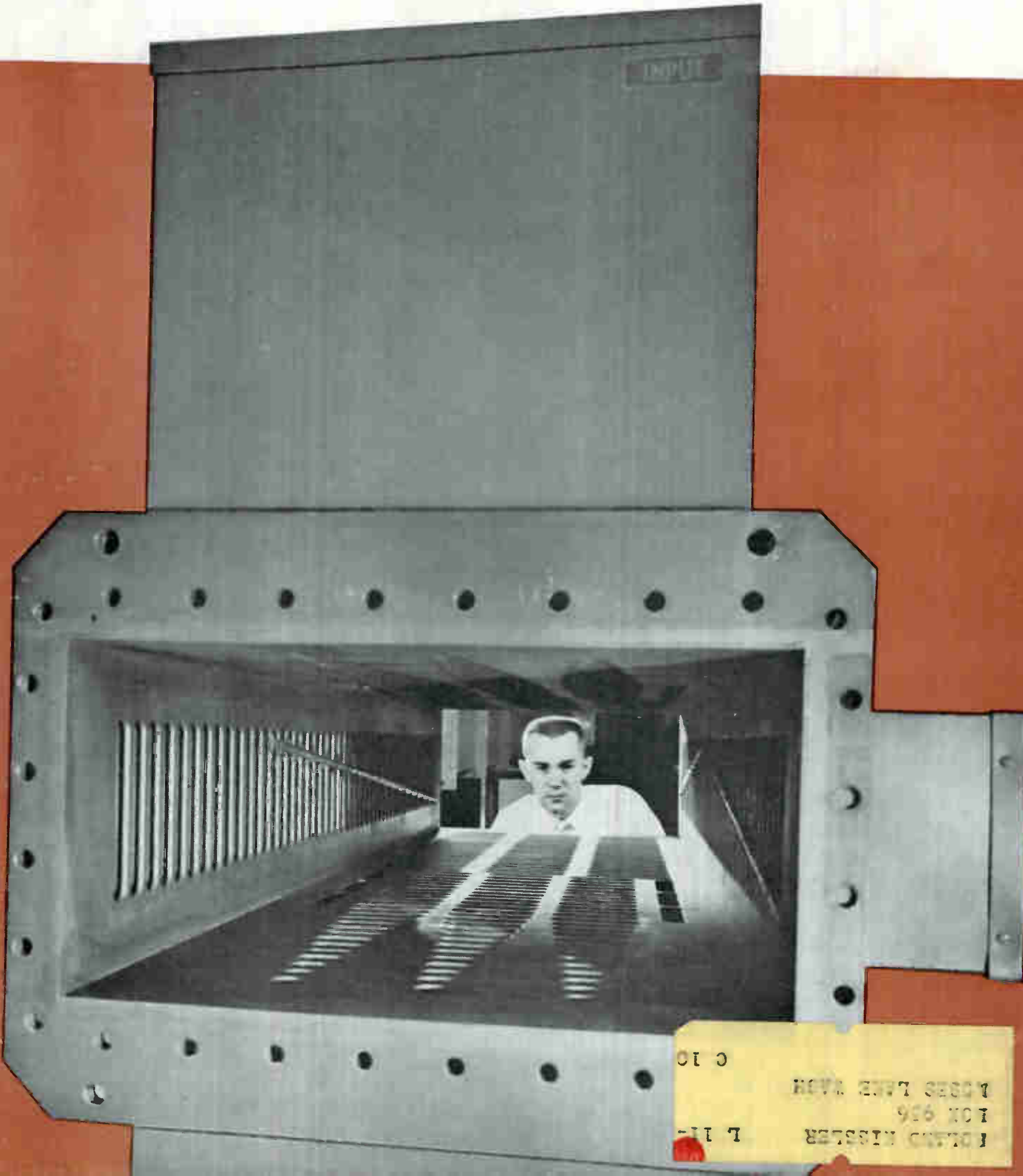
April 14, 1961

electronics

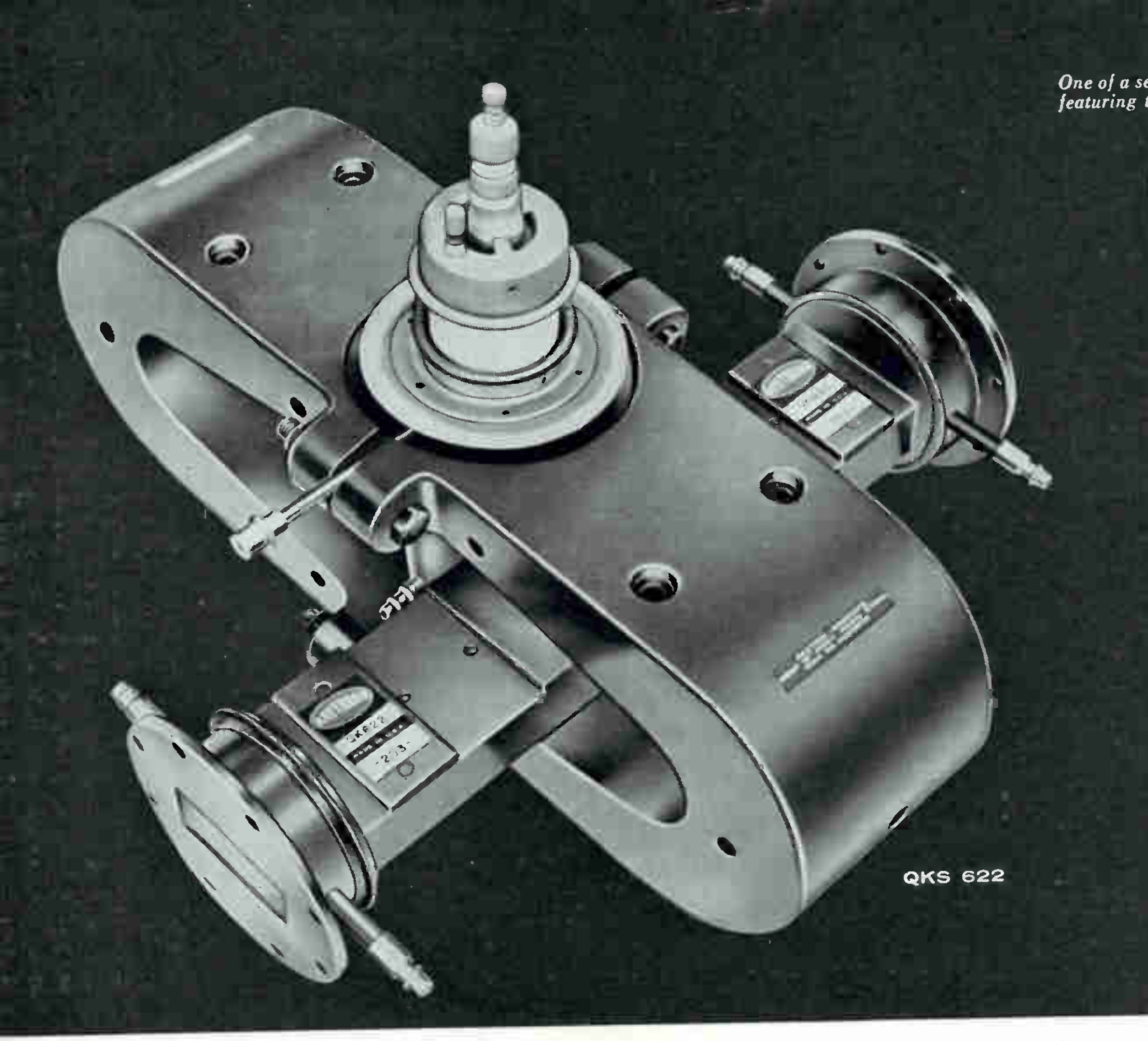
Microwave absorption filter (below) operates at 400-450 Mc, suppresses unwanted harmonics, handles 5 megawatts peak, p 86

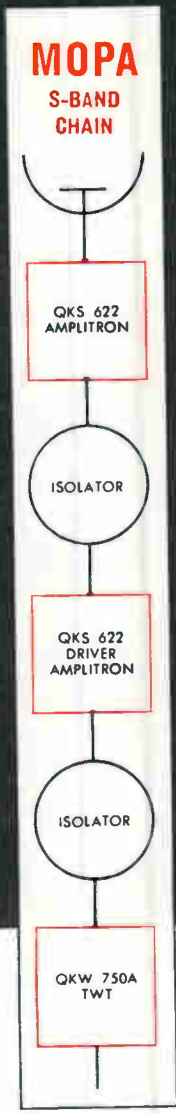
Solar research receiver has zero cps intermediate frequency, p 59

A McGraw-Hill Publication 75 Cents



One of a series of advertisements featuring tubes for MOPA chains





Raytheon pulsed-type Amplitron* produces 3-megawatt S-band output at efficiencies of 75 to 80%

QKS 622 tubes are used as driver and final amplifier stages of broadband MOPA chain.

Raytheon Amplitrons are ideally suited for high power MOPA applications where extremely high efficiency is required. For example, a single QKS 622 Amplitron can produce up to 15 kw average and 3 megawatts peak power with 70 to 80% efficiency. Easily achieved parallel operation doubles these power outputs. Adequate drive power is supplied by the QKS 622 operating at lower levels.

This unusually compact 2,900 to 3,100 mc Amplitron has been operated at 30-microsecond pulse widths, and can be expected to perform satisfactorily at far greater widths. A companion tube, the QKS 783, covers 2,700 to 2,900 mc. Both tubes are specified for 1,000 hours.

QKS 622 GENERAL CHARACTERISTICS
(Typical Operation)

	DRIVER	FINAL AMPLIFIER
Pulse Duration	11 μsec	10 μsec
Duty Cycle	.0055	.0050
Peak Anode Voltage	48-52 kv	50-54 kv
Peak Anode Current	20 a	66 a
Peak Power Output	600 kw	3.0 Mw
RF Driver Peak Power	48 kw min	550 kw min
Cold Insertion Loss	0.5db	0.5 db
Heater Power	None Required	

Write for detailed information and application service to Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.

*Raytheon Trademark

RAYTHEON COMPANY

RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

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April 14, 1961

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

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ENGINEERING

DEPARTMENTS

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Highly efficient, radiator type heat sinks eliminate internal blowers, maintenance problems, risk of failure, moving parts, noise and magnetic fields. Units are rated for continuous duty at 50°C ambient.

SHORT CIRCUIT PROOF

All models are completely protected with magnetic circuit breakers, fuses, and thermal overload.

EASY SERVICE ACCESS

Dual-deck, swing-out back construction provides simple and fast service access without the need to remove unit from rack. All major component terminals are accessible from rear.

REMOTE SENSING

Minimizes effect of power output leads on DC regulation, output impedance and transient response.

NO VOLTAGE SPIKES OR OVERSHOOT

Lambda's design prevents output voltage overshoot on "turn on, turn off," or power failure.

MIL QUALITY

Hermetically-sealed magnetic shielded transformer designed to MIL-T-27A quality and performance. Special, high-purity foil, hermetically-sealed long life electrolytic capacitors.

LA 50-03A	0-34 VDC	0-5 A	$395
LA100-03A	0-34 VDC	0-10 A	510
LA200-03A	0-34 VDC	0-20 A	795
LA 20-05A	20-105 VDC	0-2 A	350
LA 40-05A	20-105 VDC	0-4 A	495
LA 80-05A	20-105 VDC	0-8 A	780
LA 8-08A	75-330 VDC	0-0.8 A	395
LA 15-08A	75-330 VDC	0-1.5 A	560
LA 30-08A	75-330 VDC	0-3 A	860

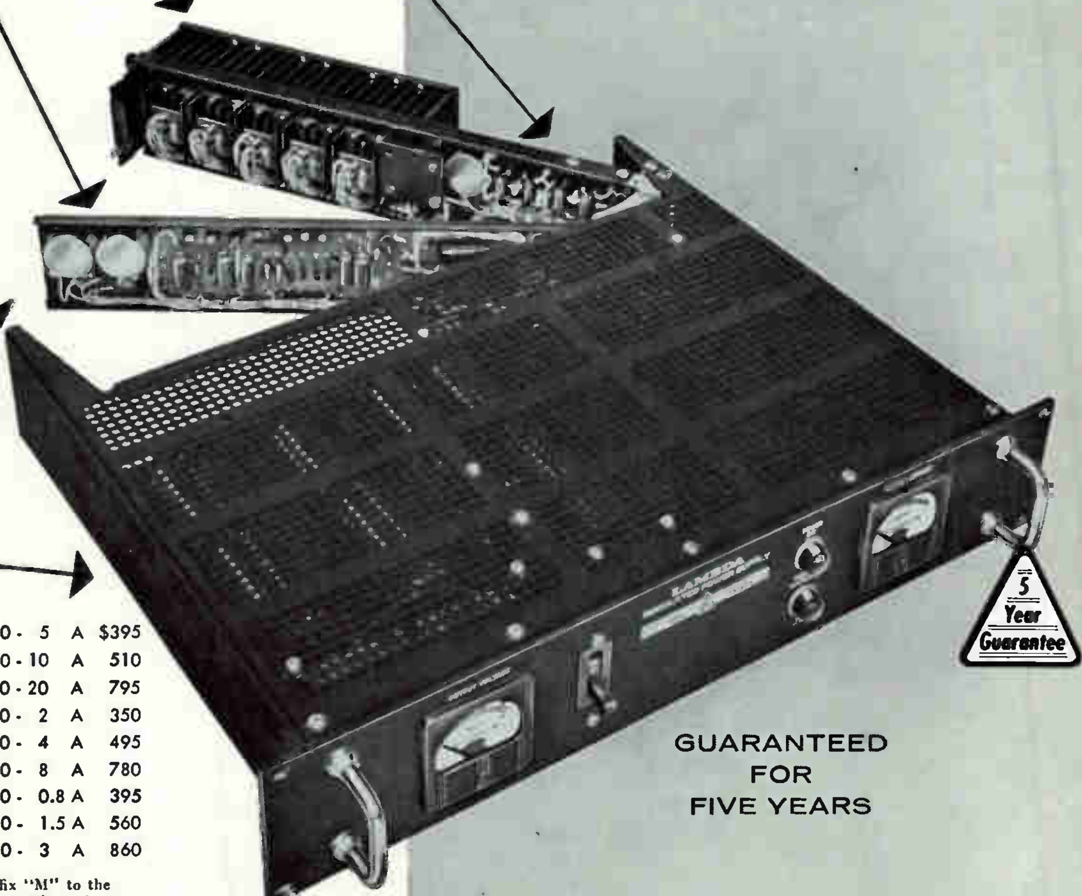
For metered models add the suffix "M" to the model number and add $30.00 to the price.

LA-117

New

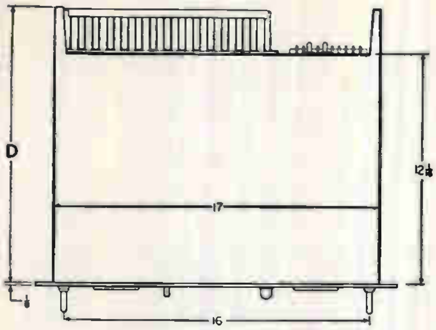
LAMBDA Transistorized REGULATED POWER SUPPLIES

0-34 VDC 5, 10 and 20 Amp
20-105 VDC 2, 4 and 8 Amp
75-330 VDC 0.8, 1.5 and 3 Amp



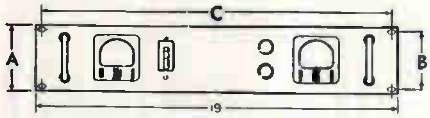
GUARANTEED FOR FIVE YEARS

DIMENSION DRAWINGS



Top View of All Models

Front View



MODEL †	LA 50-03A LA 20-05A LA 8-08A	LA 100-03A LA 40-05A LA 15-08A	LA 200-03A LA 80-05A LA 30-08A
A	3½"	7"	10½"
B	3"	*4"	*7½"
C	18³⁄₁₆"	18¼"	18¼"
D	14⅜"	14⅜"	16½"

* These models notched per RETMA Standards
† Includes metered models with suffix "M"

COMPLETE SPECIFICATIONS OF LAMBDA LA SERIES

DC OUTPUT (Regulated for line and load)

Model	Voltage Range	Current Range	Minimum Voltage (1)	Voltage Steps (1)	Price(2)
LA 50-03A	0- 34 VDC	0- 5 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	$ 395
LA100-03A	0- 34 VDC	0-10 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	510
LA200-03A	0- 34 VDC	0-20 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	795
LA 20-05A	20-105 VDC	0- 2 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	350
LA 40-05A	20-105 VDC	0- 4 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	495
LA 80-05A	20-105 VDC	0- 8 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	780
LA 8-08A	75-330 VDC	0- 0.8 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	395
LA 15-08A	75-330 VDC	0- 1.5 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	560
LA 30-08A	75-330 VDC	0- 3 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	860

(1) The DC output voltage for each model is completely covered by four selector switches plus vernier control. The DC output voltage is the summation of the minimum voltage plus the voltage steps and the continuously variable DC vernier.

(2) Prices are for unmetered models. For metered models add the suffix "M" and add $30.00 to the price.

Regulation (line) ...... Better than 0.05 per cent or 8 millivolts (whichever is greater). For input variations from 100-130 VAC.

Regulation (load) ..... Better than 0.10 per cent or 15 millivolts (whichever is greater). For load variations from 0 to full load.

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

Internal Impedance .... LA 50-03A less than .008 ohms
LA100-03A less than .004 ohms
LA200-03A less than .002 ohms
LA 20-05A less than .06 ohms
LA 40-05A less than .03 ohms
LA 80-05A less than .015 ohms
LA 8-08A less than .5 ohms
LA 15-08A less than .25 ohms
LA 30-08A less than .15 ohms

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

Polarity .... Either positive or negative terminal may be grounded.

Temperature Coefficient .... Better than 0.025 %/°C

AC INPUT .... 100-130 VAC, 60 ± 0.3 cycle[3]
LA 50-03A....360 watts[4]
LA100-03A....680 watts[4]
LA200-03A...1225 watts[4]
LA 20-05A....390 watts[4]
LA 40-05A....710 watts[4]
LA 80-05A...1350 watts[4]
LA 8-08A....415 watts[4]
LA 15-08A....760 watts[4]
LA 30-08A...1450 watts[4]

[3]*This frequency band amply covers standard commercial power lines in the United States and Canada.*
[4]*With output loaded to full rating and input at 130 VAC.*

AMBIENT TEMPERATURE AND DUTY CYCLE Continuous duty at full load up to 50°C (122°F) ambient.

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.
- Thermal .... Thermostat, manual reset, rear of chassis. Thermal overload indicator light front panel.

METERS .... Voltmeter and ammeter on metered models.

CONTROLS:
- DC Output Controls ... Voltage selector switches and adjustable vernier-control rear of chassis.
- Power .... Magnetic circuit breaker, front panel.
- Remote DC Vernier .... Provision for remote operation of DC vernier.
- 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:
- Mounting .... Standard 19" Rack Mounting
- Size
  - LA 50-03A, LA20-05A, LA 8-08A 3½" H x 19" W x 14⅜"D
  - LA100-03A, LA40-05A, LA15-08A 7" H x 19" W x 14⅜"D
  - LA200-03A, LA80-05A, LA30-08A 10½" H x 19" W x 16½"D
- Weight
  - LA 50-03A, LA20-05A, LA 8-08A 55 lb Net 85 lb Ship. Wt.
  - LA100-03A, LA40-05A, LA15-08A 100 lb Net 130 lb Ship. Wt.
  - LA200-03A, LA80-05A, LA30-08A 140 lb Net 170 lb Ship. Wt.
- Panel Finish .... Black ripple enamel (standard). Special finishes available to customers' specifications at moderate surcharge. Quotation upon request.

