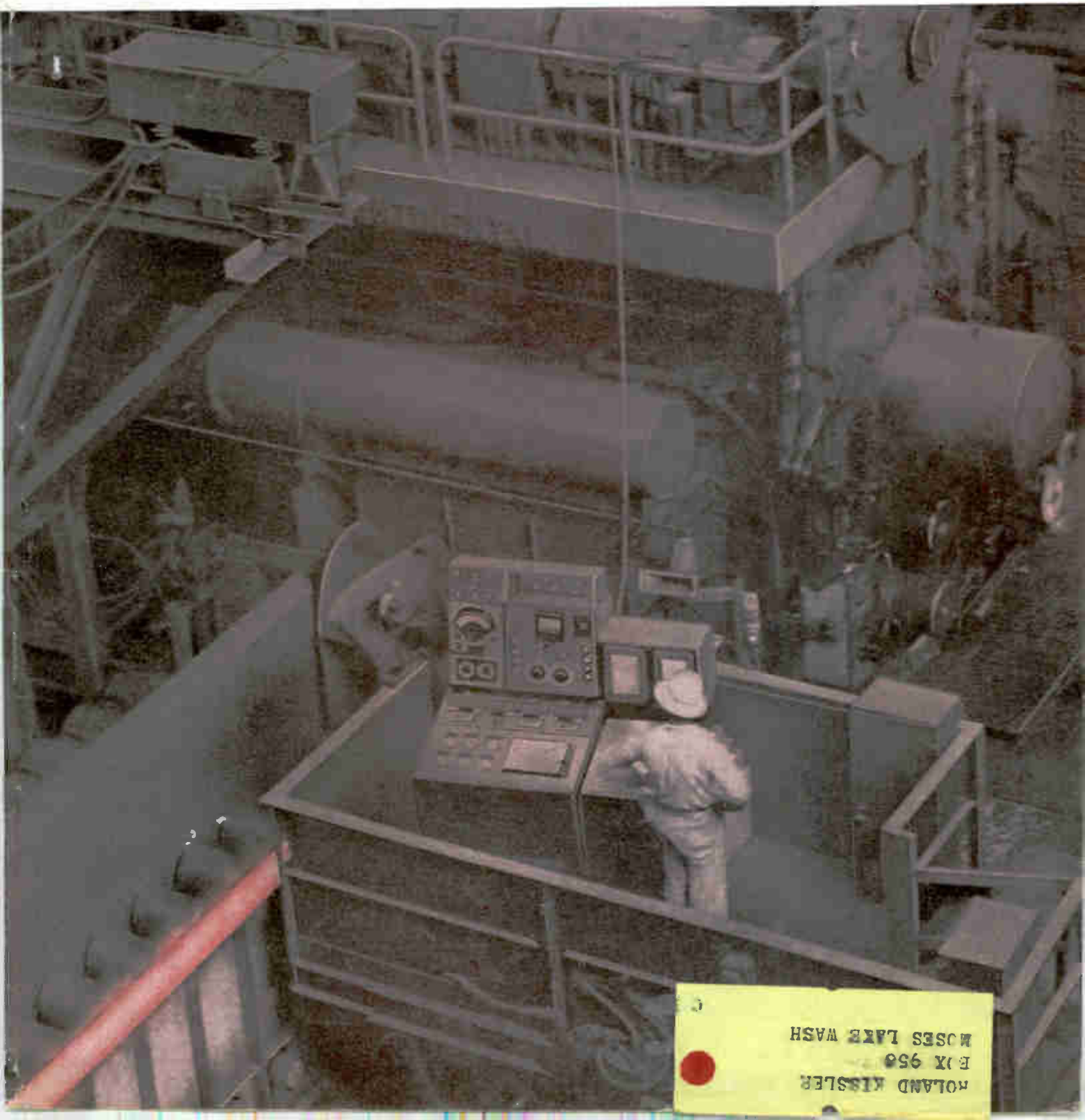
October 21, 1960

electronics

Infrared width gage (upper left) in steel-rolling mill measures width of fast-moving, red-hot strip within one-eighth inch. *See p 65*

Telemetry system records automobile performance. *See p 57*

A McGraw-Hill Publication 75 Cents



Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 4

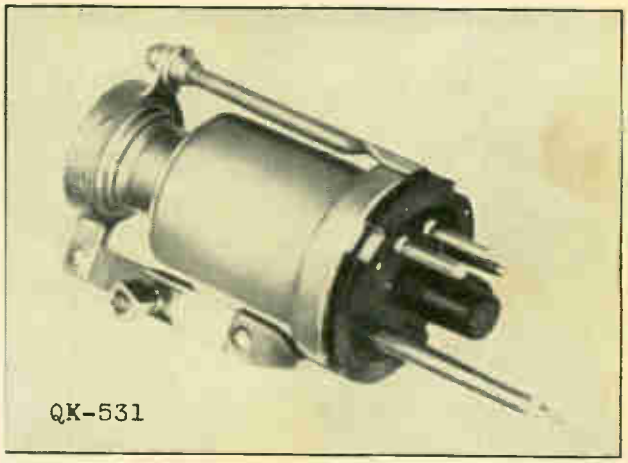
RAYTHEON KLYSTRON CLOCKS 62,000 HOURS OF SERVICE

--tube retired after seven years of continuous operation

We don't send out 62,000-hour warranties; however, you can expect unusual performance from Raytheon klystrons. Take the tube cited above -- the QK-531 -- a 6,575-6,875 mc reflex klystron which we conservatively warrant for 7,500 hours. As the local oscillator in the Houstonia, Missouri, link of the Panhandle Eastern Pipeline Company's 400-mile microwave system, the tube performed a major function in relaying up to ten channels of information between the Odessa and Boonville stations.

How is this kind of performance built into a tube? Advanced manufacturing techniques and rigorous quality control is the answer.

If you need low-power coverage of government, studio link and common carrier frequency bands, look into the characteristics of Raytheon's complete line of klystrons.



QK-531

The QK-531 is particularly suited for local oscillator service in microwave receivers. It is useful, also, as a local oscillator in microwave spectrum analyzers, as a pulse generator for testing circuit response and as a frequency modulated source in microwave relay links.

Homer Marrs of Motorola presents gold-plated klystron trophy to F. J. McElhatton, Panhandle Eastern Pipeline Co. J. A. Fowler, Supervisor of Communications for Panhandle, is at the left. Prized klystron, the Raytheon QK-531, performed for 62,000 hours.

Close control of product quality and costs at every state of production is responsible, in part, for Raytheon's success in meeting industry and government specifications. Every step of assembly is spot checked by inspectors, each with 10 years or more experience in microwave tube production.

Excellence in Electronics

RAYTHEON

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: E. Waterloo, Ontario.

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

October 21, 1960

electronics

A McGraw-Hill Publication 75 Cents

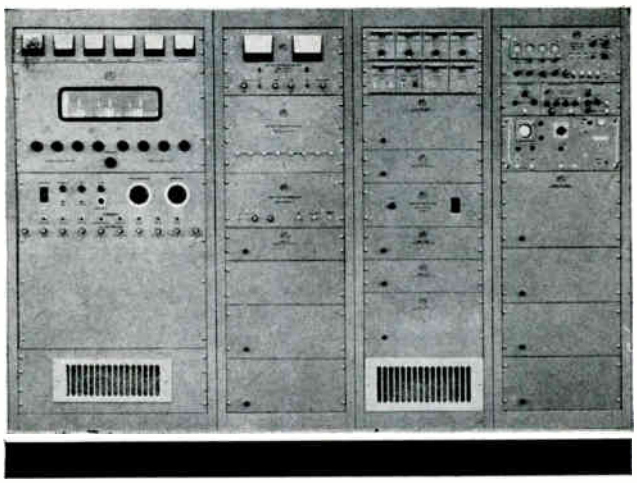
W. W. MacDONALD, Editor

BUSINESS

ENGINEERING

DEPARTMENTS

GRANGER ASSOCIATES' fast-stepping ionosphere sounder makes possible substantial improvements in long-distance hf radio communications ● it provides instantaneous optimum frequency measurement ● it automatically selects alternate frequency following point-to-point circuit failure ● it observes hf broadcast coverage area by means of backscatter sounding



THE PROBLEM: Long distance hf radio communication depends critically on ionospheric conditions. Under "normal" conditions, gross changes occur between day and night; and solar flares can, and frequently do, cause rapid variations that cannot be predicted. To improve hf communication reliability, major communication centers need the capability to select the *optimum working frequency* based on actual conditions at the time of operation. A related problem: in point-to-point communications it is often necessary for both parties to switch rapidly to an alternate frequency when sudden disturbances cause a circuit failure. This alternate frequency should be selected automatically and instantaneously; and both operators must immediately know what the new frequency is.

THE EFFECTIVE ANSWER is Grangers Associates' high speed step-frequency ionosphere sounder. It scans up to 160 frequencies from 4 to 64 Mc at rates up to 50 channels per second. It can be used for vertical-incidence or backscatter sounding; and two equipments can be remotely synchronized for instantaneous optimum frequency measurement. Operation is entirely electronic—there are no mechanical switches or tuning devices. Special antennas for use with the sounder are available from G/A.

FOR POINT-TO-POINT COMMUNICATIONS: With two sounders operating on a synchronized transponder mode instantaneous measurement of the best working frequency is provided among the available channels. Following a circuit failure, operators at each end need only push a single button to place the sounder in operation. Within minutes a new frequency has been selected, and operators at both ends are informed of the new frequency. Both coordinating order wires and the need for tedious systematic frequency searches are eliminated. Since the time required for this operation is so brief, a single sounder may suffice for all the circuits served by a communications station.

FOR BROADCAST APPLICATIONS: Backscatter sounders have already been effectively utilized in determining high frequency broadcast coverage. This technique makes it possible to observe broadcast coverage area in detail from the transmitter location. Range information is provided by the time delay of the backscattered signals, and azimuth information may be obtained with a rotating directional antenna. Since the new G/A sounder is extremely flexible, it becomes possible to sound on the broadcast frequency automatically at times when the program material is interrupted for even a fraction of a second. This enables the station operator to observe the skip distance and the propagation conditions during the normal programming period. He will know immediately if abnormal propagation conditions develop, and broadcast listeners can be directly informed at that time of a frequency or band more likely to produce satisfactory reception.

SPECIFICATIONS/STEP-FREQUENCY IONOSPHERE SOUNDER MODEL 902

Frequency Range	4.05 Mc to 63.6 Mc
Number of Channels	Selectable: 160 or 40
Frequency Increment	100 kc, 200 kc, 400 kc and 800 kc in four octave bands
Pulses Per Channel	Selectable: 1, 2, 5, or 10
Pulse Length	Selectable: 50, 100, 500, or 1000 μs
Pulse Repetition Rate	Selectable: 2, 5, 10, 20, or 50 pps
Duty Cycle	2% Max.
Channel Scan Rate	$\frac{\text{Channels/Scan} \times \text{Pulses/Channel}}{\text{PRF}}$
Range Marks	Timing comb with markers every 0.2, 1.0, 2.0 and 10.0 milliseconds.
Frequency Marks	Every tenth channel.
Receiver Bandwidth	Selectable: 6 or 16 kc
Receiver Sensitivity	0.5 μv for 2:1 signal + noise to noise.
Receiver Dyn. Range	Greater than 30 db.
Power Output	500 watts.
Operating Controls	Pulse length, repetition rate, receiver gain and bandwidth, manual or automatic frequency step.
Frequency Stability	5 x 10^{-8} parts per week.

Also Available: Model 903 Step-Freq. Receiver, identical to Model 902 without transmitter section; Model 904 Step-Freq. Transmitter, identical to Model 902 without receiver section. 30, 60, or 100 kw Pulse Distributed Amplifiers, and antennas for Sounder.

Granger ASSOCIATES

Send For Complete Information **GRANGER ASSOCIATES / 974 Commercial Street / Palo Alto, California / DAvenport 1-4175**

New LAMBDA
Regulated Power Supplies
5 and 10 AMP 0-34 VDC

CONVECTION COOLED

3½" PANEL HEIGHT ON 5 AMP MODELS

- **Convection cooled—no internal blowers to wear out**
- **Guaranteed for a full 5 years**
- **Ambient temperature 50°C**
- **Excess ambient thermal protection**
- **Special, high purity foil, hermetically sealed long-life electrolytic capacitors**
- **Hermetically sealed transformer designed to MIL-T-27A**
- **Remote sensing and DC vernier**

New LAMBDA LA Series Condensed Data

DC OUTPUT:

(Regulated for line and load)

MODEL	VOLTAGE RANGE[1]	CURRENT RANGE[2]	PRICE
LA50-03A	0-34 VDC	0- 5A	$395
LA50-03AM	0-34 VDC	0- 5A	$425
LA100-03A	0-34 VDC	0-10A	$510
LA100-03AM	0-34 VDC	0-10A	$540

[1] The output voltage for each model is completely covered in four steps by selector switches plus vernier control and is obtained by summation of voltage steps and continuously variable DC vernier as follows:

MODEL	VOLTAGE STEPS
LA 50-03A, LA 50-03AM	2, 4, 8, 16 and 0-4 volt vernier
LA100-03A, LA100-03AM	2, 4, 8, 16 and 0-4 volt vernier

[2] Current rating applies over entire output voltage range

Regulation: Line: Better than 0.15 per cent or 20 millivolts (whichever is greater).
Load: Better than 0.15 per cent or 20 millivolts (whichever is greater).

Transient Response: Line or Load: Output voltage is constant within regulation specifications for step function line voltage change from 100-130 VAC or 130-100 VAC or for step-function load change from 0 to full load or full load to 0 within 50 microseconds after application.

Ripple and Noise: Less than 1 millivolt rms with either terminal grounded.

AC INPUT:

100-130 VAC, 60 ± 0.3 cycle. This frequency band amply covers standard commercial power lines in the United States and Canada.

OVERLOAD PROTECTION:

Electrical: Magnetic circuit breaker front panel mounted. Special transistor circuitry provides independent protection against transistor complement overload. Fuses provide internal failure protection. Unit cannot be injured by short circuit or overload.

REMOTE SENSING:

Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

PHYSICAL DATA:

Size: LA 50-03A...3½" H x 19" W x 14⅜" D
LA100-03A...7" H x 19" W x 14⅜" D

Panel Finish: Black ripple enamel (standard). Special finishes available to customers specifications at moderate surcharge. Quotation upon request.

Send today for complete data

LAMBDA ELECTRONICS CORP.
11-11 131 STREET • DEPT. 1 • COLLEGE POINT 56, N. Y. • INDEPENDENCE 1-8500

CIRCLE 3 ON READER SERVICE CARD

electronics

Oct. 21, 1960 Volume 33 Number 43

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CROSSTALK

UPGRADING THE CONSUMER. With the television receiver manufacturing industry bumping its nose every year now with a market saturation of some 90 percent, industry leaders are devoting a lot of time to schemes for expanding the market.

Thinner sets made possible by 110-deg picture tubes, the 19-in. and 23-in. tubes, and remote-control systems have helped but they have not forced anything like the planned obsolescence an industry such as the automobile industry has been able to create. Color television seems still to be around some corner or other.

Another answer is to educate the consumer to how good television can be. A decade of price-cutting design changes has so eroded the performance of the average television receiver that most consumers no longer know what really good television reception looks like. Travelers abroad often return singing the praises of British television when actually the British tv standards technically are inferior to ours.

If the consumer could be taught to want better television reception it would be well within the ability of set manufacturers to design it into new models with only a moderate increase in price. For example, there is d-c restoration; if the consumer knew that the tv picture was supposed to fade to black, not mouse-grey. Also, full 4.5-Mc video bandwidth instead of the 2.5 to 3.5-Mc bandwidth common today; if the consumer knew there was such a thing as grey scale, that pictures didn't have to be just black or white with nothing much in between these extremes. Other improvements could include improved horizontal linearity to reduce picture distortion, video response control not uncommon on European sets and really low-noise front ends using new r-f amplifying devices.

Maybe the consumer forever will buy television strictly on price and cabinet styling alone, content with marginal technical performance of the set. But if the industry can upgrade the consumer's taste, what a wonderful opportunity to resell a large part of the television set market. To us, it seems worth some effort and investigation.

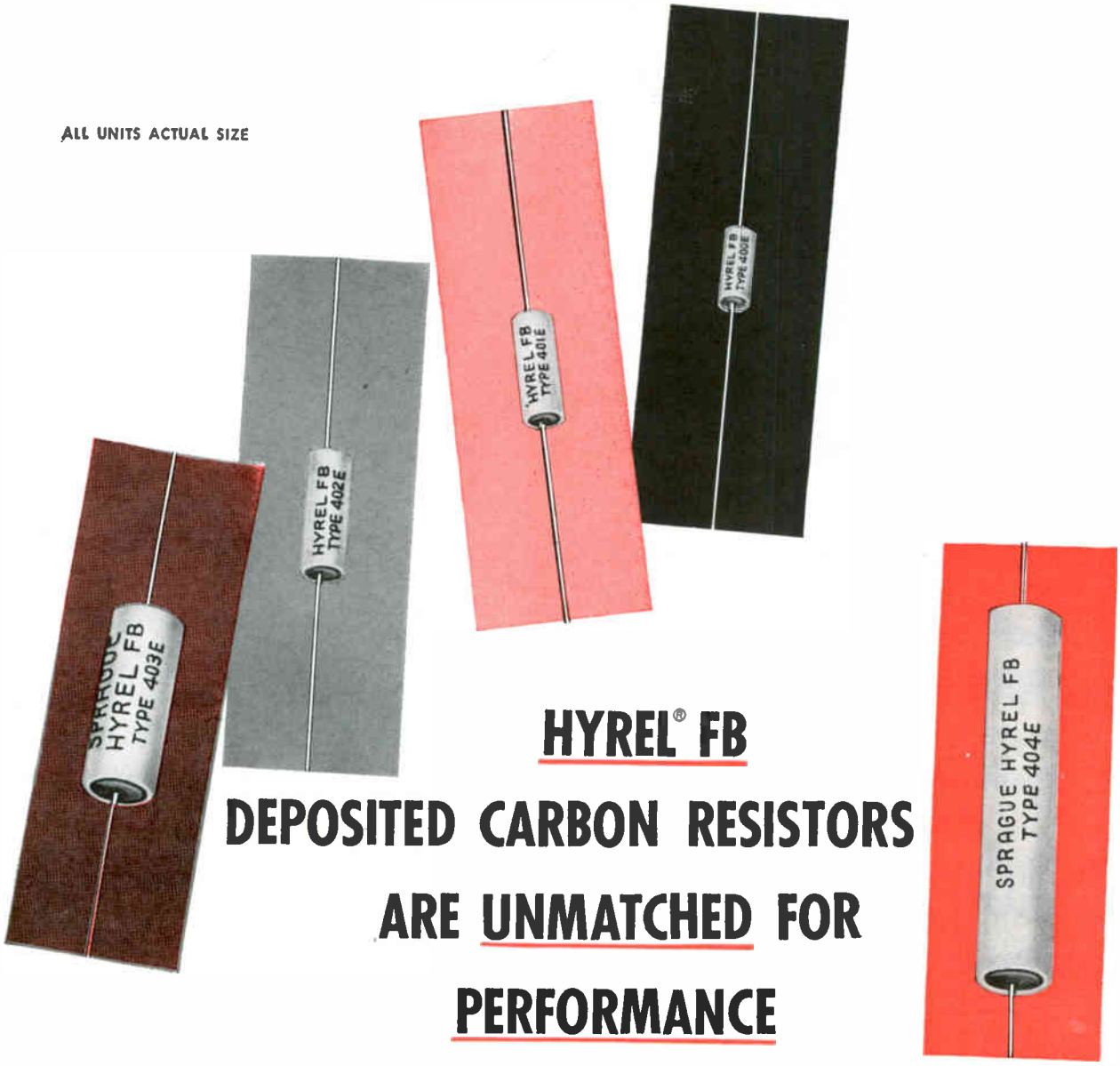
Coming In Our October 28 Issue

NEXT ABLE SPACE PROBE. One day next month, missilemen hope to see the next in the historic series of Able space probes blast off for an orbit about the moon. Largest and most sophisticated of the NASA/USAF Able series, the Able-5 lunar satellite will carry scientific experiments for obtaining data concerning the moon, its immediate environment and the space between earth and moon.

In our next issue, P. F. Glaser and E. R. Spangler of Space Technology Laboratories describe the experiments, instrumentation and temperature control system for Able-5. Their fascinating article tells about the magnetometers, five radiation detectors and micrometeorite detector, as well as the telemetry, power supply and temperature control systems.

IN ADDITION: The variety of interesting feature articles to appear next week includes: an airborne optical beacon by A. Finlay and R. E. DeMuth of Battelle Memorial Institute and W. D. Hall of Grimes Manufacturing Co.; a telemetry system for monitoring jet car performance by A. D. Runnalls of Sir W. G. Armstrong Whitworth Co. Ltd; designing diode AND gates by F. E. Kirkland of Western Electric Co; and communications using groundscatter propagation by R. T. Wolfram of Stanford Research Institute.

ALL UNITS ACTUAL SIZE



HYREL® FB DEPOSITED CARBON RESISTORS ARE UNMATCHED FOR PERFORMANCE

★ ★

HYREL® FB DEPOSITED CARBON RESISTORS are hermetically sealed in ceramic jackets against moisture and vapor... **safely protected** against mechanical abuse. The Hyrel FB series is intended for applications in military, commercial and telephone equipment where **long life under high humidity, small size, and stability of electrical characteristics** are important.

WRITE FOR ENGINEERING BULLETIN 7010B

SPRAGUE ELECTRIC COMPANY

35 MARSHALL STREET • NORTH ADAMS, MASS.

SPRAGUE®

THE MARK OF RELIABILITY

Made to far exceed MIL-R-10509C Specifications

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

COMMENT

Down on the Farm

There has been much talk about the farm problem and it seems that modern methods of communication and computation now make it possible to do something about it.

Without subsidy, a farmer will choose to grow the crop which will bring the best price. This price can be predicted in advance by totalizing reports from County Agents all over the country on planned acreage of each crop. Total production compared with demand extrapolated from the previous year will result in a probable unit price for each crop. Then daily transmission to all County Agents of revised commodity prices for all crops will enable each farmer to make an intelligent decision as to which crop is most advisable to plant.

It would be good business for the electronics industry as well as the poor taxpayer if a system of this magnitude were installed in the United States. The present bill for farm subsidy is over $8 billion annually. The electronics required for this plan would be considerably less than this, but certainly not to be scoffed at. And surely no taxpayer would be against such an improvement.

CHARLES W. GASTON
MONTGOMERY, ALA.

It's not a bad notion, and certainly we need some new ideas on handling our farm surplus. But we feel that few farmers would welcome placing their financial wellbeing at the mercy of a mechanized system. Also, reader Gaston's system would require farmers continually to readjust planting plans right up to plowing time.

Besides, both political parties stand firmly on farm planks that commit the federal government to uncomputerized supports and controls.

The Reinvented Circuit

Reference is made to the article by E. W. Van Winkle ("Circuit Removes D-C from Amplifier Signal Output") in ELECTRONICS for Aug. 12, p 150.

I am certainly glad that this circuit has been "recently declassified"!

I had been totally unaware that I was violating the security regulations by keeping my Vol. 18, MIT Radiation Lab Series on the bookshelf.

On page 486, a circuit by J. W. Gray is described. I call particular attention to the last sentence on the page.

"Recently declassified" indeed!

I appreciate the efforts of engineers who want to propagate new and useful circuitry for the general benefit of others. I think, however, it is a duty to first give a cursory check in the existing literature to see if this information is not already available.

This is a pet peeve of mine, as I constantly see engineers wasting valuable time reinventing solutions to problems already solved, when a few hours spent looking through reference books and technical magazines could save endless days wasted on repeating the brainwork of others.

SERGIO BERNSTEIN-BERVERY
BERNE ELECTRONICS
VALHALLA, N. Y.

Here's how author Van Winkle answers reader Bernstein-Bervery:

The phrase "recently declassified" referred to the circuit discussed in my article. This circuit is covered in patent application 414,911, which was a classified application. The secrecy order was rescinded on Oct. 26, 1959, and the application processing continued. Patent 2,927,164 was granted on Mar. 1, 1960, covering this circuit.

Part of the circuit appears on p 428, Fig. 11.14, and part of the circuit is on p 486, Fig. 11.69, of Vol. 18, MIT Radiation Lab. Series. A similar circuit appears in Chestnut and Mayer, *Servomechanisms and Regulating System Design*. Vol. II, p 173,, Fig. 5.6-2.

None of these figures embodies the whole circuit, and the date of the invention preceded the publication of the volumes. References cited in the patent are prior patents 2,369,138; 2,513,354; 2,549,833; 2,554,469; 2,579,633 and 2,763,733. Sufficient differences existed to justify granting patent 2,927,164.

EDGAR W. VAN WINKLE
BENDIX CORP.
TETERBORO, N. J.

EX-CELL-O CONTOUR PROJECTORS GIVE YOU MORE—

1. **LARGEST WORK AREA** — Regardless of magnification there is a constant eight inches of work space from lens to focal plane to accommodate large objects. The Model 30 has a 12" diameter capacity.

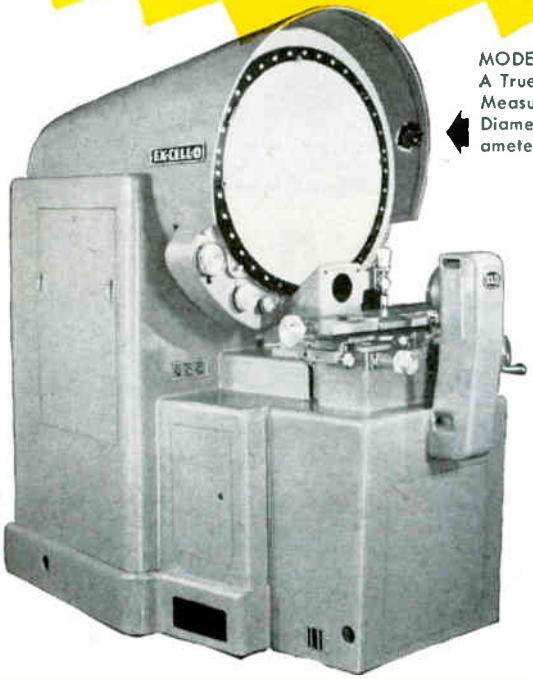
2. **UNSURPASSED ACCURACY** — Kodak optics with famed Ektar® lenses guarantee accurate measurements and give clear undistorted images over entire screen. You can depend upon optical decisions made on the Ex-Cell-O.

3. **TRUEST MEASURING PRECISION** — All Ex-Cell-O Contour Projectors read to tenths and measure to tenths. Each Ex-Cell-O contour projector is tested and checked to the highest laboratory standards before shipping.

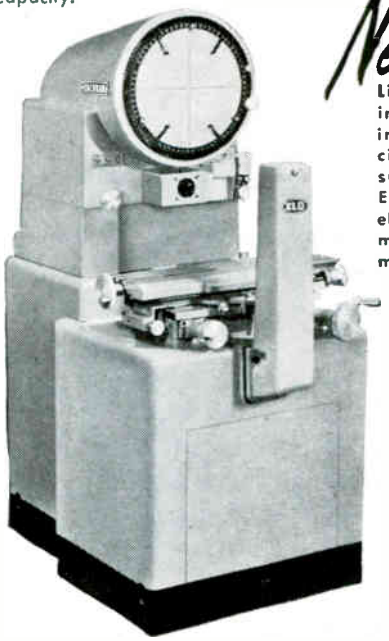
4. **BRIGHTEST GLARE FREE SCREEN** — Coated lenses and mirrors have been standard on all Ex-Cell-O models for many years. The patented "Fresnel" lens (exclusive with Ex-Cell-O) brings entire screen into clear view from normal operator position. Sharp clear images in normal room light—the brightest and clearest in the contour projector field!

5. **MOST RUGGED CONSTRUCTION** — Built to "stand the gaff." Solid construction with optical system locked into lifetime cabinets. Will withstand factory wear and tear—without getting out of adjustment. Guaranteed by Ex-Cell-O's long experience in the manufacture of precision machine tools.

6. **SIMPLEST OPERATION** — Finger tip controls, cool to the touch lamphouses, simple setting and measuring devices, unreversed images, all add up to comfortable day long operation. A precision machine of great accuracy that can be quickly mastered by average factory inspection personnel.



MODEL 30
A True, Heavy Duty Precision Measuring Projector with 30" Diameter Screen, and 12" Diameter Capacity.



New! **The Ex-Cell-O Mercury Arc Light Source Accessory. A high intensity Accessory light source including Mercury Arc Lamp, special collimator and auxiliary power supply. Quickly adaptable to all Ex-Cell-O Contour Projector Models (except Model 8) to give maximum screen brightness at higher magnifications.**

Write for new booklet "See The Savings" which graphically demonstrates time savings through optical gaging over conventional methods.

MODEL 14-5
The Finest, Most Versatile, 14" Screen Contour Projector Available.

Manufactured by EX-CELL-O Corporation of Detroit, Mich.

SOLD AND SERVICED BY

OPTICAL GAGING PRODUCTS, INC.

26 FORBES STREET ROCHESTER 11, N. Y.

(A subsidiary of EX-CELL-O Corporation)

Now you can monitor directly, continuously .... on operating

All-New, Transistorized hp 344AR Noise Figure Meter

The new hp 344AR Noise Figure Meter assures you that your radar is continuously operating at peak performance, and you are enjoying maximum range. The instrument's fast meter response lets you optimize or adjust the system during operation or maintenance. Model 344AR is designed for the utmost in dependability—it is militarized, transistorized, very compact and very rugged.

With this new 5¼" high instrument system noise figure is measured on a time-shared basis with the radar scan. The unit has high sensitivity to minimize signal and transmitter losses; the noise source may be decoupled 20 db from the main transmitter line. Two alarm functions give visible and electrical indication when an allowable noise figure is exceeded, or a noise source malfunctions.

High voltage on antenna slip rings is eliminated with a remote noise source modulator operated with low voltage triggers. Other features include quick, easy front panel calibration, and remote metering and alarms if desired.

FREE APPLICATION NOTES INCLUDE CONSIDERATIONS FOR AUTOMATIC MEASUREMENT OF NOISE FIGURE ON A CONTINUOUS BASIS

Write hp direct for Application Note 43—"Continuous Monitoring of Radar Noise Frequency". Discussion includes description of hp 344AR and its application to radar systems.

noise figure and automatically radars!

Separate Modulator, Noise Source

The new hp 344AR Noise Figure Meter operates on either a 25 or 30 MC IF frequency. It is designed for pulse radars with repetition rates of 90 to 500 pps; also, its high sensitivity and compact design make it very valuable in all radars, including high PRF and CW Types. In its free-run mode it measures receiver noise figure without turning on the transmitter or radar timing circuitry. Thus periodic measurement and maintenance procedures are simplified.

The 344AR's noise source and modulator are separate units which may be mounted on the antenna mast or in an aircraft. In the first case, high voltage connections are short and beyond slip rings. In the second case, you save weight and space and measure noise figure on the ground through low voltage connections.

Operation

The hp 344AR measures noise figure by operating a standard noise source and comparing the noise output of equipment under test when the noise source is off to the noise output when the noise source is on. Since the hp 344AR measures in synchronism with the radar, the noise source and measuring circuitry are triggered by a pulse from the radar's timing circuit, occurring at the end of the radar scan.

SPECIFICATIONS

hp 344AR Noise Figure Meter

Input Frequency:	25 or 30 MC, as specified
Bandwidth:	1 MC
Input Sensitivity:	Requires 35 db ± 5 db gain between noise source and 344AR input
Input Impedance:	75 ohms nominal. Passive termination during radar scan
Return Loss:	20 db from 20 to 40 MC
Accuracy:	± 0.5 db, 0 to 12 db; ± 1 db, 12 to 20 db
Repetition Rate:	90 to 500 pps, as specified
Total Duty Factor:	0.075 + (100 μsec) × (PRF)
Input Trigger:	3 v pos. peak, 3 μsec duration
Output:	100 μamp into 2,000 or 3,000 ohms
Temperature Range:	0 to 52° C
Humidity:	95%
Power:	115 v ± 10%, 50/1,000 cps, 20 to 40 watts (depending on noise source and duty cycle)
Dimensions:	5¼" high, 19" wide, 8" deep.
Price:	$1,600.00 approximate. Depends on options and modifications.

hp 340B/342A Noise Figure Meters

General-purpose instruments making possible, in minutes, receiver and component alignment jobs that once took hours. Simplify accurate alignment; encourage better maintenance; better performance.

hp **340B** automatically measures, continuously displays noise figure of IF amplifiers or microwave devices with output at 30 or 60 MC. Other frequencies on special order. Operates both temperature limited diodes or hp 347 Waveguide Noise Sources. $715.00 (cabinet) $700.00 (rack).

hp **342A**, similar, operates on 30, 60, 70, 105, 200 MC. 30 MC and 4 other frequencies between 38 and 200 MC on special order. $815.00 (cabinet) $800.00 (rack).

(Note: Models 340B and 342A available only in the U.S.A. and Canada.)

hp **343A vhf Noise Source**, temperature limited diode broadband source, 10 to 600 MC, 5.2 db excess noise, $100.00.

hp **345B IF Noise Source**, 30 or 60 MC (others to order); 4 impedances, 5.2 db excess noise. $75.00.

hp **347A Waveguide Noise Source**. Argon gas discharge tubes in waveguide sections; for bands S, G, J, H, X, P, 2.6 to 18.0 KMC, 15.2 db excess noise. $190.00 to $250.00.

HEWLETT-PACKARD COMPANY

1053A Page Mill Road Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000

Field representatives in all principal areas

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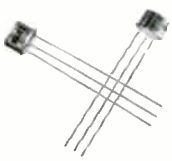
Data subject to change without notice. Prices f.o.b. factory.

HUGHES 2N1196 & 2N1197 DOUBLE-DIFFUSED MESA SILICON TRANSISTORS

These amplifiers can take it. Hughes 2N1196 & 2N1197 transistors were developed in conjunction with the U.S. Army Signal Corps on an IPS contract for military devices. They meet the exacting requirements of MIL-T-19500-A. ■ Among the ordeals these devices have undergone is a 5000-hour storage test at 200°C. But they re-prove their ruggedness and reliability every time. h_{fe} and leakage currents stay constant and uniform. They're guaranteed to do so. ■ All units are stabilized at 300°C during processing. ■ These PNP double-diffused mesa silicon transistors are outstanding in another way. They have an extraordinary *combination* of parameters. For instance: High alpha cutoff frequency, low collector shunt capacitance, low power requirements and low signal distortion, high gain at high frequency. And, as proven by the vigorous tests, for high-temperature operation these amplifiers can really take it. ■ For further information contact your nearest Hughes Semiconductor sales office or authorized distributor. Or write Hughes Semiconductor Div., Marketing Dept., 500 Superior Ave., Newport Beach, Calif. For export, write Hughes International, Culver City, Calif.

SPECIFICATIONS @ 25° C			
ABSOLUTE MAXIMUM RATING	2N1196	2N1197	Units
V_{CEO} @ I_{CEO} = −100 μA	−70	−70	volts max
V_{CBO} @ I_{CBO} = −100 μA	−70	−70	volts max
V_{EBO} @ I_{EBO} = −100 μA	− 4	− 4	volts max
ELECTRICAL CHARACTERISTICS			
G_e @ V_{CE} −10V, I_C = mA	28 @ 4.3Mc	22 @ 12.5Mc	db typ
$f_{\alpha b}$ @ V_{CB} = −10V, I_E = 2mA	45	55	Mc typ
C_{ob} @ V_{CB} = −10V, I_E = 0, f = 140Kc	3	3	pf typ
I_{CBO} @ −20V, T = 200°C	−50	−50	μA max

350 mW dissipation in Free Air
Operating temperature range −65°C to +200°C



CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

SEMICONDUCTOR DIVISION
HUGHES AIRCRAFT COMPANY

ELECTRONICS NEWSLETTER

Stereo Standards Group Files Field-Test Report

DOCUMENTATION of stereo field-test data—amounting to a half-foot-high pile of paper—is due to be completed this week by the National Stereophonic Radio Committee, the study group set up by Electronic Industries Association to determine standards for stereophonic radio. After evaluating the data, Federal Communications Commission will select a system for broadcast use. With luck, the Commission will make its choice by yearend.

Along with the paperwork are tape recordings of broadcasts received over the air from station KDKA in Pittsburgh, the test site NSRC used. The report will make no recommendations regarding the six systems tested, will merely submit findings of fact to FCC.

Air Force To Set Up Electronics Plans Agency

AIR FORCE general staff is now studying a blueprint for overhauling the Air Force "L" systems (electronic communications, command, and control). The plan results from a 6-month effort by the 140 members of the USAF winter study group at Hanscom AFB, Bedford, Mass. It recommends the creation of a strong central planning and design agency for all electronic command-control systems.

Nucleus of the central planning agency will be the USAF command and control development division at Hanscom AFB; the division is currently headed by Major General K. P. Berquist. The Air Force Scientific Advisory Board will meet at Bedford next Monday for a three-day discussion of command-control problems.

Commercial Communications To Get Help From NASA

NATIONAL AERONAUTICS & Space Administration chief T. K. Glennan says the government will make rockets and launching facilities available to private industry for development of an international commercial satellite communications system.

Speaking to a state planning group in Oregon, Glennan indicated that the first nongovernmental satellite launching may take place "in the not too distant future," added that reliable satellite communications are "several years" away.

NASA expects to leave commercial developments to industry, will continue research for the present in both active and passive systems. Agency support will be given to "technically promising private proposals on a cost-reimbursable basis." Support will include "vehicles, launching and tracking facilities and technical services," to be made available at cost.

Silicon Carbide Transistors Now Reach for 925 F

TRANSISTOR capable of operating above 650 F was announced last week by two Westinghouse engineers. The device is made from silicon carbide, operates at a temperature above the melting point of lead. It was described at the Fall meeting of the Electrochemical Society in Houston, Tex. The new transistor was developed under sponsorship of the Electronics Research Directorate of the Air Force Cambridge Research Laboratories.

Germanium transistors are currently temperature-limited at about 200 F; silicon units can operate up to 400 F. Lab tests of the SiC device show that it amplifies power up to 670 F; with further development. Westinghouse expects to be able to push its limit up to more than 925 F.

National Alarm Device Tested By OCDM

OFFICE OF CIVIL & Defense Mobilization has successfully tested a simple alarm device that could alert 96 percent of the U.S. population in seconds in case of national emergency.

The device, dubbed NEAR (national emergency alarm repeater) was tested last week in more than a thousand homes in Charlotte, Mich. Several designs are currently held under OCDM patent; the one tested last week was designed by Midwest Research Institute, built by the AC Spark Plug division of General Motors. It consists of a vibrating reed, a timing motor and a relay sensitive to 240 cps. Only electronic component is a diode rectifier.

The 3x3x2-inch device plugs into an electric outlet. In case of emergency, national attack warning system (NAWAS) would send out a master alarm from its Colorado Springs headquarters to all electric-power companies. These in turn would send out a 1-volt 240-cps signal superimposed on the ordinary 60-cps utility service. After a 70-second delay (to keep the alarm from being triggered by transients), the receiver emits a loud, insistent buzzing.

Outfitting the power companies would cost $60-70 million. The alarm receivers would probably cost about $10. OCDM hopes the NEAR system will be a nationwide reality within three years.

Soviets Use Computer For Brain Research

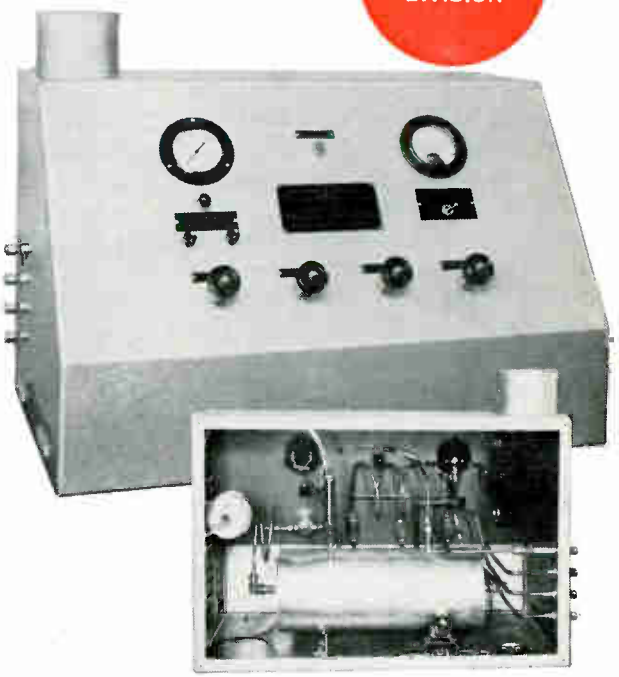
SOVIET LIFE-SCIENCE researches are digging into the operational intricacies of the human brain. M. Livanov of the Soviet Academy's Research Institute of Physiology in Higher Nervous Activity has hooked an electric encephaloscope to a computer in an effort to establish the pattern of cortical connections and find out more about brain conditioning and the learning process.

Livanov's encephaloscope was first exhibited at the Brussels World Fair in 1958. It picks up bioelectric currents by means of 100 electrodes affixed to the head. Livanov is now developing an instrument for simultaneously recording 400 pickoffs.

By hooking the instrument into a computer, Livanov expects to be able to correlate readings to determine close and loose couplings and watch how they change under conditioning. Part of his aim is to aid in diagnosis; he is also interested in pursuing further Pavlov's work in conditioned reflexes.

Palladium Diffusion Purifier removes all impurities from commercial cylinder hydrogen

CHEMICAL DIVISION



The Engelhard Palladium Diffusion Purifier is used to remove all impurities from commercial cylinder hydrogen. This includes such impurities as oxygen, nitrogen, argon, water vapor, hydrocarbons and any others found in commercially bottled hydrogen.

The hydrogen purity achieved is, without question, the highest obtainable—no trace of impurities are detectable in the purified gas, by any known method.

Electrical circuit interlocks prevent palladium and hydrogen contacting at 150°C to form beta phase Pd-H2 system which is brittle and impervious. Impurities are not permitted to accumulate within the palladium tubes. Impurities are bled off continuously with a small hydrogen stream which is vented to a hood or a small burner. A check valve located in the pure product line prevents back flow into the tubes.

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Thermal Conductivity	0.71 c g s UNITS (20°C)
Coef. Linear Expansion	14.2 Micro Inches /°C (20°C)
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WASHINGTON OUTLOOK

MILITARY ELECTRONICS research and procurement for the years ahead is sure to be affected by the interservice squabble now bubbling up in the Pentagon. The argument is over the nation's deterrent strategy. At stake are decisions on the numbers and types of manned aircraft, missiles and other strategic weapons systems to be added to U. S. retaliatory strength over the next decade.

Air Force strategists on the one side, and the Army and Navy on the other, are arguing about what size nuclear striking forces this country should maintain to deter Soviet aggression. Air Force is putting forth a theory of an evergrowing counter-force; Army and Navy want to stop piling up an over-kill potential and start planning against brushfire wars.

Air Force theorists believe the Soviets could never knock out U. S. retaliatory forces in one big blow. They're concerned, therefore, with our second-strike capabilities. Their theory holds that an all-out nuclear war does not necessarily involve city-busting or genocide. Says one USAF strategist: "Our analysis is that if the Soviets were to attack the U. S., the last thing they would want to attack is our people. Genocide has no military value. Populated cities are hostages and you don't want to kill hostages."

The Air Force envisages that offensive strikes in any possible nuclear war would be aimed at sources of military power—missile sites, bomber bases, and the like; cities would suffer only collateral damage. Air Force's argument is that as the enemy's offensive capacity increases, our own forces must grow to be able to strike at and destroy his more numerous bases of operation.

Implicit in the Air Force theory is a projection of ever-rising military expenditure.

Army and Navy theorists disagree with the argument that strategic forces must continue to grow. They say an all-out nuclear war is unlikely because of its suicidal consequences, that limited local conflicts are a greater threat. Instead of building up an enormous over-kill capacity in heavy bombers and big missiles, the elder services say the U. S. should be putting more money into conventional forces to fight these brushfires as they break out.

Their theory is that we need only enough nuclear striking power, in invulnerable or highly mobile forces, to deter Soviet attack. "Enough" in this view is the relatively stable arsenal of weapons needed to wipe out 150 or so major Soviet strategic centers.

The controversy over strategy takes on new significance as the Presidential election nears. The issue will be one of the key military questions dumped on the new administration. But it's not a question that will be resolved easily, quickly or even permanently. Policy of the Eisenhower administration, for example, has in theory reflected the Air Force opinion; in practice, limitations on defense spending have brought U. S. deterrent strategy more in line with Army-Navy views.

AIR FORCE plans to award a contract for development of a new fighter-bomber within the next six months. At least $25 million is earmarked in the current budget for initial development.

The plane has been tagged the F-X (also the F-111) and is envisaged as "the most flexible tactical aircraft ever designed." Some Air Force planners also foresee use of the plane as an advanced fighter-interceptor and as a carrier-based craft for the Navy. The F-X is to have short-takeoff-and-landing capability, will be able to operate at both low and extremely high speeds.

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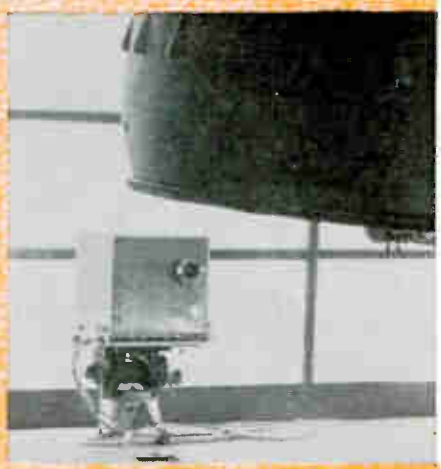

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TRACE-MASTER'S multiple-feedback wide-range Driver circuitry, combined with the advanced pen-motor design, produces wider frequency response *at larger amplitudes* than any other recorder. TRACE-MASTER response is flat—*within 1%*—from dc to 110 cps at 40 mm!

Band Amplitude Product (i.e. Bandwidth times Amplitude) is 5600...140 cps (3 db point) x 40mm!

Finest Chart-Drive Facilities

TRACE-MASTER provides widest chart-speed range...0.1 to 500 mm/sec...of any direct-writing recorder! Convenient push-button selection. Take-up reel automatically stores full 1000 ft. record. Writing table tilts for easy chart annotations. Guide rails permit quick, easy paper-roll changes. Low cost chart paper makes practical protracted recording at high speeds.

Finest Resolution, Linearity, Stability

Thin carbon trace (thinner by 4 to 1 over most recorders) and high Band Amplitude Product (higher by 6 to 1 over other recorders) provide up to 24 times the resolving power or ability to detect short, sharp variations in the record. The superior linearity (± 1%) and stability in rectilinear presentation permit full use of this unexcelled resolution.

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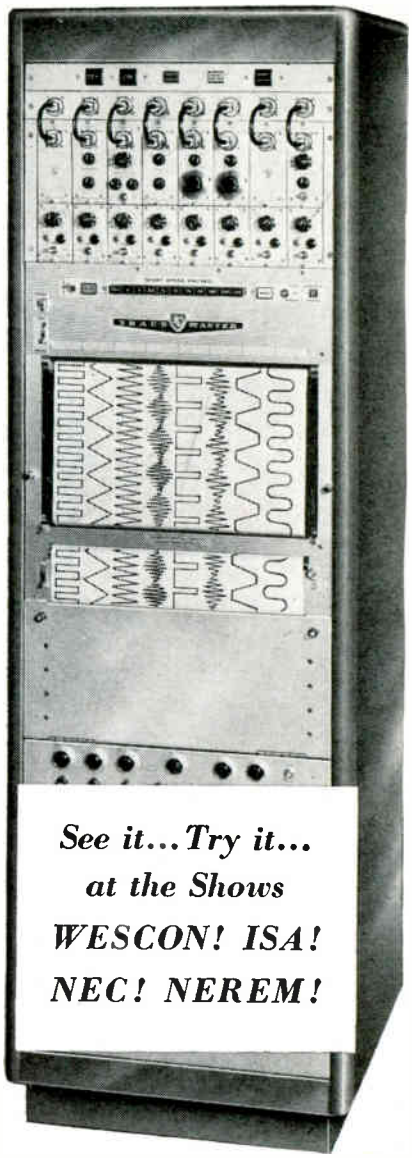
Fully transistorized circuitry...application of combined dc level and signal multiple feedback...complete interchangeability of modular signal-conditioning elements... are some of the features that make the AO TRACE-MASTER the world's finest 8-channel direct writing recorder.



