A standards have amassed a record of reliability far in excess of original expectations. On high frequency vibration, shock, and other environmental tests, failure rate has been almost zero. On accelerated life tests (250 hours at 140% rated voltage, 125° C) *failure rate has been less than .05%.* This performance is virtually impossible to beat . . . now and for some years to come. But Sprague doesn't stop here. The company's research on materials, processes, and controls is now more intensive than ever. Sprague knows that only through continuous research can high reliability be made *higher.*

If you're interested in the fine points of high reliability capacitors, call your Sprague District Office or Representative. Or write letterhead request for Sprague's Hyrel Bulletin 2900A and Specification PV-100A to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Mass.

SPRAGUE®

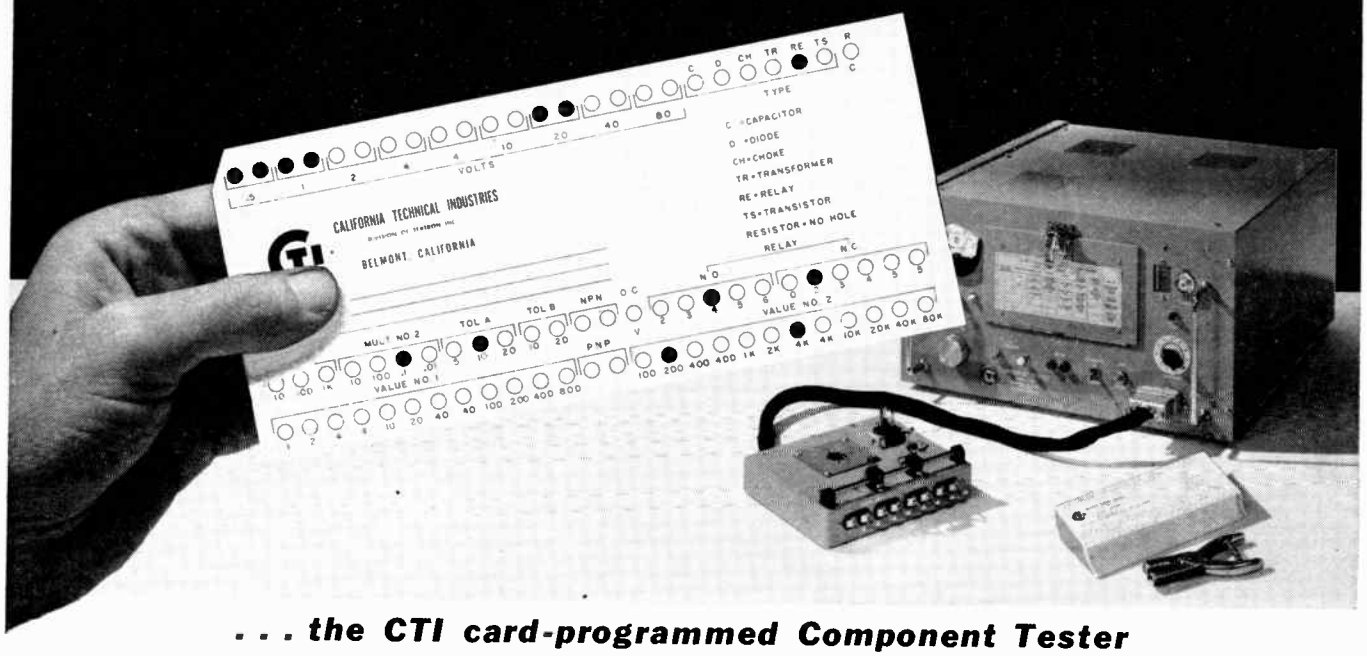
THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS

HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

A revolutionary approach to INCOMING INSPECTION . . .



. . . the CTI card-programmed Component Tester

Reduce your incoming-test procedures to the insertion of a card and the push of a button! Large quantities or varied, small lots of any of the basic electronic components can be handled with equal efficiency by the CTI Component Tester. An unskilled operator merely selects the appropriate card. The Component Tester performs the required series of tests and indicates either that the component has passed or the type of failure that has been found. "Over", "under", and "pass" circuits are provided for completely automatic operation with handling and sorting devices.

The simplicity of operation and surprisingly low cost of this instrument are the result of CTI's extensive experience in the field of automatic testing. An ingenious card reader provides both reliability and economic design. Precision bridge measurements and fail-safe circuitry are features gained in the development of CTI's automatic circuit testers.

Programming is accomplished with an ordinary hand punch. A single hole selects one of the test sequences listed below. Several additional holes dictate specific values and tolerances. Combinations or modifications of these standard tests can be used for special measurements.

CAPACITORS

Capacity: .002 to 100 mfd; smaller values using external oscillator
Leakage or Shunt Resistance Limit: 1 ohm to 1.62 megohms at 6 volts d-c, or 50 megohms at 100 v d-c

TRANSISTORS

Cut-off Current (I_{CO}): 0.375 microamperes to 1 amp
A-C Current Gain (base to collector—emitter common): 10 to 100

CHOKES

Inductance with rated D-C Current flowing: .03 to 50 henries: 0.5 to 161 ma
D-C Winding Resistance: 1 ohm to 1.62 megohms
Leakage Resistance Limit from winding to core: 50 megohms

DIODES and RECTIFIERS

Forward Resistance at 1 volt: 1 ohm to 1.62 megohms
Reverse Resistance at rated Reverse Voltage: 1 ohm to 1.62 megohms, 1 to 161 volts d-c

RESISTORS

Resistance: 1 ohm to 16.2 megohms

TRANSFORMERS

Primary Inductance: .03 to 12 henries
Winding Ratio: 1:1 to 100:1
Winding Polarity
Leakage Resistance Limit from winding to core: 50 megohms at 100 v d-c

RELAYS

Pull-In Voltage: a-c or d-c, 0.5 to 161 volts
Continuity of each contact when closed: 1 ohm to 1.62 megohms
Leakage Resistance Limit between contacts in open position: 50 megohms at 100 v d-c
Coil Resistance: 1 ohm to 16.2 megohms
Leakage Resistance Limit from coil to frame: 50 megohms at 100 v d-c
Leakage Resistance Limit from all swingers and fixed contacts to frame: 50 megohms at 100 v d-c

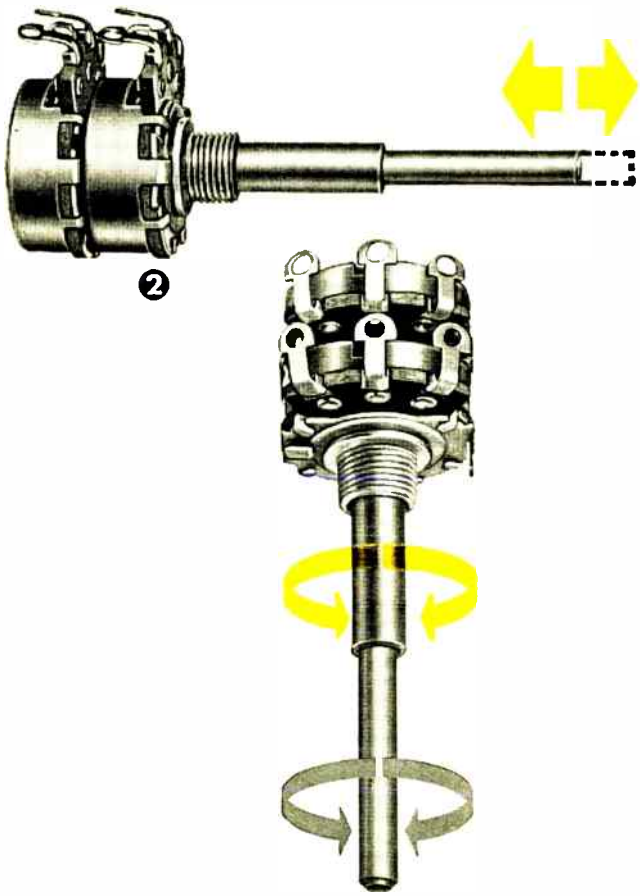
Engineers: Career opportunities are currently available at CTI

CTI®

CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC.
BELMONT 8, CALIFORNIA
Foremost in Automatic Testing

NEW CONTROLS FOR STEREO

Flexibility without Complexity



Even a wife can appreciate the major points of these special dual-element controls for 2-channel stereo equipment! No longer is it necessary to fiddle with 2 bass controls, 2 treble controls, and 2 volume controls to obtain proper stereo balance—then re-adjust everything when listening to monophonic material. No longer, that is, unless you're an ardent audiophile who would have it no other way.

For these new Stackpole controls "clean-up" the panels of stereo equipment, make them easier to operate and understand . . . yet retain all the flexibility of individual adjustments required on the most elaborate equipment.

❶ **FRICTION SHAFT DUAL**—Type LS3: A friction fit between shafts causes both elements of this dual concentric shaft control to operate in tandem when either shaft is turned. Either element can also be adjusted independently by holding one shaft while rotating the other. Once set, either knob can be turned while maintaining stereo balance through a wide range of adjustment.

❷ **CLUTCH SHAFT DUAL**—Type LS1: This wonderfully convenient control allows either simultaneous or individual adjustment of its two elements. A push on the inner shaft engages a clutch which connects both elements together for tandem operation by either shaft. Pulling the inner shaft permits each element to be individually adjusted without disturbing the other.

❸ **MATCHED ELEMENT TANDEM**—Type L-Tandem: Through precise electrical matching and careful mechanical alignment, this stereo tandem control allows convenient, single-knob adjustment of both channels. It's ideal for adjustment of master volume or of bass or treble in systems where an absolute minimum of panel complexity is desired.

Mechanical and electrical specifications on these dependable 0.75-watt variable composition resistors are available on request. Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.

STACKPOLE

Coldite 70+® fixed composition Resistors • Slide & Snap Switches • Ceramag® Ferrite Cores • Fixed composition Capacitors • Ceramagnet® Ceramic Magnets • Electrical Contacts • Brushes for all rotating electrical equipment • Hundreds of related carbon, graphite, and metal powder products.

NOW!

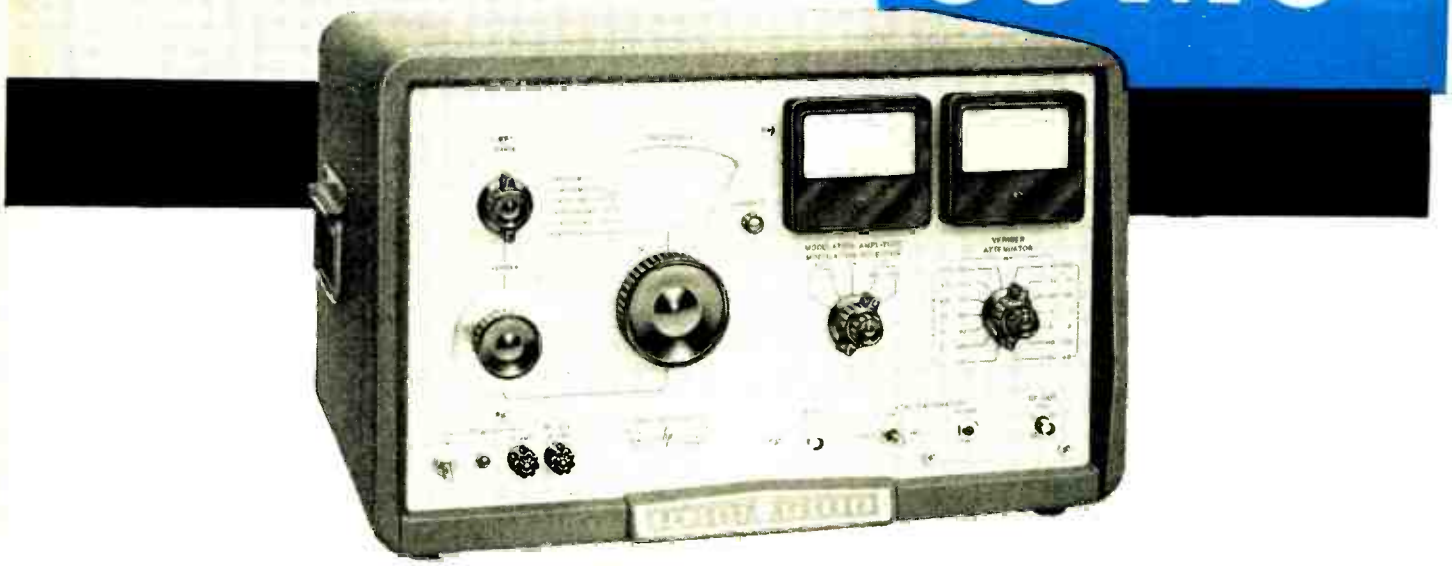
Constant output level

Constant modulation level

3 volt output into 50 ohms

Low envelope distortion

50 kc to 65 MC



NEW -*hp*- 606A HF Signal Generator

Here at last is a compact, convenient, moderately-priced signal generator providing constant output and constant modulation level plus high output from 50 kc to 65 MC. Tedious, error-producing resetting of output level and % modulation are eliminated.

Covering the high frequency spectrum, (which includes the 30 and 60 MC radar IF bands) the new -*hp*- 606A is exceptionally useful in driving bridges, antennas and filters, and measuring gain, selectivity and image rejection of receivers and IF circuits.

Output is constant within ±1 db over the full frequency range, and is adjustable from +20 dbm (3 volts rms) to —110 dbm (0.1 μv rms). No level adjustments are required during operation; the instrument has a minimum of controls and high accuracy results are assured due to the constant internal impedance. The generator can be provided with a 10:1 voltage divider and dummy antenna lowering minimum output to 0.01 μv (from 5 ohms) and simulating IRE standards for precision receiver measurements. (See Accessories Available in Specifications.)

The new -*hp*- 606A may be modulated by sine waves and complex waveforms from dc to 20 KC. A meter indicates percent modulation. Distortion in sine waves is extremely low due to use of a feedback circuit.

To insure maximum accuracy of frequency setting, the 606A includes an internal crystal calibrator providing check points at 100 kc and 1 MC intervals with error less than 0.01%.

hp offers the world's most complete

Specifications

Frequency Range: 50 kc to 65 MC in 6 bands.

50— 170 kc	1.76— 6.0 MC
165— 560 kc	5.8 —19.2 MC
530—1800 kc	19.0 —65.0 MC

Frequency Accuracy: Within ±1%.

Frequency Calibrator: Crystal oscillator provides check points at 100 kc and 1 MC intervals accurate within 0.01% from 0° to 50° C.

RF Output Level: Continuously adjustable from 0.1 μv to 3 volts into a 50 ohm resistive load. Calibration is in volts and dbm (0 dbm is 1 milliwatt).

Output Accuracy: Within ±1 db into 50 ohm resistive load.

Frequency Response: Within ±1 db into 50 ohm resistive load over entire frequency range at any output level setting.

Output Impedance: 50 ohms, SWR less than 1.1:1 at 0.3 v and below. BNC Output connector mates with UG-88A/B/C/D.

Spurious Harmonic Output: Less than 3%.

Leakage: Negligible; permits sensitivity measurements down to 0.1 μv.

Amplitude Modulation: Continuously adjustable from 0 to 100%. Indicated by a panel meter. Modulation level is constant within ±½ db regardless of carrier frequency.

Internal Modulation: 0 to 100% sinusoidal modulation at 400 cps ±5% or 1000 cps ±5%.

Modulation Bandwidth: Dc to 20 kc maximum, depends on carrier frequency, f_c, and percent modulation as shown in the following table:

	30% Mod.	*70% Mod.*	*Squarewave Mod.*
Max. Mod. Frequency	0.06 f_c	0.02 f_c	0.003 f_c (3 kc max)

External Modulation: 0 to 100% sinusoidal modulation dc to 20 kc. 4.5 volts peak produces 100% modulation at modulating frequencies from dc to 20 kc. Input impedance is 600 ohms. May also be modulated by square waves and other complex signals.

Envelope Distortion: Less than 3% envelope distortion from 0 to 70% modulation at output levels of 1 volt or less.

Modulation Meter Accuracy: Within ±5% of full scale reading from 0 to 90%.

Spurious FM: 0.0025% or 100 cps, whichever is greater, at an output of 1 v or less and 30% AM modulation.

Spurious AM: Hum and noise sidebands are 70 db below carrier.

Power: 115/230 volts ±10%, 50 to 1000 cps, 135 watts.

Accessories Available: *-hp-* AC-606A-34 Output Voltage Divider with 50 and 5 ohms termination (10:1 voltage divider) and IRE standard dummy antenna (10:1 voltage divider). $50.00.

Price: (cabinet) $1,200.00. (rack mount) $1,185.00.

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

Other -hp- Signal Generators—10 to 21,000 MC

Instrument	Frequency Range	Characteristics	Price
-hp- 608C	10 to 480 MC	Output 0.1 μv to 1 v into 50 ohm load. AM, pulse, or CW modulation. Direct calibration	$1,000.00
-hp- 608D	10 to 420 MC	Output 0.1 μv to 0.5 v. Incidentol FM 0.001% entire ronge	1,100.00
-hp- 612A	450 to 1,230 MC	Output 0.1 μv to 0.5 v into 50 ohm load. AM, pulse, CW or square wave modulation. Direct calibration	1,200.00
-hp- 614A	800 to 2,100 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration	1,950.00
-hp- 616A	1,800 to 4,000 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulotion. Direct calibration	1,950.00
-hp- 618B	3,800 to 7,600 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW, FM or square wave modulation. Direct calibration	2,250.00
-hp- 620A	7,000 to 11,000 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, FM or square wave modulation. Direct calibration	2,250.00
-hp- 623B	5,925 to 7,725 MC	Output 70 μv to 0.223 v into 50 ohm load. FM or square wave modulation. Separate power meter and wave meter section.	1,900.00
-hp- 624C	8,500 to 10,000 MC	Output 3.0 μv to 0.223 v into 50 ohm load. Pulse, FM or square wave modulation. Separate power meter and wave meter section	2,265.00Δ
-hp- 626A	10 to 15.5 KMC	Output 10 dbm to —90 dbm. Pulse, FM, or square wave modulation. Direct calibration	3,250.00
-hp- 628A	15 to 21 KMC	Output 10 dbm to —90 dbm. Pulse, FM, or square wave modulation. Direct calibration	3,250.00

ΔRack mounted instrument available for $15.00 less.

-hp- 608D vhf Signal Generator

10 to 420 MC. Highest stability. No incidental FM or frequency drift. Calibrated output 0.1 μv to 0.5 v throughout range. Built-in crystal calibrator provides frequency check accurate within 0.01% each 1 and 5 MC. Master-oscillator, intermediate and output amplifier circuit design. Premium quality performance, direct calibration, ideal for aircraft communications equipment testing. $1,100.00.

-hp- 608C vhf Signal Generator. High power (1 v max.) stable, accurate generator for lab or field use. 10 to 480 MC. Ideal for testing receivers, amplifiers, driving bridges, slotted lines, antennas, etc. $1,000.00.

-hp- 626 A/628A shf Signal Generators

New instruments, bringing high power, wide range, convenience and accuracy to 10 to 21 KMC range. Frequencies, output voltage directly set and read. Output 10 to 20 db better than previous spot-frequency sets SWR better than 1.2 at 0 dbm and lower. Internal pulse, FM or square wave modulation; also external pulsing or FM'ing. *-hp-* 626A, 10 to 15.5 KMC, $3,250.00. *-hp-* 628A, 15 to 21 KMC, $3,250.00.

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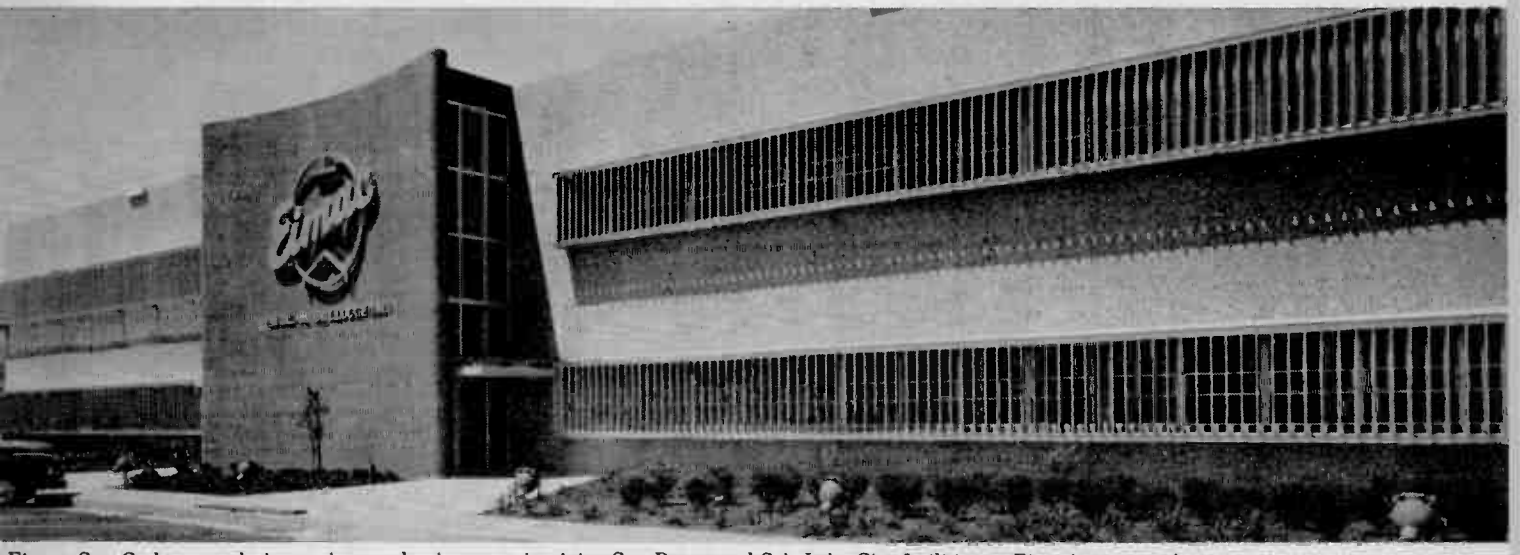
line of precision signal generators

EIMAC TUBES
NOW IN PRODUCTION
IN AMERICA'S NEWEST, MOST MODERN TUBE PLANT

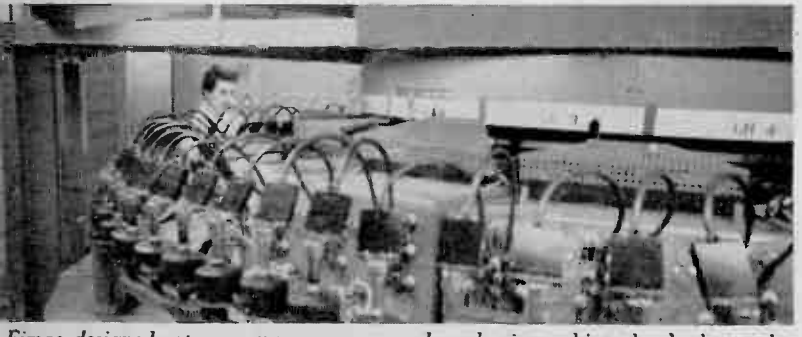
In San Carlos, California, Eimac's third and largest plant is now in full production to meet the great demand for many popular Eimac electron tube families. Never before have so many advanced techniques and processes been applied to vacuum tube manufacture. Eimac's leadership in new processing methods has brought a new era of quality to electron tubes.

Ready for shipment, these Eimac ceramic tetrodes are just one of more than a hundred different tube types manufactured by Eitel-McCullough, Inc., including negative grid tubes, power amplifier klystrons, reflex klystrons and traveling wave tubes.



Eimac, San Carlos, greatly increasing production capacity, joins San Bruno and Salt Lake City facilities as Eimac's newest plant.

Final tube assembly in near-sterile "clean rooms" assures exceptional tube reliability. These rooms are pressurized with filtered, conditioned air to prevent the tiniest dust particles from entering. Even shoes are automatically vacuum cleaned as personnel enter the room through double-door air locks.



Eimac designed rotary vacuum pumps speed production, achieve hard, clean tube vacuums. Pumping Eimac tubes at high voltages and ambient temperatures assures long life and reliability. These giant rotary pumps are typical of production equipment custom designed by Eimac for transmitting tube manufacture.

Every tube meets rigid Eimac specifications before shipment. On test consoles like this, dozens of electrical characteristics are patiently tested and recorded for each Eimac tube produced. Environmental testing equipment is also available for testing for severe applications.

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

ELECTRONICS NEWSLETTER

DIGITAL COMPUTER USE in industrial process control receives new impetus with the team-up of RCA and The Foxboro Co. of Foxboro, Mass., big name in industrial instruments and controls. RCA Industrial Electronic Products division is packaging the heart of the input-output processor from its big new 501 computer as a separate model, the 110. The 110 is being sold as a master control unit for industrial production processes. Team hopes to crack the industrial control field by offering to engineer and build control systems in depth.

Panel meetings on problems in circuit theory, recruiting of scientific personnel and education for leadership in electronics will highlight the 15th annual National Electronics Conference to be held next week in Chicago. More than 13,000 persons are expected to choose from 28 sessions and over 125 papers, plus 282 exhibit booths.

NEW GUIDANCE SYSTEM for missiles and aircraft called PINPOINT combines ATRAN and inertial guidance. ATRAN is the Goodyear Aircraft guidance system, used on the TM-76A Mace missile, which compares the terrain shown on a radarscope with a film strip previously obtained from the scope over the same course. System can then use landmarks such as lakes to correct flight. PINPOINT, just announced by Goodyear as an outgrowth and refinement of ATRAN, is said to correct errors generated by its inertial guidance subsystem, with accuracy independent of both range and velocity of the missile or aircraft.

FIFTY-MILLION-WATT RADAR will be designed and manufactured by FXR, Inc. of Woodside, New York, under a $500,000 subcontract from Cornell Aeronautical Laboratory, which has an R&D prime contract from Army Ordnance. CAL's goal of 50 million watts peak power, with a variety of pulse lengths and repetition rates, follows CAL achievement of transmission of 21 million watts of peak power. FXR will make the complete transmitter, which will use a series of amplifier tubes. The tubes will require synchronized frequency of about 3.5 millimicroseconds.

Theoretical study of an interferometer tracking system is being carried out by Smith Electronics, Cleveland, under a contract from Air Proving Ground Center, Elgin AFB, Fla. System under study will track a telemetry signal in the 2,200-2,300-mc range over a distance of 5,000 mi. It will provide Doppler velocity measurement besides position data.

AUTOMOTIVE INDUSTRY continues electronics expansion. On one hand, electrical equipment suppliers are seeking new product lines. On the other hand, automakers want to improve their cars, often with their own electronic products. In the first category is Electric Autolite, which expects to market a new electronic commutator this fall for about $50. Other new developments: a transistorized inkless recorder, radiation-resistant wire and surface-discharge spark plugs. Autolite is also developing high-temperature ceramics for electronic applications. Chrysler reports that its compact new Valiant will use a Chrysler-made alternator-rectifier unit to provide 12-volt d-c, claims the new unit weighs 12 lb less than a conventional d-c generator of equivalent output. Automaker says the unit provides 10 A output at idle speed and increases brush life through the use of smooth slip rings instead of a serrated commutator. Rectifier transforms 19-cycle a-c to d-c: three silicon diodes permit positive pulses to pass and three others pass negative pulses to provide full wave rectification. System eliminates the current-regulating solenoid. Chrysler hopes to produce at least 200,000 1960-model Valiants, will also use the device in its Imperial model. Ford offers a similar unit on heavy-duty trucks. GM, through its Delco-Remy division, provides its device as an option for fleet owners.

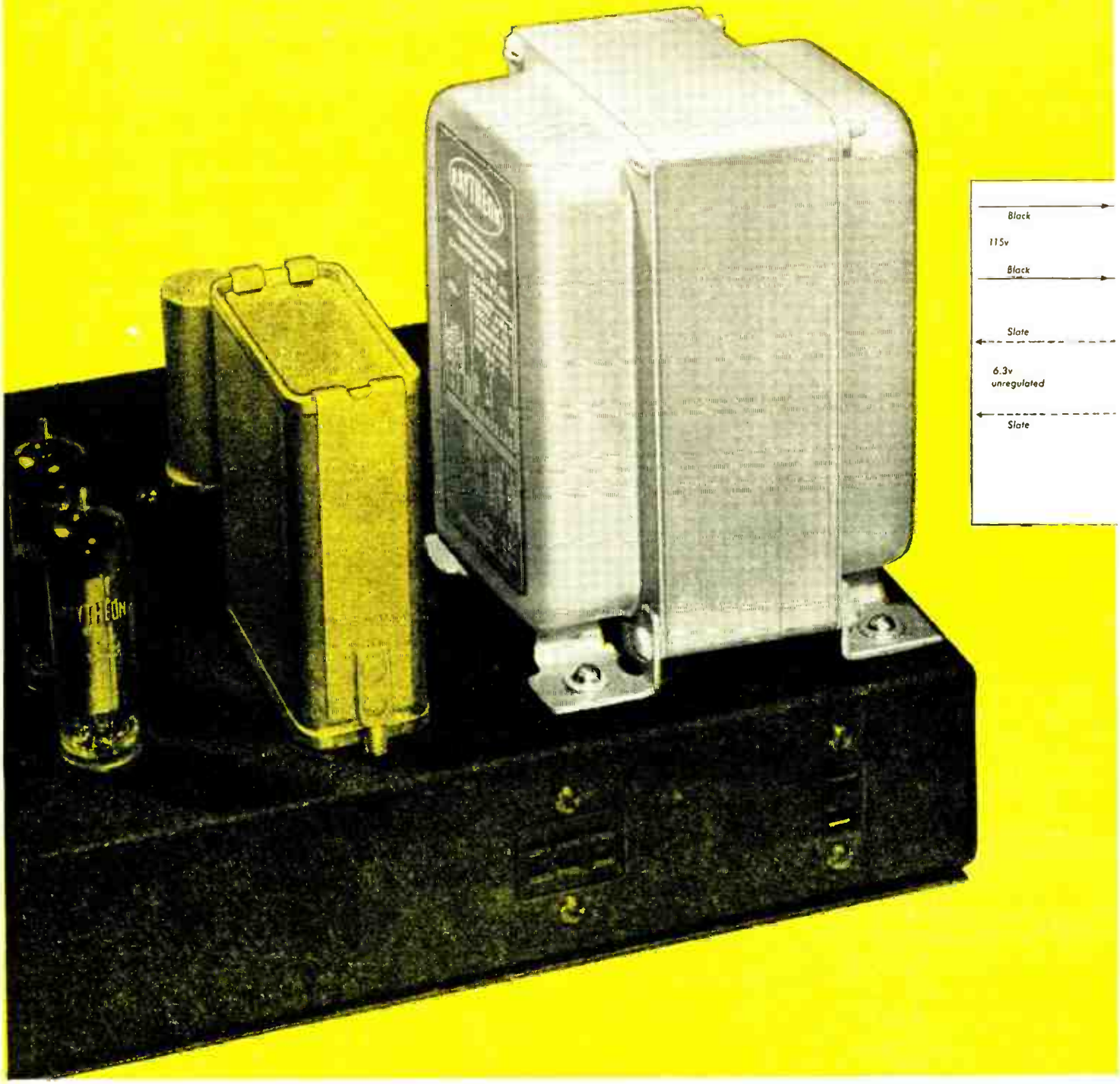
Solar power system for space satellites, capable of producing 100 watts of electricity continuously and 500 watts peak, will be developed by Hoffman Laboratories, Los Angeles, a division of Hoffman Electronics Corp., under a $600,000 contract from Wright ADC. The large-area panel will be applicable to various space programs.

AUTOPILOTS for the fast-growing business aircraft market get a marketing push with the introduction of a new transistorized unit by Sperry Phoenix division of Sperry Rand. The company expects that business aircraft will number 38,000 by 1965, 95,000 by 1975. Sperry says modular construction of its new autopilot permits a user to install a single axis, later make it a two-axis or complete three-axis flight control system.

SOVIET OCEANOGRAPHIC SUBMARINE *Severyanka* (ELECTRONICS, p 19, Sept. 18, p 31, Mar. 20) is equipped with "a depth stabilizing device which enables it to remain at any depth" and an exit chamber through which scientists in diving gear can leave the sub while it lies on the bottom of the sea. This new information was reported in *Tekhnika Molodezhi* by Yu. Kryuchkov.

ULTRASONIC MACHINE is bringing home leaner bacon in Britain, where the British Oil and Cake Mills at Barlby, Yorkshire, is using it to determine the suitability of boars as sires before a litter of bacon rasher types has been bred. Waves are sent at right angles to the skin and reflected back from the interface between the underlying fat and muscle with a time lag related to the depth of fat. Lean area can then be determined. Since thickness of outer fat is an inherited characteristic in pigs, boars that would bring home fatty bacon through their progeny are not allowed to breed.

Raytheon Voltage Regulating
PLATE-FILAMENT



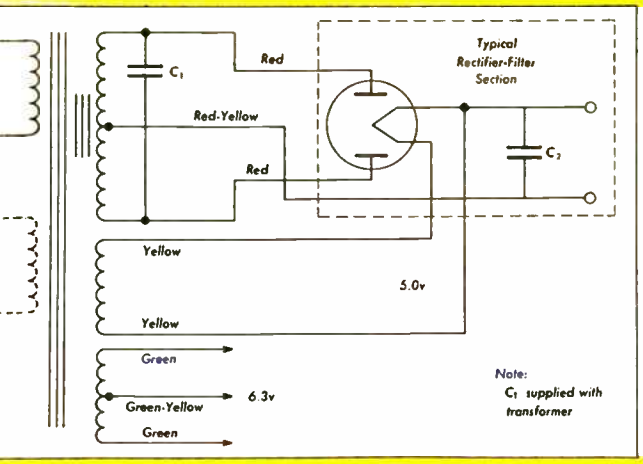
TRANSFORMERS . . . . . .

Transformers that regulate voltage to within ± 3%

This versatile Raytheon unit looks like a transformer, but does the combined job of transformer plus voltage regulator.

In a conventional power supply circuit, the voltage regulating transformer maintains a dc output voltage within ±3% with line variations of ±15%.

For custom requirements, please write our Applications Engineering Group for an answer to your particular need. Raytheon Company, Manchester, New Hampshire.



CIRCUIT DIAGRAM shows Raytheon Voltage Regulating Transformer in typical full-wave rectifier circuit. Three standard models with ratings up to 380 VDC @ 250 MA are immediately available from stock.

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RAYTHEON COMPANY
Industrial Apparatus Division

RAYTHEON

Excellence in Electronics

WASHINGTON OUTLOOK

WASHINGTON—THE PENTAGON'S SHAKEUP of its space organizations has several results of importance to electronics firms:

The once-powerful Advanced Research Projects Agency is about washed up.

Herbert York, the Pentagon's recently appointed director of defense research and engineering, has a stronger hand in the Pentagon's hierarchy. He now has clearcut policy-making responsibility over all military research and development efforts, including military space projects.

In the cutting up of ARPA, the Air Force was assigned full control over development of the Midas early-warning and Samos reconnaissance satellites. Later on, it will also get complete responsibility for development, production and launching of all rocket boosters for military space; space transportation projects; and the Discoverer experiments on recovery of space vehicles.

The Navy was assigned full control over development of the Transit navigation satellite and the Army over the Notus satellite-borne communications system. But both services will have to turn to the Air Force for launching their specially-designed satellites.

The shakeup does not affect the $500-million worth of purely scientific space projects of the National Aeronautics & Space Administration. NASA will remain in charge of scientific earth satellites, lunar probes, deep space probes and other astronautic projects not directly tied to military needs.

ARPA was set up in the Pentagon during Washington's post-sputnik furor. For the most part, ARPA farmed out operating tasks and contract administration on military space projects to the three services. That's why the new switch in responsibilities will involve no major contract changes.

The four projects covered by the switchover will total $110.9 million this year. Lockheed is prime contractor on Midas and Samos; Johns Hopkins' Applied Physics Laboratory on Transit; and Philco, GE, Bendix Aviation, ITT, and Radiation, Inc. on Notus. The other projects the Air Force is slated to take over from ARPA have a total budget of close to $200 million.

Defense Secy. McElroy plans to continue ARPA. Its staff of 60 scientists will now be limited to "advanced research" in materials, solid propellants, scientific problems connected with ballistic missile defense, and other non-engineering fields.

- **The success of the Japanese** in selling transistors in the U.S. market is going to be taken up by the Office of Civilian and Defense Mobilization to see whether the booming trade is having a harmful impact on our security.

  The agency has been asked to investigate the situation by the Electronic Industries Association. The charge is that Japanese production costs are low, that transportation costs are negligible, and that the 15 percent duty helps very little. The result, says EIA, is that a U.S. transistor that sells for $1.35 is up against a competitive Japanese product that sells for 80 cents or less.

  The EIA's point is this: despite the expansion of U.S. transistor capacity, the Japanese threat is such that U.S. producers won't be able to expand enough or finance enough R&D to keep pace with Soviet and other developments in electronics.

  There's no quick relief available. The OCDM procedures take months and months. First step: allowing interested parties—the U.S. industry, U.S. consumers, manufacturers of finished items, the Defense Department—to say how they think the situation affects them and the security of the country.

POWER

handling capacity
of the new
Westinghouse
Silicon

POWER

transistor!

Greater than 99% efficiency when used to handle 1.5 kw of power in a low-frequency DC switch! Power loss is only 10-15 watts when handling 1.5 kw. That's just one of the impressive specifications established by a remarkable new semiconductor device—the Westinghouse Silicon Power Transistor.

This Power Transistor is remarkable in other ways, too . . .

- It is the first power transistor available in voltage ranges above 100 volts.
- It has power dissipation capability of 150 watts made possible by the low thermal resistance of .7°C/watt.
- It can operate at higher temperatures than germanium (150°C., compared to 85°C).
- It has astonishingly low saturation resistance—less than .5 ohms at 5 amperes and .75 ohms at 2 amperes, an achievement made possible through extensive research and development of hyper-pure Siemens-Westinghouse Silicon.
- It is 100% power-tested under actual maximum rated specifications before leaving the plant.
- It is encapsulated in a rugged, all-welded case.

HERE ARE A FEW OF THE APPLICATIONS . . .

• Inverters and converters • Data processing circuits • Servo output circuits • Series regulated power supplies • As a low frequency switch • In class A amplifiers.

Available in 2 and 5 ampere collector ratings in production quantities now. For complete specifications and details, contact your local Westinghouse representative.

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SERIES	10B	20	116-216	117-217	126-226	136-236	1156C-1256C	H-C
AMPERES	1.75	3.0	7.5 3.0	10.0 4.0	12.5 6.0	20.0 9.0	45.0 28.0	200 and up

the NEW 10B SERIES

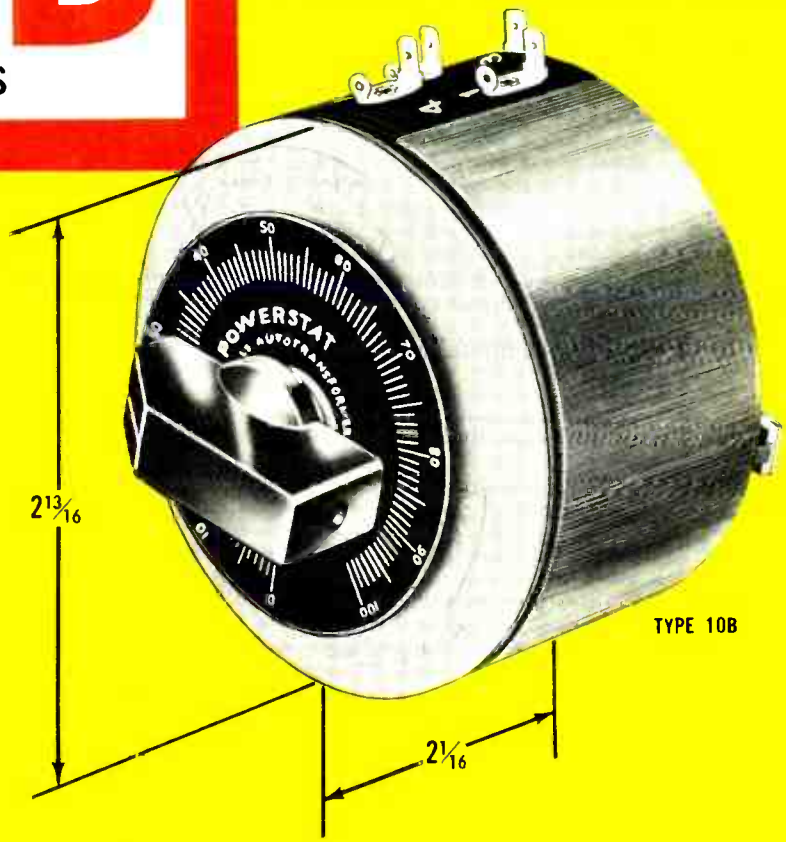
POWERSTAT® variable transformers

40% INCREASE IN RATING . . .

NO INCREASE IN PRICE!

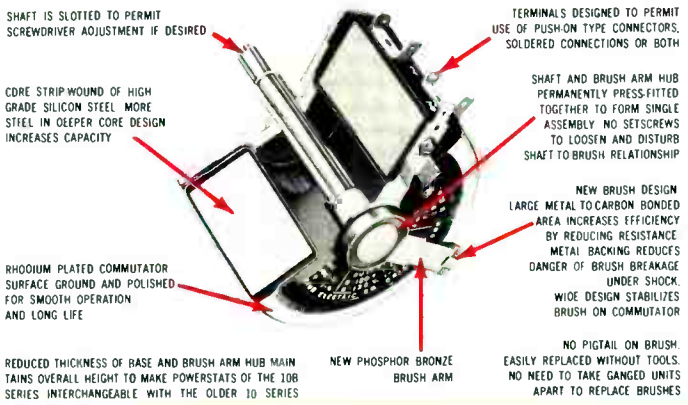
NO INCREASE IN SIZE!

POWERSTATS of the new 10B Series incorporate the most up-to-date variable transformer design refinements to provide the highest ratings and performance characteristics in their price and size range. Separate ratings are given for constant-impedance and constant-current loads to permit maximum utilization of the POWERSTAT. Features include a rhodium-plated commutator surface and space-saving core and coil design. Ruggedly constructed for long life and dependable service. Two- and three-gang assemblies are available for increased ratings and three-phase operation.



RATING CHART

INPUT		OUTPUT					
			CONSTANT CURRENT LOAD		CONSTANT IMPEDANCE LOAD		
VOLTS	CYCLES	VOLTS	MAX. AMPS.	MAX. KVA	MAX. AMPS.	MAX. KVA	TYPE
SINGLE	PHASE						
120 120	50 60 60	0-120 0-132	1.75 1.75	.21 .23	2.5 1.75	.30 .23	10B
240 240	50 60 60	0-240 0-264	1.75 1.75	.42 .46	2.5 1.75	.60 .46	10B-2
THREE	PHASE						
120 120	50 60 60	0-120 0-132	1.75 1.75	.36 .40	2.5 1.75	.52 .40	10B-2
240	60	0-240	1.75	.73	2.5	1.0	10B-3



THE SUPERIOR ELECTRIC COMPANY
Bristol, Connecticut, U.S.A.

ADAPTER KITS are available for mounting potentiometers, rheostats, tap switches and other devices to operate in unisnn with POWERSTAT type 10B. If desired, complete assemblies are furnished with the device already mounted.

	SERIES	10B	20	116-216	117-217	126-226	136-236	1156C-1256C	H-C
	AMPERES	1.75	3.0	7.5 / 3.0	10.0 / 4.0	12.5/6.0	20.0 / 9.0	45.0 / 28.0	200 and up

the NEW 126-226 SERIES

TYPE 126

POWERSTAT® variable transformers

For control applications having

. . . up to 12.5 amperes constant-current loads

. . . up to 18.0 amperes constant-impedance loads

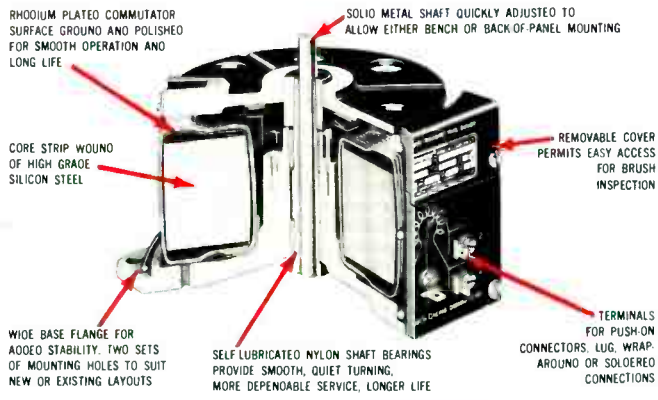
This all-new series rounds out the complete POWERSTAT variable transformer line. The 126-226 series offers open, enclosed, fused, cord-plug and enclosed terminal models; single, two- and three-gang types; manually operated and 5, 15, 30 or 60 second motor-driven assemblies — all available in a new, compact functional design. They incorporate the characteristics inherent in every POWERSTAT: zero wave-form distortion, excellent regulation, high efficiency, conservative ratings, smooth control and linear output voltage.