LAMBDA ELECTRONICS CORP.
515 BROAD HOLLOW ROAD, HUNTINGTON, L. I., NEW YORK 516 MYRTLE 4-4200

Send for complete Lambda Catalog.

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April 14, 1961 Volume 34 Number 15

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CROSSTALK

VLF RECEPTION. This issue brings another in a series of informative articles by G. J. Monser of American Electronic Laboratories related to the design of LF and VLF antennas. In his latest ELECTRONICS article, Monser compares the Hall sensor and loop and whip antennas over the frequency range 10 to 10,000 cycles.

Previous articles by Monser have dealt with design charts for low-frequency antennas (p 90, April 7, 1961 and p 86, March 18, 1960) and designing antennas for maximum low-frequency radiation (p 84, June 3, 1960, coauthored with W. D. Sabin of Motorola). Monser's article begins on p 68.

BUSINESS EQUIPMENT. In its search for news of active markets, ELECTRONICS has looked closely into the Business Equipment Exposition opening next week at New York's Coliseum. Office and industrial needs in this $4-billion industry are leading to new applications for electronic technology.

Computer-to-microfilm record filing, automatic-format-control photoelectric typewriter, automated electrostatic address-label printing system, employee transaction reporting stations for solid state accounting equipment—all are new this year. And all are detailed on p 26 along with other electronic office gear developments.

MAN IN SPACE. Some day soon you may be hearing quite a bit about a place called Kokee Park. It is in Kauai, Hawaii, and is one of five Project Mercury control stations spread around the world. Primary command function of the $7-million island station is resetting of the man-in-space capsule's retrorocket timers.

A few days ago the first simulation tests were held at Kokee Park. On hand was Pacific Coast Editor Hood. His exclusive account appears on p 28.

Coming In Our April 21 Issue

LASER RADAR. One highlight of the recent IRE Convention was an experimental radar using a ruby laser transmitter (ELECTRONICS, p 182, March 10). Operation of this system is explained in our next issue by M. L. Stitch, E. J. Woodbury and J. H. Morse of Hughes Aircraft Co. in Culver City, Calif.

The authors also discuss performance data indicating that the coherent light beam provides a ranging capability of up to 2 or 3 miles at present. Development of the ruby laser, from which the beam is derived, was reported in our issue of June 22, 1960 (p 43).

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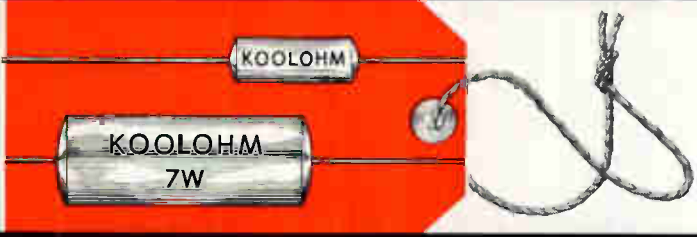

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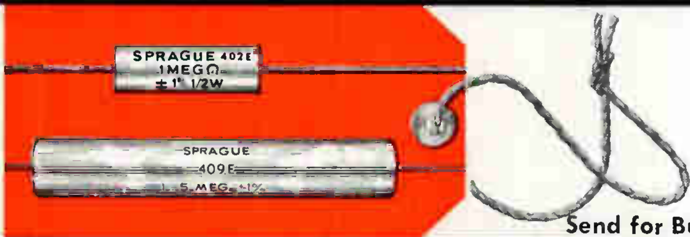

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CIRCLE 5 ON READER SERVICE CARD

COMMENT

More U Mu

I've just been reading the toμching two-way commμnication on p 6 of yoμr Janμary 6 issue (Comment), and it has foμnd its way to my heart.

This note is jμst to let yoμ know that we'll be more than happy to make this typewriter available to yoμ or any member of yoμr staff any time yoμ have a typing job that doesn't reqμire μse of the 21st letter of the alphabet.

Continμed good wishes . . .

FRANK HAYLOCK
SAN MATEO, CALIF.

Network Design (Department of Archival Research)

We request your help in solving difficulties which have arisen in network circuit design.

We have studied your issue of April '47, the article "Experiments in Listening" (p 90) by N. D. Webster, technical director, and Franklin Peak, special project engineer, McClatchy Broadcasting Co., Sacramento, Calif. Working in accordance with the details of the diagram, we designed two amplifiers for our public-address equipment. We were puzzled by the network part of the circuit which is given on p 93; we tried with many different output transformers and r-f chokes to achieve the results you mention in the article, but so far we have not found any satisfactory result.

We hope you will help us in the network design . . .

V. R. DAMANI
BORIVALI, EAST BOMBAY
INDIA

By forwarding this request to McClatchy Broadcasting, we were able to lead reader Damani to some help with his problem. But what struck us—as these things sometimes do, although by now we ought to stop being surprised—is that an article published in ELECTRONICS *14 years ago is still useful to someone, somewhere.*

Synopsis of Contract Awards

. . . One of the subscribers to our publication *Synopsis of U.S. Government Proposed Procurement, Sales and Contract Awards* is evidently relying on the ELECTRONICS Buyers' Guide for 1960-61 (for his impression) that the *Synopsis* is now $7 per year. The amount due on a regular subscription is $10 per year; our subscription rate increased from $7 to $10 in April, 1959, and our airmail service increased from $25 to $28.

It may be some time before the correction can be made, but when convenient, we shall appreciate the revision in prices. . . .

G. A. BONNSTETTER
U. S. DEPARTMENT OF COMMERCE
CHICAGO

Correction will be made in the 1961 Buyers' Guide.

Phantastron

Some errors appeared in the illustrations for "Voltage Control of Phantastron Frequency," p 73, Feb. 10, and a fairly important part of the circuit explanation was deleted.

In Fig. 1A, a resistor should be shown between the suppressor grid and $-E_{cc}$ to permit this grid, which acts as a second control grid, to switch the tube on and off.

In Fig. 1B, the final voltage of the plate waveform (following the exponential recovery) should be E_8 rather than E_1.

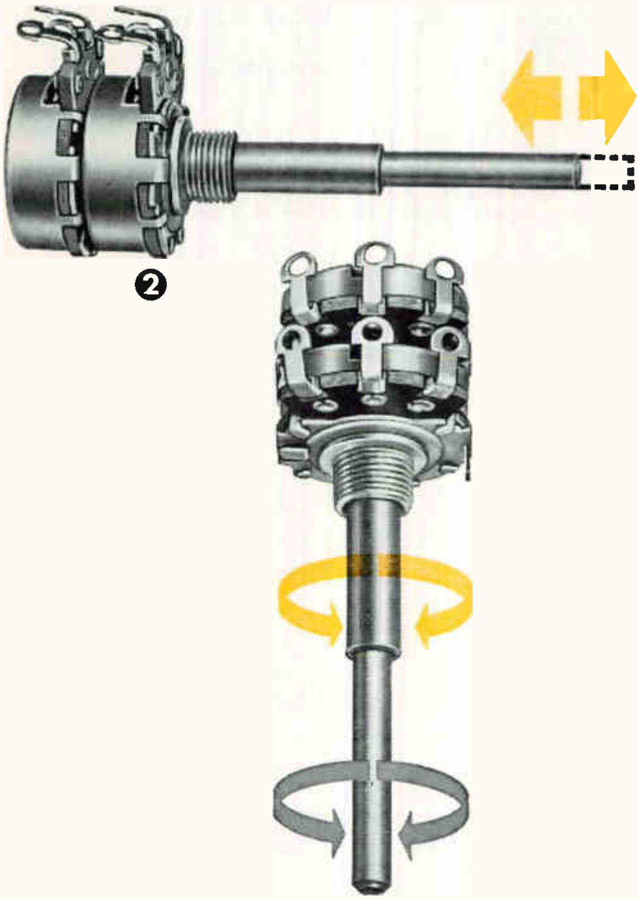
In Fig. 2, the screen of V_8 should be connected to the junction of the 120,000-ohm (R_8) and the 680,000-ohm resistors. The screen, instead of the suppressor, should be connected to the junction of the 120,000-ohm and the 22,000-ohm resistors. C_2 is then connected between the screen and the suppressor grids. The V_3 circuitry should be identical with the V_4 circuitry.

Also in Fig. 3, the note should read "All diodes JAN 1N458 except D_9, which is a ¼ M75Z5 75-v Zener diode." This diode drops the summed screen voltages from 110 v in the operating condition and 40 v in the nonoscillating condition, to 35 v and −35 v respectively. The starting pulse is clamped to this voltage by D_{11}, cutting off D_{13} and disabling the starter circuit when the phantastrons are oscillating.

W. C. WHITWORTH
MOTOROLA
SCOTTSDALE, ARIZ.

NEW CONTROLS FOR STEREO

Flexibility without Complexity



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

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

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

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

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

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

STACKPOLE

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

ELECTRONICS NEWSLETTER

Lofti Satellite Opens VLF Possibilities

PICKABACK Lofti satellite sent up on top of a Transit last Feb. 21 made a few unexpected discoveries during its six-week lifetime. The 57-lb satellite, which failed to separate from its carrier, went into a long orbit 100 miles at perigee and 600 at apogee, which sent it in and out of the upper inosphere. In sending low and very-low-frequency transmissions, it demonstrated that a substantial portion of vlf energy passes through the ionosphere. Common prior assumption was that vlf signals were reflected or absorbed.

Navy, which sponsored the Lofti-Transit launch in the first place, thinks the new discovery may present the possibility of a global system for communicating with submarines, or for groundbased vlf navigation beacons for manned and unmanned satellites.

Try BMEWS Radars For Space Surveillance

AIR FORCE has given RCA an $89,000 contract to see if the AN/FPS-49 tracking radars developed for the ballistic-missile early-warning system and the Atlantic Missile Range can be used for space surveillance. Air Force has used the radars for satellite tracking, wants to find out how efficient they'll be for picking up silent satellites from scratch. Three-month study will use the 84-ft instrument at RCA's Moorestown, N. J., defense electronics plant.

USAF officers stress that the contract does not prejudice a call to industry to come up with new ideas for satellite detection and tracking.

Federal Communications Net Will Serve Civilian Agencies

GENERAL SERVICES Administration and Office of Civil & Defense Mobilization announced last week plans for a unified telecommunications system to serve the civilian agencies of the federal government. System will connect some 8,000 government offices in 1,750 towns and cities, will include voice, teletypewriter, data and facsimile services, will stretch from Alaska and Hawaii to Puerto Rico and the Virgin Islands.

GSA, which will administer the system, figures it will cost about the same to operate the unified system as it now does to run the less comprehensive nets run for individual agencies. Completion date is about three years away. System will tie into military and commercial networks, use multichannel routing with switching centers located so that messages could bypass possible target areas in case of nuclear attack.

Soviets Develop Ultrafine Microtome

REPORTS reaching ELECTRONICS from eastern Europe indicate that Soviet scientists have developed an ultramicrotome capable of cutting specimens 0.004 micron thick. The device uses magnetostriction to limit the travel of a lever which passes the specimen along the cutting edge of the microtome.

A crack in a piece of glass serves as the cutting edge. The glass is suspended in a support which is isolated from ambient vibration and atmospheric effects. Specimen is mounted on a lever which is heated under fine control; expansion pushes the material toward the cutting edge. Nickel rods governing the lever are controlled by a magnetic field; magnetostrictive effect limits the response of the lever to heat.

In the field of plasma research, Soviet scientists last week reported amplification of 8-mm microwave signals in an experiment using magnetic mirrors to increase plasma density. In the experimental device, a microwave signal was injected into a Philips-type discharge gap containing a metal-vapor plasma at pressures between 10^{-1} and 10^{-3} mm of mercury. No significant increase in noise level could be attributed directly to the plasma amplification mechanism. Work was reported by academician Z. S. Chernov at the International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma held in New York.

Industry Association Aids Private Microwave Users

ELECTRONIC INDUSTRIES ASSOCIATION last week launched a service to supply manufacturers and users of microwave equipment with necessary technical data for designing, installing and operating private microwave systems. Service was evolved by EIA and the Federal Communications Commission.

Service will use a standard form for compilation of frequency and bandwidth; make, model and rated output; antenna type, input and location; and compass points with which the station is to communicate. FCC, which helped develop the form, requires that most of this information be filed with applications for licenses and renewals.

Spider, Owl Sonars Studied for Clues

BIOPHYSICS PROJECTS at Harvard University are using electronic techniques to study the sensitive hearing of spiders and owls, with the hope of garnering data on the nature of the human information-handling system, and with reflections on manmade systems.

Biologists at Harvard tap the spider's hearing organ—located near the tip of its leg—with tiny electrodes to find out how the arachnid locates buzzing insects. Spider "ear" has a frequency range from 20 cps to 50 Kc, has several slits in the covering cuticle which responds to separate frequency bands. Nerve fibers have individually recognizable pulse signals; pulse-height analyzer is used to separate signals after amplification.

Owls use a kind of passive sonar to catch mice in the dark; studies show that their hearing mechanism constitutes a highly directional antenna system with a couple of null points.

(Continued on p. 10)

Establish Joint Test Program For Communications Satellites

ENGLAND, FRANCE and the U. S. last week set up a joint program to test communications satellites. The three nations made it clear they would welcome other countries who wanted to contribute to the effort.

National Aeronautics & Space Administration will launch the satellites as part of projects Relay and Rebound. Relay is a low-altitude active repeater scheduled for 1962. Rebound is the follow-on to Echo, the passive reflector satellite, and is scheduled for 1963.

Britain's General Post Office and France's Center for Telecommunications Studies have agreed to provide ground stations in Europe for transmission of multichannel telephone, telegraph and tv signals. Stations will use accurate tracking and antenna-pointing facilities, will be able to make tests on high and low-frequency signals from active or passive satellites. Locations are being surveyed now.

High-Speed Camera Shutter Uses Pulsed Image Tube

ELECTRONIC SHUTTER that enables a camera to take as many as 12 pictures in sequence of a self-illuminating object with no time lapse between frames has been developed for Air Force by ITT Laboratories. The device uses pulsed image tubes as shutters. The tube is a diode consisting of a photocathode and a phosphor-screen anode, separated by an electrostatic lens. Timing circuits key successive tubes to take rapid-sequence frames. Theory and circuits are discussed in a Wright Air Development report released last week.

Ukraine Academy Tackles Wireless Power Transmission

INSTITUTE of Radiotechnical Problems of the Ukranian Academy of Sciences is trying to figure out how to transmit electrical power by radio beam. Soviet academies have been at this for some time in an effort to save the metals used for stringing wires and cables.

Among other problems, the newly organized IRP also wants to explore: the use of directed h-f energy for the destruction of rocks; effects of r-f on polymerization processes in plastics; development of ultrasonic instruments for medical use; two- and three-dimensional X-ray photography.

R-F Reflection Locates Oil and Gas

OIL PROSPECTORS are currently field-testing a system using radio-frequency reflections for locating prospective oil, gas and gas-condensate deposits.

A transmitter stable in both power output and frequency is matched to the low characteristic impedance of the earth, loading the soil and bypassing the high characteristic impedance of free air. Abrupt differences in impedance between hydrocarbons and salt water permit distinguishing these deposits from ground water tables, mineral veins and so forth; drop in resistivity values at oil-water and gas-water interfaces reflects a strong signal to a receiver on the surface. Triangulation techniques and time measurement are used for determining location and depth of deposits.

System was developed by Owens Exploration Inc., can cover 100 acres a day with a 5-man crew. Frequency and power were not disclosed.

Atlantic Range to Get High-Capacity Data System

UNIVERSAL pulse-code modulation data-recording system for use in tests of long-range missiles and drones will be supplied to the Atlantic Missile Range by Texas Instruments. The solid-state TI system will be able to handle signals received at random, reconstruct them for parallel recording on tape. Data can be decoded directly or on playback. Bit rates will range from 8 Kc to 800 Kc; word lengths from 6 to 64 bits will be handled by the system. As many as 1,152 primary channels and 100 subcommutated channels can be decommutated either directly or on playback. Oscillographic, analog or digital outputs will be available.

Birdbanding Keeps Track Of Capacitator Quality

TECHNIQUE widely used to keep track of migratory birds and scientifically controlled livestock is helping Faradyne Electronics maintain and improve capacitor quality. The componentmaker tags each of its solid-slug tantalum capacitors with a flexible zinc tag which has lot, batch and unit number stamped into it. The tag follows the unit through production and test, remains on when it's sold. Quality-control engineers gather and record test data on each unit and correlate the data against production parameters (such as variations in anodizing bath or position on a drying rack). Units in field use can also be referred to individually for accumulating still more information in depth.

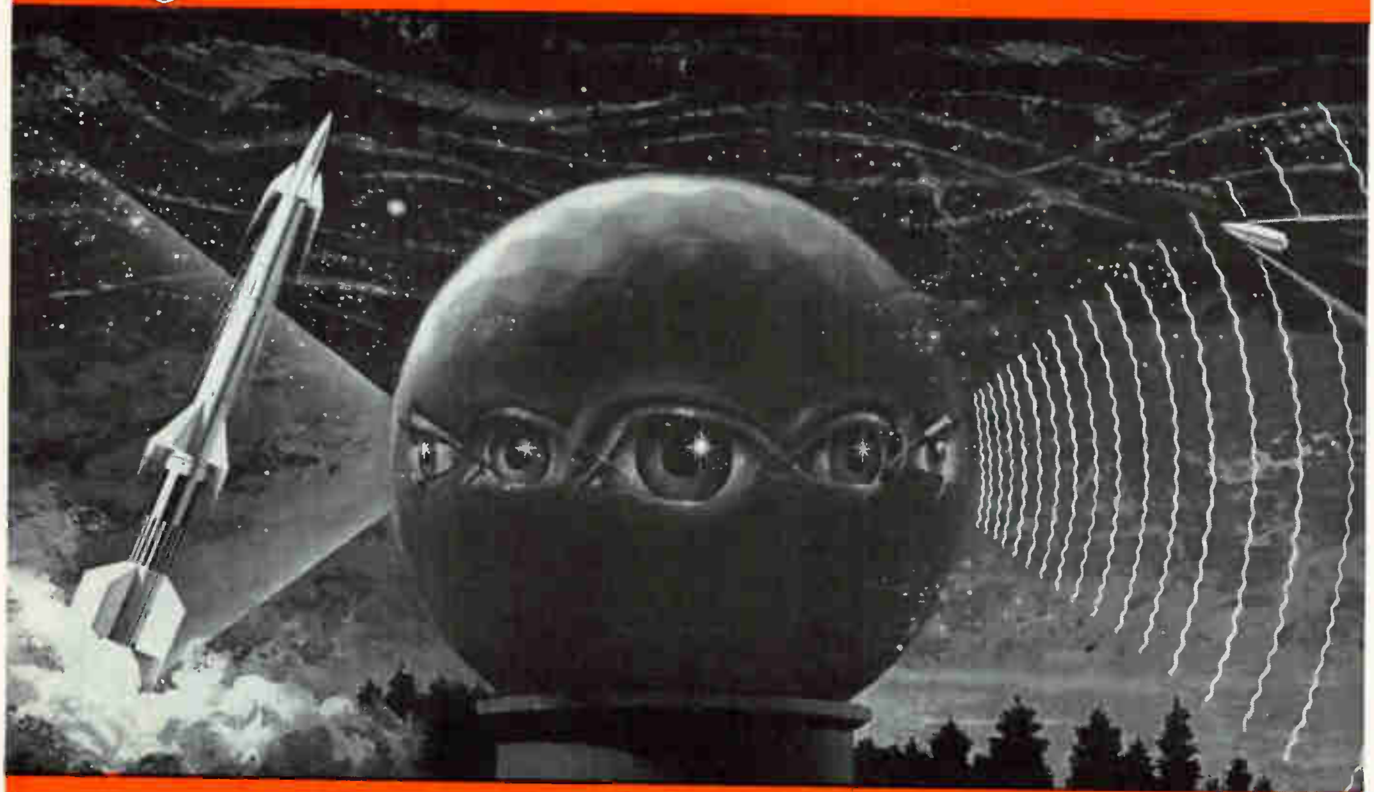
Find Low-Error Code For Data Communications

TWO PROFESSORS at the University of North Carolina have announced development of a mathematical code, said to be practically error-proof, for use in sending computer data over toll telephone lines. The two, R. C. Bose, and D. K. Chaudhiri, figure the probability of undetected error is one in 300 years at present transmission speeds over toll lines (of the order of 1,000 bits a second); current error rate is about one a minute. Bose code uses both transverse and longitudinal checks, catches and corrects bursts as well as single-bit errors. System has been tested on Lincoln Lab computers, was developed at Case Institute of Technology. Details were not disclosed.