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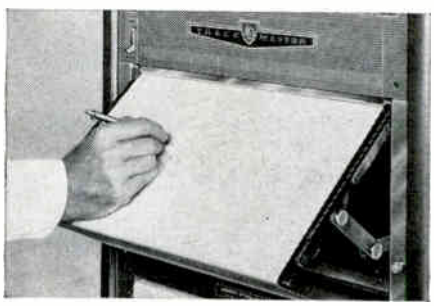
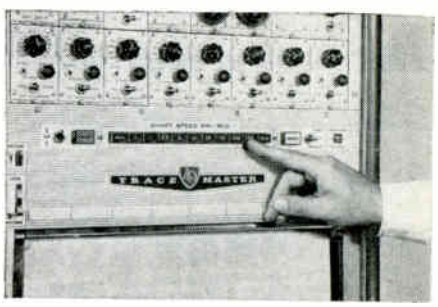
Entire channel easily accessible and completely interchangeable as single unit.



Platen tilts to convenient writing angle.



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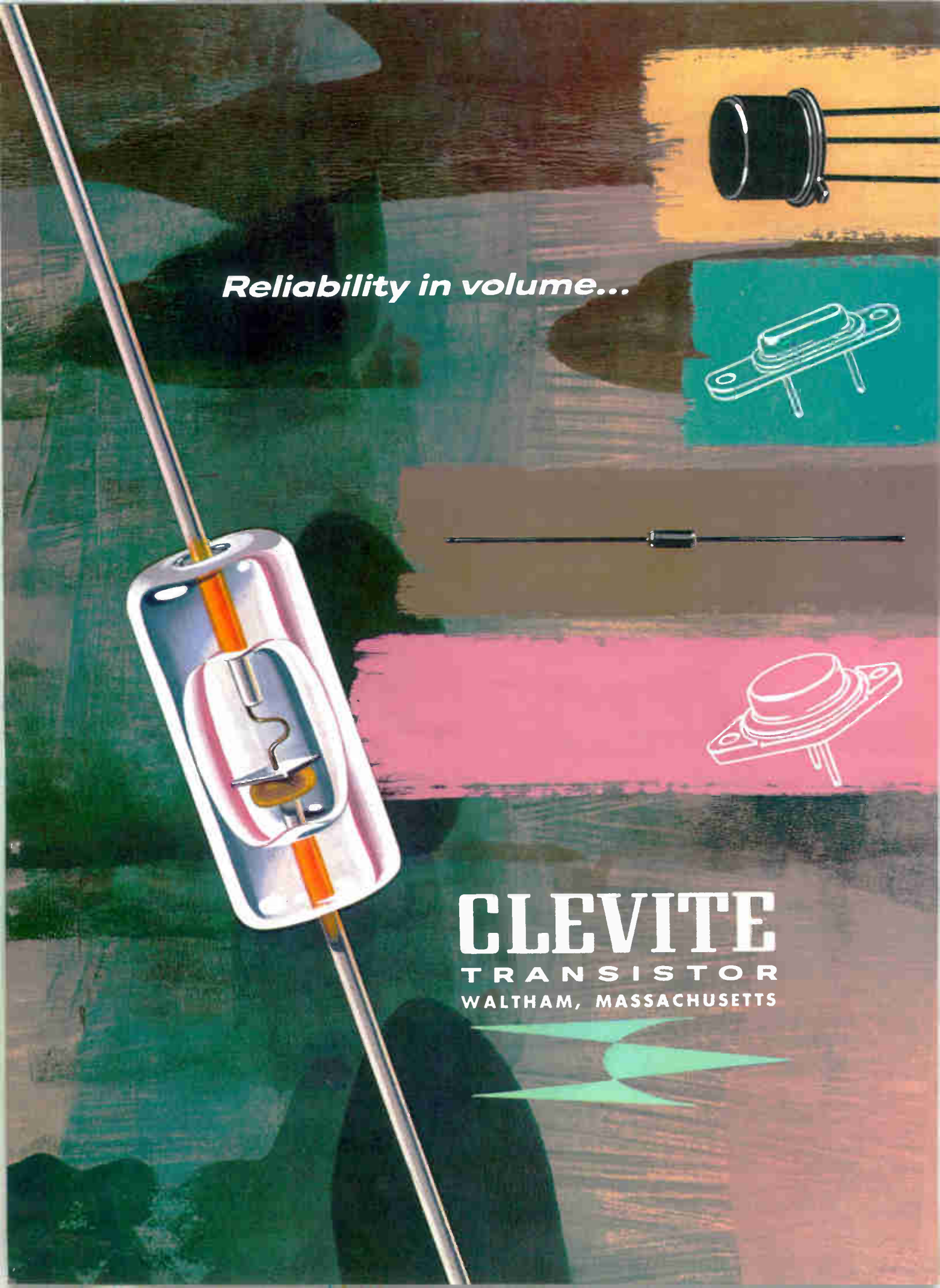
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Switching Types	Amplifier Types
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8 ampere	4 watt
15 ampere	2 watt Spacesaver
25 ampere	
3 ampere Spacesaver	

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For latest data and prices or application assistance, write for Bulletin 60 . . .

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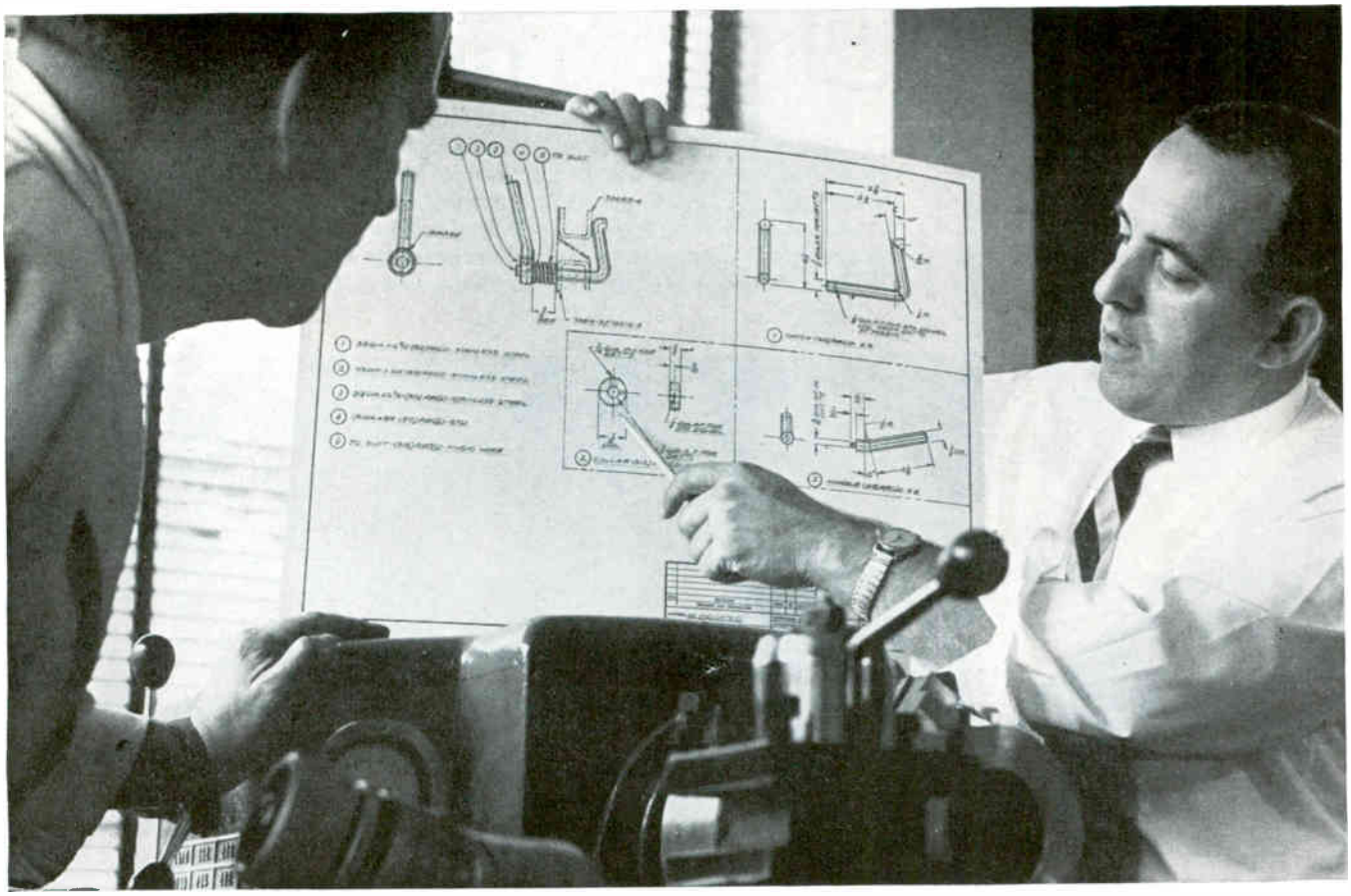
OZALID NEWSLETTER



Newest black-line intermediate paper copies fine details ... gives fast, easy-to-read prints

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Chances are you've already thought of a dozen more uses for 102 ITF . . . or will, as soon as you start working with it. We'll appreciate it mightily if you'll shoot 'em along to us!

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Also from Ozalid—two superior copy papers. *Black* image paper, standard speed, for office use. And *blue* image paper, rapid speed, for engineering drawings.

Both are smooth-surfaced, semi-glossy. Both make crisp prints and copies. The black image paper (105 SZ) reproduces halftones from a film positive with photographic clarity. The blue image paper (208 SZ) is tough enough for shop and field use, and wipes clean with a damp cloth.

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Perkin-Elmer Sales Up 26 Percent

THE PERKIN-ELMER CORP., Norwalk, Conn., reports a rise in net income as a percentage of sales for the fifth consecutive year. In fiscal 1960, ended July 31, this percentage was 5.5, compared with 5.1 the year before. Sales of $22.4 million were 26 percent ahead of the previous year's $17.5 million. Earnings of $1,208,085, equivalent to $1.05 a share, marked a 34-percent increase over earnings of $900,799, equal to $.80 per share, the year before. Backlog is reported at $11.5 million.

International Rectifier Corp., El Segundo, Calif., announces a sales rise of 21 percent and an increase in earnings after taxes of 37 percent for the fiscal year ended June 30 this year, compared with the same period last year. For this fiscal year, sales were $13,124,586, compared with $10,870,038 last year. Earnings after taxes were $1,206,007 or 52 cents a share, as against $877,371 or 36.4 cents in the preceding year.

Consolidated net income for **The Bendix Corp.** for the nine months ended June 30 this year was $17,359,408, equivalent to $3.23 a common share. These earnings compare with the higher figure of $17,745,589, or $3.48 a share, in the same fiscal period of 1959. Net income for the first nine months of this year is after provision for federal income taxes of $18,467,601. The comparable figure for the first nine months of last year was $20,705,693. Consolidated net sales, royalties and other operating income for the first nine months amounted to $606,009,118, compared with $504,553,408 reported for the first nine months of last year.

Federal Pacific Electric Co., Newark, N. J., reports net sales of $100,194,175 for the fiscal year ended June 30, 1960. Net earnings after deducting for minority interests amounted to $2,767,815. After deducting for dividend payments of $267,604 on all outstanding preferred stock, the earnings per share were $1.72 on 1,454,558 shares of common stock outstanding. These figures incorporate the sales and earnings of **Cornell-Dubilier** for the 12 months ending June 30, 1960, including the net loss of $395,543 for the last quarter of C-D's fiscal year which ended Sept. 30, 1960.

Craig Systems, Inc., and its wholly-owned subsidiary, **Le-Febure Corp.**, Cedar Rapids, Ia., report sales of $14,253,755 and net earnings of $591,298, equal to 77 cents per share on 772,862 shares, for the fiscal year ended July 31, 1960. Sales of the Lawrence, Mass., firm and its subsidiary were $12,081,619 in the previous year, with net earnings of $380,887, equal to 50 cents a share on 762,862 shares which were then outstanding.

25 MOST ACTIVE STOCKS

WEEK ENDING OCTOBER 7, 1960

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	876	27⅞	26⅝	27¼
Ampex	774	24½	22⅜	22⅜
RCA	686	55½	52¼	54⅝
Gen Elec	664	75⅜	71	74⅝
Westinghouse	572	51⅜	48⅝	50¾
Elec & Mus Ind	524	6⅞	6½	6⅝
Univ Controls	497	17¼	15⅞	16
Sperry Rand	494	20⅜	19½	20
Avco	459	14⅝	14⅛	14⅛
Int'l Tel & Tel	427	37⅞	36⅛	37⅜
Gen Dynamics	387	38¾	37	38⅛
Zenith	377	114¼	107	107⅝
Sterling Precis	326	3⅛	2½	3
Gen Inst	321	36⅝	33¼	34½
Beckman Inst	317	91¼	87	88½
Raytheon	311	37⅝	35⅛	35¾
Philco	293	21⅜	20	20
Litton Ind	289	77⅜	72½	75¾
Varian Assoc	264	48¼	44½	45⅛
Collins Radio	264	51⅜	47⅞	49⅞
Motorola	261	73⅜	66¼	66¾
Telectro Ind	254	16¼	14¼	15½
Nat'l Cash Register	225	57⅜	53¾	53¾
Texas Inst	216	184⅞	175¼	180⅜
Tung Sol Elec	213	35⅞	30¾	33⅝

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.

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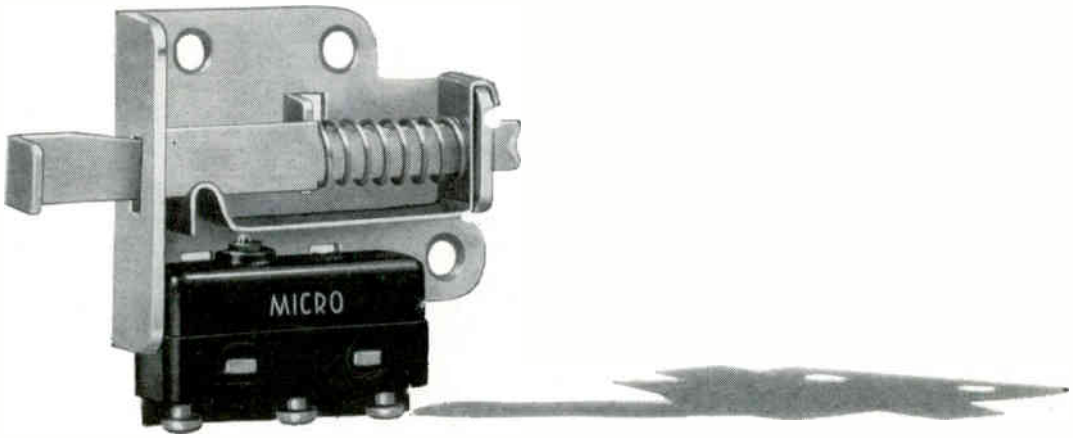
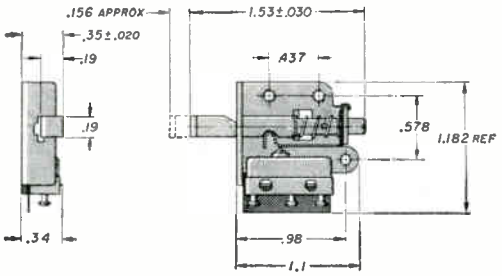
New Subminiature Door Interlock Switch...



Reliable safeguard even in contaminated atmosphere

Now you can specify reliable protection for electronic equipment with minimum size and weight requirements. This new subminiature door interlock switch can be installed on high voltage cabinets to automatically cut off the power circuit when the door is opened for repairs or testing. It operates reliably in locations subject to the effects of fungus, salt, fog, dirt, dust and high temperatures up to 250°F. Stainless steel is used in all metal parts to resist corrosion, give longer life, greater reliability. The basic switch conforms with military specification MIL-S-6743.

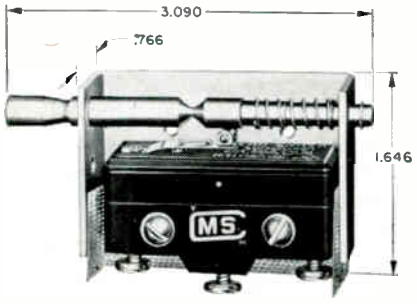
A "safety" position adds protection during maintenance. By manually pulling the plunger out to the maintained-contact position, you safely close the circuit for checking. When the door closes, the plunger returns automatically to normal operating position. This eliminates dangers in "tying down" or wiring around a conventional switch which may be forgotten after service is completed.



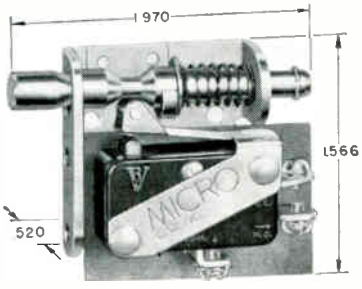
Series "17AC" Door Interlock Switch. Weight of this new switch is only .32 oz. Maximum dimension is only 1.5". Write for full information—ask for Catalog 63.

In Door Interlock Switches . . .

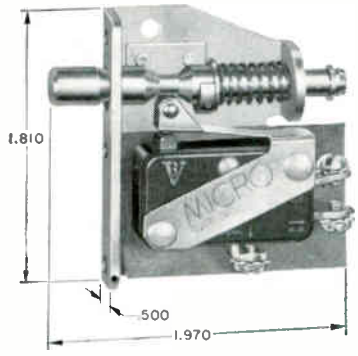
Only MICRO SWITCH Reliability means absolute safety!



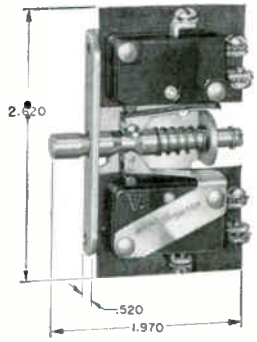
1AC Single-pole double-throw circuit. Basic switch is UL listed for 15 amps. 125, 250 or 460 vac; ½ amp. 125 vdc; ¼ amp. 250 vdc. Operating Force—3½ lb. max. Total Travel—.312 in. (approx.) each direction.



2AC Single-pole double-throw circuit. Basic switch is UL listed for 10 amps. 125 or 250 vac; ½ amp. 125 vdc; ¼ amp. 250 vdc. Operating Force—4 lb. max. Total Travel—¼ in. (approx.) push. 3/16 in. (approx.) pull.



3AC Single-pole double-throw circuit. Basic switch is UL listed for 10 amps. 125 or 250 vac; ½ amp. 125 vdc; ¼ amp. 250 vdc. Operating Force—4 lb. max. Total Travel—¼ in. (approx.) push. 3/16 in. (approx.) pull.



4AC A two switch double-pole double-throw assembly for controlling two circuits simultaneously. Basic switches are UL listed for 10 amps. 125 or 250 vac; ½ amp. 125 vdc; ¼ amp. 250 vdc. Operating Force—3 lb. max. Total Travel—¼ in. (approx.) push. 3/16 in. (approx.) pull.

Consult the Yellow Pages for the name of the nearby MICRO SWITCH branch office. Engineering assistance is available without obligation.

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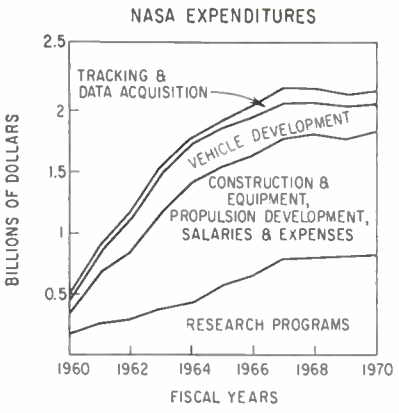
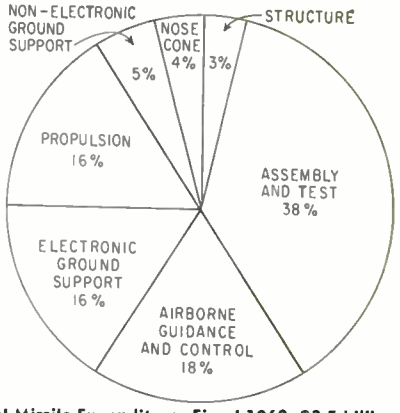




Total Missile Expenditures Fiscal 1960, $3.5 billion
Source: Comptroller's Div., Department of Defense

Space Complements Missile Growth

SPACE PROGRAM is based in great measure on military missile capability, and missile production is already the fastest-growing segment of military spending, opines Murray Weidenbaum, Boeing Airplane corporate economist.

His rough estimates of total missile and astronautics spending for the three services total approximately $4 billion for fiscal 1960. Fiscal 1970 spending will rise to about $8 billion, he indicates, accounting for 58 percent of Air Force procurement expenditures, 53 percent of Army expenditures and 20 percent of Navy expenditures.

Military economists estimate 33⅓ to 40 percent of missile procurement now goes to the electronics industry. Many say this portion will soon increase to about 50 percent.

Spending by National Aeronautics & Space Administration is expected to rise from less than $500 million in fiscal 1960 to $2.2 billion by 1967, Weidenbaum told a recent American Management conference on space technology. Cumulative expenditures through 1970 should total about $17½ billion, he said.

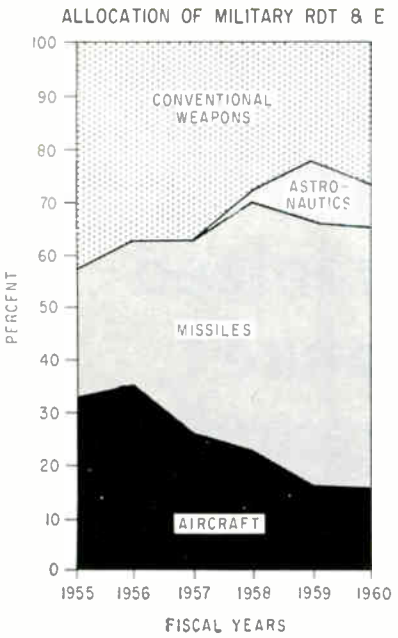
Electronics' share, about 20 percent in fiscal 1960, will rise to nearly 50 percent in 1970, David R. Hull, past president of Electronic, Industries Association, reported some months ago. This expected trend in NASA expenditures is shown above.

Chart on military research, development, and evaluation test expenditures is a lead indicator of military procurement trends, Weidenbaum believes. Intimations in the mid-1950s of the coming crossover between missiles and aircraft procurement expenditures came into full flower in 1960 when missile RDT&E was three to four times aircraft RDT&E. Missile procurement expenditures will, according to all indications, top aircraft procurement in 1963.

Weidenbaum estimates that about one quarter of all military research and development, test and evaluation is devoted to research and the rest to the testing and developing of weapon systems. A little more than $100 million a year is spent on basic research, he believes.

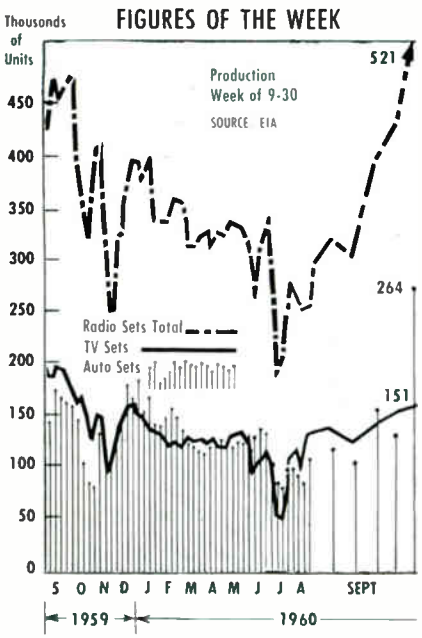
First step in constructing Weidenbaum's military and space estimates is a careful analysis of overall economic activity. Four basic factors used in the report to AMA are population growth, consumer demand, total R&D expenditures and nondefense government expenditures.

From analysis of these four factors he arrived at an estimated gross national product of about $700 billion for 1970. But since defense spending has been a declining



percentage of the GNP ever since the end of the Korean War, and since the most reasonable expectation is for this trend to continue, he says, military spending will rise from $41 billion today to about $49 billion in 1970.

Weidenbaum considers this level of military spending is consistent with existing tax rates, large increases in nondefense programs, a balanced budget and a moderate surplus available for tax reduction or debt retirement.



General Electric 2N396A and 2N526 transistors feature guaranteed maximum high temperature I_{CO} and minimum low temperature h_{FE}

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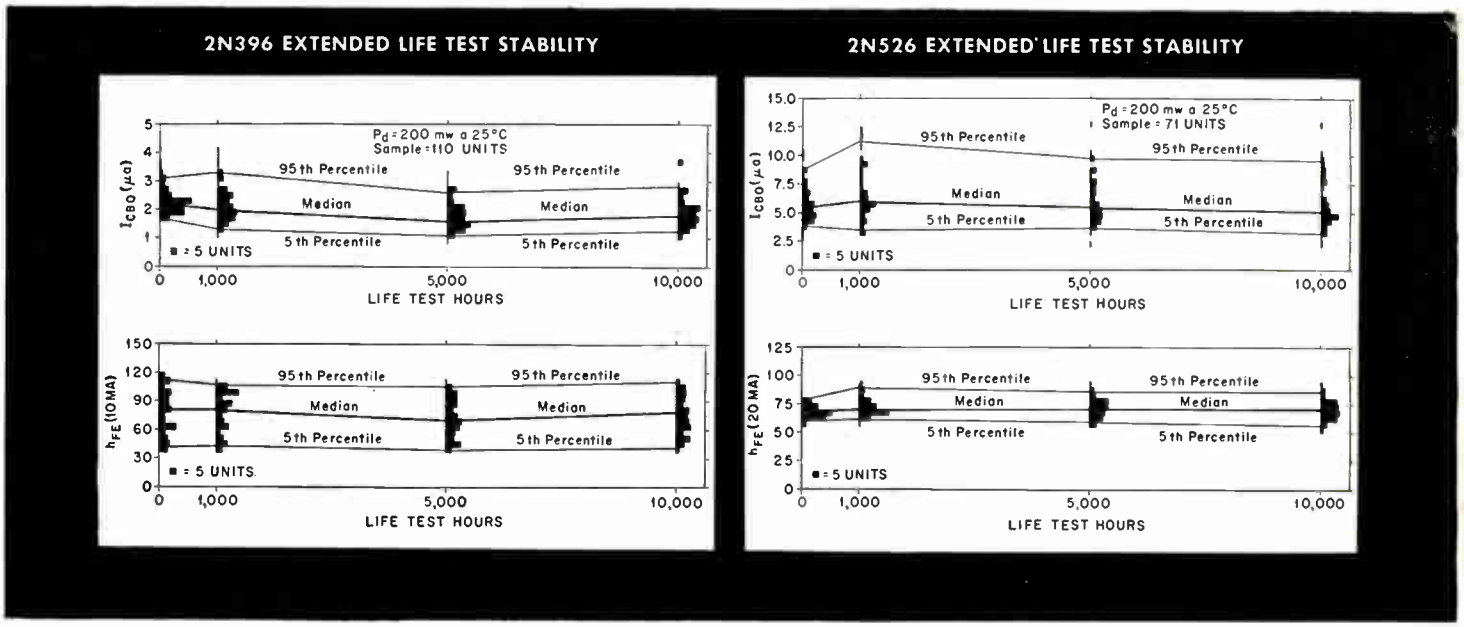
USN 2N396A

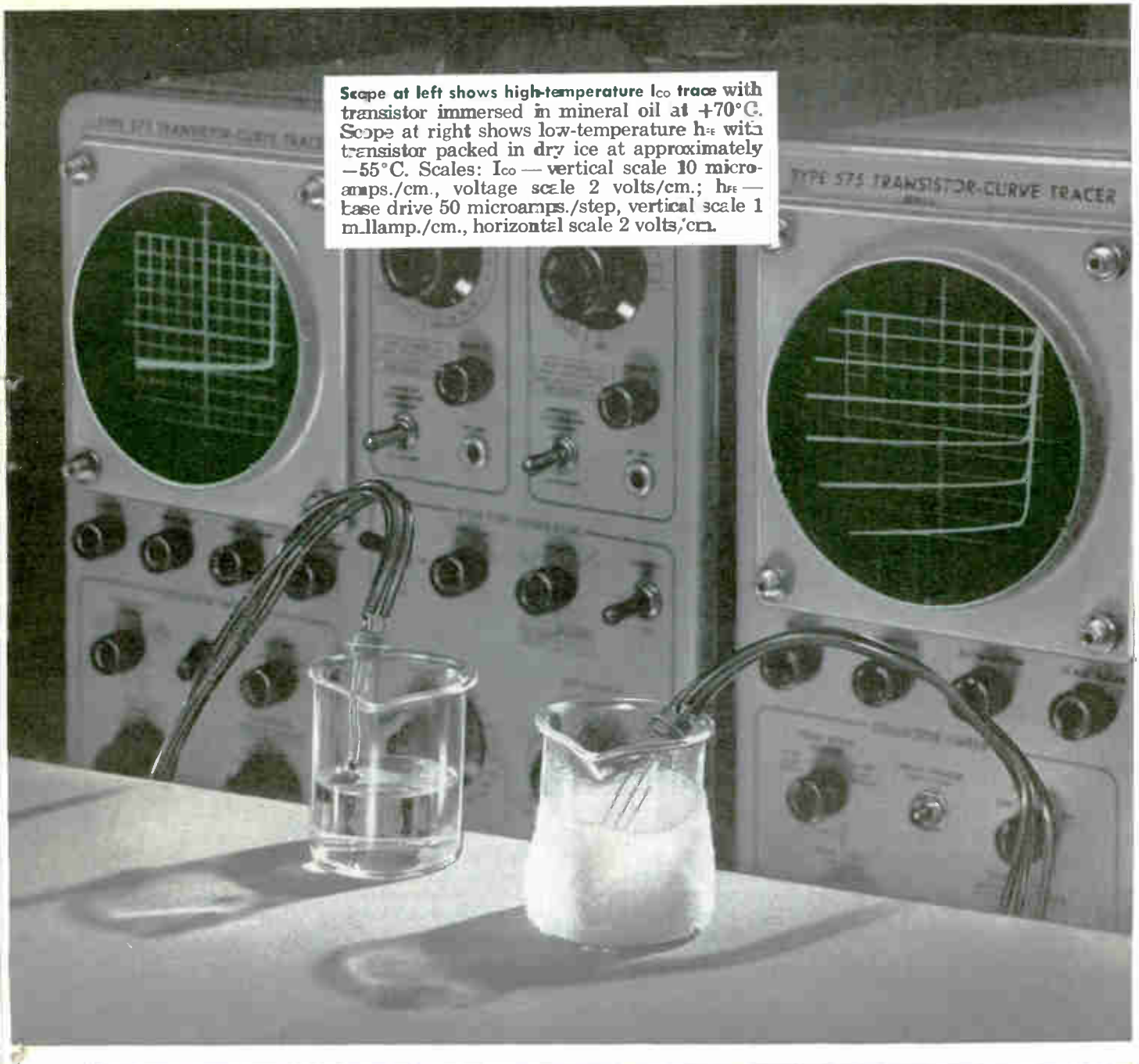
Method B life-test of MIL-S-19500 assures exceptional reliability for General Electric's USN 2N396A. Life-test reliability is the highest for any transistor now covered by military specifications. The G-E USN 2N396A is guaranteed to have extremely low failure rates, being required to meet acceptance criteria roughly equivalent to 0.65 AQL. Compare this with the AQL's of 4.0 and 6.5 generally used for life assurance in MIL specs.

USN 2N526

The Navy specification for General Electric's 2N526 reflects the outstanding characteristics of this transistor type. Among the features which contribute to its superiority are high dissipation (225 mw), 100°C maximum storage temperature and h_{FE} from 53 to 90.

See your General Electric Semiconductor District Sales Manager for complete specifications. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, New York.





Scope at left shows high-temperature I_{CO} trace with transistor immersed in mineral oil at +70°C. Scope at right shows low-temperature h_{FE} with transistor packed in dry ice at approximately −55°C. Scales: I_{CO} — vertical scale 10 microamps./cm., voltage scale 2 volts/cm.; h_{FE} — base drive 50 microamps./step, vertical scale 1 millamp./cm., horizontal scale 2 volts/cm.

TYPE	MAXIMUM RATINGS (25°C)				ELECTRICAL CHARACTERISTICS				
							25°C h_{FE}		h_{FE}
	V_{CBO}	V_{CER}	V_{EBO}	P_T	25°C Max. I_{CO}	70°C Max. I_{CO}	min.	max.	min.
2N526	−45***	−30	−15	225 mw	−10μa @ −30V	−220μa @ −30V	53	90	27 (−25°C)
2N396A	−30	−20*	−20	200 mw**	− 6μa @ −20V	−120μa @ −20V	30	150	20 (−55°C)

*V_{CEO}
**Mil Version 150 mw
***Mil Version −30V

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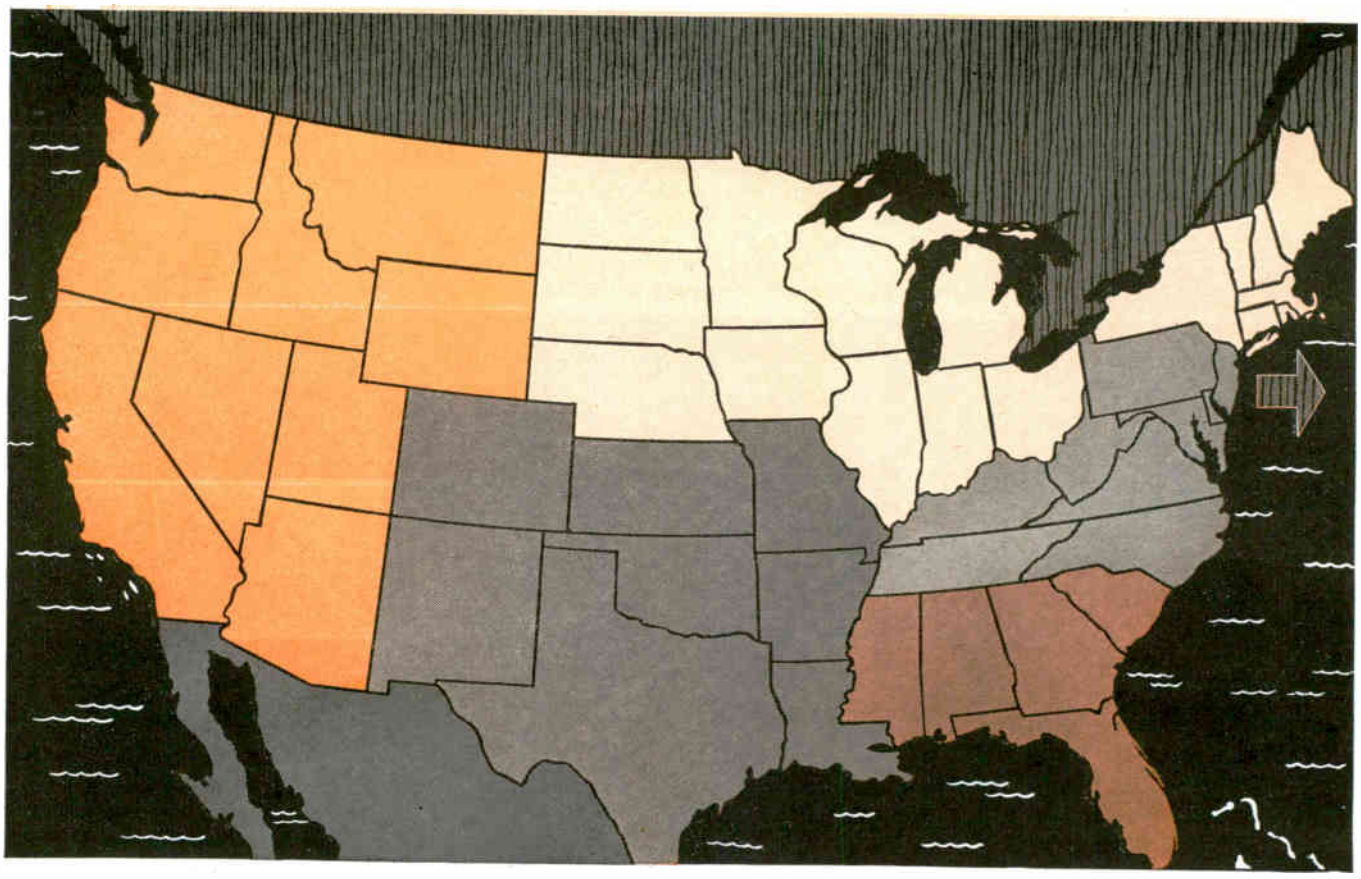

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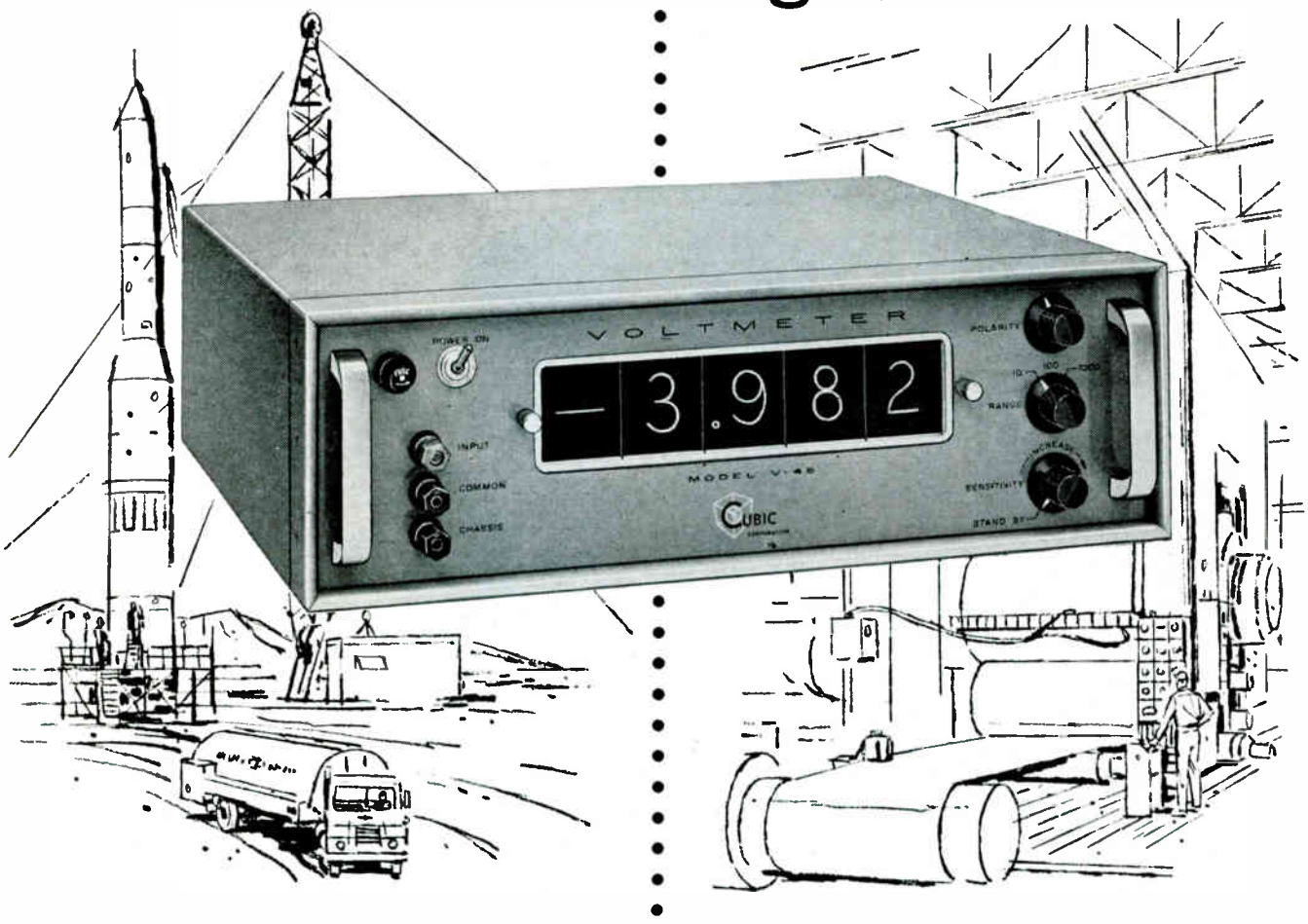
THE Bendix CORPORATION

New Cubic V-45 Digital Meters



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SPECIFICATIONS

Absolute accuracy: 0.02% ±1 digit (rms sum of system tolerances)

Input: Floating or grounded, from front panel connections.

Input impedance: 10 megohms at balance

Input filter: 60 cps rejection

Ranges: Manually selected, 10% expanded range

Low	±0.000 to ±10.999 vdc
Mid	±00.00 to ±109.99 vdc
High	±000.0 to ±1099.9 vdc

Sensitivity: 1 millivolt

Sensitivity control: continuous from 1 digit to 10,000 digits, with standby lockout.

Power Input: 105-125 vac, 50-60 cps, 20 watts

Dimensions: 19″ wide x 5¼″ high x 15½″ deep, rack or bench mounting, with dust-proof switch and bridge section.

Now, at last, the top quality and dependability of Cubic digital voltmeters are available in a meter priced for the industrial market. It is the new four-digit V-45 Digital Voltmeter, fully transistorized, accurate, economically priced.

The practical manager recognizes the costliness of operator errors through misreading and misinterpretation. These errors occur daily on the production line, in quality control, testing and receiving inspection. Alert managers are continuously seeking instrumentation which will eliminate the human element in measurement procedures.

The new Cubic Model V-45 Voltmeter is the answer. It offers the precision expected from custom-built equipment and covers the full d-c range from 1 millivolt to 1099.9 volts. It is rugged enough for operation in any industrial environment. Like all Cubic digital voltmeters, the V-45 features the proven reliability and accuracy of transistor-driven stepping switches.

Write for more information to Dept. E-3, Industrial Division, Cubic Corporation, San Diego 11, California.

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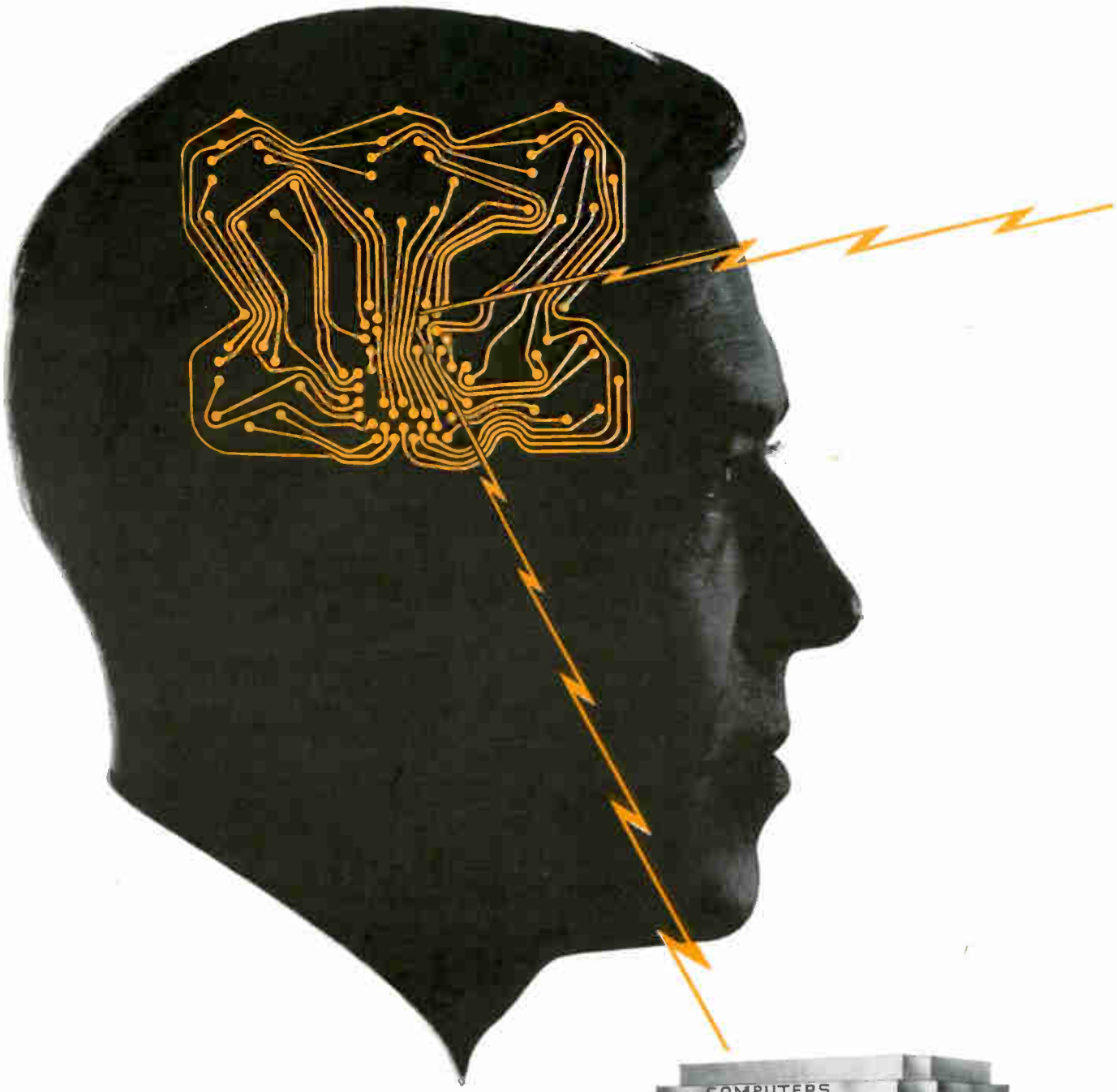

INSIDE THIS "BLACK BOX" the wizardry of electronic circuitry is carried out by Beck Insulated Electronic Circuitry, capable of handling voltages as high as 2500 volts.

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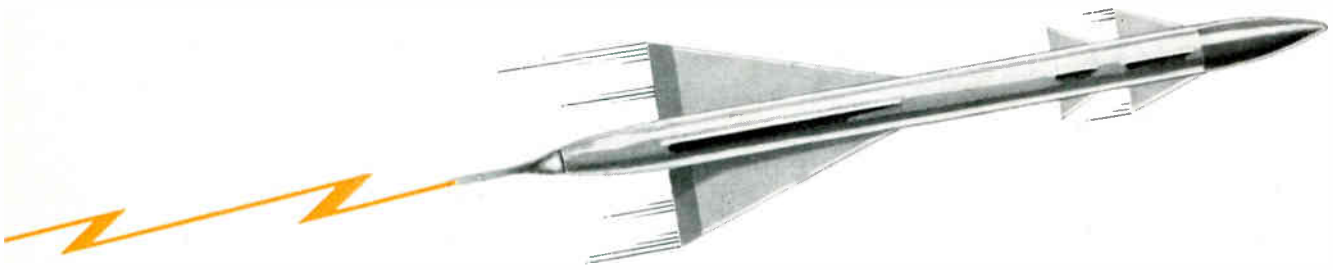

PROBING outer space or plumbing the depths of the sea . . . computing figures or operating TV, Beck Patented Insulated Electronic Circuitry performs with maximum reliability under the most extreme conditions. To make sure that their printed circuits are of the finest quality obtainable, Beck's Incorporated, St. Paul, Minnesota, uses Revere Rolled Copper exclusively. Here's why you, too, should insist that Revere Rolled Copper be used when ordering blanks from your laminator.

1. It has a minimum tensile strength of 55,000 pounds per square inch. This higher tensile strength results in a higher fatigue strength, a factor which has become quite important in critical missile circuitry where roll copper is practically a must.
2. It is more dense and has a harder surface, which is extremely important in switch or other wear applications of circuitry.
3. It is held to closer gauge tolerances. This consistently uniform thickness results in better production rates in the etching process.
4. It is free from oxidation as it comes from the mill and does not contain lead inclusions. It has longer shelf life without the need for major cleaning operation prior to soldering.
5. In 1 oz., it is comparatively freer from pits, pinholes and other imperfections, while in 2 oz. and heavier, it is free of pinholes. (Beck's uses copper in weights ranging from 3 oz. to 25 oz. for their circuitry.)
6. Its smooth, hard surface without peaks or valleys permits the resist to clean off easily and eliminates this problem in the soldering operation.
7. Its clean surface permits fluxes to wet readily and the automatic soldering operation provides a uniform solder coat free of skips or bald spots.
8. Extremely fine-line etching can be accomplished due to more uniform etching qualities.
9. Its close tolerance (10% of gauge) enables the laminator to maintain better gauge control on the finished laminated board as required by the user.
10. It makes it possible for the laminator to realize substantial savings on his copper requirements.

It is available in unlimited quantities in standard coils of 350 lbs. in widths up to 38" and in .0014, .0028 and .0042 gauges, weighing approximately 1 oz. and 2 oz. and 3 oz. per square foot, or heavier if required. Revere Rolled Copper exceeds requirements of standard specifications and meets Electrolytic Tough Pitch Copper ASTM B5 specifications for purity with 99.9% minimum.

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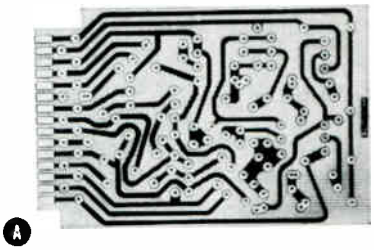
Revere does no laminating of printed circuit boards, making only the rolled copper. Revere Rolled Copper can also be furnished for coil winding applications.