TYPE 3PN126


TYPE 126U

RATING CHART

INPUT VOLTS	INPUT CYCLES	OUTPUT VOLTS	CONSTANT CURRENT LOAD MAX. AMPS.	CONSTANT CURRENT LOAD MAX. KVA	CONSTANT IMPEDANCE LOAD MAX. AMPS.	CONSTANT IMPEDANCE LOAD MAX. KVA	TYPE
SINGLE PHASE							
120	50 60	0-120	12.5	1.5	18.0	2.2	126
120	50 60	0-140	12.5	1.8	12.5	1.8	
240	50 60	0-240	6.0	1.4	9.0	2.2	226
240	50 60	0-280	6.0	1.7	6.0	1.7	
240	50 60	0-240	12.5	3.0	18.0	4.3	126-2
240	50 60	0-280	12.5	3.5	12.5	3.5	
480	50 60	0-480	6.0	2.9	9.0	4.3	226-2
480	50 60	0-560	6.0	3.4	6.0	3.4	
THREE PHASE							
120	50 60	0-120	12.5	2.6	18.0	3.7	126-2
120	50 60	0-140	12.5	3.0	12.5	3.0	
240	50 60	0-240	6.0	2.5	9.0	3.7	226-2
240	50 60	0-280	6.0	2.9	6.0	2.9	
240	50 60	0-240	12.5	5.2	18.0	7.5	126-3
240	60	0-280	12.5	6.1	12.5	6.1	
480	50 60	0-480	6.0	5.0	9.0	7.5	226-3
480	60	0-560	6.0	5.8	6.0	5.8	



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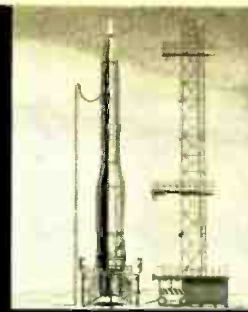

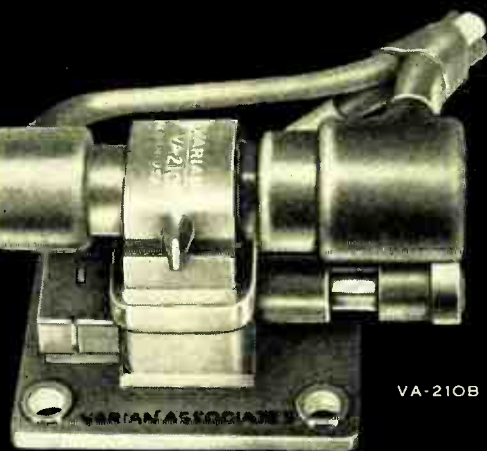

VA-210B

FOR RADAR RECEIVERS

VARIAN KLYSTRONS

HIGH FREQUENCY STABILITY, RUGGED CONSTRUCTION, LONG LIFE

The new VA-210B Klystron is a super-rugged oscillator, engineered to give long, reliable service under severe operating conditions. Frequency is extremely stable, even under conditions of the most severe shock, vibration and temperature variation. Features include a unique brazed-on external tuning cavity, a very rugged, quick-heating cathode, a slow-rate non-microphonic tuner and an all metal and ceramic construction.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Tests and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy.

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Two Stock Splits Announced

TWO-FOR-ONE STOCK SPLIT has been voted by stockholders of **Continental Connector Corp.**, Woodside, N. Y. The firm's board of directors also declared a quarterly dividend of 12½ cents on the new split class A shares. This dividend on the basis of the old non-split stock would have amounted to 25 cents a share, as compared with the 15 cents a share previously paid.

• **Litton Industries** stockholders have received announcement of a two-for-one split voted in mid-September by company directors. Stockholders will vote at the regular annual meeting slated for Nov. 21 on the increase of authorized shares for this purpose.

• **Collins Radio**, Cedar Rapids, Ia., board of directors have declared a regular quarterly dividend of 50 cents a share on the firm's 4-percent cumulative preferred stock.

• **Airwork Corp.**, Millville, N. J., has declared a stock dividend of three percent on common shares, payable Oct. 15 to stockholders of record at the close of business Sept. 30. Cash will be paid in lieu of fractional shares. This is the first dividend to be paid by Airwork, which made its first public offering in July of this year. The company was organized in 1946 and is engaged in repair and overhaul of aviation electronics gear, instruments and aircraft engines.

• **Northern Plastics Co.**, La-Crosse, Wis., has declared a special year-end stock dividend of 10 percent in addition to its usual dividend of 10 cents a share. The company manufactures industrial laminates and other plastic products for the electronic and electrical industries.

• **Leetronics, Inc.**, Brooklyn, N. Y., stockholders have received dividend checks of 7 cents a share. Payment was made to stockholders of record at the close of business Sept. 17.

• **A quarterly dividend** of 12½ cents a share on 5 percent preferred stock was paid on the first of this month to shareholders of **Fischer and Porter Co.**, Hatboro, Pa. The company makes data reduction systems as well as industrial instruments and precision glass products.

• **Motorola** announces stock dividend of 37½ cents a share payable to stockholders of record on Sept. 30. Checks will start on their way on Oct. 15.

• **General Electric** stockholders of record on Sept. 25 will receive dividend checks in the amount of 50 cents a share on Oct. 28. This will represent GE's regular quarterly dividend.

• **Central Transformer**, Chicago, has issued dividend checks of 15 cents a share to stockholders of record on the first day of last month.

25 MOST ACTIVE STOCKS

WEEK ENDING SEPTEMBER 25

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avco	1362	13¼	11½	12⅞
Int'l Tel & Tel	1138	34½	30⅛	33¾
Sperry Rand	1020	23⅛	22½	22¾
Zenith	886	98⅞	87¼	95¾
Gen Tel & Elec	766	69⅜	66	69
Gen Elec	717	77¾	74	77½
RCA	650	58⅞	54¾	58⅛
Lear Inc	603	14⅛	11	13½
Raytheon	582	47⅞	44⅝	46⅝
Texas Inst	537	131½	117¼	131
Gen Dynamics	530	46¾	44	46¼
Univ Control	506	17¼	15¾	16⅞
Westinghouse	462	91⅝	86¾	91
Burroughs	395	30⅝	29⅛	30½
Emerson	375	15½	12⅜	14¾
Elec & Mus Ind	359	7¼	6⅞	7
Admiral	354	20⅞	17	20¼
Philco	335	25⅜	21¼	24¾
Litton Ind	338	110⅞	102⅛	110⅜
Amer Bosch Arma	336	28⅜	23¾	27¾
Standard Coil	335	16	13¾	15¾
Dynamics Corp	308	8¾	7¼	8⅛
Beckman Inst	305	52¼	47	51¼
Ampex Corp	297	78½	72¼	78½
Int'l Bus Mach	292	422	401	419½

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.

STOCK PRICE AVERAGES

(Standard & Poor's)	Sept. 23, 1959	Aug. 26, 1959	Change From One Year Ago
Electronics mfrs.	82.40	89.05	+37.1%
Radio & tv mfrs.	99.55	108.67	+67.3%
Broadcasters	90.42	97.41	+30.8%

NEW TRANSISTORIZED PORTABLE OSCILLOSCOPE

Operates from { **Internal Battery, External DC and AC Line**

TYPE 321

TRULY PORTABLE

Bottery Powered.
Weighs only 13½ lbs. without botteries.
Batteries weigh 2 to 4 lbs.
Size only 5¾" x 8¼" x 16".

HIGH PERFORMANCE

Verticol Response: DC to 5 MC, 0.07 μsec risetime.
Colibroted Sensitivity: 0.01 v/div to 20 v/div in 11 colibroted steps. Continuously odjustoble from 0.01 v/div to 50 v/div.
Colibroted Sweeps: 0.5 μsec/div to 0.5 sec/div in 19 colibroted steps. Accurote 5x mognifier extends colibroted ronge to 0.1 μsec/div. Continuously odjustoble from 0.1 μsec/div to 1 sec/div.
Simplified Triggering: Fully outomotic, or omplitude-level selection with preset stobility control.
4-KV Acceleroting Potentiol on 3" crt.
6-div by 10-div Disploy Area.
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NO POWER SOURCE PROBLEMS

Operotes from:

1. Ten size D Floshlight cells, ½ hour continuous, more with intermittent, operation.
2. Ten rechorgeable cells, 2.5AH—3 hours continuous operotion. Ten rechargeoble cells, 4.3AH—5 hours continuous operation.
3. 11 to 35 v dc (oircroft, auto, boat, etc.).
4. 105 to 125 v oc or 210 to 250 v ac, 50 to 800 cps.

Price **$775.00**
Built-in Battery Charger **35.00**
Complete Set of 2.5AH Batteries **36.50**
f.o.b. factory

It's so easy to take the Type 321 wherever an oscilloscope is useful. It's a convenient solution to many difficult situations, too . . . for example: Where power cords are apt to be a nuisance—where isolation from ground is desirable—where power-line fluctuations are troublesome—where hum pick-up is a problem. The Type 321 is sure to satisfy your portable oscilloscope needs.

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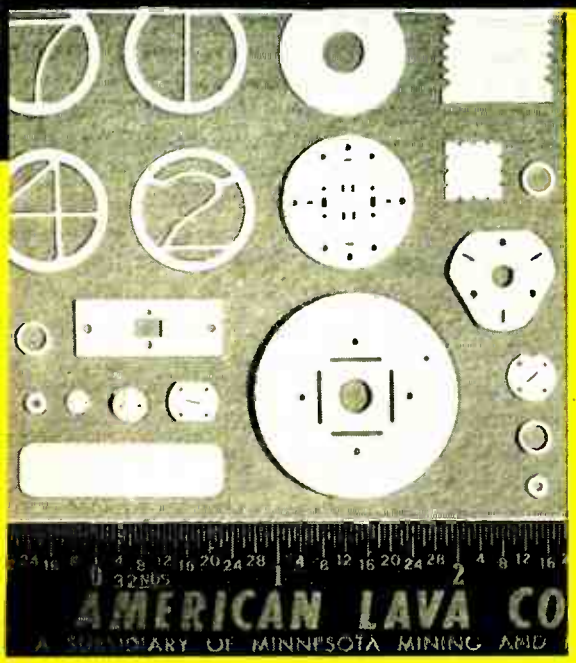
ENGINEERS—Interested in furthering the advancement of the oscilloscope? We have openings for men with creative ability in circuit and instrument design, cathode-ray tube design, and semiconductor research. Please write Richard Ropiequet, V.P., Eng.

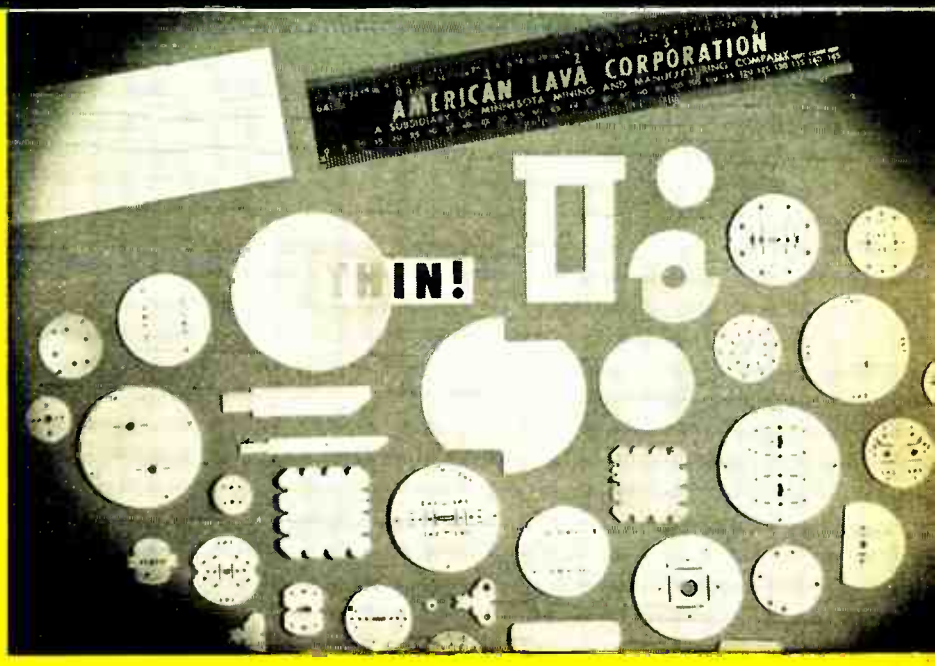
If you missed the Type 321 at WESCON, see it at NEC, booth 193-194.

NEW AlSiMag® THIN CERAMICS!

will these alumina ceramics give you

SMALLER, LIGHTER, MORE RUGGED UNITS?





Miniature AlSiMag Alumina Ceramics—some as thin as 0.005"—are being used in electron tubes, microwave windows, transistor platforms . . . as insulators in hearings aids . . . in digital counter tubes, radio crystal cages . . . in high temperature transformers, relays, fuses, micro-modules . . . high temperature amplifiers . . . and other high temperature devices including high temperature printed circuitry . . . as well as various mechanical applications.

The relatively high strength of these thin ceramics and their superior performance in high temperature, high frequency applications may help you answer the demands for smaller, lighter, more rugged units. This strength also sharply reduces damage from fatigue failure, heat deterioration, shock and vibration, and makes new automatic assembly operations practical.

Since these thin ceramics were pioneered by American Lava several years ago, demand has increased rapidly and steadily. Spurred by constantly increasing requirements, our production facilities are now capable of shipping in volume and at practical prices, small intricate shapes that were considered impossible as recently as 1955.

Free bulletin and typical samples of thin AlSiMag Ceramics sent on request

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AMERICAN LAVA CORPORATION

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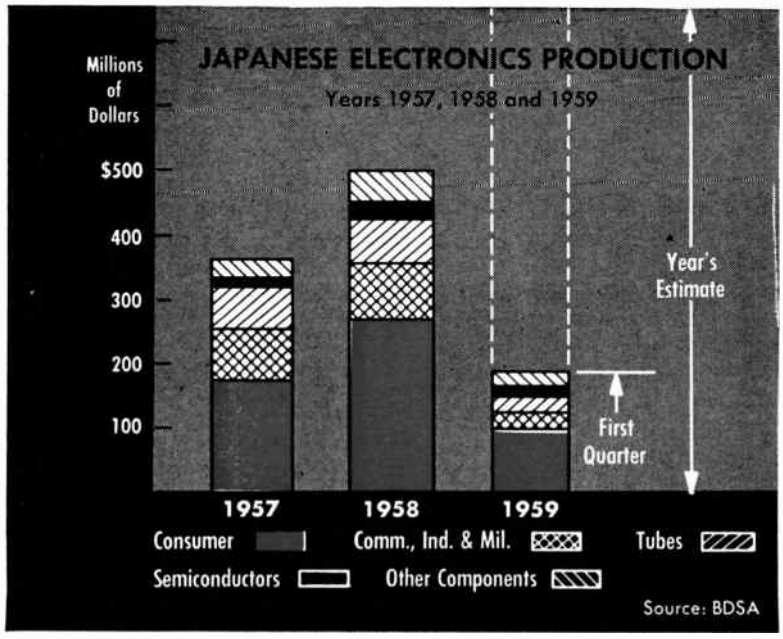
For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago: Bedford Park, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ontario. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.



Japan's Production Jumps 48%

JAPANESE PRODUCTION of electronic gear in 1959 is running 48 percent ahead of 1958, Business and Defense Services Administration reports. Last year Japan was the world's fourth largest producer of electronic products, ranking behind the United States, United Kingdom and West Germany.

Japan's first-quarter production this year was worth $184.4 million at factory values, which is equivalent to an annual rate of $736 million. This projected 1959 production is $238 million in excess of 1958 production of $498 million and twice 1957 production of $362.2 million. Actual figures were supplied to BDSA by U. S. Embassy in Tokyo.

U. S. electronic production is running at an annual rate of approximately $8.5 billion, BDSA claims. However, other industry estimates for 1959 are over $9 billion.

Consumer electronics contributed the greatest increase in Japanese end-equipment production between 1957 and 1958, rising from $170.9 million to $266.2 million. Television receivers were the key consumer item, with production rising from 0.6 million units worth $86.8 million in 1957 to 1.2 million sets worth $154.1 million in 1958. Radio set production grew from 3.6 million units worth $67.0 million to 4.9 million units worth $87.1 million over the two-year period.

Production of military, commercial and industrial items totaled only $85.2 million in 1958 and $26.8 million in the 1959 first quarter (equivalent to an annual rate of $107.2 million). However, items produced covered a broad product spectrum, including radio and tv broadcasting, industrial tv, r-f and microwave communications, detection and navigation, ultrasonics, high-frequency heating and other equipment.

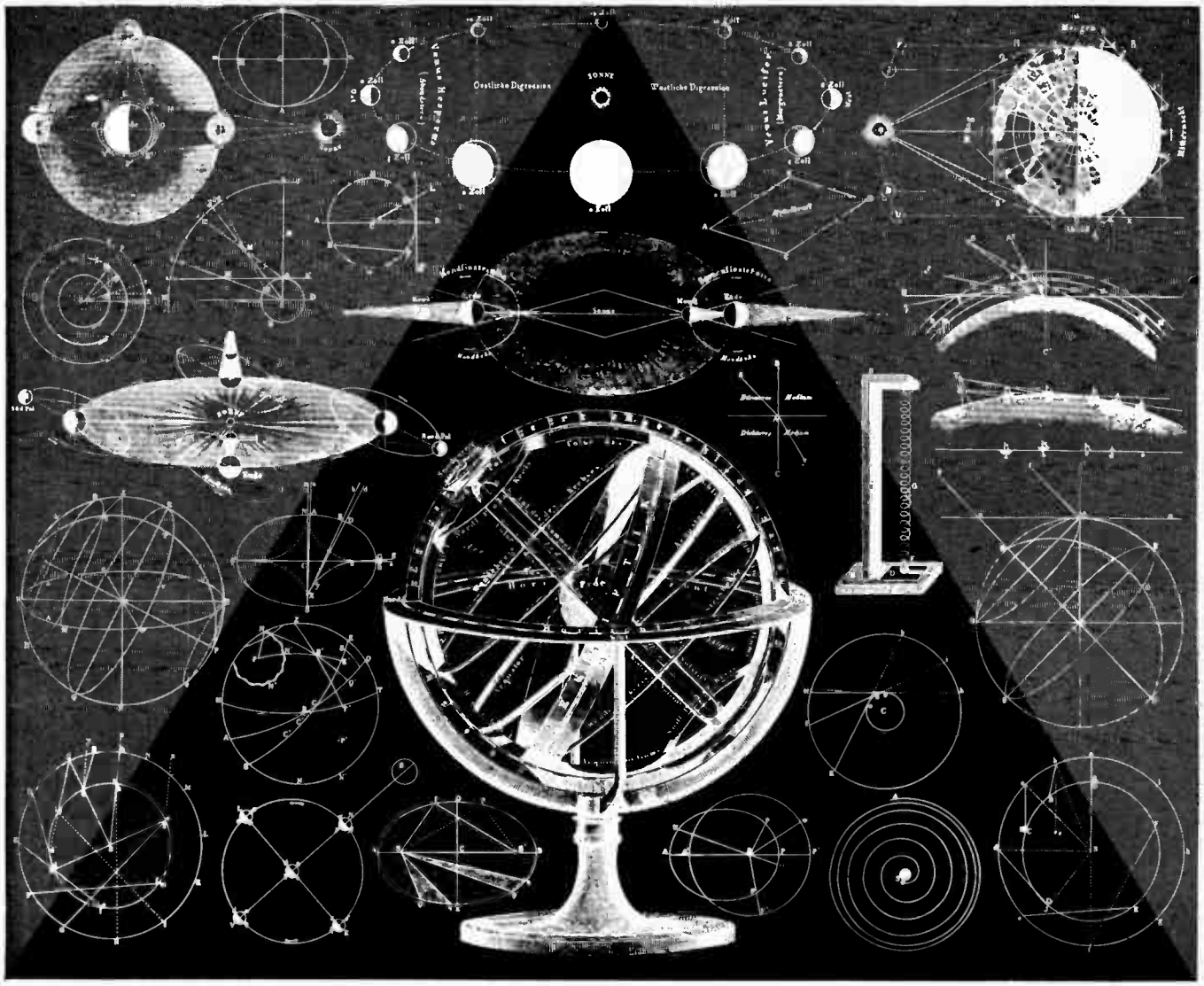
Semiconductors registered a 129-percent increase in production value between 1957 and 1958, jumping from $10.7 million to $24.5 million. First quarter 1959 production amounted to $11.5 million.

Transistors were the principal semiconductor item. In 1957, 5.7 million units valued at $8.9 million were produced, which compares with 26.7 million units valued at $21.4 million in 1958 and 15.0 million valued at $9.9 million in the first quarter of 1959.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Sept. 18, 1959	Aug. 21, 1959	Change From One Year Ago
Television sets	166,118	138,758	39.8%
Radio sets, total	421,143	274,526	35.9%
Auto sets	155,338	83,041	41.3%



Guided tour of the solar system

The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

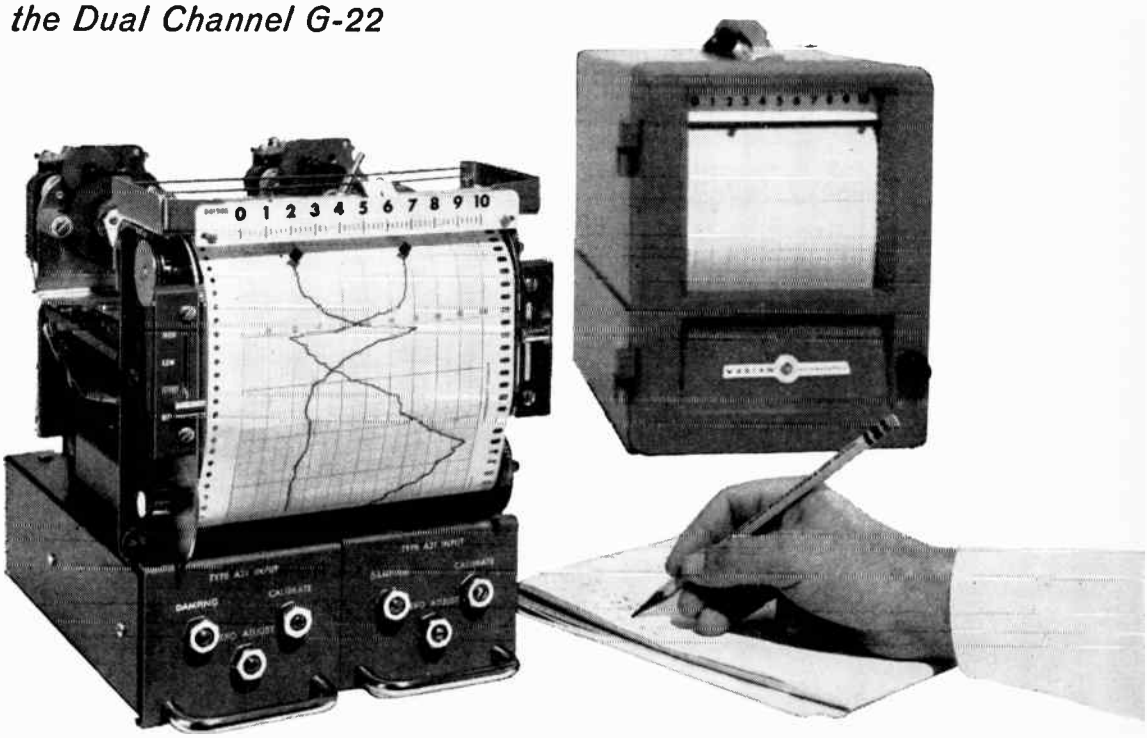
Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT

Announcing the newest

VARIAN Potentiometer RECORDER

the Dual Channel G-22



MOST COMPACT AND PORTABLE

TWO-CHANNEL RECORDER

Size and price need no longer limit the use of two-channel recorders. The Varian G-22 is the least expensive servo-operated two channel available — and also the most compact. It puts two time-correlated variables onto one chart of 5-inch calibrated width.

The Varian G-22 is of completely modular design — and a truly versatile instrument. Plug-in input chassis are interchangeable to provide various recording characteristics. Chart motors are easily changed for additional speeds. Range is adjustable from 0-9 mv to 0-100 mv on the basic input chassis. Zero can be set anywhere across the chart. And being a potentiometer recorder, the G-22 has the necessary sensitivity to serve a wide variety of recording needs.

FEATURES

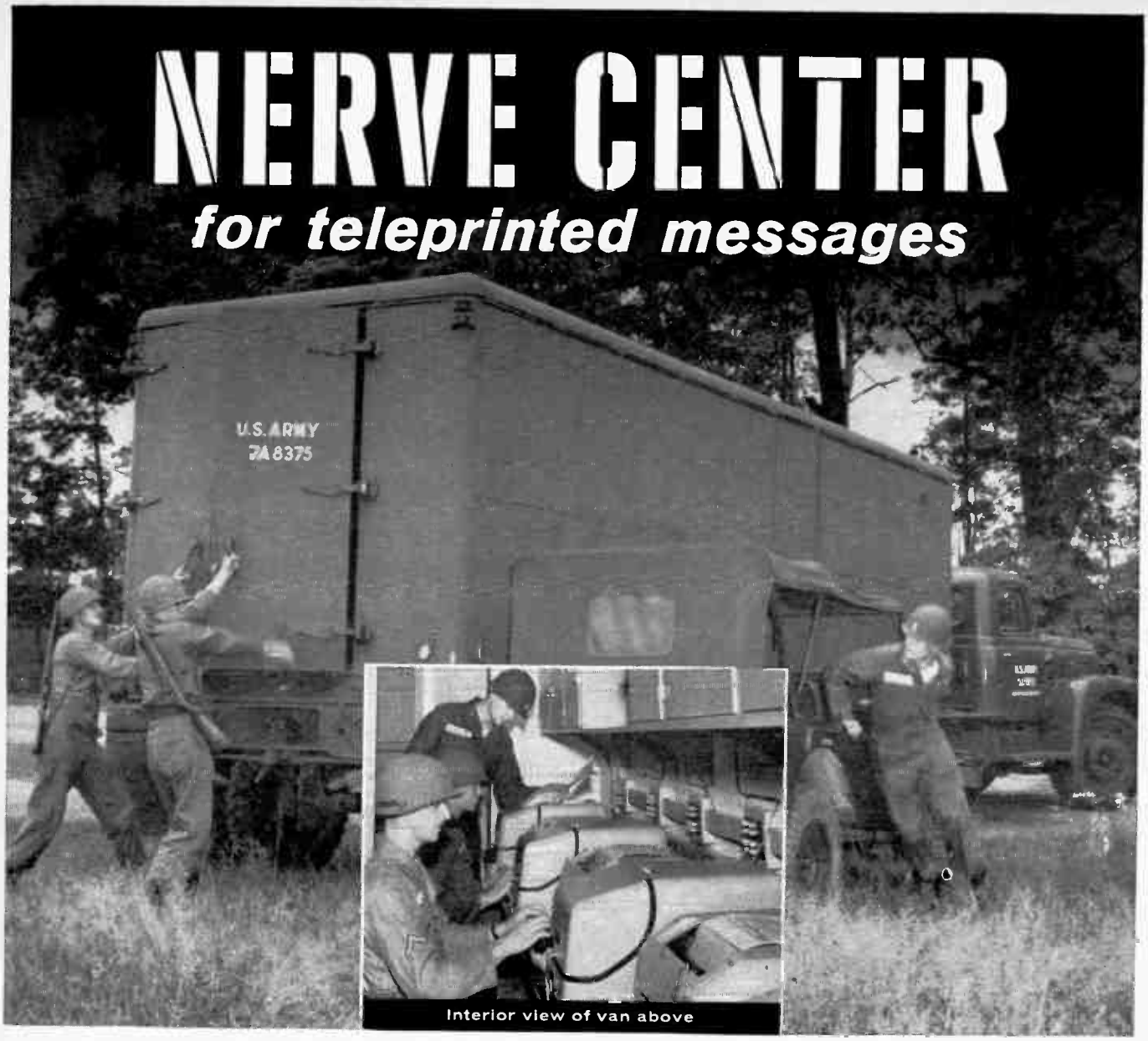
- Potentiometer measuring circuit thousands of times more sensitive than a galvanometer.
- Quickly interchangeable plug-in input chassis provide various recording characteristics.
- Two-speed gear shifter standard; four chart speeds available by dual motor option. Choice of speeds from ⅛ in/hr to 8 in/min.
- Modular construction throughout; permits rapid removal of subunits with a screwdriver.
- Panel mount or portable versions available. Total weight is 35 pounds.
- 1 % limit of error and one second full-scale balancing time.
- Cast aluminum case and box frame structure provide ruggedness.
- Direct shaft connection between servo motor and potentiometer provides positive drive and allows space for optional accessories.
- Accessories include retransmitting slidewires, event markers, and alarm contacts.
- Capillary pens and large reservoirs provide reliable inking.
- Only $975 complete

For full information, write the Instrument Division

VARIAN associates

PALO ALTO 1, CALIFORNIA

NERVE CENTER
for teleprinted messages



Interior view of van above

Kleinschmidt teletypewriters move up with the U. S. Army, operating without interruption under combat conditions

Constant contact, *in print,* between combat headquarters and widely-dispersed field units! Developed in cooperation with the U. S. Army Signal Corps, Kleinschmidt teletypewriters in this mobile communications center are capable of sending and receiving thousands of teleprinted messages a day. Operation is fast, accurate, dependable, simple. In recognition of proved performance, Kleinschmidt equipment for the U. S. Army is manufactured under the Reduced Inspection Quality Assurance Plan. Now Kleinschmidt experience points toward new accomplishments in electronic communications for business and industry. The new concepts, new applications are virtually unlimited.

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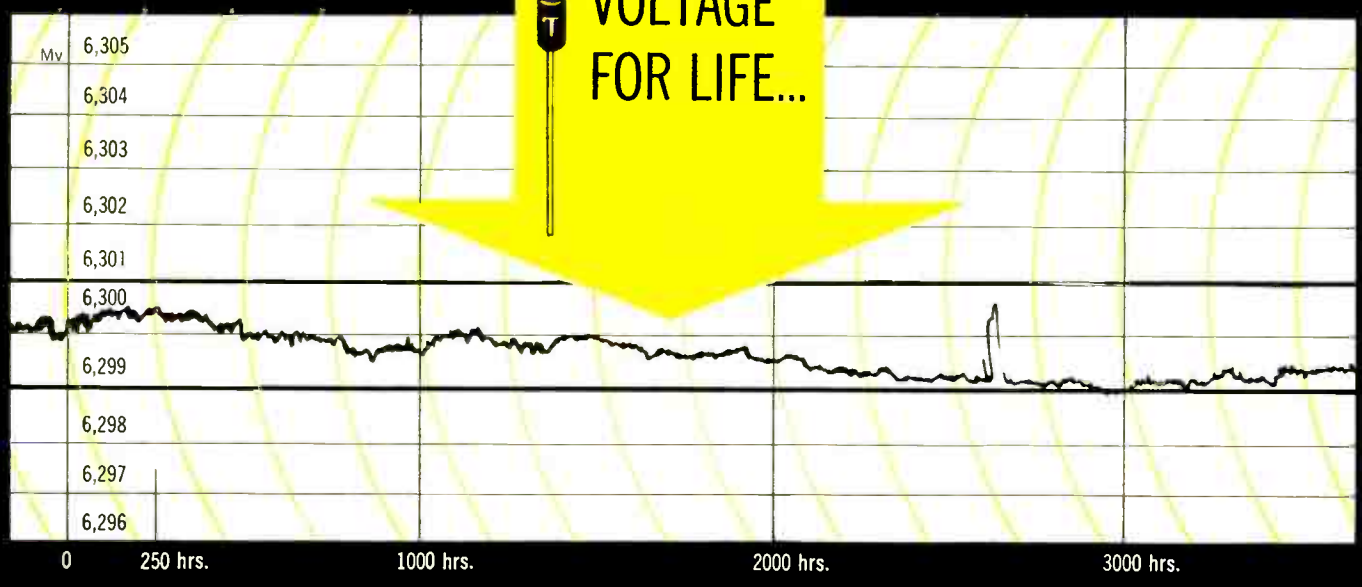
Pioneer in teleprinted communications systems and equipment since 1911

STABLE VOLTAGE FOR LIFE...



NEW ULTRA-STABLE ZENER DIODES

Type	SPECIFICATIONS: Voltage Range at I_Z = 7.5 ma at 25°C (Volts) Min.	Max.	Temp. Coefficient[2] (−55°C to +100°C) at I_Z = 7.5 ma (%/°C)	Maximum Dynamic[3] Resistance at 25°C at I_Z = 7.5 ma (ohms)	RATINGS: Operating and Storage Temperature Range (°C)	Max. Operating Temp. at I_Z = 7.5 ma (°C)
1N821	5.9	6.5	± .01	15	−65 to + 150	+125
1N822[1]	±5.9	±6.5	± .01	15	−65 to + 150	+125
1N823	5.9	6.5	± .005	15	−65 to + 150	+125
1N824[1]	±5.9	±6.5	± .005	15	−65 to + 150	+125
1N825	5.9	6.5	± .002	15	−65 to + 150	+125
1N827	5.9	6.5	± .001	15	−65 to + 150	+125

[1]Double anode types.
[2]Determined by measuring a change of voltage from −55°C to +25°C and a change of voltage from +25°C to +100°C.
[3]The Dynamic Resistance is measured by superimposing a small A.C. Signal upon the test D.C. Current. (I_{AC} RMS ≤ 1/10 I_{DC} Test)

1N822 and 1N824 types meet all specifications, including temperature coefficient, in both directions.

This new line of subminiature silicon voltage references features a combined lower dynamic resistance and voltage stability exceeding that of *any* standard cell.

Manufactured by diffusion, these devices offer temperature coefficients as low as 0.001%/°C. Unique single piece construction enables the reference to maintain excellent voltage stability when subjected to severe thermal shocks. Axial lead design and hermetically sealed glass encapsulation insure a rugged unit capable of providing long term reliability over wide ranges of environmental conditions.

These new subminiature references are also available in double anode types for symmetrical clipping applications.

Send for bulletin TE-1352.

Select from the nation's broadest line of regulators and references, including these types:

Rating	Type Number
250 MW	SV5 – SV24
250 MW	1N708 – 1N745
400 MW	1N746 – 1N759
750 MW	SV804 – SV824
1 WATT	1N1765 – 1N1802
10 WATT	SV904 – SV924

Contact your nearest authorized Transitron industrial distributor for in-stock quantities 1-999.

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"Leadership in Semiconductors"

We promise you will receive a reply within one week!

NEW OPENINGS AT HUGHES RESEARCH & DEVELOPMENT LABORATORIES

Hughes has several hundred openings for engineeers and physicists whose training and experience are applicable to the research, development, design and testing of airborne electronic equipment for use in supersonic military aircraft; in solid state physics, nuclear electronics, industrial dynamics, and related areas.

Use of the following form will, we hope, reduce to a minimum the inconvenience of submitting an employment inquiry, yet will still permit us to give you a reasonably definitive reply.

Please airmail to:
Mr. Robert A. Martin, Supervisor, Scientific Employment
Hughes Research and Development Laboratories
Culver City 66, California

HUGHES

*Name*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

*College*_____ *Degree*_____ *Year*_____

I am interested in one of the following types of assignment:

- ☐ RESEARCH
- ☐ DEVELOPMENT
- ☐ PRODUCT ENGINEERING
- ☐ TECH. ADMIN.
- ☐ SYSTEMS
- ☐ FIELD TEST
- ☐ OTHER:_____
- ☐ _____

I have had professional experience in the following specific areas:

- ☐ CIRCUIT ANALYSIS AND DESIGN
- ☐ DIGITAL COMPUTERS
- ☐ GUIDANCE DEVICES
- ☐ MICROWAVES
- ☐ STRESS ANALYSIS
- ☐ INDUSTRIAL DYNAMICS
- ☐ MATERIALS
- ☐ SYSTEMS ANALYSIS
- ☐ R-F CIRCUITS
- ☐ RELIABILITY
- ☐ ATOMIC AND/OR SOLID STATE PHYSICS
- ☐ INSTRUMENTATION
- ☐ ELECTRO-MECHANICAL DESIGN
- ☐ OTHER:_____
- ☐ _____
- ☐ _____

I have had a total of _____ years of experience.

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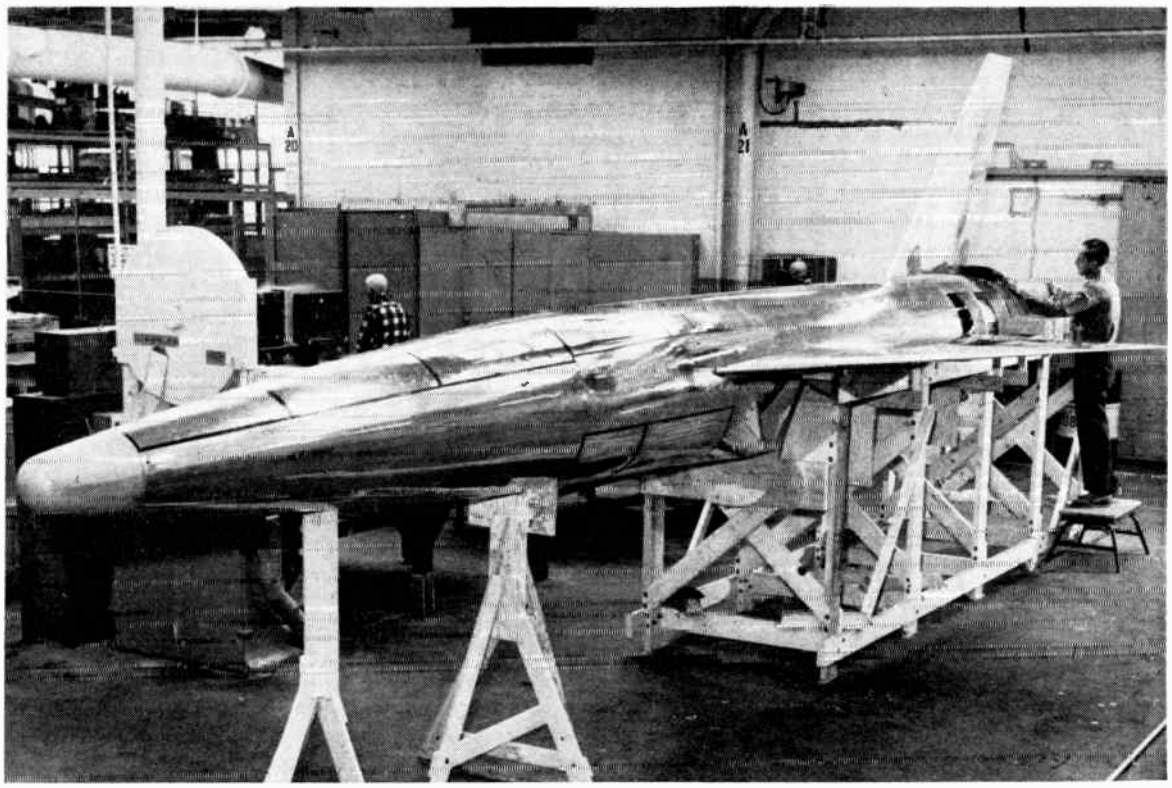


Army's SD-4 "Swallow" reconnaissance drone (mockup shown here) will use infrared, radar, photography and other sensory devices over enemy battlefield. Prime contractor Republic holds $30 million in contracts for the system

From Airframes to Electronics

Aircraft firms are pushing electronics expansion. It's the key to full weapon systems capability—and new opportunities for profits

"To obtain complete weapon systems responsibility today you've got to show capability in electronics. You can't be in the running for the big contracts if you depend on a subcontractor to tell you how to integrate his black box into your system."

This comment, from an official of an airframe company now pushing electronics expansion, typifies the attitude of most of the aircraft industry.

Setting Up Rapidly

A substantial number of plane builders, of course, have been a part of electronics for years and owe much to early electronics planning. Now, other airframe makers are rapidly setting up their own electronics research and engineering groups.

Continuing trend towards more electronics in the aircraft industry is largely the result of demand by the armed services that a weapon systems manager have complete systems capability, including electronics knowhow.

Apart from satisfying a military requirement for weapon systems management, electronics work in the aircraft industry is being spurred by new opportunities for profits. Electronics is taking more and more of the contract dollar.

Rather than buy from subcontractors, many aircraft firms are building their own electronic components. Another reason for in-house production of electronic subsystems and components is a need for extremely specialized gear, often in limited quantity.

Acquiring Knowhow

Since there has been a stepped-up rate of research in recent years by industrial and government laboratories that affects technical and business trends in electronics, aircraft firms also have found it necessary to embark on research programs to keep in the forefront of technology.

Research and engineering teams in various electronics fields permit planemakers to build up a variety of useful knowledge. These teams are also pools of skilled manpower for testing and evaluating available hardware and components, especially useful when management must decide whether to buy an item or make its own.

Device development can follow naturally from these cores of scientific organization if management decides the facts call for this.

The commercial aircraft market is by no means being overlooked in the planemakers' electronics expansion. Advent of jet airliners has accented the same systems management problems and opportunities that have arisen in the military field.

Evolution of aircraft design has also influenced the planemaker's role in electronics. For some time

antenna systems have been designed and manufactured by airframe makers because antenna configuration is so much a part of the configuration of the plane itself.

Supersonic jet craft have tied in electronics more closely with aerodynamics. Now, electronic controls are usually necessary to make aircraft flight stable.

How far will the aircraft firms go in electronics?

Off-the-record conversations with aircraft company officials suggest that the future will see electronic gear being marketed more and more by companies that once made only airframes. At first, such gear is likely to consist of critical aircraft subsystems and components.

Some aircraft firms that jumped into electronics to beef up their systems engineering have seen this effort return profit in other ways. Their electronics divisions now market subsystems and components to outside airframe companies, submarine builders and other firms outside the aircraft industry.

Satellites Point Cameras at Moon

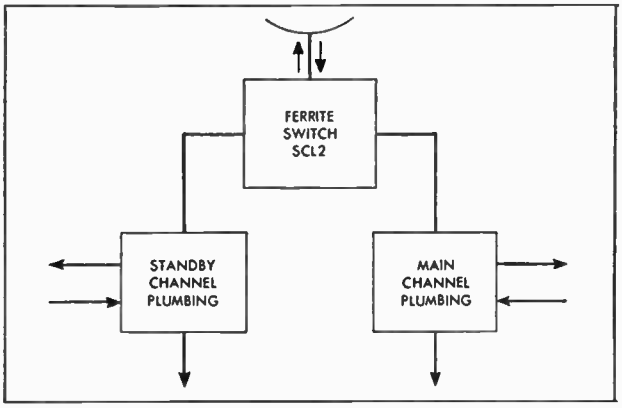
WASHINGTON — The photograph of the earth made recently from a satellite at an altitude of 17,000 mi is the forerunner of a series of satellite photographs planned by the National Aeronautics and Space Administration.

Before the end of the year, NASA hopes to make similar photographs of the dark side of the moon and extensive pictures of the earth's cloud coverage. Eventually, spokesmen working on the project say, earth pictures of Venus and other planets will be made.

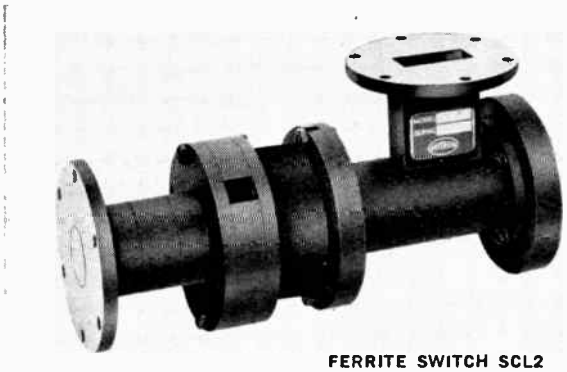
The picture was made from the Explorer VI satellite launched on Aug. 7. Equipment included a 2-lb camera and three transmitters—a digital transmitter operating on a 378-mc frequency and two analog transmitters operating on 108.06 mc and 108.09 mc.

Equipment to photograph the moon, however, will use only digital transmitters because of better speed and accuracy. It will employ 150-watt transmission—same as for the Explorer VI pictures.

THREE-POSITION FERRITE SWITCH FOR C-BAND



TYPICAL MICROWAVE CIRCUIT in which Raytheon ferrite switch is now being used. Switch has three positions: antenna to main channel; antenna to standby channel; antenna to both channels simultaneously.



FERRITE SWITCH SCL2

FERRITE SWITCH IS ACTIVATED when fault is detected in sensing unit. Receiver fault causes switch to transfer to intermediate position for comparison of main and standby. Normal baseband receiver noise and pilot tone allow switch to complete switchover.

TYPICAL SPECIFICATIONS

	SCL2
Frequency range (mc)	*6,575-6,875*
Isolation, minimum	*20db*
Isolation, maximum	*30db*
Insertion loss, minimum	*0.5db*
Insertion loss, maximum	*0.8db*
Power, average	*10 watts*
Power, peak	*1 kw*
VSWR, minimum	*1.02*
VSWR, maximum	*1.28*
Type of switch	*SPDT reciprocal*
Coil current	*400 ma*
Coil resistance	*60 ohms*
Length	*8 in.*
Waveguide	*RG-50/U**

*Mates with

ADVANCED SWITCHOVER PROTECTION PERMITS MORE RAPID AND FLEXIBLE OPERATION THAN EVER BEFORE

A completely new ferrite switch has just been introduced by Raytheon. The device, which is controlled by a specially designed switchover unit, provides foolproof switchover protection. It has three positions, connecting:

1. antenna to main channel
2. antenna to standby channel
3. antenna to both channels simultaneously

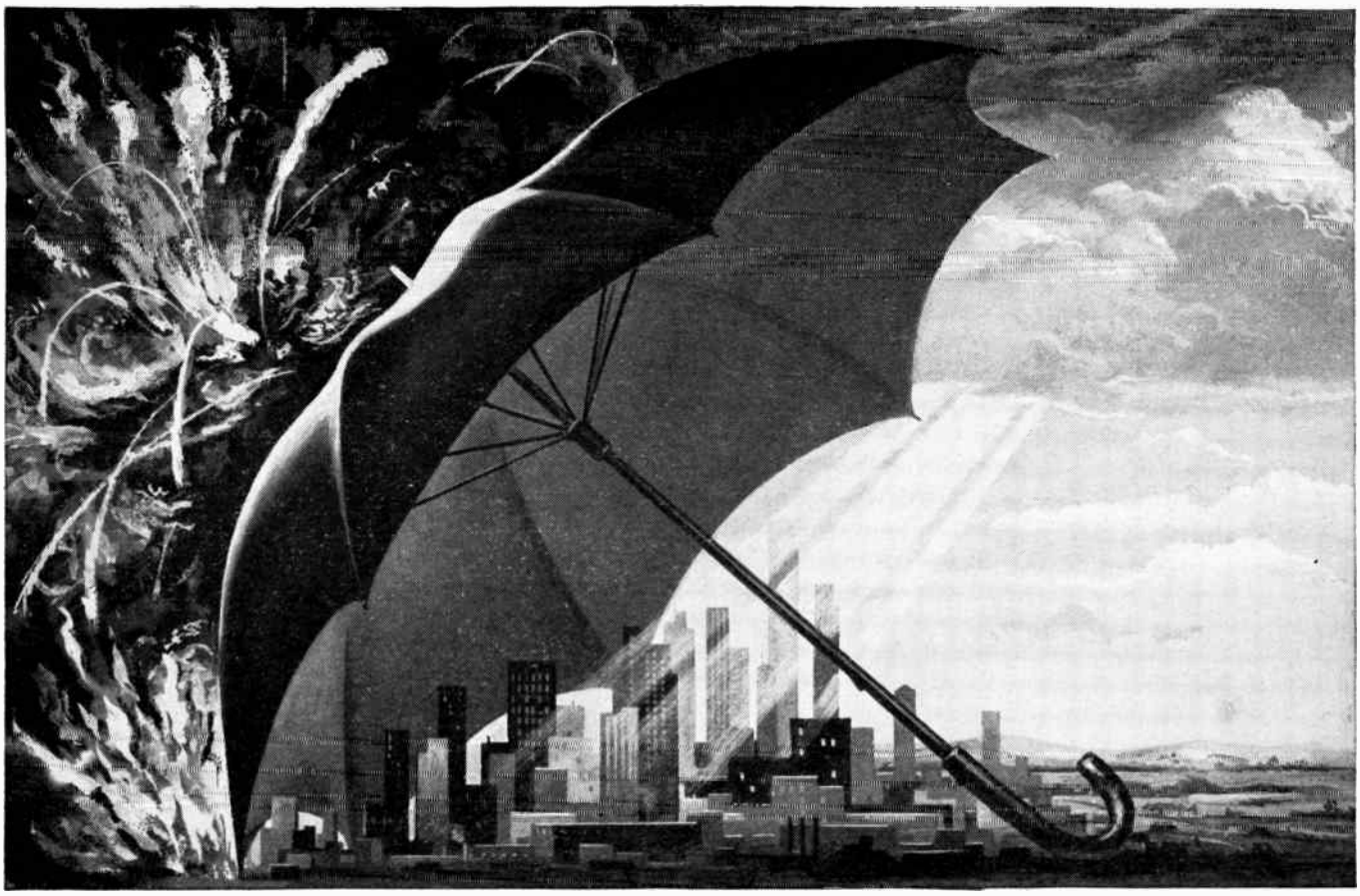
In the third position, the received signal is divided equally between the arms feeding the main and standby receivers.