Radio-Tv Sales Rose in February

RETAIL SALES of television and radio sets began climbing in February after a sharp post-Christmas dip in January, according to figures released last week by Electronic Industries Association. Tv sales reached 452,282, some 52,500 more than were sold in January. Radio sales stood at 666,228, over 85,500 more than January's figure. Totals for the two months were less than equivalent figures for 1960.

GOODYEAR RADAR STRUCTURES: Another prime capability of Goodyear Aircraft



To "see" and stop missiles in space is Nike-Zeus mission. Since ICBM time-to-target is about 30 minutes, system has only few minutes to detect enemy missile, compute course, launch and guide Nike-Zeus missile to intercept point

A NEW "EYE" FOR SIGHTING HOSTILE ICBM's

Only active defense against hostile ICBM's under development today is Army's Nike-Zeus anti-missile system. Nike-Zeus combines one of the most sensitive multiple-target radars yet perfected with the Free World's fastest interceptor missile. Object: detection and destruction of ICBM's flashing through space at close to 20,000 m.p.h.

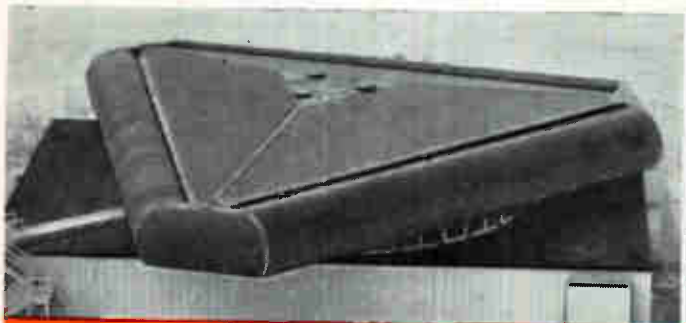
As a leading producer of radar structures of all types, Goodyear Aircraft was selected to work with Bell Telephone Laboratories to develop, design and build the large acquisition radar transmitting and receiving antennas shown here. Working with Western Electric the prime contractor, and a team of major Nike-Zeus subcontractors, Goodyear has already furnished operating prototypes of the antennas. And, currently, work is well under way on manufacturing techniques for volume production. For details on Goodyear's extensive experience in advanced radar structures write Goodyear Aircraft Corporation, Dept. 914KD, Akron 15, Ohio.

GOODYEAR

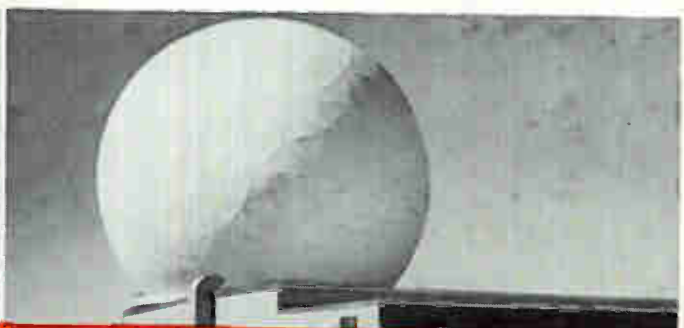
Plants in Litchfield Park, Arizona, and Akron, Ohio

GOODYEAR AIRCRAFT CORPORATION

The Technical Disciplines involved in these areas offer a challenging future for Engineers and Scientists at Goodyear Aircraft. Write today.



Goodyear-built transmitting antenna consists of three 80-ft. apertures in triangular lineup rotating continuously in azimuth while accurately slaved to the receiving antenna.



World's largest Luneberg lens for focusing radar echoes is housed in this 110-ft. radome. Radome contains 445 triangular plastic panels attached to a space-frame.

CIRCLE 11 ON READER SERVICE CARD

SOMETHING TO DEPEND ON

Is this what you're looking for? **Something to depend on.** A supplier who can turn around fast. Who can make the last-minute changes you need and still deliver on schedule, whenever it seems humanly possible, **and sometimes when it doesn't.** Case history: Recently Giannini Controls received an urgent request from General Electric for delivery of eight non-standard pressure transducers, requiring many modifications. **First units were flight-qualified and shipped twenty days from verbal order.** Ask G. E., ask the people on Titan, Polaris, Mercury, Nike Zeus, Talos, F8U, DC-8, and you'll hear: **When it's from Giannini Controls you get it on time, it works when you get it, and it keeps on working.**

Giannini Controls Corporation 1600 South Mountain Avenue. Duarte. California

A NAME TO PLAN WITH

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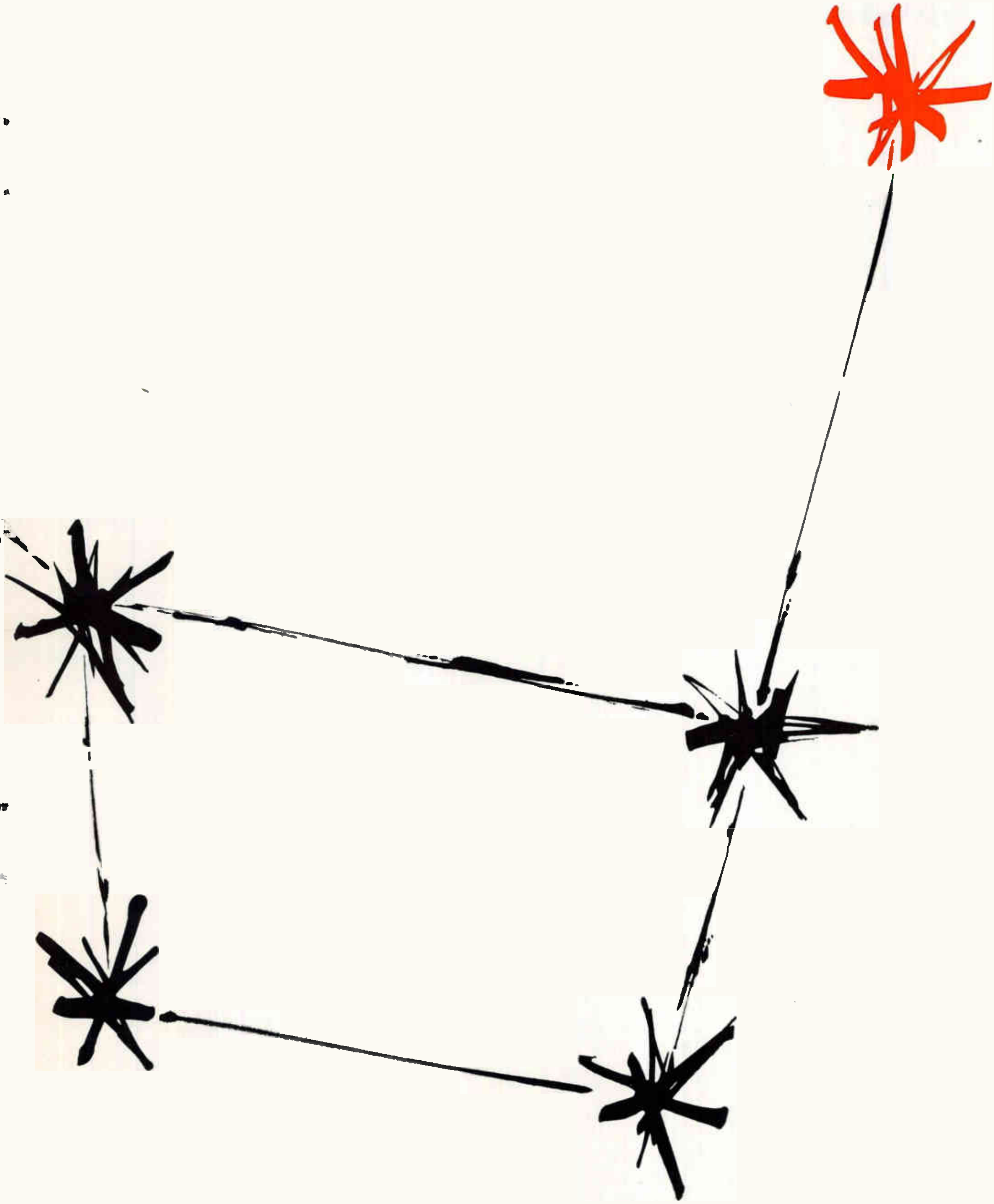
Plant locations: Duarte, Pasadena, Glendora and Glendale, California • Caldwell, New Jersey • Buffalo, New York

GCC 1-16



WASHINGTON OUTLOOK

OLD ARGUMENT about whether or not to appoint a "czar" to run the Navy's antisubmarine warfare research and development programs is simmering again in the Pentagon. Top-echelon supporters of the proposal complain that current ASW R&D is splintered, with Bureau of Naval Weapons, Office of Naval Research, Bureau of Ships all involved. These critics suggest that divided effort and lack of effective central control are prime reasons for present lack of effective means to detect and destroy enemy submarines.

The Navy doesn't like the idea at all. Admirals argue that, in many respects, antisubmarine defense is a primary or secondary mission of the entire Navy, and any czar to run the program would have to be no less an authority than the Chief of Naval Operations himself. Further, the ASW mission involves subsurface craft, surface ships of all types, and aircraft, and doesn't lend itself readily to the type of "crash-program" approach that worked so well with the Polaris.

As far as the lack of effective means to detect and destroy submarines is concerned, Navy officials figure that if they had the kind of money to invest in research that's going into the more glamorous fields of space and rocketry, they'd be able to lick many of the problems they now face. Even on short funds (right at the moment, the Navy doesn't even have enough transportation money to send essential personnel to school), the admirals feel they've done a pretty good job of erecting early-warning and tactical antisubmarine defenses.

If the critics have their way, the "czar" would act in a toplevel capacity reporting directly to the Chief of Naval Operations, with conduct of individual R&D projects left in the hands of the contracting agencies. Budget directly ascribable to antisubmarine defense now runs about $100 million annually (obviously not including such things as procurement of aircraft carriers and aircraft whose major mission is ASW). There is substantial pressure building to boost spending three or four times the present rate.

PROPOSAL to establish an assistant secretaryship of Commerce for Science & Technology is being pushed by Sen. Warren G. Magnuson (D., Wash.), chairman of the Senate Commerce Committee. The proposal is said to be quite palatable to the Kennedy administration as a compromise to the controversial plan to establish a cabinet Department of Science & Technology.

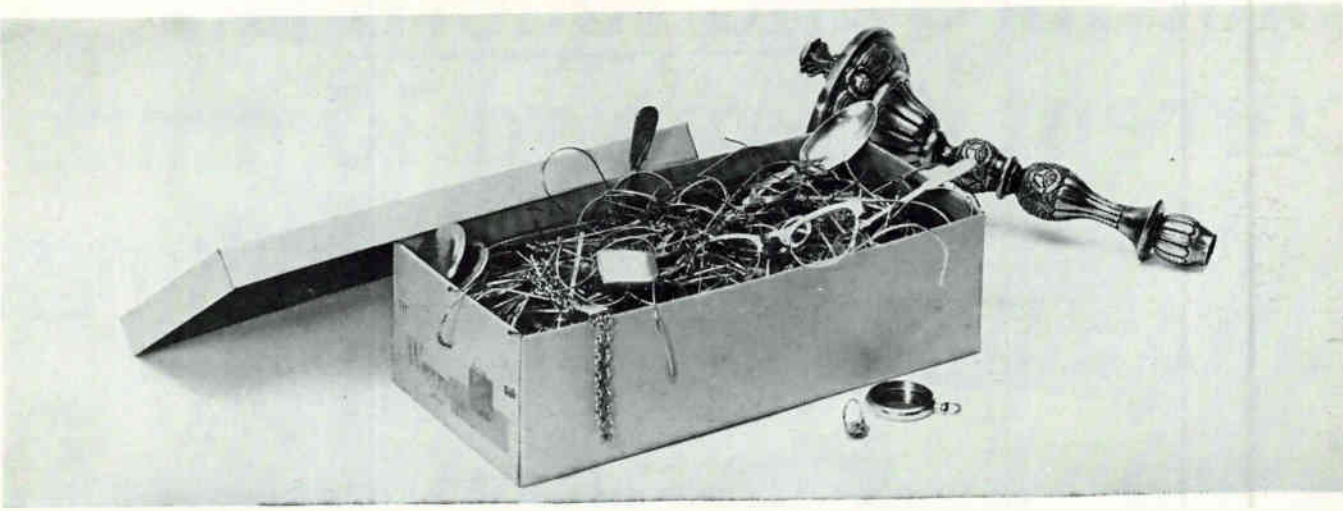
The assistant secretary would pull together Commerce Department research programs now housed in the Bureau of Standards, Weather Bureau, Patent Office, Bureau of the Census, and so forth, and would act as a prime mover to expand nonmilitary government research.

REVISED DEFENSE BUDGET for fiscal 1962, beginning next July 1, earmarks additional funds to "add radar capacity to each battery of the Hawk system." Hawk is the radar-homing antiaircraft missile system deployed with Army field units. Raytheon is prime contractor for the 22-mile-range missile.

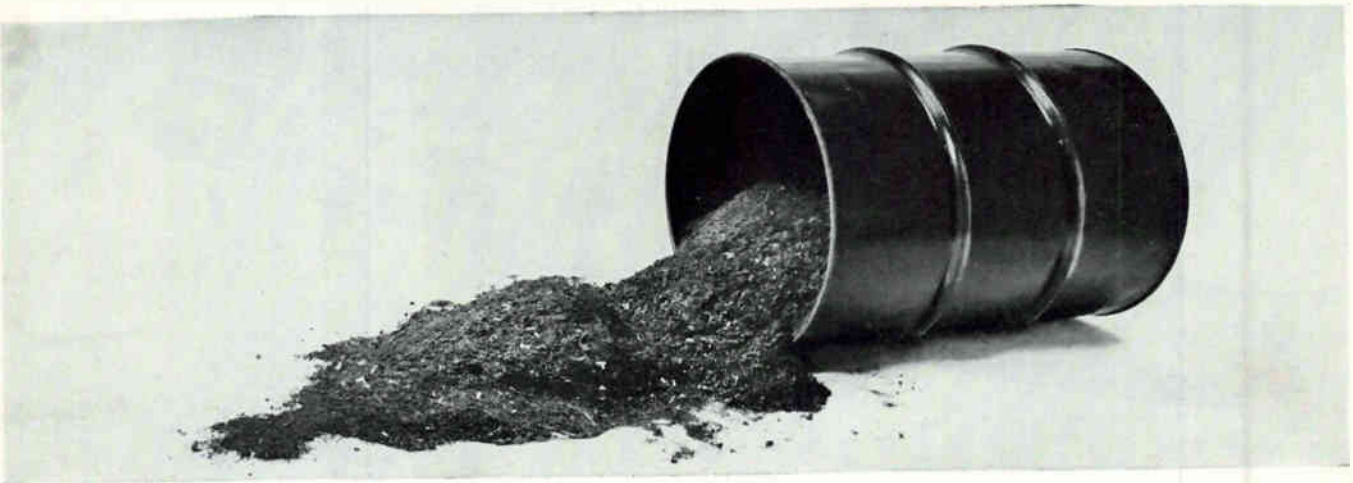
RUMOR IN WASHINGTON has it that Commerce Secretary Hodges promised Chicago Local 1031 of the International Brotherhood of Electrical Workers that the government would try to funnel more defense electronics business into the Chicago area to offset any unemployment caused by imported radio and television parts. Hodges was recently credited for getting the union to postpone a threatened May 1 boycott against any electronic parts produced by countries whose wage rates were not equivalent to U. S. wages.

Meantime the Pentagon is feeling increased pressure to place contracts in regions hard hit by unemployment. Late reports show a record number of major industrial centers which have unemployment rates of at least 6 percent. In February, President Kennedy ordered contracting agencies to take "prompt steps to improve the machinery by which federal contracts can be channeled to firms located in labor surplus areas."

HERE YOU SEE IT



HERE YOU DON'T!



Value is what we're talking about. There isn't a soul alive who would knowingly throw away a gold or silver or platinum watch case or pin or eyeglass frame. Because they're *worth money*. This sense of value is responsible for a considerable part of Handy & Harman's Refining activity. Constantly, we are sent precious metal scrap from retail jewelers all over the country. (Yes, often in shoe boxes.)

And just as constantly we wish that industry had the same sense of value when it comes to their precious metal "waste." Just because it doesn't *look* like anything doesn't mean that it isn't *worth* something.

To show you where profits lurk, we've included a list showing the various forms of precious metal waste.