EXAMPLES OF PATENTED BECK INSULATED CIRCUITRY



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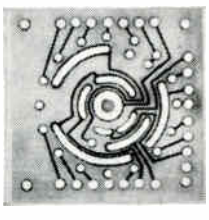

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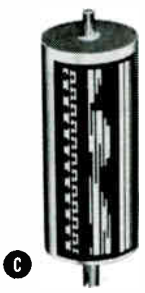

C

A Circuit board with edge contacts for slip on connector. Epoxy-fiberglass base with .006 terminals and contacts .003 circuit path. Imbedded type.

B Combination of imbedded and flush circuit. Switch plate. Switch segments and terminals are flush, circuit paths are imbedded.

C Standard code drum, used for aerial research, usually made of brass. Contact area is flush, insulated on area showing code.

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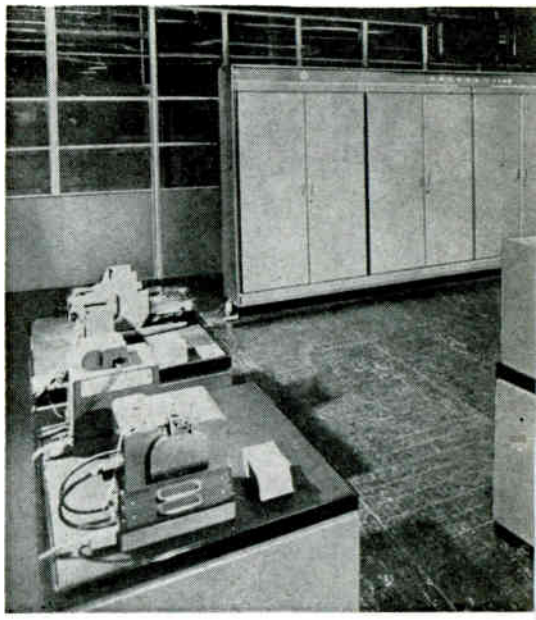
IN COMPUTERS AND CONTROLS

EUROPE
Is Catching Up

Germany's Interkama exhibition, plus reports from returning observers, point up rapid European progress in cybernetic techniques



SIGNIFICANCE OF INTERKAMA (International Congress & Exhibition for Instrumentation & Automation) to world market balance in electronics is pointed up by reports reaching ELECTRONICS this month of new computer developments throughout Europe.

The 1960 Interkama is being held this week and next in Duesseldorf, Germany, is the second exhibition of its kind; the first was held in 1957. More than 300 exhibitors are showing their wares. A hundred or more came from outside Germany, including several from the U. S.

The congress stresses automatic industrial systems, is also concerned with computers, data-analysis techniques and related areas of the technology. It is more than a trade fair; a hearty schedule of lectures and seminars covers the problems and recent progress in instrumentation and automation. Digital controls and telemetering are receiving considerable attention. One series of discussions looks at man as a model of a biological control system. Among talks on hardware are pneumatic and hydraulic logic, nucleonic instruments, and magnetic and transistor circuits.

Electronic instruments and computing equipment have become increasingly important factors in trade between Western Europe and the U. S. Last year, for example, the U. S. was Germany's best customer for electronic instruments, with total shipments of more than $3.6 million. The U. S. was also Germany's largest supplier of such equipment; total shipments the other way were valued at $4.5 million.

But the favorable trade balances in the fields of computers and instruments may not last too much longer. All over free Europe, a long period of germination in the twin technologies of computers and controls is coming to an end with an explosion of new systems. The British, French and German manufacturers are particularly active; but Sweden, Denmark, the Netherlands, Italy and Austria are also bringing out new systems. (Item: Austria's transistorized Mailuefterl, whose name, an ironic commentary on U. S.-built Typhoons and Whirlwinds, means "a gentle spring breeze.")

Returning U. S. observers comment that men in industry and in the universities are vigorously pursuing basic research and developing new equipment and techniques. In a recent intensive 7-week, 9-country tour for the Office of Naval Research, I. L. Auerbach, president of Auerbach Electronics and of the International Federation of Information Processing Societies, saw some of the work being done, told the Navy several things:

"The U. S. is still in the forefront in both the state of the industry and the state of the art. Lead time varies from one to two years, and results in large measure from R&D expenditures by the Pentagon . . .

"The Europeans follow technological progress in the U. S. in detail. Even the Russians—for example, Soviet engineers know exactly what transistor Bell is using in the Tradic. . . .

"Engineering practice in Europe is efficient and productive. There is a great deal to be gained by taking a few competent people and giving them what they need to solve a problem. The British say that in the U. S. we always hire three times as many people as needed and then trample the problem to death. . . .

"American computermen will begin to experience a tough time in the next three years because of the more competent production capability of European industry. We have no monopoly on ideas; Europe's ideas are just as good. U. S. industry, to compete efficiently with our friends abroad—let alone to compete with monolithic Soviet industry—will need to place greater emphasis on productivity."

Among ideas which European computermen are exploring that depart from U. S. practice, Auerbach cited three areas: fixed high-speed internal memory; novel random-access systems, and hydraulic logic.

Wired-core fixed memories are not new, but have found limited use in the U. S. Bell Labs' Mark VI uses wired cores in the program unit; the Atlas guidance computer also uses them. They are faster than coincident-current memories (as little as 0.1 microsecond access), less expensive to make and non-

destructive on readout. In Europe, they are being engineered into most computers to hold basic machine procedures (such as START or LOAD TAPE) or much-used subroutines (square root, sine, cosine). Emidec (illustrated) Elliott and Leo in Britain, and the Dutch Electrologica, are among systems using wired-core memories for fixed high-speed storage; sizes range from Ferranti's Stretch-class Atlas system, now in development, to Telefunken's small business systems.

Fixed-rod memories were invented by T. Kilburn at the University of Manchester. The system uses ordinary insulated wire woven into a screen with ends connected to form looped pairs. The screen is mounted in soft plastic into which linear-ferrite rods 0.1 mm in diameter and 0.5 mm long are pushed. These rods, magnetized to represent a stored binary ONE, couple the X lines to coincident Y lines. Noncoupling loops are connected with neutral rods representing binary ZEROs for magnetic return. A unit 3 ft wide, 8 ft long and less than an inch thick holds 4,000 48-bit words with an access time of 0.2 microseconds. Major problem: loading the memory; it takes a girl half an hour to plug 256 rods.

Among random-access memories being used, the K-10 of the German firm Standard Electric Lorenz and Swedish Facit's Carousel are particularly unusual.

The K-10 was developed for an airline reservation system being developed by SEL for Air France and British European Airways. It is a multitape file using 10 loops of tape in a bin, somewhat like a small version of Burroughs' Datafile. A head and drive mechanism is supplied for each tape loop. Electronic circuits select the tape loop; the tape drive passes 100 in. of tape a second, on which data are stored at 250 bits to the inch. Access time averages 10 sec for a block of data; the control mechanism can read and write on 4 simultaneously. Cost is small.

Facit's Carousel is—as its name suggests—a revolving ring containing 64 spools of tape, each about the size of a large spool of thread. Each spool holds 28 ft of 8-channel tape. The spools are indexed to a single reading station; then arms adjust the spool to the head. After the tape is read it is rewound and the spool is returned to its place in the merry-go-round. Capacity is 8,192 40-bit words, stored as 128 blocks of 64 words each. Average access time is less than two seconds to the spool.

IBM Zurich Laboratories are experimenting with hydraulic logic in a move to design a low-speed high-reliability logic element (in the range of 300 to 2,000 cps). Basic hydraulic element has been devised that performs logical AND, OR and NOT functions by valves connected to high and low pressure points. Bistable elements have also been devised, operating at about 400 cps. Advantage is high reliability and predictability of hydraulic systems. Complete computers are somewhat problematic, since topology would have to be precisely calculated to ensure exact delays.

Observers comment that the hydraulic elements, and pneumatic logic developed and operating in the USSR, are "shockingly" similar. Pneumatic and hydraulic logic elements meet faster acceptance in automatic control fields, where these technologies are better known and understood than electronics is.

Decca, EMI and other European companies are reported to have developed excellent tape units, but many U. S.-made digital tape devices are used and more are needed. The Rank organization has developed a xerographic printer that operates at about 3,000 lines a minute; most big systems use high-speed printers similar to those used in the U. S. Punched-card readers and paper-tape devices are highly advanced in development; one paper-tape reader, built by Facit, uses ferroresonant techniques to read at high speeds by sensing changes in capacitance.

New Moon-Bounce Ear Goes Up In Jersey

This 40-ft dish antenna at ITT will receive radio signals reflected from the moon or passive satellites

Engineers Form Physical Standards Groups

Both individuals and laboratories in instrument calibration field organize to coordinate physical standards work in electronics and other technical fields

By GEORGE SIDERIS,
Buyers' Guide Editor

SPECIALISTS in measurement standards, instrument standards and calibration are close to forming a nationwide organization, coordinating standards activities in electronics and other fields.

Two almost parallel groups, one for individuals and one for standards laboratories, held organization meetings during the Instrument Society of America (ISA) conference in New York last month. In physical standards and instruments, these groups would cut across industry lines as the American Standards Association does for written standards and ASTM for materials. Spokesmen pointed out that the U.S. lacks an organization concentrating on measurement standards.

Many professional and trade organizations are concerned with standards, but they generally stay close to their own field. It was estimated that there are 350 organizations with some standards activity and 3,000 standards laboratories.

Both groups want help from other organizations in funneling information to and from a common pool. Once data is organized, efforts would be made to fill in gaps.

The two groups are a new division of ISA and a proposed Association of Standards Laboratories (ASL).

The ISA division will be called division 6H, Measurement Standards. About 50 members attended the organization meeting after an all-day laboratories workshop session.

ASL's steering committee met the day before to draft tentative goals. Another meeting, with an expanded committee, will be held at the American Ordnance Association conference in Albuquerque next February.

Orval Linebrink, of Battelle Memorial Institute, is director of the new ISA division. Ralph Bowen, of the Naval Reference Standards Laboratory, Pensacola, and S. C. Richardson, of General Electric's Electrical Measurements Laboratory, are functioning as associate directors.

Linebrink recommended these goals for ISA division 6H:

- Survey of measurements standards and facilities.
- Establishment of a measurement standards information center and publication of significant developments.
- Quality control of standards laboratories. Linebrink suggested this be handled by ASL with ISA assistance.
- Initiating development of better standards and instruments.
- Organization of working committees such as a long-range planning committee to advise the director; functional committees handling organization and manpower, education and personnel, liaison with other groups, and semantics and statistics; and technical committees on electrical, electronic, physical and dimensional measurement standards.

ASL got its start in June at the 1960 Conference on Standards and Electronics Measurements, held at the Boulder Laboratories of the National Bureau of Standards. It was suggested by Harvey W. Lance of the NBS Electronic Calibration Center. The steering committee was appointed after a meeting of some 200 representatives from industry, institutions and government agencies.

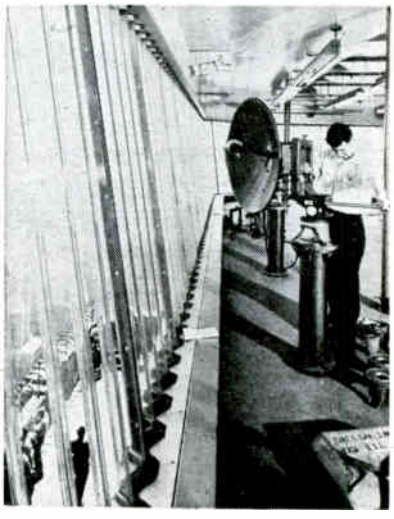
The steering committee now has 12 members. During its meeting at the ISA conference, it voted to increase its membership to 20. Appointment of new members was left to the discretion of H. C. Biggs, of Sandia Corporation, the chairman. But he was asked to seek representation from IRE, AIEE and large industrial laboratories. The ISA division will be asked to set up liaison with other organizations.

If the steering committee decides in February to formally organize ASL, it will probably be helped by the Department of Defense and the Precision Measurements Association, as well as ISA and NBS.

Objectives drafted by the ASL committee included:

- Setting up a method by which laboratories can qualify themselves according to accuracy of equipment, experience of personnel, environmental control and procedures.
- Realistic accuracy requirements in specifications, especially in the military specifications.
- Faster development of good physical standards.
- Information coordination and publication.
- Assistance in the educating and

Transmission Disk



Low energy absorbent Plexiglas acrylicplastic protects New York Telephone Co. microwave relay station on Empire State Building from high winds

training of various personnel.

• Standardization of terminology and test report forms.

• Establishment of arbitrary standards.

Written, as opposed to physical standards, would probably be developed through the American Standards Association, according to ASA's procedures for preparing written standards that affect more than one industry or profession.

Electronics Plays Role In Microscopy Advances

BETHESDA, MD.—Electronics' role in recent advances in microscopy were highlighted at the 10th annual Instrument Symposium and Research Equipment Exhibit at the National Institutes of Health here.

According to O. W. Richards of American Optical Co., fluorescent, phase, interference, and electronic scanning are methods that have recently proven especially helpful for examining specimens too transparent for the brightfield microscope. It is possible to estimate mass with the interference microscope and to do quantitative chemical analysis with absorption spectrophotometric methods.

A paper on "Microscopy for Experimental and Quantitative Studies on Living Cells" by M. J. Kopac of New York University pointed out that useful information is obtained by high-speed electronic image scanning. Closed circuit tv combined with scan line selection and analysis by delayed sweep cathode ray oscillography is an important quantitative approach.

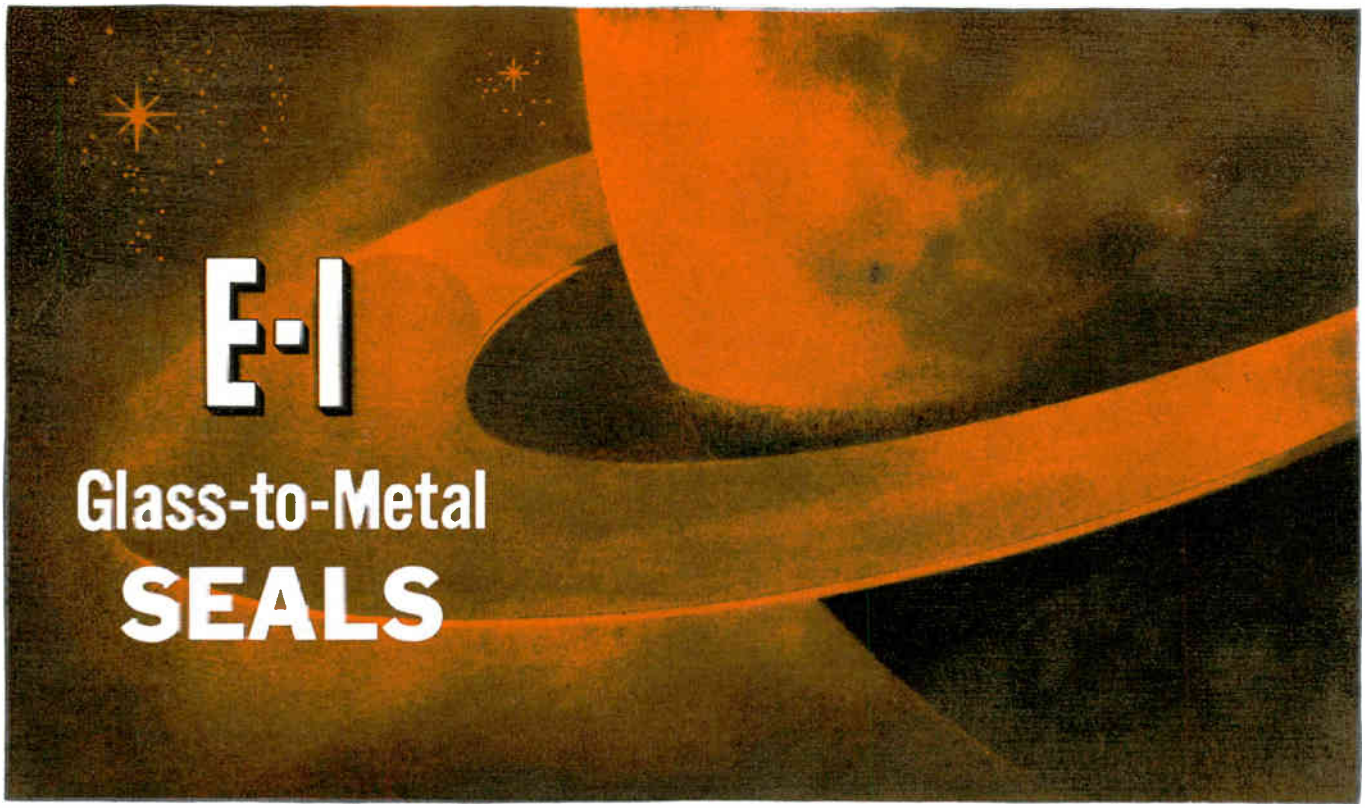
Ultraviolet flying spot microscopy provides a method of studying living cells under ultraviolet without the excessive damage generally produced with ultraviolet illumination.

Latest electronic devices for laboratory and chemical investigations, plus optical and mechanical ones, were exhibited by 120 firms.

Among devices manufacturers representatives demonstrated at instrumentation sessions were an electronic counter, a physiological gas analyzer, a fluorescent microscope, a robot chemist, recording balance, and nitrogen analyzer.

Attendance at the symposium was estimated at 1,500. About 5,500 viewed the exhibits.

Universal in Application...



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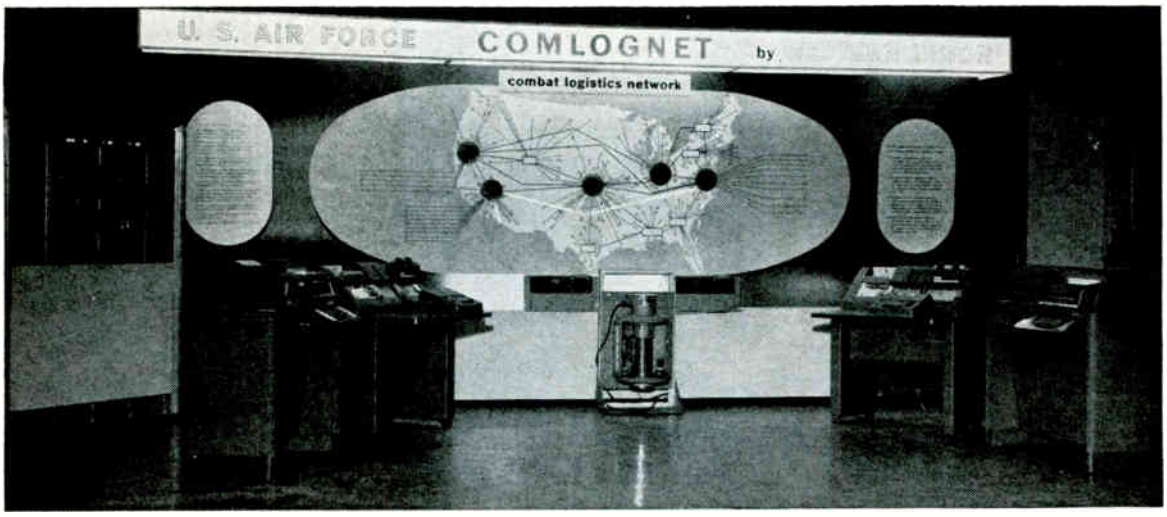


Subcontractor RCA constructed and assembled electronic equipment under $50 million contract. The Air Force will lease the service from prime contractor Western Union for $22 million a year

USAF to Get Fast Data Link Net

BY JANUARY 1962, USAF will get "the largest and most sophisticated logistic data and message communications system in the world," it was announced recently by USAF and prime contractor Western Union.

Called Comlognet (Combat Logistic Network), the system will consist of five large automatic switching centers with connecting terminals at 450 air bases, air stations and civilian contractors.

As an integral part of USAF's global communications system Aircom, the new network will interchange traffic on an automatic, compatible basis with other Air Force networks. Data from overseas will be brought into the domestic network by facilities at gateway centers.

The system will ultimately handle many millions of messages concerning aircraft movements, air traffic maintenance, passenger information and flight control data. Plans also call for inclusion of financial, medical, personnel control and statistical reports requiring more than 24 million messages a year. The system will convert data for entry into electronic computers, and distribute the traffic delivered by the computers.

Commercial potential for a system like Comlognet is good, says John L. Burns, president of RCA, major subcontractor for manufacturing and assembling the electronic equipment.

"Comlognet is a forerunner of automatic civilian communications systems which some day will provide a high-speed interflow of data among all the far-flung branches of business and industry," Burns says.

The switching centers, in conjunction with the station terminals, will handle digital information of any type including digitalized voice for graphics. Service for record message traffic by conventional type telegraph apparatus will also be provided.

The system will initially handle about 10 million punched cards (equivalent to 130 million words) daily.

Both "store and forward" (message switching) and direct "user-to-user" (circuit switching) service will be provided at the five leased centers.

The first center will be opened at Norton Air Force Base, Calif., in Nov. 1961.

The system will operate initially at rates of from 100 words per minute (75 bauds or "bits" per second) up to 3,000 words per minute (2400 bauds), and is designed to be capable of handling rates up to 62,500 words per minute (50,000 bauds) as needed, by adding channel termination modules.

All channels, including trunks, will be cryptographically secured, link-by-link, with no loss of transmission synchronism resulting from tandem interconnection of circuit-switched channels. The system will automatically reject traffic that is classified higher than the security clearance of a destination terminal.

Messages will be interchanged between different terminal devices. The system is designed to accommodate a variety of input and output devices, including punch card readers and punches, magnetic tape transports, digital computers, teletypewriters, paper tape transmitters, perforators of various kinds, and digitalized graphic transceivers and transmitters.

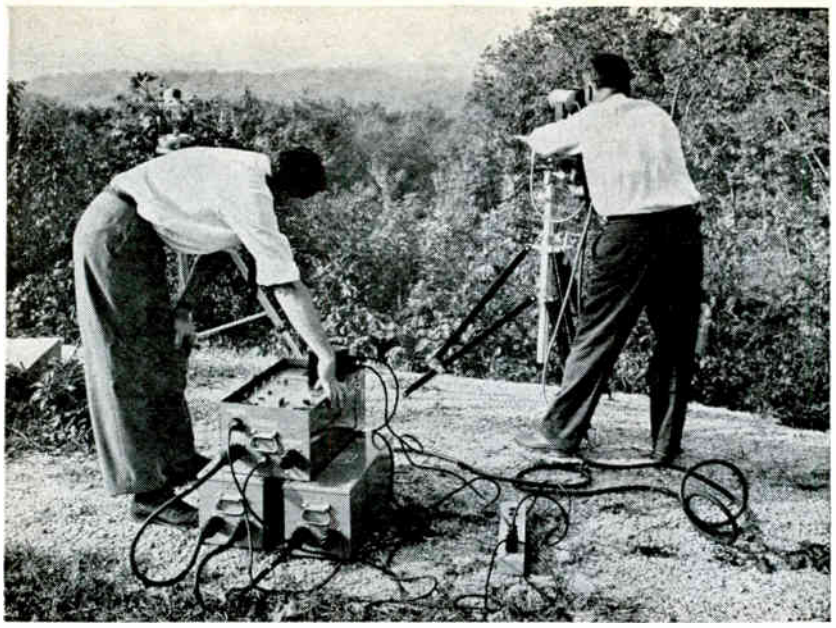
Standard operating channels will be full duplex, providing two-way operation in conjunction with automatic accuracy controls. Switching centers will be capable of high duplex operation for transmission in either direction.

With a few exceptions all channels will operate in a bit-synchronous mode.

The eight-level Fieldata code was chosen as the "common language" code and all originating codes are converted to it.

Line facilities, tributary stations and switching centers incorporate automatic accuracy control features assuring that not more than one error in 10 million characters will go undetected.

Switching centers are fully solid-state design, utilizing transistor and magnetic core circuits.



Optical maser is set for firing during twenty-five mile communication test

Scientists Demonstrate Optical Maser

Intense short pulses emitted by optical maser may make possible 10,000,000 simultaneous transmissions

SCIENTISTS at Bell Telephone Labs believe they have experimentally proved the communications feasibility of the Labs' optical maser, it was revealed at a recent demonstration of the device in New York City. The optical maser is similar in principle to the Hughes Aircraft laser (see ELECTRONICS, July 22, 1960, p 43).

As with the Hughes laser, the heart of the optical maser is a synthetic ruby rod, which in this instance is 1½ inches long and ½ inch in diameter. As with the laser, the two ends of the rod were polished until extremely flat and parallel, then covered with a reflecting layer of silver thin enough to be slightly transparent. The ruby rod is held in the center of a spiral photoflash lamp that illuminates it with an intense flash of ordinary white light.

Bell Lab investigators found that when flash-lamp power exceeded a certain value, a nearly parallel beam of light having a width of 0.05 degree, was emitted through the silvered ends of the rod. The light beam met the directionality requirement of communications. Like ordinary fluorescent light emitted from ruby, this stimulated light was red, but was sixty times closer to being monochromatic—that is, having a single frequency. This light was also shown to be coherent—of a single phase. By thickening the silver coating at one end of the ruby rod and cutting two fine parallel slits in the coating, an emitted light pattern of constructive and destructive interference was obtained that proved the in-phase condition.

The coherent light was found to be emitted in short, intense bursts a millionth of a second long. Several hundred of these bursts were observed during the thousandth second of maser action sustained by the flash lamp. Such short pulse bursts rather than a smooth pulse makes eventual modulation of the signal possible so that many telephone conversations or television signals can be transmitted simultaneously over a maser link—perhaps as many as 10,000,000.

Bell Labs scientists feel that there is one way that they might explain the bursts: In the usual fluorescence of ruby, the green component of the source white light excites some of the chromium atoms in the ruby to their highest energy level. The atoms rapidly relax to an intermediate level. Somewhat more slowly, the atoms then relax from the intermediate (metastable) level to the original lowest level, emitting quanta of light in the process. The optical maser causes the atoms to make the last jump more readily by bathing them in light of the emitted frequency—that is, the red light confined within the rod by the silvered ends. This intensifies or stimulates the red light until it is able to pass through the silvered ends. At this point, the metastable level is depopulated so rapidly that the green light component is no longer able to maintain a population of atoms in that state sufficient for the action to continue. Radiation abruptly dies down until the exciting lamp can restore metastable population. Alternating depletion and restoration of the atom population results in the extremely rapid pulsing of stimulated light.

Practical feasibility of the optical maser was indicated by two Bell Lab experiments: a line-of-sight transmission of the red-light signal pulses over a twenty-five mile distance, and a transmission through a quarter-mile, 2-inch diameter circular waveguide without extraneous reflection.

Now that favorable communication properties of ruby have been determined, scientists are actively exploring means for extending the radio-communication techniques of modulation, amplification and detection to the much higher frequencies of radiation from the optical maser. Maser experimental work is also being performed with gaseous systems in which atomic collisions impart energy.

Possible applications mentioned for the optical maser include control of chemical reactions, high-frequency switching, relativity experiments and accurate measurement of long distances.

Maser's concentration of large amounts of energy would permit it to direct a beam at orbiting satellite with sufficient pressure to maintain the satellite in orbit. Also, maser would, because of its high directionality, permit private communications between satellites, say Bell Labs spokesmen.

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Soviets Are Pushing All Technologies

SOVIET TECHNOLOGY continues to increase the speed of its advance.

Electron-beam welding has been successfully reported in the Soviet technical press. Recent reports indicate successful welds on molybdenum and tungsten.

Factories in the Gorky region will soon start production of program-controlled machine tools for export. Speed of the Soviet progress in this field is illustrated by the fact that only last June, USSR experts said that all the Union factories would produce only 60 program-controlled systems this year.

In the Azerbaijan SSR, a young researcher has used high-voltage pulses to alter the internal structure of cottonseed, causing an increase in germination speed and higher cotton yield. Seeds were soaked in water, dried and subjected to 2,500-v fields. Plants sprouted two or three days sooner than usual, had more buds, ovaries and bolls.

Tass reports use of nucleonic instruments in automatic controls for ore extracting and tunneling machines. A gamma source on the cutter head is focused on the ore being cut; absorption by ore directs position and movement of the head.

In the space field, Soviet Academy space expert N. Sisyakian indicated in a recent speech that the USSR is pushing ahead in controlled space probes. He said that flights to Mars and Venus present "new difficulties." The degree of accuracy needed to hit the moon could still have a Mars-bound rocket miss its mark by a million kilometers, he said. He mentioned "fundamentally new guidance systems" that would have to be applied to steer a Mars probe.

Television Brings Classes To Electronics Engineers

CLASSES IN NETWORK THEORY are provided for 1,500 engineers by a special three-way network set up by the University of Wisconsin. The closed-circuit tv network went into operation between Madison and Milwaukee this fall.

Classes originate at the University's main campus in Madison, are piped 80 miles to the suburban Milwaukee plant of AC Sparkplug, the electronics division of General Motors. The University's branch in downtown Milwaukee is the third

Space Radiation Measurement Vehicle

Nuclear emulsion recovery vehicle (NERV), by GE, was recovered after being launched to 1,200-mi altitude to measure radiation

station. Three-way audio permits students in either location to communicate with the professors in Madison.

Courses are televised three mornings a week, use two textbooks, include homework. Successful completion—determined by a tv-administered examination — results in three hours of graduate or undergraduate credit.

Missile-Warning System: One Down, Two to Go

FIRST STATION in the ballistic-missile early-warning system recently went on the air at Thule, Greenland. Immediately after, Sylvania began airlifting parts of the electronic data-processing equipment for the second site at Clear, Alaska.

Computing gear for BMEWS includes detection-radar data takeoff, for estimating target azimuth, range and radial velocity; and missile impact predictor, which uses two IBM computers plus a giant Sylvania storage system. The data takeoff system coordinates a dozen special-purpose computers which analyze returns from the BMEWS radars, excludes noise return, meteor echoes and other natural phenomena.

Third site, at Flyingdales, England, will contain only radar receiving gear and computers, will be the last site of the three to be finished.

Defense circles are currently reviving the idea for a southern BMEWS. Recent international developments—including the Soviet attempt to subvert the Congo—point up the possibility that hostile missiles may come from directions other than the North.

British to Display Fast Printer, Punch

BUSINESS EFFICIENCY exhibition at London's Olympia will this month show a high-speed serial printer designed to operate at 1,000 words a minute, and a tape punch that can put out 5, 6, or 8-track paper tape at 3,000 words a minute.

Both devices, reportedly 10 times faster than existing teletypewriter equipment, were developed by Creed & Co. of Croydon, Surrey.

OVER AND UNDER THE TOP OF THE WORLD

In early 1960, American craft pierced the North Pole in two elements. Fathoms below solid ice the USS Sargo probed unerringly to "90 North"; miles above, a GAM-77 missile on a B-52 pinpointed the featureless goal. Both used Inertial Navigation systems by Autonetics—where today's results pave the way for tomorrow's breakthroughs.

Electromechanical Systems by **Autonetics** Division of North American Aviation

Army Develops New Silicon Solar Cell

ARMY SIGNAL CORPS has developed a silicon solar cell that will resist four times more radiation than conventional cells for a period ten times longer.

The new design, Army says, "is perhaps the most important advance in the field since the first solar cell was produced in 1954."

The new cells will be of immediate benefit to space flights. The vulnerability of solar cells to radiation damage limits their operating life under conditions of prolonged exposure to the intense radiation in the Van Allen belts, Army says.

In addition to its importance in space, the discovery may open the way to techniques for producing highly resistant transistors, diodes and other semiconductor devices basic to military and civilian electronic equipment.

The new cells are similar in appearance to present types except that the active layers are reversed. The cells are made by diffusing phosphorous into the surface of a *p*-type silicon crystal. Present cells are made by diffusing boron into an *n*-type silicon crystal.

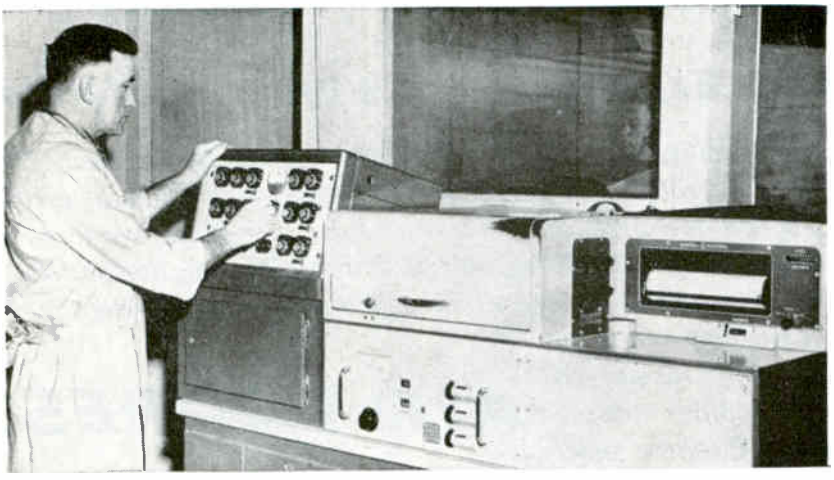
The new *n*-on-*p* solar cells are produced at a temperature of 950 C, significantly lower than the temperature employed in producing conventional cells. The milder environment causes less damage to the delicate internal crystal structure of the silicon, so that fewer are spoiled and rejected. For this reason, cells of higher performance may be produced at lower costs. Scientists now are analyzing the new process to pinpoint the exact mechanism that gives the cells their unique properties.

The new cells were exposed to protons with an energy of 740 million electron volts by the University of California synchrocyclotron. These high energy protons produced an unexpectedly large reduction in power output of conventional cells. This is believed to be related to disintegration of silicon atoms within the solar cell. The resistance to disintegration of new cells was approximately four times greater.

Although it is known that *n*-on-*p* solar cells are also produced in the Soviet Union, manufacturing processes and radiation damage resistance have not been reported.

The new process was developed by the U. S. Army Signal Corps at Fort Monmouth, N. J. Special characteristics of the cells were measured in radiation exposures by RCA Laboratories, Princeton, N. J. and supported by NASA. Similar measurements have been made by the Transitron Electronic Corp., Measurements of extremely high proton energies have been carried out by STL under a NASA contract.

Electronic Color-Matching



General Electric spectrophotometer (on the right) analyzes colors of Monsanto plastic compounds. The resulting mathematical values are then compared to standard color by Davidson & Hemmendinger computer (left)

Students Need Good Apparatus

NATIONAL SCIENCE FOUNDATION is inviting scientists, engineers, and science teachers in colleges, universities and nonprofit organizations to submit more proposals for development of prototypes of new science equipment for use in the nation's schools and colleges.

Good apparatus to perform good experiments is needed by science students, but modern science equipment is often too expensive for secondary schools and undergraduate colleges, says Alan T. Waterman, Foundation director.

The high caliber of work that scientists, science teachers, and engineers have already done indicates that this program should continue, he said. The program has been sponsored on a limited basis for two years during which grants were awarded for some 50 projects including a low-cost opthalmascope, supersonic wind tunnel and mass spectrophotometer.

UNIVERSITY OF CALIFORNIA associate engineer Warren Flock, during research for his Ph.D dissertation, simulated spaceship plasma problem in the laboratory, under supervision of Prof. Robert S. Elliot. Flock found that the degree of distortion in radio signals from spacecraft depends on the thickness of the plasma layer. A higher radio frequency might be a possible solution but this can raise new problems, says Flock.

UNIVERSITY OF WISCONSIN will have a one-million dollar electronic computer installed early in 1961 at the University's Numerical Analysis Laboratory. Funds for the computer are being supplied by the Wisconsin Alumni Research Foundation, the National Science Foundation and the U.S. Army Mathematics Research Center on the Madison campus. Builder of the computer is Control Data Corporation of Minneapolis. Conrad A. Elvekjem, university president, said the new computer would handle 100,000 instructions per second and would store 1,500,000 pieces of information, which it would recall at a two-millionth of a second rate.

PENNSYLVANIA STATE UNIVERSITY was recently the recipient of the Curtiss-Wright nuclear reactor located at Quehanna, Pa. The reactor is a four megawatt swimming-pool type. With its auxiliary laboratories, it provides complete radiation services required in nuclear programs.

NEWARK COLLEGE OF ENGINEERING has been granted authority by the New Jersey State Board of Education to confer the degree Doctor of Engineeering Science in addition to B.S. and M.S. degrees the college now offers in various engineering departments. Initially, the new doctoral program will be offered in chemical and electrical engineering.

ILLINOIS INSTITUTE OF TECHNOLGY's Armour Research Division will sponsor the 1960 Computer Applications Symposium, next Wednesday and Thursday, to be held in Chicago's Morrison Hotel. Problems to be discussed include common computer programming languages for business and scientific applications, and the development of cooperative computing centers. Business management applications will be discussed on Oct. 26. On Oct 27, engineering and scientific applications topics will be heard.

Electronic Teacher

Student learns foreign language in new electronic language laboratory booth made by Bernco, Inc.

MEETINGS AHEAD

Oct. 19-26: International Congress & Exhibition for Instrumentation & Automation, INTERKAMA, Dusseldorf, Germany.

Oct. 24-26: Aero & Nav. Elec. Cong., PGANE of IRE, Lord Baltimore Hotel, Baltimore.

Oct. 26-27: Computer Applications Symposium, Armour Research Foundation & Illinois Inst. of Tech., Morrison Hotel, Chicago.

Oct. 26-28: Non-Linear Magnetics and Magnetic Amplifiers, AIEE, PGIE of IRE, Bellevue-Stratford Hotel, Philadelphia.

Oct. 27-28: Magnetodynamics, Engineering Applications, Engineering Institutes, Univ. of Wisconsin, Madison, Wis.

Oct. 27-28: Electron Devices Meeting, PGED of IRE, Shoreham Hotel, Washington, D. C.

Oct. 31-Nov. 2: Radio Fall Meeting, IRE, EIA, Syracuse Hotel, Syracuse, N. Y.

Oct. 31-Nov. 4: Seventh Institute of Electronics in Management; American University, Wash., D. C.

Oct. 31-Nov. 2: Electronic Techniques in Medicine & Biology, PGME of IRE, AIEE, ISA, Sheraton Park Hotel, Wash., D. C.

Nov. 1-2: Electrical Techniques in Medicine & Biology, AIEE, ISA, IRE, Sheraton Park Hotel, Wash., D. C.

Nov. 4: Automatic Data Processing Systems, Institute of Electronics in Management, American University, Wash., D. C.

Nov. 14-17: Magnetism & Magnetic Materials, AIEE, AIP, ONR, IRE, AIME, Hotel New Yorker, New York City.

Nov. 15: Product Engineering & Production, PGPEP of IRE, Contact D. Ehrenpreis, 325 Spring St., New York City.

Nov. 15-16: Mid-American Elect. Convention, MAECON, Hotel Muehlebach, Kansas City, Mo.

Nov. 15-16: Northeast Electronics Research & Engineering Meeting, NEREM, PGPT of IRE, Commonwealth Armory, Boston.

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MINIATURE MODULAR COMPUTER DELAY LINES

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Module No.	Delay	Size
15-89	100 musec.	3/8" x 1/2" x 3 5/8"
15-90	75 musec.	3/8" x 1/2" x 3 5/8"
15-91	20, 10, 10, 5 musec.	3/8" x 1/2" x 3 5/8"
15-92	50 musec.	3/8" x 1/2" x 2 5/16"
15-93	20, 20 musec.	3/8" x 1/2" x 2 5/16"
15-94	10, 5 musec.	3/8" x 1/2" x 2 5/16"

As a group these miniature, modular, lumped constant delay lines constitute an adjustable delay line. They offer great flexibility in design by providing adjustable delays ranging from 5 musec. to 335 musec. or greater, if additional units are employed.

Impedance — 93 ohms with a maximum pulse attenuation of .5 db and pulse rise time of 30 musec. (max.) for any module.

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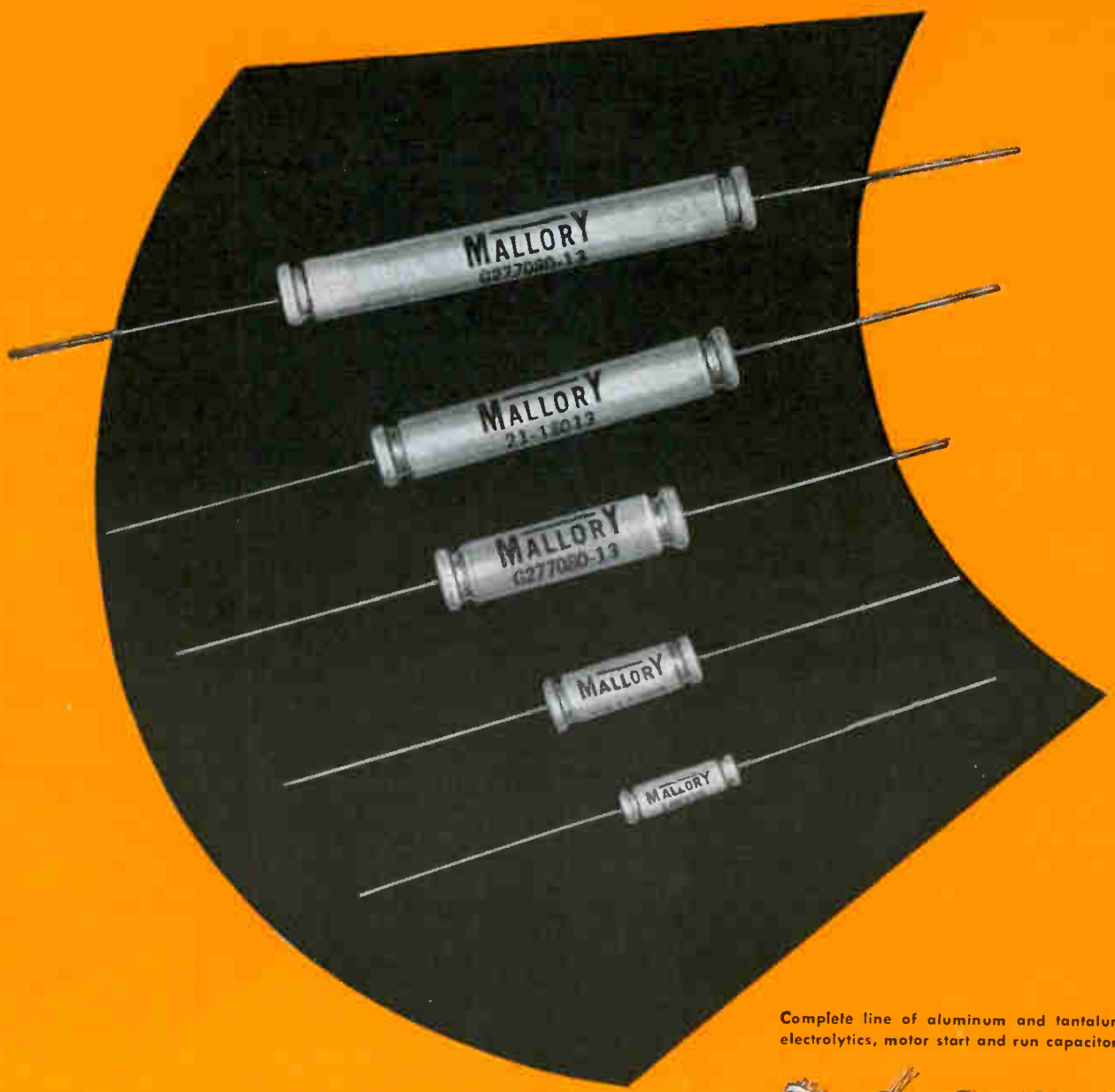

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4-160	3.5-85	$1\frac{7}{16}$	$\frac{3}{8}$
8-350	7-170	$2\frac{1}{8}$	$\frac{3}{8}$
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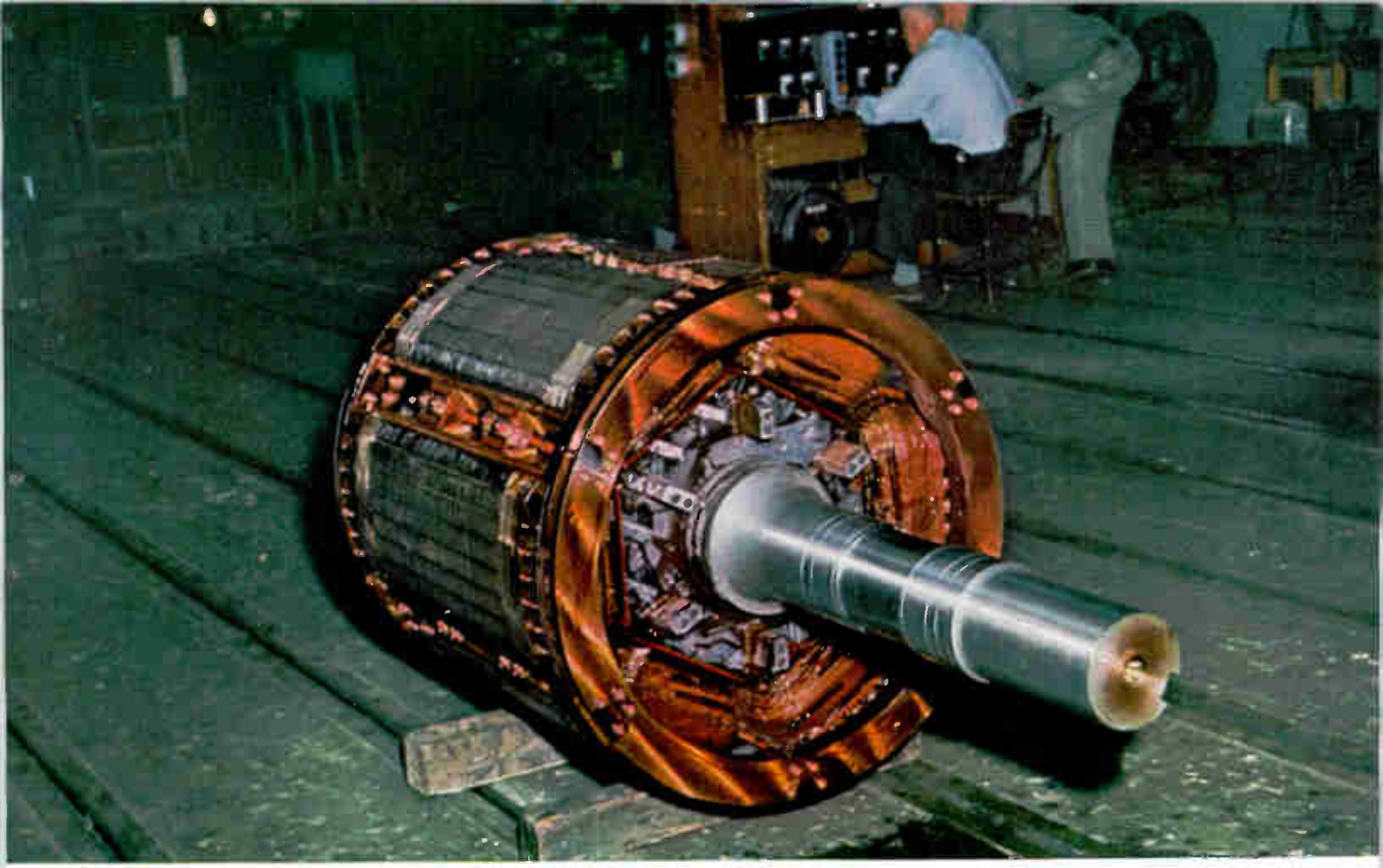

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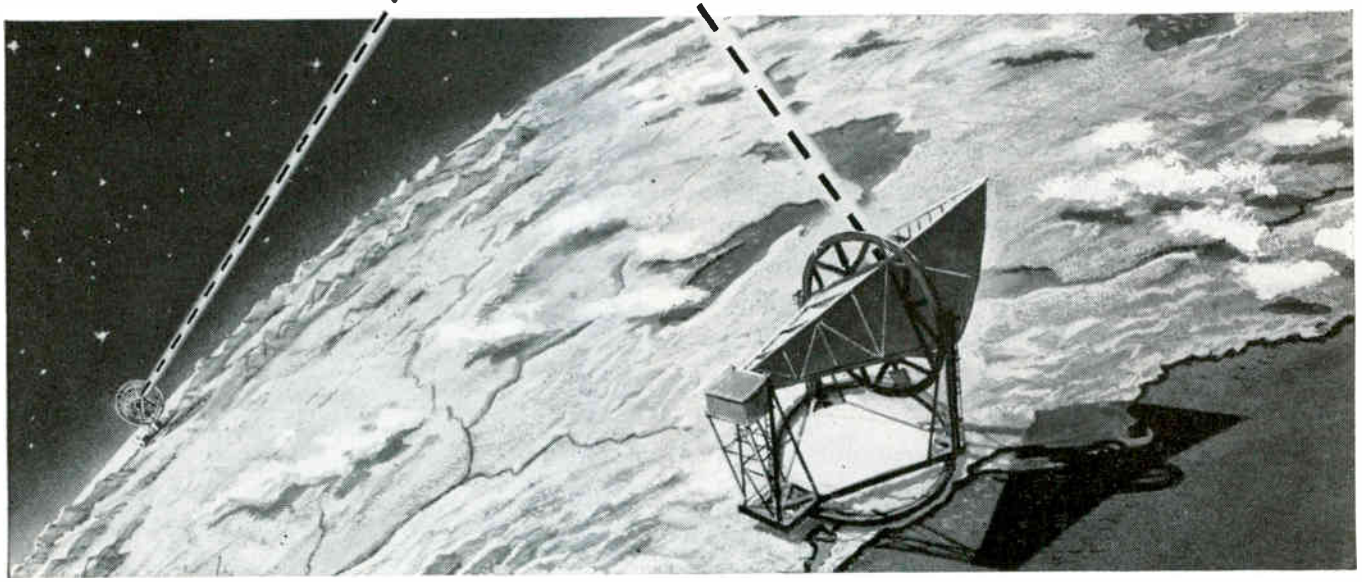


BELL TELEPHONE LABORATORIES BOUNCES VOICE OFF SPHERE PLACED IN ORBIT A THOUSAND MILES ABOVE THE EARTH

Think of watching a royal wedding in Europe by live TV, or telephoning to Singapore or Calcutta—*by way of outer-space satellites!* A mere dream a few years ago, this idea is now a giant step closer to reality.