This allows an actual comparison of the two receiver signals before switching and eliminates the need for complex and unreliable signal injection systems.

To learn more about this significant development or other important Raytheon advances in microwave ferrite devices, please write to the address below stating your particular area of interest.

RAYTHEON COMPANY
SPECIAL MICROWAVE DEVICES
WALTHAM 54, MASSACHUSETTS

RAYTHEON *Excellence in Electronics*



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ENGINEERS: Join our rapidly expanding QRC team now. For complete information address your inquiry to: William F. Frankart, Director of Engineering.

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HAMILTON *Tuning Fork* FREQUENCY STANDARDS

Hamilton provides complete circuit development and packaging of a wide range of miniaturized, transistorized tuning fork frequency standards. Hamilton engineers will be glad to assist you with your frequency control applications. Write today for product catalogs and complete information.

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HATHAWAY INSTRUMENT DIVISION
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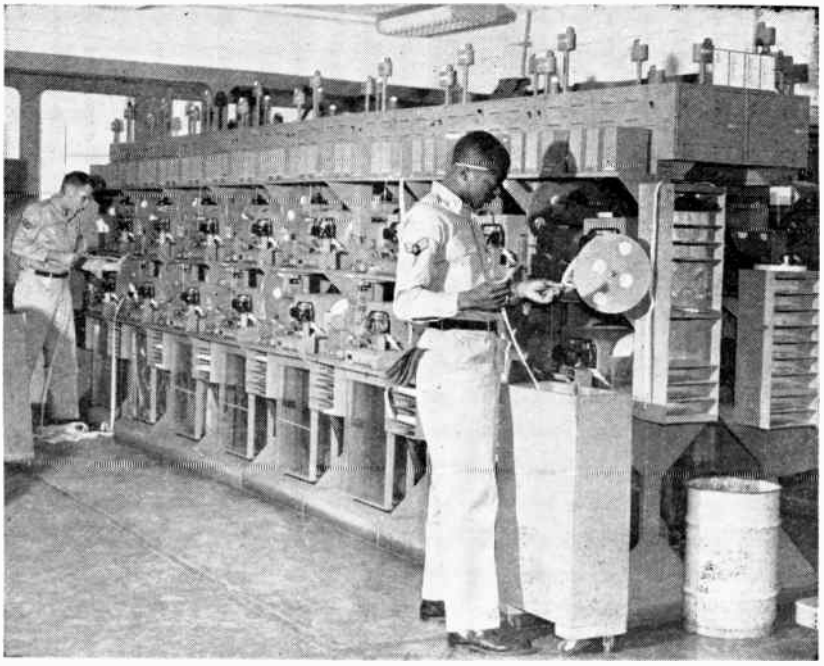
U. S. to Use More Computers

Federal spending for electronic data processing gear is $50 million—up 150% in 2 years



Armed services have long been heavy users of computers. Above: Air Force personnel are busy at a system's "repeater bank"

FEDERAL OUTLAY for renting electronic data processing systems will run close to $50 million this year, an increase of $30 million— or 150 percent—since 1957.

Two years ago federal agencies were operating about 121 computer installations. The present number in use is more than 175.

Payroll for personnel to operate this equipment, estimated at about $27 million in 1957, is expected to top the $80 million mark by 1963.

This information, as well as other facts, emerges from testimony given to the House of Representatives subcommittee on Census and Government Statistics.

Savings Cited

A reason for the increase in spending for computers and other edp gear is the substantial savings reported by departments, once the electronic gear is put in operation.

The Treasury Department shows savings of about $2 million annually resulting from computer processing. The Social Security Administration reports close to $1 million savings a year in processing work electronically instead of manually. Savings of similar magnitude are reported by other federal groups.

A sizable percentage of the cost reductions are traced to reductions in personnel made possible through the use of computers. Additional savings came about through faster record posting, information retrieval and arithmetic processing.

One area slated for additional study by the investigating group concerns decisions regarding purchase vs. lease of computer equipment.

Leasing Most Likely

Many department heads fear that purchase of equipment might be unwise because of the rapid pace of today's computer technology.

Spokesmen before the group cited several instances where federal departments purchased equipment, only to find that later refinements in technology rendered their purchases obsolete. From all indications, it appears likely that leased rather than purchased equipment will be used for quite some time to come.

Centralized facilities will most likely be emphasized in the obtaining of equipment. Subcommittee members are particularly interested in making certain that as much doubling up as possible will come about to insure maximum operational usage for all new edp purchases. Federal personnel will be instructed to make careful studies along these lines.

Personnel Needed

In commenting on this subject a spokesman for the General Accounting Office says: "We find that the degree of success in working with this equipment is directly related to the amount of pre-planning and study that goes in before the acquisition of the equipment. There is a direct relationship."

Another area requiring intensive study is edp personnel recruitment. Department heads have found that more is involved than a mere shifting of available personnel. Attempts to do this were made by the General Accounting Office and the Treasury Department.

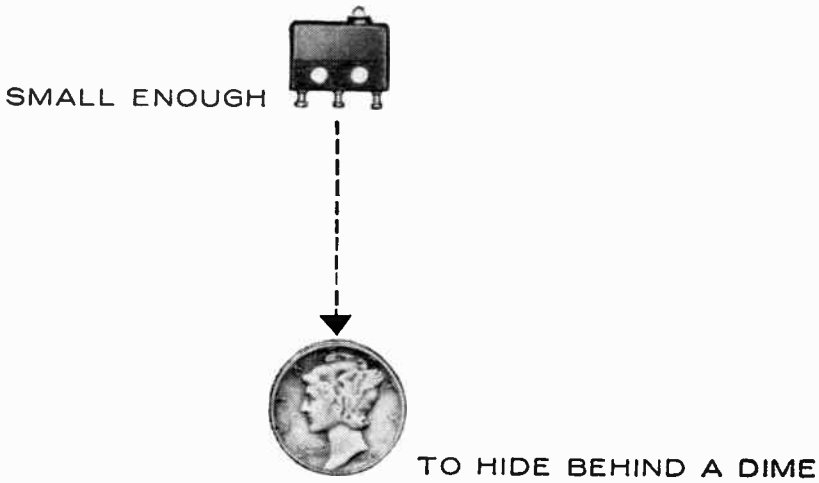
The results of one aptitude test: Total tested — 303; selected for training — 51; completed training —15.

Similar results were obtained from other attempts.

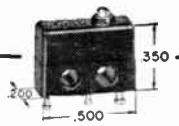
Spokesmen from several departments indicated that unless additional training is made available by academic institutions and computer manufacturers, the supply of skilled personnel in the edp field will become critically low.

Reason cited as creating the increased personnel requirements is the growing potential of computers in such applications as price support computations, soil bank and wool program accounting.

Also mentioned before the committee was increased government participation in road and bridge design, housing research and engineering and the processing of statistics related to this field.



Smallest of precision snap-action switches ... ½ kw capacity



CASE SIZE: .500″ x .200″ x .350″—ten to the square inch.

WEIGHT: 1 gram—28 switches to the ounce.

ELECTRICAL RATING: 28 vdc: 7a. resistive, 4 a. inductive—sea level; 2.5 a. inductive—50,000 ft.; 4 a. motor load, 2.5 a. lamp load, 24 a. max. inrush. 115/230 vac: 60 to 400 cycles: 5 a.; 15 a. inrush.

MECHANICAL LIFE is in the millions of operations.

The case of the 1SX1 has two through holes that accept #2 screws. One hole is slightly elongated to facilitate mounting.

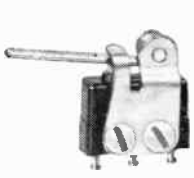
The 1SX1 operates dependably in temperatures from −65°F to +250°F. Operating force is controlled and predictable within 3 oz. to 5 oz. limits.

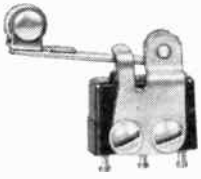
For more information about this important switch, ask for Catalog 63.

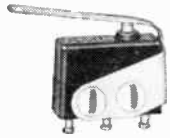
MICRO SWITCH field engineers will be glad to provide application assistance and give you full information on this sub-subminiature switch and its actuators. Call your nearby MICRO SWITCH branch office.

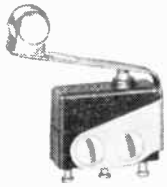
Now offered with six actuators

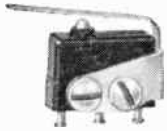
These actuators are offered in four basic designs and, in addition, two reversed actuators are offered which provide lower free position and reduced pre-travel.


Pivoted lever actuator


Pivoted roller lever actuator


Leaf actuator


Roller leaf actuator


Reverse leaf actuator


Reverse roller leaf actuator

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MICRO SWITCH Precision Switches

CIRCLE 41 ON READER SERVICE CARD→

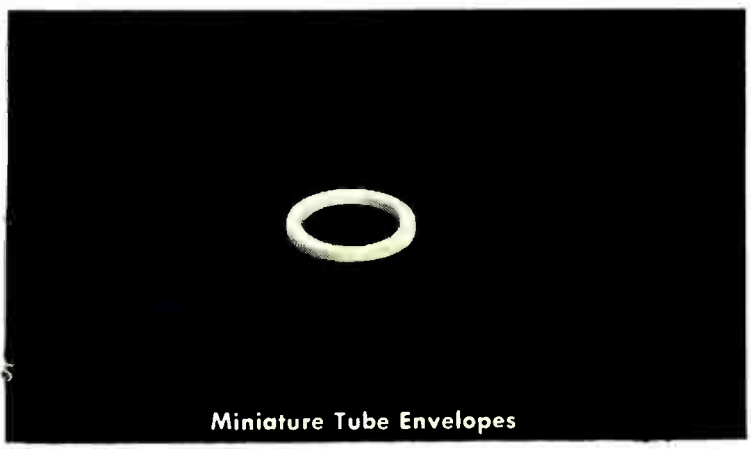
Precision Is The Standard At Coors

Ceramic Wafers for Micro-Modules

Micro-Module Wafers

The hottest news in extreme miniaturization of electronic equipment is the micro-module—an amazingly small combination of sub-miniature electronic circuit components. The fundamental unit of a micro-module is the high alumina ceramic base plate—a tiny ceramic wafer, approximately 0.300" square x 0.010" thick. Upon this is deposited or metalized a component of a circuit—a resistor, capacitor, transistor, diode, etc. The micro-module is a combination of several of these elements in a small space to serve a specific circuit function—amplifier, oscillator, etc.

Coors is manufacturing these precision wafers in large quantity production runs for several manufacturers working on the same project. Coors holds all dimensions of the tiny ceramic wafer to extremely close tolerances so that the micro-elements produced from them are entirely interchangeable from manufacturer to manufacturer



Miniature Tube Envelopes

Tube Envelopes

Coors makes high strength ceramic envelopes to extremely close dimensional tolerances and in a wide range of sizes for use in modern electron tubes. Certain of the Coors ceramic compositions were developed specifically to meet the rigorous operating conditions and reliability requirements to which high power, high frequency tubes are subjected.

Illustrated here is one of the miniature ceramic envelopes in regular production. Coors regularly produces many other sizes up to 10" O.D. Larger sizes can be manufactured.

Coors ceramics have outstanding electrical and physical characteristics. These properties are not affected by high outgassing or high operating temperatures.

LOWER COSTS for Precision Ceramic Parts Through Quantity Production—Coors has been able to make substantial reductions in manufacturing costs by stepping up production of high precision parts through automation.

All this adds up to these advantages for you: 1. Faster delivery on large quantity orders. 2. Precision parts—uniform and interchangeable, permitting you to use them on a production basis. 3. Prices that are correspondingly low.

For further information about Coors Space Age Ceramics and for a complete description of physical properties, write for Bulletin 858.

Ceramic-to-Metal Standard Terminal Insulators

Standard Terminal Insulators

Coors furnishes *standard* terminal insulators—available from stock—in various ratings and, also, can manufacture custom made insulators to meet your specific requirements. In the range of standard sizes, metal parts are bonded to the ceramic by Coors High Temperature Metalizing Techniques, thus producing strong hermetic ceramic-to-metal seals. The result is standard terminal insulators available for a wide range of requirements—insulators that have superior electrical and mechanical characteristics. Production is on a large quantity basis—you do not pay a premium for high quality, precision terminals.

Coors

COORS PORCELAIN COMPANY

600 Ninth Street, Golden, Colorado

Magnetic Devices

Washington conference gives 400 engineers newest data on developments, applications

WASHINGTON—RUNDOWN on latest developments with parametrons in Japan, description of a fast, high-density vacuum-evaporated magnetic memory, and use of magnetic amplifiers with high-power silicon transistors in missile control circuits were among the high points of the 1959 Technical Conference on Nonlinear Magnetics and Magnetic Amplifiers here recently.

Sponsored by the AIEE and the IRE, the conference attracted some 400 engineers and featured 25 papers.

H. F. Storm of GE, who returned recently from Japan, discussed the state of the magnetic art there.

He said a considerable effort is being made to sell parametrons in this country. Storm said an assembly consisting of 25 parametrons including tank capacitors and resistors sells for approximately $20.

Describes Circuit

C. L. Boyajion of GE discussed the operating characteristics of the transfluxor and analog memory circuit. K. D. Broadbent of the Hughes Research Laboratories presented a description of a vacuum-evaporated random-access memory matrix. The matrix consists of a multipath evaporated magnetic structure and multiple evaporations of insulating and conducting materials, and features magnetic turnover less than 80 millimicroseconds, wide latitude in selection currents and a typical volume of 0.25 by 0.100 by 0.007-in. per bit.

B. Mokrytzki and R. A. Stuart of Westinghouse, described a magnetic amplifier-silicon transistor power supply for a missile application. The use of high-power silicon transistors in combination with magnetic amplifiers resulted in a highly efficient, well regulated, rugged unit capable of operating reliably over a wide range of temperatures, the authors said.

Lovell of MIT showed a model developed by D. Woodson (also of MIT) for a saturable reactor core and indicated how it is used to explain the operation of multicore and polyphase magnetic amplifier circuits.

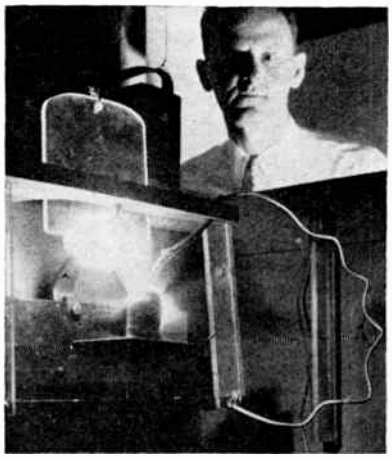
The effects of environment on magnetic properties of toroidal cores, and the effects of vibration, shock, acceleration and temperature on the magnetic characteristics of tape core material, were discussed by J. E. Mitch and H. A. Lewis of Arnold Engineering.

Contract Proposals Losing You Sales?

BOSTON — "Oversimplification is most frequently the Navy's reason for rejecting an R&D contract proposal. Professional integrity and technical honesty count most. Technical dishonesty shows up when problem areas are minimized, ignored or camouflaged.

"Omit the sales talk—we've heard it before," advised Capt. Frank W. Evans of the Office of

Explosive Forming



Man-made lightning triggers underwater explosion that bulges an aluminum tube with 6,000-hp force, during demonstration at Republic Aviation. Firm hopes to use technique in a machine tool for forming such space-age metals as steel and titanium alloys

Revealed

Naval Material. He addressed the Boston session of the national symposium conducted by the IRE Professional Group on Engineering Writing and Speech.

Other tips to proposal writers: Proposals are not judged by weight —don't send a truckload; they should be written on the working-engineer level, with a one-page summary for executive personnel; don't copy chunks of the military specs; use simple, precise language; don't underestimate costs; use color only if significant for the R&D problem; put into the cost of preparing your proposal only as much money as the company can afford to lose on it.

James Girdwood, publisher of ELECTRONICS, spoke on "Technical Journalism and the Business Press." Pointing out there are 2,000 business publications in the U. S., he said this dissemination network is peculiar to the U. S. and is obviously related to its primacy in production.

Supports Industry

Chief aim of the business press, Girdwood said, is to advance the status of the industry it serves. "It deals directly with the reader's interest in his job and his business. Its specific obligation to the reader is in providing valuable editorial material in return for an investment—the reader's time as well as the subscription cost."

Publication of an idea lends validity, he said, "and it is our obligation to edit against this standard."

Trade publications, Girdwood said, are vital tools of communication: "How effective they are depends on the writing engineer."

He urged engineers to contribute to the communications system by writing articles, keeping in mind the specific audience the publication has. Demands on time have doubled in the past decade, he said, so engineering publications cannot use lengthy treatises. Technical articles must appeal to broad interests. "Write to whet the interest of our best engineers and you'll interest the rest," he said.

The Silicon Controlled Rectifier

how will it affect your business?

General Electric's revolutionary Silicon Controlled Rectifier was introduced just two short years ago. The SCR has already proved it lowers costs, improves performance and solves old problems in radically new ways. It can replace thyratrons, magnetic amplifiers, power tubes and transistors, relays, switches, and many other devices. These are a few of the changes the SCR is now bringing about:

Vastly superior motor control systems for industry. Faster, more precise, smaller, more versatile, non-mechanical.

AC current for vehicles and aircraft. The SCR is the first really practical means of getting high power AC from variable DC. Static inverters with ratings of several kilowatts are possible.

Simple temperature controls accurate to 1/10th degree or better. Practical for all types of industrial furnaces.

Superior DC motor operation from an AC source. Extends the use of DC where desirable. Eliminates motor generator sets or magnetic amplifiers. Replaces mechanical speed and direction changers.

Stage lighting dimmer controls. Small, precise, reduces cost of installation for the entire system.

Current-limiting circuit breaker. Opens in less than twelve micro-seconds, long before a fault current can reach its peak.

More efficient lighting systems. Much more light per bulb through small, efficient SCR frequency converters that result in higher frequency and smaller ballasts.

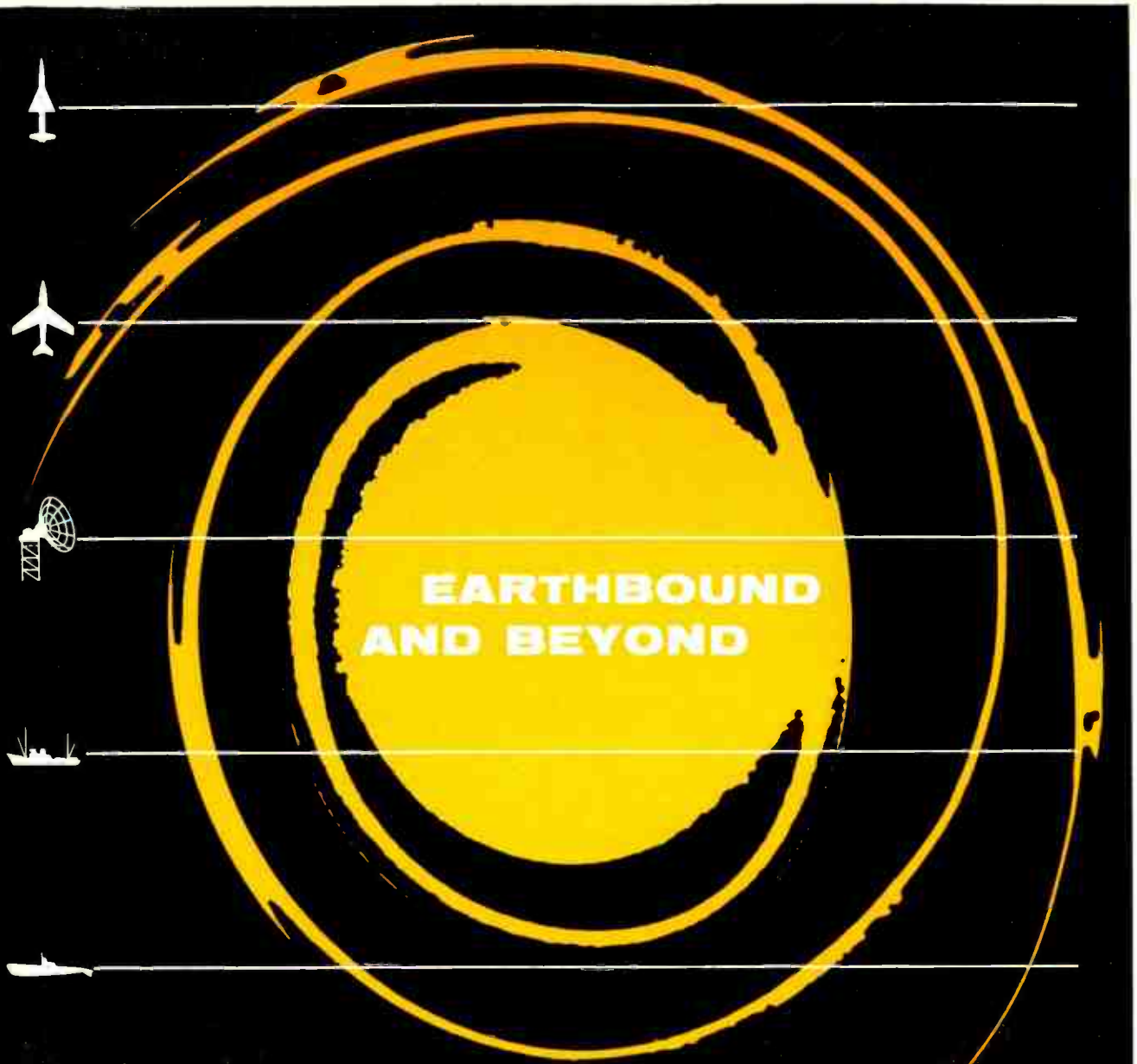
How will it affect your business?

You'll be better able to judge after you have read our informative new folder. Write today to General Electric Company, Semiconductor Products Department, Section S25119, Electronics Park, Syracuse, New York.

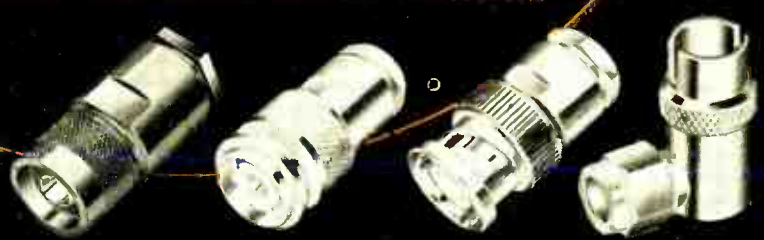
Progress Is Our Most Important Product

GENERAL ELECTRIC

Semiconductor Products Department



CANNON RF COAXIAL PLUGS MEET ANY CHALLENGE...ANYWHERE

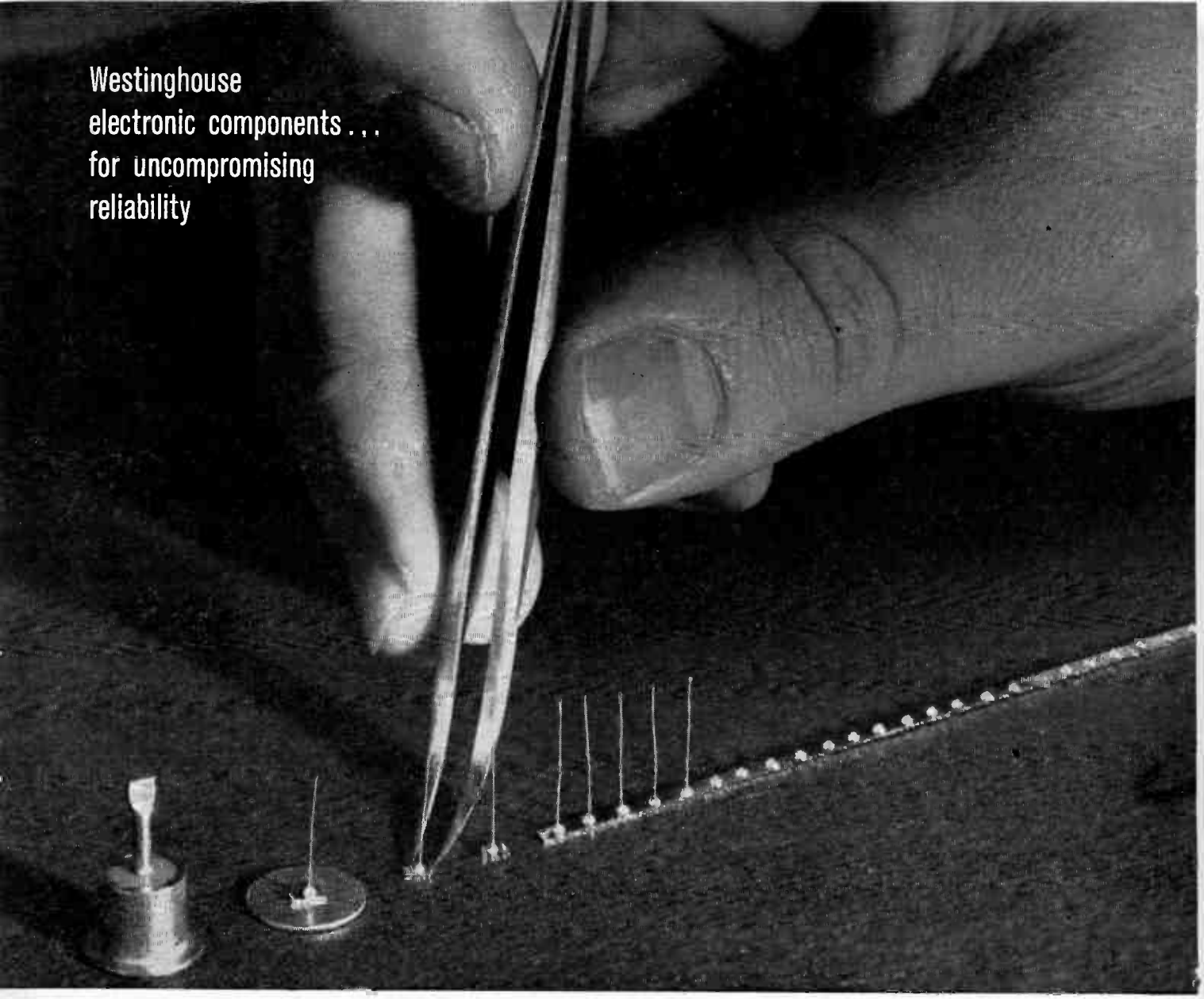


CANNON PLUGS

Cannon's complete line of RF coaxial plugs meet the exacting demands of today's technology with room to spare! Wherever coaxial cable is used; land, sea, air, or outer space, Cannon's RF plugs—standard, miniature, and light-weight aluminum—provide the exact type and size for any application . . . whether industrial or military • Aircraft • Missiles • Ground Support Equipment • Ships • Submarines • Write for literature to:

CANNON ELECTRIC CO., 3208 Humboldt Street, Los Angeles 31, California • Please refer to Department 120.

Largest Facility in the World for Plug Research—Development—Manufacture



1400% more reliability through research

Original research in electronics and related fields is constantly in progress at Westinghouse. Here, the latest development—molectronics—has reduced parts from 14 to 1, soldered connections from 15 to 2, in a light telemetry subsystem. The improvements in reliability when products like these reach automatic production are boundless.

You can take advantage of this kind of component research and development by specifying Westinghouse high-reliability components for all of your circuit designs. At Westinghouse, you can draw not only from a wealth of off-the-shelf components, but also from a vast stock pile of knowledge, experience, and research which makes "break-throughs" like molecular electronics a reality.

For all of your needs in ultramodern components, contact your local Westinghouse sales engineer or write: Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

Old and new—At left, a present semiconductor. At right, dendritically grown germanium crystals which perform the same function. Westinghouse expects to build several different electronic functions into single tiny slabs like these.

J-92028

WESTINGHOUSE ELECTRONIC COMPONENTS
for projects that must not fail

Control Devices • Instrumentation • Laminated Plastic Forms (Micarta®) • Magnetic Amplifiers • Magnetic Materials • Power Supplies • Static Inverters • Semiconductors • Transformers and Components • Tubes: Cathode-Receiving-Power-Nuclear Control

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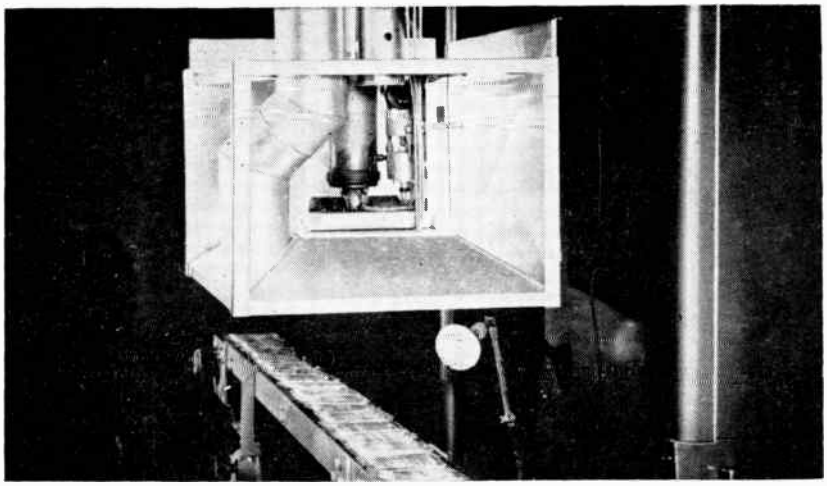


Tests on storage potential of irradiated food have been encouraging. Midwest Irradiation Center rents its reactor for $100 per hour

Electrons Aid Food Storage

By L. G. SANDS, Consultant, Ridgewood, N. J.

TODAY'S FOOD FREEZERS may someday be replaced by electron accelerators. Successful experiments in food preservation by irradiation have been going on for some time, but the Midwest Irradiation Center's recent announcement that its accelerator will be available to all food industries indicates a definite speed-up in the experimental program.

Intensive testing of the storage potential of irradiated food has been carried on by the U. S. Quartermaster Corps. Results have been so encouraging that approval by the U. S. Food and Drug Administration would almost certainly open this new area of food preservation to commercial use.

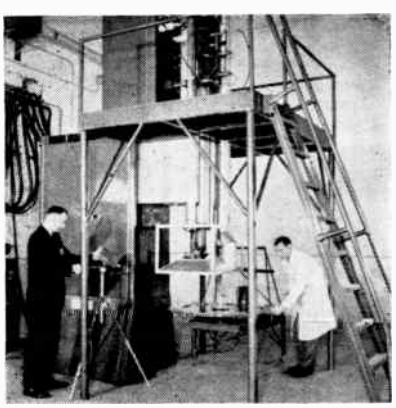
Experiments have shown that meats can be processed, irradiated and stored for extended periods of time. Milk and other canned goods can be pasteurized in their containers.

According to *Food Engineering* (a McGraw-Hill publication), the taste of some foods is changed by irradiation. However, this may not have a serious effect on the technique's commercial possibilities since the taste of some products changes under ordinary refrigeration without hurting their marketability.

The machine shown on the cover of this issue is the Applied Radiation Corp.'s 8-million-electron-volt linear accelerator. The machine cost $175,000. Another $45,000 was spent for shielding.

A 10-microsecond electron burst is fed through an aperture in a klystron into the accelerator waveguide. The electrons reach a speed close to the velocity of light, and the electron beam energy may be as high as 9 mev. The beam, 1 centimeter wide at the window at the output end of the waveguide, flares out to 8 cm.

The beam can irradiate materials of unit density up to thicknesses of 1 in. Materials two inches thick can be penetrated by irradiation from both sides. The beam energy can be adjusted to vary the depth of penetration. A tungsten target converts the beam into X-rays, which are more penetrating than gamma rays of cobalt-60.



THE FRONT COVER—Rockford, Ill., accelerator is being prepared for food irradiation test. $175,000 machine is operated by the W. F. Barnes Co. and Applied Radiation Corp.

It takes a TEAM
to solve timing problems

The control of time is an extremely complex science that demands a thorough knowledge of many individual technologies. For this reason, Haydon maintains a team of engineering specialists to provide the reservoir of skill, knowledge, experience, and creative ability necessary to solve industry's timing problems.

When you submit a timing problem to Haydon, it's handled by a team of specialists – *not* an individual engineer. And you can be sure the Haydon Timing Team is equipped with all the electric, electronic, mechanical and manufacturing know-how needed to analyze your requirements and develop the best possible new or modified timing unit for your specific application.

Correctly designed and efficiently manufactured, Haydon timing devices are exhaustively tested before release to a customer. The results are uniformly high quality devices that are known for fine performance, and long life. May we put our Timing Team to work for you?

A few units from the complete Haydon line are shown at the right. Send now for further information, outlining your requirements.

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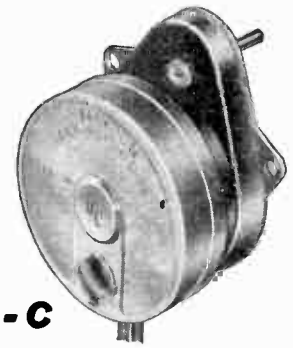
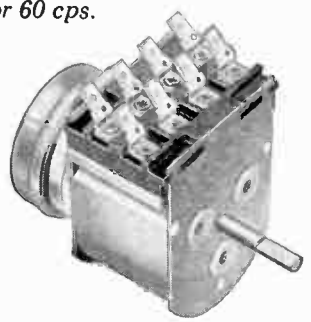
ELAPSED TIME INDICATOR ED-71

Compact, low-cost instrument for machine tools, communications equipment and other commercial applications where an accurate record of operating time is desired. Time Registered: 9,999.9 hours. Weight: 5 oz. Voltages: 120 or 240 v, 60 cps. Power Required: 2.5 watts at 120 v, 60 cps.



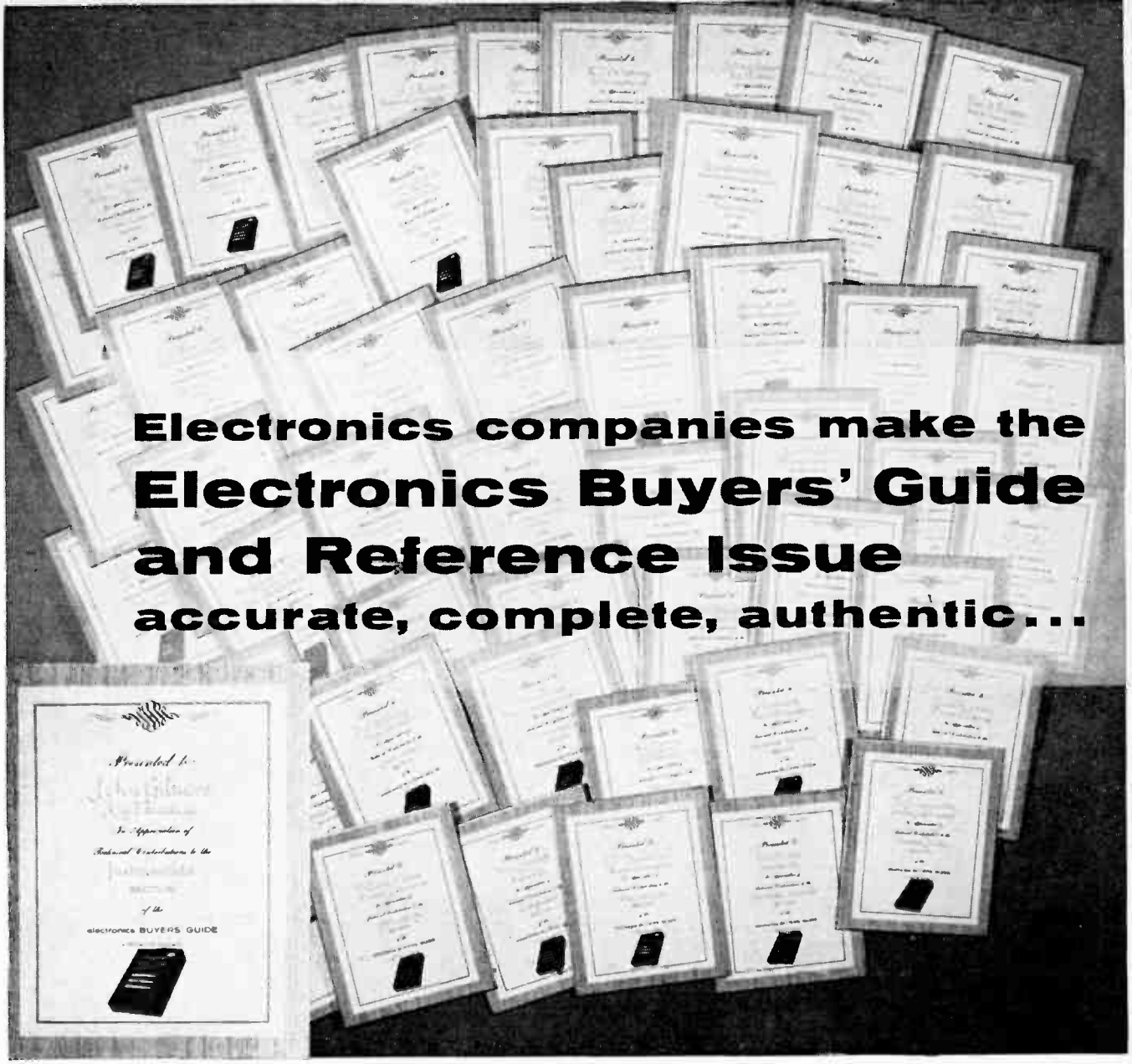
A-C TIMING MOTORS

A complete line of synchronous, compact timing motors, speeds from 1/60 to 60 rpm. Guaranteed torques from 6 ounce-inches to 30 ounce-inches at 1 rpm. Voltage ranges 103-132 and 206-264 vac, 50 or 60 cps.



INTERVAL TIMER

Directly controls heavy duty electrical loads. Type AD can be supplied with up to 3 SPST switches. Type AT has 1 SPST switch only. Intervals available with dial and knob: 15, 60 and 180 minutes. Intervals to meet your specific requirements can be supplied. Voltages: 120 or 240 v, 50 and 60 cps. Switch Rating: 28 amps, 250 vac non-inductive; 1 hp, 240 vac.

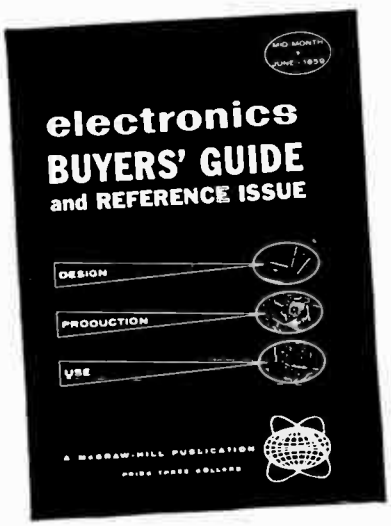


For nineteen years, firms in the electronics industry have made direct contributions to the accuracy, completeness and authenticity of the BUYERS' GUIDE.

Recently, the staff of the BUYERS' GUIDE decided to award plaques to express appreciation to those in the industry who had made direct contributions to improve the product listings. The photograph above represents a few of the awards that have been made.

The awarding of the plaques is but one indication of how the BUYERS' GUIDE evolved over the years . . . a *cooperative effort between the publication and the industry it serves.*

Only through years of experience can a buyers' guide reflect the needs of an industry as complex and dynamic as electronics . . . one more reason why the BUYERS' GUIDE is the ONE accepted product and data book in the field.



Published mid-year as the 53rd issue of **electronics**

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MEETINGS AHEAD

Oct. 11-16: American Institute of Electrical Engineers, Fall General Meeting, Hotel Morrison, Chicago.

Oct. 12-14: National Electronics Conference, AIEE, EIA, IRE, SMPTE, Hotel Sherman, Chicago.

Oct. 12-16: Aeronautics and Space Administration Inspection, NASA, Langley Research Center, Norfolk, Va.

Oct. 14: Institute of Printed Circuits, Fall Meeting, Sheraton Towers, Chicago.

Oct. 14: Medical Electronics, Evaluating Cardio-Vascular Function, PGME of IRE, Moore School, Univ. of Penn., Philadelphia.

Oct. 19-21: National Academy of Sciences, Research Council, URSI, IRE, Fall Meeting, El Cortez Hotel, San Diego, Calif.

Oct. 19-22: Semiconductor Symposium, Fall Meeting, Electrochemical Society, Deshler-Hilton Hotel, Columbus, O.

Oct. 26-28: Aeronautical & Navigation Electronics, East Coast Conf., PGANE of IRE, Lord Baltimore Hotel, Baltimore.

Oct. 28-29: Michigan Industrial Electronics Exposition, Electronics Representatives Inc., Detroit Artillery Armory, Oak Park, Mich.

Oct. 29-30: Electron Devices Meeting, PGED of IRE, Shoreham Hotel, Washington, D. C.

Nov. 3-5: Mid-American Electronics Conf., MAECON, Municipal Auditorium and Hotel Muehlenbach, Kansas City, Mo.

Nov. 4-6: Automatic Control, National Conf., PGAC & PGIE of IRE, Sheraton-Dallas Hotel, Dallas.

Nov. 5-6: Instrumentation Conf., School of Engineering, Louisiana Polytechnic Institute, Ruston, La.

Nov. 9-11: Radio Fall Meeting, IRE, EIA, Hotel Syracuse, Syracuse, N. Y.

Nov. 9-11: Instrumentation Conf., PGI of IRE, Biltmore Hotel, Atlanta.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 92.