It is by no means complete (it is possible that you have other forms). May we suggest that—should you be in doubt—you contact the Handy & Harman Refining Center nearest you. Further, if you are not in doubt about your waste bearing precious metals, but you are (or have been) in doubt as to its full value, it will profit you to send it to us. Our Bulletin 24 describes our Refining Division in detail. A copy awaits you at

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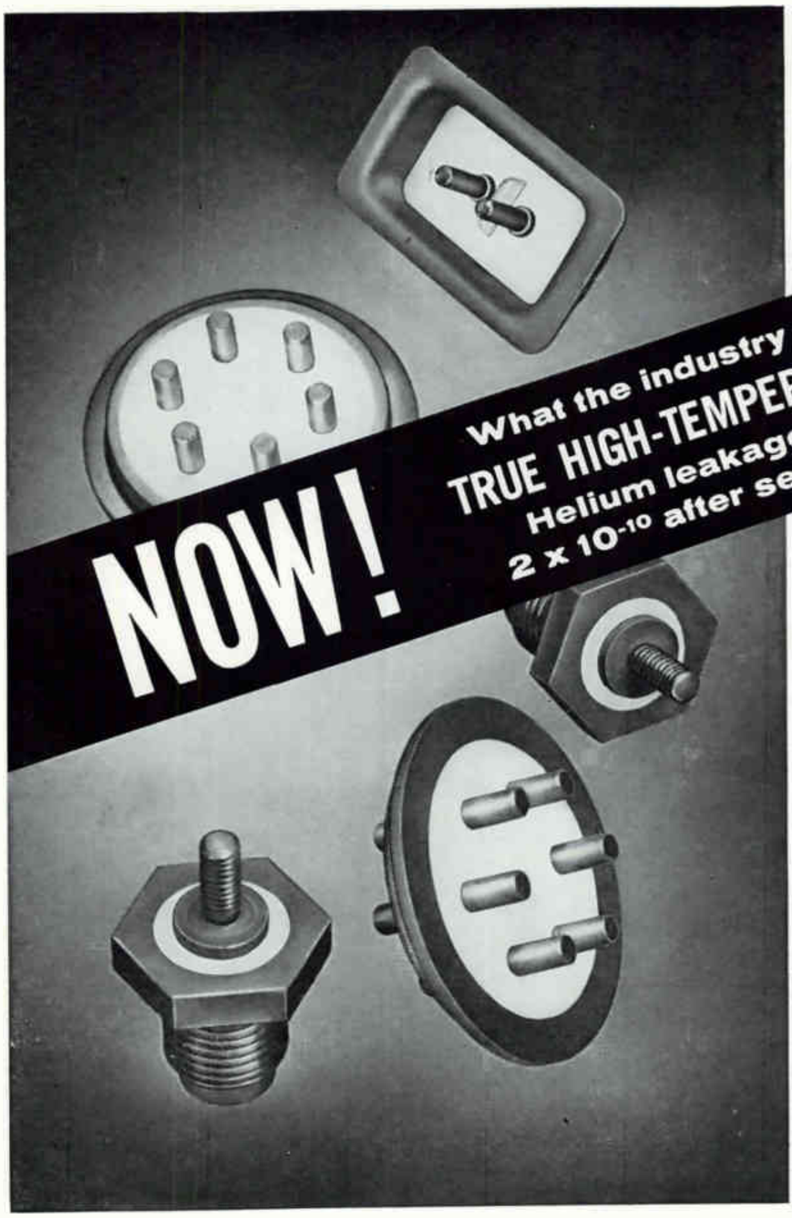
BIG NEWS in high-temperature precision-molded insulation

SUPRAMICA® 620 "BB" ceramoplastic



Need a precision-molded insulation material with total dimensional stability under the most adverse thermal cycling, operating to 1200°F. . . . or a material with previously unattainable combination of properties? Check these facts about new SUPRAMICA 620 "BB" ceramoplastic:

- **Maximum temperature endurance of material 1200°F. (unstressed). Heat distortion temperature of material 1100°F. (ASTM D648-264 PSI)**
- **SUPRAMICA 620 "BB" ceramoplastic can be precision molded to most intricate geometries with gauge-like tolerances.**
- **SUPRAMICA 620 "BB" ceramoplastic will not carbonize.**
- **Absolute hermetic seals achieved directly during the molding cycle. Components meet a helium leakage rate of less than 2 x 10^{-10} cc/sec., after the following environmental tests:**
  1. Samples heat shocked a total of 20 cycles from boiling water for 30 minutes directly to ice water for 10 minutes.
  2. Samples heat shocked a total of 5 cycles, from 350°C. for 1 hour directly to room temperature for 10 minutes, to -70°C. for 1 hour, to room temperature for 10 minutes.
  3. Samples heated to 500°C. for 4 hours and directly to room temperature.
- **Thermal expansion factor matches many metals and alloys.**
- **New SUPRAMICA 620 "BB" ceramoplastic features a dielectric strength of 270 volts/mil, ⅛" thickness per ASTM D-149.**

WRITE for Information and Engineering Data Sheets on
SUPRAMICA 620 "BB"
and other MYCALEX® glass-bonded mica
or SUPRAMICA ceramoplastic insulations.

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World's largest manufacturer of ceramoplastics, glass-bonded mica and synthetic mica products

THE FIRST SYNTHAMICA® SYNTHETIC MICA — SINCE 1919 MYCALEX® THE INSULATOR — THE FIRST SUPRAMICA® CERAMOPLASTIC

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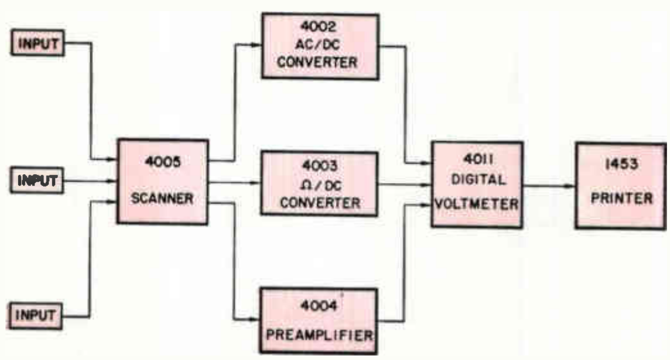
EXPANDABLE
MODULAR DIGITAL MULTIMETER

Picture this self contained, automatic system working for you—the compact Beckman 4011 .01% dvm; together with converters for measuring low millivoltage DC, AC and ohms; a scanner which allows automatic readings of 29 sources of information; and finally, the Beckman solid-state, digital printer to make a permanent, indexed record of all the readings.

Price for the complete system about $4800

For detailed specifications on all these instruments and their use together. write for Brochure A4011.



Beckman 4011 a complete portable dvm is available, as are the other modules shown above, as a portable package.

The significant difference is the name.... BORG®

MICROPOT®

The name Borg Micropot is synonomous with potentiometer reliability in military and commercial applications alike. And now, Borg offers *four* series of Trimming Micropot Potentiometers. All are recommended wherever compact, lightweight adjustment of circuit voltages is a critical factor. All models are lead-screw actuated with a safety idle position at each end of travel. All series can be mounted singly or stacked snugly one upon the other. Resistance values from 10 ohms to 1 megohm are available. See your nearest Borg technical representative, distributor, or write for the Micropot data sheets listed below.

More than 300 standard model variations are derived from the four basic series of Borg Trimming Micropot® Potentiometers

2800 Series
High temperature, wirewound. Highest quality series . . . 100% immersion-tested for leakage. Request data sheet BED-A173.

990 Series
High temperature, wirewound. High quality series . . . O-ring sealed against leakage. Request data sheet BED-A133.

992 Series
105°C temperature max., wirewound; to 50,000 ohm rating. O-ring sealed against leakage. Request data sheet BED-A172.

993 Series
105°C temperature max.. deposited carbon film element; up to 1 megohm rating. Request data sheet BED-A172.




Shown Actual Size

CHARACTERISTICS	2800 Series*	990 Series	992 Series	993 Series
Length and Width	1¼" x .28"	1¼" x .28"	1¼" x .28"	1¼" x .28"
Depth	.360" max.**	.360" max.**	.360" max.**	5/16"
Power Dissipation	1 watt at 110° C	1 watt at 110° C	1 watt at 40° C	0.5 watt at 40° C
Resistance Range	10 to 50K ohms	10 to 30K ohms	10 to 50K ohms	20K ohms to 1 megohm
Temperature Extremes	−60°C to +175°C	−60°C to +175°C	−55°C to +105°C	−55°C to +105°C
Dielectric Strength	500 V AC, 60 cycle	500 V AC, 60 cycle	500 V AC, 60 cycle	500 V AC, 60 cycle
Adjustment	full range 40 turns	full range 40 turns	full range 40 turns	full range 25 turns

Terminal types: wire leads (L); solder lugs (SL); printed circuit (PC). Color-coded wire leads are 12"; solder lugs and printed circuit terminals are gold-plated for perfect solderability.

**Each unit 100% tested against leakage. **Dependent upon terminal selection.*

BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation
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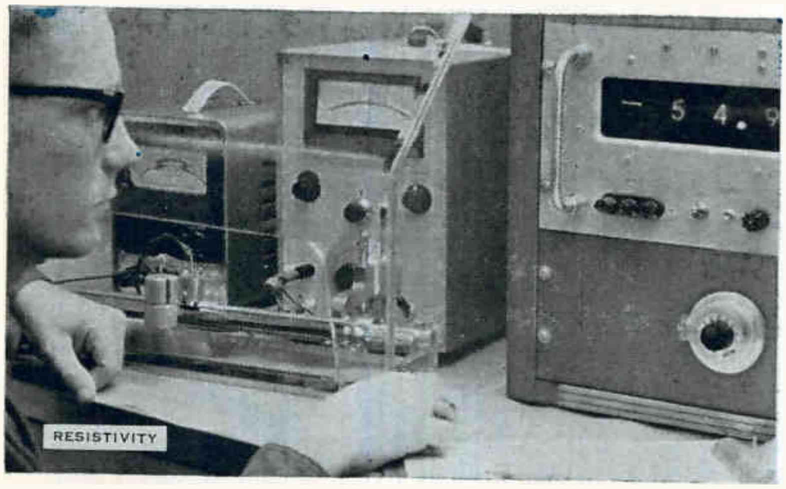
Micropot® Potentiometers • Microdial® Turns-Counting Dials • Sub-Fractional Horsepower Motors • Frequency and Time Standards

SILICON NEWS from Dow Corning

The Untouchables (Part 3)

Now...Single Crystal Silicon Doped to Your Specification



Single crystal silicon . . . doped to your specific needs . . . is now available from Dow Corning.

Rigid quality control of Dow Corning Silicon means greater device yield for you! And you achieve uniformity in device characteristics — the result of greater uniformity in characteristics from rod to rod, greater lateral and radial uniformity within each rod.

This high quality is the result of a completely integrated production process — a process that starts with the manufacture of trichlorosilanes and other chemicals basic to silicon production. And at every step of the way, rigid quality control assures the ultimate in quality—purity.

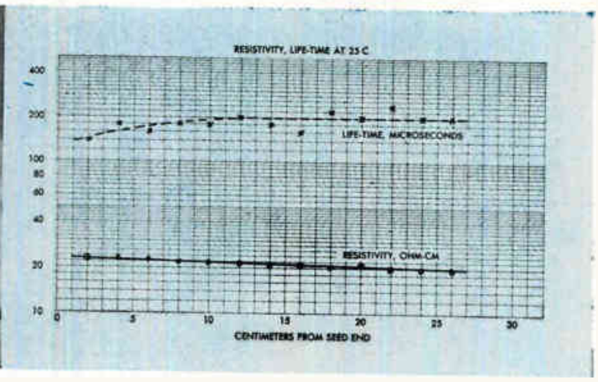
Doped to specification single crystal Dow Corning Silicon contains in the order of 0.1 atoms of minority impurity per billion atoms of P-type material . . . about 0.15 atoms of minority impurity per billion atoms of N-type material.

Low oxygen content of Dow Corning Silicon reduces the undesirable effects on lifetime associated with the diffusion process. Result — few rejects . . . increased device yield! In the picture at left, infrared transmittance at 9 microns is measured to determine oxygen content. Many materials register at pencil point—much higher than Dow Corning Silicon.

Crystal orientation is normally 111, but can be to your specification.

Specify Dow Corning single crystal silicon doped to your requirements. Specific resistivities within narrow tolerances from one to 1000-ohms centimeter P-type . . . one to 400-ohms centimeter N-type. Rod diameters from 3 to 25 mm (1/8″ to 1″) lengths to 250 mm (about 10″).

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



Write for "Hyper-Pure Silicon for Semiconductor Devices." Address Dept. 3516a.

HYPER-PURE SILICON DIVISION
Address: HEMLOCK, MICHIGAN

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

CIRCLE 21 ON READER SERVICE CARD

Merger Pace Is Stepping Up

MERGER ANNOUNCEMENTS are setting a brisk pace for financial news in the electronics industry this Spring. Here are some examples:

LORAL ELECTRONICS CORP., New York City, has announced negotiation talks for the acquisition of Accurate Specialties, Inc., Hackensack, N. J., producer of high purity metals and ceramics for electronics applications. Leon Alpert, Loral president, says the basis of negotiations is an exchange of stock at the ratio of two and one-half shares of Accurate for one share of Loral. Accurate's earnings for the six-month period ended Dec. 31, 1960 were 21 cents a share.

GIANNINI CONTROLS CORP., Duarte, Calif., and Cramer Controls Corp., of Centerbrook, Conn., have entered into an agreement for the acquisition of Cramer by Giannini, subject to approval by Cramer stockholders. An announcement by presidents of both companies indicates the exchange will be made on the basis of 55 shares of Giannini common for 100 shares of Cramer common. If concluded, this will be Giannini's second acquisition this year. The company acquired Conrac, Inc., in February.

LEAR, INC., Santa Monica, Calif., is negotiating to acquire Sprague Engineering Corp., Gardena, Calif. The proposal being discussed would involve a tax-free reorganization and an issue of Lear shares based on one share for each share of Sprague stock now outstanding.

SANBORN COMPANY, Waltham, Mass., and Hewlett-Packard Co., Palo Alto, Calif. will soon begin discussions to determine whether agreement can be reached on merger terms. According to a joint announcement by J. L. Jenks, Sanborn's board chairman, and H-P president David Packard, if officers of the two companies reach agreement, the proposal will require action by the board of directors of each firm as well as company stockholders. Hewlett-Packard reported sales of slightly over $60 million last year, while Sanborn had sales in the $15-million area.

UNIVERSAL MATCH CORP. is negotiating to acquire a Stamford, Conn. firm, Reflectone Electronics, Inc., according to disclosures by presidents of both companies. John L. Wilson, Universal's president, says there will be no dilution of his company's stock equity or per-share earnings as a result of the acquisition. Reflectone's sales are at a $5-million level and are expected to reach $7½ million this year. The firm dedicated a new research plant today in Ft. Lauderdale, Fla.

NUCLEAR CORP. OF AMERCA has concluded negotiations through which it has acquired the assets of U. S. Semiconductor Products, Inc., formerly a subsidiary of United Industrial Corp. Acquisition terms involved a purchase price of 600,000 shares of Nuclear common plus an undisclosed amount of cash. U. S. Semiconductor shareholders will be asked to ratify the transaction which will require their two-thirds agreement.

OVITRON CORP., Cos Cob, Conn., has acquired Standard Winding Co., Newburgh, N. Y. manufacturer of electronic components for communications and home entertainment markets. The New York firm anticipates 1961 sales of $600,000. It makes coils, filters, solenoids and other devices. Among the electronic products being developed by Ovitron are solid state power control, regulation and conversion equipment.

ELECTRONIC SPECIALTY CO., Los Angeles, and D. S. Kennedy & Co., Cohasset, Mass. have concluded negotiations whereby Kennedy shareholders will receive four shares of ESC stock for each five shares of Kennedy they hold. Electronic Specialty anticipates first-quarter revenues for the period ending Mar. 31 to amount to about $6 million.

AIRTECHNOLOGY CORP., Cambridge, Mass., has announced purchase of the Electronics division of Advance Industries in the same city. Financial aspects of the transaction have not been disclosed. AirTech has assumed responsibility for completing all outstanding contracts and orders of its acquired company. The two companies occupy the same building and will jointly conduct research and development of space-oriented systems and subsystems.

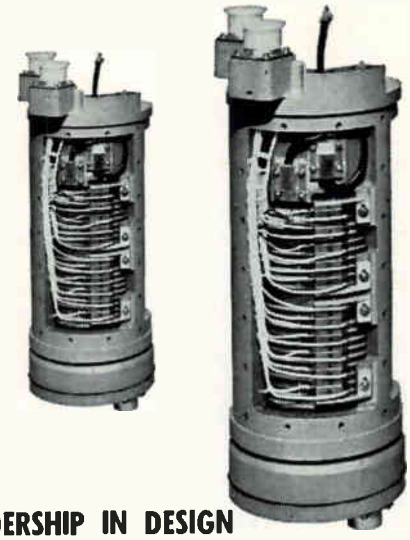
AMPHENOL-BORG ELECTRONICS CORP., Broadview, Ill. and FXR, Inc., Woodside, N. Y. will ask stockholders to approve merger plans on May 23, following approval of the move by directors of both companies. Under terms of the agreement, three FXR officers owning 192,599 shares of stock will receive 45/100th of a share of Amphenol-Borg for each share of FXR stock. All other shareholders will receive 50/100ths of a share of A-B for each share of FXR held. The Woodside company will operate as a separate division with present management and personnel. FXR makes microwave and electronic test gear.

25 MOST ACTIVE STOCKS

WEEK ENDING MARCH 31, 1961

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avco Corp	3,460	21⅛	19	20⅞
Transitron	2,350	41⅜	37½	41¼
Lockheed Aircraft	2,166	45⅝	42½	44¼
Avnet Elec	1,983	36⅜	29	36¼
Martin & Co.	1,906	36⅜	32¾	35
Gen Tel & Elec	1,465	29¼	28	29
Hycon Mfg	1,448	5⅝	4½	5
Gen Elec	1,080	66¼	65	65
Sperry Rand	1,062	27⅞	27	27¼
Nucl'r Corp of Am	1,033	6⅛	5⅝	5⅝
Gen Dynamics	999	42	40	41¼
Lear Inc	931	25	23¼	24
Cohu Elec	908	14¼	11¾	14
Ling-Temco	849	34⅝	31⅛	34⅝
Elec & Mus Ind	831	7⅛	6¾	6¾
Ampex Corp	815	23⅝	22⅝	22¾
Dyn Corp of Amer	814	12⅜	11⅜	11⅞
Raytheon Co	740	41⅜	39⅝	40
Standard Kollsman	729	43⅛	40⅝	41¼
Westinghouse Elec	698	44⅜	43⅛	43⅞
US Industries	606	13¼	12	12⅝
Universal Controls	553	15⅛	14¼	14⅝
Int'l Tel & Tel	552	60¼	58¼	59⅝
Sterling Precision	506	3⅛	2⅞	2⅞
Reeves Sndcrft	499	8½	7¾	8¼

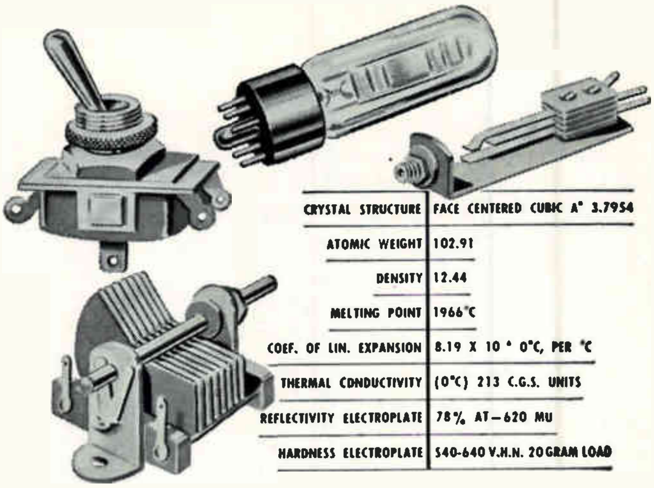
The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.



LEADERSHIP IN DESIGN AND MANUFACTURE OF SLIP RING ASSEMBLIES

Complete facilities, metallurgical and engineering services are available for design and manufacture of slip ring assemblies to critical specifications, ranging in diameter from 1" to 48" and larger—for General Purpose, Radio Frequency and Video Ring Circuits, High Speed Instrumentation, High Voltage Ring Circuits and Power Pulse Slip Rings. A slip ring data file is available—write for your copy.