Bell Telephone Laboratories recently took the step by successfully bouncing a phone call between its Holmdel. N. J., test site and the Jet Propulsion Laboratory of the National Aeronautics and Space Administration (NASA) in Goldstone, California. The reflector was a 100-foot sphere of aluminized plastic orbiting the earth 1000 miles up.

Dramatic application of telephone science

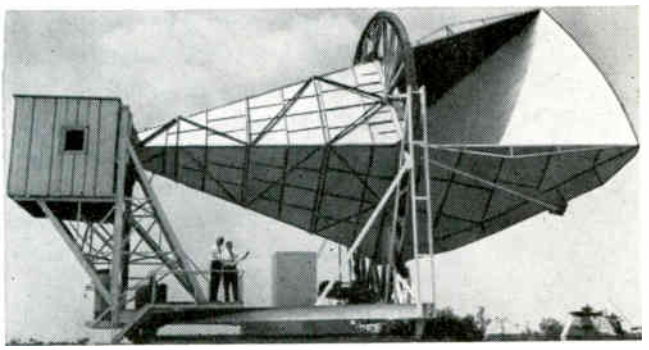
Sponsored by NASA, this dramatic experiment—known as "Project Echo"—relied heavily on telephone science for its fulfillment . . .

- The Delta rocket which carried the satellite into space was steered into a precise orbit by the Bell Laboratories Command Guidance System. This is the same system which recently guided the remarkable Tiros I weather satellite into its near-perfect circular orbit.

- To pick up the signals, a special horn-reflector antenna was used. Previously perfected by Bell Laboratories for microwave radio relay, it is virtually immune to common radio "noise" interference. The amplifier—also a Laboratories development—was a traveling wave "maser" with very low noise susceptibility. The signals were still further protected from noise by a special FM receiving technique invented at Bell Laboratories.

"Project Echo" foreshadows the day when numerous man-made satellites might be in orbit all around the earth, acting as 24-hour-a-day relay stations for TV programs and phone calls between all nations.

This experiment shows how Bell Laboratories, as part of the Bell System, is working to advance space communication. Just as we pioneered in world-wide telephone service by radio and cable, so we are pioneering now in using outer space to improve communications on earth. It's part of our job, and we are a long way toward the goal.



Giant ultra-sensitive horn-reflector antenna which received signals bounced off the satellite. It is located at Bell Telephone Laboratories, Holmdel, New Jersey.

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Polarity Of Aluminum Electrolytic Capacitors

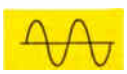
Many electrolytic capacitors have plus and minus terminals, like flashlight batteries, which makes them quite different from other types of capacitors. Polarity becomes necessary because of special construction that provides maximum capacitance for a given volume, weight, and cost.

Aluminum electrolytic capacitors are built around one of the best overall dielectric materials available. Aluminum oxide formed on a high-purity aluminum foil has a dielectric constant of from 7 to 10 and an extremely high dielectric strength of 2.5 million volts per 0.1 inch of thickness.

These unique dielectric characteristics of aluminum oxide can be utilized fully by controlling thickness of the oxide dielectric from a film only a few molecules thick to any depth required for conventional voltage ratings of electrolytic capacitors. Furthermore, aluminum foil can be etched to increase its surface area as much as ten times, increasing capacitance proportionally.

This extremely thin dielectric film offers very high resistance to passage of electrical current as long as the anode is positive with respect to the cathode. If the capacitor is connected with polarity reversed, the oxide film offers very little resistance to current flow and the resulting high currents will cause the capacitor to overheat.

This is the reason why polar electrolytic capacitors must be properly connected in a d-c circuit. Most electrolytic capacitors for filter, by-pass, and energy storage applications are polar capacitors. That is, they are constructed with the anode covered with dielectric oxide to a thickness capable of withstanding both rated and surge voltage of the capacitors. The negative plate normally has no dielectric oxide other than a thin film formed when aluminum is exposed to air.



It is possible to adapt the electrolytic principle for a non-polar capacitor to a-c applications. Two anodes are used, each plate having an aluminum-oxide dielectric formed on its surface to a thickness capable of withstanding normal and surge-voltage rating in either direction. When connected to an a-c source, one foil acts as an anode for one-half the cycle while the other functions as an anode on the other half of the cycle. Thus, there is no need to observe polarity with a non-polar capacitor. Because a non-polar capacitor is really two capacitors in series, it will have approximately one-half the capacitance of a polar capacitor of the same voltage rating when read on a bridge. Or, to put it another way, it will have twice the volume of a polar capacitor for the same capacity and voltage rating.

Non-polar electrolytic capacitors can operate on a-c provided service is intermittent or if reactive currents are low enough to prevent overheating. They cannot operate continuously at a-c potentials higher than 40 volts rms because of their high power factor and small surface area for dissipation of heat.

Type DCM, Polar Energy Storage | Type MJ, Non-Polar Motor Starting | Type TR, Polar High Reliability | Type MT, Polar General Purpose

Motor-starter capacitors are non-polar. They are also used where voltage may reverse on occasion or where a-c current must be passed continuously during the starting period.

There is another large family of electrolytic capacitors which, for lack of a better name, are called semi-non-polar. As the name implies, oxide is purposely formed on the negative plate, but of a thickness less than that formed on the anode. Most semi-non-polar capacitors are especially designed for particular applications.

Where a-c ripple voltage across semi-non-polar capacitors is high in filter applications, it is desirable to have oxide formed on the cathode capable of withstanding peak-to-peak voltage of the ripple wave — otherwise, oxide will accumulate on the cathode which will reduce capacitance and increase impedance.

Since non-polar and semi-non-polar electrolytic capacitors have more foil area to absorb heat, more parallel paths for current, and larger case sizes with greater area to dissipate heat, they are used where high a-c ripple currents and/or low impedance requirements make polar capacitors impractical.

Sangamo has a complete line of polar and non-polar capacitors for filtering, energy storage, motor starting, by-pass, coupling, and non-critical timing circuit applications. Where semi-non-polar capacitors are required, Sangamo engineers are well qualified to supply the most economical design that will give good service and long life.

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October 21, 1960

Telemetry System for Testing Automobiles

By ALAN POTTON,

Armstrong Whitworth Aircraft Ltd., Coventry, England

Author adjusts transmitter (above) that enables tests to be made at various points on a car and transmitted to a recording and monitoring station (below) where it is possible to warn the driver of danger from a part nearing the breaking point

A SATISFACTORY METHOD of measuring temperatures, pressures, and other parameters in a moving vehicle has been needed by automobile industry. Direct recording techniques have been used such as carrying the recording equipment in the vehicle itself, or in a second vehicle attached to the test vehicle by a cable.

A four-channel telemetry system was developed to test the feasibility of a telemetry scheme designed for vehicle designers in the automobile industry. A four-channel unit was chosen as having the minimum number of channels to allow assessment of the scheme, but the addition of more channels involves little further complications.

A block diagram of the transmitter is shown in Fig. 1A. A time multiplex pam/f-m/a-m system having an f-m subcarrier amplitude-modulating a transmitter with a carrier frequency in the decimeter wave band is used. The test vehicle was fitted with four transducers comprising two strain gages, one thermocouple and one thermistor. Strain gages are fitted to one track rod and one steering arm in pairs of one active and one passive element to compensate for temperature changes. A thermocouple is fitted to the exhaust manifold, and a thermistor measures the temperature in the oil sump.

Lowlevel transducer outputs from the strain gage and thermocouple circuits are connected to bank 1 of a double-bank 24-channel telemetry sampling switch. The output from bank 1 of the switch is amplified by a heat-stabilized low-drift d-c amplifier. This signal is then fed to bank 2 of the sampling switch. At this point, a synchronizing voltage source and the thermistor output are connected to the switch.

The output from bank 2 of the switch frequency-modulates the subcarrier oscillator, which in turn is used to amplitude-modulate a uhf transmitter. A monopole antenna fitted to the roof of the vehicle transmits the signal.

A block diagram of the receiver is shown in Fig. 1B. The receiving

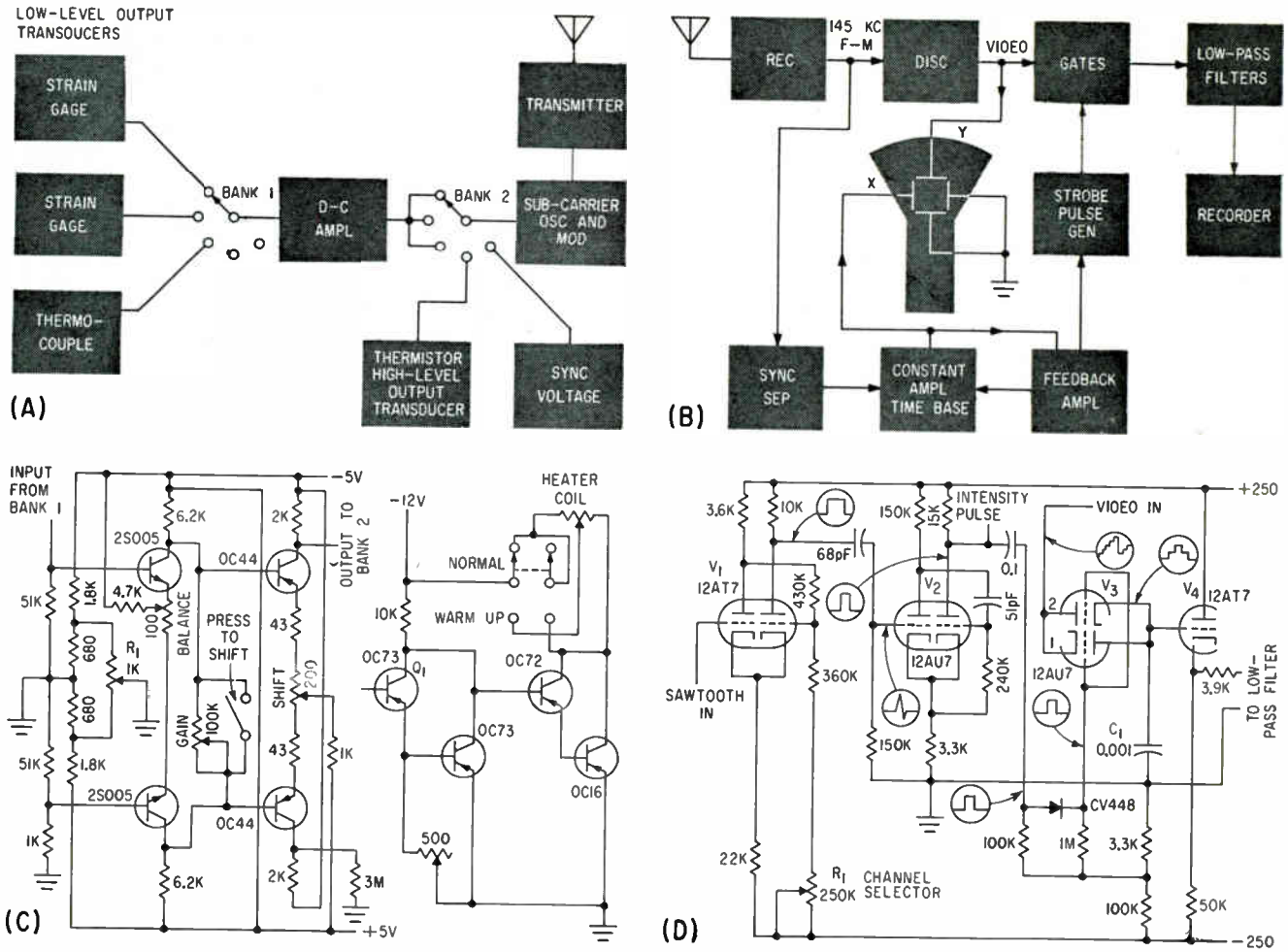


FIG. 1—Block diagrams of transmitter unit (A) and receiving station (B). Transmitter d-c amplifier (C left); temperature control circuit (C right); receiving unit strobe pulse generator (D)

antenna is a folded dipole with a single reflector and is matched to the input impedance of the uhf receiver. The detected signal is then fed to the frequency discriminator. The discriminator output is displayed on a cathode-ray tube. After discrimination, the signal is demultiplexed in the strobing system and the individual channels are recorded by ultra-violet recorders.

Since the transmitter modulator requires a single-ended input going positive and negative about ground, it is necessary that the transducer circuits give this type of output. A further restriction is that to satisfy the bias requirements of the input stage of the d-c amplifier, signals must be presented to a resistance of 1,000 ohms. Voltage supplies for the transducers consist of a +12 v and −12 v stabilized supply.

The transducer circuit is shown in Fig. 2A. The strain gages are connected in half-bridge circuits with one passive and one active element. A variable resistance balances the system, and in view of the amplifier input requirements, 2,000-ohm strain gages are used. From an estimate of the strains involved, an output from the strain gage circuits of ± 10 mv at maximum strain was expected. A similar output was also anticipated from the thermocouple circuit. The output from the thermistor circuit, however, is ± 1.5v over the expected temperature range and amplification is therefore not required.

A circuit of the d-c amplifier is shown in Fig. 1C. The amplifier consists of two stages, each stage comprising an emitter-coupled pair. This configuration results in a symmetrical circuit which minimizes effects due to the thermal drift of individual transistor parameters. To further minimize thermal drift, Q_1 is a temperature-sensing element which controls the current through the heater of a temperature-controlled block. The base of Q_1 is left floating. Variations of ambient temperature are reduced by a factor of ten inside the block' and the transistors are maintained at a steady 40 C. Since noise in a mechanical switch depends partly on the current through the contacts, R_1 may be adjusted so that the amplifier draws no current from the input source for zero input level.

The gain of the amplifier is variable with a maximum of 240, and zero level drift is equivalent to 10 μv at the input per degree centrigrade change of ambient temperature. The output of the amplifier is 3 db down at 50 Kc. Power supplies are obtained from a 10 v transistorized stabilizer.

The frequency modulator circuit is a conventional reactance tube type. The uhf transmitter is amplitude modulated by feeding the subcarrier output to the grid of a tube in series with the transmitter. The uhf transmitter uses two type A1714 tubes in a push-pull circuit with a quarter-wave lecher line. Loop coupling is used at the output of the transmitter and the signal is fed to a monopole antenna on the roof of the vehicle. Maximum power

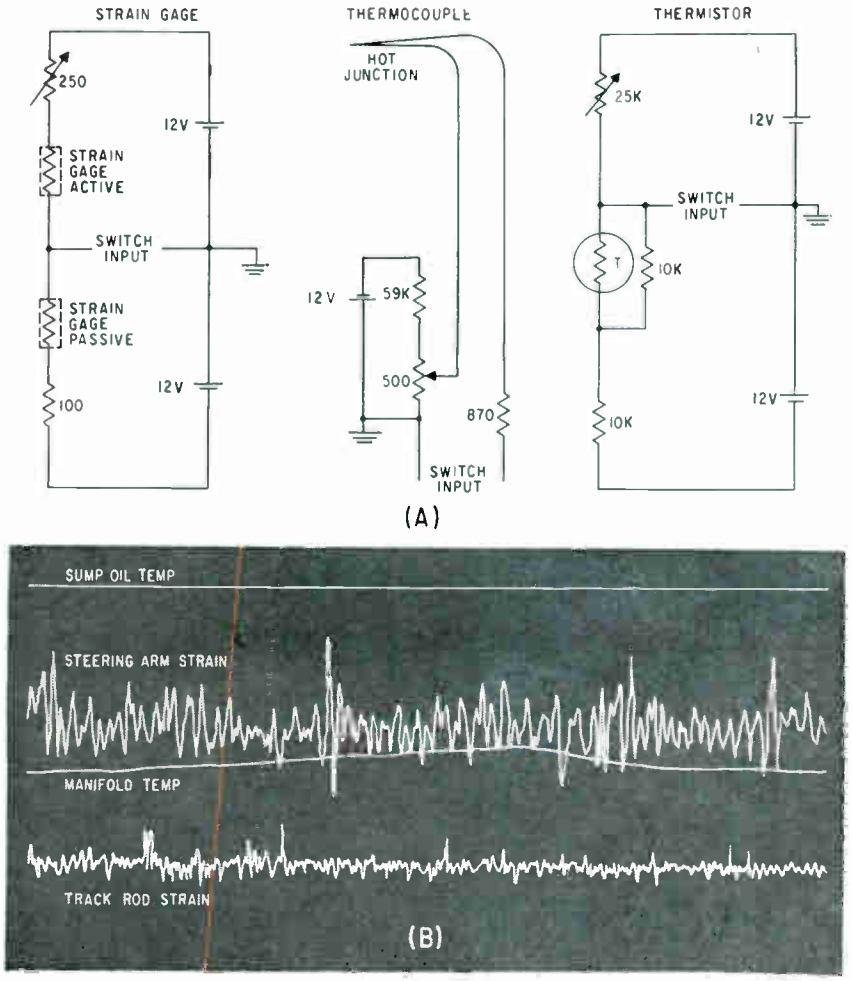


FIG. 2—The transducers (A) measure the temperature and strain parameters shown in a typical record of a test run (B)

output of the transmitter is 1.5 watts, and range with the present antenna is well over two miles. The maximum frequency of the information transmitted is 60 cps with the present design.

The entire transmitter weighs 30 pounds and will fit easily into the front seat next to the driver. An attempt to minimize the effects of vibration is made by mounting the unit on a sheet of rubber and strapping it firmly to the front seat, which has always been satisfactory in practice. When fitted in the front seat in this way, the equipment can easily be operated by the driver and it is therefore unnecessary to carry a second person specifically to operate the sender unit.

A folded dipole with a single reflector is used as a receiving aerial and is matched to the receiver at the carrier frequency. The receiver is a conventional uhf receiver using a type A2521 tube in the grounded-grid configuration as a low-noise amplifier giving an effective noise temperature of approximately 3,000 K. The bandwidth of the available receiver is 4.5 Mc which, although excessive for the immediate application, is a facility available for high information systems that may come into use.

After detection of the signal, it is passed into a Travis-Round discriminator. This discriminator is of the simple balanced type utilizing two circuits tuned to frequencies above and below the subcarrier center frequency. The output of the discriminator is a telemetry histogram that is displayed on a cathode-ray tube for visually monitoring the signal before demultiplexing. The display system also separates synchronizing channel from the composite signal and uses it to lock the visual display.

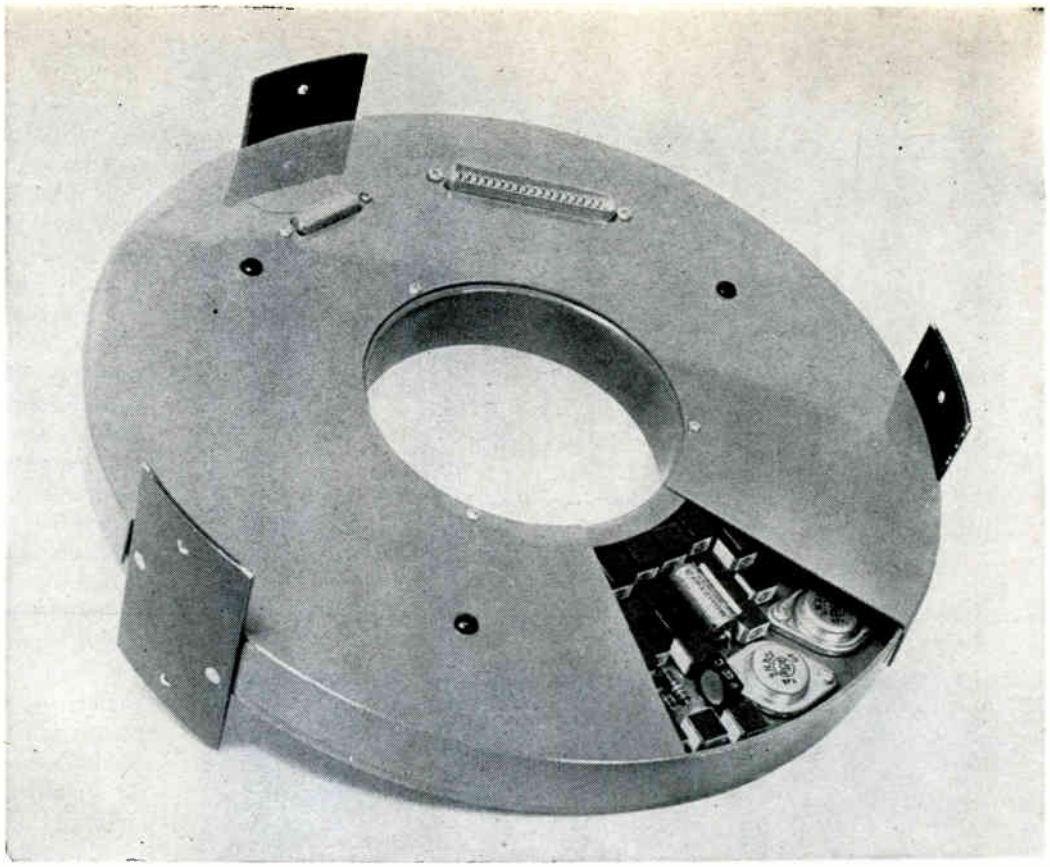
The transitron type of timebase uses a feedback loop to ensure a sawtooth output of constant amplitude. The timebase output is amplified by an EF91 tube and d-c restored by an EB91. Two EF91 pentodes act as a differential amplifier, the output from which is fed to the grid of the sawtooth oscillator EF91 tube. This tube has an 0.002 μf capacitor between its plate and the grid resistor. The rate of charge of this capacitor and hence the slope of the timebase is controlled by this feedback voltage. Since the frequency of the timebase is fixed by the synchronizing frequency, the result is a sawtooth output of constant amplitude.

The circuit of the strobing unit is shown in Fig. 1D. The constant amplitude sawtooth from the display unit timebase is fed to the left-hand control grid of V_1. This tube is connected as a Schmitt trigger circuit, and when the grid reaches a predetermined voltage, the drop in plate voltage causes the second half of the tube to be cut off. Potentiometer R_1 sets the triggering level, which is used to select the channel to be strobed out. The output from the Schmitt trigger is now differentiated, and the differentiated waveform triggers one-shot multivibrator V_2. A pulse 0.1 msec wide is produced by the multivibrator and the position of the pulse relative to the start of the timebase is controlled by R_1. The output pulse from the multivibrator acts as a gating pulse and also identifies the strobed channel on the visual display by brightening the trace at that point.

When the strobing pulse is applied to the grids of double-triode gating tube V_3, the gate will select the required channel from the composite signal applied to cathode 1 and plate 2. The gate is of the sample-and-hold type, since capacitor C_1 holds each gate level until the next gating pulse comes. The gate output is a stepped wave, which is passed through a low-pass filter by way of cathode follower buffer stage V_4. Since the cutoff frequency of the filter is 60 cps, the output from the filter is no longer a stepped waveform, and all frequency components of the original signal up to 60 cps appear at the output. The maximum output voltage from the filter is $\pm$ 15 v across the 30,000-ohm input resistance of the recording unit.

REFERENCE

(1) H. Kemhadjian, A Simple Temperature Control System for Transistors, Mullard Technical Communications, Dec., 1958.



Mockup of micromodular autopilot, complete except for gyros, takes up 0.035 cu ft, weighs slightly over three pounds

MINIATURIZED

Autopilot System for Missiles

Micromodular construction cuts volume and weight, enables system to be mounted in bulkhead of airframe. Unique magnetic shift register permits simple, versatile programming of inflight operations

By J. H. PORTER, RCA West Coast Missiles and Surface Radar Division, Van Nuys, Calif.

AUTOPILOTS are used to maintain airborne vehicles in a flight path. To alleviate the space and weight problems in missiles, a miniature autopilot system is required. A full-scale mockup of such a system using micromodular fabrication is described.

Each axis of the system consists of rate and position gyros, an a-c amplifier in which the error signals from the gyros are mixed, a caging amplifier, and a demodulator that recovers the sense and amplitude of the error signal. The pitch and yaw demodulator outputs are fed directly to appropriate response shaping networks, while the roll signal is first passed through a phase inverter. Three d-c amplifiers, feedback networks and valve drivers position the pitch and yaw actuators. (See Fig. 1).

A programmer generates a total of 19 discrete pulses occurring at predetermined times for actuation of torquing, gain change and guidance control switches. These times are resolvable to one second intervals and are flexible within a 2,000 sec period. A one-pps clock signal is derived from the stable 400-cps square wave supply by time division techniques. The programmer is held in a nonoperative condition by a reset generator until lift-off or some other initiating signal occurs.

During programmed flight, step levels of 2,400-cps square-wave current are supplied to the torquing fields of the pitch and roll gyros. At changeover, roll torquing is discontinued, and the pitch and yaw torquing fields are made available for guidance control.

The switches shown in Fig. 1 as functional items are actually electronic devices. Three types of electronic switches are used: one to select levels of current to the torquing fields of the roll and pitch position gyros, one to introduce a gain change in the a-c amplifier, and one to make both the torque and pattern field windings of the gyros available for control by guidance signals. Control of the switches is effected by a flip-flop.

Both d-c and a-c gyro torquing techniques were considered, d-c be-

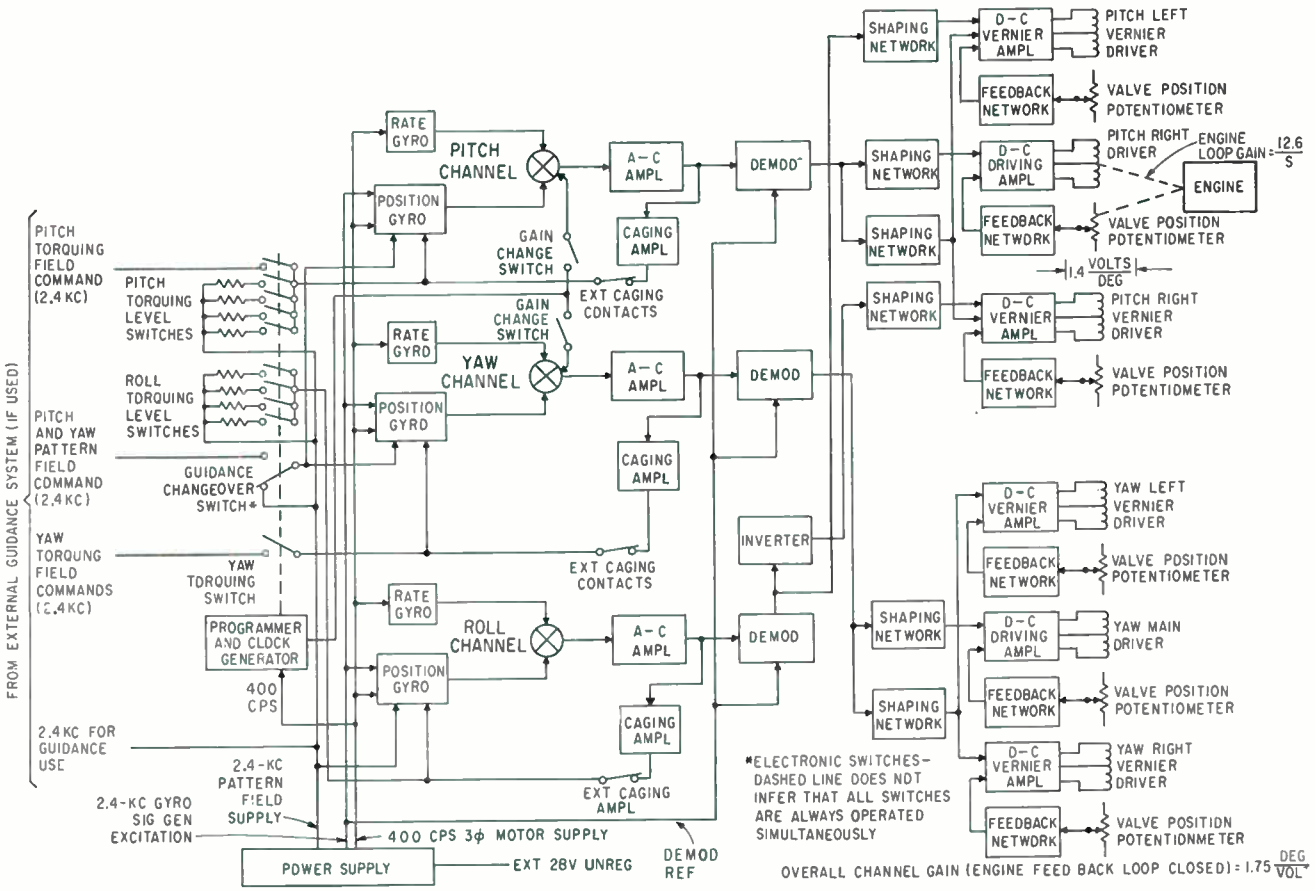


FIG. 1—Missile autopilot system uses wafer semiconductors throughout except for seven silicon power transistors in power supply. Use of magnetic programmer offers ruggedness, low power consumption and memory of stored time despite momentary power failure

ing mandatory for a miniature integrating type gyro such as the MIG. It was decided to adhere to the HIG-4 gyros used in another autopilot and apply torquing current levels only to the torquing fields of the gyros. Separate caging amplifiers are used.

Error signals from the rate and position gyros for the pitch, yaw, and roll channels are resistively summed and fed through a-c amplifiers, demodulators, shaping networks and driving amplifiers to actuate the main pitch and yaw valves. Feedback loops from the valve position potentiometer feed the d-c amplifier through other shaping networks with lead-lag-lag characteristics.

To drive the pitch and yaw vernier engine actuator valves, signals from the demodulators are passed through shaping networks and summed at the input of another d-c amplifier. Feedback signals representing valve positions are shaped and fed to their respective driving amplifier input.

Pitch and yaw channels are straight through, while roll control is accomplished by differential motions of the pitch vernier engine actuators. A unity-gain inverter provides a signal of opposite sense for the control from the roll demodulator. Gain changing is done by increasing the attenuation of the position and rate gyro coupling networks.

A unique magnetic shift register element is used in both the one-pps clock generator (Fig. 2A) and the 2,000-second counter (Fig. 2B). For both applications, the elements are connected in rings with the output of the last element in a ring connected to the input of the first element in that ring. Each ring has its own driver and all drivers are operated from the same pulse generator. Thus, one generator is required for the 400:1 divider (Fig. 2A) triggered at a 400-pps rate, and one for the 2,000-second counter (Fig. 2B) triggered by the output of the divider at one-pps rate. Prior to lift-off, all elements of all rings contain logic ZERO's; at lift-off, logic ONE's are inserted in the first element of each ring.

In the clock generator (Fig. 2A), the logic ONE's in each ring are circulated by the pulse generator and driver at the 400-pps rate. The numbers of elements in the four rings were chosen as 3, 4, 5 and 7 so that all but one ring contains a prime number of elements. The product of the number of elements should exceed the desired count by as small an amount as possible, in this case $3 \times 4 \times 5 \times 7$ or 420.

To determine where the ONE is in each ring at any given time, such as 400 pulses after lift-off, divide 400 by 3 to get 133 1/3 and use the remainder, 1, as the element number desired for the 3-element ring; divide 400 by 4 to get 99 4/4, and use the remainder, 4, as the element in the 4-element ring; divide 400 by 5 to get 79 5/5 and use the remainder, 5, as the correct element in the 5-element ring; and divide 400 by 7 to get 57 1/7, and use the remainder of, 1, as the element desired in the 7-element ring. Another way of saying this, with respect to the 7-element ring, is

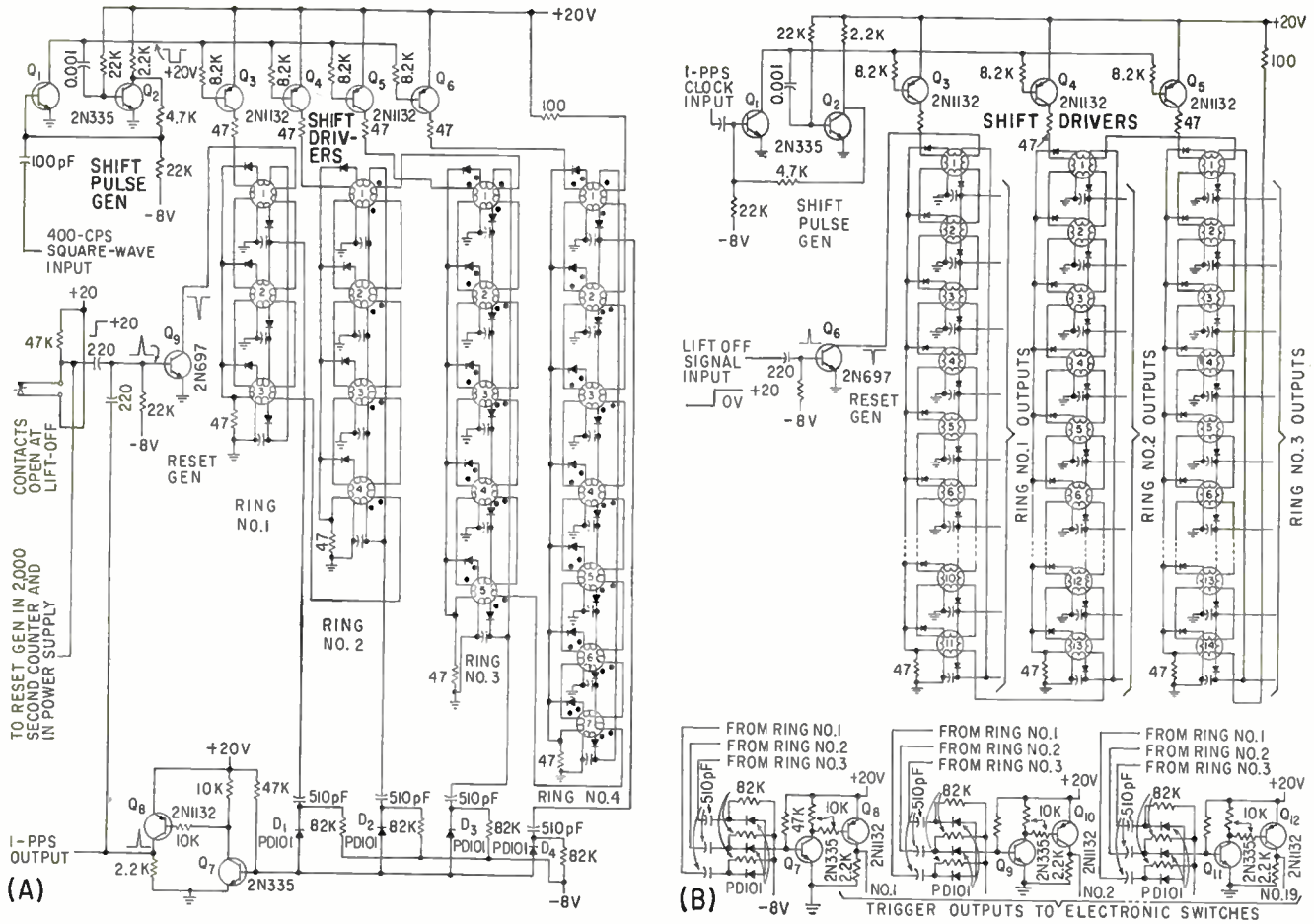


FIG. 2—One-pps output of clock generator (A) is derived from a much higher frequency crystal oscillator, thus any desired clock rate can be obtained with only minor reassembly of modules. As many as 20 AND gate inputs can be supplied by each ring element in 2,000-second counter (B)

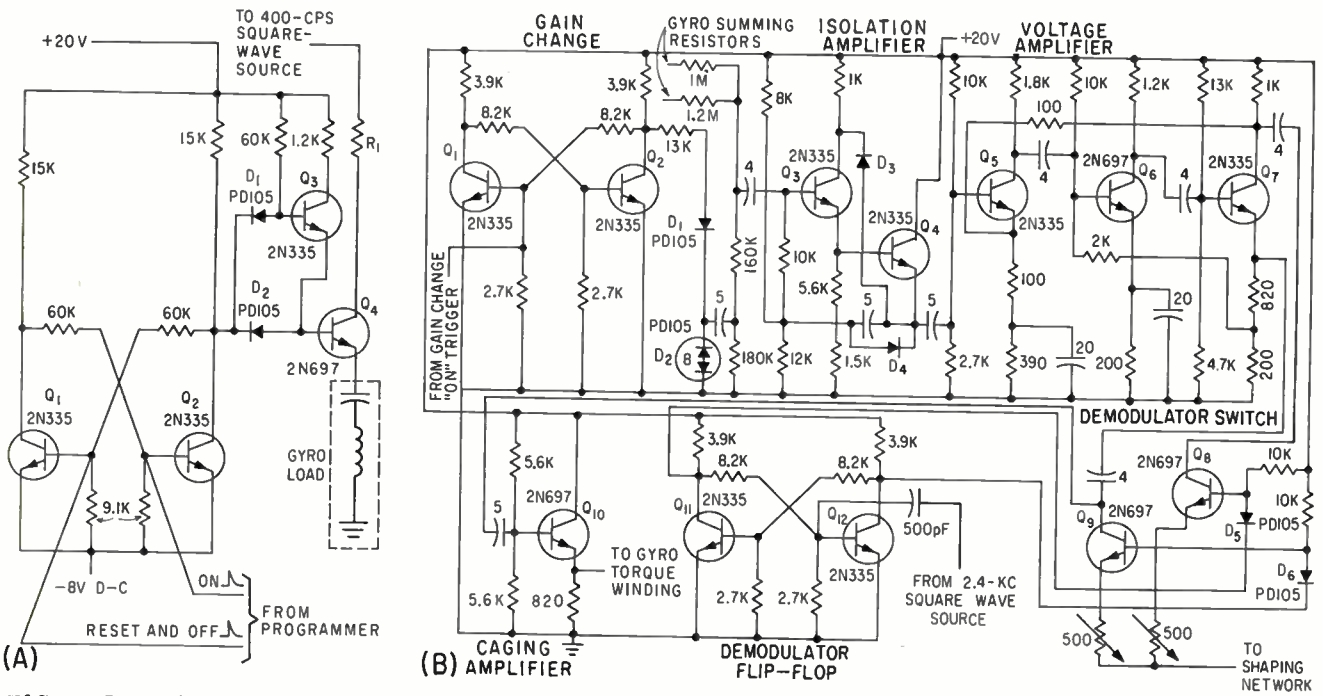


FIG. 3—Typical gyro torquing switch (A) can pass square wave with 10-v peak. Gain change, a-c amplifier-demodulator and caging amplifier circuit (B) can be used in either the pitch or yaw channels; roll channel requires additional phase inverters (see Fig. 4A)

that the original ONE has made 57 complete circuits of the ring and is now in the 1 element.

A 4-leg diode and gate consisting of D_1, D_2, D_3 and D_4 determines coincidence of the ONE's in the proper element of each ring and generates a negative pulse in the collector of Q_7. The negative pulse is inverted by Q_8, and is used as a trigger for the 2,000-second counter and to reset ONE's into the element number 1 of each ring in the 400:1 divider so that another clock pulse will be generated 800 pulses after lift-off.

The one-pps clock triggers operate the 2,000-second counter pulse generator (Fig. 2B) and associated shift pulse drivers. Just as in the 400:1 divider, closed rings are used, with a total count capacity of 2,002 seconds. Circulation of the ONE's is carried out just as was done in the 400:1 divider. The total capacity is 11 × 13 × 14 or 2,002 sec and, for this application, reset at 2,002 sec is not required.

Element number 1 in each ring is primed with ONE's at lift-off; every second thereafter the ONE's are stepped along. A total of 19 positive-going pulses are required, each suitable for operating flip-flops in the electronic switches.

A typical requirement is a pitch torque change 4 seconds after lift-off. This operation is easy because an output is taken from element number 4 in each ring and, since there are 3 rings, fed to a 3-legged diode AND gate to generate the positive pulse. This pitch torque level might then be switched at 19 seconds to another level, while at 17 seconds a new roll torque level may be required.

For a discrete output at 17 seconds the remainders after dividing 17 by 11, 13, and 14 respectively are used. These remainders or 6, 4, and 3, and these elements will be tied to the inputs of another AND gate. An example may be the operation at 1,999 seconds. Here the elements to be used will be: 1,999/11 = 181 8/11 or 8; 1,999/13 = 153 4/13 or 4; and 1,999/14 = 142 11/14 or 11, for the 3 rings, respectively. To generate positive-going output signals from the programmer, the register elements are polarized to yield positive capacitor potentials. During the ANDing operation and subsequent two-stage amplification, the output signals from the programmer have positive polarity.

A typical gyro torquing switch is shown in Fig. 3A. A flip-flop (Q_1 and Q_2) controls transistor Q_3 driving switching transistor Q_4. Trigger signals from the programmer control the state of the flip-flop.

A switch closure is initiated by a positive step voltage from the flip-flop applied to diodes D_1 and D_2 connected to the drive transistor. A large base current flow saturates the switching transistor, thus passing the square wave torquing current to the gyro torque field. When the state of the flip-flop is changed, a negative step voltage is applied to the diodes, back-biasing the switching transistor and effectively isolating the square wave source from the gyro torque field. Resistor R_1 determines the level of torquing current.

External guidance control for the pattern and torque fields is done by the same type switch. The flip-flop for the pattern field, however, will drive two switching transistors connected to opposite collectors of the control flip-flop. During autopilot operation, the pattern field will be excited through a normally closed switch. The switches will reverse their state at the proper time for external control and pattern field excitation will be by external guidance.

Gain change is introduced in the pitch and yaw a-c amplifiers after a fixed amount of fuel has been consumed. This is achieved by shorting to ground part of the resistor network of the summing stage. As shown in Fig. 3B, a flip-flop controls the breakdown of the Zener diode, D_3. At breakdown D_3 exhibits a low impedance, shunting the 180,000-ohm resistor and reducing the input to the a-c amplifier. The pattern and torquing currents provide a maximum torquing rate of approximately 2.5 deg per sec. The gyro signal generator is supplied with square wave excitation at 2.4 Kc on the primary. The higher impedance secondary is resonated to this frequency with a small capacitor. The secondary waveform then becomes a clean sine wave at the same impedance level that it would have had with sine-wave excitation at a lower frequency.

A caging gain of 26 is inherent in the a-c signal amplifier and demodulator while the separate amplifier provides impedance matching to the gyro torquing field. Since the 2.4-Kc and 400-cps supplies are precisely phased together, these separate frequencies could be used for gyro pattern and torquing field excitation. To minimize interaction due to the different frequencies and because the caging loop operates at 2.4 Kc, this frequency is used for both field windings. Prior to guidance control changeover, all position gyro pattern fields are supplied with a fixed level of 2.4 Kc; at changeover the pattern and control fields of the pitch and yaw gyros are made available for guidance control.

The a-c amplifier, shown in Fig. 3B, is a 5-stage circuit: the first two stages (Q_3 and Q_4) as a high-impedance bootstrapped isolation amplifier; the third and fourth stages (Q_5 and Q_6) act as a voltage amplifier; and the last stage (Q_7) acts as a phase splitter supplying equal voltages of opposite phase to the demodulator.

Voltage gain is obtained in the third and fourth stages, and good stability is achieved by two feedback loops. The amplifier operates linearly for inputs up to 0.2 volt peak-to-peak and the overall voltage gain is 27.

The demodulator is composed of a bistable flip-flop (Q_{11} and Q_{12}) and two series switching transistors (Q_8 and Q_9) connected to opposite collectors of a control flip-flop and is designed to give a no-signal d-c output of 9 volts. This level is modulated approximately ±3 volts for maximum in-phase or out-of-phase error signals from the gyros.

The 2.4-Kc square-wave reference voltage is differentiated and used to trigger the flip-flop ON and OFF at a switching rate of twice the reference frequency. Switching transistors Q_8 and Q_9 will alternately be turned ON and OFF at this frequency. Since the switching transistors are coupled to the two outputs of the phase splitter, the opening and closing of the transistor switches pass half cycles of the error signal. From the switches, the half cycles of the error signal are resistively summed and then

coupled to the shaping network. Since the transistor switches alternately pass half cycles of the error signal that are 180 degrees out of phase, the demodulator gives a full-wave rectified output. The output can be made positive going or negative going, depending on the state of the flip-flop and the connection of the transistor switches to the phase splitter.

The a-c amplifier-demodulator shown is for a single channel and is applicable for either the pitch or yaw channels; however, to provide the differential roll motion, an additional unity gain inverter (Fig. 4A) is required.

The caging amplifier used to null the gyro is shown in Fig. 3B. It is an emitter-follower, Q_{10}, connected to the emitter of the phase splitter and works with the a-c amplifier during caging to give an over-all voltage gain of 30. Output of the caging amplifier is connected to the gyro torquing field through external contacts in the ground equipment prior to missile liftoff.

The networks shown in Fig. 4B provide a current transfer function I_{out}/I_{in} having the desired frequency response when terminated in a low impedance such as the input impedance of the d-c amplifier, which is approximately 200 ohms. Resistor R_1 at the input of the network from the demodulator provides bias current for the demodulator. The networks isolate their inputs from the amplifier, while permitting the amplifier to be driven by a high impedance, or current source.

The d-c amplifier (Fig. 4B) has a current gain of 4,000 with voltage feedback and a voltage gain of 28,000 to give a power gain of 51 db. It consists of two differential stages (Q_1 and Q_2, Q_3 and Q_4) driving two emitter followers Q_5 and Q_6. The first differential stage Q_1 and Q_2 utilizes a 2N1247 which is a low-level, low-leakage transistor.

The second differential amplifier stage (Q_3 and Q_4) uses *pnp* silicon transistors to provide the right polarity for the tandem connections and for I_{co} cancellation between this stage and the emitter followers. Transistor Q_7 acts as a high impedance while passing a high current to improve the differential action of Q_3 and Q_4.

Transistors Q_5 and Q_6 drive the valve coils and dissipate a maximum of 72 milliwatts each. The small collector loads permit an isolated output from which to derive voltage feedback for stability. The 2N1132's and the 2N697's are complementary, thus by being connected in tandem they effect mutual leakage current cancellation. To facilitate this cancellation, transistors Q_1 through Q_7 are mounted in the same micromodule. One of the advantages of the micromodule effort is a reduction in system volume. A micromodularized autopilot can be assembled readily in 0.035 cubic foot (weighing slightly over 3 pounds complete with power supply and capable of operating to 100 C) exclusive of gyros and gyro temperature controllers. Using HIG-4 gyros, a total volume of 0.238 cubic foot and a total weight of 13 pounds can be obtained. Pallets with the wide angle MIG gyros would reduce the total volume and weight to 0.155 cubic foot and 8 pounds, respectively. In most instances, each module contains no more than one silicon transistor which, together with associated components, has less than 0.5 watt dissipation. For some cases, such as in the d-c amplifier, two waferized transistors are mounted in close proximity for thermal equilibrium. This is made possible by backing the metal enclosures of the transistors together. Certain components are not now presently practical on micromodule wafers; for example, a 1-watt resistor would require at least 2 modules of waferized resistances and a 0.01 pF stable capacitor would require at least 10 stacked wafers.

Two cascaded magnetic shift register elements can be assembled on one module. The actual limitation of number of components per module is determined by the power dissipation, and by the number of connections to be made to the module. Likewise, the number of modules which can be laid out on an etched wiring board depends on the number of conductors that can be etched on that board. A suitable design may well be a flat disk approximately 9 inches in diameter and 1-inch thick with a 2-inch diameter hole in the center through which missile cabling and tubing can pass. Connectors will be mounted on the flat side of the disk for the gyro, power and guidance cabling.