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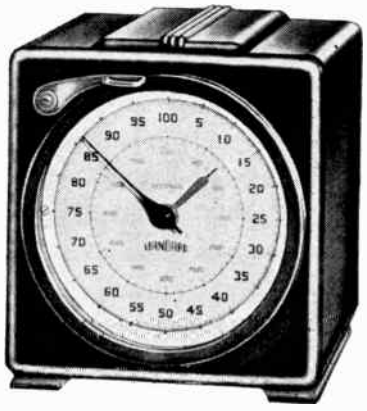

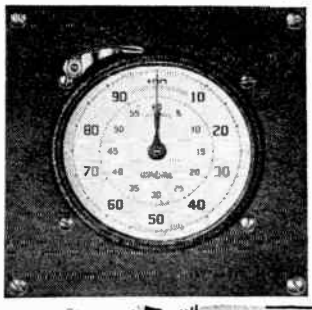

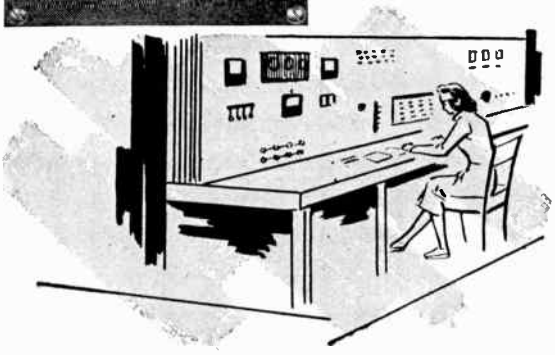

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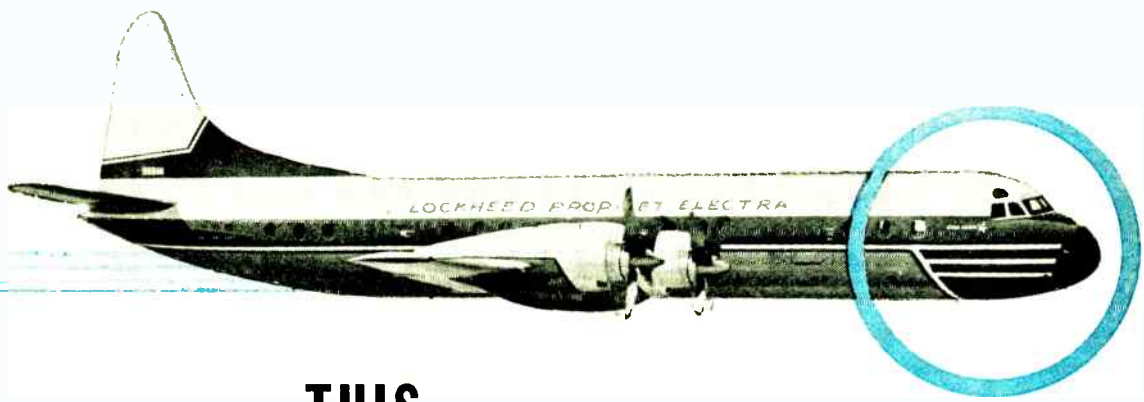
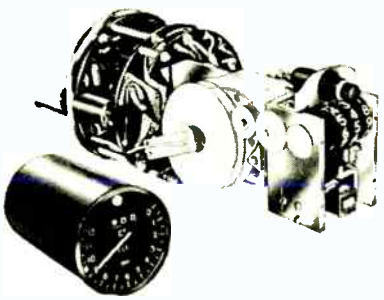


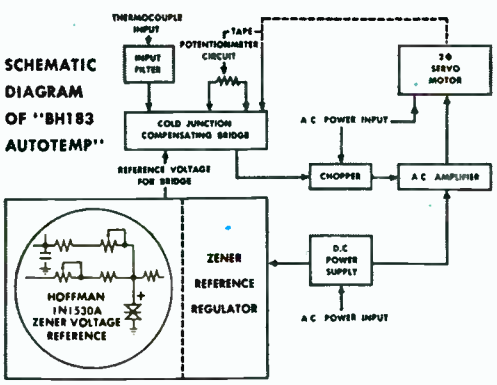
THIS VOLTAGE STABILITY PROBLEM HAD TO BE SOLVED

VISIT BOOTHS
NOS. 227-228
AT THE NEC SHOW

FOR CIRCUIT RELIABILITY IN A JET ENGINE TEMPERATURE INDICATOR



SCHEMATIC DIAGRAM OF "BH183 AUTOTEMP"



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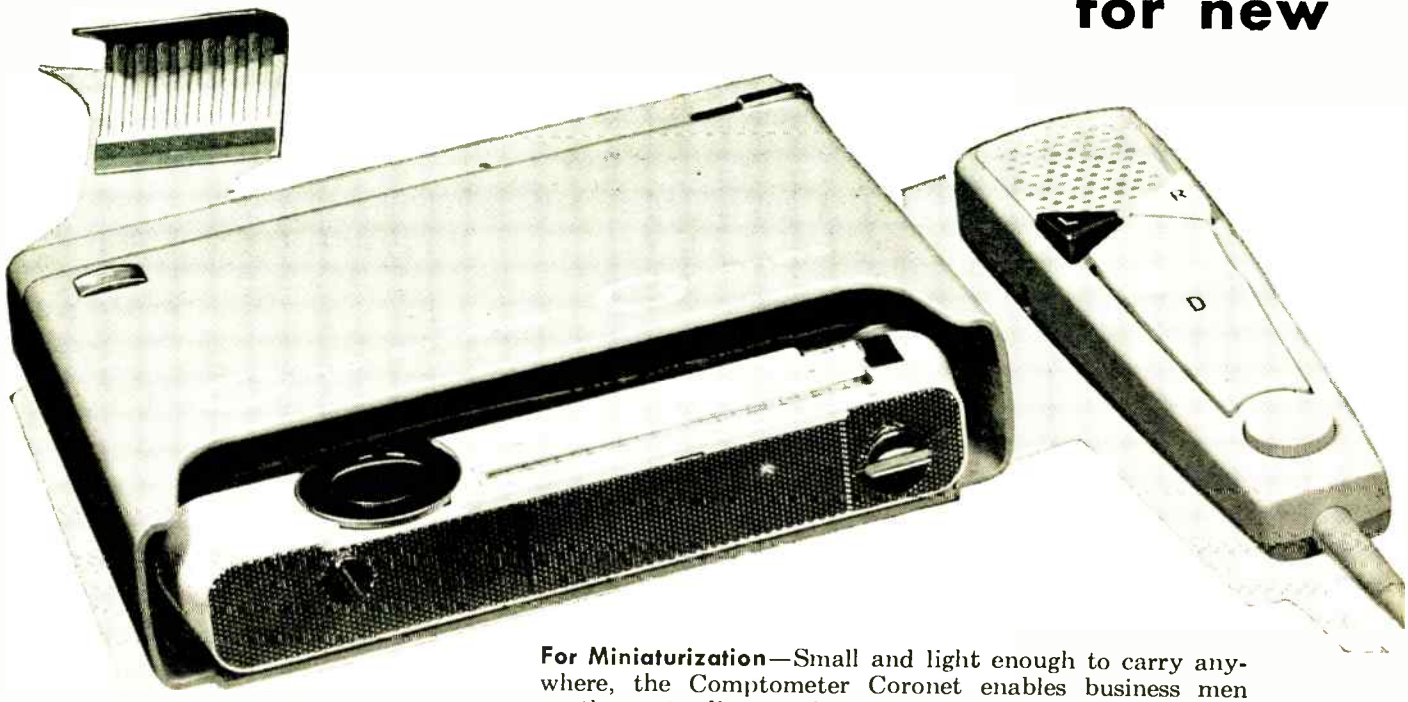

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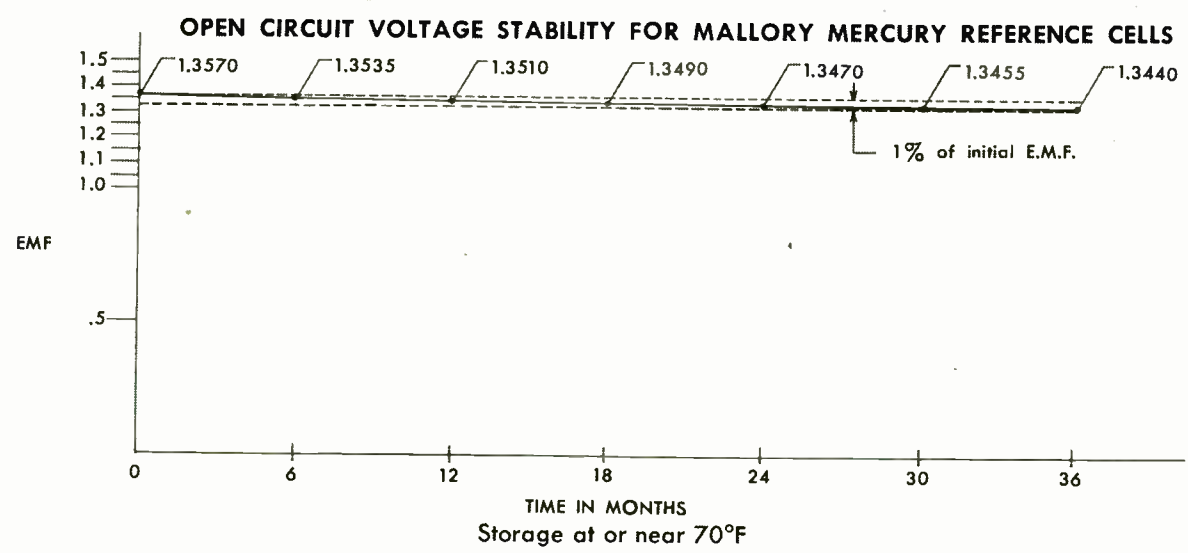

For Steady Output—Highly constant output voltage of mercury batteries makes them valuable as reference sources in instrument circuits. The curve shows how open circuit voltage keeps within 1% of original value during 36 months storage. Exceptionally high accuracy can be obtained for short run service under load, as in missile telemetering, by calibration prior to use in the intended circuit.

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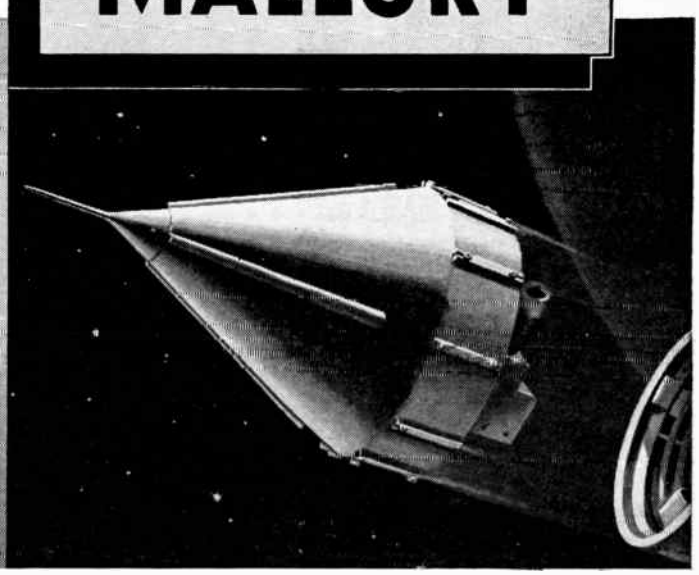

For Long Life—Mallory mercury batteries have been used as a primary power source for the telemetering transmitters in the U. S. satellite program. In the Pioneer IV space probe, they powered radio transmission up to 407,000 miles, the greatest distance over which a radio signal has ever been received . . . and they far exceeded life expectations in Explorer and Vanguard flights.

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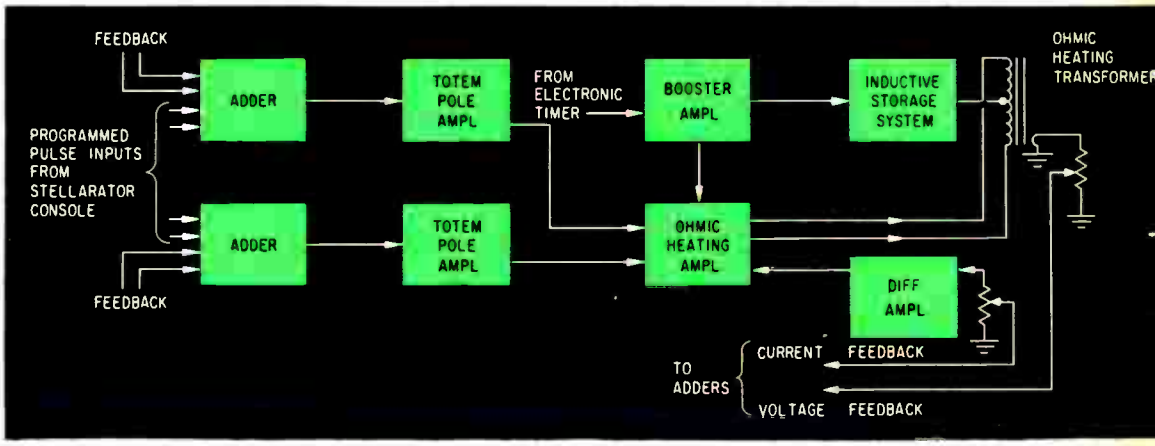

FIG. 1—Ohmic heating system develops 1.2 megavolt-amps at audio frequencies

Ohmic Heating Circuits For Plasma Physics

Audio generator heats stellarator plasmas to one million degrees C during thermonuclear fusion process. Experimental system produces 1.2 megavolt-amperes at 0 to 20 kc

By RODGER L. GAMBLIN*, Project Matterhorn, Princeton University, Princeton, N. J.

CONTROLLED THERMONUCLEAR POWER production requires maintaining a plasma of hydrogen isotopes at temperatures near one hundred million degrees C for an appreciable fraction of a second. One approach to this goal is through the use of stellarators (ELECTRONICS, p 75, Dec. 19, 1958).

Hydrogen gas is confined in the stellarator by a twisted, toroidially-shaped magnetic field of 20,000 gauss or greater. Initially, electric fields are applied parallel to the magnetic field to ionize and heat the gas. First an r-f field partially ionizes the gas, then a d-c or audio signal completes ionization and raises the resulting plasma to 10^6 C. The circuits to be described generates the d-c signal. The r-f generator was described in an earlier article (ELECTRONICS, p 50, July 3, 1959).

OHMIC HEATING—The d-c or audio signal used to heat the plasma is called the ohmic heating pulse. Normally, it consists of an arbitrary waveform of up to five milliseconds duration. The B3 stellarator, for which the ohmic heating equipment was designed, has a vacuum chamber five cm in diameter and 640 cm long with an inductance of four μh. During operation, the vacuum tube is filled with ionized gas of such conductivity that the resistance offered to passage of the ohmic heating current may drop to 10 milliohms from an initial value of one ohm.

The twist of the confining magnetic field tends to be unwound, or wound up to 2 π radians, by the cir-

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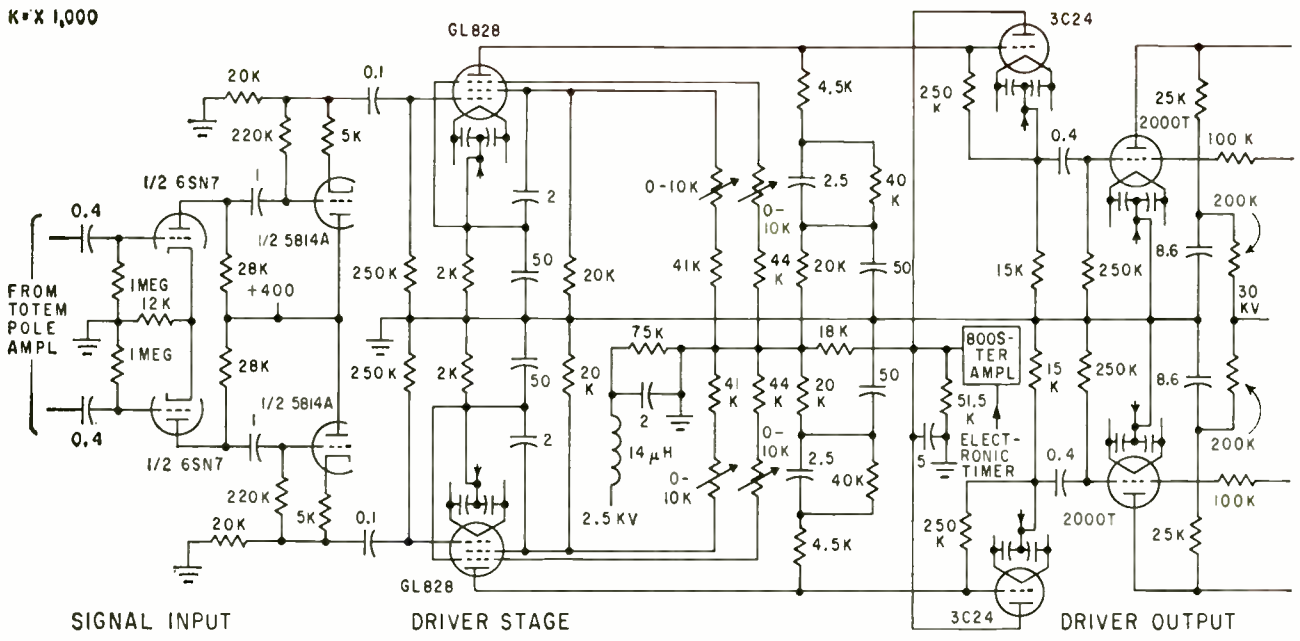


FIG. 2—Ohmic heating amplifier delivers high-power, finely-controlled audio signal to hydrogen plasma. Plasma is shown as single turn

cular magnetic field produced by the ohmic heating current. When the twisting effect of the stellarator becomes completely neutralized, the plasma becomes hydromagnetically unstable and can no longer be confined. In the B3 stellarator, maximum permissable current before onset of this instability at a confining field of 60,000 gauss is 6,000 amp. Such a current level is generally the maximum desirable stellarator current.

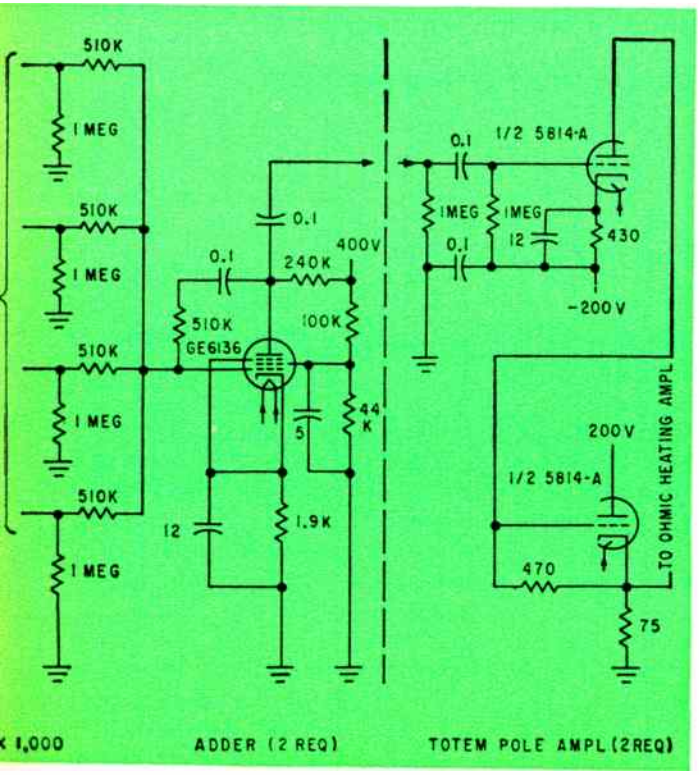
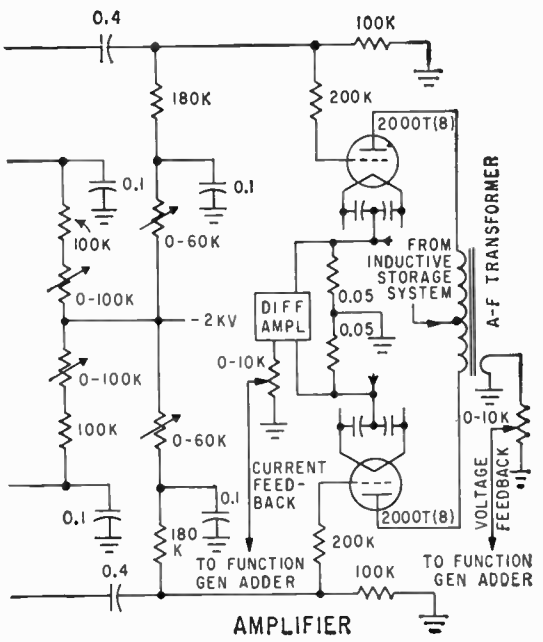


FIG. 3—Totem pole amplifier minimizes distortion

When the ohmic heating pulse is applied to the stellarator, each electron gains energy which it dissipates in collisions with ions or neutral particles. The higher the energy of an electron, however, the smaller its collision cross section. If the voltage applied to the stellarator is too high, then some electrons gain so much energy between collisions that they escape because of the decline in collision cross section. Primarily because of this problem, but also for other reasons dictated by the physics of the stellarator and needs for observation, it is desirable that the ohmic heating apparatus apply an arbitrarily-shaped waveform to the plasma. Figure 1 shows the basic block diagram of the ohmic heating system.

DESIGN REQUIREMENTS—Two modes of stellarator operation are needed: constant voltage and constant current. In the first mode, it is necessary to apply a voltage waveform closely approaching the input irrespective of the plasma impedance. In the second mode, it is desired that the plasma current approximate the input voltage waveform. For d-c pulse conditions (square unidirectional waveforms up to five milliseconds in duration) the ohmic heating pulse needs to be less than 200 v, indicating a power level operation of 1.2 megavolt-amperes. For operation at 10 kc, the voltage output needed is on the order of 680 v; however, since the plasma impedance increases because of inductive effects, total power requirements are comparable to the d-c case.

Thus, the requirements for an ohmic heating system are that it be able to operate at a power level of 1.2 megavolt-amperes at any frequency ranging from zero to 20 kc into a load that varies from $1 + j0.2$ to $0.01 + j0.2$ ohms. Since the possibility of operating the system with a capacitor tuning the inductance of the plasma is precluded by flatness requirements of frequency response and by a minimum rise time re-



on output transformer

quirement, the output must operate into an inductive load. The amplifier must have an internal impedance small compared to 0.01 ohm for constant voltage operation and large compared to one ohm for constant current operation.

OHMIC HEATING AMPLIFIER—Figure 2 shows the basic circuit of the ohmic heating amplifier. A primary design criterion for the amplifier is the stability of the feedback loop. It has been shown that when an amplifier consists of a number of stages of nearly identical frequency response, and of one low-pass stage, an approximate criterion for stability is that the feedback factor $|A\beta|$ be less than the ratio of the frequency response of the high-pass stages to that of the low-pass stage. Since feedbacks on the order of 22 db are needed in the ohmic heating system, a frequency response ratio of 20 was selected. All stages, except the driver, are at least 180 kc and the latter is 9 kc. Since the driver is capable of a higher pass output, 200,000-ohm resistors are in series with each grid of the final stage. The rise time of the amplifier with voltage feedback is near 10 μsec, indicating an approximate bandpass of 50 kc.

The physical location of the feedback pickup loop requires that the signal be transmitted over 50 ft to couple with the amplifier. A totem pole amplifier, shown in Fig. 3, was selected to minimize distortion in driving the return coaxial cable.

OUTPUT STAGE POWER SUPPLY—The power supply for the output stage consists of a shunt-regulated, electronically-switched inductive energy storage system shown in Fig. 4. Coil L_1 is charged through the vacuum switch. Just prior to operation of the ohmic heating system the grid of V_1 is pulsed positive and simultaneously the vacuum switch is opened. Tube V_1 breaks down as the switch opens. When the high voltage is needed, V_2 is fired and the negatively-charged capacitor in its cathode puts an inverse voltage on V_1 that de-ionizes it. The capacitor in the cathode of V_2 is then charged up by the coil current until the system reaches 20,000 v, at which time the regulator starts operating and maintains the voltage constant.

An electronic feedback regulator in shunt with coil L_1 draws current so that the output voltage is maintained constant at 20,000 v.

The ohmic heating system has been operating since Aug. 1958. It was supported under contract AT(30-1)—1238 with the Atomic Energy Commission.

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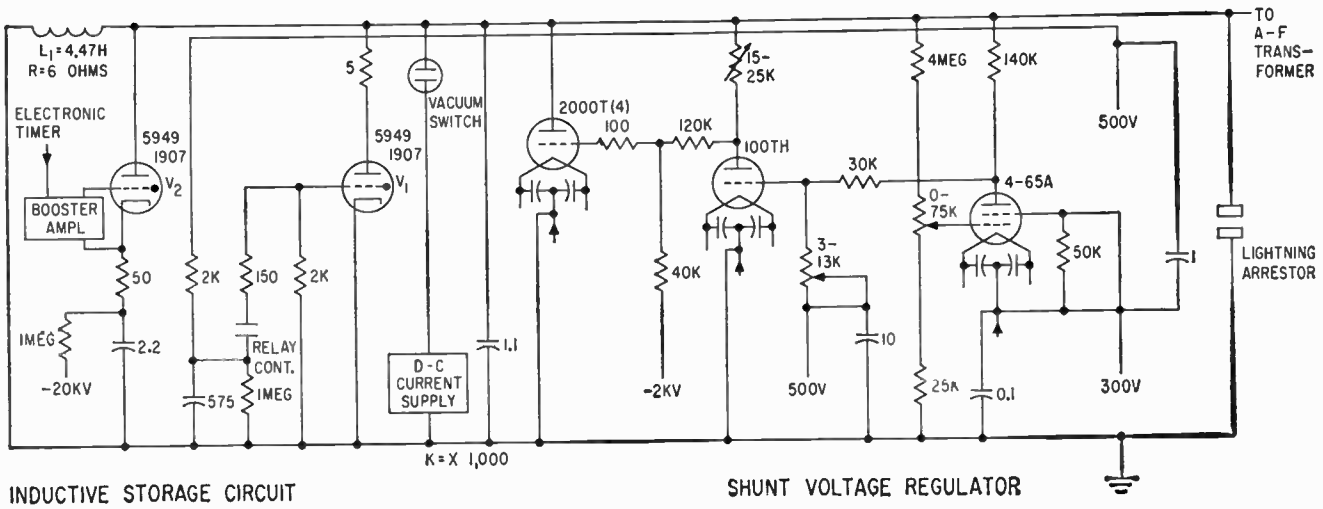
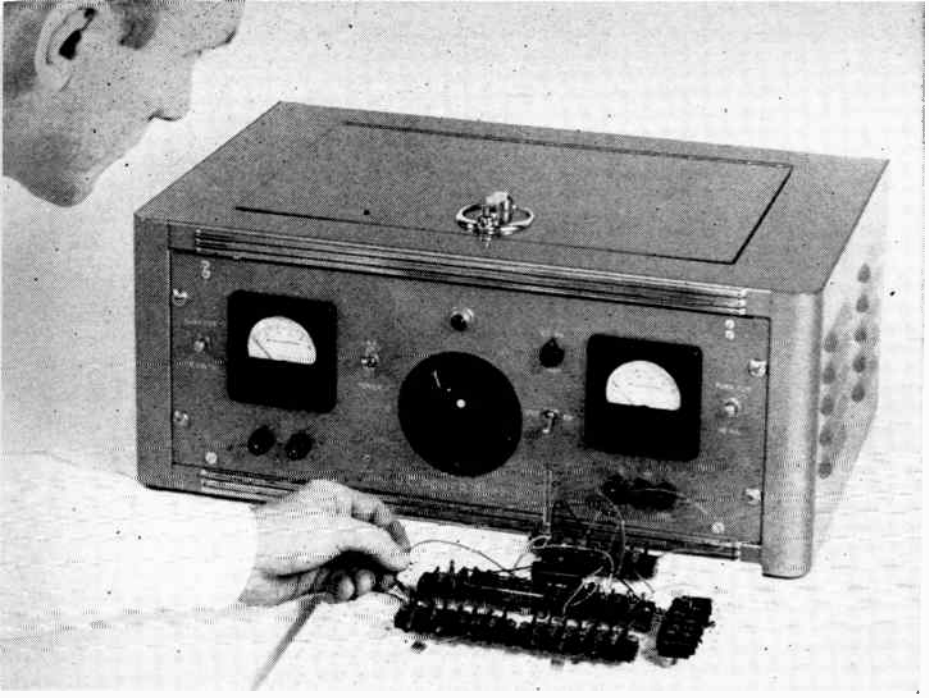


FIG. 4—Inductive storage system provides power for ohmic heating amplifier output stage



Experimental circuit is tested, using the closely regulated supply as a reliable source of constant voltage power

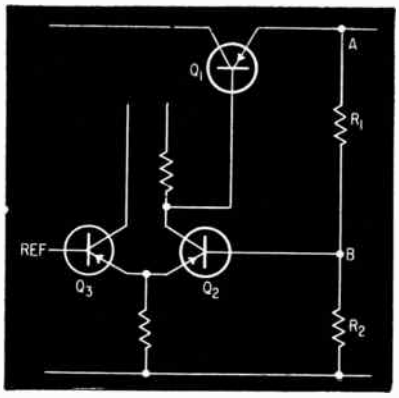


FIG. 1.—Error voltage of series-regulated power supply appears at point *B* attenuated by the R_1R_2 network

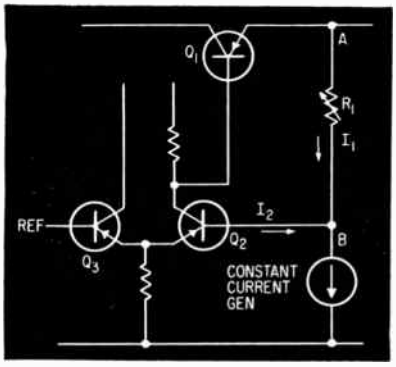


FIG. 2—Constant current circuit allows total error to appear at *B*

By EDWIN GORDY and PETER HASENPUSCH
Instrument Design and Development Dept.,
Roswell Park Memorial Institute, Buffalo, New York

Constant-Current-Coupled

By driving a constant current through a fixed resistance, the total error voltage of a power supply can be fed into an error-correcting amplifier

SERIES REGULATED power supplies operate on the principle of using an error signal to control the series regulating device. If the gain of the control loop can be increased, the load regulating characteristics of the power supply can be improved. A similar improvement in regulation can also be obtained if the error voltage is sampled without attenuation by the customary resistive divider network.

The basic circuit of a conventional series regulated, transistor power supply is shown in Fig. 1. Transistor Q_1 is the series regulator and point B the input to the error correcting loop. The desired or reference voltage is set in at Q_3. The error signal appears at point B and is the voltage at point A attenuated by the factor $R_2/(R_1 + R_2)$.

New Approach

Some factors which tend to lower the loop gain of the error correcting amplifier are reduced by a special circuit[1]. In addition, it is possible to lower the output impedance of the regulated supply by feeding the unattenuated output error voltage directly into a differential amplifier which is operated from two gas tube regulated auxiliary supplies[2].

A design using a new principle to obtain an unattenuated error signal is shown in Fig 2. A constant current generator feeds resistor R_1. For a fixed value of R_1, there will exist a constant voltage across this resistor equal to I_1R_1. The resistor with its constant current may then be considered the equivalent of a battery. Therefore, any error voltage existing at point A will be transferred, without attenuation, to point B, the input of the error-correcting amplifier. By making either I_1 or R_1 variable, the output voltage can be varied.

The ideal condition of constant current through R_1 is modified in practice by the finite current drawn by the base circuit of the input transistor of the error-correcting amplifier. The loading effect is

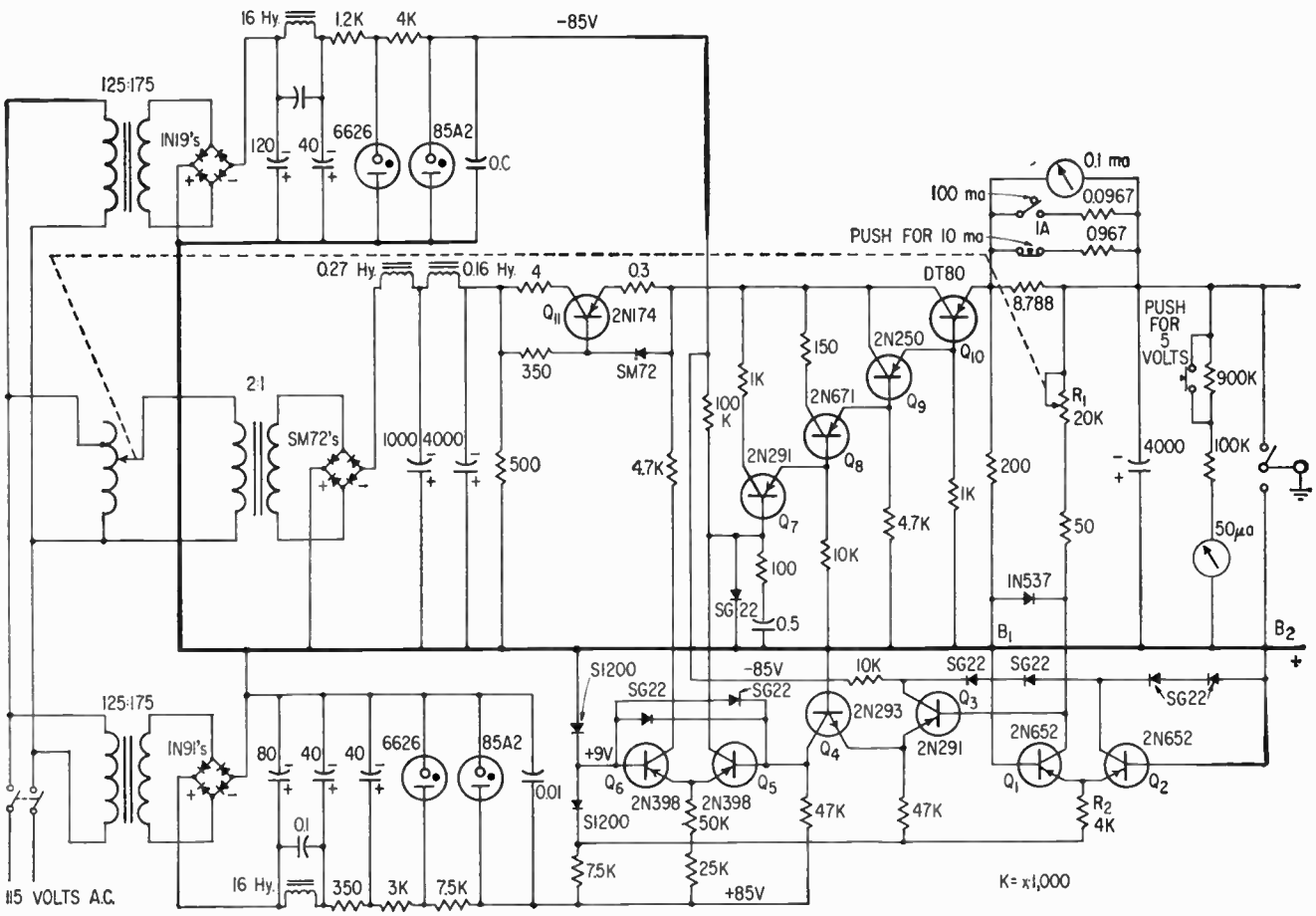


FIG. 3.—Regulated power supply uses two gas tube regulated auxiliary supplies to obtain performance. With a load current of 900 ma, drift in 30 minutes is about 5 mv

Transistor Power Supply

minimized by keeping constant current I_1 much larger than the base current of the input transistor.

Constant current coupling as used in this power supply is not unusual in d-c amplifiers designed for neurophysiologic use[3]. The application of this circuit to a regulated power supply appears to be a new approach to the problem.

A transistor operated in the common-base configuration has a high output resistance and can be used satisfactorily as a constant-current source. In the practical operational circuit of Fig. 3, Q_1 is the constant-current source and Q_2 is used as thermal compensation for Q_1. Both Q_1 and Q_2 are fastened to a common heat sink to keep them at the same temperature.

The points B_1 and B_2 on the B+ bus must be kept close together physically. Otherwise, the IR drop along as little as ¼ in. of solid number 12 copper wire is enough to cause a rise in output voltage as the load current increases.

The use of auxiliary positive and negative supplies follows from reference 2. The 6626 regulator tube is used in preference to an OA2 since it has better constant-voltage characteristics. The supply shown at the lower left of the schematic uses S1200 thermally compensated Zener diodes to obtain a drift-free reference voltage.

Performance

Regulation of the supply from zero load to 900 ma is 30 mv at 36 volts output. Ripple is less than 2.5 mv peak-to-peak. Line changes up to 10 percent do not affect the output.

Drift of the supply is less than 5 mv after 30 minutes operation at 750 ma. But temperature changes have a relatively large effect on drift. Without a one inch blanket of acoustic grade fiberglass over Q_1 through Q_6 transistors and circuits, drift was approximately 40 mv in 15 minutes. With the chassis removed from the cabinet and no thermal blanket, drift was 100 mv over a few minutes. Thus a 20 to one improvement in drift was obtained by relatively simple means.

The complete supply is shown in the photograph where it is being used to check an experimental circuit.

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(2) T. H. Brown and W. L. Stephenson, A Stabilized D-C Power Supply Using Transistors, *Electronic Engineering*, 30, p 425, Sept. 1957.

(3) J. Y. Lettvin, personal communication.

New technique achieves densities of 65 analog components and 160 digital components per cubic inch. Reliability and production rate also improved by modular construction process

3-D Packaging Reduces Size of Electronic Units

By ELDON C. HALL and RICHARD M. JANSSON,
Staff Engineers, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

RESEARCH AND DEVELOPMENT in the field of air and space vehicle guidance systems is placing an ever-increasing premium on lightweight, miniature and reliable electronics. The electronic devices used must also be able to operate satisfactorily over a wide range of environmental conditions, particularly those of temperature, humidity, vibration and acceleration or shock. The electronic packaging technique to be described was developed to meet, more fully than in the past, these critical demands.

Referred to as 3-D or high-density electronic packaging, the new technique involves mounting and wiring circuit components in a miniature three-dimensional unit mass. By using miniature components now available from manufacturers and a newly-applied method of joining wire leads, 3-D packaging has achieved a maximum component density without sacrificing production feasibility.

The 3-D technique consists of placing circuit elements side by side and forming the electrical connections on a three-dimensional basis as opposed to the two-dimensional printed circuit board. The wires are joined by electrical resistance spot welding, which is similar to the vacuum tube technique. After assembly and electrical checkout, the unit is encapsulated in epoxy potting compounds to form a module. The resulting miniature package is a maximum-density assembly occupying all practical space within the package.

When applied to analog circuits, 3-D packaging has achieved component densities up to 65 components per cu in. Although these figures do not compare with densities achieved in microminiature binary-circuit techniques now under development, they have been obtained using such components as JETEC-cased transistors, transformers, microfarad capacitors and others not found in binary circuits. In digital circuits, densities of 3-D modules up to 160 components per cu in. have been obtained.

With a high component density, the completed module forms a unit mass that is nonresonant and structurally rigid—a desirable design feature for meeting conditions of shock and vibration that may be encountered under operating conditions for air and space vehicles.

Analog Circuits

Distinct differences in approach have been found necessary for packaging digital computing circuits and analog servo circuits. In digital wiring, the large number of interconnecting logic wires complicates the design of the 3-D wiring setup and special layout techniques are necessary. In analog packaging, on the other hand, the chief problems encountered are heat dissipation from the module and interelement coupling effects of components in close proximity.

An example of analog wiring and component arrangement is shown in Fig. 1, which illustrates a resolver drive amplifier. Electrical designers must deal with the problem of interelement coupling in this type of 3-D module, a problem usually not found in the breadboard or printed circuit assembly. Types of circuits used in analog electronics are, in general, very broadband, high-gain amplifiers with generous feedback. A compact three-transistor amplifier, for example, if potted in a Mu-metal shielding can, may give rise to stray coupling through the can to the input. Circuit design and component arrangement, therefore, must be carefully planned to avoid combinations that would lead to any oscillatory instabilities.

After accomplishing the circuit design and component layout, taking into account the coupling problem and the most efficient packing arrangement, a production drawing is prepared in plan and elevation showing all views of the unit and the location and orientation of each component as well as the location of each weld. Components are numbered on the drawing for production identification. The wiring configuration is clearly outlined

FIG. 1—Resolver drive amplifier shows application of 3-D packaging technique to analog circuits

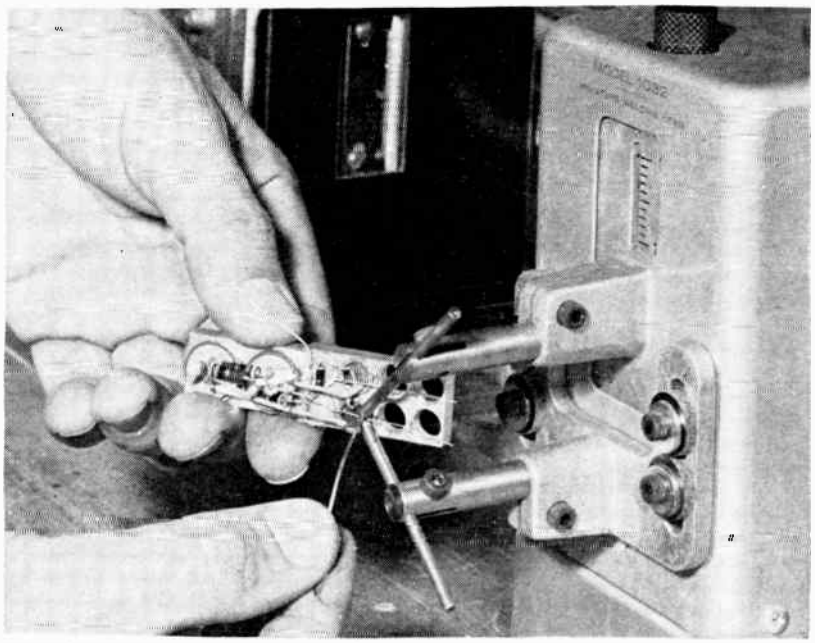


FIG. 2—Miniature welding head and special jig holds components during welding of wire leads

showing all connections. Terminal connection instructions are also included, along with color coding of the terminals.

A major problem in the assembly of analog circuits was the variety of weld types to be handled, since component leads span quite a range of sizes and materials. It was found that by using a flat, nickel ribbon as the common lead-joining medium, welding became more uniform and one weld setting could handle a number of weld types. A by-product of the use of this type wiring was an increase in structural rigidity of the unit before encapsulation. This is an important consideration since the unpotted assembly is held together only by leads, welds and small amounts of Mylar tape.

Handling must be kept to a minimum since damaging strains can result from excessively rough treatment. After potting, of course, the modules are quite rugged and are fully capable of meeting missile environmental specifications. Figure 2 shows a weld being made on a 3-D component, using a miniature welding head and a special jig to hold the components during welding.

As an illustration of the densities to be achieved, plans are in effect to provide for a package containing analog electronics with dimensions of 0.15 to 0.19 cu ft, weighing 15 to 20 pounds, in one unit mass structure. For this same system, a tightly designed electronics package using printed circuit boards had a volume of 0.6 cu ft and a weight of slightly less than 40 pounds.

Thermal Problems

Thermal conditions within modules must be seriously studied. If power levels are reasonably low, as in the case of digital computer circuits, the modules can be stacked into one block and tied together, with the thermal problem treated rather lightly. For example, aluminum foil can be placed between layers to conduct the dissipated heat to an appropriate heat sink. However, analog circuits contain elements that require more heat sinking than corresponding elements of digital circuits. To accomplish the necessary heat transfer in the case of individual signal-level transistors, the transistor can be wrapped in aluminum foil which, in turn, is attached to an aluminum plate on one face of the module. A layer of such modules can be clamped to each side of a cold plate, thereby removing the heat from each module.

In addition to signal-level modules, power transistors potted into modules with the copper heat transfer face exposed (without studs) can also be effectively handled by this method of clamping to a cold plate. The result is a greatly simplified (and cheaper) cold plate design; and there are no mounting studs to interrupt the heat-transfer fluid passages. This design feature alone effects a considerable reduction in the volume required for heat exchanger equipment.

To determine the values, and the distribution of values, of the thermal resistance between encapsulated power transistors and the surface of a cold plate, tests were made with representative modules mounted on a heat exchanger. An average value of the mounting thermal resistance for H-10 transistors, based on 64 test points, was determined to be 0.38 C/w with maximum and minimum values of 0.49 C/w and 0.26 C/w, respectively. For H-7 transistors, the thermal resistance is higher due to the smaller contact area, and results of the test gave an average (based on 56 points) of 0.84 C/w. Maximum and minimum values of the thermal resistance in this case were 1.00 C/w and 0.74 C/w.

Digital Circuits

The digital circuits described are used in an inertial guidance digital computer. In this type of computer, the thermal problem is not as critical in the design of 3-D packages. On the other hand, however, the large number of interconnecting

wires and the importance of correct logic wiring has made it necessary to develop special techniques in applying the design to the 3-D package.

It may be seen, from a brief explanation of the type of data-handling circuits used in the computer, that the logic wiring has been made the controlling member in the computer design.

The computer is made up of three basic elements: NOR gates, a shift-register memory, and a crystal-controlled clock. The interconnecting wiring between these three elements provides the logical function of the computer.

The NOR gate is the only type of circuit building block used in the logic, the memory read-in and the memory read-out circuits. Each memory read-out consists of two NOR gates connected to provide a set-reset flip flop, resistor-coupled to the memory. The memory read-in circuit consists of an OR block, which is the same standard NOR gate circuit with the collector load resistor removed. The installation of the resistor between the flip flop and the memory and the removal of the collector load resistor in establishing the OR block are both part of the production process when the logic wiring is applied.

The circuit shown in Fig. 3 is an example of the data-handling arrangement. An explanation of the NOR and OR symbols is also shown. Because of the exclusive use of identical NOR gates, a series of identical circuits can be used in 3-D packages and interconnected as needed in the design throughout the computer.

The computer is designed around the shift-register memory (also called a memory stick), which also contains repetitive circuit features whereby a standardized form of component layout can be employed in the 3-D module. The clock is the only element containing nonrepetitive circuits. Therefore, the design of the computer is established by controlling the pattern of the logic wiring.

The resulting 3-D package can be constructed in the form of a stick. This form of module can easily be assembled into a cube or other shape to provide for a multiple-stick assembly. Figure 4 shows such an assembly together with the various stages of assembly of a logic stick containing 36 transistors, 144 diodes, 36 capacitors and 108 resistors. The stick is 7.5 in. long.

Logic Stick Construction

To position the multitude of parts in the stick and to hold them together during welding, a technique of film jigging was developed. This technique employs two punched insulating films of Mylar tape to ac-

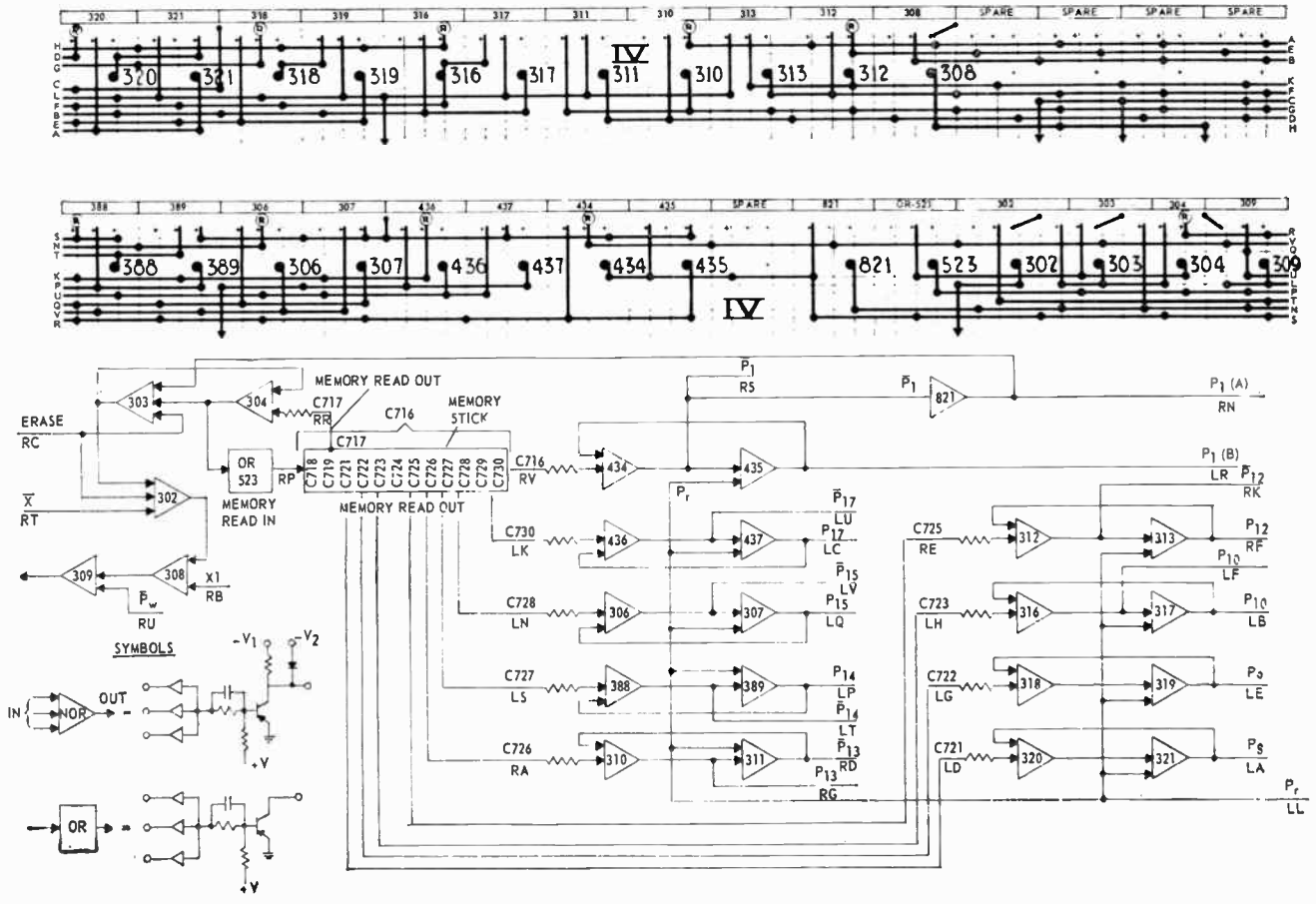


FIG. 3—Logic matrices (top) show film instructions for circuit diagram at bottom

curately position all component leads. The film becomes a permanent part of the assembly, also acting as a physical insulating barrier between the stick components and the power buses and/or logic wiring incorporated on them.