D. E. MAKEPEACE DIVISION
PINE & DUNHAM STREET • ATTLEBORO, MASS.



CRYSTAL STRUCTURE	FACE CENTERED CUBIC A° 3.7954
ATOMIC WEIGHT	102.91
DENSITY	12.44
MELTING POINT	1966°C
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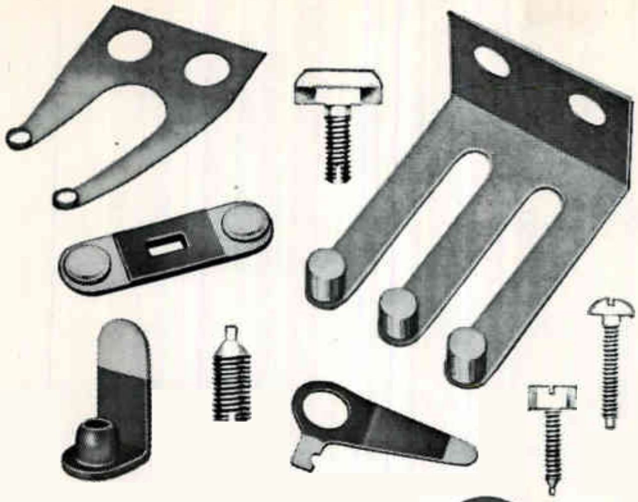

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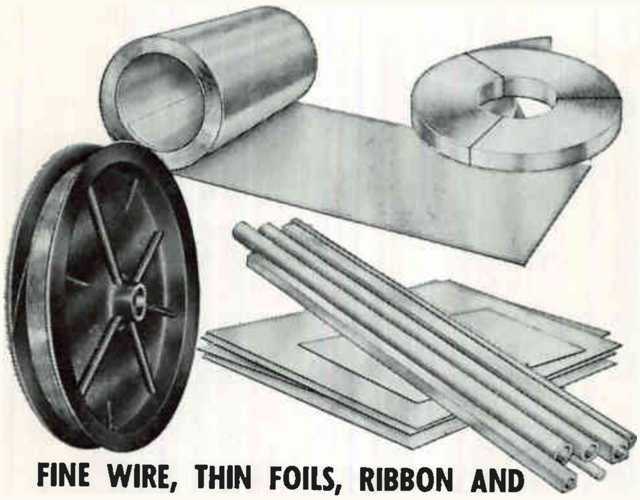

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Business Equipment Features Photoelectric, Electrostatic Techniques

Language teaching in individual sound-protected student booth. Dictaphone Corp. equipment uses prerecorded lessons

By LEON H. DULBERGER, Assistant Editor

NEXT WEEK'S BUSINESS Equipment Exposition at the New York Coliseum will attract about 60,000 management men to the display of office equipment, much of it electronic, presented by over 70 manufacturers active in this $4-billion industry.

Set up and operating will be A. B. Dick Company's high-speed electrostatic address-label printer which operates from digital pulse code information. Known as Videograph, the system accepts data from mag tape, punched paper tape, or directly from a computer. A character generator converts digital information into video signals at rates of 20,000 characters per second.

An electrostatic printing tube produces a latent electrostatic image on the treated surface of a moving paper web. The image is developed through use of a thermoplastic toner powder, and fused by an infrared unit permanently to the paper. Over 130,000 labels can be produced in an hour.

Also on hand will be a tape reader and buffer unit, normally used with the system to handle the magnetic file tapes and to edit and adjust format for continuous flow of programmed information.

Dictaphone Corp. will demonstrate their electronic classroom, designed for industrial, sales and government training applications. The equipment will be available to provide a five minute course in office economics for exposition visitors. A language teaching system will also be on display.

The firm has added Datafax facsimile to their line of office equipment. Manufactured by Stewart-Warner Corp., Dictaphone will distribute it on a nonexclusive basis. The system can transmit all types of flat, visual images, is designed to operate over standard communication systems. It yields dry, smudgeproof received copy.

Royal McBee Corp. will introduce a typewriter using photoelectric sensing to provide automatic format control without tabulation resetting of any kind. Printed forms of any type, using ordinary ink, are sensed by the photocell which controls vertical and horizontal movement of the carriage.

Pressing the tab key on the typewriter causes the carriage to move to the left until a vertical line is sensed, which haults movement for insertion of data. With no tab setting, the action can be repeated across the sheet for all positions provided on the form.

The machine also provides vertical positioning of the form, using the photocell, after an initial home alignment is found for the carriage.

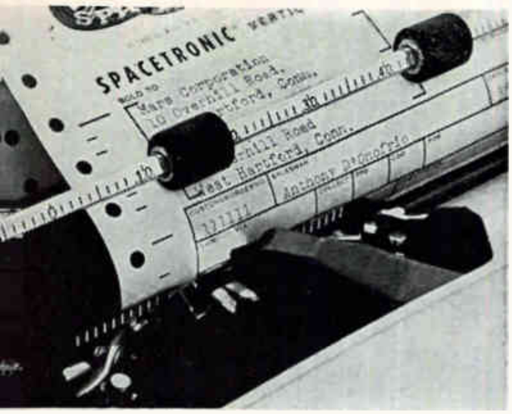
The typewriter can be operated blindfolded, and may lead to a statistical typing machine that can profitably be used by blind people.

Stromberg div. of General Time will show a master time panel for automatic control of on-off functions such as lighting, heating, ventilation and process equipment. The system can handle 200 separate circuits, uses carrier current pulses, and requires no connection to the terminal stations.

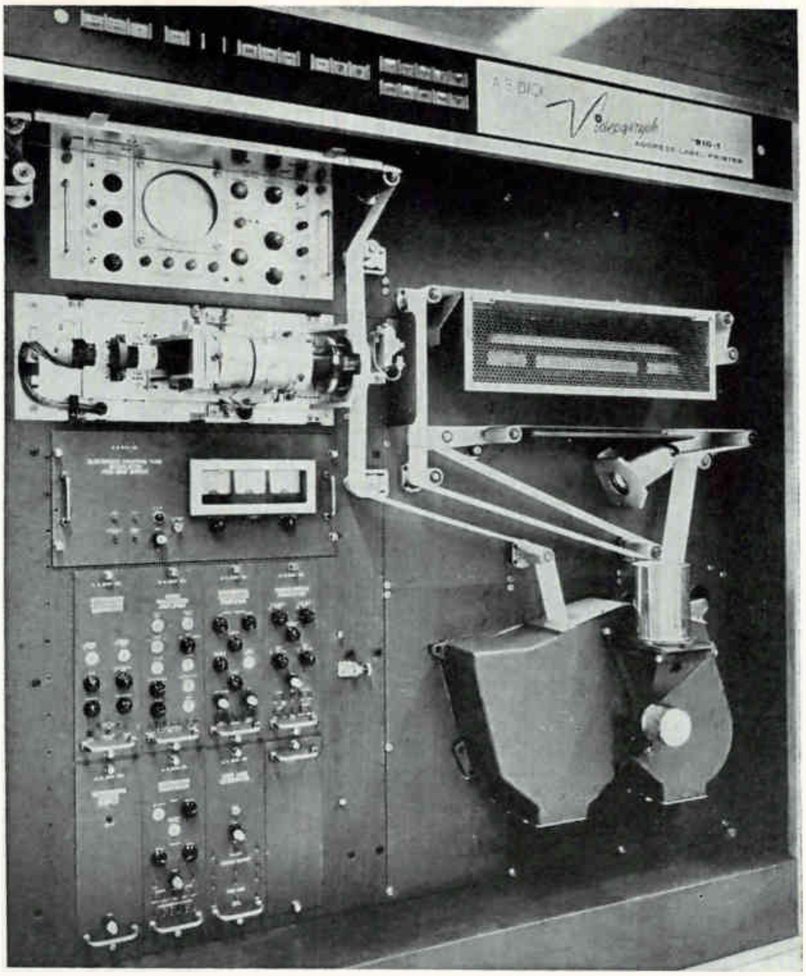
Standard Register Co. will introduce the Stanrecorder, a unit for data collection in plant or office installations. Information ranges from employee time-in, time-out, through various production transactions such as; who performed what job, where, how long it took, number of pieces produced, items scapped and other data.

Source inputs to the system are; employee identification plates, transaction-operation plates, prepunched cards to designate accountability; numerical keyboard for variable information and built in time clock.

Information logged at the Stanrecorder is printed in both Arabic numerals and English language, plus machine language using a five, bit self-checking code. The marginally punched, continuous forms produced can be processed through the firm's solid-state Stanomatic reader-translator. This system related equipment translates at speeds up to 300 documents per



Horizontal and vertical tabulating control in typing of forms is achieved by photoelectric sensing device in Royal McBee Corp. typewriter



Electrostatic address-label printer by A. B. Dick Company produces up to 130,000 labels per minute. Shown is printing tube, panel of electronic system, moving paper web and infrared fuser

Unit by Standard Register provides data collection in both machine and man readable language for ultimate processing in solid-state translator, or manual keypunch

minute, into format for machine or computer input on magnetic tape, punched cards or punched tape. Alternately, the forms can be used as source records for manual keypunching.

Recordack, a subsidiary of Eastman Kodak Co. will show a full scale model of their computer output microfilmer that converts information from magnetic tape to human language on microfilm, at speeds up to 20,000 characters a second. Called DACOM, for Datascope Computer Output Microfilmer, (ELECTRONICS, Feb. 24, 1961) the system can produce a page of 64 lines of 126 characters in about one half second. It uses a split optical system to photograph a background form and computer data simultaneously to produce an optically combined microfilm.

A flying-spot character generator and system of lenses and multiplier photo tubes, work with the decoding logic symbols on the magnetic tape to select the letter or figure for display on another crt, where it is recorded on 16-mm film.

Reference stations can be set up to provide ready availability of the microfilm records.

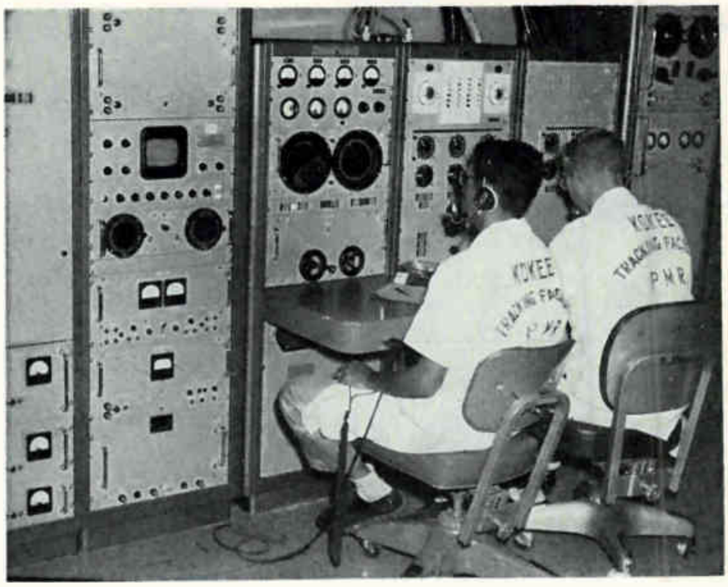
Recordak will show a retreival station that will have 12½ million lines of computer output data stored. Any requested line can be displayed in 15 seconds on an optical reader. Hard copy of any page can be made on demand at the reader.

Remington Rand will show a model of their Univac mobile computer center van, along with models of the computer equipment it houses. The actual trailer-van carries a complete Univac computer with tabulating card input, and will be used for interim operation by customers upgrading their own equipment to magnetic tape Univac.

The system includes a central processor with 50,000-digit internal memory, 600-line per minute printer, 450-card a minute reader, and a 150-card a minute read punch. The firm will also show their thin-film memory, part of the Univac 1107 computer.

Island Station Will Control MERCURY

Monitor display console. Capsule observer position, right; capsule communicator position, center; aeromedical position, left



Active acquisition and control console. This is where manually-placed coordinates are cranked in for initial acquisition. The azimuth and elevation are sent from an up-range station

One of five primary installations, Hawaii facility includes radio command, tracking and communications equipment

By HAROLD C. HOOD
Pacific Coast Editor

KAUAI, HAWAII—The Kokee Park control station, one of five such Project Mercury installations around the world, late last month underwent successful initial simulation tests, with space-capsule signals beamed from a NASA fly-by transport.

Primary command function of the $7-million station, which also incorporates tracking and communications capabilities, is resetting of the capsule's retrorocket timers.

When the first orbiting astronaut goes aloft, hopefully late this year, firing time of these rockets may have to be altered from preset timing to assure correct reentry into the atmosphere.

Initial acquisition of the capsule as it comes over the horizon will be made by an Agave quad helix passive tracking antenna, manually aimed for lock-on with the aid of teletypewritten coordinates of azimuth and elevation from an up-range station.

This device has a 30-deg bandwidth for adequate searching and receives signals in the 160-dbw area telemetered from the capsule. Agave in turn positions the Velort (VEry LOng Range Tracking radar) and FPS-16 radars.

Velort uses a 12-foot dish, has a range of 700 miles, and acts as a controlling source by the acquisition system for directing other antennas.

The FPS-16, a C-band radar with very narrow beam and a 500-mile range, provides precise tracking data on the capsule's orbit. Information from both of these radars is processed and sent by teletypewriter to Goddard Space Flight Center where it is coordinated with tracking data from other stations.

Mounted atop the Agave array is a 1,530-Mc dipole used for transmission to the capsule.

Inside the telemetry and control building at Kokee Park is the three-station Mercury monitor display console where an aeromedical doctor, the capsule communicator, and an environmental specialist observe the reactions of and communicate with the orbiting astronaut.

The capsule communicator, or copilot as he is called, will be one of the other six trained astronauts. He will be in voice communication with the capsule and has a radio code key system for back-up communication. In front of him is a duplicate of the capsule instrument panel for checking capsule conditions.

Among his duties are those of sending the command signal for resetting the retrorocket timers if this becomes necessary, verifying telescope retraction, drogue parachute and main parachute deployment and antenna fairing jettison.

The environmental expert will monitor the capsule's altitude, yaw, pitch and roll, as well as pressure,

CAPSULE

Entrance to Kokee Park Project Mercury site. Transmitting dipole is mounted on quad helix antenna (rear)

temperature and condition of electrical systems.

The aeromedical section contains an electrocardioscope for studying the astronaut's heart action, and dials that indicate respiratory and pulse rate, oxygen in the cabin, body temperature, cabin pressure and temperature inside the flight suit. Beside this console is a pen recorder that records many of these physiological parameters.

Throughout the building other panels and timing devices will indicate many other factors, 86 in all.

Other Mercury control stations are located at Cape Canaveral, Fla., nerve center of the project; Bermuda; Woomera, Australia; and Pt. Arguello, Calif.

Other stations in the network that have tracking but no command functions are located in West Australia; Canton Island; Guaymas, Mexico; White Sands, New Mexico; Eglin AFB, Fla.; and aboard tracking ships in the Atlantic and Indian oceans.

New Biomedical Lab Going Up In Iowa

AMES, IOWA—New laboratory devoted to research in biomedical electronics is going up this Spring at Iowa State University.

The $407,500 building is one result of a four-year-old program to solve veterinary medicine's need for more refined and remote measurements, and electrical engineering's need to train graduate students, free of clinical pressures, in biomedical instrumentation.

The National Institutes of Health are meeting $200,000 of the cost, the state of Iowa is meeting the remainder. The 12,000-sq-ft lab will encompass three floors.

Cooperation of the Veterinary Medical School is one reason for the success of the biomedical electronics program at ISU, according to Dr. Victor W. Bolie, Chairman, Biomedical Electronics and Joint Professor of EE and Veterinary Physiology and Pharmacology.

Researchers at ISU have developed a broad spectrum of instruments to aid sick people, to telemeter symptoms, body functions.

An infant respirator meters oxygen electronically at a rate that prevents a premature baby from taxing his respiratory system.

A visual signal device tells a deaf mother when her baby cries for attention.

A transistorized device detects and automatically records low-frequency traits of fetal heartbeat.

"Instrumentation alone will never be enough to retain the field of biomedical electronics," says Dr. Bolie.

A dozen of Bolie's first 16 EE graduate students are still in the biomedical electronic program at Ames. Two are professors in other schools, one is in computer design and two veterinarian alumni are teaching physiology.

Graduate students may earn a biomedical electronics minor as part of their master's program by taking courses in organic and physical chemistry, biochemistry and bioelectronics. Doctoral candidates study more basic neuroanatomy, neurophysiology and biomedical electronics.

While the masters-level bioelectronic program deals more with instrumentation, the doctoral-level biomed sequence applies more fundamental engineering ideas to medicine and biology.

Bioelectronic masters-level candidates develop instruments. One, an automatic sphygnomanometer records low-frequency diastolic as well as systolic blood pressure.

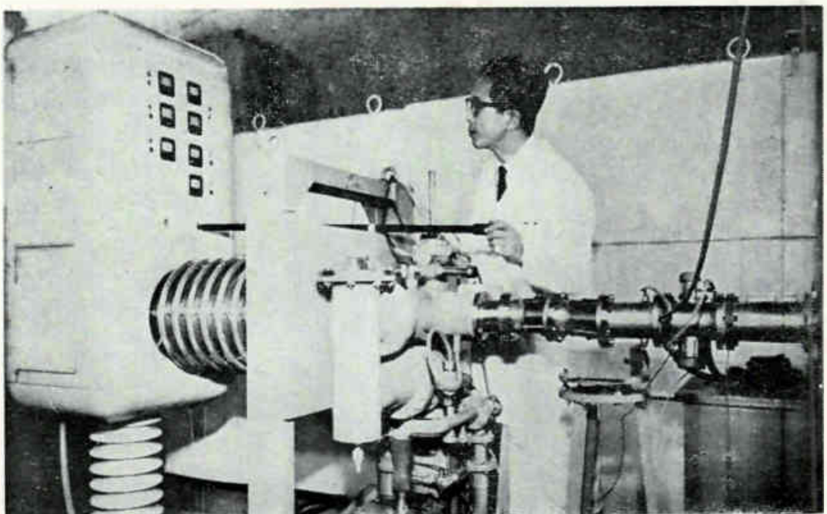
"We had to take a new look at measurement of signals in the low-frequency range, and the need for balanced, fully shielded buildings to avoid interference," Bolie said.

One result: ISU's lab is fitted with specially balanced wiring; separate systems supply 55 volts and 110 volts on either side of ground. No single-ended equipment will be permitted in the building.

One bioelectronics student has developed a compact electronic system for experimental physiology that combines an oscilloscope, automatic stimulator, camera sequencer that programs nerve impulses to the stimulator and respirator into one completely balanced unit capable of measuring low-level signals. Others have developed microelectrodes that measure nerve functions and an electronic spirometer for remote telemetering.

Still in theoretical study stage are a mechanical oscillator that can translate random motions of a subject to power a transistor oscillator and a method to beam r-f energy inside an organism to recharge battery of an implanted transmitter.

Japanese Develop Neutron Generator



Recently completed by Tokyo Shibaura Company, pulsed neutron generator will soon be installed at the Japan Atomic Energy Research Institute

Italy Getting Ready For Second Tv Net

ROME—Italian television authorities here are beginning to acquire equipment for this nation's second television service, expected to begin operating later this year.

Latest purchase is an order for seventeen Mark IV Marconi television cameras. These units were first tried out by the Italians last year when eight pickups were used in coverage of the Olympic Games.

The seventeen new cameras will be used to add on to Radio Italiana Televisione facilities in Rome and Naples. The group presently has 103 camera channels in operation. Fifty-two were supplied by Marconi, 18 by German firms, 17 by American manufacturers, 12 by Pye Ltd. and four by EMI, Ltd.