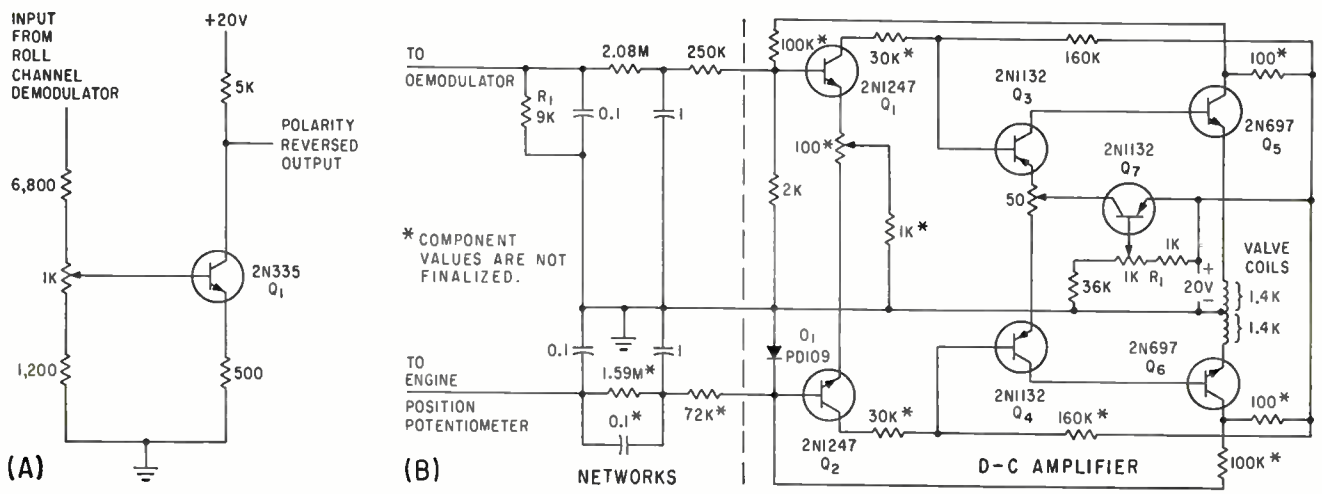
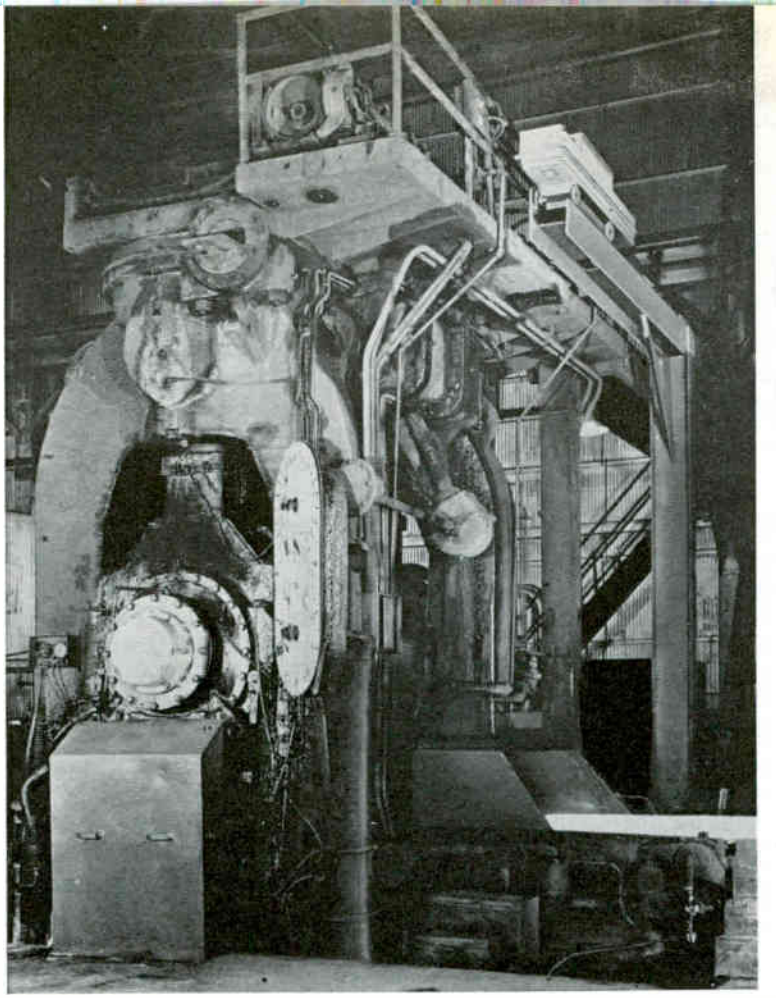
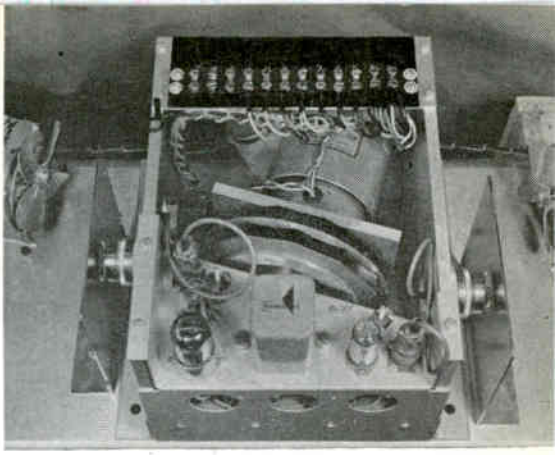


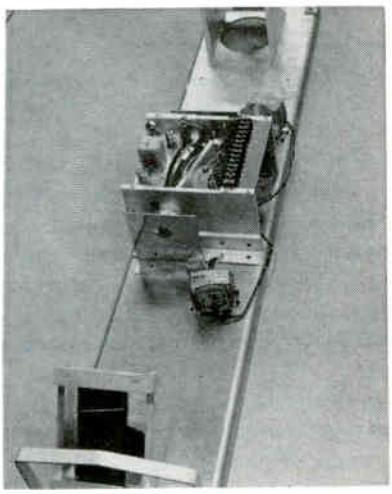
FIG. 4—Differential roll motion is provided for by phase inverter (A). The d-c amplifier and shaping networks (B) are used only in pitch and yaw channels. Networks isolate inputs from the d-c amplifier driving valve coils



(A)



(B)



(C)

FIG. 1 Detecting head mounted above moving steel strip (A) consists of rotating scanner (B) operating with a pair of mirrors (C) and infrared-sensitive photocells so that each portion covers half of the mill table

Infrared Gage Measures Hot Steel Strip Width

Measuring the width of strip steel within one-eighth inch when the strip is heated to approximately 2,100 F and moving at speeds up to 3,000 feet per minute is a problem. This gage solves it

By FRED J. DANKS,
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STRIP STEEL is produced from large slabs by continuous rolling. The slabs are heated to about 2,100 F and rolled through a scale breaker, several roughing mills with edge rolls and finally into a series of five or six finishing mills before being coiled as thin hot-rolled strip. This is a high-volume process with the leading edge of one strip following the tail of another by a few feet. Rolling speeds are typically 1,000 to 3,000 ft per min at the last finishing stand.

Instrumentation is essential to insure consistently good quality. Temperatures, thickness and width are of prime concern. The width of the strip is set far back in the process by edge rolls working on the width of the slab as it emerges from the furnace. However, if the speeds of the finishing stands are not properly set, they can stretch the strip causing neckdown. If the strip is necked down to where it does not meet the minimum width tolerance, it must be diverted and stored until it can be used for an order calling for the same alloy, same thickness, same heat treatment but slightly narrower width.

Before the width gage there was no way to measure finished width except by one reading taken by hand on the outer wrap or two of the finished coil long after it left the mill. To increase the yield of the mill, it was common practice to roll the coil ½- to 1-in. wider than ordered to permit side trimming

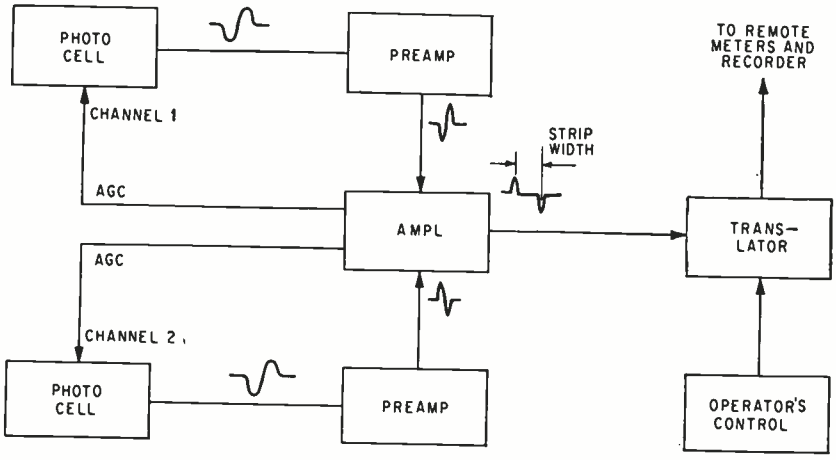

FIG. 2—Automatic gain control maintains photocell output constant over wide range of strip temperatures

later to the specified width. On an average width of 40 inches, ½-in. is 1.25 percent and 1-in. equals 2.5 percent scrap. With the width gage, these figures have been reduced about 50 percent affecting savings in scrap steel and storage costs.

In designing the gage, the following requirements were set: to cover a range of widths from 20 to 80 inches (since extended down to 10 in. and up to 100 in.); to display on wide-scale meters in several locations as well as record a full-scale deviation of ±1 in.; to have an accuracy of ±¼ in. while tolerating vertical strip bounce, side sway of ±3 in. and temperature variations of the strip from 1,000 to 2,000 F, with reasonable amounts of scale and oxide dust in the air between strip and pickup head; to permit direct setting of nominal width from an operator's control cabinet mounted remote from the head and main console; to maintain calibration for reasonable periods of time such as one week of continuous service and then be easily and completely checked against a standard reference; and the pickup head or sensing unit to be mounted far enough above the strip at the last finishing stand to protect it from cobbles between stands and to permit access by overhead cranes to all operating parts of the mill.

It was decided early in the design to reduce the number of moving parts and approach as nearly as possible an all-electronic solution. The result was a unit with one moving part, a rotating scanner driven by a low-speed ball-bearing motor. The photocells had to respond to the red and near infrared radiation of the strip to provide maximum efficiency. The speed of response was also important since it was desirable to have a sharp pulse generated by the image of the edge of the strip as it passed the cell. Lead sulphide cells were chosen.

The layout of the scanning system is shown in Fig. 1 and a block diagram is shown in Fig. 2. Each half of the pickup is a 45-degree front-surfaced mirror, lens, 12-sided front-surfaced rotating mirror and photocell behind a 0.020-in. slit aperture. The distance from pickup to strip (typically 12 to 20 ft), the lens focal length and the length of a mirror face are such that a scan covers approximately one-half of the mill table and therefore one-half of the widest strip plus its side weave.

As the scanning mirror rotates, the image of the mill table and strip is swept past the photo-cell aperture. In channel one (shown in Fig. 3A) as the edge of the hot strip passes, cell D_1 resistance drops and produces a negative-going pulse that remains until the strip image is cut off by the corner of the scanner. This pulse is amplified, differentiated, clipped and differentiated again by V_1. Clipping diode D_2 eliminates the unwanted pulse generated by the scanner corner cutting off the strip image.

The signal through channel two (also shown in Fig. 3A) is similar except that the first pulse is the unwanted one; the second is indicative of the strip edge. The reversed polarity of diode D_3 accomplishes this selection. Both signals are fed into cathode followers V_2 to provide low-impedance drives for the shielded cable to the main console.

The original square wave at the photocell does not have an instantaneous rise time due to the response of the cell, the finite width of the aperture and the temperature gradient at the strip edge. By differentiating this signal, a pulse is generated whose peak occurs at the time of maximum rate-of-change of temperature and this time point represents the true strip edge. By a second differentiation the pulse is sharpened but more important the needed point in time is now at the base line or zero amplitude for transmission through the shielded cable to the main amplifier. This approach, together with agc circuits, permits good stability with wide variations in strip temperature.

The two signals from the preamplifier are fed to the main amplifier shown in Fig. 3B. As both circuits are similar, only one will be described.

The input signal is amplified by one triode of V_3, clipped by grid limiting in the second triode of V_3 and amplified by the first triode of V_4.

The signals from both channels are combined at the second triode of V_4. The combined signal fed to the translator consists of a positive-going pulse from channel 1 and a negative-going pulse from channel 2 with the distance between the pulses indicating the strip width.

Each photocell has its own agc system. As shown in Fig. 3B, the signal at the first triode of V_4 is sampled by a differentiator and clamper, inverted and amplified by V_5 and applied to peak detector V_6. The detected output is amplified by the d-c amplifier portion of V_6 and applied to the photocell circuit in the preamplifier. The agc maintains the photocell output constant over a wide range of strip temperatures (1,000 to 2,000 F).

The combined signal output from the main amplifier is coupled to the translator circuit shown in Fig. 3C and triggers bistable multivibrator V_7. The output of V_7 is a rectangular pulse whose width is proportional to the steel strip width. The pulse is clamped and amplified by V_8 and passed to comparator V_9.

The comparator provides an out-

put proportional in amplitude to the width of the input pulse. The d-c bias established by the operator's width control setting circuit must be overcome by the sum of the d-c bias on the first section control grid and the positive peak value of the rectangular pulse from V_7 and V_8. With the peak-to-peak amplitude of the pulse held constant by V_8, the base line to positive-peak amplitude at V_8 control grid will vary linearly with pulse width.

Comparator V_9 bias voltage is determined by settings of the operator's control unit. Potentiometer R_1 determines the operting level when measuring the widest strip; the widest strip is measured with width-setting control R_2 (shown simplified) set at its lowest voltage setting.

The strip signal varying in amplitude and width with changes in input, is amplified by the second half of V_{11}, clamped and peak detected by V_{12} and applied to the remote meters and recording equipment by one half of V_{13} acting as a cathode follower. The other half of V_{13} also acts as a cathode follower but remains at a fixed level at all times.

The rectangular wave at the cathode of bistable multivibrator V_7 is amplified by one half of V_{11}, differentiated and passed to peak detector V_{10}. The detected signal is amplified by the second section of V_{10} that has the coil of relay K_1 in its plate circuit.

When the hot steel strip has passed out of sight of the photocells, relay K_1 opens. When this happens, contacts of K_1 place a short circuit across the metering and recording lines to cause a zero indication. Other contacts of K_1 operate relay K_2 in the main amplifier (see Fig. 3B) limiting the agc voltage to prevent overheating the photocells. The appearance of the next hot strip under the gage resets relay K_1 and allows the operation to start again.

The device is calibrated by a group of infrared lamps that can be selected in pairs. The calibrator is installed away from the mill and the pickup head is rolled above it for calibration.

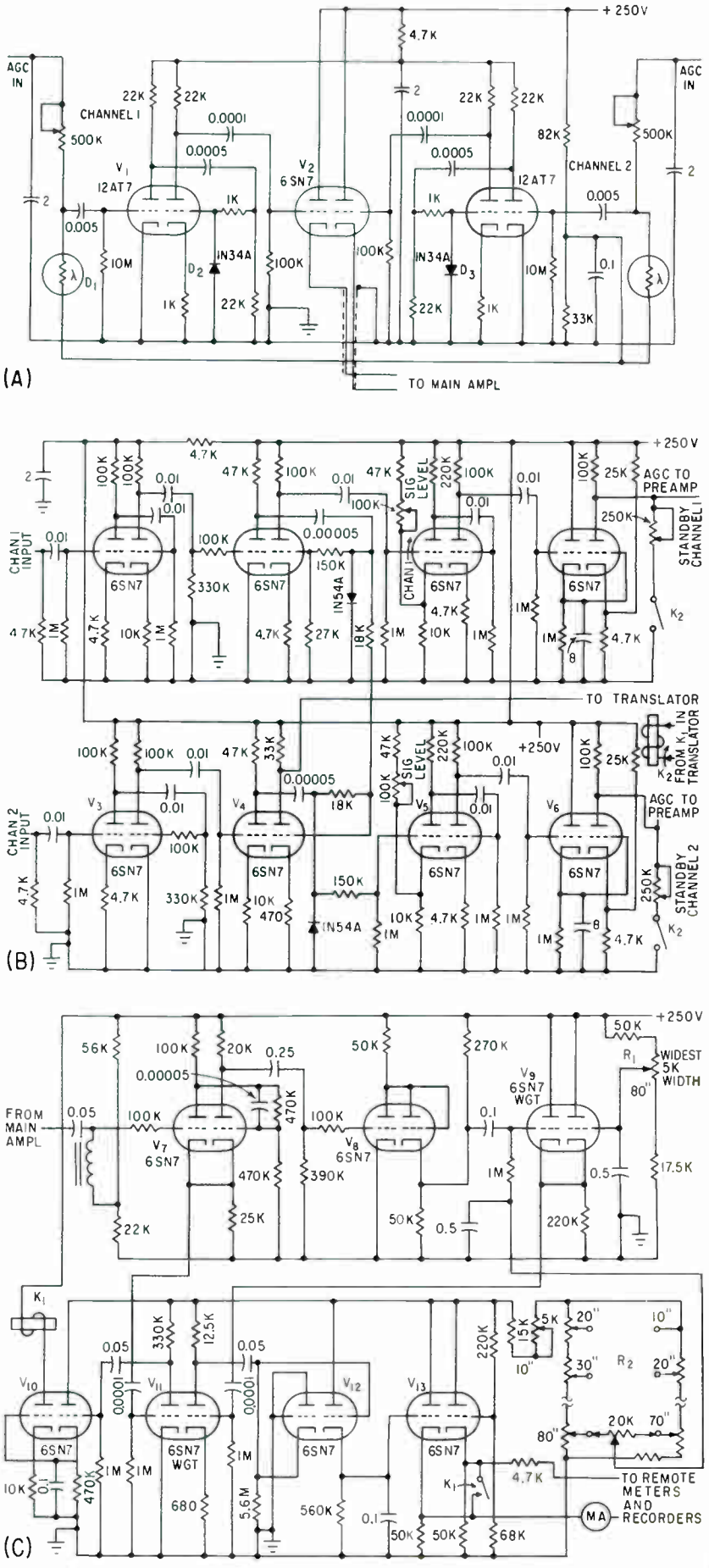

FIG. 3—Preamplifier (A) supplies signals to main amplifier (B) that generates both agc for photocells and composite signal for translator (C). Translator signals are read out on remote indicators and recorders

REFERENCE

(1) U. S. Patent 2,659,823, assigned to Carl Vossberg.

Digital Instrumentation

Analyzer and readout cabinet is to left of author

By E. J. WADE,*
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General Electric Co.,
Schenectady, N. Y.

NUCLEAR ANALYZERS collect and store data in a form readily available for interpretation and study. An analyzer consists of a scaler, or counter, for temporary storage of pulses from neutrons or other inputs. The pulses are then transferred to a memory. The memory is divided into a number of compartments, or time channels, in each of which data may be stored as a binary number.

The analyzer discussed here is used for neutron time-of-flight measurements (Fig. 1A) and pulsed neutron measurements (Fig. 1B). In 1A, the neutron beam is interrupted by a mechanical shutter which is made of the number of neutrons, as a function of time, that arrive at a detector several meters from the shutter. From the count spectrum, which provides an indication of neutron velocities, much information is obtained.

When a short burst of neutrons is injected into a test assembly, as in Fig. 1B, the rate of loss of neutrons depends upon factors such as absorption, leakage and multiplication. Analyzers record the neutron decay curve. The analyzer first takes a background count of the ambient radiation level; then it triggers the neutron source; after a short interval, it begins to record the neutron count. The analyzer counts neutrons during successive fixed-time periods that are called channels. The data obtained, which consist of the neutron pulses counted during 256 channels, is valuable in subcritical reactivity measurements.

The analyzer block diagram (Fig. 2) shows the interconnections between the circuit blocks. The count down (C.D.), address overflow (O.F.) memory cycle (M.C.), sync and gate binaries are identical (Fig. 3). Their triggering conditions are controlled by diode gates in coincidence with clock pulses derived from a 200-Kc crystal oscillator. The matrix (Fig. 2) contains core switching circuits and the memory-cycle generators (M.C. GEN) which are blocking oscillators that supply control pulses to the drivers of the ferrite-core memory.

Analyzer functioning will be described for the pulsed-neutron test. After a cycle, the C.D. binaries are in the tripped condition and stopped because of gate *B* from M.C. 2, which is also tripped as are the sync, gate, O.F. 1, O.F. 2 and O.F. 3 binaries. Data from the last chan-

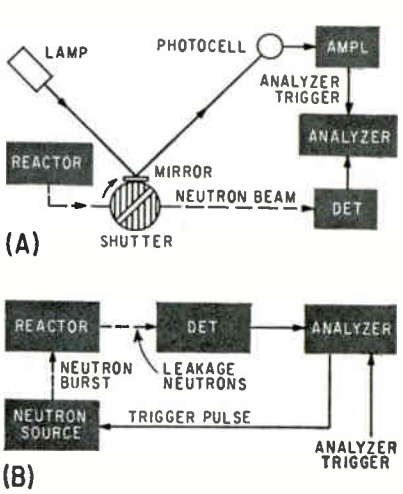

FIG. 1—Setup for time-of-flight test (A). Setup for pulsed neutron test (B)

* Now with Mohawk Development Service, Inc., Schenectady, N. Y.

for Nuclear Research Tests

A detailed account of how digital techniques have been used in a 256-channel neutron analyzer. These channels are time intervals in which nuclear measurements take place

nel are still stored in the arithmetic binaries.

The analyzer trigger, which may be made manually or by a variable-pulse-rate generator, starts a cycle by resetting O.F. 1, O.F. 2 and O.F. 3 and the gate. Since the analyzer trigger is not keyed to the clock pulses (the clock runs continuously), a clock pulse which is delayed 2½ μsec is used to trip the sync binary after its gate has been opened by resetting O.F. 3.

Tripping of the sync binary drops the potential at its *P* output, producing a negative signal at *N* of M.C. 1. This allows the next clock pulse to trigger M.C. 1, flipping all the address binaries to the reset position, which is channel zero, the channel at which background counts are taken.

Output *C* from M.C. 1 triggers M.C. Gen 1, which resets the arithmetic binaries and delivers a *read* signal to the matrix. Assuming that this cycle is not the first in a series of cycles, background counts will have been stored during the previous cycles. Thus the *read* signal now causes the memory's sense windings to deliver the accumulated background count to the arithmetic binaries. Channel-zero background counts are accumulated from many successive cycles so that a high statistical accuracy can be obtained from the average of the background-count total.

On the next clock pulse, both M.C. 1 and M.C. 2 (M.C. 2 had remained tripped since the previous cycle) are reset through the delay. Gate *A* of O.F. 2 prevents further triggering of M.C. 1 and 2.

The resetting of M.C. 2 allows the C.D. and address binaries to start counting background time. The data gate is also opened by the resetting of M.C. 2, allowing background counts to accumulate in the arithmetic binaries. Note that the address binaries now control the time background counts are taken. This time is adjustable from 2 to 256 times the channel length by the background count switch, which selects the address binary that trips O.F. 1.

When O.F. 1 trips, it resets the address and the gate binaries and triggers the neutron source; when the gate resets, it closes the data gate. The C.D. and address binaries now measure the delay, which is adjusted by the delay switch to be between 2 to 256 times the channel length. At the end of this delay time, the output of the delay switch

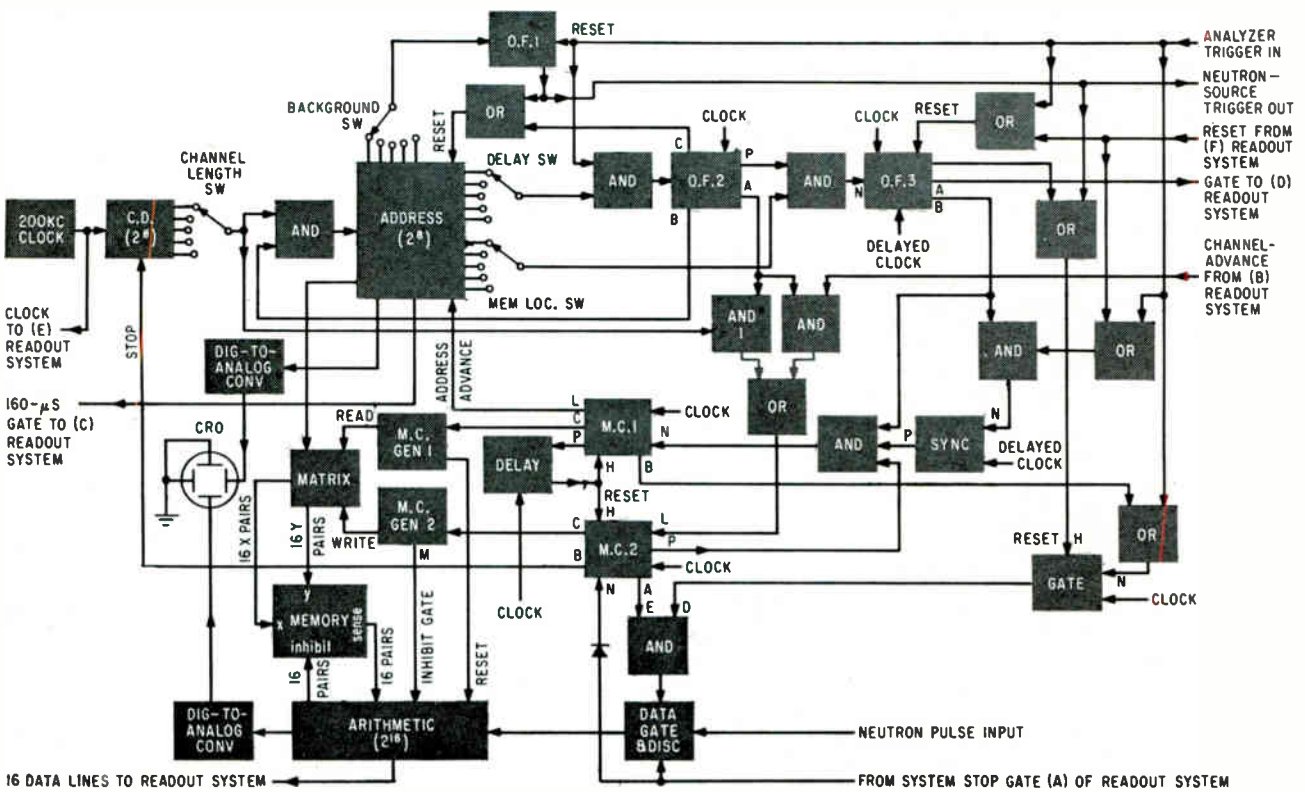

FIG. 2—Neutron analyzer has a cro for showing a spectrum of neutron counts against time channels—the x-axis; display is obtained by using a prf generator to repetitively trigger tests

trips O.F. 2. When O.F. 2 trips, it resets the address binary with its *C* output. Gate *B* of O.F. 2 blocks the pulses from the C.D. to the address binaries. Gate *A* of O.F. 2 allows M.C. 2 to trigger on the next clock pulse. (O.F. 2 remains tripped for rest of cycle.)

Output *B* from M.C. 2 stops the C.D. during the storage cycle, which lasts 10 μsec. Output *C* triggers M.C. GEN 2, which delivers a *write* signal to the matrix, transferring the background-count data held in the arithmetic binaries to the memory. Triggering M.C. 2 also drops the potential on its *P* output, allowing the next clock pulse to trigger M.C. 1, which advances the address binaries.

Now M. C. 1 triggers M. C. GEN 1, which resets the arithmetic binaries and delivers a *read* signal to the matrix. The memory now gives the arithmetic binaries the channel-1 counts that the memory accumulated from previous cycles.

Both M.C. 1 and M.C. 2 are then reset by the next clock pulse through the delay. The C.D. binaries are thus allowed to time the channel length as determined by the channel length switch; this switch adjusts channel durations to 20 to 1,280 μsec. With resetting of M.C. 2, the data gate opens, admitting neutron counts for channel 1. These counts are added to the count accumulated from previous cycles, which is held in the arithmetic binaries.

Since O.F. 2 is still tripped, the gate to the address binary remains closed but the channel-length-switch gate from C. D. to *L* of M. C. 2 is open. Thus at the end of channel 1, the memory cycle is again initiated by the triggering of M.C. 2. This starts the cycle that closes the data gate, stores the data, advances the address binary, resets the arithmetic binaries, reads into the arithmetic binaries the next channel's counts—which were accumulated during previous cycles, and reopens the data gate to start channel 2. This process continues through 63, 127 or 255 data channels, depending upon the setting of the memory location switch, until all the address binaries flip to the tripped position. This drops the potential of the series gate to O.F. 3, which trips 2.5 μsec early on receiving the delayed clock pulse. Its gate *B* to M.C. 1 prevents further tripping of M.C. 1, thus preventing triggering of the address binary. Since M.C. 1 is not tripped, M.C. 2 is not reset; therefore, the C.D. remains stopped.

The data-taking cycle is complete, all data having been stored in the ferrite-core memory. Power can be turned off indefinitely with no loss of stored data.

The readout system (Fig. 4) transfers the data to magnetic tap in the form used by an IBM 704 computer. This system is made from units similar to those used in the analyzer, with different interconnections and gates to provide the logic.

The readout cycle is started by tripping the ready binary. If the analyzer has finished taking count data, the readout system AND gate allows the record binary to trip on the next clock pulse. This causes all succeeding readout-cycle operations to be keyed by the 200-Kc clock pulses *E*.

The record binary starts the tape drive, and after a 50-m sec delay to allow the tape to start, the analyzer is activated by output *F*, which resets O.F. 3 and sync. (Note that the record binary also produces a stop gate *A*, which prevents the memory cycle of the analyzer from being operated except from the readout system.) Now M.C. 1 advances the address binary to channel zero, resets the arithmetic binary and *reads* the background count data held in the memory into the arithmetic binary. The arithmetic binaries deliver count data to the diode gate matrix of the readout system. The data is transferred to the tape, six bits at a time since there are six writing heads across the tape for data; there is a seventh head for check bits, which are used to make the count in each line odd (only 1's are written on the tape).

A 160 μsec pulse at *C*, from the analyzer, triggers the readout-system's shift register transferring the data in groups of six bits to the storage binaries. At each step, gates are successively opened in groups of six. Only three steps are necessary to read the 16 bits from the arithmetic binaries, but since the standard word on the computer contains 36 bits, the remaining 20 bits are used for identification data.

Check bits are also generated and recorded on the tape to detect errors or defects in the tape. The time required to transfer the data from 256 channels to the tape is 0.5 sec.

The computer processes the data so that information is presented in the desired form.

A trigger pulse generator is provided for repetitive tests, which may be varied from 0.06 to 120 cps.

All binaries (the basic type is shown in Fig. 3), except those used in the arithmetic scaler are adapted from a nonsaturated design[2]. The triggering system used with the logic circuits formed by the binaries also produces a series gate system which has negligible propagation time. As logic elements, the *N* inputs are controlled through diode gates, and when held at +10 v or more, tripping will not occur because the clock pulse cannot override the potential at the base of Q_1. When used as a scaler, diodes are connected between *L* of one stage and *P* of the following stage. The scaler will operate at somewhat above 1 Mc with transistors having grounded-emitter cutoff frequencies of 6 to 8 Mc.

The arithmetic binaries[3] (Fig. 5) are series triggered, using 2N501 transistors, catching diodes and peaking coils. They will operate at about 30 Mc, but the data input rate is limited to about 15 Mc by the input shaper. The shaper circuit is

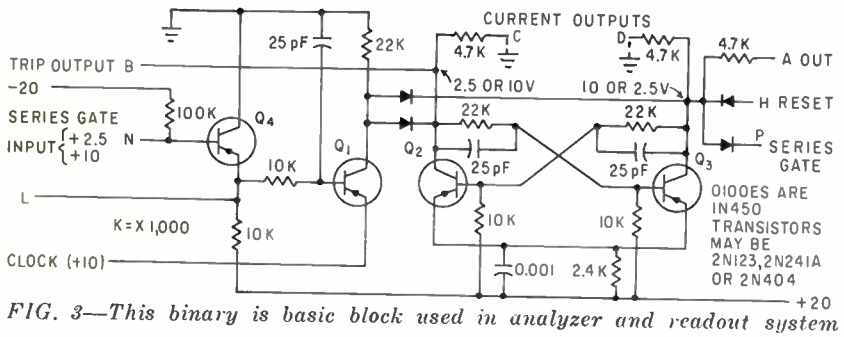

FIG. 3—This binary is basic block used in analyzer and readout system

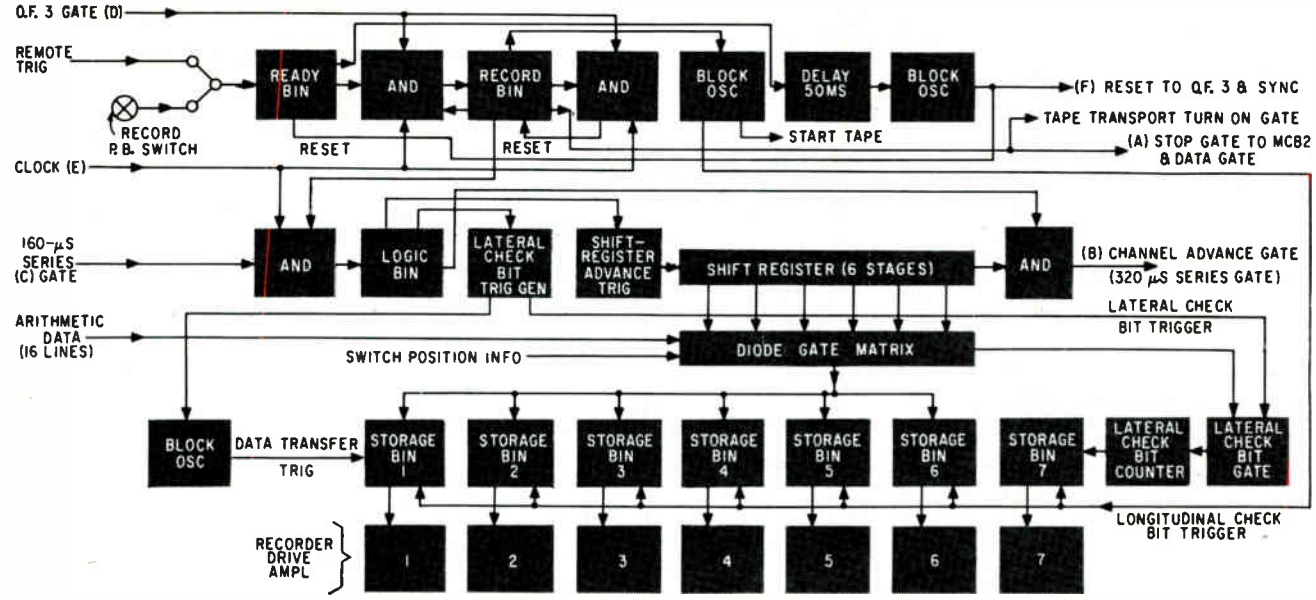

FIG. 4—Readout system. Its output is recorded on tape, which is then processed by a computer

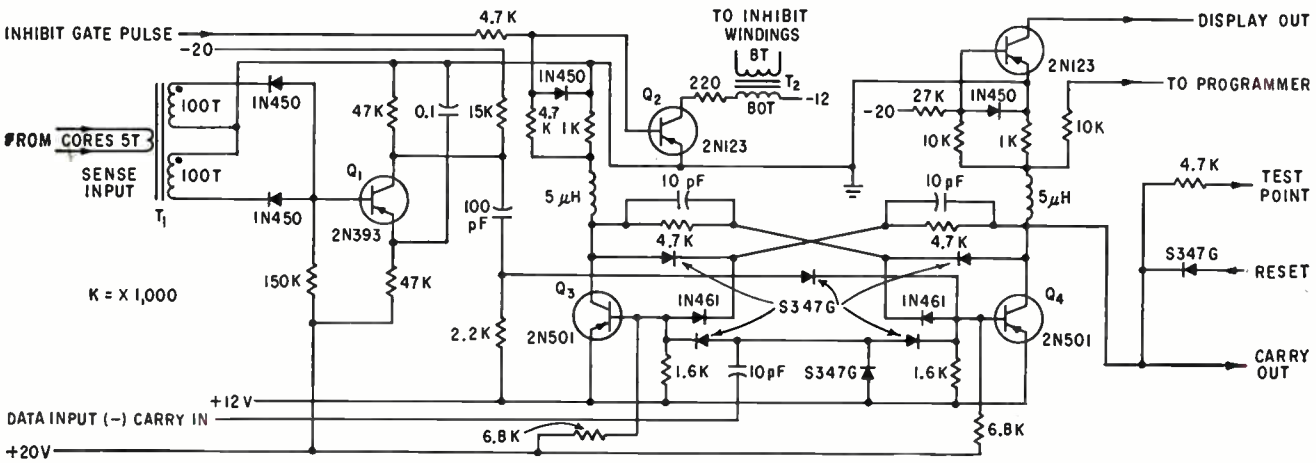

FIG. 5—This circuit is one of the 16 binaries that comprise the arithmetic scaler

similar to Fig. 5, with added gates and a biased-diode amplitude selector.

When data is to be read out from the memory, each arithmetic binary is first reset by a positive 10-v reset pulse from M.C. GEN 1 (Fig. 2), making Q_1 conduct. When the cores are switched by *read* current, a 50-mv pulse, which indicates the storage of ONES is produced at the input to T_1. Amplifier Q_1 applies a positive pulse to Q_4, tripping the binary. (Note that the output from the cores may be of either polarity because the direction of the *sense* winding is reversed on adjacent cores to reduce pickup.)

When a number is written into the memory, the presence or absence of an *inhibit* pulse from an arithmetic binary determines whether the number written into the memory is a ONE or ZERO. Transistor Q_2 gates the *inhibit* gate pulse, which comes from M.C. GEN 2. When a ONE is stored in this binary it is tripped, that is, Q_3 conducts. Thus. Q_3 is biased positive and prevents current flow to T_2. This allows the full address current to switch the corresponding core. Each arithmetic-binary *inhibit* output drives an *inhibit* winding which threads the cores of one memory plane.

The ferrite-core memory is conventional[1]. There are 16 frames, each containing 256 cores in a 16 × 16 x-y matrix. Each frame corresponds to one binary digit; since $2^{16} = 65{,}536$, 65,535 is the largest number that can be stored. The corresponding x lines of the 16 frames are driven in parallel, as are their y lines. Thus, for the *write* sequence, the address switches one of the 256 cores in each plane, these 16 cores corresponding to one of the 256 channels.

The work of D. S. Davidson, now vice president of Technical Measurement Corp., was important in the successful design of these analyzers.

REFERENCES

(1) E. J. Wade and D. S. Davidson, Transistorized Time of Flight Analyzer with Ferrite Core Memory, *IRE Con Record*, 5, Part 9, p 89, Mar. 18, 1957.
(2) J. J. Suran and F. A. Reibert, Two-terminal Analysis and Synthesis of Junction Transistor Multivibrators, *Trans IRE*, CT-3, p 26, Mar. 1956.
(3) J. J. Suran and B. K. Eriksen, Design of VHF Asynchronous Pulse Circuit, GOSAM, May 1958.
(4) R. W. Schumann and J. P. McMahon, Argonne 256 Channel Pulse-Height Analyzer and 1024 Channel Neutron Time of Flight Analyzer, R.S.I., 27, No. 9, p 675, Sept. 1956.

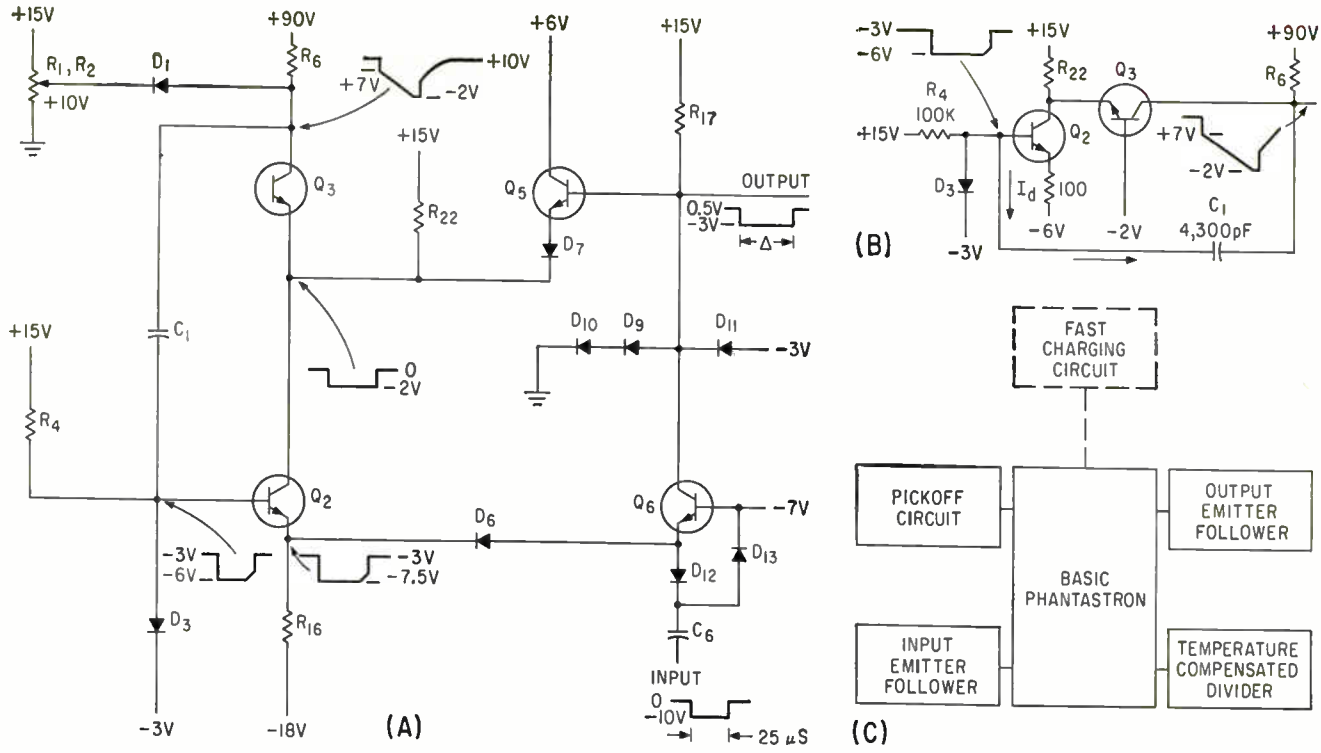

FIG. 1—Phantastron before modifications are introduced (A), basic circuit during the active period, showing the integrating section isolated from the rest of the circut (B), final block diagram showing where error correcting modifications are needed (C)

HIGHLY ACCURATE

This circuit uses solid-state components throughout and incorporates compensating arrangements to cancel the sources of timing error. Final circuit is designed to provide a delay of 220 microseconds with an accuracy of plus or minus one percent

By S. RALPH PARRIS,
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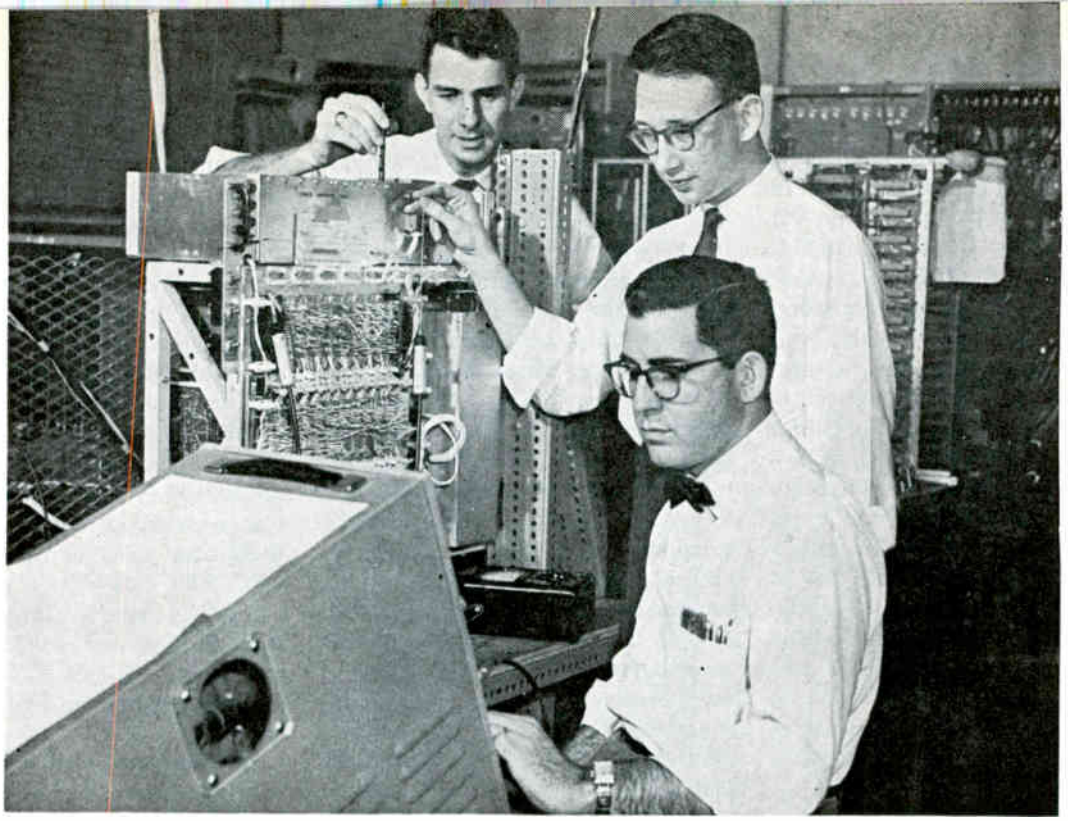
DAVID A. STAAR,
Senior Development Engineer,
Burroughs Corporation Research Center,
Paoli, Pennsylvania

THE OPERATION of the phantastron can be examined most easily using a simplified circuit as shown in Fig. 1A. In the stable or quiescent state, D_6 is back-biased and transistor Q_6 is OFF since both its base and emitter are at nearly the same voltage. This condition allows the collector of Q_6 and the base of Q_5 to rise to approximately +0.5 v where diodes D_9 and D_{10} in series are clamped by current supplied through R_{17}. The emitter of Q_5 follows its base by emitter follower action and holds the collector of Q_2 and emitter of Q_3 at about zero volts. Since the base of Q_2 is clamped to about −3 v by current through R_4 and D_3, the emitter of Q_2 remains at about −3 v with its emitter current causing a 15-v drop across R_{16}. Resistor R_{22} is included to keep Q_2 biased as the desired operating point (high beta) in the active state of circuit operation. Because the base of Q_3 is returned to about −2 v, Q_3 is held OFF by Q_5 and the collector of Q_3 rises to about +10 v, which is the output voltage of the low impedance divider, R_1 and R_2. During this quiescent state, capacitor C_1 is charged to about 13 v.

The circuit is switched into its active state by a negative trigger pulse which is a-c coupled to the emitter circuit of Q_6, causing it to turn ON. The collector of Q_6 falls and is clamped at −3 v by D_{11}, which keeps it from saturating. The positive-going trailing edge of the trigger pulse is blocked by diode D_{12} so that it will not turn Q_6 OFF and diode D_{13} provides an alternate charging path for C_6. The collector of Q_6 pulls the base of Q_5 to −3 v. The emitter of Q_5 tries to follow and in so doing allows Q_3 to be turned ON when the emitter of Q_3 reaches −2 v. Transistor Q_5 now turns OFF since its emitter junction is back-biased by about 1 volt.

When Q_3 is turned ON D_1 disconnects as current begins to flow through R_6 causing the collector of Q_3 to fall rapidly. Capacitor C_1 couples the collector of Q_3 to the base



Engineers adjust performance of delay circuit incorporated in Burroughs B-100 Sorter-Reader

PHANTASTRON DELAY CIRCUIT

of Q_2 so that the emitter of Q_2 also falls by emitter follower action. The emitter of Q_2 approaches equilibrium at about −13 v where the level would be established by the currents supplied through R_6 and R_{22}. In actual operation, however, the emitter of Q_2 is clamped at −7.5 v by D_6 and the emitter of Q_6, which is being held ON by the input pulse at this time.

While the circuit is in its active state, Q_2 cannot supply sufficient current to hold its emitter above −7.5 v so that Q_4 remains ON and acts as an emitter follower even after the input pulse is removed. This provides a low impedance source in the emitter circuit of Q_2. The circuit operation during the active state can be analyzed by redrawing part of the circuit as shown in Fig. 1B.

This is basically an operational integrator where Q_2 and Q_3 provide the open-loop gain and R_4 and C_1 are the feedback elements. If the open-loop current gain is large, the error voltage at the base of Q_2 remains nearly constant and the capacitor is charged by a nearly-constant current (approximately = [15 − (−6)]/100,000 amperes). This causes the output to fall linearly with time, since $\partial_v/\partial t = I_4/C_1$.