The original layout of the stick is reflected in the instructions on the film, thus providing the information for proper positioning of the components. The film jig information is based on the original component layout drawings, which indicate all component positions, lead locations, and power bus interconnections in plan and section. From these drawings, overlay drawings are made showing the location of each lead in the plane of the film jig. This layout is photographically reduced to the jig size and produced on the Mylar tape.

The lead locations are punched on a power punch to provide the properly oriented holes through which the lead wires are to protrude when the components are inserted. In the design and layout of sticks, the film jigging procedure eases the design process and ultimately results in the transfer of information to the fabricator in an expeditious manner.

The logic wiring matrix that is applied to each side of the stick is manufactured separately from a wire mesh structure mounted in a frame. Mylar tape, with instructions for the welder, is also used in this operation to separate and hold the wires. Logic film layouts are prepared, as in the component layout, and tack-weld points, clip areas, switch number, bus identification and subassembly identification are all included on the film. The logic film is slipped between the longitudinal and cross-bus layers of the wire mesh and all welds are then made. Weld points are indicated by a hole punched in the tape. The welded matrix is clipped from the metal jig and the subassembly is hand-clipped and tested for conformance to the layout.

As a further comparison with the printed circuit board technique, a 3-D digital computer electronic package now being designed will have a total volume of 0.1 cu ft and weigh under 10 pounds, whereas the volume of a tightly designed printed circuit computer package, assembled for the same system, is 0.4 cu ft with a weight of approximately 26 pounds.

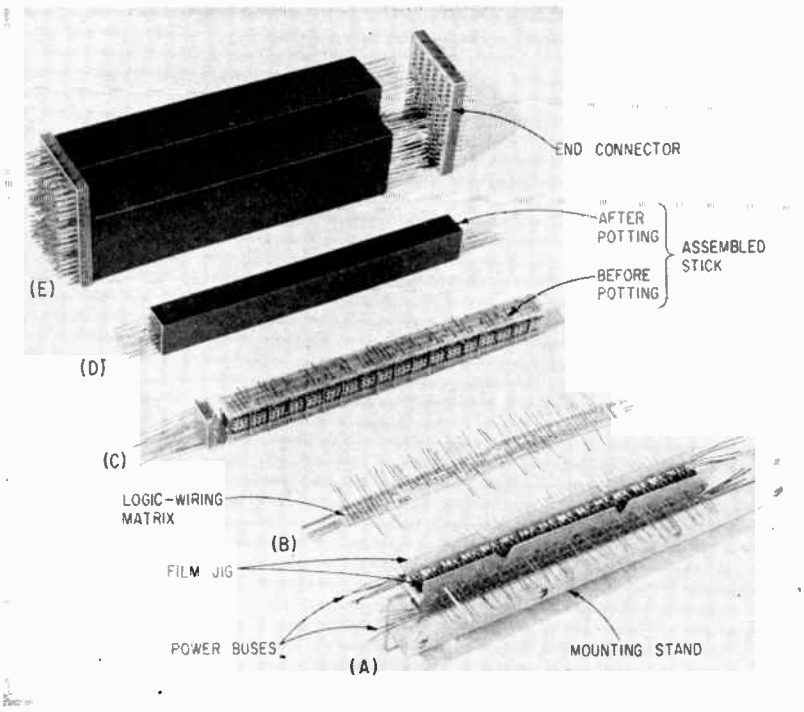


FIG. 4—Film jig holds components in place (A); logic wiring matrix (B) is then welded on, resulting in assembled stick (C and D). Multiple-stick assembly (E) requires end connector to connect logic wiring between sticks in accordance with logical design of computer

Other Advantages

Some marked advantages over other methods have emerged from experiments in producing and testing these 3-D units. One significant feature is the fact that present welding facilities for vacuum tube manufacturing are ideally suited, and the manufacturers are therefore presently equipped, for the production of 3-D modules.

It has also been shown on a developmental basis that this welding technique greatly reduces the assembly time as compared with manual assembly of printed circuit boards. For example, it is estimated that two technicians can assemble a 3-D package in the same time it takes six technicians to assemble the same circuit using two-dimensional printed circuit boards.

Design flexibility is another important feature because of the variety of components that can be handled and the manner in which they can be used. Transistor circuitry from signal level to power level when packaged by this method lends itself to easier solution of heat transfer, mounting accessibility and package design problems. This is because the shape of the module can be molded to suit particular needs and module groups can be arranged to fit unique package configurations. As for reliability, a vacuum tube manufacturer has estimated on the basis of vacuum tube production experience that for an assembly using 3-D packaging and containing several hundred welds, only one in 10,000 assemblies will be rejected because of bad welds.

The 3-D packaging program described herein is being carried out under the joint sponsorship of the Ballistic Missile Division, U. S. Air Force and the Bureau of Ordnance, Department of the Navy. Acknowledgment is also due Samuel Francis of Francis Associates, Marion, Mass. for the original concept on which the M.I.T. Instrumentation Laboratory's development work is based; Raytheon Manufacturing Company and Sippican Corp. for their manufacturing and engineering help, under subcontract to M.I.T.; and William H. Mann of Jackson & Moreland, Inc. for assistance with this presentation.

High Vacuum Pumping for Modern Electronic Needs

Simulating space environments, constructing molecular electronic circuits, degassing components and materials are chores for high-performance pumps

By **NORMAN BEECHER,** Project Manager, National Research Corp., Cambridge, Mass.

RADIO TUBES were one of the earliest applications of high vacuum. The diffusion pump, developed by Langmuir, is still the workhorse of the high vacuum field. Today, many new electronic techniques also require vacuum systems.

Semiconductor thin films are formed by vacuum evaporation and deposition at very low pressures. Vacuum degassing and drying prepares dielectric oils. Oil impregnation in vacuum chambers eliminates trapped moisture and gas bubbles.

The space age requires new specifications for electronic equipment operating in satellites and rockets. Vacuum testing to detect vibration failure, overheating or evaporation of materials is essential. Chambers large enough to house satellites have been built. They must be pumped down rapidly and maintain high vacuum despite the release of large amounts of absorbed gases from the components tested.

FOREPUMPS—High vacuum pumps attain pressures of 10^{-3} mm Hg or below. Ordinary mechanical vacuum pumps sealed with oil will produce 10^{-2} mm Hg with fairly low pumping speeds. Simple rotary types handle permanent gases satisfactorily. Rotary gas ballast types handle condensable gases like water vapor. Air is admitted with the pumped gas, diluting the gas so that it will not condense in the pump. This prevents addition of condensed water to the pump oil.

Rotary pumps are generally used as the forepump backing up a high vacuum pump. All diffusion pumps and molecular drag pumps constructed to date require a forepump. Ion-gettering pumps need a forepump for startup and initial pumpdown, but have the advantage of consuming gases rather than discharging them.

PUMP SELECTION—Oil diffusion pumps are the most economical. If the vacuum system cannot tolerate even a trace of oil vapor, it may be feasible to use mercury diffusion pumps. The latter is used, for example, in evacuating fluorescent lamps where mercury vapor is already present.

Where the pressure on the high vacuum side is as high as 0.1 mm Hg, the use of the ejector principle with oil or mercury is advantageous. Ordinary diffusion pumps begin to lose efficiency above 10^{-3} mm Hg. The booster type oil diffusion pumps cover the range between ejectors and regular diffusion pumps.

For high capacity pumping between 10 and 0.001 mm Hg, Roots blowers with a mechanical forepump can be used. The Roots blower pumps with a pair of interlocking metal impellers. For pressures below 5×10^{-7} mm Hg, it is usually desirable to use a cold trap with diffusion pumps to minimize escape of pumping fluid into the vacuum system. Such traps generally have a liquid nitrogen-cooled surface blocking line-of-sight passage between pump and vacuum chamber.

Ion-gettering pumps are especially useful for cyclotrons where low helium pressure is permissible, but all air in-leakage should be removed. They can pump for long periods in a sealed system.

Molecular drag pumps are not used much in this country, but provide satisfactory clean systems for experimental work. The Pfeiffer pump should be commercially available soon and the Beaudoin pump has been on the market for some time. These pumps, however, operate at high speed and are expensive.

Cryogenic pumps, using very cold surfaces to condense certain gases, have long been used and are highly efficient for condensable gases. Temperatures in the range from liquid nitrogen to helium are used. It is usually desirable to design the cryogenic pump for a specific system (NRC and Arthur D. Little, Inc., have experience in this field).

The list of pumps in Table I is not exhaustive and omission of a pump or manufacturer does not imply an unfavorable judgment. Only the largest pump in a line is described. These are generally large enough for test chambers. Smaller pumps will handle such pumping work as tube evacuation. Construction material is metal, except that EIM and NRC-G-2-M employ glass.

KEY TO MANUFACTURERS

BEA	Beaudouin (French, available through NRC)
CEC	Consolidated Electrodynamics Corp.
EIM	Eitel-McCullough, Inc.
KIN	Kinney Manufacturing Co.
LEY	Leybold (German, available through NRC)
NRC	NRC Equipment Corp.
PFE	Pfeiffer (Germany)
STO	F. J. Stokes Corp.
VAR	Varian Associates
VEE	Veeco Vacuum Corp.

Table I—Characteristics of Representative Commercial High Vacuum Pumps

Mfgr and Model	Dimensions (inches)	Optimum Range (mm Hg)	Max Pump Speed, Air (liters/sec)	Discharge Pressure (mm Hg)	Heater Power (kw)	Cooling Water (gpm)	Advantages	Disadvantages
FRACTIONATING OIL DIFFUSION, 3-STAGE								
NRC H-32-P[a]	60 high 32 i.d.	5×10^{-7} -1×10^{-3}	30,000 @ 4×10^{-5} (b)	0.2	9.5	4 @ 20 C	no controls, no moving parts, pumps all gases, inexpensive, oil has low vapor pressure eliminating need for cold traps	oil vapor may contaminate vacuum system, forepump required
CEC MCF 15000A[a]	80 high 32 i.d.	5×10^{-7} -1×10^{-3}	27,500 @ 1×10^{-4} (b)	0.07	7	2 @ 20 C		
STO 16″ Ring Jet[a]	54 high 16 i.d.	5×10^{-6} -1×10^{-2}	5,000 @ 1×10^{-3} (b)	0.1	5	2 @ 20 C		
KIN VF-1600[a]	31 high 16 i.d.	5×10^{-7} -1×10^{-3}	5,200 @ 2×10^{-4} (b)	0.2	5	1 @ 20 C		
LEY DO-4001[a]	27 high 14 i.d.	5×10^{-7} -2×10^{-3}	4,000 @ 1×10^{-6} (b)	0.2	3	0.3 @ 20 C		
VEE[a] EP-4W	15 high 4 i.d.	5×10^{-5} -2×10^{-2}	400 @ 5×10^{-3} (b)	0.5	0.5	0.5 @ 20 C		
EIM	16 high 4 i.d.	5×10^{-7} -1×10^{-4}	67 @ 1×10^{-5} (b)	0.001	0.2	(air cooled)		
BOOSTER TYPE OIL DIFFUSION, 2-STAGE								
NRC B-12[a]	49 high 12 i.d.	5×10^{-4} -5×10^{-2}	2,800 @ 1×10^{-3} (c)	0.8	14	4 @ 20 C	same as above, designed for higher pressure range, large mass capacity	same as above
STO 16″ Ring Jet	92 high 16 i.d.	5×10^{-4} -1×10^{-1}	3,500 @ 1×10^{-2} (c)	1.5	36	5 @ 20 C		
LEY OT8000	47 high 20 i.d.	5×10^{-4} -1×10^{-2}	6,000 @ 1×10^{-3} (c)	0.3	5.7	4 @ 20 C		
OIL EJECTOR (OE) AND OIL DIFFUSION-EJECTOR (ODE)								
CEC (OE) KJ-5000[a]	140 high 70 long	2×10^{-3} -1×10^{-1}	5,500 @ 9×10^{-2} (c)	3.2	23	4 @ 20 C	same as above; quieter than Roots blower, no damage from dirt	same as above; bulkier, narrower pressure range than Roots blower; oil traps dirt, must be periodically changed
LEY (OE) ODP-300[a]	60 high 80 long	3×10^{-3} -5×10^{-1}	300 @ 1×10^{-1} (c)	3	9	4 @ 20 C		
CEC (ODE) KS-16000[a]	111 high 156 long	3×10^{-4} -6×10^{-3}	19,200 @ 2×10^{-3} (c)	2	19	33 @ 20 C		
MERCURY DIFFUSION (MD) AND MERCURY EJECTOR-DIFFUSION (MED)								
CEC (MD) MHG-900[a]	29 high 10 i.d.	1×10^{-6} -2×10^{-4}[d]	1,600 @ 5×10^{-5} (b)	0.26	2	0.3 @ 5 C	same as oil diffusion, Hg contaminant sometimes more tolerable than oil	Hg poisonous, Hg contamination in case of trap failure very substantial; cold trap needed below 10^{-3} mm; forepump needed
NRC (MD) G-2-M	20 high 3 i.d.	5×10^{-6} -5×10^{-2}[d]	55 @ 1×10^{-5} (b)	0.5	0.3	1 @ 25 C		
LEY (MED) Hg 45	33 high —	1×10^{-6} -5×10^{-1}[d]	45 @ 1×10^{-1} (b)	20	2.4	1 @ 25 C	like MD except max speed at 10^{-1} to 10^{-2}	
ION-GETTERING								
CEC EI-2000	25×22 pump[e]	1×10^{-7} -1×10^{-4}	1,900 @ 2×10^{-6} (f)	(g)	(h)		little contamination, sealed, forepump only for startup	getter feeding mechanism may break down[i]
VAR Vac-Ion	35×10 pump[e]	1×10^{-9} -1×10^{-4}	280 @ 10^{-6} -10^{-7} (j)	(g)	(k)		no contamination, no moving parts, selfmeasuring	high cost for amount of pumping[i]
MOLECULAR DRAG								
BEA	15 high 15 long	1×10^{-6} -1×10^{-3}	60 @ 10^{-3} -10^{-4} (l)	2	(1/9 hp motor)		no contamination, no seals (motor in vacuum)	7,000 rpm, 0.002 clearances, dirt damage
PFE	15 high 20 long	1×10^{-9} -1×10^{-3}	140 @ 10^{-3} -10^{-8} (l)	0.004	(1/4 hp motor)		good design for high capacity, elimination of seal leakage	16,000 rpm but fairly wide clearances, bearing seal problems

(a) Manufacturer has line of pumps with similar characteristics (b) Other gases: pumping speed increases with decreasing molecular weight, H_2 pumped at approximately twice air rate (c) Like (b) but not as much as 3-stage pumps (d) Pressure of permanent gases only; Hg has vapor pressure of 2×10^{-3} at 25 C, can be eliminated with cold trap (e) Controls add 25×42 and 22×12 inches, respectively (f) Pumps noble gases about 1 percent air speed, methane poorly (g) Gas is consumed, not discharged; pump down to 0.015 mm required for startup (h) Variable to 2 kw for heater, small motor, controls (i) Also, complex controls and power supply (j) Pumps noble gases about 10 percent air speed (k) Variable to 1 kw for controls, electron emission (l) Light gases slightly faster

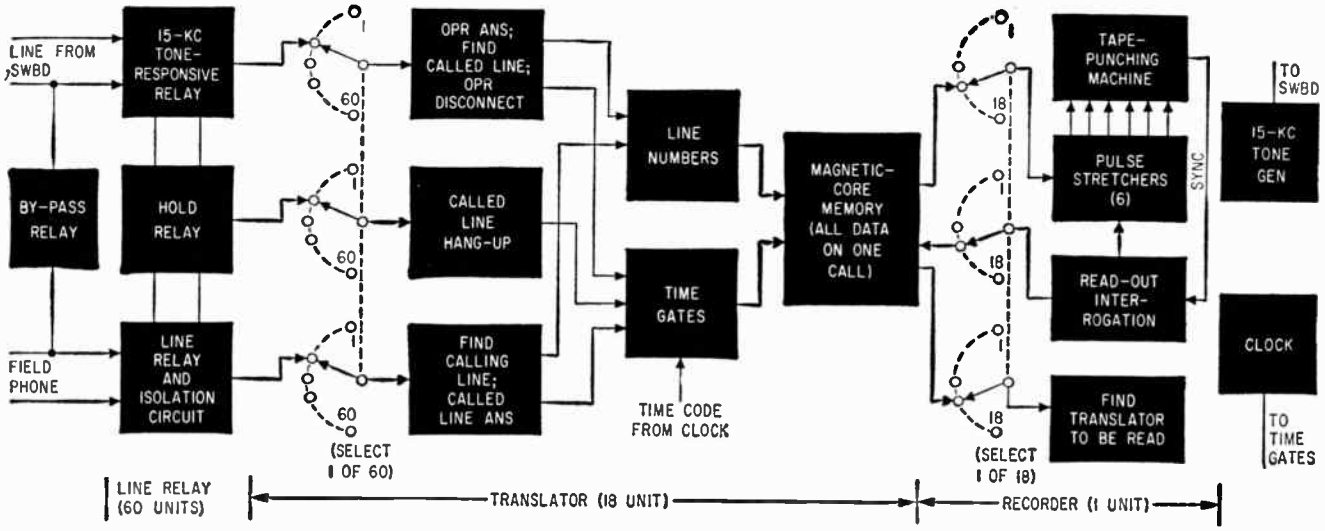


FIG. 1—Functional diagram of traffic recorder system shows method of obtaining information on each call and call attempt

Ferrite Memories Simplify

In typical telephone traffic data recorder systems, data reduction is necessary before all information on one particular call is obtained. This recorder allows information on individual calls to be recorded as one entry

By J. W. BLANCHARD, E. C. BELLEE and J. SMITH, University of Arizona, Tucson, Arizona

COMPLETE ANALYSIS of telephone traffic in a communications system requires a permanent record of all action occurring at each telephone switchboard. The records obtained at the switchboards can be reduced, at a central location, by means of a high-speed digital computer. The result of this process of telephone traffic data collection will be a complete tabulation of all calls.

Figure 1 is the functional diagram of a traffic recorder system designed to work with a switchboard that has provisions for 60 telephone lines and patch cords that allow 15 calls to be in process at any time.

Each of the 60 telephone lines has a line-relay unit that senses signals and, depending on the sequence of the signals, provides logic signals to control the translator unit.

To record data on the 15 calls that may be in progress at one time and to record call attempts during an all circuits busy condition, 18 translation units are used. Each translator has access to all 60 line-relay units. A temporary memory in each translator allows it to record all data on any complete telephone conversation or call attempt, thereby grouping the data for later ease of analysis. When all necessary data have been collected on any call, the contents of the memory are transferred, in a group, to the recorder unit. Here the data are permanently stored on punched paper tape for later collection and analysis at the data analysis center.

Auxiliary equipment consists of a clock unit that provides real time signals in the form of 6-digit binary signals, a 15-kc tone generator that provides a carrier signal to the switchboard, permitting recognition of operator functions, and a power supply that provides input power of 50 v for operation of the relay and transistor circuits.

The clock shown in Fig. 2 provides real time signals in six-digit binary code to all translator units. It consists of 17 cascaded binary counters with feedback around the seconds and minutes sections to reset after 60 counts and feedback around the hours section to reset after 24 counts.

In contrast to the usual electronic binary counters this unit consists of relay binary counters.

Using a zero-impedance source, as provided by relay contacts, for the binary time signals to the translators eliminates the need for individual buffer matrix drive units in each translator. This provides a considerable reduction in equipment size and complexity.

Translator

The translator provides the line search mechanism by which the calling line and called line are found and identified. This function is performed in conjunction with command signals from the line relay units. A signal from the calling line-relay unit activates the line-search circuit, allowing a stepping switch to run self interrupted until the line is found.

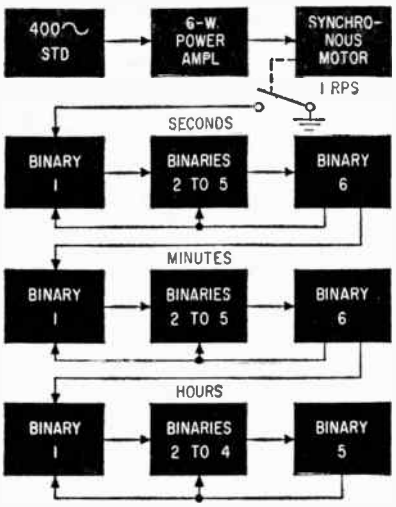
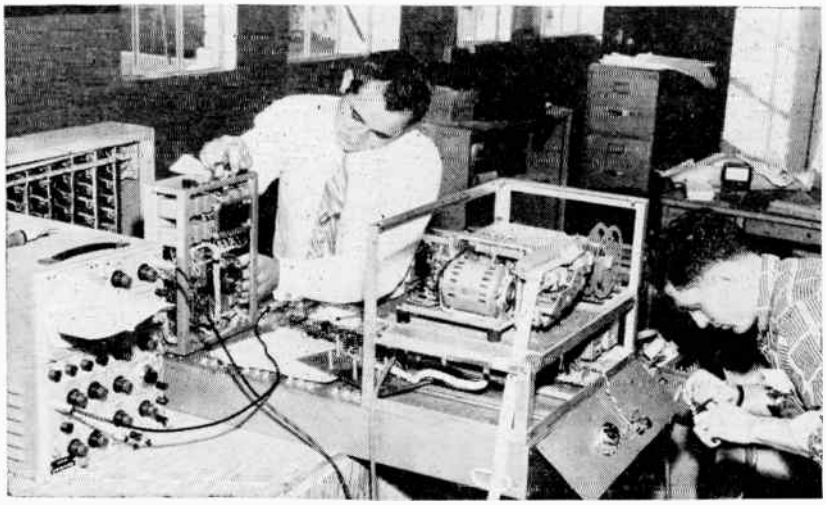


FIG. 2—Binary clock uses relays and feedback to obtain real time signals



Two of the authors checking pulse sensing and stretching networks by manually interrogating ferrite core memory

Telephone Data Analysis

When the called line-relay unit receives a 15-kc signal it reactivates the search circuit allowing the same stepping switch to find the line-relay unit associated with the called line. A binary code corresponding to the number of each telephone line is produced by the stepping switch.

The translator also provides the necessary switching logic and ground gates that allow the real time signals on the clock output to be recorded in the temporary storage unit whenever the proper sequence of events occur. For example, when a call is placed, the time and line identification are read into storage after the calling line has been found. When the operator answers the calling party, a signal from the line-relay unit to the translator triggers the switching necessary for recording the time of occurrence of this operation.

Upon completion of the call, the magnetic memory is full, and an associated relay circuit signals the recorder unit that it is ready for

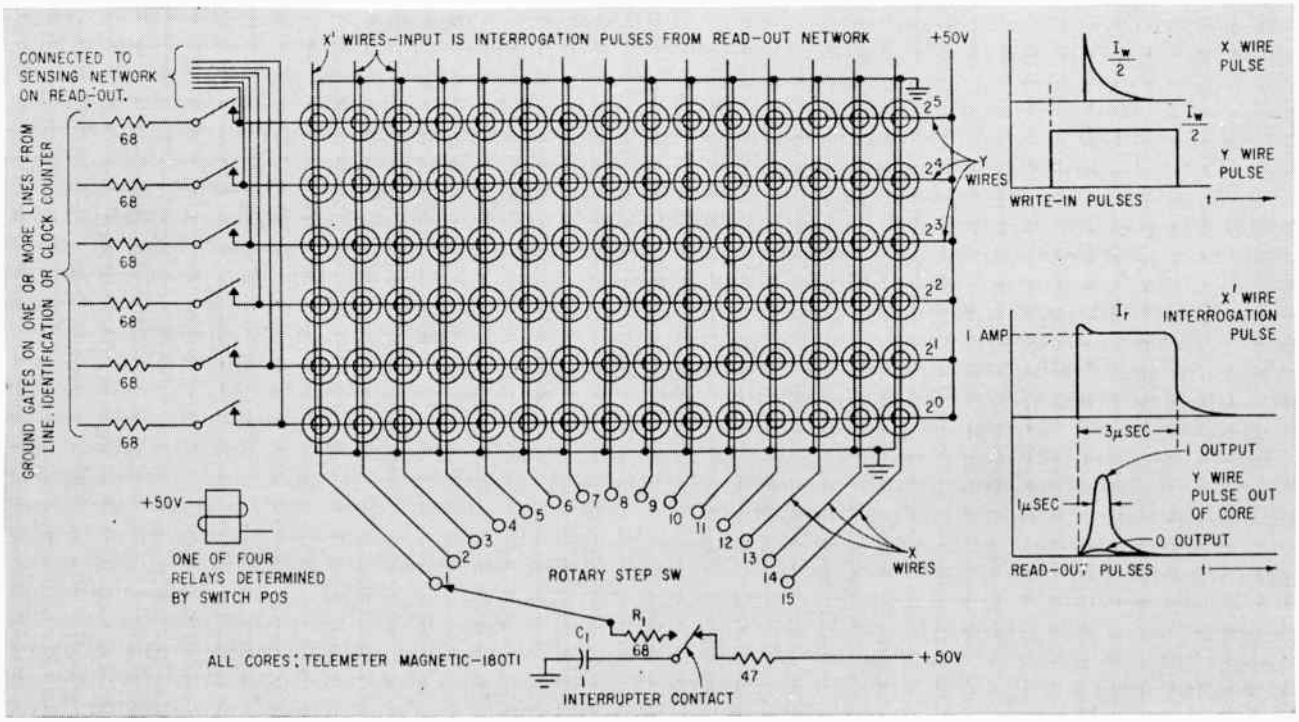


FIG. 3—Matrix circuit uses rotary step switch to provide time signals and line identification at output. Read-out and write-in pulses are shown

readout. In the case of busy lines or any other unusual call situations, a gate causes the memory to be completed, making it ready for readout. In these cases the time recorded in the memory will be the same for each storage position beyond the last position in which the call sequence was normal. This feature permits the identification of the different unusual call situations.

Memory

The use of a temporary memory in each translator virtually eliminates data reduction. The temporary memory allows association of a memory matrix with each individual phone call from the time of its origination to the time of its completion. At the time the call is completed the data is transferred, as one entry, into the paper tape permanent storage section of the recorder unit. Data from the permanent storage unit is converted directly to card form for processing on a computer.

The matrix stores the data on a call in the form of 15 six-bit binary numbers, two numbers identifying the two lines involved in the call and the other thirteen giving the times that various events occur.

Figure 3 shows the write-in circuit and the write-in and read-out pulse waveforms. Depending upon the position of the stepping switch the low side of the matrix is connected to either one of the three sections of the clock or to the line identification section of the translator. If the switch is on position ONE, a relay is activated which connects the Y-write lines to the hours section of the clock counter.

The clock counter will supply ground gates corresponding to the time. If the hour is ten, a ground will appear on the 2^1 and 2^3 Y-write wires and these two matrix columns will receive half-write current pulses. The second and fourth cores in the first row are selected by a half-write current pulse supplied by C_1 discharging through R_1, the interrupter contact and the first X-write wire.

Both the X and the Y wires are single turn windings, while the X' windings, which are the interrogation windings, have five turns. One of the relays on the low side of the matrix connects the Y windings to the sensing circuit when the translator is selected by the recorder unit for the readout operation. The Y wires serve as both write-in wires and sensing wires in the readout operation.

The interrogation pulse for the readout is a 1-amp, 3-μsec pulse that is provided by a blocking oscillator. Figure 4 is a schematic of the readout network that senses the output of the matrix. There are six of these circuits, one for each Y wire. The input to this network contains a transistor coincidence circuit, Q_1 and Q_2. This coincidence circuit is necessary for reliable sensing because of the physical distance between the matrix and the recorder unit and the presence of the noise generated by the many rotary switches and relay used.

The interrogation pulse from the blocking oscillator which is applied to the X' wire in the matrix is also applied to Q_1. If the core selected was in the ONE state, a 6-v, 1-μsec pulse appears on the secondary of pulse transformer T_1 and at the base of Q_2. This establishes coincidence, and a 1-μsec, 25-v negative pulse is applied to the input of the pulse stretching multivibrator Q_3 and Q_4. The output of the multivibrator is a positive 25-v, 20 millisecond pulse which turns on Q_5.

Relay K_1 is activated when Q_5 is switched on. A contact of K_1 completes the circuit through a punch magnet K_2 on a Friden tape punch. This punch magnet corresponds to the particular matrix column. The punch permanently records the fact that the selected core was in the ONE state by punching a hole in the paper tape.

Typical Record

Figure 5 shows a typical punched tape record for one phone call. The record shows that line 21 placed a call 5 seconds after 11:40 and the operator answered 15 seconds later. Then at 11:40 + 25 seconds, the operator rang line 1. Line 1 answered at 11:40 + 51 seconds, the conversation lasted until 11:42 + 2 seconds and the circuit was cleared at 11:42 + 21 seconds.

Figure 5 also shows the information recording sequence; starting with time of calling line appearance and ending with operator disconnect.

The authors wish to acknowledge that much of the original design of this recorder was the work of G. R. Peterson and G. M. Russell of the Electrical Engineering Department of the University of Arizona. This equipment was developed under contract with the U.S. Army Electronic Proving Ground, Contract DA-36-039-SC-80012.

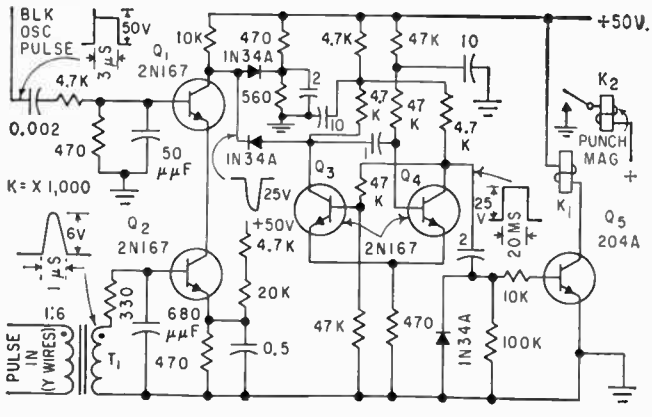


FIG. 4—Readout network uses coincidence circuit to insure reliable sensing

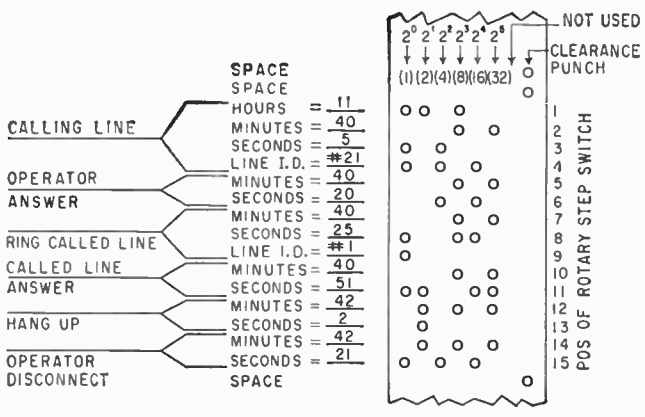


FIG. 5—Tape record shows how recording sequence is determined by rotary step switch in matrix circuit

Using Feedback in Electrometer Design

Here are the factors involved in designing a highly sensitive, wide-bandwidth, electrometer. Analysis shows how feedback circuits get desired results

By **D. ALLENDEN,** Electronics Section Leader, Associated Electrical Industries Ltd., Aldermaston, Berkshire, England

THE INSTRUMENT to be described measures currents in the range of 10^{-11} amp to 10^{-15} amp. Measuring technique used is to pass a current through a high-value precision resistor and amplify the voltage across the resistor with the direct-coupled amplifier of an electrometer. Two problems inherent to this method are bandwidth reduction by the distributed capacitance across the resistor and the high input-impedance requirement of the d-c amplifier, which must not draw appreciable current. Another problem is drift in the d-c amplifier.

Drift

Drift resulting from changes of supply voltages and tube characteristics is so large that drift less than $\approx$ 1 mv/hr, referred to the input, is hard to achieve.[1, 2] Very low drift requires a carier-frequency amplifier and at high impedance levels only the expensive vibrating-capacitor electrometer is available.[3, 4]

With a current-measuring electrometer the effect of drift is decreased by developing 100 mv or more across the measuring resistor. Thus, a direct-coupled amplifier with 1-mv drift is adequate for the electrometer unless very long-term stability, or a current sensitivity > 10^{-11} amp fsd (full-scale deflection) are required; current sensitivity is a factor because resistor stability and reliability fall off above 10^{12} to 10^{13} ohms.

Cathode variations in the first electrometer tube are the main cause of drift. However, if the stage gain is not very different from one, such variations in the second stage are equally significant. Balanced stages have been widely employed to reduce drift but have the disadvantage of increasing tube noise and uncorrelated drift by a factor of $\sqrt{2}$. As short-term cathodic variations are largely uncorrelated,[5] this electrometer uses single-ended rather than balanced stages.[6, 7]

Filamentary electrometer tubes are particularly suited to this application, since their low filament current permits efficient and economical stabilization, and as they give a high gain (above 50), second-stage drift is hardly significant. Voltage-dependent cathode drift is somewhat greater than 10 mv per 1-percent voltage change.

Electrometer Feedback

Electrometer bandwidth is essentially determined by the high-impedance input circuit (Fig. 1A). Current-measuring resistor R has its own stray shunt capacitance C. The steady state output voltage is $-AiR$ and the rise time-constant and bandwidth are, respectively, $R(C+C_o)$ and $1/2\pi R(C+C_o)$. Inserting typical values, ($R = 10^{12}$ ohms, $C \approx 1\mu\mu f$, $C_o = 5\mu\mu f$) gives an input time constant of 6 sec and a bandwidth of 0.025 cps.

Sensitivity of a simple electrometer of this type is normally varied by switching the input resistor.

This requires a special high insulation switch and accurate input resistors.

Figure 1B shows the system with

Electrometer stage V_1 is inside a separate 5 × 3 × 2 in. screening box

feedback added. Here, feedback-factor β is frequency-independent. In this case, the steady state output (subject to the normal feedback-system criterion that $A\beta >> 1$) is $V_o = (-iR/\beta)$. Thus, the sensitivity can be changed by variation of β, eliminating the special switch, and range factors are established at low impedance levels in the feedback circuit where accurate resistors are reliable and inexpensive. Voltage gain is reduced, but large voltage gain is seldom required for electrometer application.

Effective input impedance is now $R/A\beta$, shunted by capacitors $CA\beta$ and C_o. The steady state resistance is much lowered, and, as $|A|$ varies arbitrarily, is not precisely defined; this is unimportant. The input time-constant is

$$(R/A\beta)(CA\beta + C_o) = R\,(C + C_o/A\beta$$

Thus loop gain reduces the effect of C_o, but leaves the RC term unchanged. In the previous example an infinite loop gain would increase the bandwidth by a factor of only

6, and a loop gain of 10 would increase it almost as much.

Inclusion of an integrating network (γ) in the feedback path (Fig. 1C) giving a β-transfer function of $\beta_o/(1 + p\tau)$ modifies the effects of input capacitance more significantly.[5] If $\tau = CR$, then C is eliminated and the input impedance becomes $R/A\beta_o$ paralleled by C_o. The bandwidth can now be increased to any desired value by applying high loop gain. The difficulty imposed by C being a distributed element can be avoided by adding lumped capacitance.

If β is real, C should be kept as small as possible; if β is complex it is C_o which should be minimized.

However, the use of feedback-path integration may involve a time constant in the hundreds of millisec, and loop gain at power-line and audio frequencies may then be too low to obtain the desired reduction of ripple, hum and microphony. Consequently feedback integration is an optional feature in this electrometer and is used only when maximum bandwidth is the main requirement. Figure 1D shows a compromise solution which reduces the effect of C_o by a predetermined factor. In the β equation k is in the range 0.1 to 0.25.

Noise

In an electrometer the unusual input conditions are such that noise and drift levels may be comparable. Significant noise sources are thermal noise in the input resistor, noise due to statistical fluctuations of steady grid current, tube shot and partition noise (of uniform spectral density), and tube flicker noise.

About 20 μv of noise (rms) is possible; thus, corresponding peak-to-peak fluctuations may be of the order of 100 μv.

Amplifier Design

Requirements, were for a sensitivity variable between 10^{-11} and 10^{-14} amp (fsd) with the best noise and drift performance possible, and a bandwidth of 0.2 cps at max sensitivity.

The highest available reliable value of input resistor was chosen (10^{12} ohms) in the interests of signal-to-noise ratio and drift minimization. A loop gain of 10^4 was then necessary to achieve the required bandwidth. Decade range variation by β-switching gives a loop gain of 10^4 at 10^{-11} amp (fsd), when the input voltage is 10 v; since 10 v is also a convenient output voltage, 100-percent feedback can be employed in this range, and the forward gain is thus also 10^4.

A single-ended high-gain electrometer stage with stabilized heater and plate supplies is used (Fig. 2). The British CV2348 (similar to the CK5886) is used. Tests on a number of tubes show a grid current of about 2×10^{-15} amp and an effective heater drift of $\approx$ 30 mv per 1-percent filament-current fluctuation. Thus the zero offset due to grid current will be about 20 percent of fsd at 10^{-14} amp —which is unimportant if grid current is stable. If we assume 10-percent fluctuation, a zero uncertainty of only 2 percent of fsd results. The input voltage at 10^{-14} amp is normally 10 mv and therefore a filament current stability of 1 part in 10^4 gives a drift of 3-percent fsd. An overall estimate of noise suggests probable peak-to-peak fluctuations of about 80 to 100 μv, or 1-percent fsd; thus, these three limiting factors have nearly equal effects, with drift predominating.

With a gain of 50 in the electrometer stage, the plate can be allowed 15-mv variation for 300 μv equivalent input. At 10-v plate voltage this variation is only a part in 700; a 1-in-10^4 supply for plate and filament is used. The second stage of the amplifier requires a heater-voltage stability of 1 part in 70 for 300-μv equivalent input. Since this requirement is easily furnished, the voltage-fluctuation drift of the whole amplifier can be about that of the electrometer tube filament.

The requirement for a loop gain of 10^4 means that the frequency responses of individual stages may have to be controlled well into the mc region; a dominant time-constant is needed somewhere in the feedback loop. This time constant is located in the plate circuit of the stage V_1. The cable connecting the electrometer-tube stage to stage V_2 acts as loading capacitance.

Head Amplifier

Stage V_1 is housed in a separate head. Tube V_1 operates at plate voltage and current of 10v, 5 μamp and 8.2-ma filament current. Pentode performance is maintained down to zero frequency by a 6-v Zener, diode D_1, across the screen; this diode must be selected to avoid fluctuations. The 2.5-μa screen current hardly loads the divider. Tube V_1 is biased by the voltage drop across R_1 and R_2. The plate resistance of V_1 is so high that it causes no significant zero-frequency degeneration. A gain of 43 is obtained from this stage.

Potentiometer R_3, which varies plate voltage of V_1, forms the fine set-zero control. As this control is inside the feedback loop, its effectiveness is decreased as loop gain increases—on the 10^{-11}-amp range it has virtually no effect. Potentiometer R_3 is adjusted only

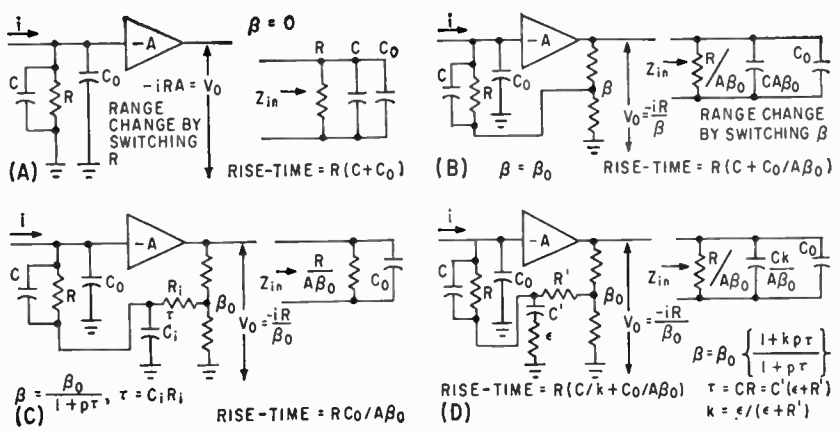


FIG. 1—Electrometer amplifiers without and with, feedback; without feedback (A); frequency-independent feedback (B); integrating circuit added to feedback loop (C); restricted-range integrating circuit in feedback loop (D).

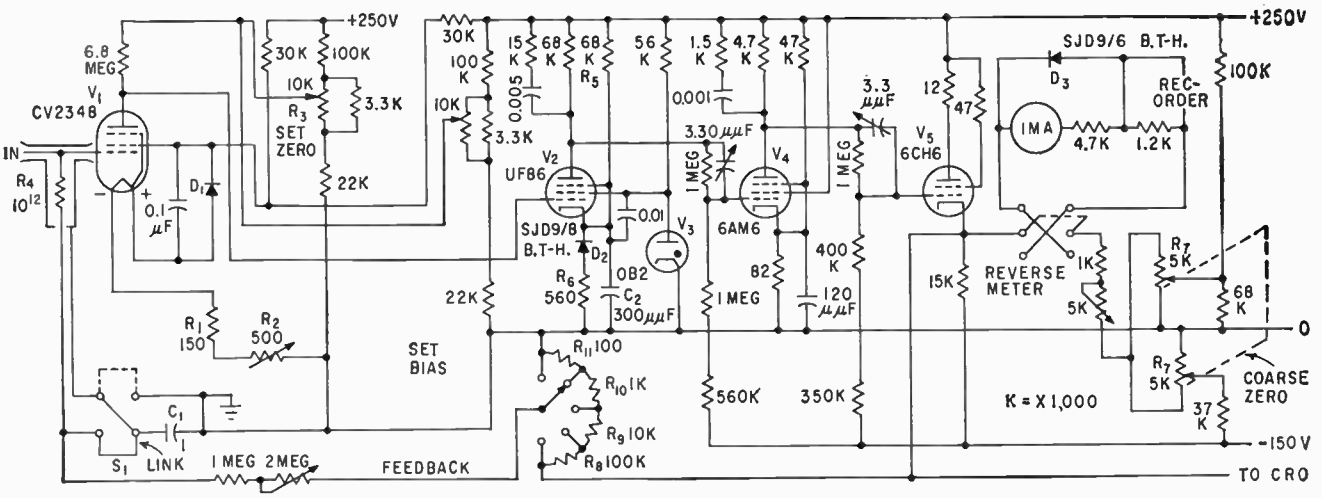


Fig. 2—Coaxial cable connects the electrometer tube V_1 stage to the second stage of amplification. Link switch S_1 is in position that connects integrating capacitor C_1 to feedback circuit

when V_1 is changed. Resistor R_4 is enclosed in a brass tube which forms a shunt capacitance of about 3 $\mu\mu$f.

The optional β-integration time-constant is located in the head to prevent shift of zero setting caused by leakage in the cable that links head and main amplifiers. Link switch S_1 removes capacitor C_1 and grounds the R_4 enclosure when β-integration is not required.

The first stage is loaded to cut-off at 100 cps (power-line ripple frequency) by the 235-$\mu\mu$f capacitance of the coaxial signal cable to V_2.

Main Amplifier

Overall gain of stages V_2, V_3 and V_4 is 250. Tube V_2 has a stabilized d-c heater supply. The low (10v) plate level necessitates a cathode resistor which introduces zero-frequency degeneration. Impedance of the self-bias source is 560 ohms; this is provided by R_5 and R_6 combined with D_2, an 8-v Zener diode. Capacitor C_2 effects high-frequency compensation, raising the bandwidth from 187 to 374 kc.

After V_2, direct anode-grid coupling is not practicable. A stabilized negative line is required, but as there is high gain, anode stability requirements are nominal.

Gain to the grid of V_3 is 1,600, leaving a gain of about 7 to be provided. Assuming a cathode-follower gain of 0.9 and a coupling loss of 0.4, the actual gain required in V_4 is 19.5 with a possible anode swing of some ±30 v. Tube V_4, a wide-band pentode, is chosen on gain-bandwidth considerations as its response must be controlled well into the mc region. Since a large (180-ohm) bias resistor would introduce too much degeneration, a bias voltage divider is used. Cathode compensation brings bandwidth up from 4.25 mc to 7.5 mc.

Coupling gain from V_4 to V_5 is 0.42, owing to the relatively high plate voltage of V_4. The output is taken from V_5 cathode, provision being made for recorder and cro in addition to the internal meter. The meter and recorder circuits are returned to the coarse set-zero control R_7. As this control is outside the feedback loop, its effect is independent of range setting. Zener diode D_3 provides meter overload protection by clamping at about 20 percent overload and reversal.