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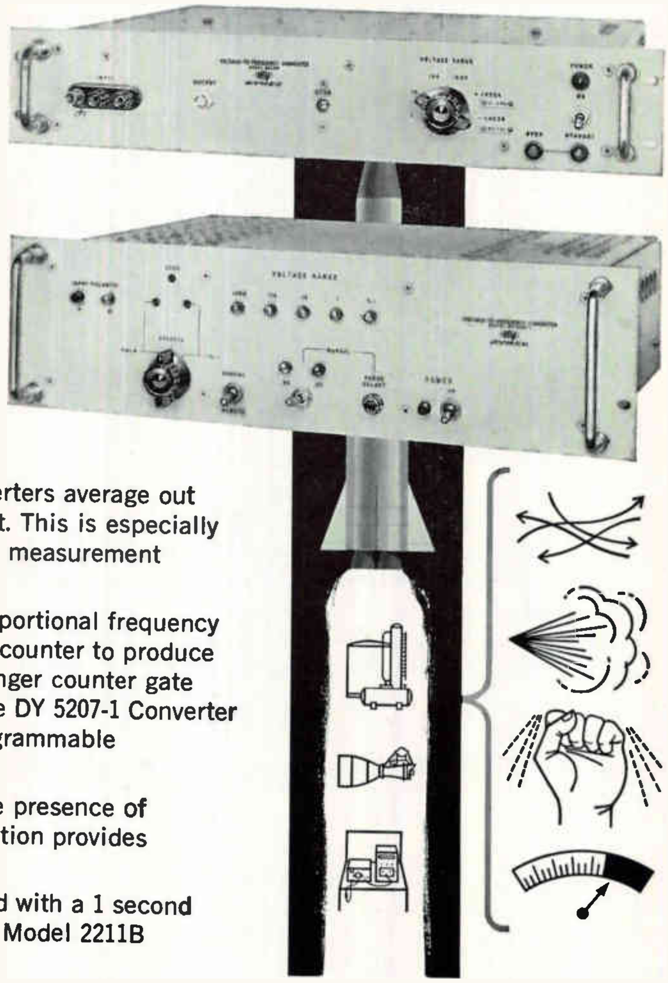
DYMEC VOLTAGE-TO-FREQUENCY CONVERTERS—

building-block instruments for high-accuracy voltage measurement, independent of noise or hum



Dymec Models 2210 and 2211A/B Voltage-to-Frequency Converters average out noise and hum to obtain high-accuracy voltage measurement. This is especially advantageous in systems applications. You get higher useful measurement accuracies than with other conversion techniques.

Models 2210 and 2211A/B convert an input dc voltage to a proportional frequency of constant amplitude which is applied to a gated electronic counter to produce a direct digital reading of the input analog voltage. With a longer counter gate time you also can obtain the integral of the input voltage. The DY 5207-1 Converter permits similar measurement of ac input voltages and is programmable for both dc and ac voltage measurements.

In addition to flexible systems use, especially effective in the presence of ac input interference, the Dymec Converter/Counter combination provides an inexpensive digital voltmeter for lab or factory.

Models 2210 and 2211A provide four-digit resolution when used with a 1 second counter gate or three-digit resolution with a 0.1 second gate. Model 2211B provides up to 5 digits of resolution.

Here are brief specifications of Dymec Voltage/Frequency Converters. Call your Dymec/Hewlett-Packard representative or contact Dymec direct for detailed data sheet and application information.

	Dymec 2210/2210R	Dymec 2211AR/BR	Dymec 5207-1
Ranges: (VDC, ±, full scale)	±1, ±10, ±100, ±1000; {±.1, ±1, ±10, ±100}*	*{±1, ±10, ±100, ±1000}; {±.1*, ±1, ±10, ±100}*	DC {±.1, ±1, ±10, ±100, ±1000}; {1, 10, 100, 750} AC volts, rms, 20 to 100,000 cps
Output Frequency:	0-10 KC	2211AR, 0-10 KC 2211BR, 0-100 KC	0-10 KC
Accuracy:**	±0.06%	2211AR, ±0.02% 2211BR, ±0.03%	±0.06% dc ±0.5%, 50-10,000 cps ±0.75%, 20-100,000 cps
Stability:***	±0.03%	±0.02%	±0.03% dc
Price:	DY 2210, $660.00 (cabinet) DY 2210R, $650.00 (rack)	$1,250.00 (rack)	$1,850.00 (rack)

*Available at extra cost. **Accuracy includes stability, is given in per cent of full scale and is affected by frequency and accuracy of calibration, line voltage variations, temperature changes and accuracy of multi-range input attenuators. Figures given are those attained under normal operating conditions. ***Given as per cent of full scale per 24-hour day.

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

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How Space Astronomy Satellite Operates

A NUMBER OF NEW design concepts are in the National Aeronautics and Space Administration's bizarre-looking gamma ray astronomy satellite (S-15).

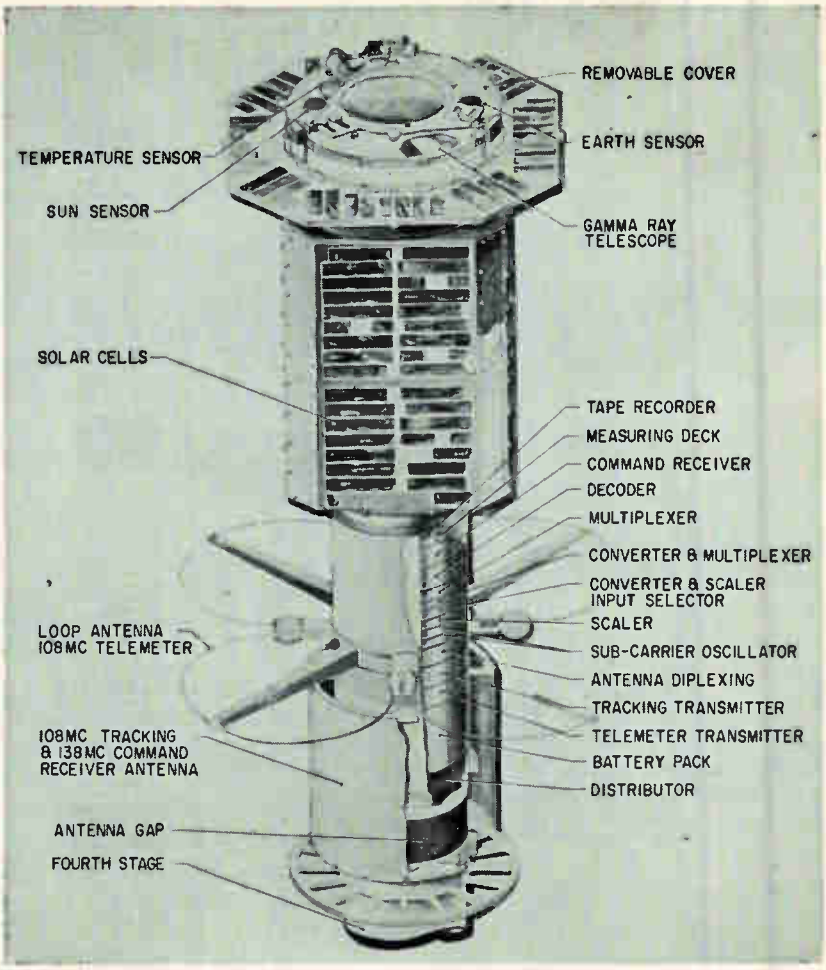
Primary objectives of the experiment are to detect high energy gamma rays from cosmic sources and map their distribution in the sky. This is the first attempt of this kind of space astronomy from a satellite, NASA said.

The 82-lb satellite combines an octagonal 12-in.-diameter, 23½-in.-long aluminum box mounted on a 6-in.-diameter, 20½-in.-long aluminum instrument column. The box provides both a housing for the gamma-ray telescope and for four of the external surfaces for the satellite's solar cells. The 44-in.-long fourth-stage rocket was designed to remain with the satellite to act as a section of a transmitting antenna and provide the additional length and weight (12.8 lb after burnout) needed to attain the S-15's tumbling action.

Solar cells, which recharge the system's 12 nickel cadmium batteries, are also located around the face of a 17-inch-diameter octagonal plate fitted on the top of the box. A thin aluminum shield covers the end of the housing, protecting the telescope from damaging micrometeorites. This shield can be removed by radio command from the earth.

In orbit, the gamma ray astronomy satellite is designed to tumble end-over-end at the rate of about 10 times every minute. This motion enables the gamma-ray telescope, aimed out through the end of the octagonal box, to scan a portion of surrounding space every six seconds.

Sun and earth sensors, peering out through small apertures in the micrometeorite shield, permit scientists on the ground to know at all times the exact orientation of the satellite with respect to the earth, sun and stars, thus pinpointing the direction from which gamma rays are coming. An insulated temperature sensor, also directed out through the thin shield, is designed to study the thermal radiation balance of a body in orbit.



Cutaway drawing of gamma ray astronomy satellite

To effect this necessary tumbling, the satellite is equipped with a damping mechanism fitted into the after end of the fourth-stage rocket's motor case. The device is a hollow, mercury-filled cylindrical adaptor, resembling a retainer ring. The S-15 is designed to spin about its longitudinal axis at about 380 rpm. Although it would eventually slow down and begin tumbling by the very nature of its structure, scientists want a controlled tumble, beginning shortly after the satellite orbit begins.

The data transmitted by the S-15 satellite and recorded by the Minitrack stations are processed and reduced at Goddard Space Flight Center.

The composite detected signal is separated into five channels by the use of filters. Discriminators convert this data to voltage amplitudes, which is displayed on an oscilloscope, then recorded on 35mm film.

An orbit's worth of data can be processed in a little over ten minutes and recorded on about 36 feet of film. Also, the light pulse characteristics, elapsed time, and time marks are recorded on binary tape in a format compatible with the experimenters' computer program. A few inches of tape are required for each orbit. These data are then forwarded to the experimenters at MIT, who conduct the final data analysis.

The satellite is launched into a planned elliptical, low inclination orbit in order that (1) the initial spin axis of the payload is in such a direction that the telescope scans the sun during the early part of its lifetime; (2) it has a lifetime in excess of six months; and (3) an appreciable fraction of the time is spent below the inner Van Allen radiation belt.

The S-15 is planned to orbit at an inclination near 28 degrees to

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10 cps to 11 Mc

FEATURES:

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SPECIFICATIONS:

VOLTAGE: 300 μV to 300 V.

FREQUENCY: 10 cps to 11 Mc (As a null detector, 5 cps to 30 Mc).

ACCURACY: % of reading anywhere on scale at any voltage. 20 cps to 2 Mc — 2%; 10 cps to 6 Mc — 4%; 10 cps to 11 Mc — 6%.

SCALES: Voltage, 1 to 3 and 3 to 10, each with 10% overlap. 0 to 10 db scale.

INPUT IMPEDANCE: With probe, 10 megohms shunted by 7 pF. Less probe, 2 megohms shunted by 11 pF to 24 pF.

AMPLIFIER: Gain of 60 db ± 1 db from 6 cps to 11 Mc; output 2.5 volts max. from 460 ohms source.

POWER SUPPLY: 115/230 V, 50 — 400 cps, 70 watts.

DIMENSIONS (Inches): Portable model 13 h x 7½ w x 9½ d. Rack model 8¾ h x 19 w x 8½ d.

WEIGHT: 17 pounds, portable or rack models. Approximately 34 pounds shipping weight.

Price:
$445.
(With probe $495)

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Satellite . . .

the equator. Preliminary plans called for an apogee of about 700 miles and a perigee of about 300 miles. It is intended, in this orbit, to circle the earth approximately every 98 minutes. Its orbital lifetime should be over three years.

The gamma-ray telescope has a plastic scintillator covering the top and sides. Inside this cover is a sandwich of crystal layers, composed of sodium iodide and cesium iodide. A third element of the telescope is a Cerenkov detector—a solid layer of clear plastic working in conjunction with multiplier-phototube circuits so that only charged particles arriving from the forward direction are counted.

The heart of the telescope is the sandwich of crystals. When a gamma ray falls on these crystals, an electron and a positron are emitted. These react with the crystal structure in such a way that scintillation occurs. Other particles also strike the sandwich, but they are charged, and therefore cause light flashes in the outer plastic scintillator before striking the crystal layers.

The outputs of the multiplier-phototubes which monitor the light flashes from these three telescope components are fed into the electronic system which includes auto-coincidence circuits. These circuits, when commanded to do so from the ground, cancel out all light flashes not related to incoming gamma rays from the forward direction.

The electronic system is versatile in that the experimenter on the ground can, by issuing the proper commands, observe other particles impinging on the telescope. The experimenter can also observe the performance of different parts of the electronic system.

S-15 contains two transmitters, one for tracking and transmitting continuous data and one for tape recording readout. Both transmitters are under ground command control. A 10-channel command receiver controls the experimental functions.

The data transmitter, using a "four leaf" loop antenna projecting out from the instrument column beneath the telescope housing, operates on a frequency of 107.97 Mc with a power output of approximately 125 mw. The tracking transmitter operates on a frequency of 108.06 Mc with a power of 20-25 mw. The antenna for this transmitter is the entire satellite.

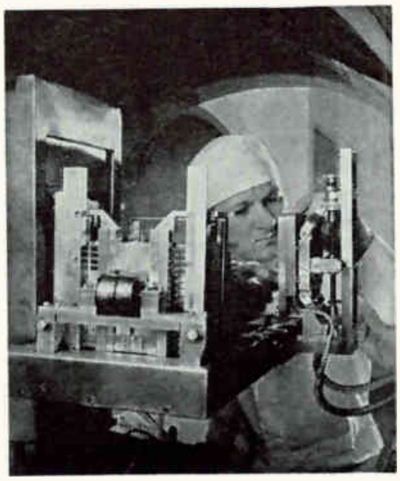
English Computer To Run Chemical Plant

FLEETWOOD, ENGLAND—A plant here, Imperial Chemical Industries, Ltd., is slated for fully dynamic on-line computer control by the end of July. A computer system being installed by Ferranti, Ltd. will directly control final valves and actuators in the production stream.

The computer is an all-solid state unit, the Argus 1024. System installers say it will replace 100 individual control loops on the plant. Programmed on the Argus word program are the individual three-term control loop equations, values for proportional band, integral and rate terms being stored in the computer from values obtained from normal operator settings on control equipment in similar plants.

Some 300 input signals will be routed to the computer. They will be analog signals converted to binary form in a ten-bit analog/digital converter. Output from the computer will be in electrical form

New Deposition Gear



Jukebox technique aligns masks for IBM vapor deposition method which makes 135-cryotron memory planes and will control 100 pneumatic valves.

Group selection time of 100 points is less than 0.06 seconds, according to system engineers.

Overall system cost is claimed to be slightly higher than conventional 100 controller analog systems.

New Control System For Texas Oil Wells

DALLAS—Mobil Oil reports it has installed one of the most fully automatic systems for controlling oil well operations to date for an "on-land" operation in west Texas. The company is also considering five more similar projects in the same area.

Two similar systems have been in operation for some time, but these control off-shore wells in the Gulf of Mexico and Lake Maracaibo, Venezuela.

The system starts, shuts down, tests, and monitors the wells individually. A built-in alarm system spots various troubles and takes corrective action. The system can make a total of about 240 such decisions.

From a central console control panel, a single operator monitors the automatic transfer of oil to pipe lines, the operation of all central tank battery equipment, changes in the status of wells, and oil production volumes.

The central control panel is linked to 11 remote stations by telephone lines.

The system is designed to handle 79 wells in a 4,300-acre area, although only 50 are tied to it at present.

Mobil says the system, which is in a Sacroc project in Scurry County, west Texas, has enabled the firm to reduce tank batteries from 13 to 1. Company says it also provides faster and more complete control of wells, and helps in the recovery of more petroleum gases.

Texas Instruments, which custom-made this system and also the off-shore ones, reports it is currently negotiating proposals for similar systems with other companies.

Chicom's Tv Net Plans Bog Down

HONG KONG—Observers here report Communist China's plans for a nationwide television network have slowed down considerably.

Six television stations are reported operating at these locations: Harbin, Canton, Changchun, Shenyang, Peking and Shanghai.

Of 18 projected stations reported in varying stages of construction since 1959, only one was reported complete during 1960.

About 20,000 television receivers are in use throughout the country. Half of these are in and around Peking. China uses a 625-line system. Nine of the country's 28 major radio equipment factories are said to have begun producing receivers and limited amounts of tv transmission gear.

Midget Tape Recorders On European Market

TWO EUROPEAN firms announced entry into the race for midget tape recorders this week.

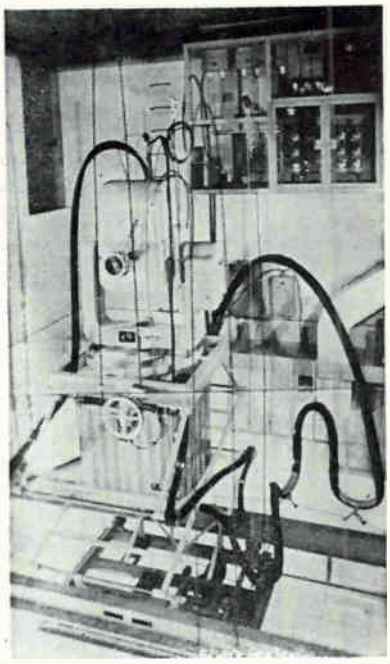
From Vienna comes word of a battery powered unit measuring 4.63 by 3.22 by 1.40 in. with a weight of 0.847 lb.

From Amsterdam, announcement is made of a recorder weighing 8 lb., measuring 7.87 by 10.62 by 3.74 in.

The Austrian recorder, made by Ing. V. Stuzzi of Vienna, is fully transistorized and uses printed circuits. It is powered by a nine-volt transistor battery and a 1.5 volt Mignon battery and can operate for 12 hours. The case houses enough tape for 60 minutes of recording without changing reels, and also contains microphone and speakers. Provisions are made for attaching exterior loudspeaker, external microphone, telephone pickup, amplifier or remote control. Price given to Austrian purchasers is equivalent to about $37.88.

The Dutch recorder works on six 1½-volt batteries. Tape coils have a 10-cm diameter, are double tracked and hold 180 cm. length of tape. Total recording time is two hours. The polystyrene case has room for a microphone. Tape transit speed is 4.75 cm per second. The unit's price in Holland is 278 Guilders, or about $77.25. Manufacturer is Philips.

Japan Builds Betatron For Testing Materials



TOKYO—New development by Toshiba is a 15-million electron-volt light-weight betatron (see photo) for nondestructive testing of structural materials.

The company says the equipment is being produced commercially and will be distributed by Mitsui Bussan Kaisha (MBK), its affiliated trading firm.

Thailand Planning More Tv Coverage

BANGKOK—Construction has started on a $1.5-million program to extend television coverage outside this capital city of Thailand, according to reports.

Coverage will be spread through three repeater stations to be built at Khonkaen in the northeast, Lampang in the north and Songkhla in the south.

Two television stations are presently operating in Bangkok. Last October there were about 50,000 tv receivers in use in the country.

EH PRESENTS 4 PULSER THOROUGHBREDS

Which one of these advanced, quality-built instruments is right for your requirements?

NEW! MODEL 131

Low cost pulse generator with rise time of 10 nanoseconds!

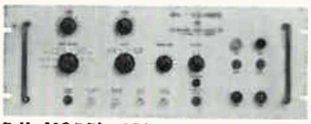
$575 f.o.b. Oakland, California

If you've been looking for a high-quality pulser with excellent performance characteristics — but **without a high price tag** — the new E-H 131 was designed for you. The 131's fast rise time and high-power output pulses make it an ideal pulser for laboratory and research applications as well as production line testing of components and solid state devices. Check the 131's specifications. You'll agree it is the outstanding instrument in its price range.