The potential across capacitor C_1 continues to fall until Q_3 bottoms at about −2 v. This short-circuits the feedback loop and allows the voltage at the base of Q_2 to rise toward +15 v as capacitor C_1 continues to charge. Current into the base of Q_2 also increases and emitter voltage of Q_2 rises, as current is supplied to R_{16}. When this current reaches about 6 ma, the emitter voltage of Q_2 rises above −7.5 v, D_6 is back-biased, and Q_6 turns OFF. This allows Q_5 to turn ON, which in turn back-biases the emitter junction of Q_3, turning Q_3 OFF. The base of Q_2 rises rapidly from −7 v and clamped by D_3 at −3 v. This same rise is coupled by C_1 to the collector of Q_3 which is now a high impedance point. The capacitor continues to recharge through R_6 toward +90 v and will be clamped by D_1 to the output voltage of the low impedance divider R_1—R_2 (+10 volts). The circuit is now in its equilibrium condition and can be retriggered. The output pulse may be taken from several points, but in this circuit, the base of Q_5 is used.

There are a number of sources of inaccuracy in the basic circuit illustrated by Figures 1A and 1B; block diagram Fig. 1C shows how some of the accuracies are corrected by specific modifications to the parts of the circuit causing the errors.

The operational integrator of Fig. 1B has been modified by the addition on an input emitter follower Q_1 as shown in Fig. 2A. This increases the open-loop current gain of the integrator and provides increased accuracy and linearity since the input current to the base of Q_1 is small compared with the charging current into C_1. Resistance R_{13} and capacitor C_3 provide a secondary feedback path which shapes the high-frequency response of the amplifier in order to guarantee stable closed-loop operation.

The time required to recharge

C_1 at the end of the cycle may be decreased greatly by the addition of transistor Q_7 and its associated circuitry. This is shown in Fig. 2B. The collector of Q_5 is returned to +15 v through R_7. Diode D_8 is used as a clamp to +6 so that Q_5 operates as an emitter follower when it is ON. The waveform at the collector of Q_5 is a-c coupled through C_4 to the emitter circuit of Q_7, the charging transistor. Normally, Q_7 is held OFF by the drop across D_2. The leading edge of the pulse from Q_5 tends to keep Q_7 OFF and has no effect. The trailing edge turns Q_7 ON at the end of the active period of circuit operation. This provides a high current rapidly charging C_1 and reduces the charging time to 5 to 10 μsec. This circuit is inoperative during all other parts of the cycle, including the quiescent state.

An improved pick-off may be obtained by the addition of transistor Q_8. The connection is shown in Fig. 2C. The emitter is grounded, the collector is connected to the base of Q_2 and the base is connected to the collector of Q_3. Transistor Q_8 is OFF whenever the collector of Q_3 is above ground. During the active state of the basic circuit, the collector voltage of Q_3 falls linearly toward −2 v, where Q_3 bottoms as described previously. With this addition, the emitter of Q_8 maintains the collector of Q_3 near ground potential, thus lifting the base of Q_2 to ground potential. This causes Q_2 to conduct more heavily, which increases the collector current in Q_3, tending to make the collector voltage of Q_3 fall. This increases the base current of Q_8 and closes a regenerative loop. As soon as Q_2 conducts sufficiently to pull its emitter above −7 v, Q_6 turns OFF and Q_5 turns ON as in the basic circuit. At the same time, Q_7 turns ON and causes the rapid charging of C_1. The collector of Q_3 charges rapidly toward its quiescent value.

Emitter follower Q_4 is added as an output buffer between the pulse forming circuits and the load. Adding the buffer allows the phantastron to drive its load without affecting timing accuracy. The timing loop and pick-off circuits are thermally stabilized by the addition of a silicon sensistor in the voltage divider, consisting of R_9, R_{10}, and R_{19}. This supplies a temperature-dependent reference level which compensates for the changing base-to-emitter voltages of the transistors. The delay time of the final circuit is nearly independent of temperature, and it varies by much less than a microsecond over the ambient temperature range of 25 to 55 C.

ACKNOWLEDGMENTS: We wish to acknowledge the support of D. Moister and H. Caswell for their help in constructing and testing the circuit described herein.

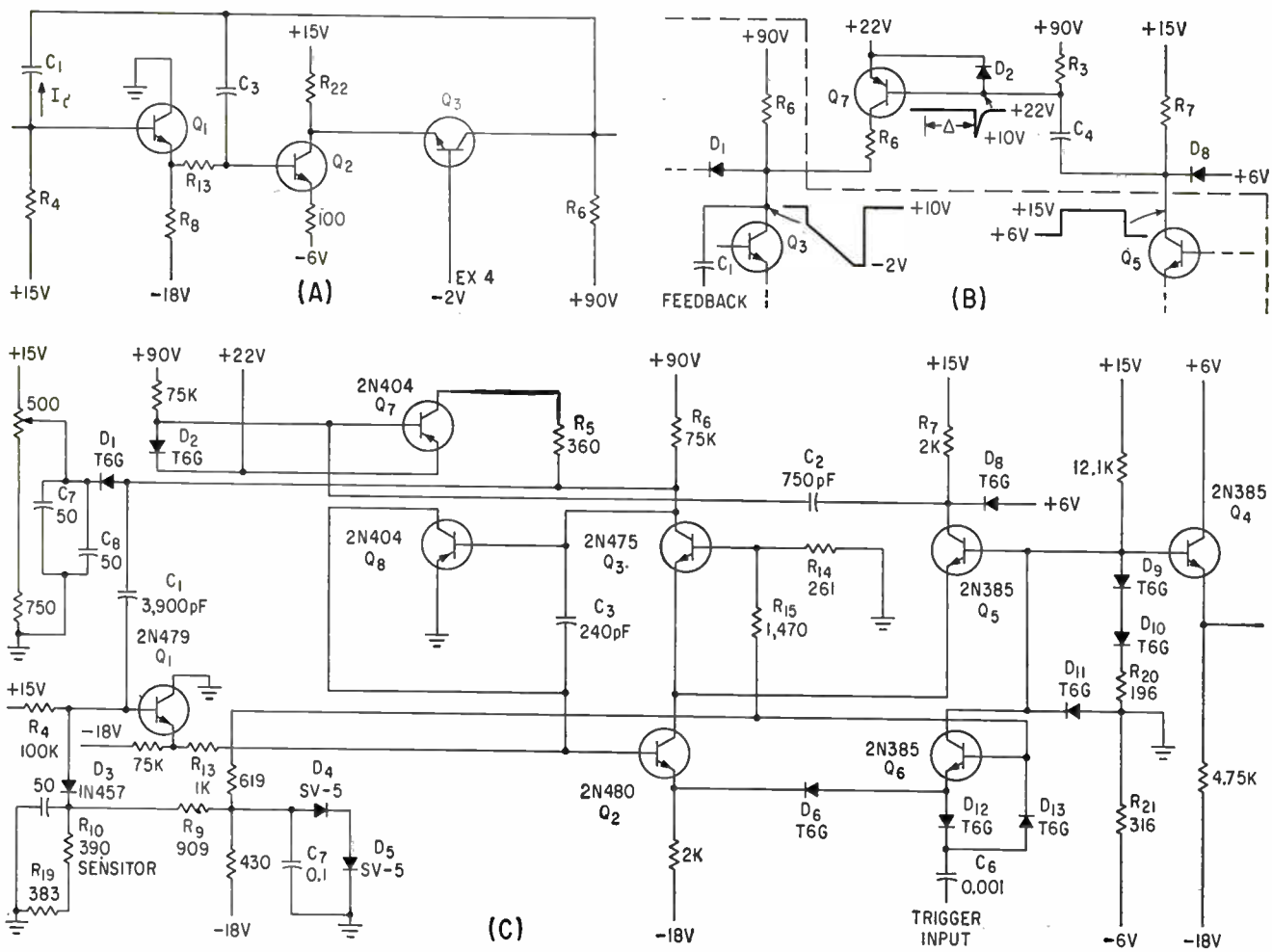


FIG. 2—Open-loop current gain of integrator is increased by addition of emitter follower Q_1 (A), addition of charging transistor Q_7 returns phantastron rapidly to quiescent state at the end of a cycle (B), final circuit with modifications and temperature corrections incorporated (C)

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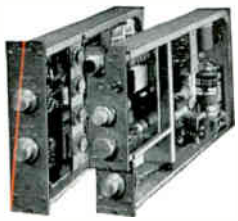

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Design Chart for Broadband Couplers

Tabulation of circuit parameters is useful in designing several types of broadband couplers

By RICHARD F. BURNS, The Hallicrafters Co., Chicago, Ill.

SEVERAL TYPES of broadband couplers can be designed from the circuit parameters tabulated in the table. These include symmetrical and nonsymmetrical circuit configurations using mutual inductance, inductive π, inductive T and capacitive π coupling.

The table is based upon design equations in Beam's paper[1] and eliminates most of the computational work involved in using Dishal's charts.[5] Filters designed from the table can be expected to have a passband peak-to-valley ratio of less than 1 db for bandwidths as large as 50 percent of the midband frequency.

The circuit parameters for the symmetrical coupler configurations are given in a normalized form in which the input and output terminations are each 1 ohm. The midband frequency, f_m, is 1 cps while bandwidths at the 1-db down points are given in percent of the midband frequency. Fig. 1 shows the response curve for a broadband coupler.

The symmetrical configurations of Fig. 2 are used when the source and load impedances are equal. The nonsymmetrical configurations of Fig. 2 are used when the source and load impedances are unequal. Ratio of the desired output to input resistance is denoted by n. For computing bandwidths at the 10-db, 20-db, and 30-db down points, the following formulas computed from Dishal's charts can be used

$$\text{BW(10-db)} = 3.3 \times \text{BW(1-db)}$$
$$\text{BW(20-db)} = 5.8 \times \text{BW(1-db)}$$
$$\text{BW(30-db)} = 10 \times \text{BW(1-db)}$$

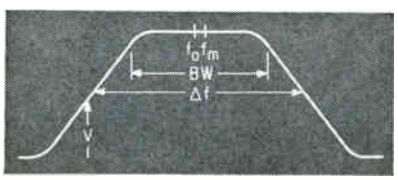

FIG. 1—Broadband coupler response curve

To compute the circuit parameters for a symmetrical coupler similar to those shown in Fig. 2A, through 2D, the following procedure is followed.

1. Determine the midband frequency, f_m, from

$$f_m = (f_1 f_2)^{1/2}$$

where f_1 and f_2 are the passband limits measured at the 1-db down points.

2. Determine the percentage bandwidth required from

$$\%BW = [(f_2 - f_1)/f_m] \times 100$$

Use the next greater tabulated percentage bandwidth.

3. From the table find the normalized parameters required for the circuit selected under the percent bandwidth column in step 2.

4. Convert the normalized circuit parameters to the required denormalized values by multiplying by a denormalizing factor. For inductances the denormalizing factor is R/f_m and for ca-

for HIGH + LOW

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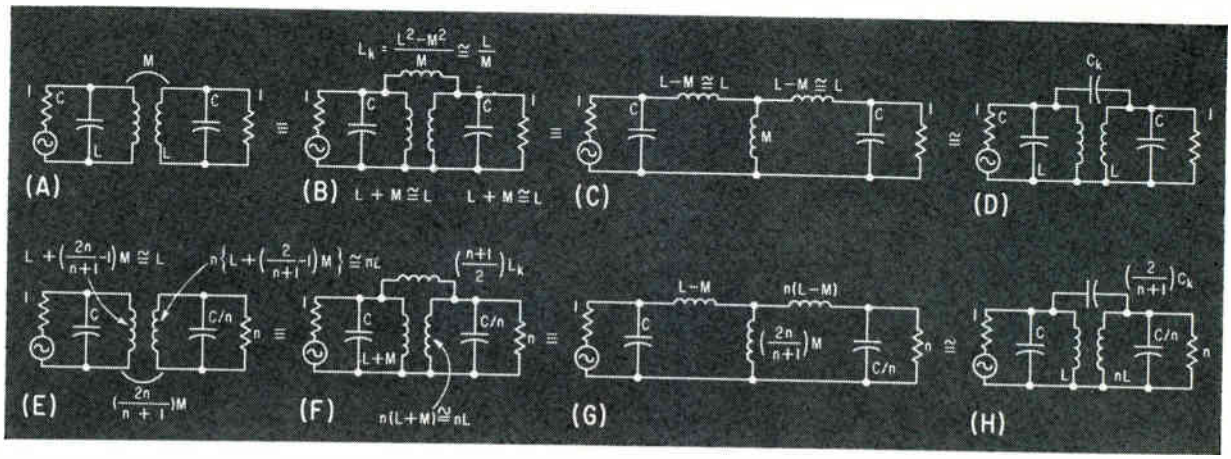


FIG. 2—Equivalent circuits are shown for symmetrical circuit configurations using mutual inductance (A), inductive π(B), inductive T (C) and capacitive π(D) coupling and for nonsymmetrical configurations using mutual inductance (E), inductive π(F), inductive T (G) and capacitive π(H) coupling

Broadband Coupler Circuit Parameters

Percent Bandwidth	1%	5%	10%	20%	30%	40%	50%
l	1.58×10^{-3}	7.94×10^{-3}	1.64×10^{-2}	3.21×10^{-2}	4.91×10^{-2}	6.72×10^{-2}	8.69×10^{-2}
c	1.61×10^{1}	3.19	1.55	8.05×10^{-1}	5.36×10^{-1}	4.07×10^{-1}	3.28×10^{-1}
m	1.56×10^{-5}	3.96×10^{-4}	1.69×10^{-3}	6.42×10^{-3}	1.41×10^{-2}	2.53×10^{-2}	3.98×10^{-2}
$l - m$	1.56×10^{-3}	7.90×10^{-3}	1.47×10^{-2}	2.57×10^{-2}	3.50×10^{-2}	4.19×10^{-2}	4.71×10^{-2}
l_k	1.60×10^{-1}	1.59×10^{-1}	1.57×10^{-1}	1.56×10^{-1}	1.55×10^{-1}	1.53×10^{-1}	1.50×10^{-1}
c_k	1.59×10^{-1}	1.68×10^{-1}	1.78×10^{-1}				
k	9.90×10^{-4}	4.99×10^{-2}	1.03×10^{-1}	2.00×10^{-1}	2.91×10^{-1}	3.77×10^{-1}	4.58×10^{-1}
f_0	1.000	1.000	1.000	0.990	0.978	0.962	0.943
$l + m$	1.60×10^{-3}	8.34×10^{-3}	1.81×10^{-2}	3.85×10^{-2}	6.38×10^{-2}	9.25×10^{-2}	1.27×10^{-1}

pacitances it is $1/f_m R$; that is,

$$L = l\,(R/f_m) \text{ henry}$$
$$C = c\,(1/f_m R) \text{ farad}$$

where l and c refer to the tabulated normalized inductance and capacitance, respectively, f_m is the midband frequency in cps computed in step 1, R is the value of the desired source resistance in ohms, and L and C are the denormalized inductance and capacitance in henries and farads, respectively. The denormalization procedure is illustrated in Examples 1 and 2.

If it is desired to change the ratio of load-to-source impedance by a factor n, the equivalent circuits shown in Fig. 2E through 2H are used. The procedure is essentially the same as that used for the symmetrical cases and is illustrated in Example 3.

EXAMPLE 1—Design a bandpass coupler using mutual inductance coupling in the form of a doubly parallel tuned transformer having load and source impedances of 10,000 ohms and a passband extending from 13.650 Mc to 14.350 Mc at the 1-db points. From these specifications

$$f_m = (1.36 \times 10^6 \times 1.43 \times 10^6)^{1/2}$$
$$= 1.4 \times 10^7 \text{ cps}$$
$$R = 10^4 \text{ ohms}$$
$$\%\,\text{BW} = \frac{7.00 \times 10^5}{1.40 \times 10^7} \times 10^2 = 5\%$$
$$R/f_m = 7.14 \times 10^{-4} \text{ ohms/cps}$$
$$1/f_m R = 7.14 \times 10^{-12} \text{ 1/cps} \times \text{ohms}$$

Using the mutual inductance equivalent circuit of Fig. 2A and substituting in the denormalization formulas

$$L = l\,(R/f_m) = (7.94 \times 10^{-3})(7.14 \times 10^{-4})$$
$$= 5.68 \times 10^{-6} \text{ henry}$$
$$C = c\,(1/f_m R) = (3.19)\,(7.14 \times 10^{-12})$$
$$= 2.28 \times 10^{-11} \text{ farad}$$
$$M = m(R/f_m) = (3.96 \times 10^{-4})(7.14 \times 10^{-4})$$
$$= 2.83 \times 10^{-7} \text{ henry}$$

EXAMPLE 2—Design a bandpass coupler equivalent to that of Example 1 but using an inductive π configuration.

Using the inductive π equivalent circuit of Fig. 2B and the circuit parameters computed in Example 1, $f_m = 1.4 \times 10^7$ cps, $R = 10^4$ ohms, %BW = 5%, $C = 2.28 \times 10^{-11}$ farad and $R/f_m = 7.14 \times 10^{-4}$ ohms/cps.

From the table, $(l + m) = 8.34 \times 10^{-3}$ henry and $l_k = 1.59 \times 10^{-1}$ henry.

How to determine high-frequency characteristics of precision film resistors

Specify with confidence from this complete line of time-proved TI resistors

MOLDED†

TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CDM⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDM¼	¼	RN65B	10 Ohm-1 Meg	500
CDM½	½	RN70B	10 Ohm-5 Meg	750
CDM 1	1	RN75B	10 Ohm-10 Meg	1000
CDM 2	2	RN80B	50 Ohm-50 Meg	2000

MIL-LINE †

TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CD⅛R	⅛	—	10 Ohm-1 Meg	350
CD¼R	¼	RN10X	10 Ohm-1 Meg	500
CD½PR	½	RN15X	10 Ohm-3 Meg	650
CD½MR	½	RN20X	10 Ohm-5 Meg	750
CD½SR	½	—	50 Ohm-10 Meg	850
CD1R	1	RN25X	10 Ohm-10 Meg	1000
CD2R	2	RN30X	50 Ohm-50 Meg	2000

HERMETICALLY SEALED LINE †

TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CDH⅛M	⅛	—	10 Ohm-500K	250
CDH⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDH¼	¼	RN65B	10 Ohm-1 Meg	500
CDH½P	½	—	10 Ohm-3 Meg	650
CDH½A	½	RN65B	10 Ohm-3 Meg	650
CDH½M	½	RN70B	10 Ohm-5 Meg	750
CDH½S	½	—	50 Ohm-10 Meg	850
CDH 1	1	RN75B	10 Ohm-10 Meg	1000
CDH 2	2	RN80B	50 Ohm-50 Meg	2000

†All values available in 1% tolerance; nominal lead length 1.5 in.

sensistor* SILICON RESISTORS

Standard available resistances @ 25° C:
68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820, 1000, 1200, 1500, 1800 ohms.‡

Type No.	Wattage Rating W	Body Dimensions Length	Diameter	Average Temperature Coefficient %/°C	Resistance Tolerance %
TM ⅛	⅛	0.585"	0.200"	+0.7	±10
TM ⅛	⅛	0.406"	0.140"	+0.7	±10
TC⅛	⅛	TO—5	Transistor	+0.7	±10

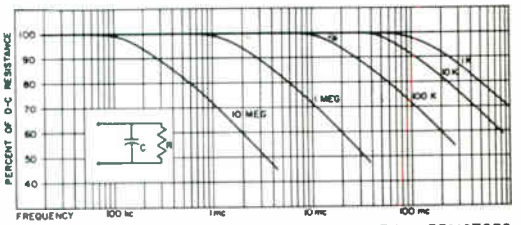
* TRADEMARK OF TEXAS INSTRUMENTS INCORPORATED
‡ Other resistance values and tolerances available on special order

For a more detailed discussion of this subject, contact your nearest TI sales office for a copy of "High-Frequency Characteristics of Precision Film Resistors."

In high frequency applications, precision film resistors are superior to composition or wirewound resistors; skin effect of the thin film is negligible.

OHMIC VALUE vs FREQUENCY

Precision film resistors of a given physical size have the same distributed capacitances regardless of their ohmic value. As the frequency increases, the shunting effect of the distributed capacitance causes the effective parallel resistance to decrease. The reactance of the stray capacitance becomes a relatively good shunt when it approximates the ohmic value of the resistor. The smaller the ohmic value of a precision film resistor (for a given physical size), the higher its usable frequency range.



HIGH FREQUENCY RESISTANCE OF PRECISION FILM RESISTORS

INDUCTANCE CONSIDERATIONS

The inductance caused by helixing the higher value resistors is negligible throughout the "useful" range of frequencies at which the resistance is greater than 60% of its d-c value.

When resistors under 500 ohms are measured using high frequency meters, the reactive component of the equivalent parallel circuit appears inductive because of lead and binding post inductance. However, the resistor itself is capacitive.

TI TYPE	SIZE (WATT RATING)				
	⅛	¼	½	1	2
MIL-LINE (CD)	0.2	0.1	0.25	0.5	0.6
MOLDED (CDM)	0.3	0.25	0.45	0.7	0.7
HERMETICALLY SEALED (CDH)	0.3	0.25	0.45	0.75	0.8

CAPACITANCE IN $\mu\mu f$ OF TI PRECISION FILM RESISTORS

CAPACITANCE CONSIDERATIONS

The average measured capacitance of Texas Instruments Precision Film Resistors is determined primarily by the end cap-to-cap capacitance which is proportional to the dielectric constant of the core and encapsulating material.

MOUNTING

Precision film resistors of 200 ohms or less perform satisfactorily at 5000 mc and higher if placed in a well-designed coaxial mount. A coaxial mount constructed from a standard UG-18B/U Type N plug can be used effectively. In conventional terminals, correct mounting of the body of the resistor off the circuit chassis and the use of short leads will minimize the stray capacitance and lead inductance.

Specify TI precision resistors!

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13500 N. CENTRAL EXPRESSWAY
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Denormalize by multiplying by appropriate factor

$$(L+M) = (l+m)\ (R/f_m)$$
$$= (8.34\times10^{-3})\ (7.14\times10^{-4})$$
$$= 5.96\times10^{-6} \text{ henry}$$

$$L_k = l_k\ (R/f_m)$$
$$= (1.59\times10^{-1})\ (7.14\times10^{-4})$$
$$= 1.14\times10^{-4} \text{ henry}$$

EXAMPLE 3—Design a bandpass coupler using the double-tuned transformer configuration of Fig. 2A having characteristics identical to those of the coupler of Example 1 except that a 20,000-ohm output termination is required. Using the equivalent circuit for the nonsymmetrical configuration of Fig. 2E and the circuit parameters computed in Example 1, $f_m = 1.4 \times 10^7$ cps, $R = 10^4$ ohms, $C = 2.29 \times 10^{-11}$ farad and $n = 2$.

Thus

$$L + \left(\frac{2n}{n+1} - 1\right) M = 5.68 \times 10^{-6}$$
$$+ \left(\frac{4}{3} - 1\right)(2.83 \times 10^{-7})$$
$$= 5.77 \times 10^{-6} \text{ henry}$$

$$n\left\{L + \left(\frac{2}{n+1} - 1\right) M\right\}$$
$$= 11.2 \times 10^{-6} \text{ henry}$$

$$C/n = 1.14 \times 10^{-11} \text{ farad}$$

The doubly-tuned air core transformer realization of the coupler is usually practical for percentage bandwidths less than 30 percent. Couplers using carbonyl-iron core transformers are practical for percentage bandwidths up to about 50 percent.

The π and T sections are usually the easiest to fabricate although they may be somewhat bulkier and more expensive. The larger percentage bandwidths may be achieved with the inductive π or T sections.

The capacitive π coupler is practical for percentage bandwidths of about 10 percent, however, because of its poor phase response, it is usually not suitable for larger bandwidths[3].

In the case of the transformer realization of the coupler, the correct spacing of the windings may be determined as follows

1. Adjust each winding to resonate with the design capacitance at f_o with the other winding open circuited.
2. Determine the terminating resistors by an impedance bridge or Q-meter remembering that the actual value of the terminating resistor may be several times as large as the design value due to coil loss. The indicated equivalent circuit parallel resistance of each coil with the terminating resistor in parallel when measured at the midband frequency by an impedance bridge should equal the design value.
3. Using the test setup shown in Fig. 3, adjust the mutual inductance by pushing the coils together until the meter peaks. Check band limits and passband flatness.

In the cases of other than the transformer realization of the coupler, it is usually sufficient to adjust the circuit components to the design values on an impedance bridge at the midband frequency.

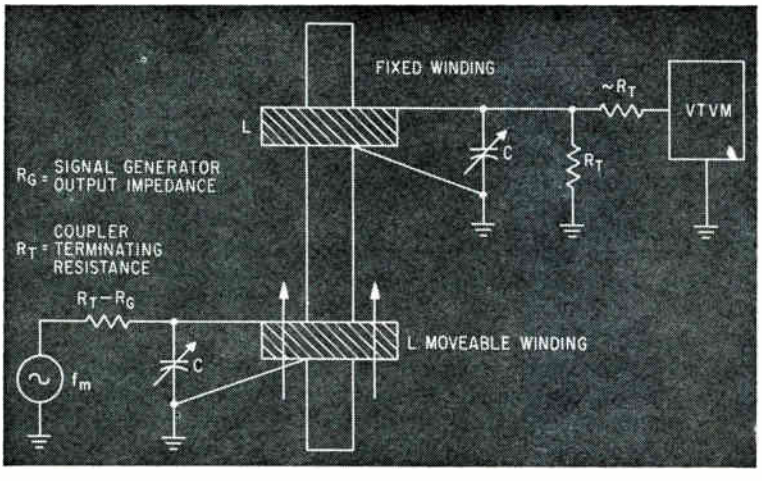

FIG. 3—This setup is used for the tuned transformer coupler alignment procedure

REFERENCES

(1) R. Beam, "Doubly Parallel—Tuned Broadband Couplers and Doubly Series-Tuned Broadband Couplers," Hallicrafters Internal Publication, 1960.
(2) M. Dishal, Exact Design and Analysis of Double and Triple Tuned Bandpass Amplifiers, *Proc. IRE*, 35, p 606, 1947.
(3) W. Dougharty, The Theory of Broadband Coupler Circuits, *Electronic Engineering*, p 488, Aug. 1959.

BIBLIOGRAPHY

C. B. Aiken, Two-Mesh-Tuned Coupled Circuit Filters, *Proc. IRE*, 25, p 230, 1937.
B. D. N. Tellegen, Coupled Circuits, *Phillips Res Rep*, 2, No. 1, 1947.
V. C. Rideout, Note on Parallel Tuned Transformer Design, *Bell System T. J.*, 27, p 96, Jan. 1948.
J. B. Rudd, Design for Double-Tuned Transformers, *AWA Tech Rev*, 8, p 147, 1949.
A. Van Weel, "The Design of Phase-Linear IF Amplifiers," J. Brit. *Inst. of Radio Engrs.* 17, p 275, 1957.
J. H. Mole, Filter Design Data, (Book, Spon, Ltd, 1952) p 243.
Valley and Wallman, Vacuum Tube Amplifiers, Rad. Lab. Series, McGraw-Hill, p 201.
E. Gruen, "A Network Theorem," p 35 *Marconi Review*, xx No. 125, 1957.

For more than a quarter century, Hallicrafters has worked in close partnership with our armed forces on fast solutions to critical military electronics problems. Out of this priceless experience are emerging startling new ideas and hard-hitting, fast-moving techniques to keep our country one jump ahead in electronic warfare . . .

B-52 and other military aircraft will be protected by the most potent Electronic Countermeasures equipments yet devised. These equipments were developed in close teamwork with the Air Force under Hallicrafters' QRC (Quick Reaction Capability) program. Now qualified to meet full environmental specifications, they are in quantity production.

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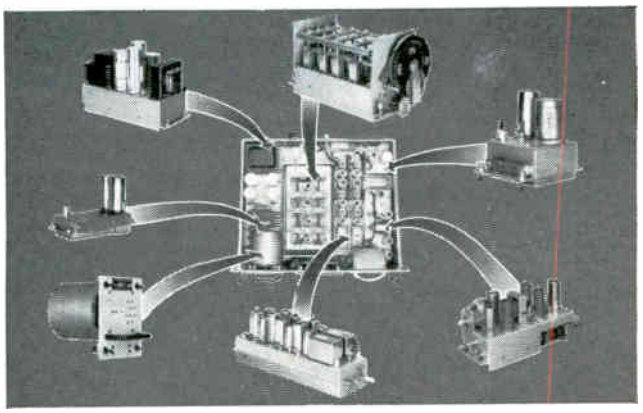

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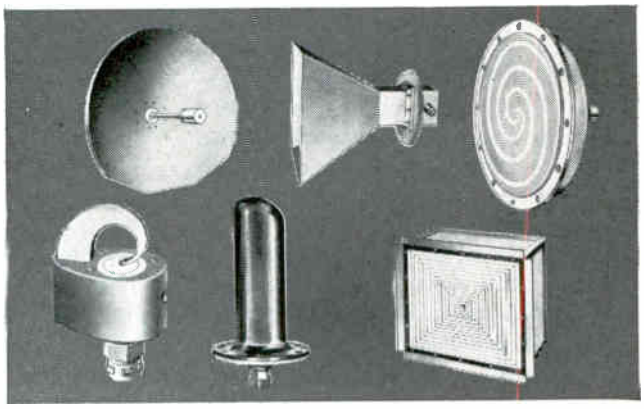
Hallicrafters participation in the Atlas missile project helped to develop capability for many areas of the complex missile field, including code translator data systems; ground support equipment; ECM testing and antenna systems. Current explorations involve latest Infra Red techniques.



Airborne antennas and micro-wave components with power capability in excess of 1,000 watts, can be made available to solve tomorrow's very high power handling requirements. Testing of microwave components is possible with special high power generators, designed and built by Hallicrafters.

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hallicrafters company

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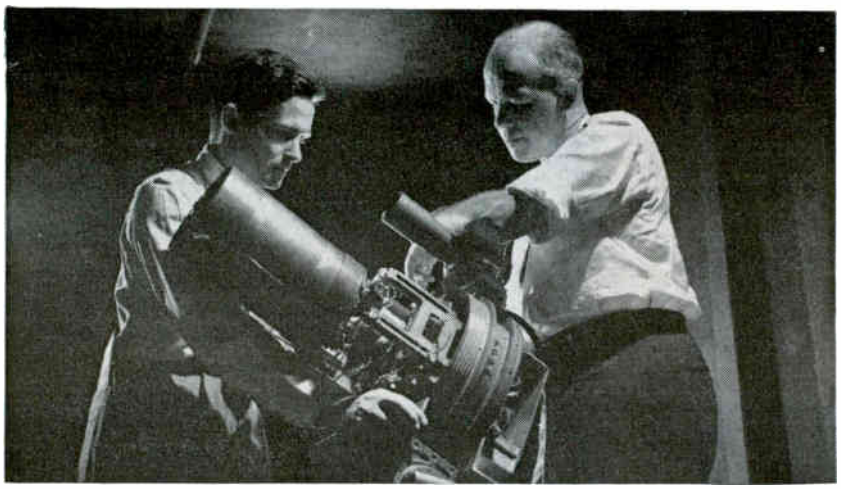
F-M Is Used in Electro-Optical Tracker



High-accuracy Raytheon tracker for aircraft and space vehicles

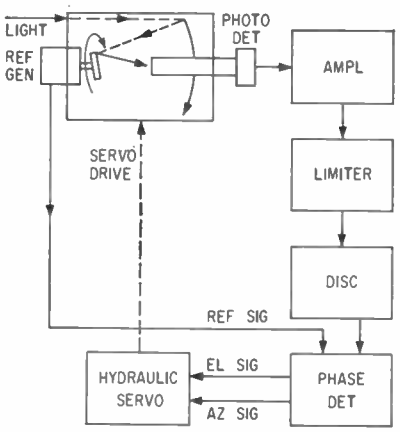
INSTANT tracking data for space vehicles is provided by an electro-optical automatic tracking system. It also provides information essential in designing systems to overcome tumbling of satellites.

The portable instrument developed by Raytheon relies on light reflected from the vehicle but can be adapted to respond to infrared energy. In the passive tracker, the expense, bulk and weight of radar equipment is saved. The tracking system, which occupies less than eight cubic feet, can be used in aircraft above cloud cover. In a space vehicle, one unit could track the sun and another a planet to establish relative position of the vehicle and help in making soft landings.

The system has tracked Echo I at 1 000 miles altitude and traveling at 18,000 mph, indicating immediately its position within a fraction of a mile. Plotting information complements photographic plotting, which is available about 45 minutes after photographing.

The high accuracy of the system stems from its reliance on the higher frequencies of light energy. By tracking re-entering vehicles, the system could predict impact areas more accurately than using estimated trajectory.

The cassagranian telescope in the tracker has a 6-inch primary mirror with a one-degree field of view. Light from the target reflected by a scanning mirror is rotated at about 50 cps over a spoked reticle. The spokes interrupt the light, providing light pulses of about 1 Kc to a multiplier phototube.



Tracking errors are resolved into azimuth and elevation signals

The output modulated in frequency at the scan rate is amplified and limited. A discriminator recovers the scan-rate signal, which is compared in phase with a reference from the scan drive motor.

Tracking errors result in a phase-error signal from the phase detector that is resolved into x and y coordinates. These d-c analogs of azimuth and elevation errors control servo valves that cause the hydraulic system to drive the telescope to the correct line of sight.

The 1-Kc carrier with bandwidths of a few hundred cps requires no special filtering techniques. The 50-cps scan rate is convenient for use with transformer-coupled amplifiers.

Automatic tracking rates to 10 deg/sec from −45 to +45 degrees in both azimuth and elevation are possible with signal-to-noise ratios exceeding two. Servo velocity in slewing to a target is about 200 deg/sec. The tracker tripod also has two degrees of freedom for manual positioning.

The system is highly sensitive—about 10-15 watts per sq cm. Stars down to about the third magnitude can be locked on and tracked.

Precision potentiometers energized with regulated supplies provide d-c analogs of both angular positions. For an angle of 90 deg, minimum measurement accuracy is about 0.1 deg. For measuring smaller angles about a mean, accuracy is about 0.005 deg. Other apparatus can be slaved to the tracker.

Multiplier phototube output is recorded to indicate light intensity as a function of time. Periodic fluctuations of about 30 seconds were observed in tracking Echo I, believed to result from tumbling.

In laboratory tests, the tracker equipped for infrared detection sensed and followed objects with temperatures as low as 150 C. With longer wavelength detectors, objects at lower temperatures could be detected.

Electronic System for Balancing Gyro Wheels

By F. W. KEAR,

Supervisor, Research and Development, Lytle Corp., Albuquerque, N. M.

INERTIAL guidance for missiles, navigation equipment and radar fire-control systems are examples of the broad variety of equipment that rely on gyros. Demands placed on these important sensing devices have increased as refinements have

Tung-Sol tubes help CHICAGO AERIAL keep 'copter blades on "right track"

Chicago Aerial Industries' automatic Electronic Blade Tracker brings new standards of accuracy to the critical job of tracking helicopter blades to assure that they are all rotating in the same plane, or track. Proper rotation means smoother flight characteristics, minimized vibration, reduced structural stresses and lower maintenance costs. It virtually makes obsolete the manual flag-tracking method.

The Tracker uses range finding principles to triangulate for each successive blade height. Electrical signals generated by photo-cells in the electro-optical pick-up positioned beneath the rotating blades are fed to a computer analyzer. These signals are then converted to dc voltages proportional to blade height, which registers on the front-panel meter.

Because rigid standards of reliability are mandatory for this equipment, Chicago Aerial selected Tung-Sol tubes to handle the vital regulation function in the conversion network. Tung-Sol 5687 series regulator tubes minimize any variations in output voltage due to load current or line voltage changes. Both tubes maintain 150 volts ± 1 volt insuring the most precise readings.

CAI adds still another name to the growing list of manufacturers who are calling upon Tung-Sol tubes and semiconductors to deliver top performance reliability. Like CAI, you can get the benefit of Tung-Sol component know-how, too. Tung-Sol makes a component for virtually every industrial and military requirement. Our applications engineers will be glad to make an impartial recommendation for the component complement that will best satisfy your design needs. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK 193.

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Toronto, Ontario.

TUNG-SOL®

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been incorporated in the systems in which they are used. An important factor in constructing reliable, high-performance gyros is balance of the gyro wheel.

A sensitive electronic system has been developed to detect imbalance in gyro wheels and to enable determination of the exact point of imbalance from a known reference. The balancing system, which displays results on an oscilloscope, can be readily adapted for many other precision rotating assemblies.

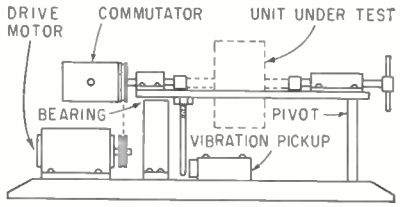


FIG. 1—Balancing fixture triggers oscilloscope reference sweep and detects vibration

The assembly to be balanced is mounted in the test fixture in Fig. 1. A variable-speed d-c motor was found suitable as a source of driving power. Energy is transferred from the motor to the rotating portion of the assembly by a drive belt made of material that will avoid oscillation in rotational velocity of the driven assembly.

Imbalance of the unit under test causes vibration. Construction of the assembly in which the test unit is held restricts movement to the horizontal plane. The support at the right acts as a pivot, while a bearing is installed on the support member immediately to the right of the drive belt to permit horizontal motion.

The rotating part of the setup must provide an output signal at the same instant during each revolution of the assembly under test. An inductive slug mounted in the driven pulley could provide a pulse to an inductive pickup. In the system described, however, a commutator with one segment grounded was found to be a convenient means of providing an output signal.

The base of transistor Q_1 in Fig. 2A is grounded once during each revolution by the grounded commutator segment. As a result, the circuit produces a sharp pulse that is used to trigger an oscilloscope sweep. The display is a sine wave of constant amplitude and starting

at the same instant during each revolution of the unit under test.

Vibration resulting from imbalance is sensed by a transducer that produces another sine wave. An inductive pickup was used in this instance, although a piezoelectric transducer could also be used. Transducer output is amplified by the circuit in Fig. 2B and also displayed on the oscilloscope. Rotational velocity of the assembly being tested is adjusted for mechanical resonance so that the displayed sine wave is at maximum.

The direction of phase difference of the vibration-induced sine wave relative to the reference sine wave indicates the direction of the imbalance from the grounded commutator segment. Actual angular phase displacement of the two sine waves indicates the position of the imbalance with respect to the grounded segment. A protractor can be used to find position of the imbalance on the unit under test.

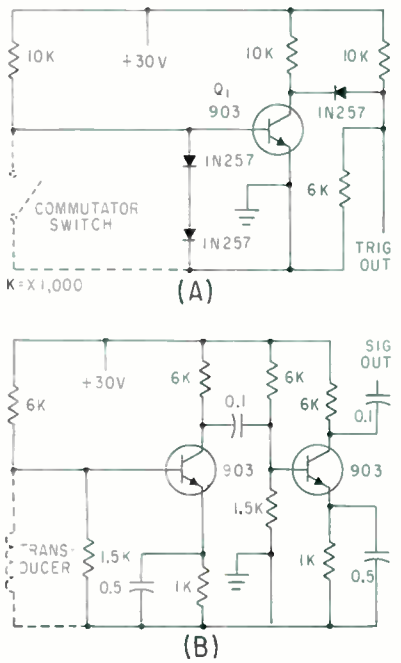


FIG. 2—Grounded commutator segment (A) triggers reference sine wave, while transducer output is amplified (B) for display

When the gyro wheel or other device is in perfect balance, only the reference sine wave and background noise appear on the oscilloscope. Motor speed can be altered to locate resonances where vibration and thus transducer output are at maximum. Thus minor imbalances that might otherwise be overlooked can be detected.

Silicon Epitaxial Transistors On Way

THE AVAILABILITY of developmental samples of a silicon epitaxial transistor was recently announced by E. M. Baldwin, Vice President and General Manager of the Rheem Semiconductor Corp., Mountain View, California, a subsidiary of the Rheem Manufacturing Co. According to Baldwin, the transistor is the first of a line of epitaxial transistors which are being readied for production at Rheem and it is the result of an intensive research and development program.

The development of epitaxial deposition techniques, as used in the fabrication of transistors, has been heralded as a great processing improvement since diffusion techniques were first used for making transistors. The basic process in making epitaxial transistors at Rheem consists of depositing a very thin layer (about one-half mil thick) of high resistivity silicon on a thicker substrate of very low resistivity material. Using this material, transistors are fabricated using the same diffusion techniques as for other high quality mesa transistors. Since the active part of the transistor is all within the high resistivity material, this process, in essence, provides a method for handling one-half mil thick silicon slices.

Two major advantages of epitaxial transistors are the virtual elimination of the collector series resistance and a large decrease in storage and turn-off times, as was indicated in the first public announcement of epitaxial transistors by Bell Telephone Laboratories at the IRE Solid State Devices Research Conference on June 13, 1960. The epitaxial transistors made show both of the above-mentioned effects.

The transistor announced today, RT409, is a 60-v collector breakdown unit and otherwise meets the general specs of the 2N697 series. The typical collector to emitter saturation voltage at 150 ma has been reduced by a factor of 2, as shown below:

V_{CE} (sat):

	RT409	2N697
Typical	0.35	0.7
Max.	0.5	1.5

The storage time for the RT409 transistor is typically less than 100 nanoseconds for the same test conditions which yield 400 nanoseconds in a 2N697. An additional dividend is that, since the power dissipation is low, the transistor may be operated at higher current levels.

Other epitaxial transistors, to be announced soon, include improved versions of other transistors like the 2N699, 2N699A, 2N657, and RT5004. Also, there will be new type numbers to utilize the combined advantages of high breakdown voltage, low saturation voltage, high current and low storage. It will be in these high voltage and high current types that the advantages of epitaxial transistors will be demonstrated most dramatically. These units will be made available at first in the TO-18, TO-5 and the newly-announced MICROBLOC packages. (MICROBLOCs are higher powered, micro-sized replacements for their electrical counterparts in TO-5 and TO-18 packages.)

Developmental samples of transistor RT409 are available six weeks after receipt of order at $170 each. In order to make the devices most widely available to industry, initial orders are limited to a maximum of ten units.

Portable Kit for Capacitor Standards

RECENT DEVELOPMENT by Arco Electronics, Inc., New York, N. Y. of precision miniature capacitor standards having a tolerance of ±0.1% and over 50 percent smaller and lighter than standards of comparable accuracy, has solved many problems for government calibration centers by providing accuracy, portability and ease in use.

A complete set of 32 plug-in type standards ranging from 0.0001 to 0.5 μf is housed in a carrying case only 12¾ in. wide by 11½ in. high by 4¾ in. deep, and comes complete with a four position adapter.

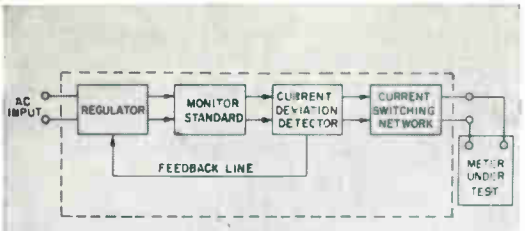
By quick and easy insertion of Arco's capacitor standards into the adapter jig, a capacitance value of four significant figures with an accuracy of ±0.1 percent is obtained.

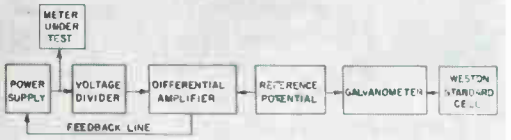
Contracts were let to Arco by the Dayton Air Force Depot for 202 kits and by Frankford Arsenal for 55 kits for use in all laboratories and calibration centers. Arco capacitor standards are available direct from the New York plant in individual unit values as well as in kit form, according to Ben Stanley, in charge of standards sales.

Set offered by Arco comes with four-position adapter

Silicon Whiskers for Instrumentation Devices

USE OF SILICON semiconductor whiskers to provide micro-sensitive instrumentation devices, 50 to 60 times more sensitive than their metallic counterparts, was described by W. V. Wright, of Electro-Optical Systems, Inc., of Pasadena. Wright





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- only one operator required
- for indicating, recording or digital instruments

One operator can now calibrate or standardize most types of indicating, digital and recording-type instruments in 1/3 the time previously required by *two skilled technicians*. Designed for speed and simplicity, Model 61 Console is an ideal laboratory standard for periodic testing of other instrumentation.

Precisely adjustable calibration points are provided by this compact unit. AC ranges of 1 through 50 amperes may be subdivided into 30 equal parts . . . and up to 1,500 volts is available in 10 ranges with 75 to 300 divisions per range. In DC calibration, all full-scale ranges may be divided automatically into as many as 15,000 equal parts.

Accuracy of ±0.05% is achieved through proved Weston circuitry and high-precision standard cells. Any load variation, drift or deviation in either input or output voltage is instantaneously and automatically corrected. Phasing of AC units permits calibration of wattmeters at unity power-factor. For limited applications, individual units are available separately.

Call your Weston representative for complete details, or write for Catalog 06-101. Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey.

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In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.

Weston Colibrotion Console consists of: Models 62 AC Ammeter; 63 AC Voltmeter; 64 DC Voltmeter; and 65 DC Ammeter Colibrotors. Power requirement: 60 cycle, 110 to 120 volts. Overall size: 5' high x 7' long x 2' deep.

DAYSTROM, INCORPORATED
WESTON INSTRUMENTS DIVISION
Reliability by Design

enumerated applications and characteristics of the 1-inch-long, half-a-mil diameter whisker, which is formed either by etching methods or through vapor deposition.

The whisker manifests a piezoresistive effect when strained. By coupling several of these devices to a cantilever beam and hooking up an ordinary bridge circuit, the semiconductor whisker can be used as a strain gage or transducer to measure force, acceleration, vibration, and other forms of physical stress. Low impedance of the silicon whisker, coupled with high output, results in superior signal-to-noise ratio. The device provides a gage factor of approximately 130.

Recently a silicon whisker has been incorporated into a semiconductor strain gage called a Micro-Sensor which is being commercially marketed by Micro Systems, Inc., a subsidiary of Electro-Optical Systems. The Micro-Sensor has a resistance of 350 ohms and an operating temperature ranging from −65 F to 180 F. It consists of a thin silicon element ⅛ inch long., 0.020 inch wide, and 0.0005 inch thick, attached to an epoxy based carrier for application.

Initial development of the whisker element was under contract to the Army Ordnance Corps' Picatinny Arsenal, Dover, New Jersey.

Epoxy, Plus Coal Tar for Electrical Insulation

A COMBINATION of epoxy resins and coal tar derivatives, possessing excellent electrical insulating qualities, has found acceptance in important industrial activities. Low in density, moderate in cost, this product, identified as Epocast H-1338, promises to serve as an important insulation work horse, according to Furane Plastics, LA.

Coal tar products in combination with epoxies have enjoyed important applications to highways and building construction. Following this trend, Furane's research laboratory has distilled the essential insulating qualities of both products into a valuable electrical insulation. Deriving economy from the presence of certain coal tar fractions and the proven excellence of epoxy resins, the research group has developed a good dielectric

which has opened new areas for electrical encapsulation.

Epocast H-1338 systems for impregnating and encapsulating have found application in industrial applications of Class A insulation of transformers, terminal boards and miscellaneous electrical components. Salient properties:

Table of Properties—Epocast's

	H-1338/ 9012-A	H-1338/ 9816
Mixed Viscosity		
At 75 F	1,200 cps	3,100 cps
At 150 F	80 cps	
Pot Life (One Lb.)	5 days	60 minutes
Cure	3 hrs. @ 250 F	Overnite @ 80 F
Cured Spec. Grav.	1.2	1.2
Dissi. Fact. Dielec. Const.		
At 10^4 Cycles (75 F)	0.007/3	0.019/3.8
Weight Loss		
1 day at 300 F	−5.3%	−6.3%
7 days at 300 F	−8.0%	−9.9%
Shore D Hardness		
At 75 F	81/79	77/74
At 200 F	35	27
Vol. Resis. (ohm-cm)		
At 75 F	1.0×10^{15}	1.8×10^{14}
At 200 F	4.8×10^{9}	9.9×10^{8}
Tens. Str.	4,000 psi	1,600 psi
Elongation	20%	20%

Multi-Function Tubes Augur Widespread Use

A NEW low slim look in home radios and television sets seems assured for 1961.

"Several makes of 'Compactronized' (ELECTRONICS, July 8, p 70) radio and television sets are scheduled to appear in the consumer market next year," said Leo T. Bowles, product planning manager of the General Electric Company's Receiving Tube Department. He added:

"At the request of 13 different manufacturers, we presently are developing 37 types of the Compactron components."

"We have firm orders for 50,000 Compactron units per month. We are completing tooling up of plants here in Owensboro, Ky. and in Tell City, Ind., to mass-produce many types of these components. In addition, it is our understanding that at least two other receiving tube manufacturers also are planning to mass produce Compactron devices."