Loop Gain and Stability

Range factors are provided by the β-divider R_8 to R_{11}. Resistor R_{11} gives a loop gain of 9 to preserve the range factor of 10 throughout. The *no-feedback* range position provides a nominal sensitivity of 10^{-15} amp fsd, but is not normally used. Loop-stabilizing networks are included in V_2 and V_4 anode circuits. Since these networks operate well below the cut-off frequencies of their associated stages, the cut-offs are extended by factors equal to the h-f attenuation of the networks.

On the three least sensitive ranges, scale factor is within 1-percent accuracy and linearity as good as the meter. On the 10^{-14} amp range, the range factor was about 2½ percent in error.

The drift figure is good, though not equal to that obtained in certain investigations.[9, 10] Noise is about 3 times the calculated value, but since the analysis assumed input resistor noise no greater than thermal value and the flicker noise[11] is subject to uncertainty, the result is not excessively high. The current sensitivity approaches the practical limit estimated[12] for amplifiers using the voltage drop principle.

The author acknowledges the assistance and cooperation of R. Thorn, E. C. Fellowes, R. N. Bloomer, D. Pomroy. He is indebted to Dr. T. E. Allibone for permission to publish.

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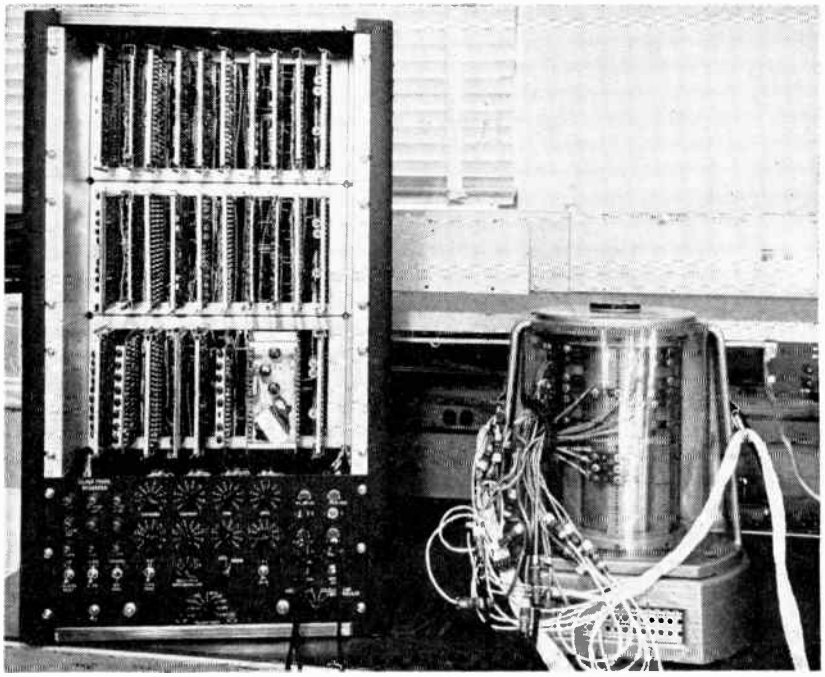
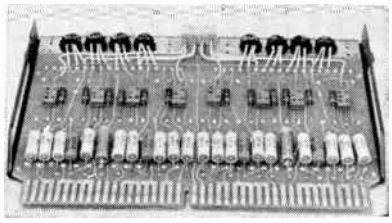
Clock Track Recorder



Clock track recorder with the magnetic drum. Complete electronics with control panel are housed in the chassis at left



Card assembly containing two flip-flops

MAGNETIC DRUMS have found widespread use in data-processing systems as memory storage units. Drums are reliable and can store a great deal of information economically.

The magnetic drum can also serve to generate the basic timing signals for the entire system. At Hughes, a transistorized clock track recorder was developed that can write, automatically, any preselected number of timing bits on one channel of the drum. The recording heads are spaced in proper position around the drum periphery. A timing track on the drum channel synchronizes all the computational cycles and information flow to and from the memory. Signals are then distributed to the rest of the computing system.

Total power consumption of the unit is about 15 watts.

Timing Signals

A block diagram of the transistorized clock track recorder is shown in Fig. 1. The central data source, module 9,999 counter, supplies all of the necessary timing signals used in both head setting and clock track recording. Four module 10 counters, connected in series, produce the total count of 9,999. Standard transistorized two-input flip-flops are used as the basic element, and diode gating accomplishes the proper timing. Since the counter is divided into four identical counters, the logical equations are the same for each, with the exception of an additional AND circuit to gate the following tens counter.

The counter can be reset in two ways: by an *RZ* origin pulse; and by the counter's own final output. The origin pulse is recorded on the drum by passing a transient current through the head while the drum is at a standstill. This records one *RZ* pulse in one spot on the drum.

The origin pulse is fed into the *OP* amplifier. The pulse is transformer-coupled to an a-c grounded-emitter stage. This, in turn, is transformer-coupled to a second a-c grounded-emitter stage. The output stage of the amplifier is transformer-coupled, but the base return of the transformer is returned to a bias point which is 2 volts more negative than the emitter return voltage. This puts the transistor in a cutoff stage until the signal overrides the bias and allows this stage to conduct.

The one-shot multivibrator supplies a gating voltage for the reset flip-flop. The multivibrator is a modified transistorized Eccles-Jordan flip-flop.

Counter Output

The counter output sets up a gating voltage for the reset flip-flop, provides a scope sync and drives the *KK* write flip-flop. The writing amplifier is controlled by a switch, Write MOP-Clock Track. In the MOP position, the output of the $K\bar{K}$ flip-flop is connected to the input of the writing amplifier. In the clock-track position, the write amplifier writes all "1's" on the drum.

The clock-pulse amplifier and digit square-wave amplifier, Fig. 2, serves two functions: it generates clock pulses which drive all of the flip-flops in the system; and it generates digit square wave signals which are used only in the Manchester conversion network of the writing amplifier.

The input of the clock-pulse amplifier and digit square-wave generator comes from either of two sources: an external signal gen-

For Memory Drum

All-transistorized unit facilitates writing of timing signals on a magnetic drum. Recording heads, properly spaced around periphery of drum, automatically write any preselected number of timing bits on one channel of the drum, and synchronize all of the memory information

By **A. J. STRASSMAN** Member of Technical Staff, Hughes Aircraft, Los Angeles
and R. E. KEETER, Member of Technical Staff, Aeroneutronics, Newport Beach, Calif.

erator provides the desired frequency for writing the time track; and timing signals, previously recorded on the drum, set up the bit spacing between the read and write heads.

The read amplifier and read flip-flop unit is used in conjunction with head space setting of the read and write heads. The input to the read amplifier comes from a reading head on the drum. The read-amplifier output goes to the read flip-flop and can be viewed with an oscilloscope.

Flip-Flops

The *JK* flip-flop, Fig. 3, is a transistorized Eccles-Jordan switch, with the collectors clamped with diodes to stabilize the operating points. Grounded collector transistors, driven from the switches, provide the current for driving voltage stage gating circuits.

The *KK̄* flip-flop is really divided into a normal *JK* flip-flop with increased input capacitance at *J*, and a pulse-steering network. This network is driven by an *npn* emitter follower. The normal *K*-side clock pulse is AND'ed with the emitter follower output and the normal *J* side pulse is introduced through a 1,200 $\mu\mu$f capacitor. The pulse reference on the *J* side becomes essentially the input voltage level and is pulsed only if this level is at −6 v. At the zero-volt level, *J* pulsing is

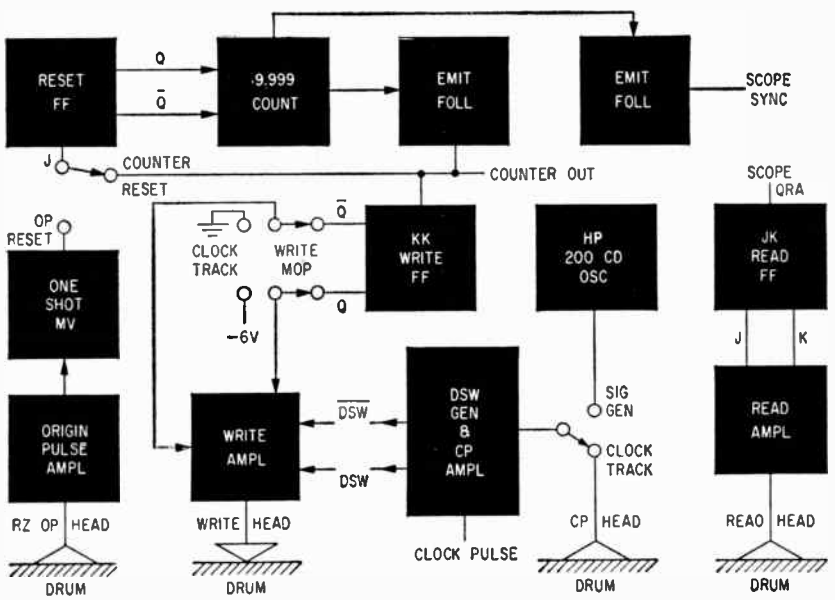


FIG. 1—Black diagram af clack track recarder

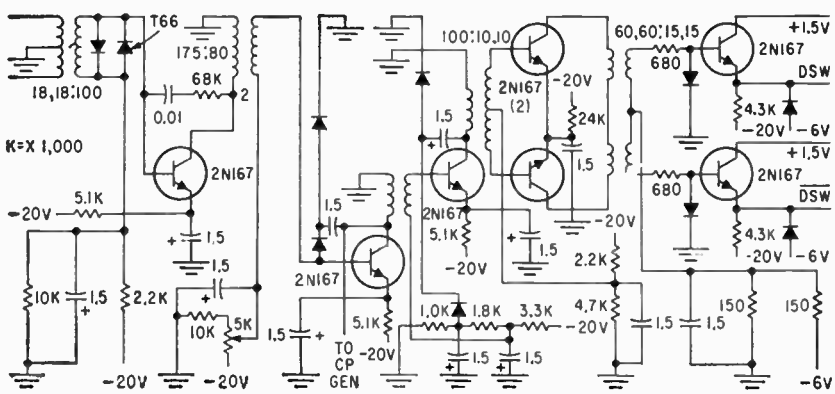


FIG. 2—Clack pulse amplifier and digit square-wave amplifier

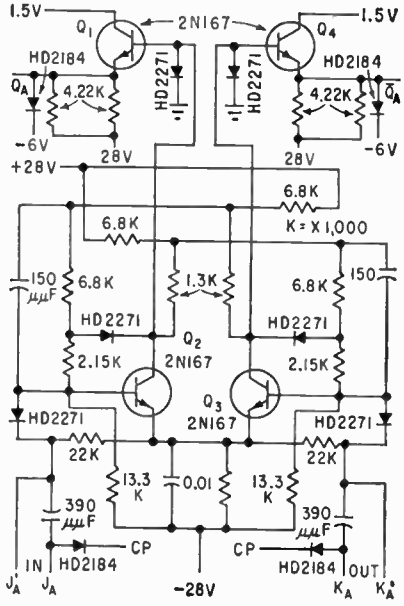


FIG. 3—The flip-flap circuit used with the read amplifier

prevented by a clamp decoupling diodes.

Write Amplifier

The digit square wave generator receives the square-wave output of the read amplifier and produces two 0 (−6) volt square waves, $\overline{DSW}$ and $\overline{DSW}$, phase displaced by 180 deg with respect to each other. These waves are utilized in the gating of the write amplifier for the Manchester conversion.

The write amplifier, Fig. 4, contains a power amplifier and impedance-changing device which is arranged to convert the voltage waveform at the output of the flip-flop into a corresponding current waveform in the low-impedance recording head. The driver consists of an a-c grounded-emitter input stage driven through a capacitor by the output stage through a 4 to 1 center-tapped step-down transformer.

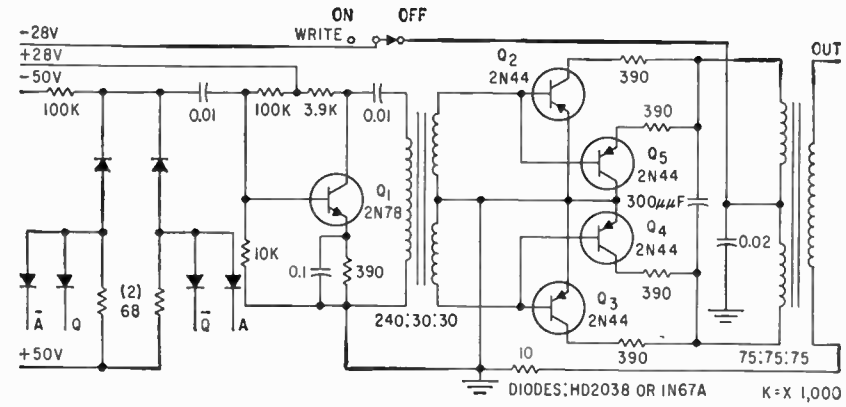


FIG. 4—Write amplifier cantains a power amplifier and an impedance-changing device

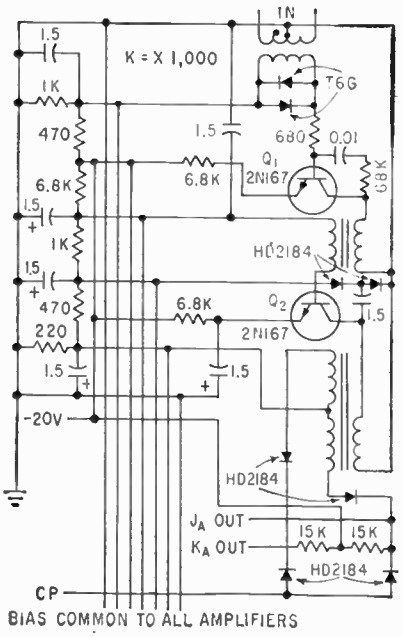


FIG. 5—Read amplifier for the reading head also used to synchronize

The output stage of the write amplifier consists of a push-pull parallel Class B amplifier, using *pnp* transistors. The square-wave signal furnished by the driver's stage is transformer-coupled into the bases of the output stage and serves to switch the two sets of the output transistors alternately on and off to provide a current square wave in the output transformer.

The write amplifier supplies the proper current waveform for Manchester recording to the write head. A 220 ma peak-to-peak current is required by the write head winding with the head-to-drum spacing of 0.001 inches.

The read amplifier, Fig. 5, is used to amplify and synchronize. Amplification is necessary because of the low read-back voltage achieved with the low-impedance reading head. This voltage is primarily a function of the head-to-drum spacing although it varies inversely with magnetic cell density. The minimum read-back voltage that will be permitted is 0.06 volts, for independence of cross talk and other noise.

The signals from the amplifier output stage are essentially square waves, OR'ed with clock pulses, the outputs of the OR gates are applied to the inputs of the read flip-flop, and trigger it so that the information finally appears as voltage states of QRA and $\overline{QRA}$. These two output states go to the oscilloscope shown in Fig. 1.

The wave form of the read-back signal for the Manchester system of magnetic recording may be considered as a phase-modulated sine wave that is step modulated. Therefore some means of phase detection must recover the stored information.

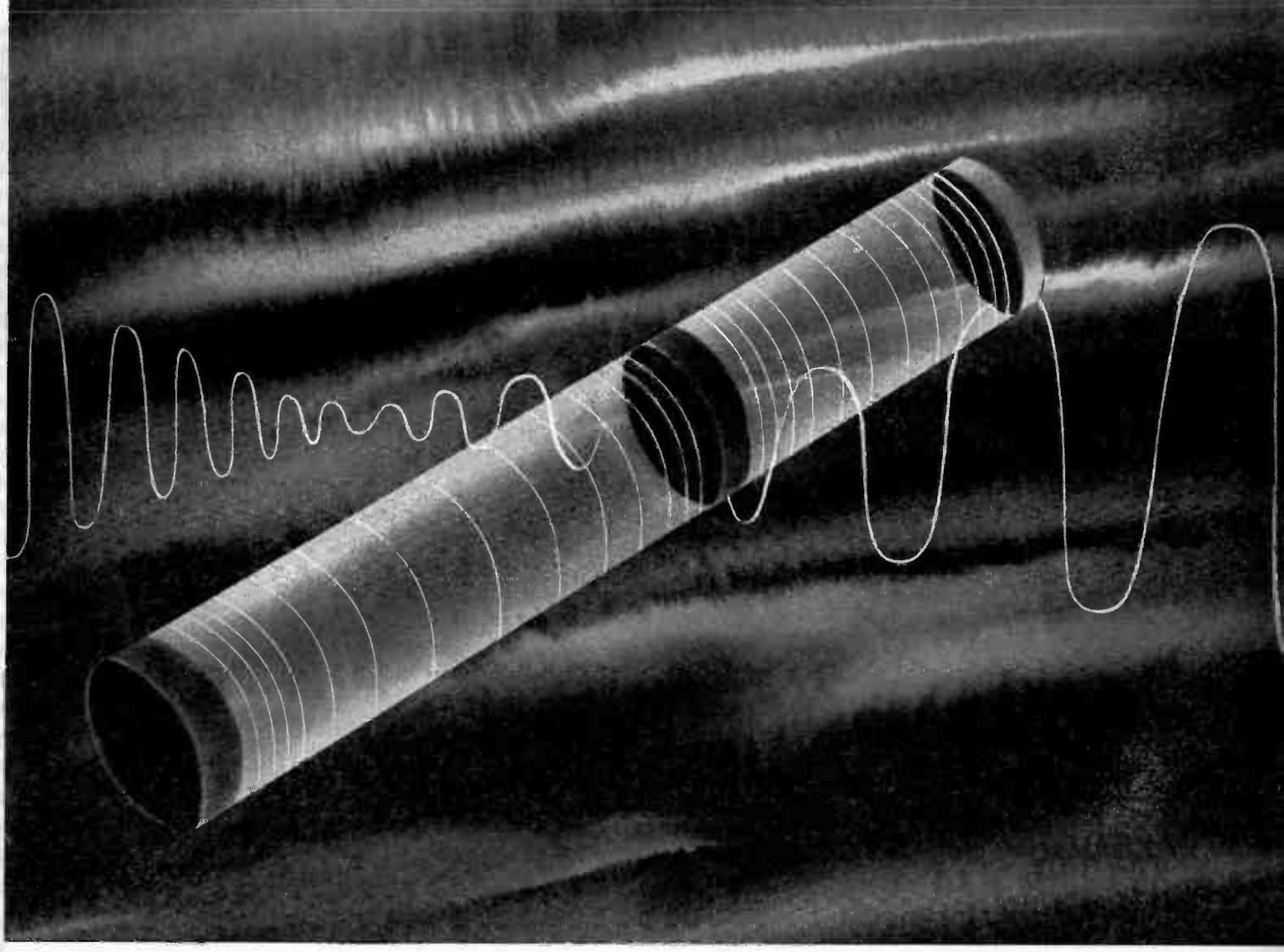
There are only two frequencies present in the signal received from the reading head—a sine wave of the bit frequency when the reading signal changes from one to zero, or vice versa. This permits use of a bandpass amplifier that must have little more than a two-to-one frequency pass band.

Voltage Feedback

The amplifier portion of the read amplifier has an a-c grounded emitter input stage transformer coupled to a second grounded emitter stage. The first stage uses voltage feedback through the series 0.01 μf, 68-K resistor to increase the band width of the stage. Voltage clamps in the second stage protect the transistor against overswing as well as provide a plateau for the gating.

A 2.5:1: 1 stepdown transformer couples the second amplifier stage to the OR gates.

The two diodes connected back-to-back to the secondary of the input transformer produce a symmetrical limiter to insure reliable operation over a wide range of amplitudes of the input signal.



Report from IBM *Yorktown Research Center, New York*

MATHEMATICS IN PURSUIT OF SUBSTANTIVE SOLUTIONS

As mathematics has advanced the physical sciences, so has the scientist's need for precise mathematical analogies spurred many new advances in mathematics. At the IBM Yorktown Research Center, a group of mathematicians are attacking a wide range of research problems in applied mathematics. Beyond immediate solutions, their work often leads to insights of a purely mathematical nature.

A project to study the mathematical theory of wave motion in compressible viscous fluids was stimulated by recent developments in new high-speed hydraulic engineering techniques. One problem involved wave motion in a compressible liquid in a tube containing a free mass. A Fourier analysis led to a new system of discontinuous orthogonal eigenfunctions, which are being studied further for their mathematical interest. At the same time the solution predicted effects of varying the physical design parameters, which are currently being tested in a mechanical model and its electrical analogue.

The stimulus to mathematical inquiry illustrated in this example from fluid mechanics characterizes the mathematics activity at IBM Research in a variety of fields. At present other studies are under way on mathematical problems in such fields as solid mechanics, electromagnetics, nonlinear oscillations and in numerical analysis.

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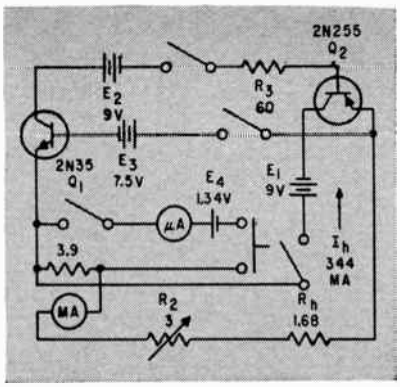

FIG. 1—Circuit used in moisture meter stabilizes heater current

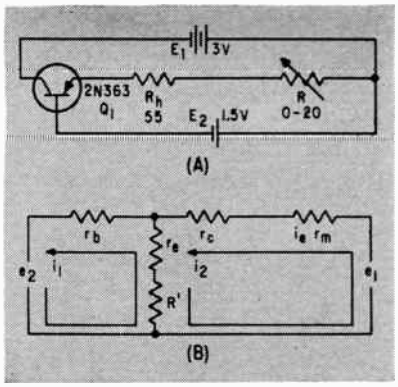

FIG. 2—Single transistor control circuit demonstrates circuit functions

Inverse Feedback Stabilizes Dry Cell Current Sources

Errors in test instruments that draw heavy current from dry cells are reduced with transistor circuit that maintains constant current

By **G. E. FASCHING,** Bureau of Mines, U. S. Department of the Interior, Morgantown, West Virginia

HIGH PERCENTAGE of negative feedback is used in transistor circuit to offset effects on dry cells of heavy current loading and consequent voltage decay.

Moisture Meter

Meter for measuring moisture in pulverized coal or other powders required constant current supply from conventional zinc-carbon cells subjected to heavy loading. In the meter, six standard cells in series provide 344 ma to a 2-watt heater. Without control, current variation with time over the 20-minute test periods introduced errors.

The transistor version of a cathode follower in Fig. 1 provides direct compensation for limited battery voltage decay. A correction voltage, about equal to change in battery voltage but opposite in polarity, appears at the output of Q_2. The correction voltage is obtained by using inverse voltage feedback in a two-stage, direct-coupled amplifier. Voltages E_1, E_2 and E_3 are bias voltages; E_4 is a mercury cell used in a voltage null detector circuit for adjusting heater current I_h through heater R_h at the beginning of each test.

Adjustment of heater current at the start of each test is done with R_2, and R_3 provides enough voltage drop to prevent Q_1 from overheating.

For analysis, a simplified version of the circuit is shown in Fig. 2. It is accompanied by the a-c equivalent when small-signal T-parameters are used. Use of these is limited to operation within the linear region or a small region of the transistor characteristics.

Analysis

To determine heater current change, i_h, that would result from voltage decay of E_1 and E_2, it was found that for a voltage change e_1 in heater source E_1: $i_{h1} = i_2 - i_1 = e_1 r_b/[(R' + r_e + r_c - r_m) r_b + (R' + r_e) r_c]$. For a voltage change e_2 in base bias E_2: $i_{h2} = i_2 - i_1 = e_2 r_c/[(R' + r_e + r_c - r_m) r_b + (R' + r_e) r_c]$.

Upon inserting values of typical junction transistor parameters and external circuit constants into these equations, it was found that a unit change in E_1 causes only a small change in heater current because of the large dynamic resistance. This resistance, being in the order of megohms, permits heater-current deviation of only microampere magnitude coincident with a unit volt change in the heater supply.

However, for voltage changes in base bias E_2, dynamic resistance is relatively small and significant heater current deviation occurs for a unit decay of base bias. This shortcoming is partly offset by the lower discharge (hence decay rate) of the source. Bias current relative to load current is dictated by the inherent forward d-c transfer ratio of the transistor used (normally 40-150).

Performance

The circuit in Fig. 1 has high current stability in the 20-minute test period. Heater current varies less than 150 μa from the preset value of 344 ma. Without the control and under similar conditions, heater current deviation ranged from 8,000 to 15,000 μa. Stability improvement factor is over 50.

CEC's 5-119 Oscillograph with 3 interchangeable magazines

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Electro Mechanical Instrument Division CEC

CONSOLIDATED ELECTRODYNAMICS *360 Sierra Madre Villa, Pasadena, California*

Computer Developments Revealed

DIODES are used to perform the role of a core-switching array in a memory under development at the University of Chicago's Institute for Computer Research.

Design of an 8,192-word, 54-bit memory using this technique and having a cycle time of less than 2×10^{-6} sec was reported to the Association for Computing Machinery at MIT. Nearly 1,200 computer users and researchers attended the 3-day conference.

R. T. Shevlin of the AEC Computing and Applied Mathematics Center at NYU disclosed that GE 1N92 germanium junction diodes are used and 420-mil RCA experimental cores. He also reported development of a combination sense and digit drive line free from the effects of noise and post-write disturbance.

In the linear-selection diode-steered switch array, selection of a memory word is similar to that of the core switch array. A steering diode is selected by a coincidence of X and Y currents so as to cause current to flow in the selected diode and consequently through the cores of word 1. All remaining diodes stay cut off. Current in the selected diode results in minority carrier storage in its base, and this charge may be used for reverse memory drive.

Core Geometry

To overcome effects of ringing on the sense line during and after rewrite, Shevlin reported a new type of core geometry was developed. By wiring the sense line as shown in Fig. 1, it appears as a balanced, loaded transmission line. It can be treated as a lossless line and terminated in its characteristic impedance. Impedance of the line can be controlled by core spacing. Sample lines have been constructed having between 200 and 400 ohms impedance and delay of 100 millimicroseconds for 4,096 cores. Because the line is balanced and twisted, it is practically immune to noise.

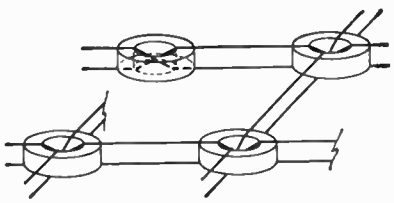


FIG. 1—Sense and digit drive line is wired so that effects of noise and post-write disturbance are eliminated

The Biax, a new magnetic computer element, was introduced to the ACM conference by W. E. Frady of Aeronutronic Systems. A small rectanguler bar of ferrite magnetic material has two orthogonal holes between which no conventional magnetic coupling exists. Rapid flux interference phenomena do occur, however, and may be made either destructive or nondestructive, depending on spacing between holes.

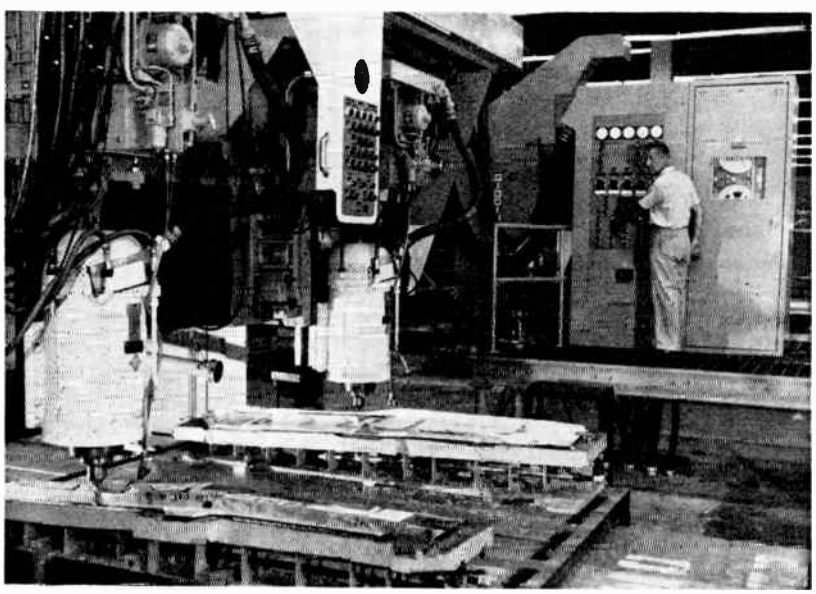
The destructive mode is used for logical gating functions and the nondestructive mode for memory.

Automatic Design

Also described to computer users were new techniques for multiprogramming, time-sharing, information storage and retrieval, and automatic computer design. J. P. Malbrain and A. V. Banes of Thompson-Ramo-Wooldridge reported that automatic design procedures have greatly reduced lead time in building new computers. Instead of the logical designer producing a finished set of equations, a computer is used to check equations, derive details and point out trouble areas.

Digital computers are used, they reported, to simulate the logic, determine parts values, compute subunit loading, write wiring lists, design logic boards, and print checkout charts and maintenance charts. The techniques are presently being used in design and fabrication of a large-scale military computer.

Programmed Tools Aid Jet Output



Tape-controlled profiler at Republic Aviation is one of a battery of such machine tools. Metallic punched tapes containing all of the data found on blueprints direct machines, which are greatly reducing time and cost of producing modern aircraft

Radar Techniques Help Meteor Study

ASTRONOMERS at Havena, Ill., are studying meteor particles and their effect on radio transmission. Operators of an elaborate electronic system hope to discover the origin

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Life Test—500 hours at 85°C and 125% of rated voltage.
Capacity Tolerance—All tolerances to ± 1%.
Insulation Resistance—40,000 meg. x mfd. at 25°C but need not exceed 70,000 megohms.
Case Styles—Available in all case style variations in MIL-C-25A.

Full rated to 125°C.

Type **616G** (Extended foil)
Type **617G** (Extended foil)

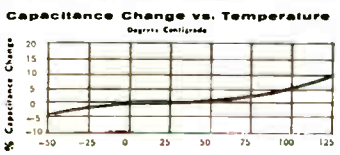
Temperature Range—Full rating to 125°C - to 150°C with 50% derating.
Life Test—500 hours at 125°C and 125% of rated voltage.
Capacity Tolerance—All tolerances to ± 1%.
Insulation Resistance—50,000 meg. x mfd. at 25°C but need not exceed 100,000 megohms.
Case Styles—Available in all case style variations in MIL-C-25A.

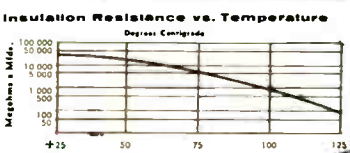
50-VOLT DIMENSIONS

Capacitance in Mfds.	626G* D	626G* L	627G D	627G L	628G D	628G L	629G D	629G L	616G*† D	616G*† L	617G† D	617G† L
.001	.173	21/32	.173	23/32	.173	1/2	.173	5/16	.173	13/16	.173	3/4
.0022	.173	21/32	.173	23/32	.173	1/2	.173	5/16	.173	13/16	.173	3/4
.0047	.173	21/32	.173	23/32	.173	1/2	.173	5/16	.193	13/16	.193	3/4
.01	.173	21/32	.173	23/32	.173	1/2	.173	5/16	.193	13/16	.193	3/4
.022	.233	21/32	.233	23/32	.193	29/32	.193	23/32	.233	3/4	.233	15/16
.047	.312	21/32	.312	23/32	.233	21/32	.233	23/32	.312	13/16	.312	3/4
.1	.312	25/32	.312	27/32	.312	21/32	.312	23/32	.400	3/4	.400	7/8
.22	.400	1	.400	1 1/16	.400	7/8	.400	15/16	.500	1	.500	1 1/16
.47	.500	1 1/16	.500	1 3/16	.500	1	.500	1 1/16	.562	1 1/16	.562	1 1/4
1.0	.560	1 17/16	.560	1 19/32	.560	1 13/32	.560	1 13/32				

*These types have one lead grounded to the case. Others have both leads insulated.

†Also available in 150V, 400V & 600V ranges.





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of meteors, the physical processes involved when a meteor particle impinges on the upper atmosphere and to study the upper atmospheric winds.

The program, sponsored by the National Bureau of Standards, is under direction of F. Whipple, director of the Smithsonian Astrophysical Observatory and Professor of Astronomy, Harvard University, and Harvard's G. S. Hawkins, who was formerly associated with the Jodrell Bank Observatory, England.

Guyed tower appears at right of one of the Raytheon radar receiver stations

Though meteors have long been credited with reflecting radio signals over long distances, until recently meteor showers were considered too sporadic for practical use. When the scientists finish bouncing radio signals off meteor trails, their findings may eventually help extend the range of radio broadcasts.

The ionized air molecules resulting from meteor bombardment of the atmosphere can be used for reflecting transmitted signals similarly to the reflection process of the ionosphere. Ionization produced by meteors may contribute significantly to the general level of ionization of the night-time E region.

If the study proves that forward scatter signals are useful, the scientists expect to be able to predict direction of arrival of meteor particles from day to day. Reflection of signals from meteor trails may be more practicable for long-

range transmission than microwave relay satellites. By using this system of transmission, it may be possible to set up an almost continuous system of worldwide communications.

Equipment

Using radar equipment, 40-mc pulses are transmitted at a peak power of 4 megawatts. Originally three receiver sites are being used. If the observation system meets expectations, the receiver network will be expanded to include six stations. Improved accuracy with six stations should enable astronomers to measure deceleration of meteor particles after they are in the atmosphere, which will increase accuracy of meteor orbital determinations.

Five radar receiver stations will be placed seven miles apart in a line running east and west, and another receiver station will be located seven miles north of the central station.

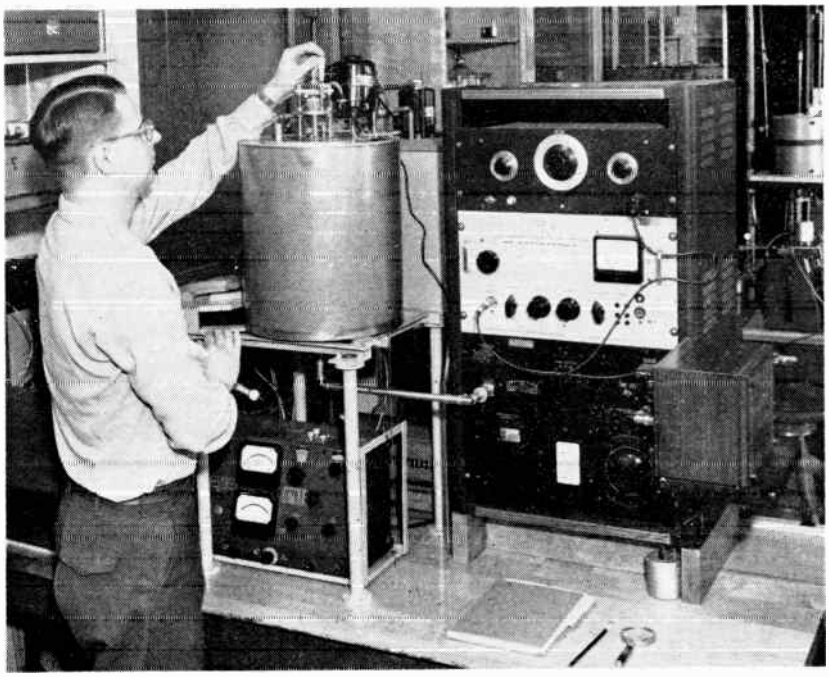
Echoes received from space by the radar receivers will be relayed to a central terminal. Output of the receiver i-f strip, which has a 200-kc bandwith centered at 3 mc, will be fed to a Raytheon microwave relay system transmitter. When the relayed i-f signals are received, they are then demodulated to video at the central terminal and applied to oscilloscopes for study.

A series of crt displays and a 70-mm camera will be used. From the time difference at which reflected energy is received at the receiver stations, astronomers can determine radiants and orbits of the meteors.

The antenna system for the Raytheon relay link is composed of 4-ft parabolic antennas and 6 by 8-ft passive reflectors supported by guyed microwave towers about 100 ft high. This type antenna-reflector combination has been found to provide adequate Fresnel Zone clearance over all obstacles along the microwave paths.

The microwave equipment eliminates need for laying cable to each location. The precision and speed with which the equipment is able to beam the signals was also a factor in it choice.

Understanding Dielectric Materials



J. J. Weeks of the National Bureau of Standards is shown making a micrometer reading to determine the dielectric properties of a material undergoing a change of state. A special fusion cell is used for this work either with the bridge shown at the right, or the higher frequency resonant circuit located beneath the fusion cell housing

To PROVIDE a better understanding of the properties exhibited by dielectric materials, the National Bureau of Standards is conducting a program of fundamental research sponsored in part by the Department of Defense.

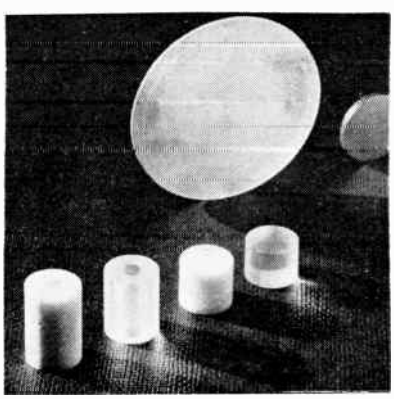
Behavior of Materials

Primary objectives of this program are to explain observed dielectric phenomenon and to develop theories which can be used to predict the behavior of certain materials. In most of this work, a solid state approach is employed to probe the molecular behavior responsible for dielectric phenomena. These studies are complemented by efforts to improve the accuracy of dielectric measurements in the fields of electricity, electromagnetic waves, electronics, solid state research, polymer studies and physical chemistry.

During the past few years, demands for dielectric materials designed for specific applications have become more and more insistent.

In the missile and aircraft fields, for example, dielectrics with electrical properties that are relatively independent of temperature are needed.

To create dielectrics for special purposes in this way, the effects of various physical conditions on electrical properties must be determined, and the relationship between molecular behavior and electrical properties must also be established.



Group of specimens typical of those studied in the dielectrics laboratory. Small disk: electrode-plated poly (methyl methacrylate); large disk: polystyrene; opaque rods (first and third from left): polychlorotrifluoroethylene; clear rods: polystyrene. The most promising materials are those whose electrical properties are not greatly affected by humidity

Programs of dielectric studies, carried out by the Bureau's Dielectrics Section and Ferroelectricity group located in Washington, and the Radio and Microwave Materials section of the Boulder, Colo. Laboratories, provide concepts for such molecular engineering.

Dielectrics for Space

Dielectric constants and dissipation factors are measured over a frequency range of 0.1 to 10^{10} cps at temperatures from −100 to 500 C. In addition, facilities for millimeter-wave work are available at Boulder and studies have been made at the low frequency end of the dielectric spectrum involving frequencies whose periods are days in length.

The Signal Corps is also supporting a program at Johns Hopkins University to determine what problems will arise and which dielectrics are most suitable for use in outer space. Nelson Terhune of the U. S. Army Signal Research and Development Laboratory in a report on dielectric materials for outer space, states: "Where it is determined that improved or special dielectrics are needed; work cannot be started too early a date because experience has shown that even with a vigorous and persistent effort, several years are always required to introduce a major improvement in a dielectric material."

Since various agencies directly concerned with the missile and satellite program are well aware of the new problems in the materials area which have arisen as a result of explorations into outer space, they have initiated several general investigations to study the behavior of available materials.

As evidence of the growing need to understand dielectrics a series of lectures in Materials and another in Insulation Practice are being held in New York City this fall. Both series will offer lectures by outstanding research specialists. The New York chapter of the American Society of Metals is sponsoring the series entitled "New

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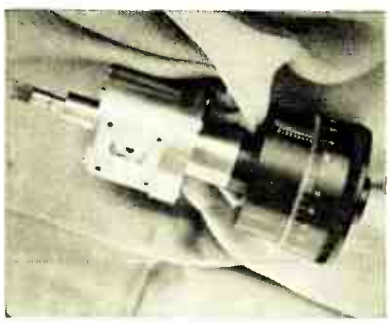
Materials for Advanced Applications: Missilery, Space, Electronics," and certificates will be awarded upon completion of the course. The New York section of the AIEE is sponsoring a series on "Developments in Insulation Practice." And various engineering groups all over the country are devoting more time for this area.

Radio and Microwaves

In the interaction between electromagnetic waves and matter, conductivity properties of materials are essentially inseparable from the dielectric properties. At radio and microwave frequencies, studies are therefore an important component of any dielectric program. In this connection, the Radio and Microwave Materials Section of the National Bureau of Standards is investigating the tensor or directional conductivity of semiconductors, such as single crystals of germanium, at microwave frequencies under different physical conditions. Some important questions in the theory of solid state will be investigated in this work. It is expected that these studies will yield a better understanding of the crystal lattice forces and processes. The results may prove of value in microwave engineering if the tensor properties for radio waves are appreciable.



Wavemeter with a precision of about 3 parts in a million, developed by the National Bureau of Standards for accurate dielectric measurements

Propagation of electromagnetic waves or radio signals through a material is governed by the product of the material's magnetic permeability and its dielectric constant. For many substances the magnetic permeability is unity. In such cases the travel of waves in the material

is dependent only on the complex dielectric constant or the ability of the material to store electrical energy. In this connection studies are being conducted on the dielectric properties of various propagation media, such as ferrite, soils, tar sands, and oil bearing sandstones. Ferrites have important magnetic properties at radio and microwave frequencies and have directional characteristics important in microwave applications. They also have very high dielectric constants which are currently being investigated.

Oil Deposits

Studies on soils are important in locating radio transmitters and antennas and establishing and predicting radio communication links. Tar sands and oil bearing sandstones contain valuable oil deposits which do not flow under their normal temperature environment in which the tar sands and paraffin in oil are solid. By application of suitable radio or microwave energy, it is hoped to tap these resources by warming the deposits sufficiently for flow. Properties of composite dielectrics are of interest.

Bondable Teflon

Teflon wire, immersed in a monomer and Cobalt 60 used as a radiation source, yields bondable wire with pull out strengths claimed to exceed all other methods. The technique, according to Tensolite Insulated Wire of Tarrytown, N. Y., produces competitively priced Teflon wire. Initial production is limited to 100,000 feet a week

Tube Parts Welded Semiautomatically

By J. F. STEWART, Electron Tube Division, Radio Corp. of America, Marion, Ind.

STUDS SUPPORTING the glass insulating rods of electron gun structures were formerly welded in place on fixtures manually loaded and operated. A semiautomatic machine was developed which increased the production rate by 400 to 500 percent.

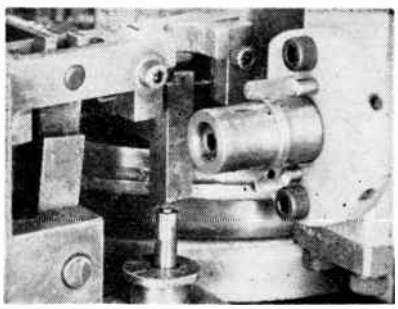
Two types of studs are used: nail head studs and staple studs. Both have flattened ends to provide a better grip in the glass. The flattened ends must be oriented lengthwise in the glass to provide adequate strength. The machine was originally developed to handle nail head studs and has been more recently modified to handle staple studs.

A fully automatic machine, with stud forming mechanisms and weld inspection devices, was considered and rejected. The low cost of the semiautomatic machines allowed a machine for each gun part, assuring flexibility. Use of operators provides full inspection and reduced scrap.

Staple stud welding machine in use. Electron gun cups are positioned on mandrel by hand, but remaining operations are automatic

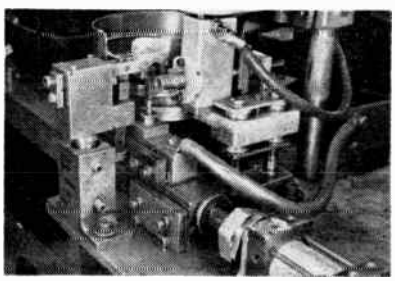
Nail Head Machine

Nail head studs progress up the spiral track of a vibratory feeder. After passing a pressure relief point, they drop head up into a special track which guides them in a row to the feed tube, from which they drop into an electrode. The gating device is simply a cross pin escapement actuated by a straight slide-bar. The vibration of the feed tube rotates the stud. When the flattened end is aligned with a slot in the electrode, the stud is oriented and falls into welding position.



Closeup of nail head escapement, electrode and mandrel. Nail head is visible at top of tubular electrode

The cross slide which carries the electrode is driven by an air cylinder. After the electrode is loaded it is retracted to welding position under the mandrel. After welding, the cross slide returns to loading position. As it returns, a cam moves the escapement slide bar, via a roller, dropping another stud into the feed tube.