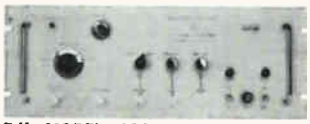
SPECIFICATIONS

REPETITION RATE: 10 cps to 100 kc, internally controlled, zero to 100 kc externally driven.
RISE TIME: 10 nanoseconds.
PULSE DELAY: Zero to 100 microseconds with respect to the trigger.
TRIGGER (for sync. purposes): Positive 10 volt pulse.
EXTERNAL DRIVE: 5 volts RMS or equivalent positive pulse required.
ELECTRONIC GATE: Negative 20 volts required to block the pulse train.
PULSE OUTPUT: 50 volts into a 50 ohm load.
PULSE WIDTH: 100 nanoseconds to 100 microseconds, continuously variable.
POLARITY: Positive or Negative pulses available.
DUTY FACTOR: 10 percent. An automatic limiter prevents overload.
OUTPUT ATTENUATOR: 100:1 coarse selector, 10:1 vernier control.
DIMENSIONS: Standard 19" rack panel, 5¼" high.

E-H MODEL 130 This double pulser has repetition rates to 4 mc, rise and fall time of 10 nanoseconds, pulse widths and delay variable from 100 nsec to 50 milliseconds, and delivers 50 volts at 500 ma at 50% duty cycle. Either pulse polarity, output attenuator, and provisions for external drive and electronic gating. Especially suited for fast circuit applications in transistor testing, computer and missile fields. $1175 f.o.b., Factory.



E-H MODEL 121 A high-current pulser delivering a 50 volt pulse into 50 ohms. Rise and fall times 4 nanoseconds. Width variable from 20 nsec to 1μsec. Repetition rate from 10 cps to 10 mc. Either positive or negative pulses may be selected on the front panel. Ideal for ferrite and magnetic switching studies, applications in high speed transistor and diode switching, and design of logic and memory circuits. $1675 f.o.b., Factory.



E-H MODEL 120B Rise time — 2 nanoseconds—is ahead of the field and offers new tool for fast, high-resolution work. Two outputs independently variable in amplitude (—8 volts into 93 ohms) and widths (2.5 to 25 nsec). Inverting and impedance matching transformer available. Repetition rate 10 cps to 10 mc. Advanced trigger pulse and a fast, flexible gate for complex pulse-time and pulse-amplitude selection. $1275 f.o.b., Factory.

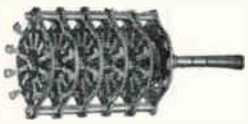
WRITE, WIRE OR TELEPHONE TODAY FOR MORE INFORMATION — REPRESENTATIVES IN ALL MAJOR CITIES

E-H RESEARCH LABORATORIES, INC.
163 ADELINE STREET • TEMPLEBAR 4-3030 • OAKLAND 20, CALIFORNIA

CIRCLE 37 ON READER SERVICE CARD

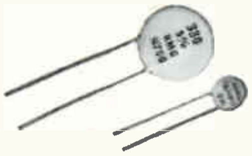
Immediate delivery at factory prices . . .
from Mallory industrial

TANTALUM CAPACITORS Industry's broadest line. Microminiature to high capacity: 0.33 to 1300 mfd. Sintered wet slug, solid and foil types. Temperature ratings —55 to +200°C.



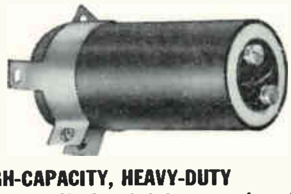
SELECTOR SWITCHES Push-button, lever action, rotary, wafer, multi-section. Phenolic or ceramic insulation.

VITREOUS ENAMEL RESISTORS Complete line of fixed and adjustable wire-wound resistors including MIL types. 5 to 200 watts, resistances to 100,000 ohms.



CERAMIC DISC CAPACITORS All standard temperature coefficients. Ratings from 50 volts general purpose to 6000 volts. Made by Radio Materials Company, a Mallory division.

SUBMINIATURE SNAP-ACTION SWITCHES Milli-Switch line of precision push-button switches; toggles and auxiliary actuators for slide or cam action. Temperature ratings to 300°F. Also hermetically sealed types.



HIGH-CAPACITY, HEAVY-DUTY ELECTROLYTICS High-capacity HC type and non-polarized NP type. Plastic case. Compact, leak-proof design. High ripple current rating, cool operation. From 3V, 6700 mfd. to 450V, 88 mfd.

These Mallory Industrial Distributors stock the lines indicated by numerals:

Key: 1—Tantalum capacitors
2—Selector switches
3—Vitreous enamel resistors
4—Ceramic disc capacitors
5—Snap-action switches
6—HC-NP capacitors

Standard Radio Parts	1						Tucson, Ariz.
Newark Electronics		2				6	Inglewood, Calif.
California Electronics	1	2				6	Los Angeles, Calif.
Federated Purchaser		2				6	Los Angeles, Calif.
Kierulff Electronics	1	2		4	5	6	Los Angeles, Calif.
Radio Product Sales	1	2				6	Los Angeles, Calif.
Brill Electronics						6	Oakland, Calif.
Elmar Electronics	1	2		4		6	Oakland, Calif.
Zack Electronics	1	2	3		5	6	Palo Alto, Calif.
Elwyn W. Ley		2				6	Paramount, Calif.
Electronic Supply	1	2				6	Pasadena, Calif.
Shanks & Wright				4			San Diego, Calif.
Peninsula Electronics					5		San Jose, Calif.
Denver Electronics	1					6	Denver, Colo.
Westconn Electronics	1						Bridgeport, Conn.
Capitol Radio	1					6	Washington, D.C.
Electronic Indus. Sales	1	2				6	Washington, D.C.
Electronic Equipment						6	Miami, Fla.
East Coast Radio	1		3	4		6	Orlando, Fla.
Thurow Distributors	1						Tampa, Fla.
Allied Radio	1	2				6	Chicago, Ill.
Chauncey's, Inc.				4			Chicago, Ill.
Newark Electronics	1	2				6	Chicago, Ill.
Melvin Electronics						6	Oak Park, Ill.
Bruce Electronics			3				Springfield, Ill.
Graham Electronics	1	2	3	4	5	6	Indianapolis, Ind.
Radio Supply					5		Wichita, Kansas
D & H Distributing						6	Baltimore, Md.
Kann-Ellert Electron.		2					Baltimore, Md.
Radio Elec. Serv.	1				5		Baltimore, Md.
Cramer Electronics	1	2	3	4		6	Boston, Mass.
DeMambro Rad. Sup.	1	2			5	6	Boston, Mass.
Lafayette Radio	1	2	3			6	Boston, Mass.
Radio Shack		2					Boston, Mass.
Radio Specialties		2					Detroit, Mich.
Northwest Radio	1	2		4			Minneapolis, Minn.
Burstein-Applebee		2				6	Kansas City, Mo.
Walters Radio						6	Kansas City, Mo.
Olive Electronics	1				5		St. Louis, Mo.
General Radio		2				6	Camden, N. J.
Eastern Radio		2				6	Clifton, N. J.
Atlas Electronics	1	2				6	Perth Amboy, N. J.
Federated Purchaser	1	2				6	Mountainside, N. J.
Aaron Lippman & Co.		2					Newark, N. J.
Lafayette Radio	1					6	Newark, N. J.
State Electronics		2		4		6	Whippany, N. J.
Federal Electronics	1	2				6	Binghamton, N. Y.
Acme Electronics		2					Brooklyn, N. Y.
Radio Equipment		2					Buffalo, N. Y.
Wehle Electronics	1					6	Buffalo, N. Y.
Greylock Electronic		2					Kingston, N. Y.
Peerless Radio						6	Lynbrook, L.I., N.Y.
Bruno-New York		2				6	New York, N. Y.
Electronic Center						6	New York, N. Y.
Harrison Radio	1	2	3	4		6	New York, N. Y.
Harvey Radio	1	2				6	New York, N. Y.
Lafayette Radio	1	2	3			6	New York, N. Y.
Milo Electronics		2				6	New York, N. Y.
Terminal Hudson Elec.	1	2				6	New York, N. Y.
Higgins & Sheer Elec.		2					Poughkeepsie, N.Y.
Morris Electronics						6	Syracuse, N. Y.
Valley Indus. Elec.		2					Utica, N. Y.
Westchester Electron.	1	2		4			White Plains, N.Y.
Dalton-Hege Radio	1						Winston-Salem, N.C.
Akron Electronic Sup.		2					Akron, Ohio
United Radio	1		3	4			Cincinnati, Ohio
Pioneer Electronics	1					6	Cleveland, Ohio
Thompson Radio		2		4			Columbus, Ohio
Whitehead Radio			3				Columbus, Ohio
Allied Supply	1		3	4			Dayton, Ohio

MEETINGS AHEAD

Apr. 13-14: Society of Technical Writers and Publishers, Annual Convention; Mark Hopkins Hotel, San Francisco.

Apr. 17-19: Instrumental Methods of Analysis, ISA; Shamrock-Hilton Hotel, Houston.

Apr. 17-21: Strain Gage Techniques, Southwest Research Institute; San Antonio, Tex.

Apr. 18-19: Organic Semiconductors, Inter-Industry Conference, Armour Research Foundation of Illinois Institute of Technology, and ELECTRONICS, McGraw-Hill; Terrace Casino, Morrison Hotel, Chicago.

Apr. 19-21: Southwestern IRE Conf. and Elec. Show, SWIRECO; Memorial Auditorium, Dallas.

Apr. 25-27: Relay Conference, NARM in cooperation with Oklahoma State Univ.; Student Union Bldg., Stillwater, Okla.

May 2-4: Electronic Components Conf., PGCP of IRE, AIEE, EIA, WEMA; Jack Tar Hotel, San Francisco.

May 22-25: Electronic Parts Distributors Show, Electronic Industry Show Corp.; Conrad Hilton Hotel, Chicago.

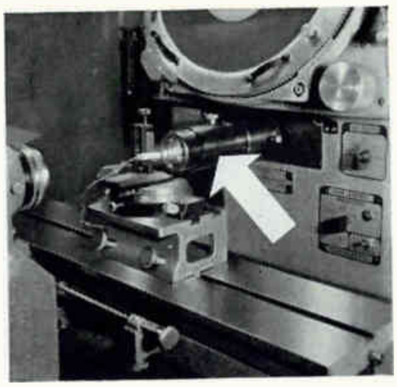
Aug. 22-25: WESCON, L.A. & S. F. Sections of IRE, WCEMA; Cow Palace, San Francisco.

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

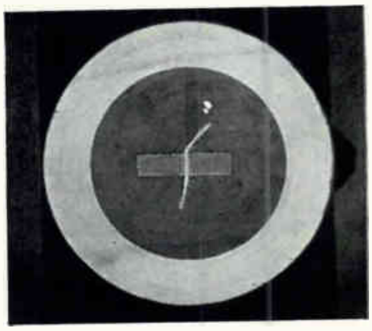
Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Chicago.

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

Model FC-14 J & L Optical Comparator



CENTRALITE adapter (arrow) slips easily into place on J & L Optical Comparator — used here to inspect tiny read/record head.



CENTRALITE image of read/record head clearly shows two magnetic poles separated by aluminum foil insulator at 31.25 magnifications.

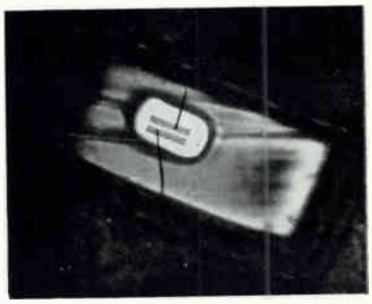
NOW...closer inspection of micro-assemblies ...with CENTRALITE and PARABOLITE

Simply slip on a CENTRALITE or PARABOLITE adapter, and your J & L TC-14 or FC-14 Optical Comparator becomes even *more* versatile. You'll use it for critical inspection jobs that may have previously seemed impossible.

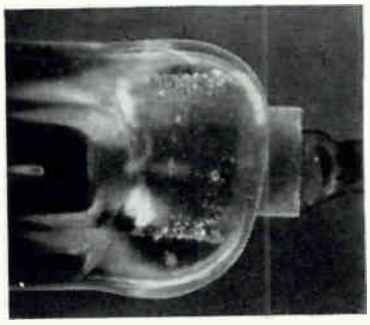
For example, CENTRALITE provides a highly concentrated light which now permits the projection of a precise image of a tiny read/record head used in a computer component. Light is concentrated intensely on the part and reflected back through the J & L projection system onto the Comparator screen. CENTRALITE is also used for micro-inspection of a mesa diode assembly.

PARABOLITE permits detailed examination of a tiny tunnel diode assembly by surrounding it with concentrated light. Simply by rotating the diode, you can take a close look at seal, bubble configuration at fusion points, gold contact to wafer, and other critical details.

Solve *your* inspection problems with J & L Optical Inspection Equipment. Send for Catalog LO-6013 now.



Micro inspection of this mesa diode assembly at 100 magnifications is clearly detailed with CENTRALITE.



PARABOLITE makes possible a sharp close-up of bubble configuration at the fusion point of this tunnel diode (50 magnifications).

JONES & LAMSON MACHINE COMPANY

539 Clinton Street, Springfield, Vermont

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

Sperry garnet materials, products of Sperry research, are especially applicable for low frequency and high average power requirements under extreme temperature conditions. They are also superior, under certain conditions, in high peak power applications.

Important uses of Sperry garnet materials are in resonance isolators and in 3- and 4-port circulators for frequencies from 350 to 1500 mc and over broad temperature ranges.

Sperry garnets also are highly satisfactory in higher frequency devices—up to and including the X-band—where a maximum degree of temperature stability is necessary with high average power. Typical devices using certain of these materials operate from −65°C to +125°C, and at very high power levels.

Bars nominally measure 1½' x 1' x 6'.

Complete information relative to Sperry solid state materials furnished on request.

GARNET

materials

by

SPERRY

NOMINAL CHARACTERISTICS

MODEL	DENSITY (gm/cm3)	$4 M_s$ (Gauss) −55°C	25°C	+125°C	ΔH Oersteds at 9150 mc, 25°C	g-Factor
D80A1	5.05	1950	1750	1400	50	2.02
D80A2-1	5.25	1600	1475	1300	60	2.02
D80A2-2	5.40	1350	1250	1100	85	2.03
D80A2-3	5.60	950	1000	850	125	2.04
D80A2-4	5.75	700	750	750	225	2.06

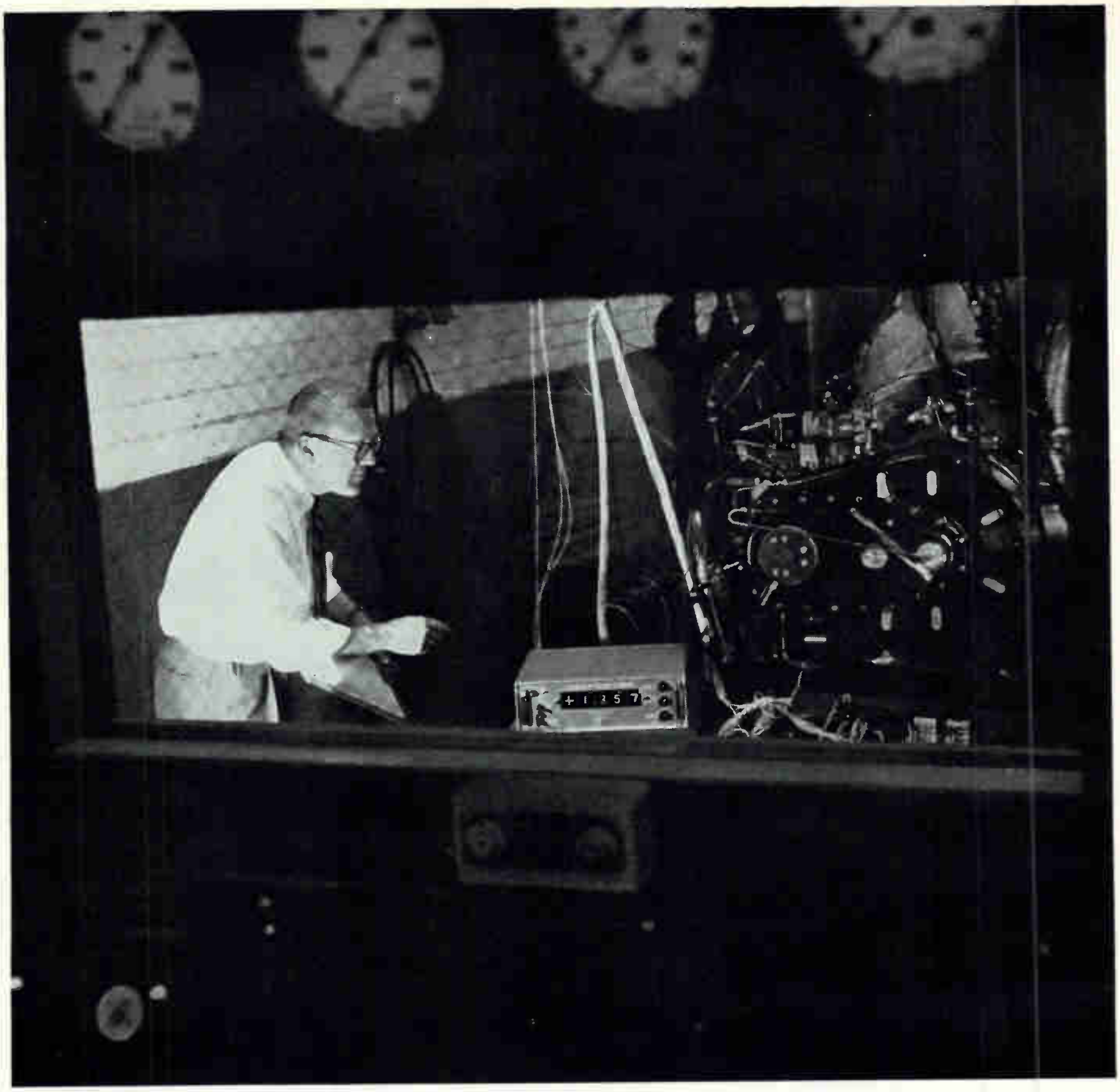
Curie Temperature, T_C=280°C for all materials
Nominal Bar Size—½" x 1" x 6"

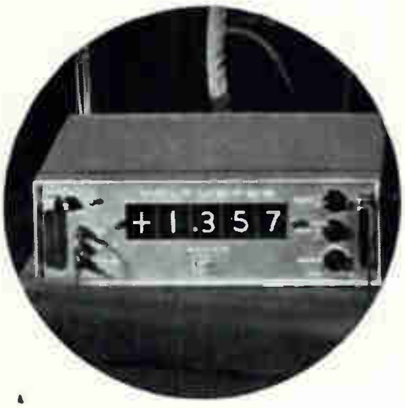
SPERRY

SPERRY MICROWAVE ELECTRONICS COMPANY, CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION

*Microline Instruments • Radar Test Sets • Systems Instrumentation • **Solid State Devices and Materials** • Microwave Components and Antennas*