Bowles said this is significant because radio and television manufacturers desire more than one source of supply.

Wire Mesh Makes Flexible R-F Shields

KNITTED WIRE MESH is generally formed into resilient shielding gaskets or r-f weatherstripping. The mesh, made on machines similar to those used to knit stockings, can also be sewed like cloth to form flexible shields in odd shapes.

The sheet shield illustrated is made by Technical Wire Products, Inc., Springfield, N. J., for a military application requiring a shield that will close a gap of varying size. The mesh structure is similar to that previously reported (ELECTRONICS, p 84, Sept. 23, 1960).

The mesh is prepared as several-ply sheets of cloth. The pieces of the pattern are cut with scissors, basted with thread and sewed together on a heavy-duty sewing machine. The pieces are permanently connected by welding with a fine wire type of welding unit and the pattern is installed in the frames.

Large gaskets are made by compressing the knitted stocking into a compact rope. The flat stocking is drawn through a funneling spiral and a series of dies with decreasing diameters. The rope is further compacted and formed to the desired gasket cross section by running it through roller dies in a process similar to calendering.

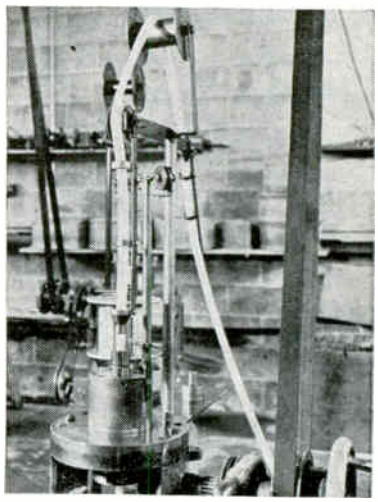
Sections of the rope are shaped to mate with rubber O-rings or other flexible seals. The rope is fixed to the rubber with adhesive dispensed from a medical syringe. If the cross section of the r-f seal is large, the mesh is formed around a core of rubber or other flexible material. This helps preserve shape and flexibility while conserving materials.

Another method of forming large closure shields is crimping the compressed mesh rope in aluminum strip extrusions. The strip is welded to door frames or housing faces so the mesh is compressed when the door is closed. Welds, or other fastenings, must be closely spaced to prevent leakage of r-f energy through long, hairline cracks.

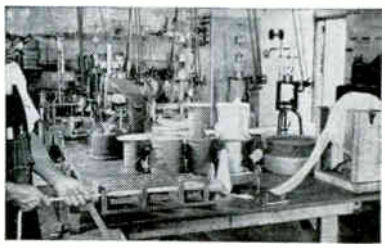
Small gaskets are die-formed from lengths of stocking bent in donut shape. The donut is placed around the female die and is pressed into shape by the male die. The small gaskets can be cemented inside small O-rings or rectangular gaskets. When they are placed on top of the gaskets, for waveguide joint sealing or similar applications, mounting holes through the gasket are usually required. The holes in the base material may be punched or molded in beforehand. Holes punched in the mesh could cause discontinuity and fraying. The holes are made by pointed die members which spread the mesh at the hole locations.

Die-pressing is also employed to

Mesh cloth is sewed into shield that covers a varying gap

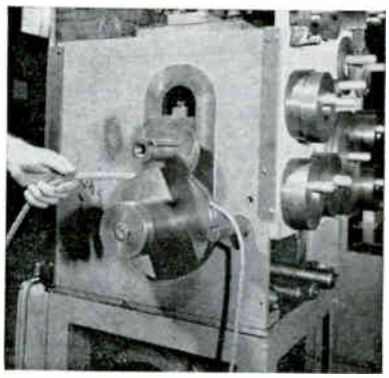


Mesh is prepared on machines similar to stocking knitters



Stocking is spiraled and compressed to form gasketing rope

Rope is cemented to gaskets to form combination seals

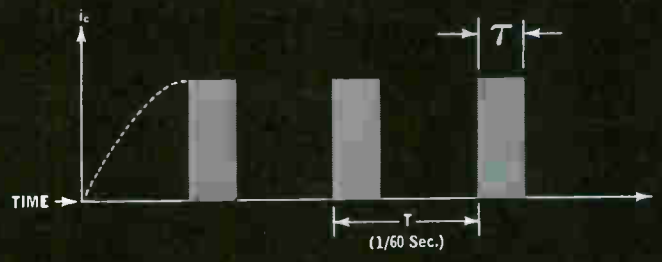


Mesh rope is compressed further and shaped by rollers

Aluminum holding strips facilitate welding to metal closures

New B/A Model NC-1

TESTS POWER TRANSISTORS BY VARYING DUTY CYCLE



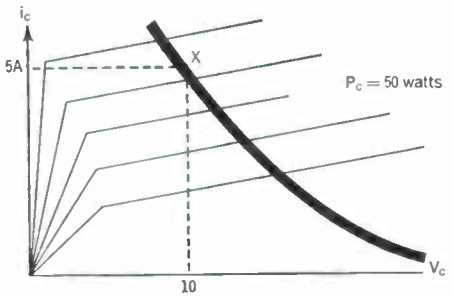
- Minimizes heat sink requirements
- Puts less stress on the transistor
- Permits tests at very high power levels — 750 watts maximum power with maximum current of 50A or maximum voltage of 250V.

The Baird-Atomic NC-1 is the only direct reading, variable duty cycle, medium and high-power transistor test set on the market. This instrument applies suitable pulse drive signals to the transistor under test and then peak detects the resulting current pulses so that they have the same measuring value as steady state DC. The average power in the pulse signals is considerably lower than would be required if steady state DC biases were applied. Thus, measurements can be made at power levels higher than the transistor could survive if normal DC measurement methods were used. At the same time, less stress is put on the transistor itself. Under optimum conditions, the power fed into the transistor is but 6/10ths of 1% of the power used with conventional DC currents.

With the NC-1, tests are conducted under pulse conditions in the common emitter configuration — the meters present DC readings of V_{BE}, I_B, V_{CE} and I_C. The instrument also measures leakage current and floating potential by standard techniques.

EXAMPLE

Here is how the variable duty cycle tests may be used to advantage. Shown below is a typical power transistor C-E set of collector characteristics.



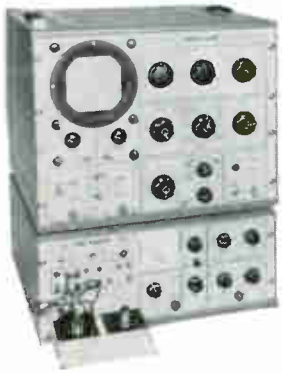
Suppose that we desire to measure the DC current gain at point X. A steady state voltage of 10V and a current of 5A would be required. If conventional DC biases were used, 50W of input power would have to be dissipated by a very large heat sink or auxiliary cooling, such as forced air.

Consider now testing this transistor by the pulse method. We can apply a peak collector voltage of 10V and suitable base drive to produce collector current pulses 5A peak.

For the current pulses 100 μsec. wide at 1/60 Sec. repetition, the average power is:

$$P = V_c I_c \tau / T$$

$$(10)(5)\frac{(100 \times 10^{-6})}{1/60} = 0.3 \text{ Watt}$$



CURVE TRACER MODEL MW-1

- Designed to display families of characteristic curves for PNP and NPN transistors — either common base or common emitter configurations.
- Both input and/or output current or voltage may be selected as components of the curves displayed.
- Operational range includes the highest maximum current (30 amp collector current continuous duty — 50 amp intermittent, 450 watts maximum available power) and the lowest observable impedance (.001 ohms) now available.
- Maximum input current is 5 amp.
- Automatic overload protection.
- Users say this is the finest, most versatile instrument on the market. (Illustration shows instrument with tube adaptor.)

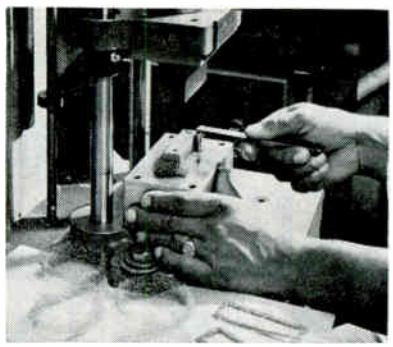
B A

BAIRD-ATOMIC, INC.

33 University Road, Cambridge 38, Mass.

BAIRD-ATOMIC HAS THE MOST COMPLETE LINE OF TRANSISTOR TEST EQUIPMENT

CIRCLE 91 ON READER SERVICE CARD

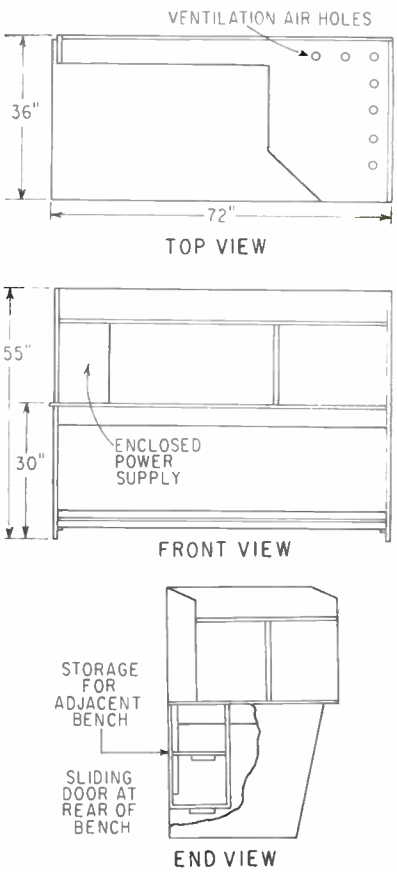


Small shielding gaskets are made by die-forming stockings

make pads for shielding between modules, contact buttons and electron tube shields.

Work Bench Enclosures Boost Lab Efficiency

COMBINATION WORK BENCHES and enclosures have stepped up the efficiency of engineering, research and test personnel, reports Telonic Industries, Inc., of Beech Grove, Beech Grove, Ind. The work benches on which the firm has standardized, incorporating suggestions by the



Construction details. Material is plywood

engineering staff, cost about $100 each when made by a cabinet maker and wired.

The company found that placing men and equipment along the conventional long laboratory bench hampered concentration and lost time through idle conversation, tool borrowing and other time-killers. Development, assembly and testing of the firm's principal product, signal generators, require long periods of attention by employes, making semi-isolation desirable.

Bench helps break up engineering or test areas so employes can concentrate

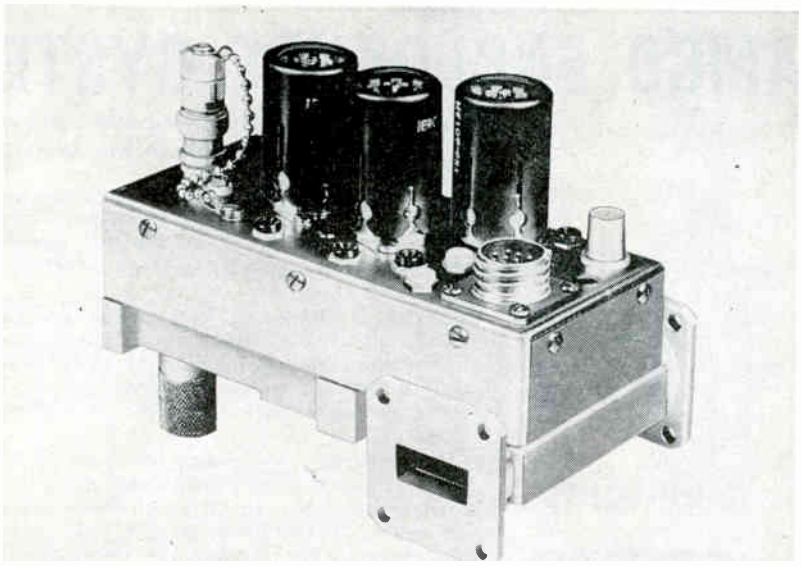
The enclosures are made of ¾-inch plywood with an overlay of Masonite or Formica on work surfaces. Work surface is about 10 feet square, ample for handling large equipments. Unwieldy test equipment, such as oscilloscopes, are placed in the alcove at the right side. Smaller test equipment, parts and tools are placed on the overhead shelf.

The power supply panel at the left end of the table contains a pilot light, on-off switch, a-c isolation transformer, voltmeter, rheostat and outlets. Below the bench are several cubic feet of storage space and a foot rest running the length of the bench.

Machine Sets Eyelets In Irregular Pattern

CONNECTOR EYELETS are automatically fed and set into small terminal boards in pairs in an irregular pattern by a machine recently developed at United Shoe Machinery Corp., Boston, Mass. The machine is a modification (Model F) of those used to insert terminals and connectors in printed circuit boards.

New On The Market



Mixer-Preamplifier

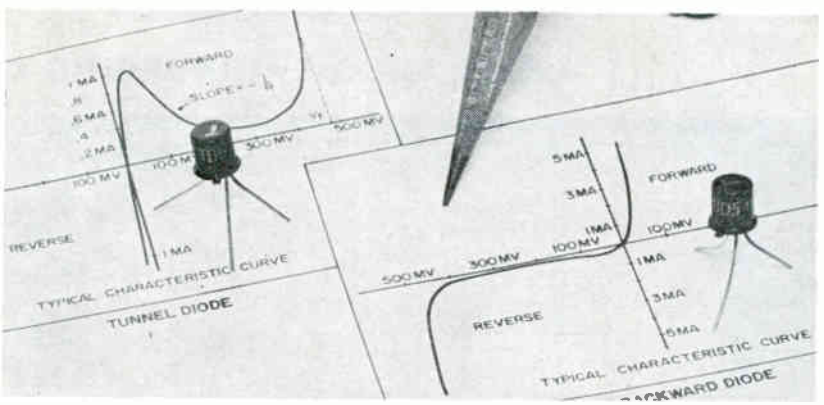
FOR MASERS AND PARAMETRICS

A 9.6 TO 10.7 Gc combination mixer-preamplifier for microwave and guidance systems, developed by Microwave Development Laboratories, Inc., Wellesley, Mass., eliminates the problem of variable parameters resulting when separate mixers and preamplifiers are combined.

The model 90MB-361F1 integrated mixer-preamplifier serves as a low-noise, wideband down-converter for maser and parametric r-f amplifiers. Noise figure of the unit is less than 9.5 db, with a minimum gain of 25 db.

The preamplifier is fix-tuned, with a stabilizing circuit that eliminates need for realignment after replacement of tubes or crystal. Preamplifier output is precisely matched to fifty ohms, allowing the main amplifier to be remotely located.

CIRCLE 301 ON READER SERVICE CARD



Germanium Tunnel Diodes

& MATCHED BACKWARD DIODES

SERIES of 1- and 5-ma germanium tunnel diodes, together with two complementary germanium backward diodes, are announced by Transitron Electronic Corp., 168 Albion St., Wakefield, Mass.

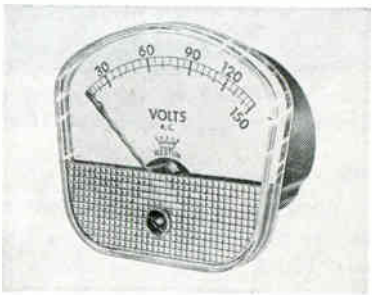
The tunnel diodes are designed for high frequency use and have the close tolerance limits in peak current needed in computers. The backward diodes are designed to be used with the tunnel diodes in logic circuits and other computer applications. Low level rectifier and detector circuits are other uses for the backward diodes.

Backward diode specifications are pegged at the critical points for computer designs utilizing tunnel diodes. Leakage current is specified at 400 ma, forward voltage at 15 percent of the companion tunnel diode's peak current.

Typical shunt capacitance of the backward diodes is 3 pf, making it possible to drive several from one tunnel diode with little reduction in speed. Forward voltage drop is a maximum of 30 millivolts. Circuit design notes are available from the manufacturer.

Prices for the tunnel diodes in quantities of 100 to 999 range from \$4 to \$9; for backward diodes from \$3 to \$3.80; units are available from factory or from distributors.

CIRCLE 302 ON READER SERVICE CARD



Low Cost Meter

A-C VOLTS AND AMPS

A LOW-COST a-c model in the Weston Crown line of panel instrumentsm with an accuracy of ± 2 per cent of full scale value, has been announced by Daystrom, Incorporated, Weston Instruments Div., 614 Frelinghuysen Ave., Newark, N. J.

Designated model 1724, the panel meter uses a movable iron vane mechanism and is available as voltmeter, ammeter, and milliammeter. The instrument has a plastic cover and molded Bakelite base. Top and sides of the cover are clear, providing excellent scale illumination and freedom from shadows; a small external bulb will provide adequate illumination for use in dimly lighted areas. Mountings of the instrument are interchangeable with any 2.5-inch MIL Spec meter.

The a-c voltmeter is normally adjusted for use on 25 to 125 cps but can be adjusted for use at desired

COMPLETE LINE OF VHF TELEMETRY EQUIPMENT

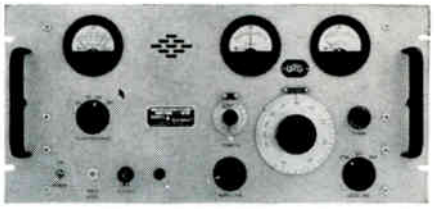
MANY ITEMS AVAILABLE FROM STOCK

TELEMETRY TRANSMITTER, 215 – 265 mc

Improved frequency stability, true frequency modulation, reduced harmonic distortions, and increased power output characterize GEL's VHF Telemetry Transmitter, Type 15A2, specifically designed to meet the exacting requirements of present day telemetry systems.

FEATURES

- *Shock:* 100g, 11 milliseconds
- *Vibration:* 15g, 2000 cps
- *Frequency Stability:* ±0.005%
- *Distortion:* Less than 1%
- *Modulation:* FM/FM, PDM/FM, PCM/FM
- *Temperature Range:* −54°C to +85°C



TELEMETRY RECEIVER, 215 – 265 mc

Designed in comformity with IRIG requirements specifically for use in FM/FM, PDM/FM, and PCM/FM Systems, GEL's Telemetry Receiver, Type 11B1, provides a versatility heretofore unobtainable. Other bandwidths than those shown below, or special response characteristics are available on order.

FEATURES

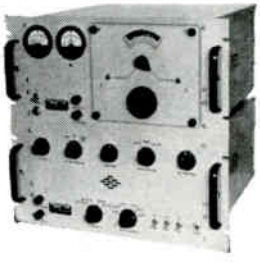
- *IF Bandwidths:* Plug-in type, 100, 300, 500, 750kc
- *OSC Radiation:* Meets MIL — I — 6181
- *VFO or Crystal:* Operation selected by panel switch
- *Image Rejection:* Greater than 60 db
- *Noise Figure:* Less than 7 db

FREQUENCY DISPLAY UNIT, SERIES 14

Accepting signals from GEL Receivers, Frequency Display Unit, Series 14, features good resolution, equalization ±3 db, low spurious radiation, edge-lighted scale, and 60 db image rejection. A signal as low as 2 microvolts at the Receiver input gives full-scale deflection.
Sweep width, center frequency, and gain control are located below a 3" Cathode Ray Tube. Unit mounts in 19" Relay Rack. Series 14 Frequency Display Units are companion units to GEL VHF Receivers.

FEATURES

- Low Spurious Radiation
- Edge-lighted Scale
- Pentagrid Mixer
- Switch for Multiple Inputs
- 20k resolution
- Adjustable sweep width 0 to 3 mc



WIDE RANGE RECEIVER, 30 – 260 mc

GEL Wide Range Receiver, Type 17A1, is used in a broad variety of applications, and is designed to receive AM, FM, and Pulse information. This unit is characterized by extreme sensitivity to the reception of weak signals. The tuning head is contained in a completely shielded sub-assembly, and has very low oscillator radiation. Tuning range is covered in two bands selectable from the front panel. Panels are notched for 19" Relay Rack mounting. Power consumption is 225w at 115-230v a-c 50-60 cycles.

FEATURES

- *Input Impedance:* 50 ohm source with separate antenna input for each band
- *Frequency:* Band 1: 30-60 mc; Band 2: 55-260 mc
- *Noise Figures:* Band 1: Less than 5 db; Band 2: Less than 6 db
- *Oscillator Radiation:* 90 db below 1 mw at antenna terminal
- *IF Bandwidths:* 10 kc, 300 kc, 4 mc

GEL Also Designs and Manufactures a Complete Line of Telemetry Equipment for Microwave Applications

Write for Technical Data Sheets on Compatible GEL Telemetry Equipment in the VHF Band.

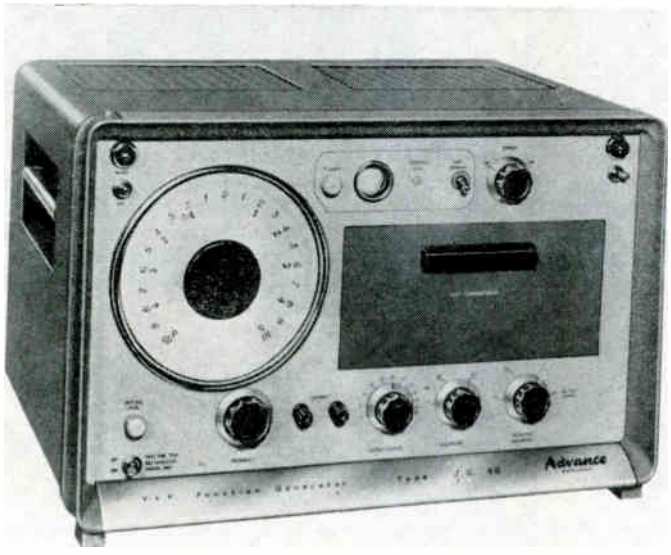
ADDRESS ALL INQUIRIES TO:
General Electronic Labs, Inc.
8521 Second Avenue
Silver Spring, Maryland

GENERAL ELECTRONIC LABORATORIES, INC.
CAMBRIDGE 42, MASS SILVER SPRING, MD.

frequencies up to 2,500 cps. Nine voltmeter ranges are available below 500 volts; higher ranges require use of external resistors or potential transformers.

Ammeters and milliameters are available for use on frequencies from 25 to 500 cps but can also be obtained for use on higher frequencies. Five ammeter models range 0-1 amp through 0-10 amp; four milliammeters from 0-15 ma through 0-500 ma.

CIRCLE 303 ON READER SERVICE CARD



Function Generator

VARIABLE WAVEFORM

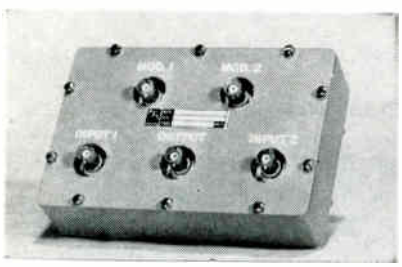
A FUNCTION GENERATOR that provides any waveform at repetition rates down to one cycle every 200 seconds has been introduced by Advance Components Limited, Hainault, Ilford, Essex, England.

Called the SG88 V.L.F. Function Generator, it combines accuracy with great flexibility of operation and is designed to fill a gap in the range of laboratory instruments currently available. It can be used for solving many simulation and computer design problems, for servo-system analysis, vibration testing and similar applications.

The generator is also valuable for analysis, performance testing and simulation problems on a variety of electronic, electric, electromechanical, seismographic and medical equipment. It eliminates the need for specially shaped and wound potentiometers and complex electronic wave-shaping circuits.

Further information is available from the exclusive U. S. distributors, General Measurements Company, Inc., 1108 Beacon Street, Newton Highlands, Mass.

CIRCLE 304 ON READER SERVICE CARD

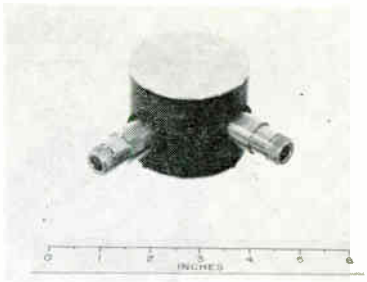


SPDT Crystal Switch

50 DB ISOLATION

A NEW single pole double throw solid state crystal switch, model SNB203A, has been developed by American Electronic Laboratories, 121 N. 7th St., Philadelphia, Pa. The switch is designed to operate at 25 Mc with a bandwidth of about ±5 Mc. However, it can be factory tuned to operate from below 10 Mc up to about 75 Mc. Other models can be built for frequencies up to 18 Gc. Closed insertion loss is less than 2 db, with an isolation greater than 50 db.

CIRCLE 305 ON READER SERVICE CARD



Microwave Filter

ELECTRONICALLY TUNED

WATKINS-JOHNSON COMPANY, 3333 Hillview Ave., Palo Alto, Calif., has announced the commercial availability of its WJ-501, an electronically tuned microwave filter that can be electronically tuned over a wide range of frequencies. The device uses the principle of low-loss gyromagnetic resonance in single crystal yttrium iron garnet (YIG) to achieve a high Q structure whose resonant frequency can be controlled by a d-c magnetic field.

The unit covers the full 2 to 4 Gc band, with a bandwidth of approximately 25 Mc. Insertion losses range from 3 db at 2 Gc to 1 db at 4 Gc. If higher selectivities are required, multiple-tuned structures can be designed but with increased insertion loss at resonance. Band rejection filters of similar characteristics have been built. Bandpass and band rejection filters can be built at frequencies through 30 Gc for specific applications.

The complete filter (15 cubic inches, 2½ pounds) is priced at $870, with about a four-week delivery date.

CIRCLE 306 ON READER SERVICE CARD

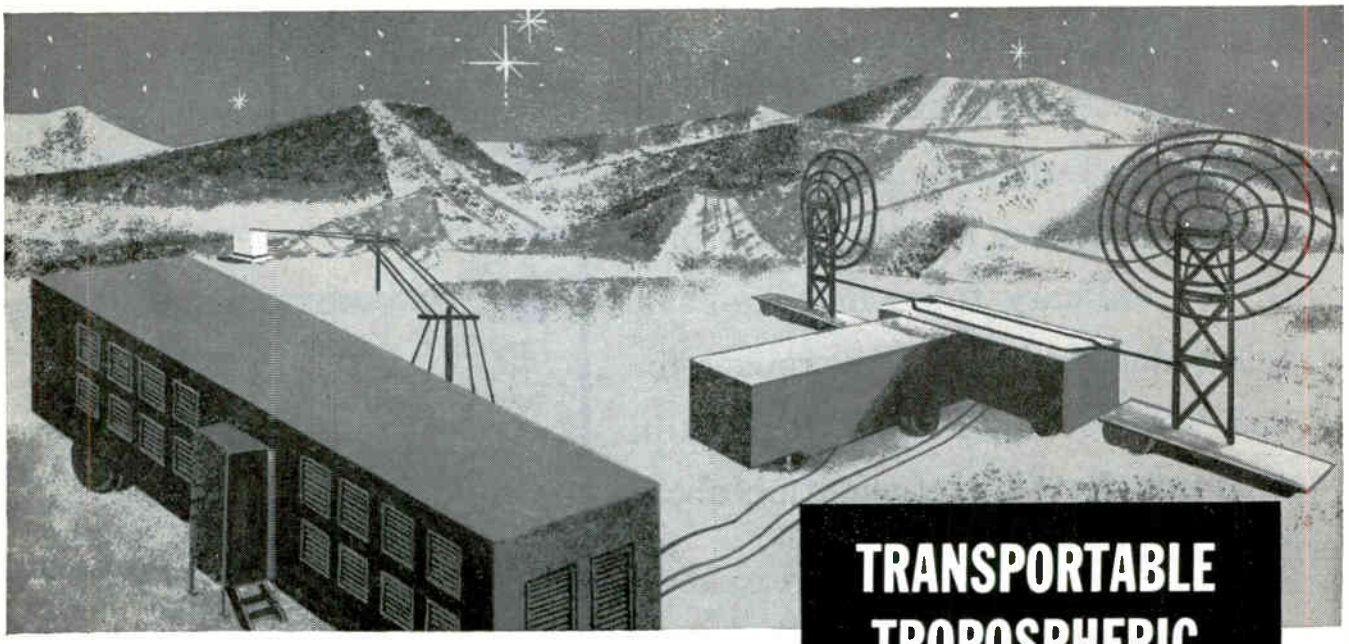
Temperature Recorder

500 TO 2,500 F SPANS

ECONOMICAL miniaturized temperature recorder that operates directly from a thermocouple is announced by Assembly Products, Inc., Chesterland, O.

The Temprint recorder is sensitive enough to permit temperature recording without a signal amplifier. The meter movement, calibrated to match the thermocouple, is essentially the same as the movement used in sensitive panel pyrometers.

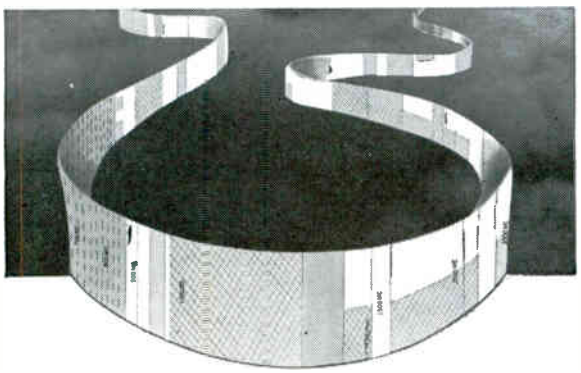
The only electrical connections



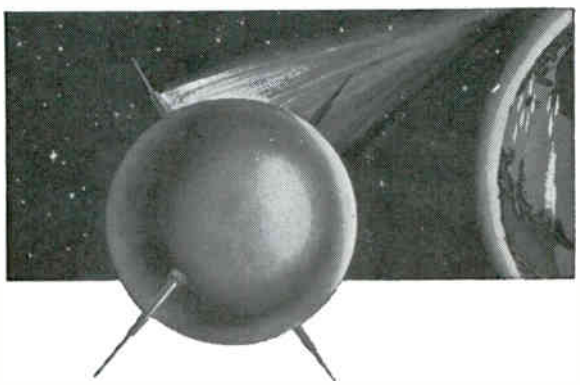
TRANSPORTABLE TROPOSPHERIC SCATTER SYSTEM

THE BIG A LEADS THE WAY TO *INTEGRATED* COMMUNICATIONS SYSTEMS

A new concept in continent-spanning tropospheric scatter communications soon will be available to the U.S. Air Force. For the first time, the full multichannel capability and reliability of a large, fixed installation will be provided in a compact, air-ground transportable package. The all-environment, 10kw, AN/MRC-85 is being designed and manufactured by ADLER under subcontract to Page Communications.



SPECTRUM-STRETCHING COMMUNICATIONS SYSTEM — ADLER heterodyne repeater techniques have opened a wide range of UHF channels for U. S. Army field communications, and prevented obsoleting of millions of dollars of VHF equipment. Developed and manufactured by ADLER, the "F-Head" converter permits the basic AN/TRC-24 VHF system to be used for UHF relaying in areas where VHF spectrum congestion is a problem. Designed for plug-in use, the compact "F-Head" heterodynes the VHF output of the AN/TRC-24 to the available UHF range. ADLER heterodyne techniques also are used in advanced TV microwave and repeater systems, and multichannel communications.



SATELLITE RELAY SYSTEM — A reliable, worldwide network for telegraphy and teletype communications will be realized through PROJECT COURIER of the Advanced Research Projects Agency and U. S. Army Research & Development Laboratories. Each of the Courier's air-ground transportable stations duplex transmit and receive 15 million bits of stored information in the 4-minute contact with the satellite. As subcontractor to ITT Laboratories, ADLER is responsible for design, manufacture and equipment installation of the ground station trailers of this earth-satellite relay system.

Write for all the facts on how ADLER experience can help solve your communications problems.

ADLER

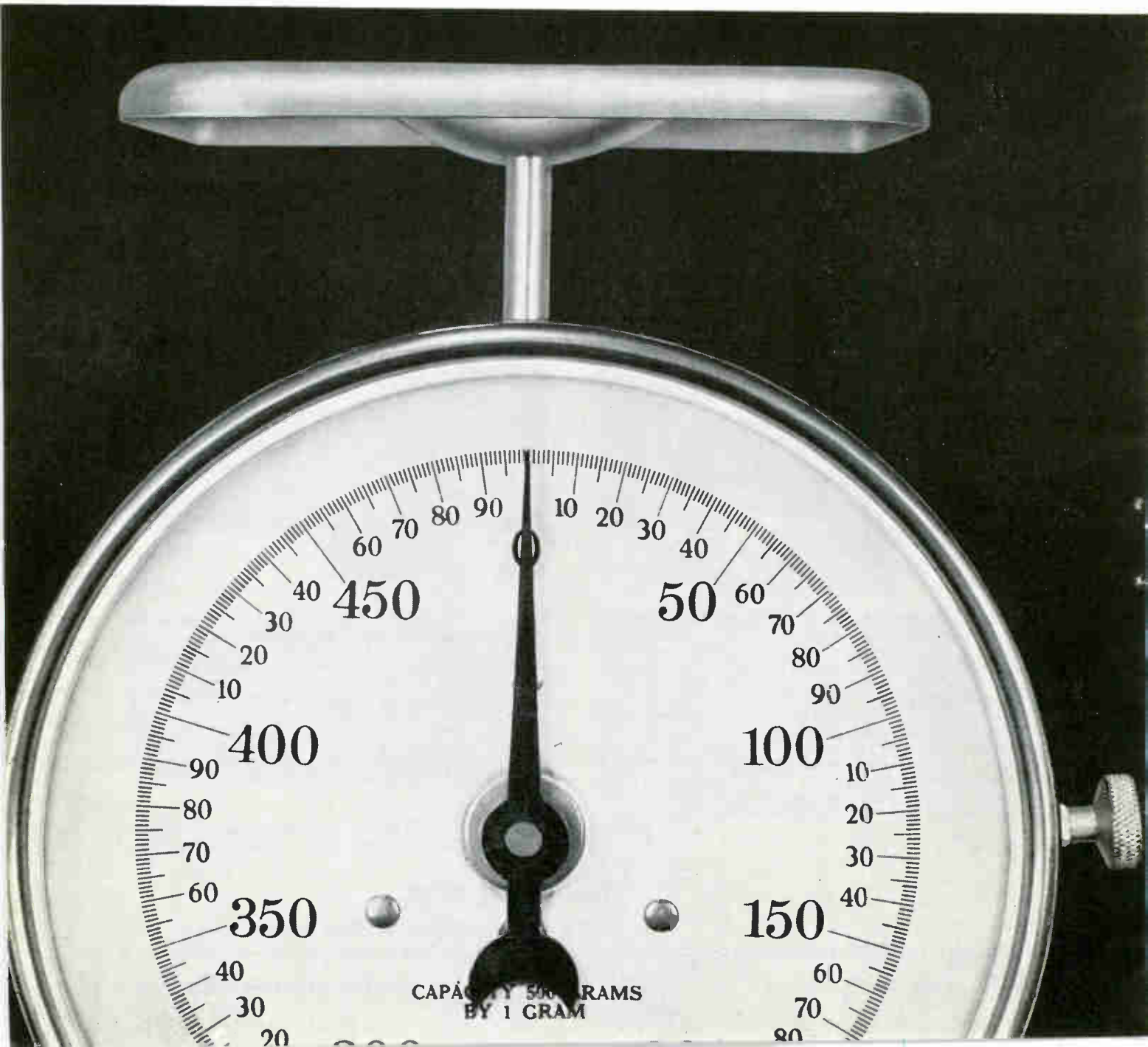
ADLER ELECTRONICS, INC. New Rochelle, N. Y.

WEIGHT of your system can be cut if you specify components capable of outstanding performance. Example: high output lets *one* Sperry traveling wave tube replace *two* ordinary tubes in Nike-Zeus. If weight reduction is a knotty problem for you, call Gainesville, Florida, FRanklin 2-0411 collect, for full information about Sperry capabilities.

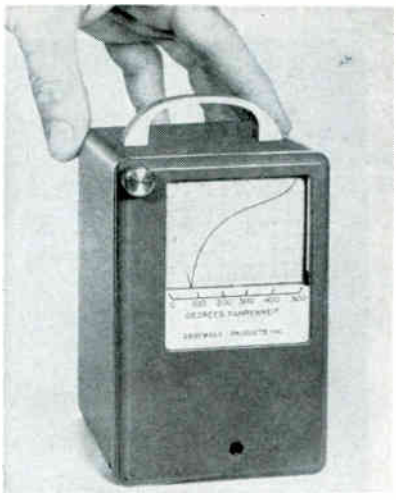
SPERRY ELECTRONIC TUBE DIVISION

Gainesville, Florida • A Division of Sperry Rand Corporation

SPERRY'S FAMILY OF TRAVELING WAVE TUBES covers P through X Bands with unusually high output and light weight. These characteristics, combined with the inherent ruggedness of metal-ceramic construction, conduction cooling and wide-range thermal compensation, make Sperry traveling wave tubes particularly suitable for airborne applications.



necessary for operation are the thermocouple and a 115-volt a-c line. A rear mounted knob simplifies adjustment for thermocouple resistance, eliminating the need to remove turns of resistor wire.



Minimum temperature span covered by the recorder is 0 to 500 degrees F; maximum span is 0 to 2,500 degrees. Accuracy is ± 2 percent of full scale. Standard chart speed is 1 inch per hour, although other speeds are available.

The recorder operates on the clamped-bar principle. Every four seconds the pointer on the moving coil is clamped briefly. A marker on the pointer then prints the pressure sensitive chart paper. Chart paper is advanced by a synchronous motor drive.

Dimensions of the recorder are 3⅝ inches wide, 5⅜ inches high, 4⅛ inches deep. Weight with paper roll is 3½ pounds.

CIRCLE 307 ON READER SERVICE CARD

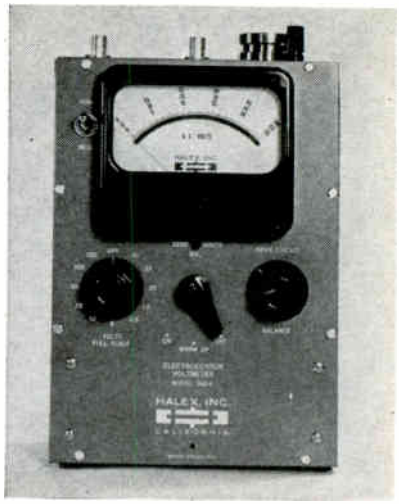
Multipurpose Lab Meter

HIGH INPUT IMPEDANCE

MODEL 302E Electrosensor has high input impedance of 10^{17} ohms with input capacitance of less than 0.01 pf and precise unity gain amplification. The device is designed to perform with stability, accuracy and extreme sensitivity as an ultra high impedance electrometer, a micromicro ammeter, unity gain amplifier, meg-megohmmeter, voltage follower, driver amplifier for d-c systems, micro coulombmeter, precision current follower, feedback amplifier for precise standards, high accuracy analog computer, and

semiconductor testing instrument.

Specifications include full voltage ranges on mirror-back meter of 100 mv to 250 volts, d-c follower



accuracy of 0.02 percent at low terminal and 0.001 percent at high terminal, and a d-c proportionality factor of 0.9995 at low terminal and 0.99997 at high terminal.

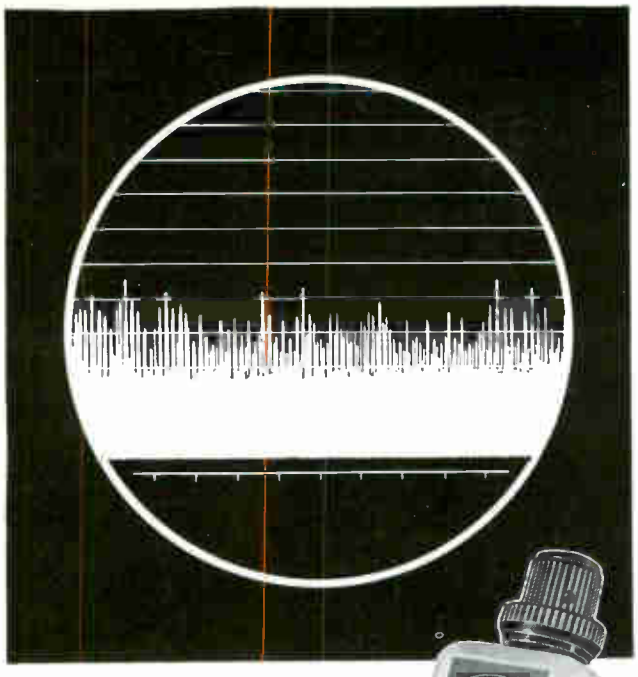
Circuits include a precision high impedance unity gain amplifier consisting of an electrometer circuit with transistorized current amplifier, and a precision unity gain transistor-vacuum tube amplifier. Relativistic coupling of these basic components provides extremely precise voltage following characteristics with an input impedance higher than that of the free space surrounding the instrument.

Device is manufactured by Halex, Inc., Box 546, El Segundo, Calif.

CIRCLE 308 ON READER SERVICE CARD

Resin Dispenser
VARIABLE RATIO

DELSEN CORP., 719 W. Broadway, Glendale 4, Calif. By providing a greater range of resin-hardener ratios, the model 395 variable ratio resin dispenser provides a much greater flexibility in metering two-component liquid resin systems. By means of a simple lever adjustment, the ratio of resin to hardener can be varied from about 20:1 to 1:1. Use of the dispenser allows rapid change over from one resin-hardener system to another. Changes in resin to hardener ratio can readily be made in order to compensate for changes in ambient temperature. A reference scale is provided so that



NEW FROM
RAYTHEON...

Wide Band Noise Source

The new transistorized Raytheon Noise Source can generate noise power, flat within ± 2 DB over the spectrum of 30 cps to 300 Kcps, at a level of 0-10 millivolts rms into a 1,000 ohm load. Designers of missile field test equipment, noise simulators, and other laboratory and production test equipment requiring a compact, low power DC-operated noise source module, will find this new Raytheon development a versatile component. For complete data on the Raytheon Wide Band Noise Source, please write to: Raytheon, Industrial Components Div., 55 Chapel St., Newton 58, Mass.

RAYTHEON COMPANY
Industrial Components Division

CIRCLE 201 ON READER SERVICE CARD

digital simulation

Realistic Tests.. mean Reliable Results

will simulate any digital code

Solid State PCM Simulator ESS-500 by Telemetrics

Realistic preliminary checkout of PCM telemetry ground stations assures reliable results in performance. The Electronic Signal Simulator ESS-500 by Telemetrics, Inc. gives this assurance . . . simulates the digital output of an airborne or ground multiplexer and digitizer for both calibration and checkout . . . presents serial input data . . . applicable also in research and development of pulse coded systems.

Versatile Signal Simulator provides for word length selection, master sync code, 0-to-full scale coding, and 11 special data codes . . . through use of plug-in units, can generate binary, binary-coded-decimal, excess three, biquinary, or any other digital code. NRZ and RZ output signals are provided at +20 volts and —10 volts for full scale; with zero volts for zero scale. Completely transistorized unit occupies only 5¼-inch panel space in standard 19-inch relay rack.

Telemetrics, Inc.

12927 S. Budlong Avenue, Gardena, California

CIRCLE 101 ON READER SERVICE CARD

ratios may be accurately reset. The new unit dispenses a reproducible ratio of resin to hardener and is equipped with drip-proof outlet valves. It is available in both hand operated and motor driven models.

CIRCLE 316 ON READER SERVICE CARD

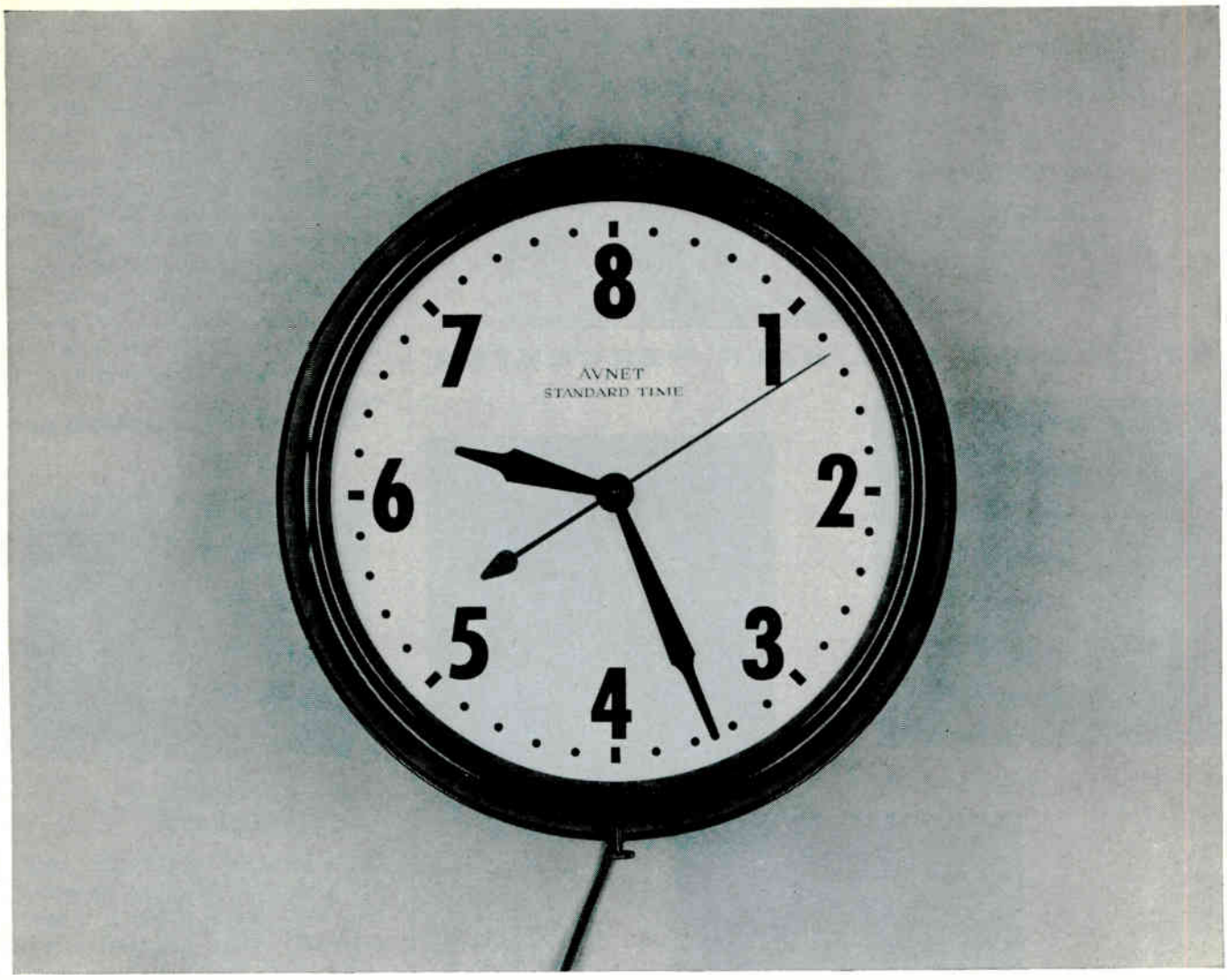
Germanium Transistor
MESA CONFIGURATION

TEXAS INSTRUMENTS INCORPORATED, P. O. Box 312, Dallas 21, Texas. The 2N1405 series germanium mesa transistor features low noise figures with f (max.) in excess of 1,000 Mc. They are especially engineered to provide a rugged and reliable device for applications as r-f amplifiers, oscillators or intermediate frequency amplifiers in transceivers and communications equipment. The 2N1405, -6 and -7 are production tested to assure maximum noise figures of 6, 8 and 10 db respectively at 200 Mc. The 2N1405 series has excellent emitter-base diode characteristics which make them useful as mixers, well into the uhf range. The 2N1405 and -6 have typical bandwidth products of 300 Mc which provide excellent characteristics for video amplifier circuits. The 2N1407 is recommended for use in local oscillator circuits, i-f amplifiers or as a general purpose h-f low cost amplifier.

CIRCLE 317 ON READER SERVICE CARD

Delay Line
AUDIO TYPE

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L. I., N. Y. Model F-483 audio type delay line has a delay of 1,000 μsec



The Avnet System

creates a new Concept of Time

A normally expedient shipping time for your order would be 9:27, as shown by the hands on the clock above. *The Avnet System* would ship at 6:18. The few hour difference (or few day difference) might not be crucial, But if time *is* an important factor, use The Avnet System. Avnet Standard Time and Avnet Standard Procedures ship your order faster than any other major source for electronic components.

This new Concept of Time is one of the many advantages in The Avnet System. *Avnet maintains a network of Sales Engineers traveling the U.S. Each engineer has his counterpart in a Service Center Expediter. Tremendous stocking facilities are maintained strategically throughout the country. Avnet maintains and operates complete assembly facilities for Connector Prototype requirements.* Avnet's Concept of Time may gain you minutes, hours, days, money. Contact your nearest Service Center in The Avnet System.

AVNET

THE AVNET SYSTEM
Men / Methods / Materials / Management
AVNET ELECTRONICS CORP.