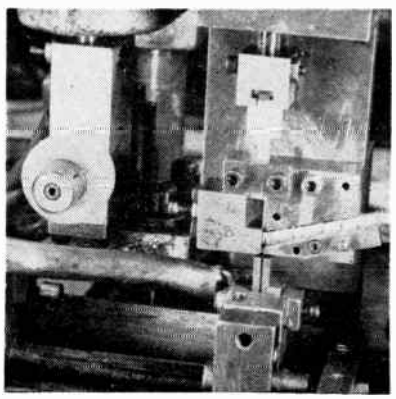


Nail head stud welding machine. Escapement cam is wedge on side of electrode cross slide. Head guide pins are at right of mandrel

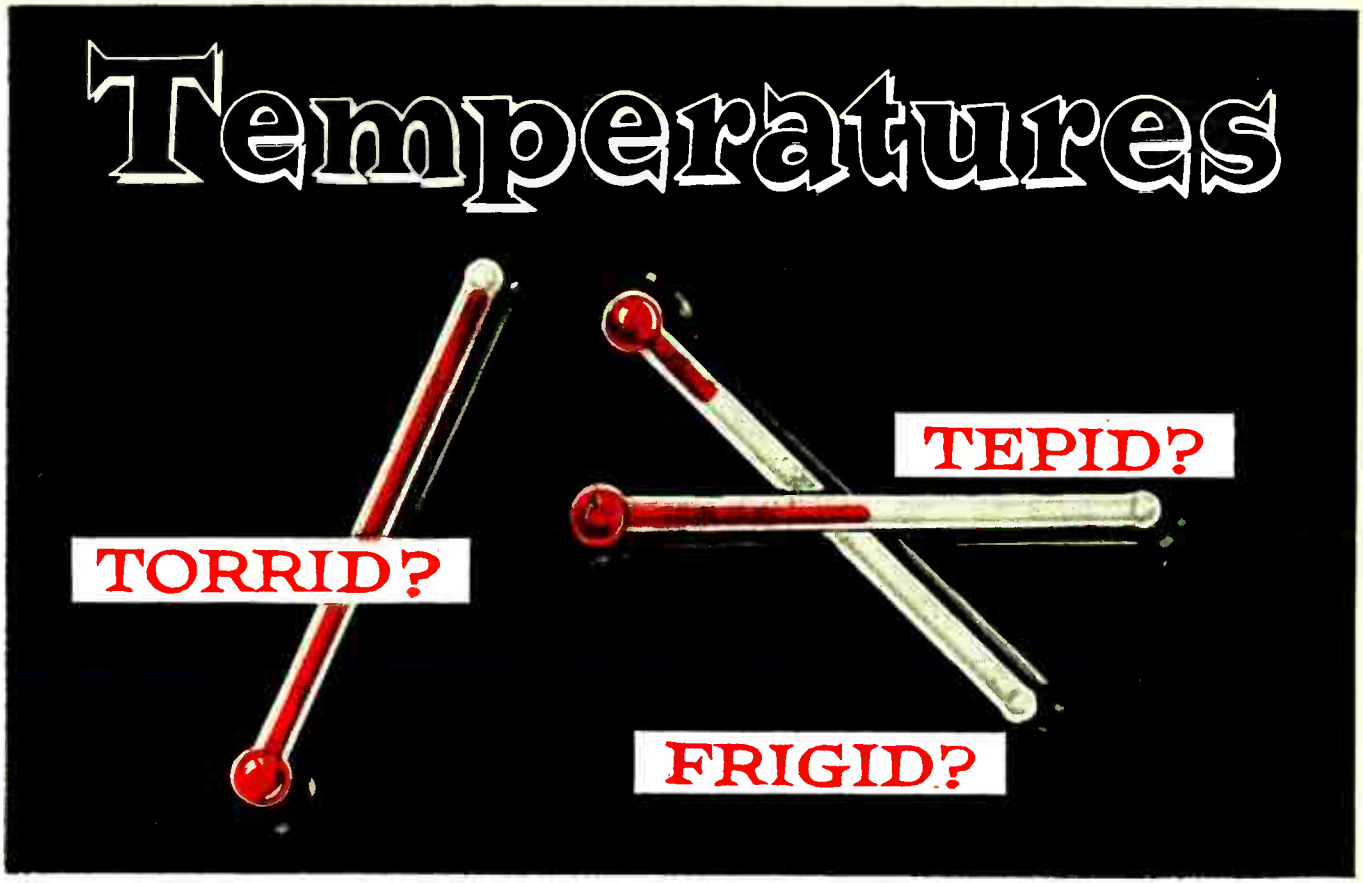
Mandrel Operation

The mandrel which holds the gun cup provides radial and longitudinal control of stud placement. It projects through the machine head and is guided and spring-loaded at the rear. The standard weld head was modified with head guide pins and linear ball bearing bushings to improve accuracy.

The operator places a cup over the mandrel and welds the first stud. The mandrel is pushed inward until the first stud is against a stop pin, then the second stud is welded. The mandrel is released, comes forward, is hand rotated 90 or 180 degrees and the next pair



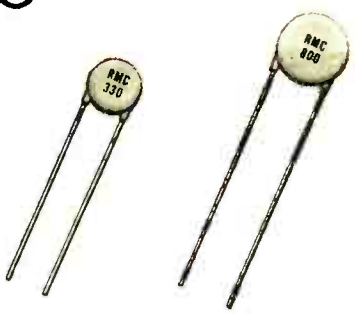
Plunger mechanism at top right pushes staples off track and into slotted electrode. Gun part is in mandrel at left



RMC type JL DISCAPS

can provide the answer because these ceramic capacitors are especially engineered for applications requiring a minimum change in capacities as temperature varies between —60°C and +110°C. The capacity change over this extreme range is only ±7.5% of capacity at 25°C. Standard working voltage of Type JL DISCAPS is 1000 V.D.C.

Type JL DISCAPS also offer the advantages of longer life, dependability, and lower cost. Write on your letterhead for additional information on these and other DISCAPS.



SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)

POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 2000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic — vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

CAPACITY TOLERANCE: ±10% ±20% at 25° C

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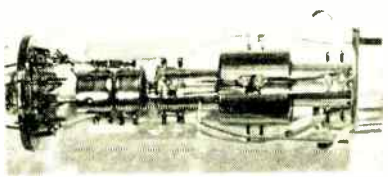
of studs is welded.

A cylinder, cam, valve and switch mechanism replaces the standard welder foot pedal mechanism and drives the welding head. Other added controls are a synchronous weld timer and the amplitude regulator of the feeder.

Staple Stud Welder

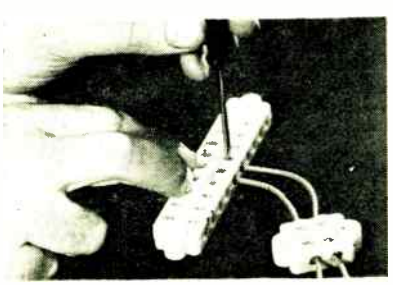
A new feed mechanism was devised for staple studs. These studs are made to straddle a feed rail.



Part of electron gun, using staples rather than pairs of nail head studs

As they leave the vibratory feeder, they are gravity fed to the throat of a transfer. The transfer cylinder drives a plunger which in turn drives each stud into the fully slotted electrode. A cross slide carries the electrode under the mandrel, which is then brought down to the stud as with the nail head welder.

Cam Locks Wires in New Connector Strip



Screwdriver is used to make or break connection

RECENT DESIGN for quick connect-disconnect wire connector strips and terminal boards employ small die-cast V-groove cams. The cam action locks one or more bare wires in position until the cam is backed off with a screwdriver.

The connectors are made by Willor Mfg. Co., New York. Cams are zinc alloy, die cast by Gries Reproducer Corp., New Rochelle, N. Y.

Cam design is shown in Fig. 1. They have a screwdriver slot on the

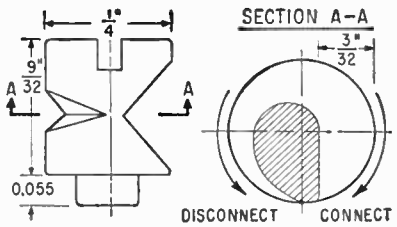
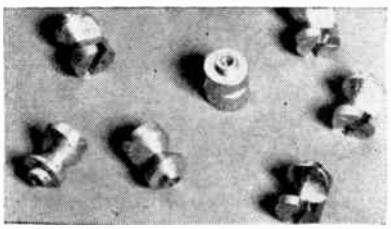


FIG. 1—Profile and cross-section of com



Cams are zinc alloy, automatically diecast

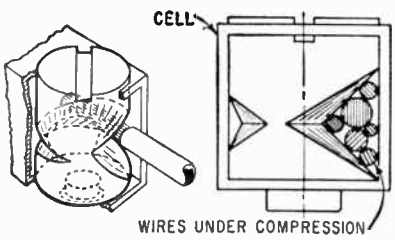


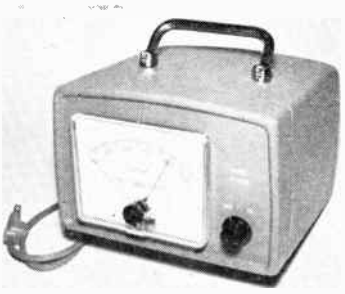
FIG. 2—Wires are locked between com groove faces and cell wall

top and a pivot boss on the bottom. As the cam turns on the pivot, the groove forms a triangular opening with a metal cell wall which is almost tangent to the cam. The groove varies in width, depth and angle along its length.

Wire ends are inserted in the groove (Fig. 2). As the cam is turned toward the wire (clockwise), the cam surface wedges the wires against the cell wall. Tension, tending to pull the wires free, causes the cam to rotate clockwise, locking the wires more firmly in place. The wires can be disconnected by turning the cam counterclockwise. The locking action reportedly gives good electrical contact without crimping or solder.

Die casting is used for the cam because the shape is difficult to machine economically and accurately, and tool marks and burrs could not be removed satisfactorily by tumbling. Cams are nickel plated. The cams are dropped into position in metal cells so that the pivot bosses protrude through a pivot hole in the cell bottom. The bosses are swaged into rivet heads and the plastic housing screwed into place over the cells.

On The Market



Tachometers
versatile units

AIRPAX ELECTRONICS INC., Seminole Div., Ft. Lauderdale, Fla. Speed or rpm problems are simplified by the series 7000 tachometer line. Providing better than 1 percent accuracy, they employ semiconductors and a saturating transformer to maintain high reliability and long life. Input signals may be supplied by electromagnetic, photoelectric, and proximity pickups, tachometer generators, turbine type flowmeters or any instrument delivering an output frequency proportional to rpm. Amplitude of the input signal may be as low as 0.005 v rms.

CIRCLE 200 ON READER SERVICE CARD

Indicator
phase sequence

MASTER SPECIALTIES CO., 956 E. 108th St., Los Angeles 59, Calif. Unit is designed for permanent installation on airborne or ground equipment to monitor the phase sequence of a 3-phase power supply;

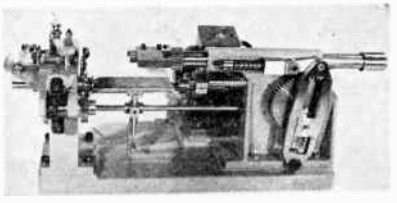
qualified per MIL-E-5272A; fail-safe in that incorrect phase sequence, or disconnected lead will not allow the neon lamp to illuminate; operates over a wide range of ambient temperature, voltage, and frequency. All static components insure long life.

CIRCLE 201 ON READER SERVICE CARD

Wire Stretcher
and cutter

THOMAS INSTRUMENT CO., Phoenix, N. Y. Compact machine is designed to automatically straighten, stretch and cut fine wire to a preset length. Operated by a ratiomotor, the quiet, rugged, bench-type machine works at the rate of 2,280 pieces per hr of 3¾ in. long No. 36 wire. Dimensions are 10 in. deep, 32 in. long and 9 in. high.

CIRCLE 202 ON READER SERVICE CARD



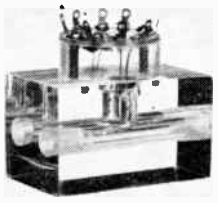
Commutator
lightweight unit

AIRFLYTE ELECTRONICS CO., 535 Ave. A, Bayonne, N. J. A miniature switching commutator features low noise, low torque, long life and angular accuracy of 10 minutes of arc. It is available either motor driven or hand detented and meets Specs 5400 and 5272. Unit is ideal for programming, data processing, selecting, telemetering, high-speed sampling, analog-digital conversion, sync drives, multipole and multi-throw switches and sinusoidal switches.

CIRCLE 203 ON READER SERVICE CARD

Thermal Cells
fast, accurate

VICTORY ENGINEERING CO., 524 Springfield Rd., Union, N. J. Gas analysis, gas chromatography and sampling or control or analysis of chemical processes are made easier

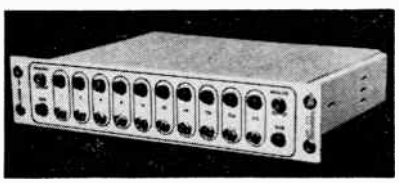


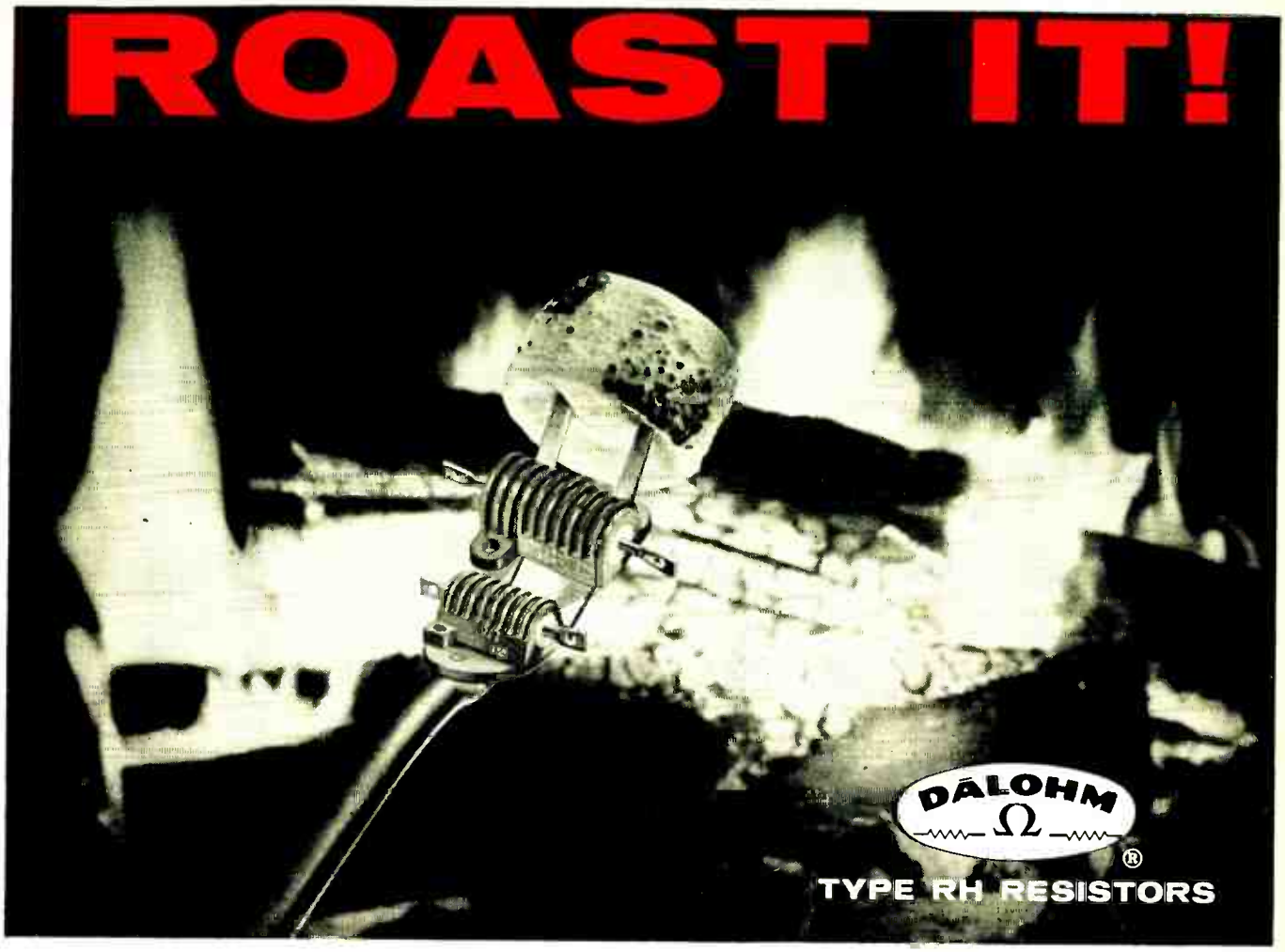
with VECO thermal conductivity cells. The sensitive cells contain a matched pair of glass coated, bead type thermistors which may be conveniently connected into any desired external circuit configuration.

CIRCLE 204 ON READER SERVICE CARD

Converter
digital to analog

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. Model 141A ladder network sums ten flip-flop outputs from binary counters or shift registers, and produces bi-polar current proportional to count. Proportional current may be applied to control devices for continuous monitoring of digital





INHERENT STABILITY
Assured in a DALOHM RH Resistor

Even searing heat from a glowing bed of coals causes no deviation from the inherent stability that is standard in Dalohm resistors.

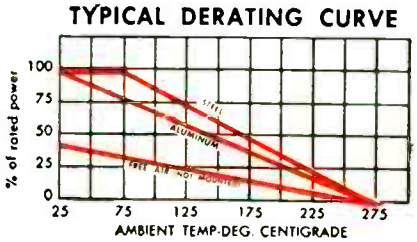
Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision resistors retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

For all applications demanding resistors that meet or surpass MIL specifications, you can depend on Dalohm.

HIGH POWER • WIRE WOUND • MINIATURE
DALOHM **TYPE RH** RESISTORS

Designed for specific application of high power requirements, coupled with precision tolerance. Mount on chassis for maximum heat dissipation.

TYPICAL DERATING CURVE



- **Rated at** 10, 25, 50, 100 and 250 watts
- **Resistance range** from 0.1 ohm to 175K ohms, depending on type
- **Tolerances** ± 0.05%, ± 0.1%, ± 0.25%, ± 0.5%, ± 1%, ± 3%
- **Temperature coefficient** 20 P.P.M.
- **Operating temperature range** from −55° C. to +275° C.
- **Welded construction** from terminal to terminal.
- **Ruggedly housed;** sealed in silicone and inserted in radiator finned aluminum housing.
- **Smallest in size,** ranging from 7/16" x ¾" to 3" x 4½"
- Surpass applicable paragraphs of MIL-R-18546B (Ships).

Write for Bulletin R-21, with handy cross-reference file card.

SPECIAL PROBLEMS?

You can depend on Dalohm, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

from **DALOHM**
Better things in smaller packages
DALE PRODUCTS, INC.
1300 28th Ave., Columbus, Nebr.

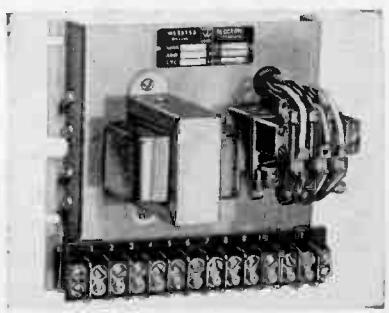
data. As a step-function generator, the size and number of steps are easily varied. Unit is a standard slide-in module measuring 2¼ by 10¾ by 7 in.

CIRCLE 205 ON READER SERVICE CARD

Band Pass Filter
170 cycle spacing

HERMETIC SEAL TRANSFORMER CO., 555 N. Fifth St., Garland, Texas. Hermetically sealed receiving filter for multiplex telegraph systems offers 18 channels with high inter-channel attenuation, flat pass bands and excellent harmonic rejection. Center frequencies, 425 cps through 3,315 cps; frequency response: center frequency, 0 db; 25 cps either side, down not more than 1 db; 50 cps either side, down not more than 5 db; 145 cps either side, down at least 40 db.

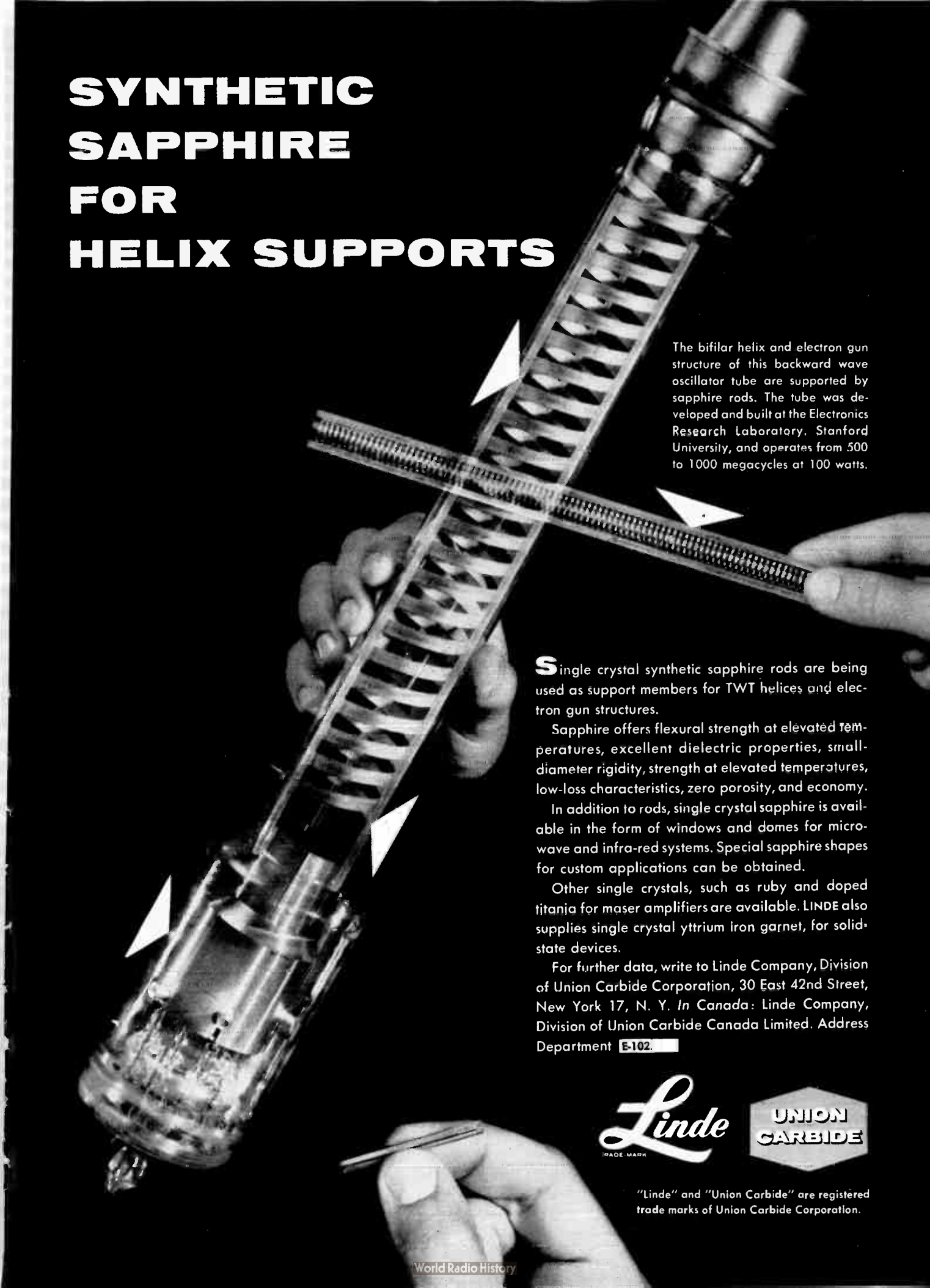
CIRCLE 206 ON READER SERVICE CARD



Pilot Relays
long life

WEBSTER ELECTRIC CO., Racine, Wisc. PR series pilot relays are used generally as single or dual level controls (pump in or out), high or low level alarm, contact meter amplifiers, liquid leak detectors and temperature detectors. Life, maintenance, installation and

SYNTHETIC SAPPHIRE FOR HELIX SUPPORTS



The bifilar helix and electron gun structure of this backward wave oscillator tube are supported by sapphire rods. The tube was developed and built at the Electronics Research Laboratory, Stanford University, and operates from 500 to 1000 megacycles at 100 watts.

Single crystal synthetic sapphire rods are being used as support members for TWT helices and electron gun structures.

Sapphire offers flexural strength at elevated temperatures, excellent dielectric properties, small-diameter rigidity, strength at elevated temperatures, low-loss characteristics, zero porosity, and economy.

In addition to rods, single crystal sapphire is available in the form of windows and domes for microwave and infra-red systems. Special sapphire shapes for custom applications can be obtained.

Other single crystals, such as ruby and doped titania for maser amplifiers are available. LINDE also supplies single crystal yttrium iron garnet, for solid-state devices.

For further data, write to Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited. Address Department E-102.

Linde TRADE-MARK

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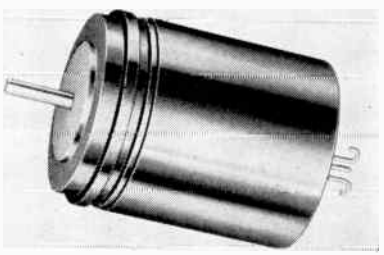
operation are improved by having no parts in the liquid, no stuffing box nor bellows. Level detection is better than 0.10 in. Special cable is not normally required.

CIRCLE 207 ON READER SERVICE CARD

Megohmmeter six ranges

ASSOCIATED RESEARCH, INC., 3777 W. Belmont Ave., Chicago 18, Ill. Model 2570 Vibrotest megohmmeter provides stable resistance measurements to 5 million megohms in six ranges. Constant voltage for these measurements is provided by a v-t power supply. Test voltage variation is less than ½ percent over the entire range with power line fluctuations from 95 to 135 v. Resistance measurements are stable over the full range and there is no drift even in the top range.

CIRCLE 208 ON READER SERVICE CARD



Servostepper for airborne use

GIANNINI CONTROLS CORP., 918 E. Green St., Pasadena 1, Calif. Model 1500C, size 15 Servostepper for high accuracy airborne applications: volume, 2.8 cu in.; weight, 4 oz.; rate, 90 steps per sec (in some applications, 160 steps per sec). Withstands 50 g shock, 75 g steady state acceleration in any axis, and temperatures from —55

CIRCLE 96 ON READER SERVICE CARD

CIRCLE 97 ON READER SERVICE CARD→

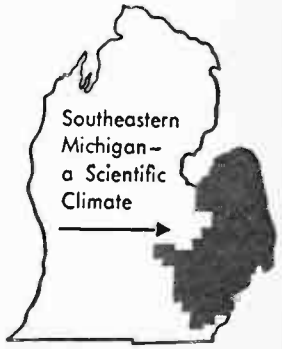
The University of Michigan's Dr. Norman Scott *(left)* demonstrates the Michigan Instructional Computer—only unit of its kind in the world—to Strand Engineering Company's Robert Carson who is working for his Ph. D.

IN SOUTHEASTERN MICHIGAN:
A SCIENTIFIC CLIMATE FOR THE ELECTRONICS INDUSTRY

Electronics companies in Southeastern Michigan have an invaluable asset right from the start. Their personnel find advanced schooling readily accessible. In the area are conveniently located science schools whose postgraduate and extension facilities and faculties are comparable with the best available anywhere.

Within easy reach of these competent schools are communities which have carefully organized and blueprinted their prosperous growth. Done by skilled professional land-use planners, it's the kind of planning which reassures management people concerned with plant location. Such communities can be particularly confident when they extend an invitation to the electronics industry to look them over. We, too, would welcome the opportunity to discuss communities and plant sites with you on a completely confidential basis.

(Left) Analog computer, Michigan State University. *(Center)* One of the modern College of Engineering buildings, Wayne State University. *(Right)* University of Detroit engineering students conduct electronic experiments in the characteristics of gravity.



Write to Plant Location Service, Area Development Division

DETROIT EDISON

C to +71 C. Can be coupled or provided with built-in potentiometers and other control devices.

CIRCLE 209 ON READER SERVICE CARD

Phase Detector
versatile unit

BOONSHAFT AND FUCHS, INC., Huntingdon Valley, Pa. The visual phase sensitive detector is used in performance evaluation of a-c servo systems and similar devices employing carrier modulation. Used with any oscilloscope it provides a visual demodulation of the carrier with no phase shift or time delay. Phase and amplitude distortion are zero, regardless of the carrier frequency. Quadrature and even harmonic rejection are on the order of 100:1, making the crossover point free of hash and noise.

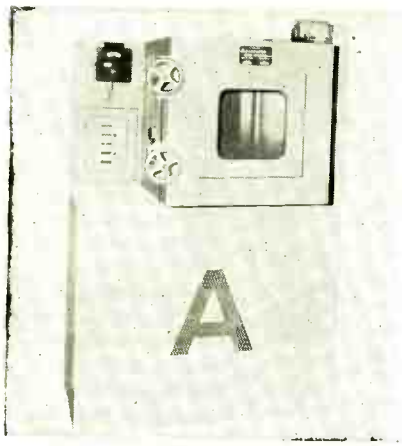
CIRCLE 210 ON READER SERVICE CARD

Tv Camera
pencil type

DIAMOND POWER SPECIALTY CORP., Lancaster, Ohio. C-C tv camera built to operate inside reactor tubes 3 in. in diameter. Permits inspection of reactor tube welds without pulling tubes from pile. Stainless steel reactor tubes blacken under radiation, but defective welds remain clean and show as white areas

on the 17-in. tv monitor. Monitor and camera control-power unit are cart mounted for movement to inspection sites.

CIRCLE 211 ON READER SERVICE CARD



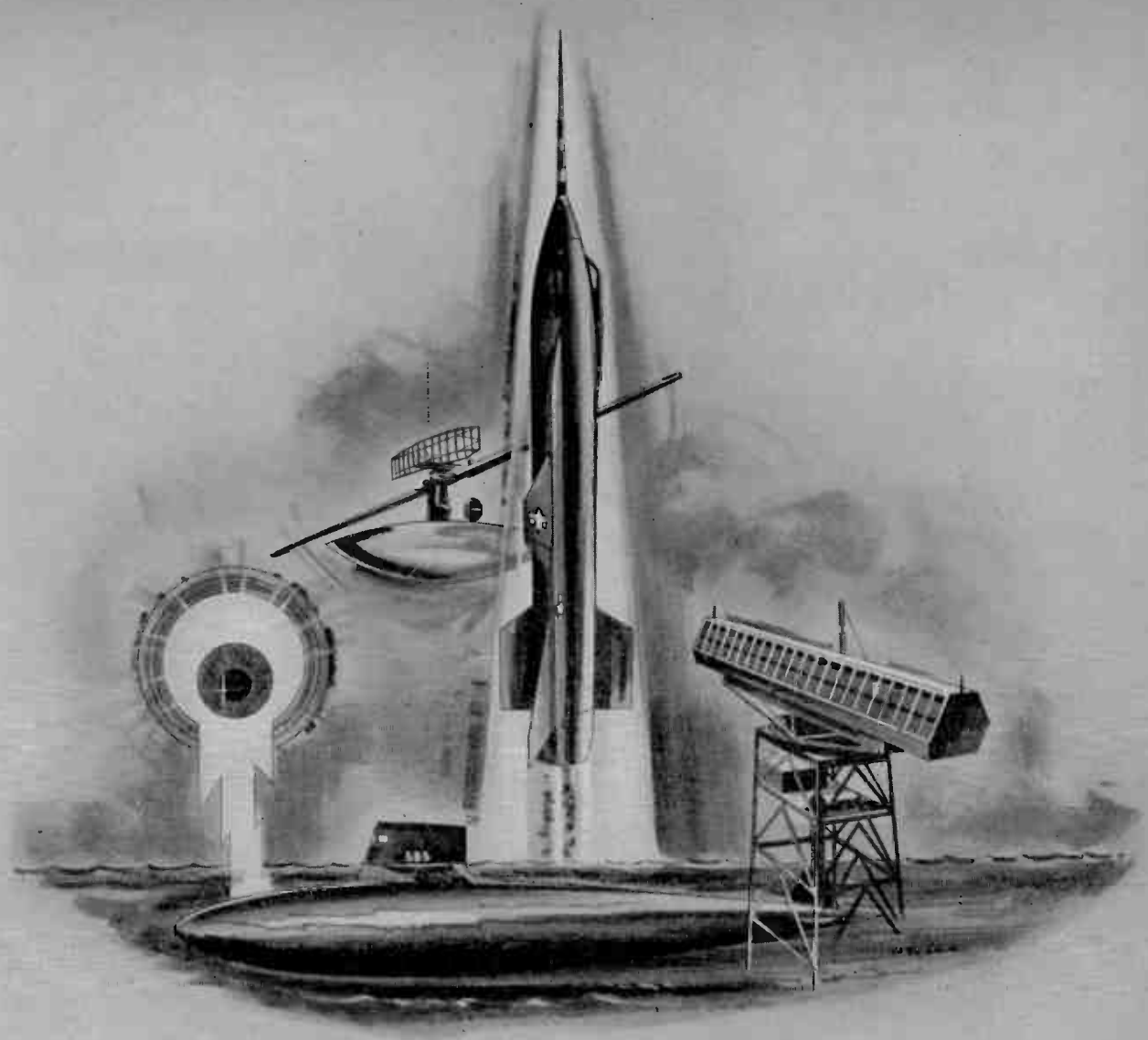
Test Chamber
temperature type

ASSOCIATED TESTING LABORATORIES, INC., Clinton Road, Caldwell, N. J. Environmental test chamber for low-high temperature testing at −100 F to +1,000 F. Liquid CO_2 will pull-down from ambient to −100 F in less than 3 minutes. Heat load dissipated in chamber is at least 5,000 BTU/hr at −100 F. Dimensions are 18 by 18 by 18 in. Price: $1,250, plus optional features.

CIRCLE 212 ON READER SERVICE CARD

Precision Ohmmeters
portable units

ASSOCIATED RESEARCH, INC., 3777 W. Belmont Ave., Chicago 18, Ill. Direct-reading ohmmeters. Accuracy is held to ½ percent of mid-scale value, for resistance measure-



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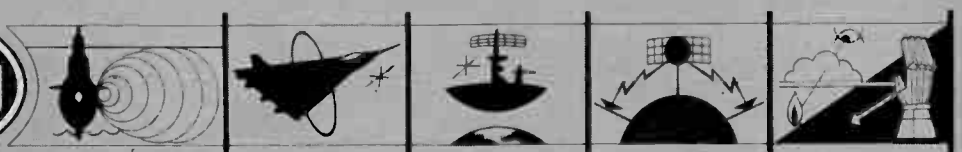
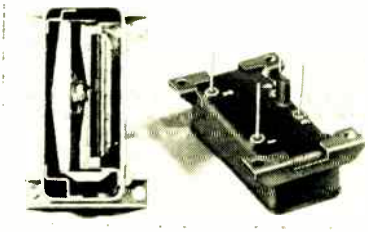
EXCELLENCE IN ELECTRONICS



SUBMARINE SIGNAL | AIRBORNE ELECTRONIC | SYSTEMS MANAGEMENT | HEAVY ELECTRONIC | SANTA BARBARA

ments of leads, grounds, components, point-to-point circuit tests, and many other applications. Model 244 is calibrated in four ranges, for measurements from 0.05 to 50,000 ohms; Model 246 for 0.01 to 100,000 ohms.

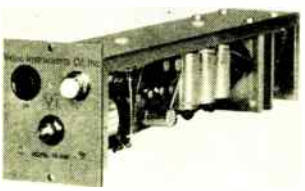
CIRCLE 213 ON READER SERVICE CARD



Thermal Relay
for missile use

G-V CONTROLS INC., Okner Parkway, Livingston, N. J. Type PT thermal time delay operable under 20 g vibration to 2,000 cps and 50 g shock for 11 millisec. There is no resonance below 2,000 cps and extended exposure to these conditions causes no damage or change in characteristics. Operating time delays of 3 to 60 sec are factory set within ±5 percent. Effects of ambient temperature are held to ±5 percent over −65 C to +125 C. Heater voltages range from 2 to 115 v for delays of 3 to 12 sec and from 2 to 230 v for longer delays.

CIRCLE 214 ON READER SERVICE CARD



D-C Power Supply
solid-state

VIDEO INSTRUMENTS CO., INC., 3002 Pennsylvania Ave., Santa Monica, Calif. Model SR-200E solid-state regulated supply with floating output is designed especially for strain gage excitation. It features less than 10 μv of noise peak to peak when measured with a 350 ohm strain gage bridge, 0.1 percent regulation for line voltage changes from 95 to 135 v, high insulation resistance to ground (at least 10,000 megohms), an extended voltage range from 0 to 15 v continu-

These R&D Projects for Future Decades in Space

typify Lockheed's vast program of Air/Space Science

■ New programs and study contracts awarded to Lockheed's California Division are planned to solve America's future exploration projects into space. The new multimillion-dollar Research Center in nearby San Gabriel mountains is further evidence of Lockheed's determination to support and supplement its already extensive research and development activities.

As a result of this markedly expanded program, there is urgent need for engineering and scientific personnel with high-level technical skills.

Long a leader in advancing the science of flight, Lockheed is placing vast resources and accumulated knowledge into programs designed to provide major break-throughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Some of these important research and development programs are:

High Altitude Flight Vehicles with speed ranges between Mach 8 to 25. Problems associated with landing **Manned Space Vehicles** capable of hypersonic glide or orbit about the earth. **Infrared System** studies as an advanced method of detecting ultrasonic missiles and high-speed aircraft. **Solar Radiation** studies. **Vertical Take-Off and Landing** and "air recovery" vehicles. **Helicopters. Supersonic Transports.**

High caliber scientists and engineers are invited to investigate Lockheed's outstanding career opportunities. Openings now exist in: Aero-thermodynamics; propulsion; armament; electronics—research and systems; servomechanisms—flight controls; sound and vibration; operations research; physics; antenna and telemetry; and underwater sound propagation.

Write today to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1510, 2400 North Hollywood Way, Burbank, California.

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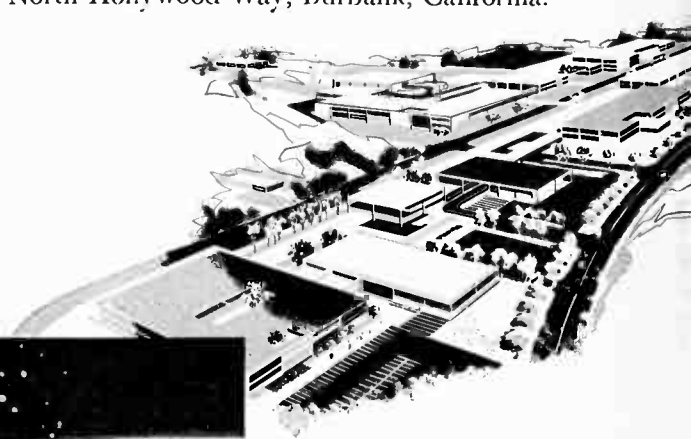
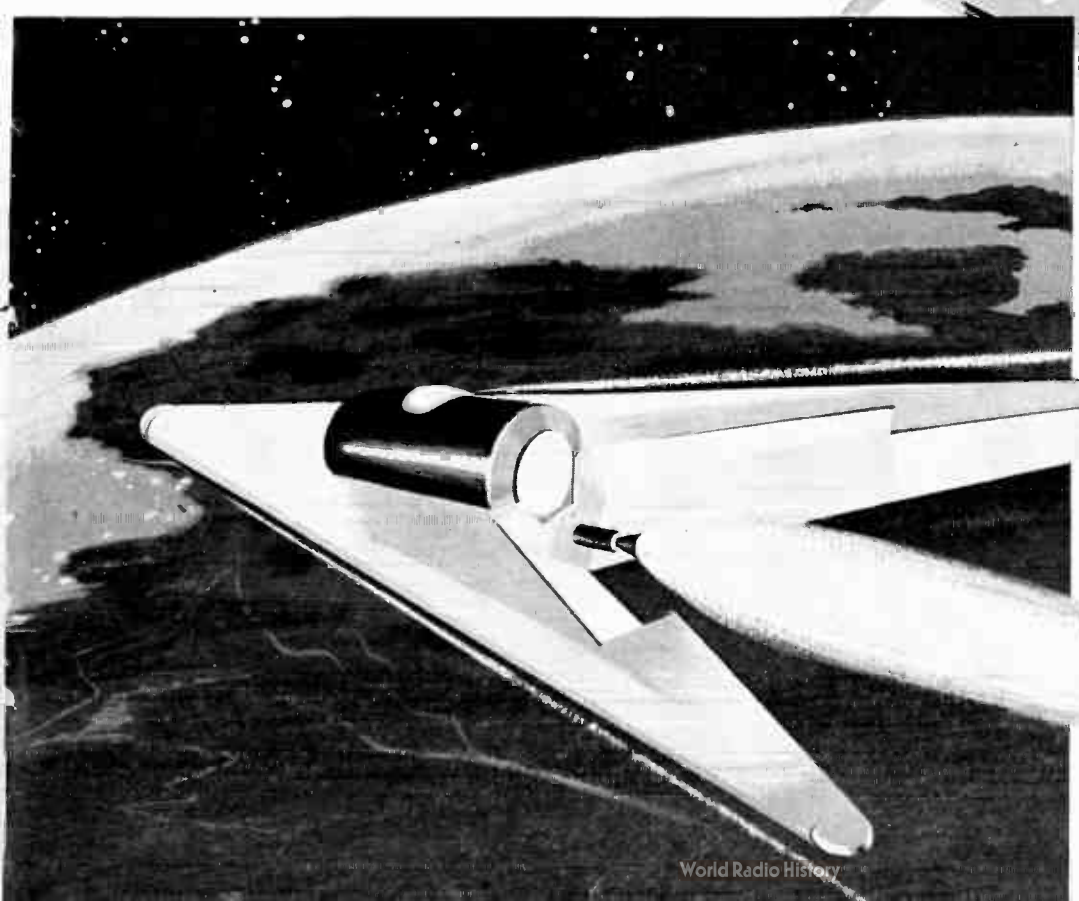


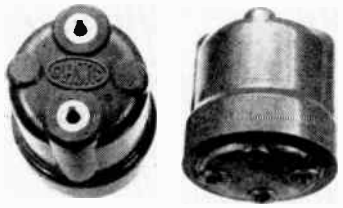
New Multimillion-Dollar Research Center under construction in Southern California's San Gabriel Mountains—designed to house most of the research facilities of Lockheed's California Division. Here will be found advanced research facilities in all fields related to atmospheric and space flight.



Space transports capable of transporting—to an orbit of more than 1000 miles—a pilot and 1000 pounds of payload, or three passengers equipped to work in space.

ously variable by means of a 10 turn helical pot, and 200 ma maximum output current.

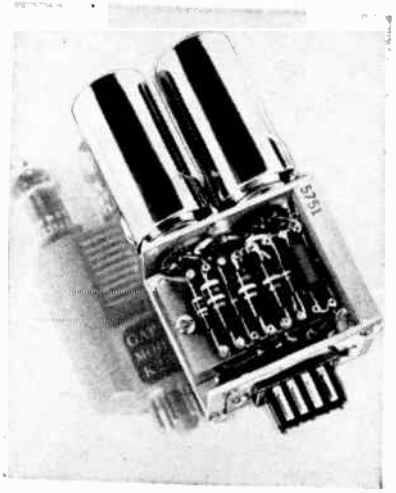
CIRCLE 215 ON READER SERVICE CARD



Standoff Insulator
5 kv rating

THE GLASTIC CORP., 4321 Glenridge Road, Cleveland 21, Ohio. Glastic fiber glass reinforced polyester insulators have a proven performance record of several years service in a variety of large mill power control apparatus (5 kv rating), where they are functioning as bus supports and switch and contactor support insulators. They feature greater dimensional accuracy, greater impact strength, no chipping, less weight and lower cost.

CIRCLE 216 ON READER SERVICE CARD



D-C Amplifier
operational type

GEORGE A. PHILBRICK RESEARCHES, INC., 285 Columbus Ave., Boston 16, Mass. Model K2-WJ plug-in d-c operational amplifier for high reliability military applications. It is similar to commercial version, but slightly smaller and has open frame construction for optimum ventilation and at higher ambient temperatures. Design center d-c

CIRCLE 150 ON READER SERVICE CARD

DON'T INVEST IN TEST EQUIPMENT 'TIL YOU COMPARE FEATURES WITH THE

NEW Simpson LABORATORY LINE

PULSE GENERATOR . . . model 2620

No Unit Offers Such Accuracy, Versatility, and Set-Up Speed Within This Price Range

Twin meters read pulse repetition frequency and pulse duration simultaneously. Rise time is 0.02 microseconds; decay time, 0.03 microseconds. Pulse duration, continuously variable from 0.1 to 1000 microseconds. Jitter, less than 0.005 microseconds. Pulse repetition rate, continuously variable from 10 to 100,000 pps in four ranges. Price **$625**

WRITE FOR COMPLETE SPECIFICATIONS

WIDE-BAND OSCILLOSCOPE . . . model 2610

For the 1001 Jobs Where You Don't Need an Expensive Specialized Scope

Here's a high-gain scope that makes your test equipment appropriation go farther. Vertical sensitivity, 6 mv RMS. Vertical calibration accuracy, ± 3%. Response (linear position): DC to 5.0 mc/sec, ± 0.5 db; DC to 8.0 mc/sec, ± 1.5 db. Response (transient position): DC to 3.5 mc/sec, −3 db, and −6 db at 5.0 mc/sec. Triggered and recurrent sweeps. Precalibrated sweep positions of 5, 50, 500, 5000 microseconds. Price **$575**

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LABORATORY STANDARD VOLT-OHM-MILLIAMMETER . . . model 2600

A Self-Powered Calibrator for Electrical Instrument Maintenance and High Accuracy Testing

Two terminal connections cover all 49 ranges for unusually fast operation. DC accuracy is ± 0.5% F.S.; AC, ± 0.75% F.S. (at 77°F. 25°C). Separate meters (*self shielded* movements) for DC and AC readings. Price **$1620**

WRITE FOR COMPLETE SPECIFICATIONS

AVAILABLE FROM MANY INDUSTRIAL ELECTRONIC DISTRIBUTORS COAST-TO-COAST
Write to Factory for Details

MANUFACTURERS OF ELECTRONIC TEST EQUIPMENT FOR OVER 50 YEARS

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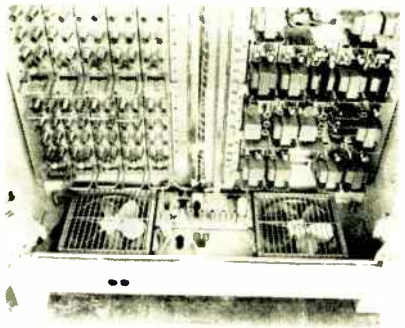
CIRCLE 105 ON READER SERVICE CARD

open loop gain is 15,000; at 500 kc the open loop gain is typically greater than 2. Maximum design output range of ±50 v at 1 ma may be increased by booster follower techniques.

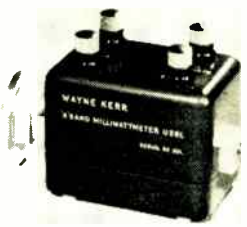
CIRCLE 217 ON READER SERVICE CARD



Reversible Fans wide range of cfm's

McLEAN ENGINEERING LABORATORIES, P. O. Box 228, Princeton, N. J. Filter box propeller fans are shown cooling computer racks in an electronic flight simulator built by the Electronics Division of Curtiss-Wright Corp. The fans have a range of cfm's suited to trailers, vans, mobile or stationary generating systems and are adaptable to many mounting arrangements.

CIRCLE 218 ON READER SERVICE CARD

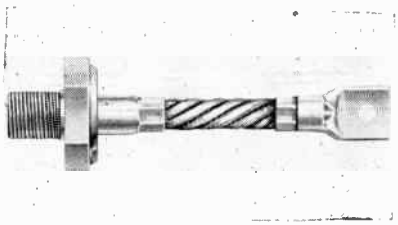


Milliwattmeter for X-band

WAYNE KERR CORP., 2920 N. 4th St., Philadelphia 33, Pa., announces a portable and extremely accurate resistive film bolometer wattmeter, the X-band microwave milliwattmeter, type U-281, for the measurement of microwave power. It measures power in a 1 to 100 mw range with an accuracy of ±3 percent, over the frequency band 8.4 to 10.2 kmc. The unit consists of a thin resistive film which is mounted symmetrically in the transverse plane of the waveguide. The rise in temperature of this film caused

by absorption of incident microwave radiation is used to measure the input power.

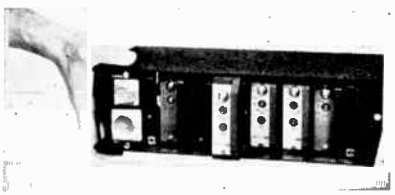
CIRCLE 219 ON READER SERVICE CARD



Silicon Rectifier 50 to 400 piv

SARKES TARZIAN, INC., 415 N. College Ave., Bloomington, Ind. Y series have thermal drop less than 10 C junction to base, junction temperature rise of approximately 60 C, and are rated at 250 amperes d-c to minimize thermal-aging problems and extend life expectancy. Either positive or negative base polarity is available. Designed for use in welding, electroplating and electrolysis, or any application requiring 1,000 or more d-c amperes.

CIRCLE 220 ON READER SERVICE CARD

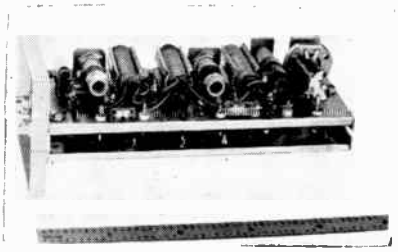


Signal Conditioner for airborne use

NEFF INSTRUMENT CORP., 2211 E. Foothill Blvd., Pasadena, Calif. The SCAMP signal-conditioning system is designed specifically for airborne telemetry and tape applications, and features transistorized d-c, a-c, or carrier amplifiers. It accepts mv inputs and produces 0-5 v to drive voltage controlled oscillators or record amplifiers. The 6-channel modular case accepts any combination of solid-state amplifiers, each containing separate controls and capable of individual operation in or out of the case. Each amplifier measures 1¼ in. wide, 3⅛ in. high and 4⅛ in. long. Gain stability is better than 1 percent over all environmental conditions including 20 g's shock, vibration of 1 in. peak-to-peak from 5

to 20 cps, and temperatures from −55 C to +85 C.

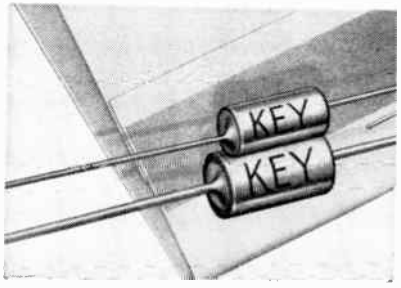
CIRCLE 221 ON READER SERVICE CARD



VHF Beacon
miniature type

LEL, INC., 380 Oak St., Copiague, N. Y. Miniature vhf beacon aircraft or drone crash locator, signaling, control, telemetering or other purposes is crystal-controlled. Three subminiature tubes supply carrier output up to 100 mw in 300 mc band. Contains transistorized modulator-power supply. Input is 6 v at 660 ma; output impedance, 50 ohms; modulation, 1,000 cycles.

CIRCLE 222 ON READER SERVICE CARD



Stable Resistor
deposited-carbon

KEY RESISTOR CORP., 321 W. Redondo Beach Blvd., Gardena, Calif. Deposited-carbon resistors shown are filled with silicone oil and hermetically sealed for stability under heat and high voltage. Units meet all MIL specs; are available in all military sizes, plus ½ w and $\frac{1}{10}$ w, in resistance values from 5 ohms to 20 megohms.

CIRCLE 223 ON READER SERVICE CARD

Ferrite Isolators
for C-band use

MOTOROLA INC., 8201 E. McDowell Rd., Phoenix, Ariz. Ferrite isolators for radar system and labora-

Meet John Mason

Associate Editor, **electronics**
MILITARY ELECTRONICS EXPERT

Resumé:

Mexico City College, Mexico, BA. Air Force officer, navigator with 32 combat missions; Director of Flight Training, Pathfinder Radar School; head of Loran School. News editor, associate editor of aeronautical trade magazine, wrote free lance aviation articles. Recalled to Air Force, 1951, and studied at Georgetown Graduate School. Assigned to Libya, then Munich. Wrote news stories plus daily digest of iron curtain radio news.

Present Occupation:

As an associate editor of **electronics** John is deeply involved with the technical and business aspects of military electronics (the current $4.5-billion government market) and draws heavily on his electronics and Air Force background.

References:

John is typical of the 26-man staff of specialists who edit **electronics** . . . men who produced 2,856 pages of editorial material during 1958. A mature, experienced staff, averaging 36 years of age, these people are dedicated to serving the needs of the reader of **electronics**. If your subscription to **electronics** is expiring, or if you are not a subscriber . . . if you will miss reading some of the exciting articles John Mason is planning for the near future . . . fill in the box on the Reader Service Card. It's easy to use. Postage is free.

ABC ABP **electronics**

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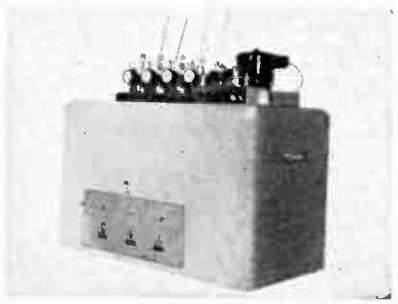
tory use in 6,575 to 6,875 mc C-band applications. Isolation loss is 40 db; insertion loss, 1.0 db; vswr, 1.2; nominal ambient temperature, 130 to 160 F; weight, 2 lb; length, 5 in.

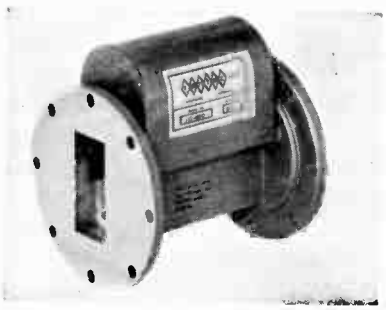
CIRCLE 224 ON READER SERVICE CARD



Deflection Tester for plastics

AMERICAN INSTRUMENT CO., INC., 8030 Georgia Ave., Silver Spring, Md. Lab instrument indicates the deflection of thermoplastics when subjected to various loads and temperatures in accordance with ASTM test D648-56. As many as four samples can be tested simultaneously by placing each in a specimen holder and lowering the holders into an insulated bath. Deflections are indicated on dials mounted on the specimen holders. Unit measures 26 by 16½ by 23 in. high. Bath temperature can be increased at the rate of 2 C per minute from ambient to 260 C, or maintained constant at any point within this range.

CIRCLE 225 ON READER SERVICE CARD

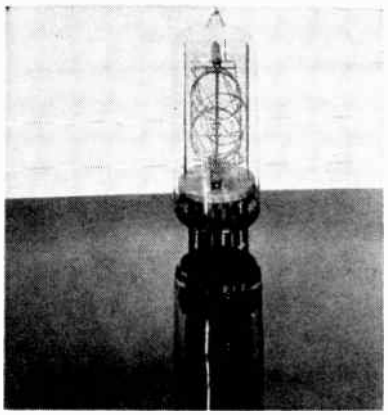


C-Band Isolator high power

RANTEC CORP., Calabasas, Calif. Model IC-400 C-band load isolator covers 4.6-6.0 kmc band and provides 12 db minimum isolation (18 db band center) with 1.0 db maximum insertion loss (0.6 db band

center). It has been successfully tested at a power level of 300 kw peak, 300 w average, in the presence of an ionizing source with a 2:1 variable phase load impedance. Unit is constructed in UG49/U waveguide with UG-149A/U flanges; length 4 in., weight 4¾ lb.

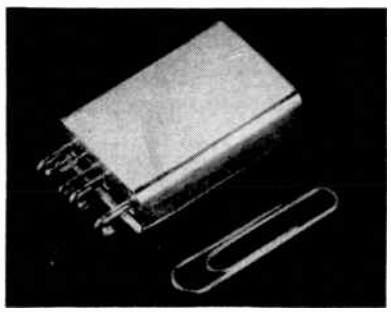
CIRCLE 226 ON READER SERVICE CARD



Register Tube
cold-cathode

BAIRD-ATOMIC, INC., 33 University Rd., Cambridge 38, Mass. Digitron cold-cathode register tube GR10G may be added to existing counter circuits to display the state of count of either hard-tube counting circuits or cold-cathode load tube decades. It is ideal for indicating the position of selector or stepping switches on a remote panel or monitor board. The 1½ in. high numerals may be read easily from distances up to 50 ft at a 160 deg angular readout in brighter than normal room illumination.

CIRCLE 227 ON READER SERVICE CARD



Crystal Can Relay
rugged construction

ELECTRONIC SPECIALTY CO., 5121 San Fernando Rd., Los Angeles 39, Calif. Crystal can relay handles 40 amperes overload. It provides a

switching mechanism capable of handling 10 ampere loads for 100,000 operations. Operating power is 150 mw for 20 g to 2,000 cps vibration. Coil resistances are available to match any transistor or vacuum tube load.

CIRCLE 228 ON READER SERVICE CARD

Laboratory Furnace multipurpose

MATERIALS RESEARCH CORP., 47 Buena Vista Ave., Yonkers, N. Y. Model MF-90 multipurpose furnace provides a heat treating and experimental laboratory furnace in one apparatus. It may be used in horizontal or vertical position at temperatures up to 1,100 C. A clock motor is mounted for use in the growth of single crystals by the Bridgman technique. An immediately replaceable furnace core avoids lengthy shut down.

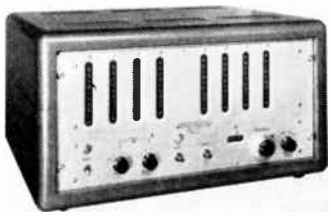
CIRCLE 229 ON READER SERVICE CARD

Energy Storage System nuclear-battery power

RADIATION RESEARCH CORP., 1114 First Ave., New York 21, N. Y. Energy storage systems capable of storage densities exceeding 10 million ergs/cu. in. utilizes nuclear battery with a specially designed low leakage, high voltage, storage capacitor and voltage regulator tube for applications requiring constant available energy over long periods of time. The nuclear bat-

tery uses Krypton 85 and is free from the hazards of ingested radioactivity.

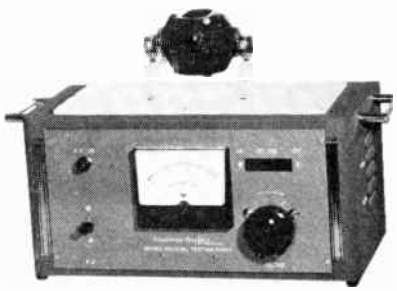
CIRCLE 230 ON READER SERVICE CARD



Scaler
count and time

RADIATION INSTRUMENT DEVELOPMENT LABORATORY, INC., 5737 S. Halsted St., Chicago 21, Ill. Model 49-33 combines decimal count scaler with time scaler on single chassis. It features preset time to 1,000 sec or preset count to 10^7; resolving time, 1 μsec; positive or negative input; includes full range discriminator, precision fixed mercury pulse generator and electrically reset four digit register.

CIRCLE 231 ON READER SERVICE CARD



Portable Tester
of insulating oil

ASSOCIATED RESEARCH INC., 3777 W. Belmont Ave., Chicago 18, Ill. Model 4505-A is a portable high voltage tester of insulating oils used in oil immersed transformers, bushings, power supplies, electronic components and assemblies. It weighs 42 lb and provides up to 35 kv a-c at 2 kva for voltage breakdown tests. Price is $725.

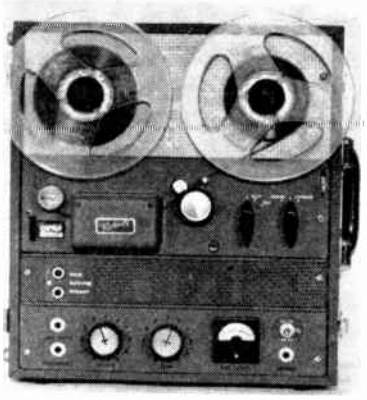
CIRCLE 232 ON READER SERVICE CARD

Thyratron Tube
high-voltage

WESTINGHOUSE ELECTRIC CORP., P. O. Box 284, Elmira, N. Y. WL-

7269 high-voltage thyratron tube for new designs of d-c power supplies. Rating of 3.2 amperes and 21-kv inverse voltage permits design of 20-kv, 10-ampere, three-phase, full-wave bridge-type rectifier adjusted by phase control from zero to full voltage. Also permits high-speed electronic regulation of the d-c output.

CIRCLE 233 ON READER SERVICE CARD



Tape Recorder full track

ROBERTS ELECTRONICS INC., 1028 N. LaBrea Ave., Los Angeles 38, Calif. Model 191 full track monaural tape recorder (similar to 90-C stereo recorder) with new full-track erase and record/playback heads. Equipped with head, preamp, amplifier outputs, Roberts hysteresis synchronous motor and VU meter. Price: $325.

CIRCLE 234 ON READER SERVICE CARD

Magnetic Clutch meets MIL-E-5272B

GUIDANCE CONTROLS CORP., 110 Duffy Ave., Hicksville, L. I., N. Y. Type C-18 magnetic clutch features high output torque for its size. For friction face models output torque is 80 oz in. (minimum) at 24 to 28 v d-c. Breakaway torque is 0.15 oz in. energized and 0.05 oz in. de-energized. Maximum weight is 13.5

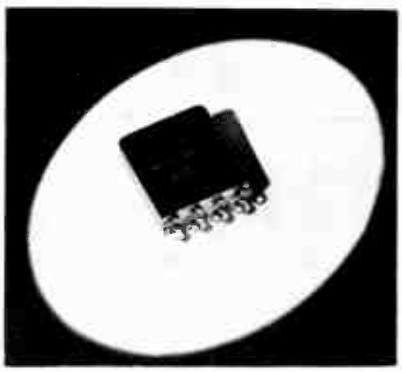
oz. It meets MIL-E-5272B environmental qualifications tests for vibration, fungus, shock, humidity, temperature, salt spray, sand and dust.

CIRCLE 235 ON READER SERVICE CARD

Motor Drive Amplifier
precision unit

PRECISION INSTRUMENT CO., San Carlos, Calif. Designed to provide precise 60 cps power for tape recorder motors, the MDA series has applications in other fields where extreme frequency regulation of the power source is required. Motor drive amplifiers are available for operation from either 24-28 v d-c or 105-125 v a-c, 48-62 cps. Output is 100 w with frequency regulation ±0.02 percent. Third harmonic component is negligible. Unit weighs 35 lb, measures 7½ in. high by 15½ in. wide by 8⅝ in. deep. Price is $1,350.

CIRCLE 236 ON READER SERVICE CARD

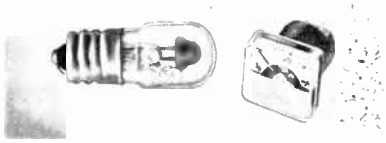


Crystal Case Relay
rugged unit

HI-G, INC., Bradley Field, Windsor Locks, Conn. Type B relay meets all requirements of MIL-Std drawing MS-24250. Also available as type BR, with internally mounted silicon rectifiers for use at 400 cps a-c or higher. Contact rating is 2 amperes at 28 v d-c or 115 v a-c for a life of 100,000 cycles. Both types

are suitable for vibration of 30 g to 2,000 cps minimum, and employ permanent magnets as "hold open" devices to eliminate contact chatter due to mechanical resonance.

CIRCLE 237 ON READER SERVICE CARD



Panel Meter
subminiature

ALCO ELECTRONICS MFG. CO., 3 Wolcott Ave., Lawrence, Mass. Model S-10 subminiature ½-in. panel meter has shielded moving coil movement and adapts to miniature transistorized circuits for voltage and current indication. Unit's clear plastic front measures ⅝ by ⅝ in., ½-in. barrel diameter. Available ranges are 0-200, 500 μa d-c; 0-1, 5, 10 and 20 ma d-c; 0-15, 0-100 v d-c; and 0.150 v a-c.

CIRCLE 238 ON READER SERVICE CARD

Terminal Boards
commercial type

GENERAL PRODUCTS CORP., Union Springs, N. Y. Terminal boards for commercial applications have molded-in conductors, do not need saddle plates on mounting supports. Solid insulating back reduces breakage, guards against moisture and makes insulating strip unnecessary. Interchangeable with other industrial boards, they feature current carrying capacity, long creepage path, and thick, high barriers for insulation.

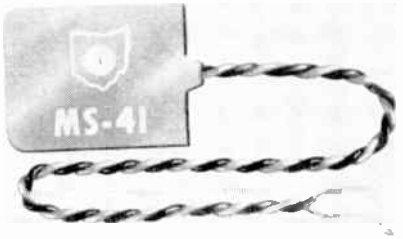
CIRCLE 239 ON READER SERVICE CARD

Control Chassis
stores encoder data

DATEX CORP., 1307 S. Myrtle Ave., Monrovia, Calif. Model K-111 con-

trol chassis offers rapid acquisition of data. Unit translates Datex or other binary-coded inputs into decimal or binary-coded outputs, and upon command stores the input information for remote readout. It utilizes transistor storage of encoder data and combines this buffer storage input with relay output. It is capable of three modes of operation: store only, follow only, or follow and store on command.

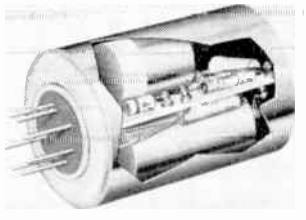
CIRCLE 240 ON READER SERVICE CARD



Resistor
very low noise

OHIO SEMICONDUCTORS, INC., 1035 W. Third Ave., Columbus 8, Ohio. Type MS-41 Magnetoresistor is a semiconductor in which electrical resistance is a function of an applied magnetic field. It features a 10 to 1 change in resistance with an applied field of 10 kilogauss. Greater changes can be achieved at greater fields with a linear dependency. At lower field densities, it obeys an approximate square function.

CIRCLE 241 ON READER SERVICE CARD

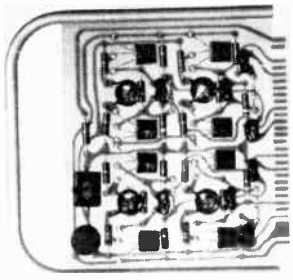


Voltage Reference
highly stable

NETWORKS ELECTRONIC CORP., 14806 Oxnard St., Van Nuys, Calif. Voltage reference has 1-v d-c output operating into 1,000 ohms. Output is held within ±1.2 mv over input conditions from 100 to 130 v a-c, 25 cps to 10,000 cps, operating temperatures of −55 C to +100 C, and any combination of specified

variations in temperature and power input. Meets MIL-E-5272A, requires 3 va nominal power, weighs 3 oz and mounts in any position. Used in power supplies, metering circuits, and strip chart recorders.

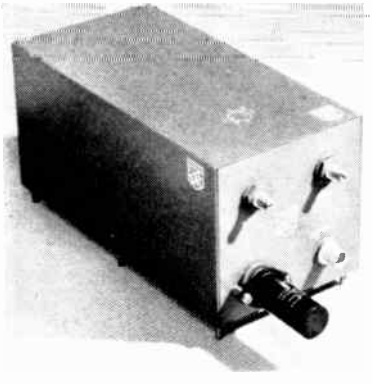
CIRCLE 242 ON READER SERVICE CARD



Thyratron Driver
3.9 K output impedance

COMPUTER CONTROL CO., INC., 92 Broad St., Wellesley 57, Mass. Model TO-10 thyratron driver accepts standard T-PAC model LE-10 signals. Generates output pulses of sufficient amplitude and width to trigger thyratrons, other devices or circuits which cannot be driven directly from the LE-10. Output amplitude is 14.0 v positive; output pulse duration; 50 μsec minimum, 75.0 μsec nominal.

CIRCLE 243 ON READER SERVICE CARD



Dual Delay Line
relay operated

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J. Model 71-50 is a relay operated, dual channel delay line, designed to obtain coincidence between two signals of different time and a third reference signal. Characteristics are: delay, 1 to 1.5 μsec, independently variable in each channel in increments of 0.05 μsec;

impedance, 1,000 ohms; output rise-time, 0.06 μsec per channel; dimensions, 8 by 4 by 4 in.

CIRCLE 244 ON READER SERVICE CARD

Panel Light
front mounted

TRANSISTOR ELECTRONICS CORP., 3357 Republic Ave., Minneapolis 26, Minn. FML series requires no rear in place by the lens which acts as a compression ring. Replacement is accomplished by removing the lens and slipping the unit forward through its own mounting hole. Connections are made by means of collet terminals, by wire wrap or by soldering. The FML mounts in a $\frac{3}{8}$ in. hole on $\frac{1}{2}$ in. centers.

CIRCLE 245 ON READER SERVICE CARD

Spatula
for relay cleaning

JONARD INTERNATIONAL CORP., 624 Madison Ave., New York, N. Y. Diacrom spatula cleans and polishes relays and contacts with diamond particles without affecting normal gap between contact points.

CIRCLE 246 ON READER SERVICE CARD

Molding Compound
polyurethane

COAST PRO-SEAL & MFG. CO., 2235 Beverly Blvd., Los Angeles 57, Calif. Pro-Seal 793 two-part polyurethane molding compound with

electrical properties and fluid resistance needed for cable. Temperature range is −65 F to +300 F; tensile strength, 2,000 psi; elongation, 500 percent. Aside from cable molding, the compound is used for general purpose molding, encapsulation and coating. Cures at room temperature.

CIRCLE 247 ON READER SERVICE CARD

R-F Receptacle for printed wiring

SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y. A ConHex type 3007 receptacle connects coax cable to printed wiring by dip soldering. Center contact is held in assembly between two insulators, preventing longitudinal or rotating movement, and is also soldered to the printed wiring on the face of the board. Mates with ConHex type 3000 straight plug, type 3005 right-angle plug or equivalent.

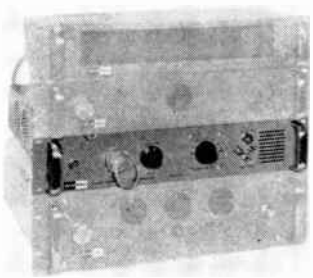
CIRCLE 248 ON READER SERVICE CARD

Test Set frequency-voltage

AIRPAX ELECTRONICS INC., Seminole Division, Ft. Lauderdale, Fla. Model 4B measures frequency, a-c and d-c voltages. Expanded-scale frequency meter (350 to 450 cps) accuracy is ½ cycle at 400 cps. D-C voltage measurement (0 to 30 v) accuracy is ½ percent at 27.5 v. Two a-c ranges (0 to 150 and 0 to 300 v) provide 1 percent accuracy at 115

and 208 v, and 2 percent full-scale. Phase checker and continuity checking are built in.

CIRCLE 249 ON READER SERVICE CARD



Preamplifier variable bandwidth

KIN TEL DIVISION of Cohu Electronics, Inc., 5725 Kearny Villa Road, San Diego 12, Calif. Model 458 preamplifier handles small d-c or a-c signals in the 30 to 2,000 cps range. It extends the sensitivity of precision measuring instruments. Gain is set at a constant value of 100, with gain accuracy of 0.1 percent. Linearity is held within 0.01 percent. Amplifier is chopper stabilized to keep drift below 2 μv per 24 hr.

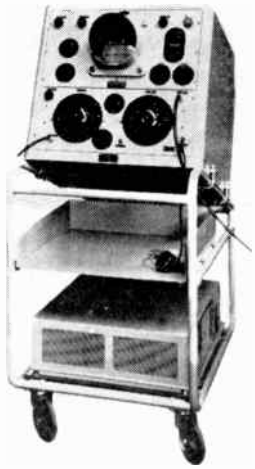
CIRCLE 250 ON READER SERVICE CARD

Portable Ohmmeter direct reading

ASSOCIATED RESEARCH, INC., 3777 W. Belmont Ave., Chicago 18, Ill. Precision ohmmeter with accuracy held to ½ percent of mid-scale, advantageous in resistance measurements of leads, grounds, components, point-to-point circuit tests and many other applications. Model 244 is calibrated in 4 ranges, for measurements from 0.05 ohm to 50,000 ohms; model 246 for meas-

urements from 0.01 ohm to 100,000 ohms.

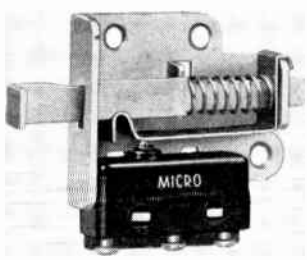
CIRCLE 251 ON READER SERVICE CARD



Spectrum Analyzer high-frequency

FURZEHILL LABORATORIES LTD., 475 Fifth Ave., New York 36, N. Y. By using the S.510 the frequency/amplitude spectrum of a-m or f-m emissions in the 3-30 mc band may be observed and measured by means of a panoramic presentation on a crt. Dual-persistence screen used permits a range of trace repetition rates from 0.1 to 30 sec. Equipment is suitable for measurement of signal components in a 60 db range and occupying a bandwidth of up to 30 kc. Type S.520 frequency changer which mounts below, and draws its power from the analyzer, extends the range below 3 mc.

CIRCLE 252 ON READER SERVICE CARD



SPDT Switch high-temperature

MICRO SWITCH, Freeport, Ill. The 17AC1-T subminiature door interlock switch for h-v cabinets, radio, radar, sonar, x-ray, and other electronic cabinets measures 1.182 in. by 1.50 in. by 0.35 in. and weighs 0.32 oz.

CIRCLE 253 ON READER SERVICE CARD

Literature of

MATERIALS

Epoxy Resin. Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. Processes for insulating transformers to meet the grades of MIL-T-27A with Scotchcast brand epoxy resin are outlined in an 8-page booklet.
CIRCLE 270 ON READER SERVICE CARD

COMPONENTS

Transformer Specification. Microtan Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y., has available a short-form interpretation of transformer type designation per MIL-T-27A.
CIRCLE 271 ON READER SERVICE CARD

Computer Transistors. Texas Instruments Inc., 13500 N. Central Expressway, Dallas, Texas. A mailing piece covers eight commercially available complementary *pnp* and *npn* alloy germanium computer transistors.
CIRCLE 272 ON READER SERVICE CARD

Miniature Clamps. Sterling Precision Corp., 17 Matinecock Ave., Port Washington, N. Y. A 48-page catalog offers the complete standard stock line of miniature clamps used by the servo computer, electromechanical and electronic industries.
CIRCLE 273 ON READER SERVICE CARD

Magnetic Clutches. Dynamic Instrument Corp., 59 New York Ave., Westbury, L. I., N. Y., announces a 4-page catalog on its magnetic clutches, brakes and clutch brakes.
CIRCLE 274 ON READER SERVICE CARD

EQUIPMENT

Meters. Helipot Division of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif. A 20-page catalog covers expanded scale a-c and d-c voltmeters, expanded scale frequency meters, and linear scale ammeters. Catalog also points up the company's

the Week

ability to provide voltage monitoring packages.

CIRCLE 275 ON READER SERVICE CARD

Servo System Simulator. Servo Corp. of America, 111 New South Road, Hicksville, L. I., N. Y. How to design, breadboard, and analyze servo systems rapidly, without need for fabrication of expensive intermediate prototypes, is detailed in a comprehensive report describing the Servolab servo system simulator.

CIRCLE 276 ON READER SERVICE CARD

Shock and Vibration Control. Barry Controls Inc., 700 Pleasant St., Watertown 72, Mass. Bulletin 59-05 contains shock and vibration control data for military applications, machinery mounts, commercial applications and test equipment.

CIRCLE 277 ON READER SERVICE CARD

Carrier Modulation Analyzer. Boonshaft and Fuchs Inc., Hatboro Industrial Park, Hatboro, Pa. Technical bulletin 91411 describes the theory and operation of the visual phase sensitive detector, a test instrument used in the performance evaluation of a-c servo amplifiers and mechanisms.

CIRCLE 278 ON READER SERVICE CARD

FACILITIES

Solder Joint Reliability. Dressen-Barnes Corp., 250 No. Vinedo Ave., Pasadena, Calif. An illustrated comprehensive report tells how failure in electronic equipment can be reduced appreciably and reliability improved by using a carefully planned, clearly defined, and illustrated checkout procedure for solder joint checks.

CIRCLE 279 ON READER SERVICE CARD

Receiver Sensitivity. HRB-Singer, Inc., Science Park, State College, Pa., has available a receiver noise figure and sensitivity slide rule. To obtain one write on company letterhead.

Sylvania: 22 Plants in Pa.

MUNCY, PA.—A new plant for custom production of computer components, assemblies and coils has just been opened here by Sylvania Electric Products Inc., subsidiary of General Telephone & Electronics Corp. The 77,000-sq-ft facility is Sylvania's 22nd plant in Pennsylvania.

The new Computer Products Operations plant employs more than 600. It replaces leased facilities in nearby Williamsport, where only 250 were working at the end of 1958.

Sylvania President Robert E. Lewis, and a senior vice president, Howard L. Richardson, were key speakers at the dedication ceremony. Lewis called the new plant "one of the most important units in the nation devoted exclusively to the custom production of computer components, assemblies and coils." Richardson pointed out Sylvania has a similar plant in Santa Cruz, Calif., to serve the West Coast electronics market.

Lewis predicted the electronic data processing market will amount to more than $1 million this year and double itself by 1965.

The new plant here supplies leading computer manufacturers, diversified electronics companies throughout the country, and the armed services.

Sylvania now has 45 plants and 22 laboratories in 39 communities in 13 states. The company's total productive area is about 6.8 million sq ft.

Barmat Heads New GI Division

APPOINTMENT of Melvin Barmat, thermoelectric physicist-engineer, as manager of the newly-created Thermoelectric Division of General Instrument Corp. is announced. He previously had been with the Martin Co. where he was project manager for Snap III, the five-pound atomic thermoelectric generator unveiled by the AEC at the White House earlier this year.

Bradley Corp. Adds to Staff

THREE appointments recently announced by Bradley Semiconductor Corp., New Haven, Conn., continue a series of changes made during the past few months in what shapes up as a general revamping of staff and production facilities.

Edward C. Keough, applications engineer, has been named to the newly created post of assistant sales manager. He will assist William J. Gagnon, sales vice president, in coordinating new engineering developments with the broadening sales program.

Robert Carr joins the Bradley organization as divisional manager in charge of the Silicon Division. He has served as an engineer with Proctor and Gamble, U.S. Steel, and most recently in charge of semiconductor design in the rectifier department at General Electric.

Robbie H. Glass is named production engineer in charge of the Selenium Division at Bradley. He was in the research department of the Lynchburg (Va.) Foundry Co., and later in the rectifier division of General Electric as component engineer.

Appoint Willits Department Head

AIRPAX ELECTRONICS, INC., names C. L. Willits as head of the Quality Control Department of the Seminole Division in Ft. Lauderdale, Fla.

Willits was previously with the Bendix Aviation Corp., Davenport, Iowa, where he was employed as senior project engineer and Bendix Pacific, as design engineer. Prior to his employment with Bendix he spent 3 years in Europe as engineering representative for Mackay Radio, a division of International Telephone and Telegraph Corp.

As head of the Quality Control Department, Willits is responsible for insuring conformance of components and systems to rigid specifications for industrial products as

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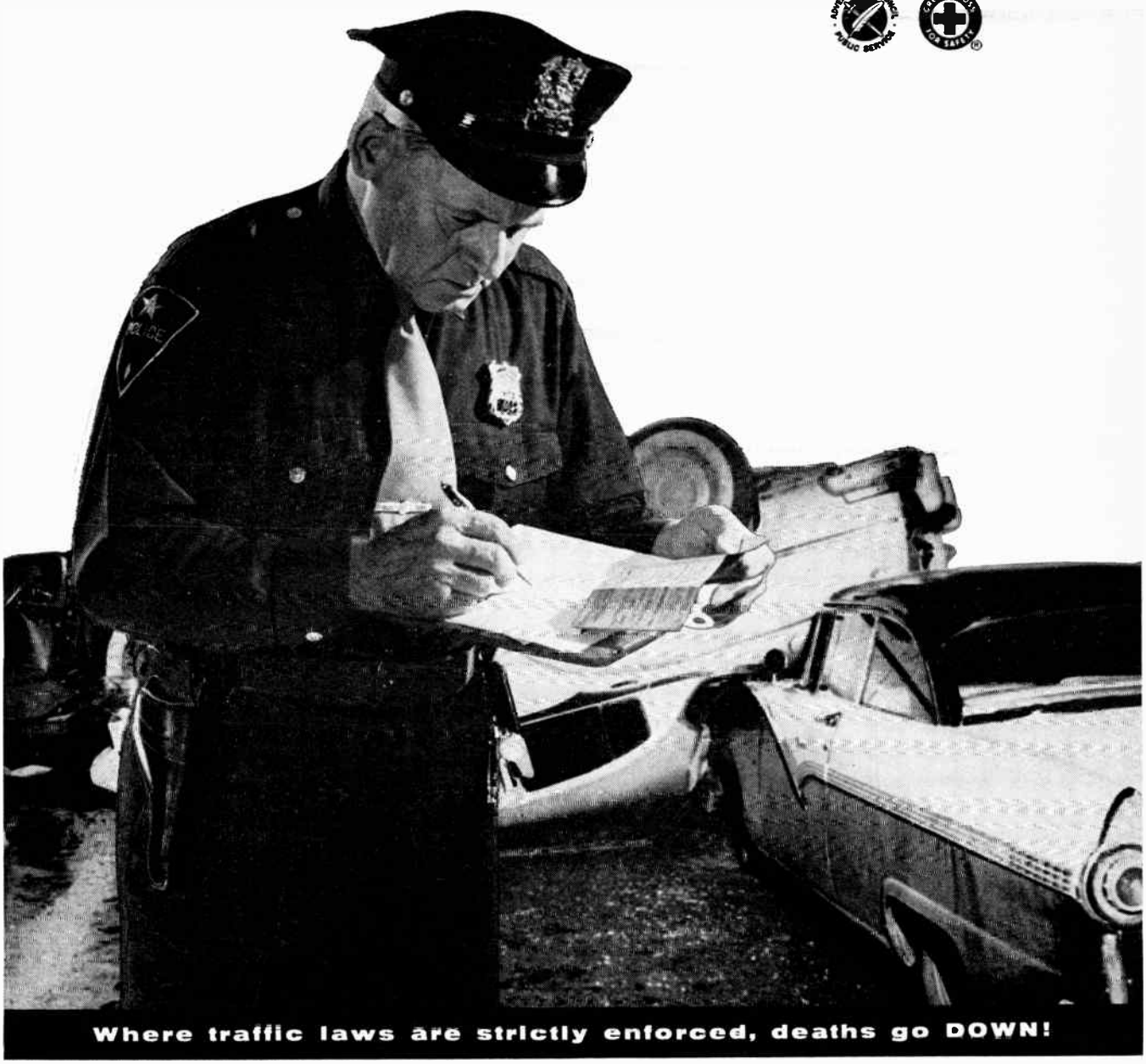

Published in an effort to save lives, in cooperation with the National Safety Council and The Advertising Council.

well as for the ever expanding missile and aircraft projects being handled at the plant.

Gattoline Joins Daystrom

APPOINTMENT of John J. Gattoline as sales manager of Daystrom Transicoil, Division of Daystrom, Inc., is announced. He was formerly vice president of E. W. Larrabee, Inc., design and development engineers. During his sales and engineering career, Gattoline has been associated with Hillyer Instrument Co., Inc., and W. L. Maxson Corp.

Daystrom Transicoil designs and manufactures servo and synchro mechanisms and components, largely for the missile industry. Company headquarters and plant are in Worcester, Montgomery County, Pa.

Organize New Corporation

CONLEY ELECTRONICS CORP. is a new corporation in Skokie, Ill., organized for the development and merchandizing of electronic products for the consumer, industrial and military markets.

The corporation now has three divisions: Waters Conley Co., Inc., Rochester, Minn., portable phonograph manufacturer; the Fidelivox Division of Skokie, Ill., which develops and manufactures automatic tape reproducers; and the Fidelipac

Division of Toledo, Ohio, which recently announced the volume introduction of a continuous play one reel magazine.

Promote Two At Bell Labs

KENNETH G. MCKAY has been elected vice president in charge of systems engineering of Bell Telephone Laboratories, New York City. A research physicist, McKay has been associated with electronic, semiconductor and solid state research and development programs at the Labs since 1946.

Morgan Sparks has been named director of developments of components and solid state devices, succeeding McKay. Previously Sparks served as director of transistor development.

News of Reps

Four new engineering sales reps have been named by Tally Register Corp., Seattle, Washington.

Pivan Engineering, with headquarters in Chicago, covers Illinois, Indiana, eastern Iowa, and eastern Wisconsin. **Dayton Associates**, with offices in Cincinnati and Dayton, covers Ohio and western Pennsylvania. **Wild Associates**, which has previously represented the firm throughout the Middle Atlantic States, has established a Boston office to cover the New England States. **Engineering Products Associates** of St. Paul services Minnesota, western Wisconsin, western Iowa, and North and South Dakota.

Wallace-Gluck Co. of Dallas, Texas, has been appointed sales rep for Perkin Engineering Corp., Electronic Division, El Segundo, Calif. Territory includes Louisiana, Arkansas, Oklahoma, and all of Texas except El Paso.

James R. Bunn, a staff engineer in the **Neely Enterprises** Albuquerque office since 1957, has been promoted to field engineer. In his new position he will headquarter at the firm's Las Cruces office.

COMMENT

Western Growth

It was interesting to read, in the Aug. 7 issue of ELECTRONICS ("Technical and Business Growth in West," p 103), your story on western industry. I was disappointed, however, to note that the Albuquerque-Santa Fe-Los Alamos area was not included.

There are more than fifteen firms in this area, even excluding Sandia Corp. and the Los Alamos Scientific Laboratory. Since a great portion of the work carried on by these laboratories is in the electronics area I feel they should be included. If this were done, the number of firms would be at least as large as that listed for Denver, and the number of employees would be considerably larger.

You may also be interested in the academic research underway at the University of New Mexico. In electrical engineering we are concerned particularly with problems of radio propagation, including radar return from the ground; submarine communications; and a classified study having to do with rocket exhausts. In addition, we are active in the semiconductor area, are developing transistor distributed amplifiers, applying information theory to distance-measuring systems, and developing a kit-style digital computer.

Our physics department is active in magnetohydrodynamics. It has the world's largest scintillation counter. The department is studying cosmic rays, ozone content of upper and lower atmosphere, and other topics.

R. K. MOORE
UNIV. OF NEW MEXICO
ALBUQUERQUE, N. M.

Wrong Head

I was pleased to see my article "Solders for Nuclear and Space Environments" in the Sept. 4 issue (p 50).

I am writing to correct one error which appeared in the article byline. I am head of the materials and devices research section of the research and analysis department here, and although I appreciate

your promoting me to head of the whole department, I believe a correction might be in order.

David Ellis is the head of research and analysis department at Litton Industries.

ALVIN B. KAUFMAN
LITTON INDUSTRIES
BEVERLY HILLS, CALIF.

Apologies to all hands.

Names in Error

Concerning my article ("Locked Oscillator for Color Tv," in Research and Development, p 90, Sept. 25), please note carefully that Brookhaven National Laboratory was only my summer mailing address. No reference to Brookhaven National Laboratory should appear with the article.

The circuit was developed by me while I was a member of the technical staff of RCA Laboratories Division, and should be so identified with the article.

My present affiliation is with the Department of Electrical Engineering, The City College . . .

MARVIN METH
THE CITY COLLEGE
NEW YORK

We regret that author Meth's letter arrived too late for us to make the necessary correction. We also made another error in giving his name as I. N. Meth instead of M. Meth.

Kudos

Here in Latin America, we regard ELECTRONICS as an authority . . .

One impressive trend I've personally noticed is how, without affecting the quality of your technical features, you've been building up the level of the departments in the back of the magazine. It's getting so that Production Techniques and Components & Materials are almost more interesting than the rest of the magazine, especially here where sophisticated techniques and advanced materials are always late arriving. Research & Development is another department that we all read avidly.

STEWART FABREGA
COLON, PANAMA

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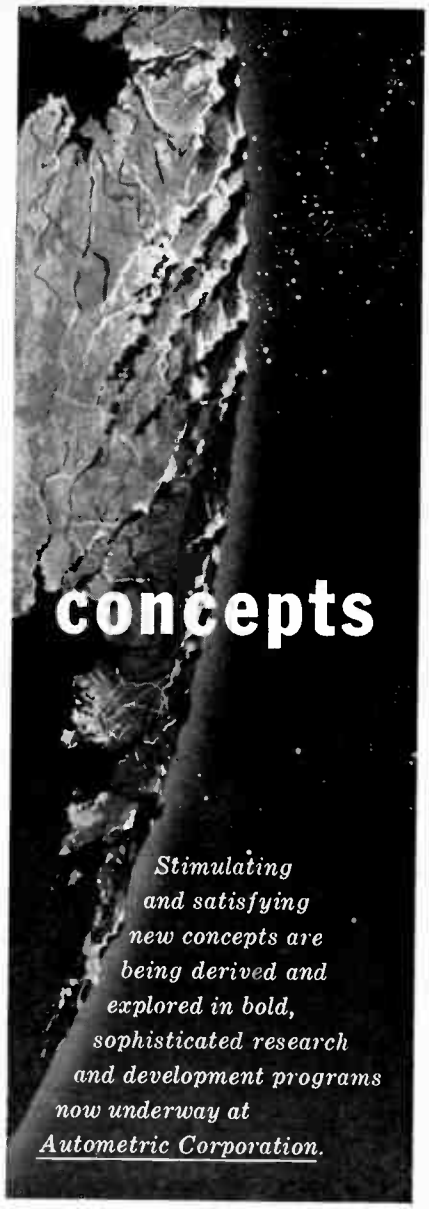

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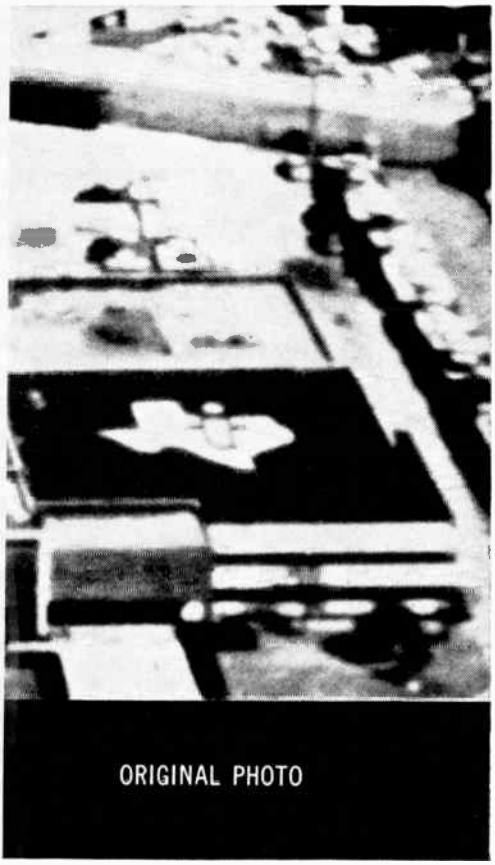

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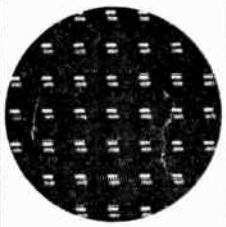

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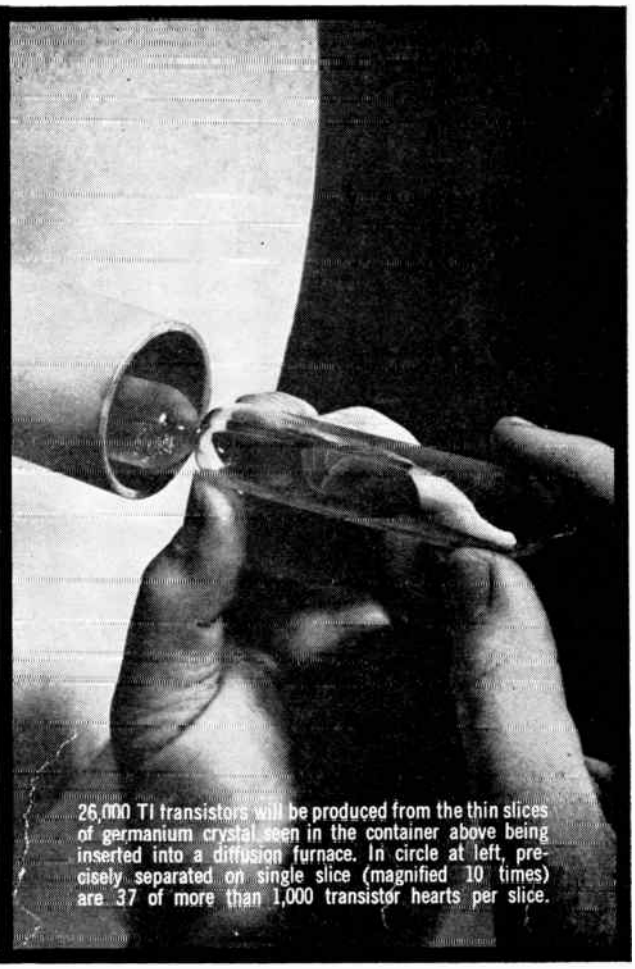

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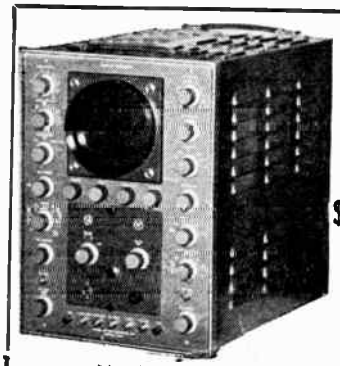

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