Avnet Service Centers and Stocking Facilities are located in Los Angeles, Cal.; Sunnyvale, Cal.; Chicago, Ill.; Dayton, Ohio; Westbury, L. I.; Burlington, Mass.

Avnet distributes from its stocking facilities: BENDIX SCINTILLA CONNECTORS, SPERRY SEMICONDUCTORS, RHEEM SEMICONDUCTORS, ELECTROSNAP AND HETHERINGTON SWITCHES, GREMAR CONNECTORS, CLARE RELAYS, ROBERTSON SPLICE & CONNECTOR CASES, BABCOCK RELAYS, KING SUBMINIATURE HI-TEMP CERAMIC CAPACITORS, TIC PRECISION TRIMMERS, VIBFEX FASTENERS by GENERAL TIRE & RUBBER CO., U. S. SEMCOR SEMICONDUCTORS, SANGAMO CAPACITORS, SPRAGUE CAPACITORS

CIRCLE 103 ON READER SERVICE CARD 103

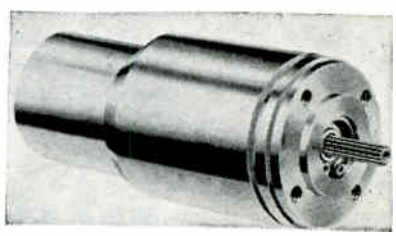
and attenuation of 3 db at 15Kc. Delay is held to ½ percent. Impedance is 600 ohms. Unit features a rise time of 40 μsec and cut-off frequency at 20 Kc. Phase linearity is better than 0.5 percent to 10 Kc. This delay line features standard rack type mounting and measures 19 in. long, 5¼ in. deep by 6 in. high. It weighs 30 lb. The line, which can be cascaded, has application in study of special wave forms, sonar returns, sonar ranging as well as survey analysis. Taps are available every 20 μsec. Availability is 6 weeks.

CIRCLE 318 ON READER SERVICE CARD

High Pot Tester
SEMIAUTOMATIC

TRANS-AMERICA DYNAMICS CORP., 149-A Babylon Turnpike, Roosevelt, L.I., N.Y. Model T-660 is a semiautomatic high potential circuit tester for detecting high resistance leakage breakdown, arcing or shorting on electronic control circuits of all types. It is capable of testing 167 related circuits simultaneously against all others or one nonrelated circuit at a time and can be expanded for programming to customer requirements in multiples of 56 circuits. Features include automatic advancement from one circuit to another and variable peak time adjustment from 1 to 60 sec.

CIRCLE 319 ON READER SERVICE CARD



Servo Motor
INERTIALLY DAMPED

JOHN OSTER MFG. CO., Avionic Division, Racine, Wisc., offers a new

THERE'S NOTHING INTANGIBLE ABOUT THIS MEASURE OF TRANSFORMER RELIABILITY

Maximum Failure Rate:

1 per 100,000,000 part hours

Extraordinarily high reliability is the essential element in the Air Force Minuteman Intercontinental Ballistic Missile program. For example, the transformers used in Minuteman must be of such quality and reliability that they will be able to survive repeated checkout testing and have a failure rate of only 0.001 per cent per 1,000 hours . . . or, to put it another way, one failure per 100,000,000 part hours.

These stringent requirements are demanded by the fact that Minuteman will be left unattended in underground silos for months, or even years, and yet must be ready for instant launching and assure pinpoint target accuracy.

Wheeler Electronic Corp. is proud to have been chosen by Autonetics to develop a program which will result in a continuous supply of transformers that will meet the objective failure rate. As with all electromagnetic products, Wheeler will engineer and design these transformers under the "Systems Concept" . . . as integral parts of the missile's inertial guidance and flight control equipment.

If you need high reliability electromagnetic products, let Wheeler show you how their "Systems Concept" can help you. You will find that Wheeler's team of exceptionally well-qualified engineers can skillfully interpret and develop your specifications, and will translate your special needs into efficient production methods constantly keeping in mind the vital part each component will play in the system.

Transformers — Power Supplies — Current Regulators — Magnetic Amplifiers — Voltage Regulators — Communications Equipment, both VHF and UHF — Special Test and Checkout Equipment — Approved Environmental Test Facilities Available.

WHEELER ELECTRONIC CORP.

Subsidiary of Sperry Rand Corporation

150 East Aurora Street, Waterbury 20, Connecticut • Telephone: PLaza 4-5191

Western Sales Office: 2200 East Imperial Highway, El Segunda, California

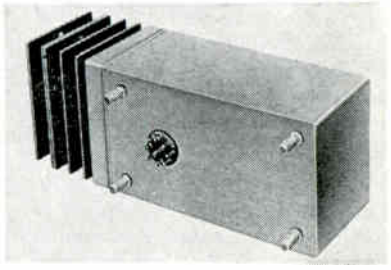
size 11 precision hi temp inertially damped servo motor for high speed and/or high gain servo systems. Inertial damping eliminates the need for a generator amplifier. Type 5752-03 is manufactured completely from corrosion-resistant materials and meets military environmental specifications. No load speed is 5,800 rpm, torque at stall 0.60 oz in., rated voltage 115 rms, 400 cps for fixed phase and 70 for control phase. Other voltages are available. Flywheel magnet inertia is 2.0 gm cm^2 and flywheel magnet damping factor 80 dyne cm/rad/sec. Corner frequencies are 2.3 cps for F_1, 6.4 cps for F_2 and 23.3 cps for F_3.

CIRCLE 320 ON READER SERVICE CARD

Mixer-Preamplifier
LOW NOISE UNIT

LEL, INC., Akron St., Copiague, N.Y. Model MMC-3 coaxial microwave front end provides a low-noise coverage over the 4,000 to 8,000 Mc spectrum. Overall gain is 25 db minimum, typical noise figure is 7.5 db minimum, i-f bandpass is 8 Mc in either 30 or 60 Mc center frequency versions. The MMC-3 supplements the MML-2 and MMC-2 octave coverage coaxial mixer/preamplifier units.

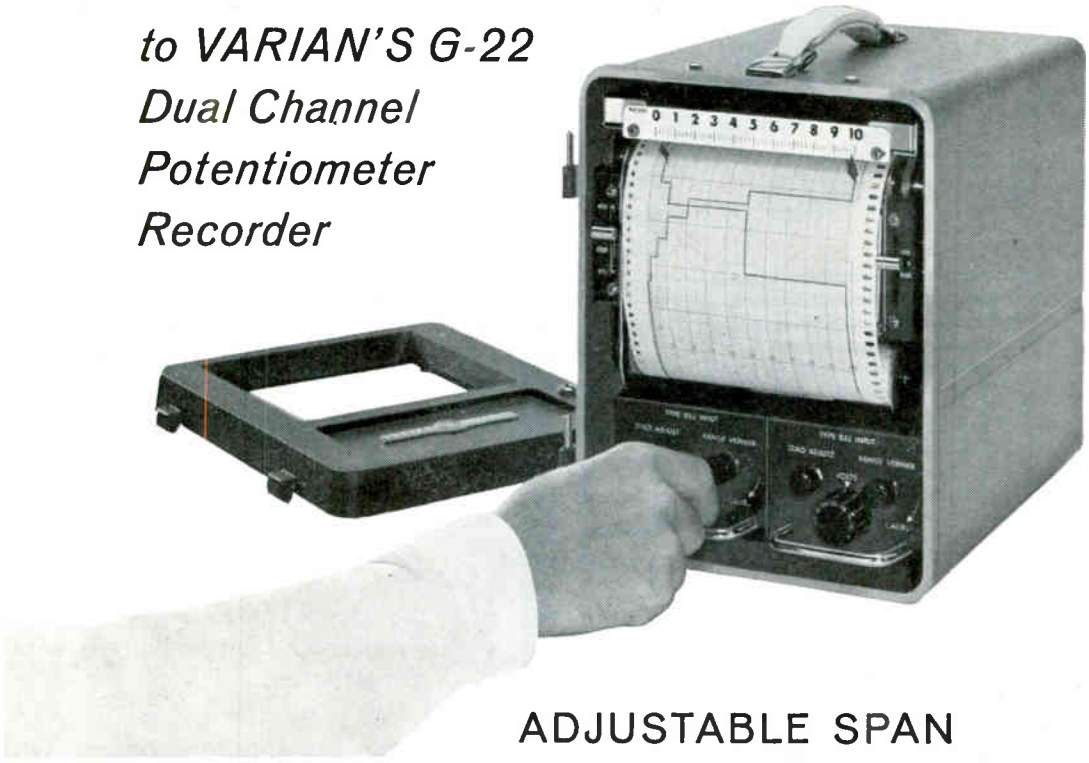
CIRCLE 321 ON READER SERVICE CARD



D-C Power Supply
IN MODULAR FORM

VIKING INDUSTRIES, INC., 21343 Roscoe Blvd., Canoga Park, Calif. Constructed in modular form, com-

A new addition to VARIAN'S G-22 Dual Channel Potentiometer Recorder

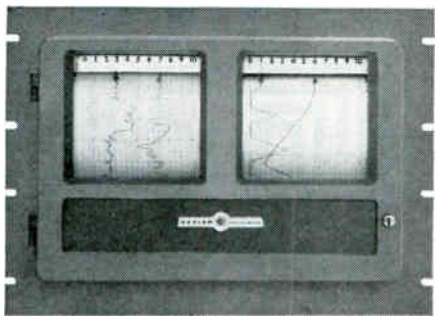


ADJUSTABLE SPAN

0-10 MV TO 0-500 VOLTS

More versatile than ever, the Varian G-22 will now record from sources of almost any likely signal voltage. A newly available plug-in input chassis, the B-22 attenuator type, is easily set as needed from spans as little as 10 millivolts full scale to as high as 500 volts. Front-panel adjustment is continuous in between for optimizing use of the chart's full width in any recording situation.

The G-22 can be your best all-purpose recorder in other ways too. Two channels in themselves also mean versatility—they make the recorder a correlator of simultaneous variables (any two you choose). Two plug-in input chassis mean that each channel's recording characteristics can be quickly changed. And zero can be reset anywhere across the chart from left to right—each channel separately. Last but not least don't underestimate the value of the handle on top. This recorder goes wherever there is recording to be done.*



*Varian offers rack mounted versions too—either singles or twins. The latter is pictured, showing how four channels of recording can be fitted within the 19-inch width of a standard rack.

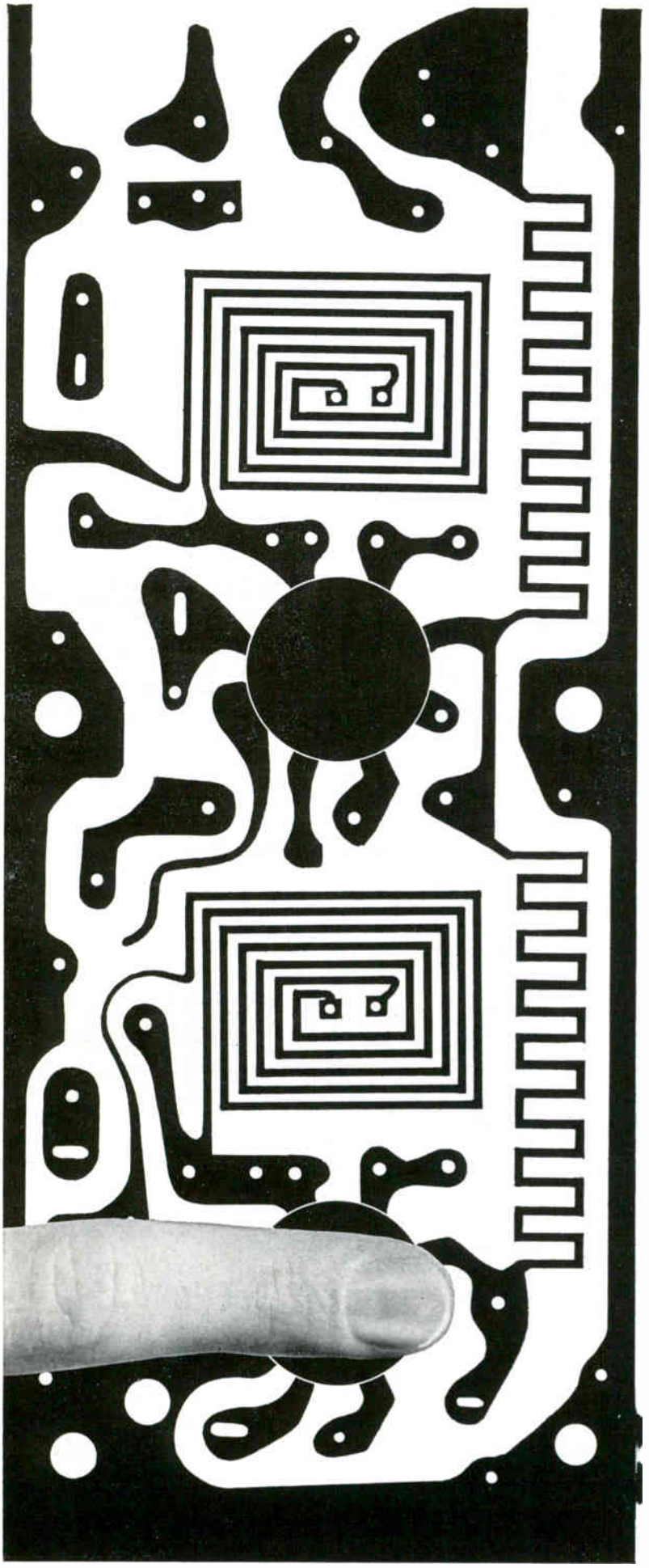
SPECIFICATIONS, OPTIONS, AND ACCESSORIES

One second full-scale balancing time • Accuracy 1% of full scale • Sensitivity 0.25% of full scale • Two chart speeds standard, four speeds optional • Wide selection of chart speeds from ⅛" per hour to 16" per minute • Weight 33 pounds • Available accessories include retransmitting slide wires, alarm contacts, event markers, etc.

For full specifications, write the Instrument Division.

VARIAN associates
PALO ALTO 1, CALIFORNIA

NMR & EPR SPECTROMETERS, MAGNETS, FLUXMETERS, GRAPHIC RECORDERS, MAGNETOMETERS, MICROWAVE TUBES, MICROWAVE SYSTEM COMPONENTS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, RESEARCH AND DEVELOPMENT SERVICES



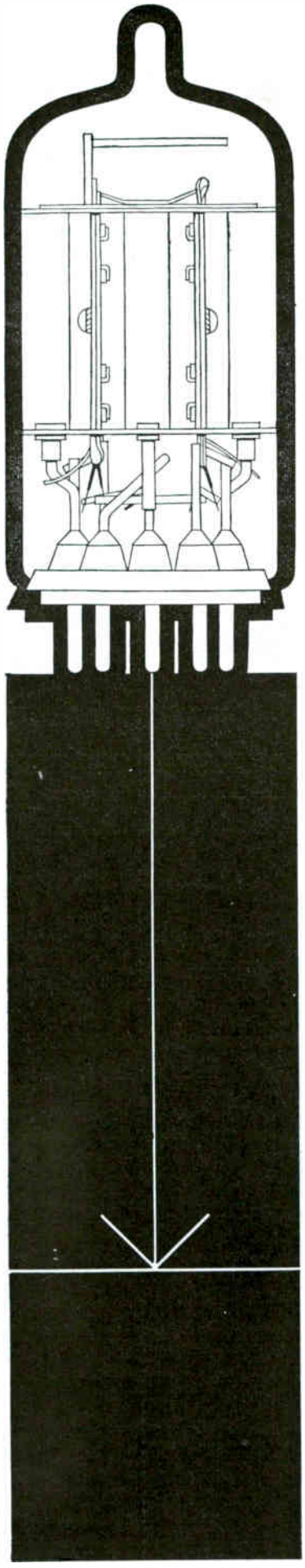
Better base for printed circuits ...Panelyte®

No matter what dramatic new uses you find for printed circuits . . . no matter what requirements you specify...count on Panelyte Copper-Clad Laminates for consistently superior construction.

At present, you can choose from a wide range of properties in six different grades. And St. Regis Panelyte is working to perfect structural qualities which will meet your *future* needs, as well.

Whether you're looking for less warp, more flexural strength, shock-resistance, or any special combination of characteristics, bring your copper-clad laminate specifications to Panelyte. We're also equipped to serve you promptly with laminated plastic sheet, rod, or tube in Military and NEMA Grades. The name again: St. Regis Panelyte. For complete information and the address of your nearest Panelyte distributor, write Dept. EL-1021 St. Regis Paper Company, 150 E. 42nd Street, New York 17, New York.

SR St.Regis PANELYTE®



ECC83
12AX7

high gain double triode

Double Triode having separate cathodes, primarily intended for use as a resistance-coupled amplifier or phase inverter.

characteristics (each section)

V_a	100	250 V
I_a	0.5	1.2 mA
V_g	− 1.0	−2.0 V
g_m	1.25	1.6 mA/V
μ	100	100
r_a	80	62.5 kΩ

'Mullard' is the trademark of Mullard Ltd.

Mullard
ELECTRONIC TUBES

BRITAIN'S FIRST CHOICE FOR FIRST EQUIPMENTS

SUPPLIES AVAILABLE FROM

IN THE U.S.A.
International Electronics Corporation
81 Spring Street, New York 12, N.Y.
Worth 6-0790

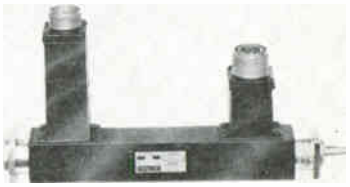
IN CANADA
Rogers Electronic Tubes & Components
116 Vanderhoof Avenue,
Toronto 17, Ontario.
Hudson 5-8621

MULLARD OVERSEAS LTD., MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND

MEV 103

pact, and easy to maintain, the model 101-D solid state power supply features 0.1 percent regulation for any combination of input voltage or load conditions. Ripple is less than 1 mv rms. Input is 100 to 130 v, 50 to 2,000 cps. Temperature stabilization insures a maximum of ± 0.01 percent/deg C drift. An output of 12 v d-c at 1 ampere is available over a temperature range of − 25 C to + 45 C and is capable of operation up to + 71 C at reduced output current. Size is 2¼ in. by 2¾ in. by 6⅛ in.

CIRCLE 322 ON READER SERVICE CARD



Coax Noise Source
SMALL AND RUGGED

TUCOR, INC., 18 Marshall St., South Norwalk, Conn. The T44L1D is a double-ended coaxial noise source covering a frequency range of 1,000 to 2,000 Mc with an 18.5 db noise output. It is small in size (10¾ in. long), and rugged enough to meet all severe environmental requirements. A companion to Tucor's T44L1C single-ended coaxial noise source, the new tube is identical in all other respects. Both tubes are used for noise measurement and testing of microwave components. Other aspects of T441D are a 180 v nominal operating voltage, 50 ma operating current and 1,200 v striking voltage.

CIRCLE 323 ON READER SERVICE CARD

Resistors
FIXED COMPOSITION

HAMILTON-HALL, INC., 227 N. Water St., Milwaukee 2, Wisc., offers a new, complete line of fixed composition resistors in ½, 1 and 2 watts. 231 resistance values are available in three wattages, and range from 10 ohms to 32 megohms in all standard EIA values. The resistors are made to meet or exceed all requirements specified by MIL-R-11 and RS-172.

CIRCLE 324 ON READER SERVICE CARD

KAY *Precision* RANDOM NOISE GENERATORS

1 KC TO 26,500 MC

COAXIAL NOISE SOURCES

1 MC to 3000 MC . . . THE *Mega-Node*® 3000

The *Mega-Node 3000* is a calibrated random noise source providing output over a wide frequency and power range. It employs a coaxial-type noise diode with a tungsten filament as a temperature-limited noise generator.

- **Noise figure, 0-20 db • Output impedance, 50 ohms unbalanced**
- **Accuracy ±.25 db below 250 mc, ±1.0 db below 2000 mc, ±1.5 db at 3000 mc.....Price $790.00, f.o.b. factory**

1 KC to 1000 MC . . . THE *Therma-Node* (Illustrated)

The *Therma-Node* is a basic noise source which provides extremely high accuracy by utilizing a basic noise generation technique—thermal noise from a heated resistive element.

- **Noise figure to 10 db • Output impedance, 50 ohms unbalanced**
- **Accuracy ±0.1 db • Operates from line or 24 V dc . . . Price $550.00, f.o.b. factory, 2—1000 mc (1 kc—300 mc, add $135.00)**

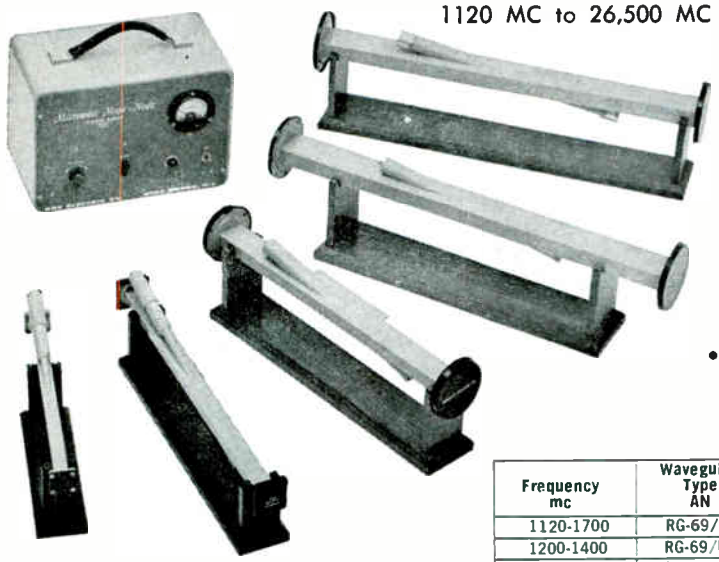
3 MC to 500 MC . . . THE *Mega-Node*® 403-A

The *Mega-Node 403-A* is a calibrated random noise source providing precise operation over a more limited frequency range at proportionately lower cost.

- **Noise figure, 0-19 db • Output impedance, 50 ohms unbalanced**
- **Accuracy ±0.5 db .....Price $375.00, f.o.b. factory**

WAVEGUIDE NOISE SOURCES

1120 MC to 26,500 MC



THE

Microwave Mega-Nodes®

The *Microwave Mega-Nodes* are precision machined and plated waveguide fixtures, utilizing argon, fluorescent, or neon gas discharge tubes. Single power supply operates all units. (Power Supply, $95.00.)

- **Noise output of 15.8 ±.025 db for fluorescent tubes, 15.45 ±0.2 db for argon, 18.0 ±0.2 db for neon. Supplied with power cables and fittings.**

Frequency mc	Waveguide Type AN	Flange AN	Catalog No. Argon	Fluor.	Neon	Price*
1120-1700	RG-69/U	UG-417/U	**	312-A	**	$595.00
1200-1400	RG-69/U	UG-417/U	311-A	310-A	313-A	$395.00
1700-2600	RG-104/U	UG-435A/U	**	870-A	**	$495.00
2200-3300	RG-112/U	UG-553/U	**	880-A	**	$495.00
2600-3950	**RG-48/U**	**UG-214/U**	**261-A**	**260-A**	**262-A**	**$175.00††**
3950-5850	**RG-49/U**	**UG-149A/U**	**271-A**	**270-A**	**272-A**	**$175.00††**
5850-8200	**RG-50/U**	**UG-344/U**	**281-A**	**280-A**	**282-A**	**$175.00††**
7050-10.000	**RG-51/U**	**UG-51/U**	**291-A**	**290-A**	**292-A**	**$175.00††**
8200-12,400	**RG-52/U**	**UG-39/U**	**301-A**	**300-A**	**302-A**	**$175.00††**
12,400-18,000	RG-91/U	UG-419/U	521-A	**	522-A	$250.00
18,000-26,500	RG-53/U	UG-425/U	531-A	**	532-A	$250.00

†† Any three plus power supply: $595.00. Any in excess of three: $167.00 ea.
** None available.
* All prices f.o.b. factory.

Write for Catalog Information

KAY ELECTRIC COMPANY

Dept. E-10 Maple Avenue, Pine Brook, N.J.
CApital 6-4000

Literature of the Week

INDICATOR LIGHTS Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y. An 8-page brochure discusses ultraminiature indicator lights (Datalites) and their use either singly or in multiples as a "Data Strip" or "Data Matrix".
CIRCLE 325 ON READER SERVICE CARD

MAGNETIC AMPLIFIERS Airpax Electronics Inc., Seminole Division, Fort Lauderdale, Fla. Bulletin M-24 describes low level FERRAC magnetic amplifiers which provide linear outputs of ± 7.5 v d-c with input signals in the low millivolt range.
CIRCLE 326 ON READER SERVICE CARD

SYNCHRONOUS MOTORS The Superior Electric Co., 83 Laurel St., Bristol, Conn. Slo-Syn folder SE-L2604 contains technical characteristics, specifications, ratings and outline dimensions of new 50, 150 and 250 oz-in. Slo-Syn synchronous motors. Conventional, militarized and explosion-proof types are offered with or without planetary gear speed reduction assemblies.
CIRCLE 327 ON READER SERVICE CARD

PRINTED CIRCUIT RELAYS Executone Inc., Components Division, 47-37 Austell Place, Long Island City 1, N. Y., has available a catalog and specification sheets describing Printact printed contact-permanent magnet relays which save space, money and manhours.
CIRCLE 328 ON READER SERVICE CARD

DIALLYL PHTHALATES Mesa Plastics Co., 12270 Nebraska Ave., Los Angeles 25, Calif. A property chart, 11 in. by 13 in., is available listing electrical, structural, thermal and other data on regular and flame-retardant diallyl phthalate and diallyl iso-phthalate plastics.
CIRCLE 329 ON READER SERVICE CARD

CHOPPERS Airpax Electronics Inc., Cambridge Division, Cambridge, Md. Bulletin C-33 describes series 300 choppers for 400 cycle operation. A summary of chopper ratings including electrical charac-

teristics, environmental conditions, and mechanical characteristics, and a glossary of chopper terms and definitions are detailed.

CIRCLE 330 ON READER SERVICE CARD

CONTROL CHASSIS Datex Corp., 1307 South Myrtle Ave., Monrovia, Calif. Bulletin DPS/A5 describes the K-111A control chassis which is designed for the acquisition, storage and translation of digital data.

CIRCLE 331 ON READER SERVICE CARD

D-C POWER SUPPLIES Opad Electric Co., 43 Walker St., New York 13, N. Y., has issued a catalog sheet illustrating and describing a new series of low cost transistor regulated d-c power supplies.

CIRCLE 332 ON READER SERVICE CARD

FREQUENCY MEASUREMENT Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. Latest techniques and equipment for accurately measuring frequency from vhf up to and above 18,000 Mc are described in a new application note now available.

CIRCLE 333 ON READER SERVICE CARD

VIDEO RECORDING GPL Division, General Precision, Inc., 63 Bedford Road, Pleasantville, N. Y. A four-page illustrated brochure outlines new developments in video recording technique. It covers a new application, tape to film transfer, and two new features now available, spot wobble and the alternate synchronizing generator.

CIRCLE 334 ON READER SERVICE CARD

CONTROLLED TEMPERATURE The Electric Hotpack Co., Inc., 5069 Cottman Ave., Philadelphia 35, Pa. Seven high-low temperature test chambers are featured in the newest controlled temperature bulletin. Included are photographs of all the units, technical data, prices and complete specification.

CIRCLE 335 ON READER SERVICE CARD

POWER SUPPLY Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J. New two-page bulletin gives complete performance characteristics for the HC40-50 high current transistorized power supply.

CIRCLE 336 ON READER SERVICE CARD

NEW BOOKS

Introduction to Statistical Communication Theory

By DAVID MIDDLETON
McGraw-Hill Book Co., Inc., New York, 1960, 1,140 *p*, $25.

THIS remarkable book cannot be recommended as an introduction to its subject since the author's sometimes awkward symbolism and murky exposition would be difficult hurdles for a beginner. For specialists in communication theory the book should prove to be useful and probably worth its considerable price.

The four parts of the book are: Part 1—an introduction to statistical communication theory; Part 2—random noise processes; Part 3—application to special systems; Part 4—a statistical theory of reception. In the first two parts, some topics are very sketchily treated and might better have been omitted; for example, the chapter on information theory. On the other hand, Part 3, dealing with random processes in modulation systems, is reasonably complete and particularly valuable. Part 4 is a thorough discussion of the application of decision theory to reception.

Figures and graphs are plentiful and there seem to be relatively few misprints.—T. M. BURFORD, *Bell Telephone Lab, Murray Hill, N. J.*

Simplified Data Control Systems

By ELIAHU I. JURY.
John Wiley & Sons, New York, $14.

THIS text presents a rather complete analysis of a relatively new field—that of control systems using time sampled rather than continuous inputs.

The author presents the sampled data system in a simplified open loop form and then proceeds to develop the tools that will be used to analyze the closed loop system. The Z transform and the modified Z transform form the basis for sampled data systems analysis and the presentation of these methods is adequate. Generally, the instructive material in the text is well pre-

sented and well ordered. The lack of illustrative samples is somewhat compensated for by the choice of some very good problems presented at the end of the chapter. It is felt, however, that the addition of answers to the problems would facilitate the students' understanding.

One general criticism of the text is that the author does not give the reader the feel for the application of the analysis, but rather presents one method after another in sequential form. It appears that the author has attempted to concentrate too much analysis within the text, thereby leaving no space for discussion of application. The result is that the reader does not fully appreciate where the analysis will lead. If the subject had dealt with simple circuits, rather than the relatively new and complex field of sampled data systems, then a discussion of application would not have been necessary.

To summarize, the content of the text is good, however, it is felt that had the author reduced the amount of material presented, he could have expounded on the application of the presented material. — RALPH J. MASTRANDREA, *Senior Research Engineer, Columbia University, Electronic Research Lab, New York.*

THUMBNAIL REVIEWS

F-M Simplified. By Milton S. Kiver, D. Van Nostrand Company, Inc., New York, 1960, 384 p, $7.50. Starting with the basic principles of f-m, the author makes a simplified detailed analysis of the operation of the various types of f-m receivers and transmitters. Besides theory of operation, the book also contains full instructions for receiver alignment. As an additional aid to the student, a set of self-check questions for each chapter is included. An excellent book for the electronics technician or student engineer.

Radiation Counters and Detectors. By C. C. H. Washtell, Philosophical Library, Inc., New York, 1960, 115 p. $7.50. An introductory survey of radiation-detection devices is given. Geiger, proportional, and scintillation types are discussed in some detail. Emphasis is on detectors; there is little information on circuits. ELECTRONICS readers will find this a bit light in content, but it serves as an easy-to-read orientation to detectors and their applications.

AEL Announces Construction Plans

AMERICAN ELECTRONIC LABORATORIES, INC., of Philadelphia, plans to construct a new plant and development center. The 32,000-sq-ft plant will be situated on a 55-acre tract at Colmar, Pa.

AEL was incorporated in 1950 with a capitalization of $500. After 10 years of rapid growth, the company now considers itself one of the leaders in the fields of microwave, communication, and medical electronic research and development. The firm now employs 200 people.

Early in 1961, AEL expects to be in full operation at the Colmar site with production of its line of industrial and electromedical products. AEL's Microwave & Communications Center has been operating from there, and it is felt that greater production efficiency will result from the move. The tract provides long test paths for research and development work.

The building is designed for expansion, and AEL expects to double in size within two years.

A special section of the new facility has been assigned to AEL's environmental test unit. New and expanded test facilities are being incorporated to enable the unit to handle a larger volume of work with a greater efficiency.

Eighty percent of AEL production and research is for the government. The company is engaged in countermeasures research, satellite tracking, equipment development, and the uhf and vhf communication fields. A contract has just been signed with the Navy Department Bureau of Ships for $449,128 for development of special antennas for a technical research ship. AEL will be responsible for all development design and fabrication for the ship's antenna installation.

Colorado Research Promotes Wendt

KARL R. WENDT has been appointed executive vice president of Colorado Research Corp., Broomfield, Colo. The company specializes in research, development, and manufacturing of precision electronic equipment.

The new executive vice president joined Colorado Research Corp. in January of this year as manager of the research department, where he has been in charge of the company's digital television development program. He will continue to supervise this phase of company operations.

Prior to his association with Colorado Research, Wendt was chief engineer of the communications and radar section of the Martin Co. He was with RCA for 18 years, pioneering in the development of both black and white and color television. He was manager of advanced tv development at Sylvania, and held similar positions with Telemeter Magnetics and International Telemeter Corp.

Watkins-Johnson Hires Nelson

J. NORMAN NELSON has joined the technical staff of Watkins-Johnson Co., Palo Alto, Calif., to be primarily concerned with the development of medium-power traveling-wave amplifiers.

Nelson spent the past three years with RCA at Harrison, N. J., where he was responsible for the design and devolpment of low noise and medium power traveling-wave tubes.

Altec Lansing Names Harrison G-M

ALTEC LANSING CORP., Anaheim, Calif., has appointed Ercell B. Harrison general manager of its Peerless Products division.

Harrison, who has been with Peerless for twenty years, will retain his current position as sales manager in addition to assuming his new duties. Peerless designs and manufactures high reliability transformers and power supplies for electronic applications.

Precision Electronics Doubles Capacity

PRECISION ELECTRONICS, INC., Rockville Center, Long Island, N. Y., manufacturer of coils and transformers, recently completed an expansion wherein it has doubled its

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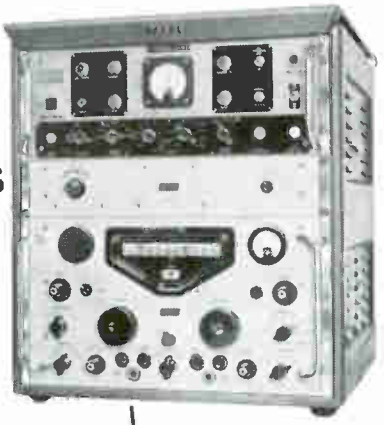

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PVC-744 PLAST. TUBING	Specifically designed for sub-zero temperatures.		550	70°C	—67°C	Good	#24-#0 A
PIF-130 PLASTIC IMPREGNATED FIBERGLASS SLEEVING	Class B insulation for continuous operation to 130°C. Excellent color retention even on prolonged baking at high altitudes.	A-1 B-1 C-1	8000 4500 2500	130°C 130°C 130°C	—30°C —30°C —30°C	Good Good Good	#24-#2 B, C, D, G #1 and larger C, D
VTS-135 VARNISH IMPREGNATED TUBING & SLEEVING	Class B insulation for general use; high tensile strength, good flexibility, non-peeling cracking, low moisture absorption, acid oil resistant.	A-1 B-1 C-1	7000 4000 2500	135°C 135°C 135°C		Good Good Good	#24-#2 B, C, D, G #2½-#1 B, C
TFT-200 TEFLON EXTRUDED TUBING	Unmatched for electrical application at high temperature frequencies. Thin, flexible, permits miniaturization and compactness.		500-1000	250°C	—90°C	Excellent	#30-#15 B-K #14-#8 B, C, D, F, G, H, I, J #7-#0 J
SRT-250 SILICONE RUBBER EXTRUDED TUBING	Excellent tensile strength, elongation, and tear strength, low water absorption and good oil resistance.		400	200°C	—85°C	Good	#28-#10 H
PVC-80 EXTRUDED PLASTIC TUBING	Excellent snaking, expands to irregular shapes. Dilates under certain conditions and resumes its size if it is the polyvinylchloride type.		800	80°C	—30°C	stiffens slightly	#24-#12 A-I #11-#2 A, B, C, D, G, H #2½-#1 A, B
PLE-70	(Same as PVC-80)		1200	80°C	—70°C	swells slightly	#24-#7 J
SRF 200 SILICONE RUBBER FIBERGLASS TUBING	Class H insulation, excellent for shock resistance, extreme flexibility and freedom from cracking and crazing at extreme temperatures.	A-1 B-1 C-1	7000 4000 2500	200°C 200°C 200°C	—67°C —67°C —67°C	Good Good Good	#24-#15 B-K #14-#2 B, C, D, G, H, J #1-#½ B, C, H, J
HTF-1200 HI-TEMPERATURE FIBERGLASS SLEEVING	Class H insulation. Tightly braided sleeving for use up to 650°C. Can be colored for coding. Special constructions up to 1/16" wall thickness and double wall thickness available.		Determined by space factor	650°C	—55°C	Good	#24-#½ B, J
SFS-400 SIL CONE IMPREGNATED FIBERGLASS TUBING	Class H insulation for high temperature use. Remains flexible and retains its electrical properties to 205°C.	C-1 C-2 C-3	2500 1500 Space factor	205°C 205°C 205°C	—39°C —39°C —39°C	Good Good Good	#24-#½ J

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manufacturing capacity.

This move was brought about by the increasing demand for its products by industry, according to Jules Salit, vice president.

Contact Manufacturer To Serve West Coast

GENERAL FINDINGS & SUPPLY CO., Attleboro, Mass., developer and producer of miniature contacts and assemblies for the electronics and electrical industries, now extends its manufacturing facilities across the nation by opening a new plant in North Hollywood, Calif.

In making the announcement, Gerald F. Tucci, General Findings general manager, said that the move establishes the company as the first major Eastern precious metal fabricator to open complete research, development and fabrication facilities to serve the important West Coast electronics field.

Management of the new plant will be made up entirely of experienced staff engineers from the main factory in Attleboro. Peter Microulis, a product division manager in the Attleboro office, has been appointed to head up the new operation.

Establish New Company, Name Vice President

CHEMONICS, INC., a subsidiary of Lancer Industries Inc. of Mineola, N. Y., was recently established in Pasadena, Calif. It will specialize in the development and manufacturing of modular circuits for use in analog and digital computers and other types of electronic equipment.

W. O. Sandberg has been named vice president and will be general manager of the newly formed company. He was formerly general

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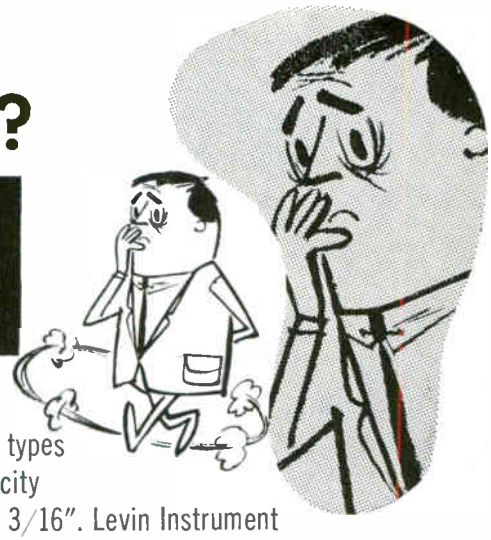

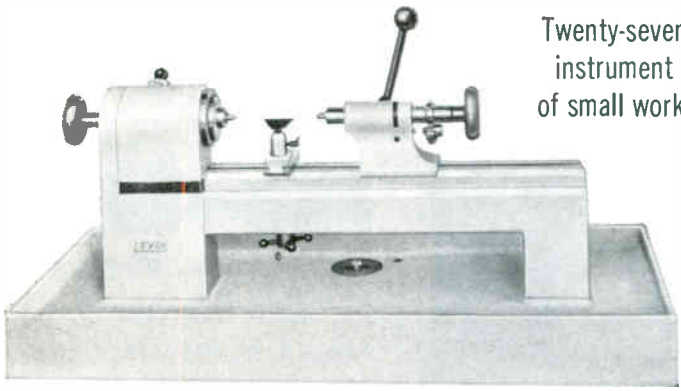

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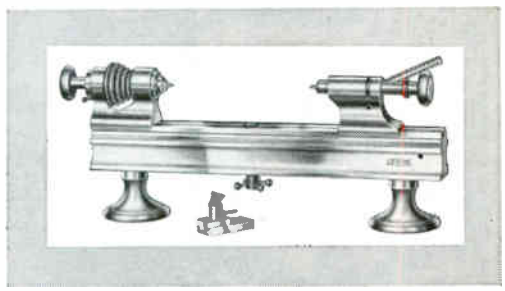

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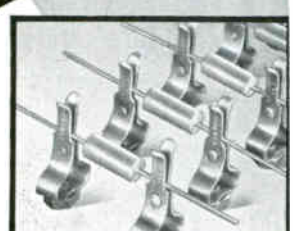

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manager of the printed circuits division of Consolidated Electrodynamics Corp. of Pasadena, and is treasurer of the Western Association of Circuit Manufacturers.

Name James Bagnall Division Director

JAMES J. BAGNALL, JR., former manager of the systems engineering department of the National Co., Inc., Malden, Mass., has been named director of the company's newly created applied research division.

Since joining National in 1954, he has also worked as a supervisor of systems of the engineering department, supervisor of the technical staff, chief engineer of electronic component and parts standardization programs, and project engineer on the AN/APS-54 airborne radar receiver production.

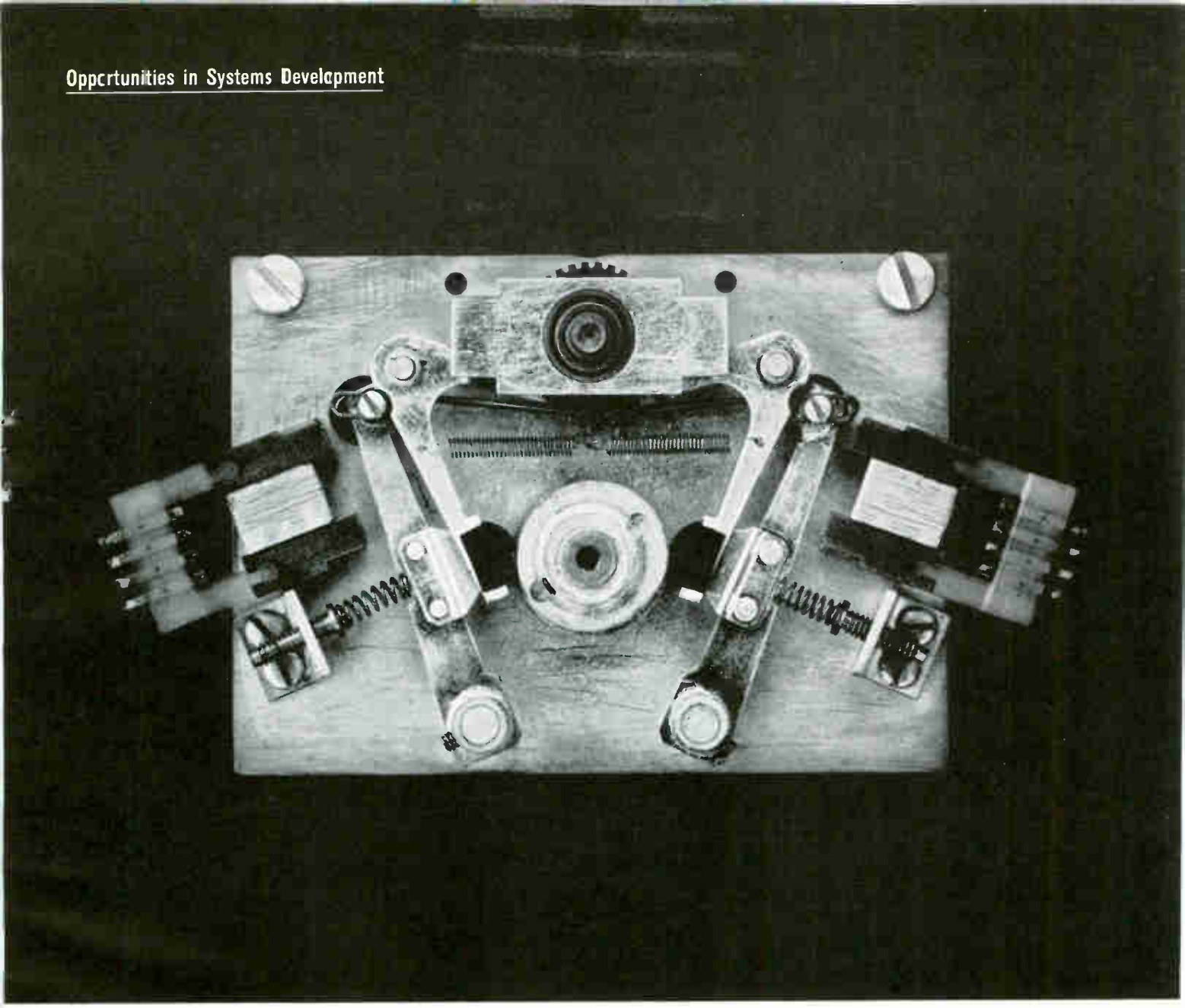
Previously, Bagnall was employed as an engineer by the Press Wireless Laboratories, Inc. and Philco Corp.

Caryotakis Joins Eitel-McCullough

GEORGE CARYOTAKIS recently joined Eitel-McCullough, Inc., San Carlos, Calif., manufacturer of electron-power tubes, as senior project engineer, power klystron laboratory. He is responsible for high-power broadband klystron development in the company's power klystron division at San Bruno, Calif.

Prior to this, Caryotakis was senior engineer, tube research department, at Varian Associates. From 1955 to 1956 he worked on periodic focusing of traveling-wave tubes at Stanford Electronics Research Laboratories as a research associate.

Oppcrtunities in Systems Develapment



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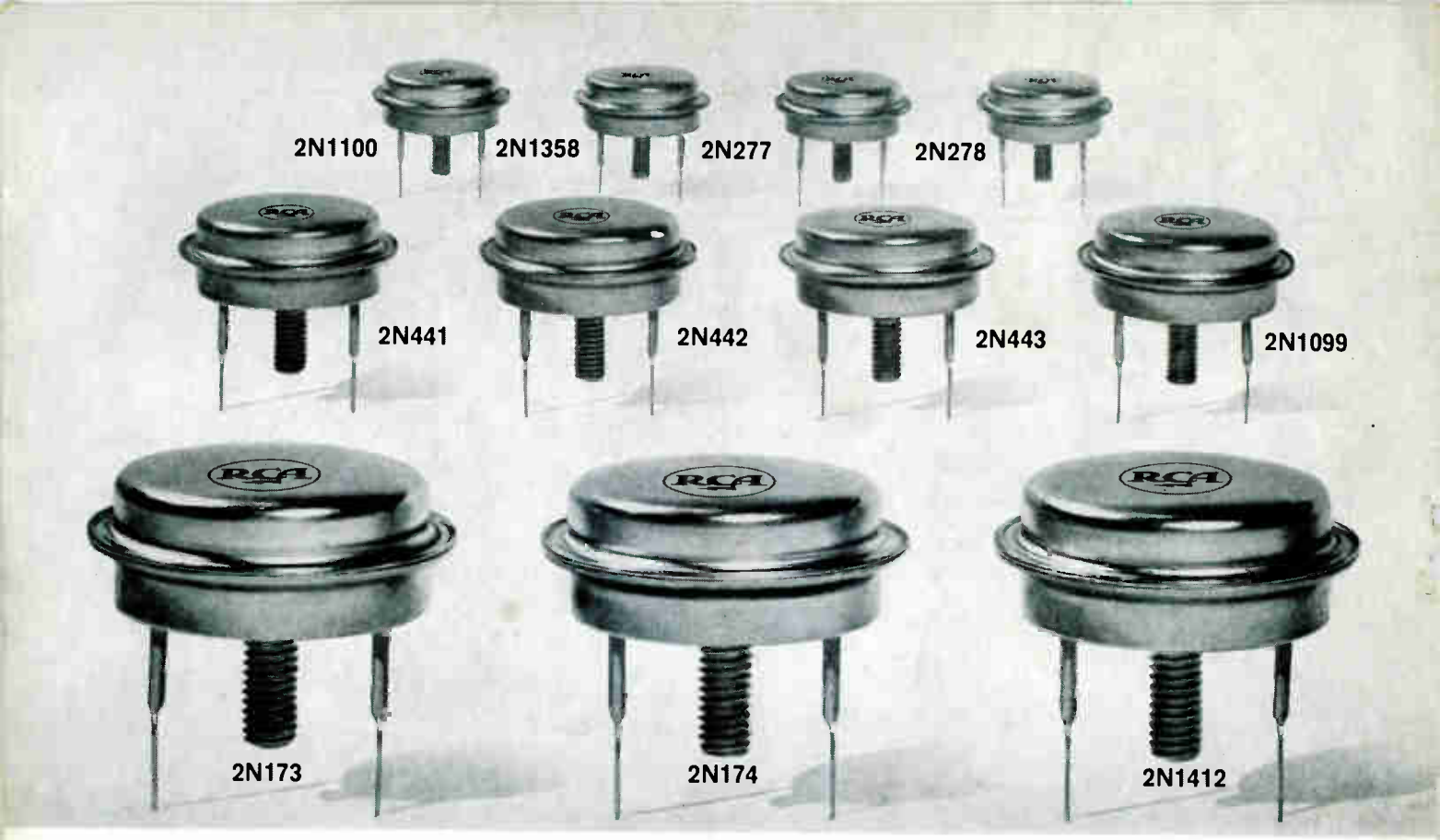

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