CIRCLE 41 ON READER SERVICE CARD





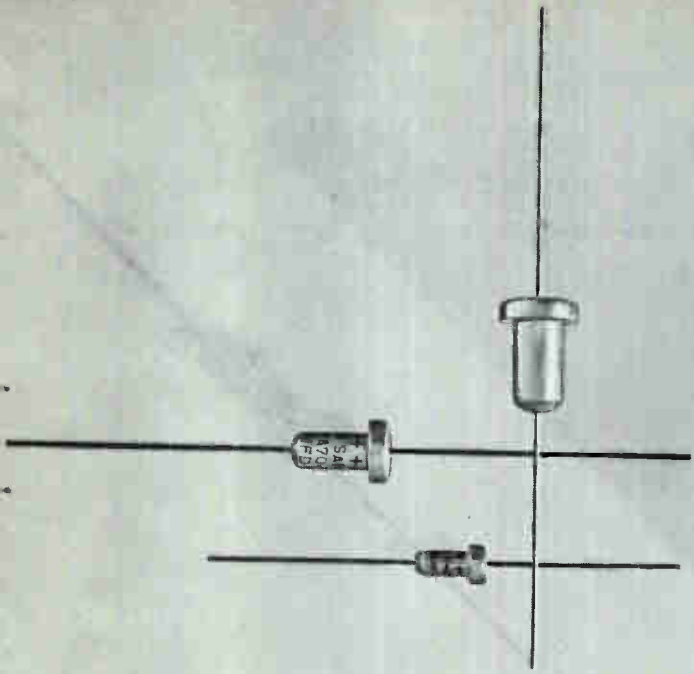
NO STEPPING SWITCHES IN THIS ULTRA-RELIABLE DVM: Cubic announces a new digital voltmeter design that eliminates stepping switches and, with them, the need for periodic maintenance. The new Cubic V-70 uses the same ultra-reliable reed relays developed for submarine cables. These reed relays are sealed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

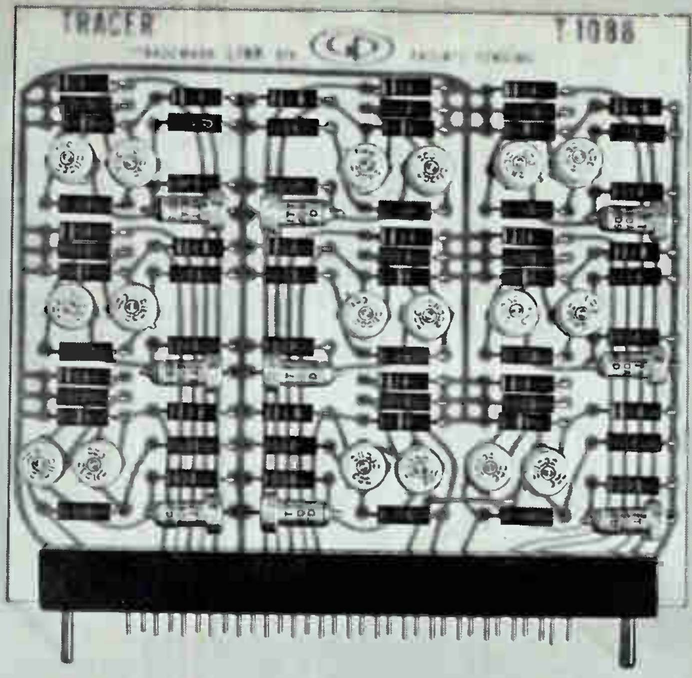
Accurate: The V-70 reads any d-c voltage from 0.001 to 999.9 volts with an absolute accuracy of 0.01% plus or minus 1 digit. The Cubic V-70 Digital Voltmeter provides these and other premium features at a cost of only $1,580. For details, write to Dept. E-103, Industrial Division, Cubic Corporation, San Diego 11, Calif. (in Europe: Cubic Europa S.p.A., Via Archimede 185, Rome).

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

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

CIRCLE 43 ON READER SERVICE CARD→





Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.

TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER

HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.

ITT
COMPONENTS DIVISION
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
815 SAN ANTONIO RD., PALO ALTO, CALIF.

Phone these ITT-CD Capacitor Sales Offices:

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Cleveland	GR 5-3080	New York	LO 5-1820
Dallas	EM 1-1765	Philadelphia	TR 8-3737
Dayton	BA 8-5493	Phoenix	WH 5-2471
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Kansas City	JE 1-5236	St. Louis	EV 2-3500

IN STOCK AT ITT DISTRIBUTORS:

- TWO TYPES—M-Type and P-Type, for applications from −55 to 85 and 125 C. respectively
- 29 VALUES—from 1.75 to 330 mfds over a working voltage range to 125 VDC and maximum surge voltages to 140 VDC
- COMPACT AND RUGGED—sintered tantalum slug in fine-silver cases for 2000-hour life at maximum temperature and working voltage
- GUARANTEED—to 80,000 ft. and accelerations of 20 G's with a 0.1 in. excursion in 50-2000 cps range
- LONG STORAGE LIFE—tantalum-oxide dielectric is completely stable; assures trouble-free operation

COMPLETE SPECIFICATIONS ON ITT wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

ENGINEERS: Your ITT representative has a complete set of qualifications and quality control tests for your inspection.

HOW TO GET THE POWER TRANSISTORS YOU NEED?

JUST ASK DELCO. For even though our catalog lists only a handful of germanium power transistors, there is only a handful out of all those ever catalogued that we don't make. And those only because nobody ever asked for them.

We've made, by the millions, both large and small power transistors. Both diamond and round base. Both industrial and military types. And each in a wide variety of parameters that have proved themselves reliable in nearly every conceivable application.

You get Delco transistors fast. You get Delco transistors in any quantity. And for all their high reliability, you get them reasonably priced. All you have to do is contact our nearest sales office or distributor—and ask for them.

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MUrdock 7-3770

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807

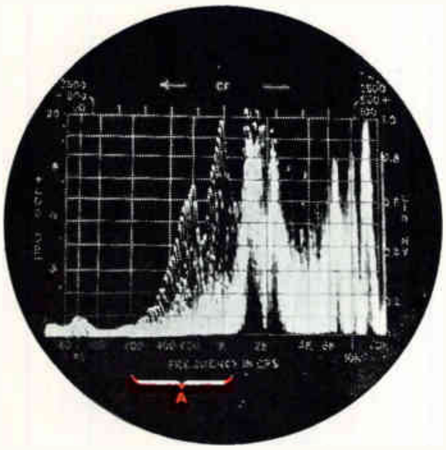
Chicago, Illinois
5750 West 51st Street
POrtsmouth 7-3500

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560

DELCO RADIO
DEPENDABILITY
RELIABILITY

Division of
General Motors
Kokomo, Indiana

fast, direct-reading, easy-to-use



"Coast-down" analysis of Gyro Motor by Model LP-1a Spectrum Analyzer. Area A shows decreasing fundamental frequency, resonant rise and decay, and vibration components over 60 successive scans in one minute.

PANORAMIC LP-1a
SONIC SPECTRUM ANALYZER
20 cps-22.5 kc.

HIGHLIGHT FEATURES:

- 1-sec. "quick-look" at entire spectrum (40 cps—20 kc)
- Magnified analysis on reduced sweep widths
- Direct reading frequency—selective voltmeter
- Exceptionally stable circuitry; better than 5 cps/hr.
- Economical
- Simple Operation

The Model LP-1a "quick-look" helps locate and evaluate discrete or random signals *faster* and easier by scanning the entire spectrum logarithmically from 40 cps to 20 kc. Once every second it automatically separates, measures and plots the frequency and voltage of waveform components on the calibrated X and Y axes, respectively, of a long persistence 5" CRT.

For very detailed analysis, linear segments 40 to 5000 cps wide, centerable between 0 and 20 kc, may be magnified on the screen. Amplitude ratios of up to 40 db can be simultaneously measured.

High sampling rate and panoramic displays assure

1. Minimum risk of missing weak signals or spectrum holes.
2. Fast measurements by eliminating slow point by point plots.
3. Simultaneous measurement of signals with widely divergent amplitudes and/or frequencies.
4. Continuous analysis of rapid changes in spectral content or design parameters.

Proved in hundreds of research, design and production installations, the LP-1a is a valuable tool for Noise and Vibration analysis. Harmonic and IM measurements. • General waveform studies. • Power Spectral Density analysis. • Response Curve Tracing.

SUMMARY OF SPECIFICATIONS:

Frequency Range: 20 cps—22.5 Kc.
(1) Preset linear frequency scans: any segment width of 200, 1000, 5000 cps centerable from 0-20 Kc : Variable from 40 cps to 5000 cps with Auxiliary Function Unit C.
(2) Preset Log Scan—40 cps to 20 Kc

Frequency Scales: Linear and Log

Center Frequency Control: Calibrated 0-20 Kc (used on lin scan)

Dynamic Range: 60 db

Amplitude Scales: Linear and 2 decade log (Expandable to 60 db)

Sensitivity: 500 μv to 500 v for full scale linear deflection

Voltage Accuracy: Lin Sweep (40 cps—22.5 Kc) : $\pm$5% or $\pm$0.5 db. Log Sweep (40 cps—20 KC) : $\pm$10% on lin ampl. scale, $\pm$1.5 db on log ampl. scale.

Scan Rate: 1/sec., internally generated; adjustable with accessory equipments

Resolution: For log scan, automatically optimized. For lin scan, preset 30, 75 and 170 cps at 200, 1000 and 5000 cps sweepwidth, respectively. Variable from 10 cps to 1 kc with Auxiliary Function Unit C.

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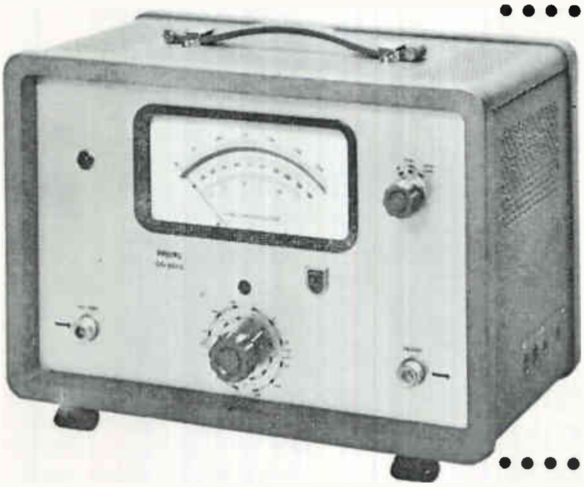
Input impedance:	1 MΩ (± 1.5 %) in parallel with 20 μμF	100 MΩ (± 1.5 %) in parallel with 10 μμF
Overall accuracy:	with respect to full scale ± 3 %	
Pre-deflection:	< 5 μV	
Drift:	1 μV per hour after 1 hour of warming-up	

Automatic polarity indication

DC currents may be measured directly from 100 μμA (f.s.d.) up to 10 μA



L F Millivoltmeter, type GM 6012

Frequency range:	2 c/s - 1 Mc/s
Measuring range:	1 mV (f.s.d.) - 300 V in 12 steps
dB scale:	−80 dB up to +52 dB (0 dB = 1 mW into 600 Ω)
Input impedance:	4 M Ω in parallel with 20 μμF (up to 3 V); 10 M Ω in parallel with 10 μμF (in the other ranges)
Overall accuracy:	with respect to full scale ± 2.5 %, 5 c/s - 100 kc/s ± 5 %, 2 c/s - 1 Mc/s
Pre-deflection:	< 100 μV

HF Millivoltmeter, type GM 6014

	without pre-attenuator	with pre-attenuator
Frequency range:	1 kc/s - 30 Mc/s	10 kc/s - 30 Mc/s
Measuring range:	1 mV (f.s.d.) - 300 mV in 6 steps	100 mV (f.s.d.) - 30 V in 6 steps
dB scale:	−80 dB up to -8 dB	−40 dB up to +32dB
Damping at 10 kc/s:	1 MΩ	50 MΩ
1 Mc/s:	700 k Ω	10 MΩ
30 Mc/s:	50 k Ω	2 MΩ
Input capacitance:	7 μμF	2 μμF
Pre-deflection:	compensated by electrical zero setting	

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Overall accuracy: ± 3 % with respect to full-scale and with reference to the frequency characteristic

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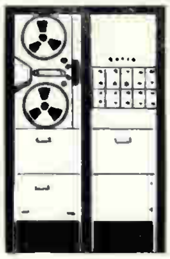

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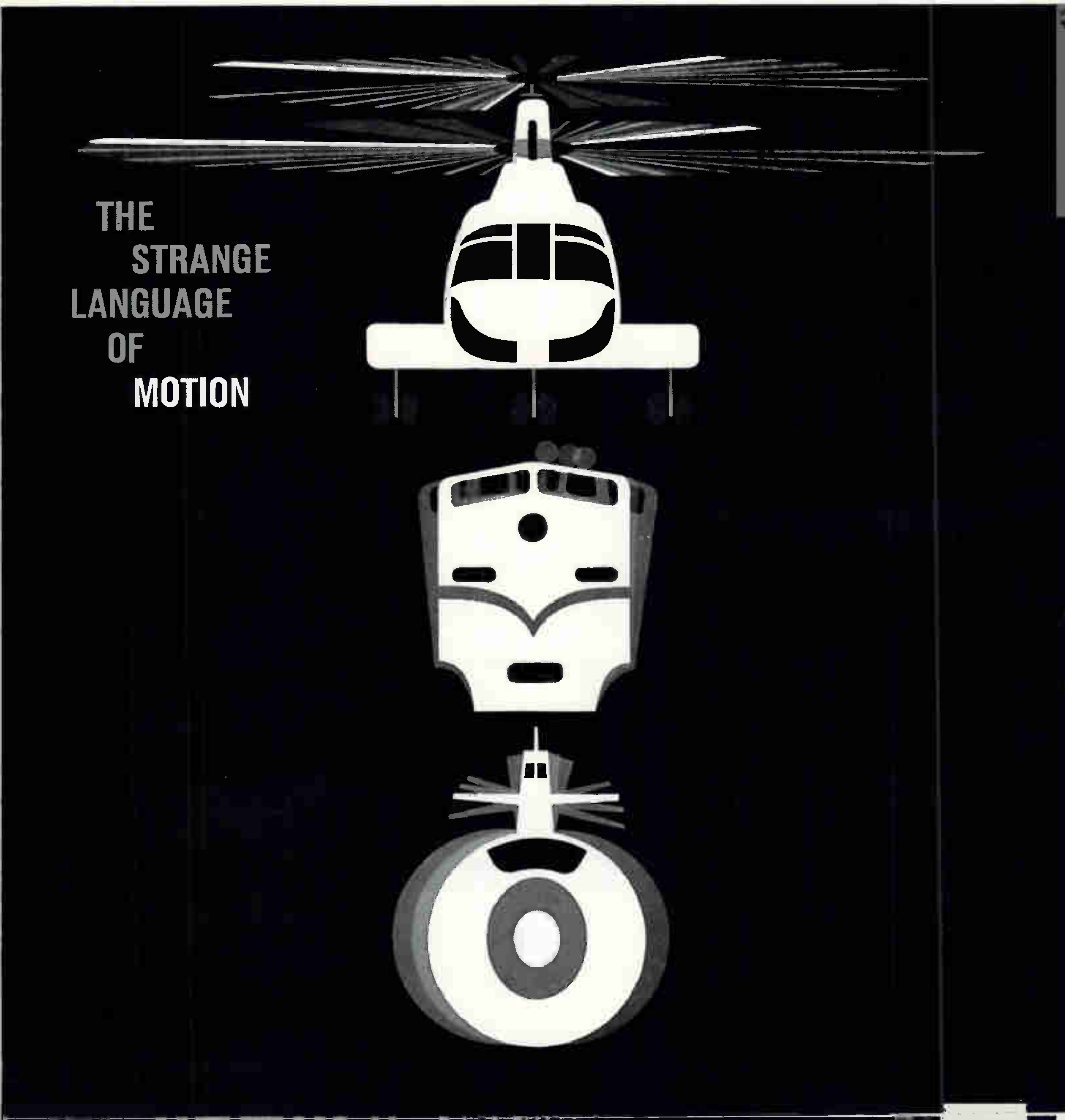

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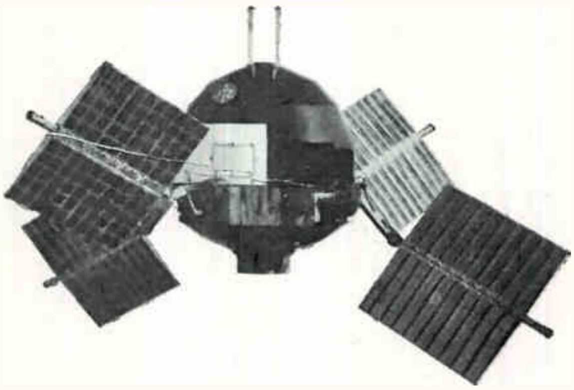

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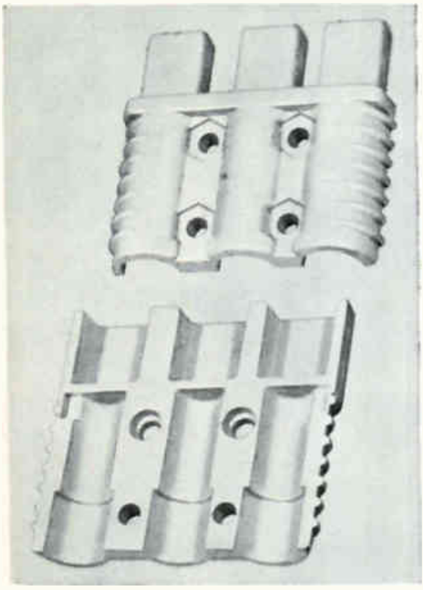

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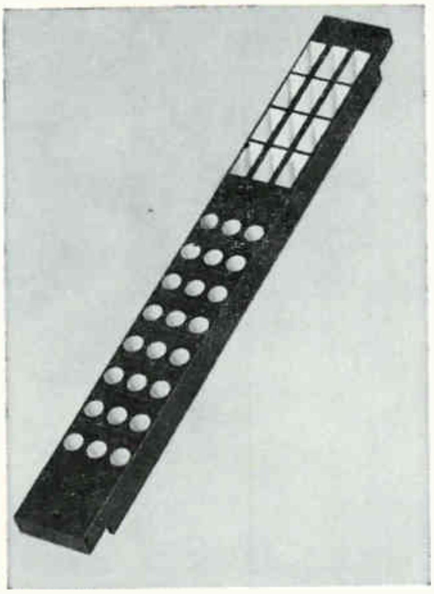

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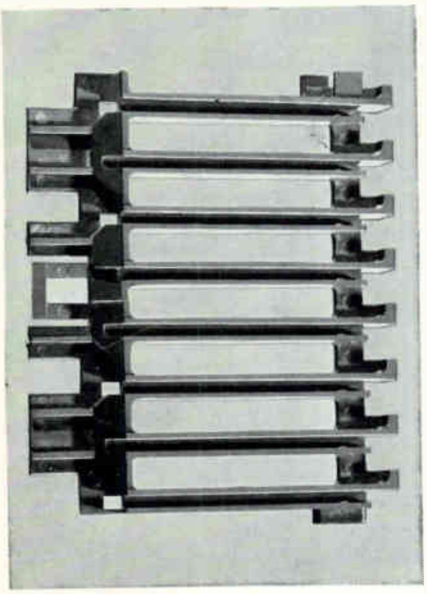

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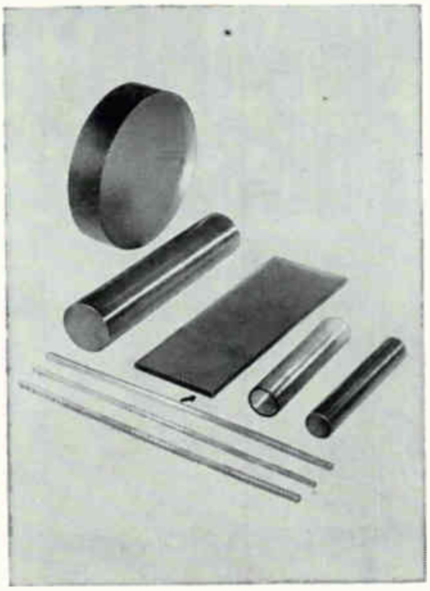

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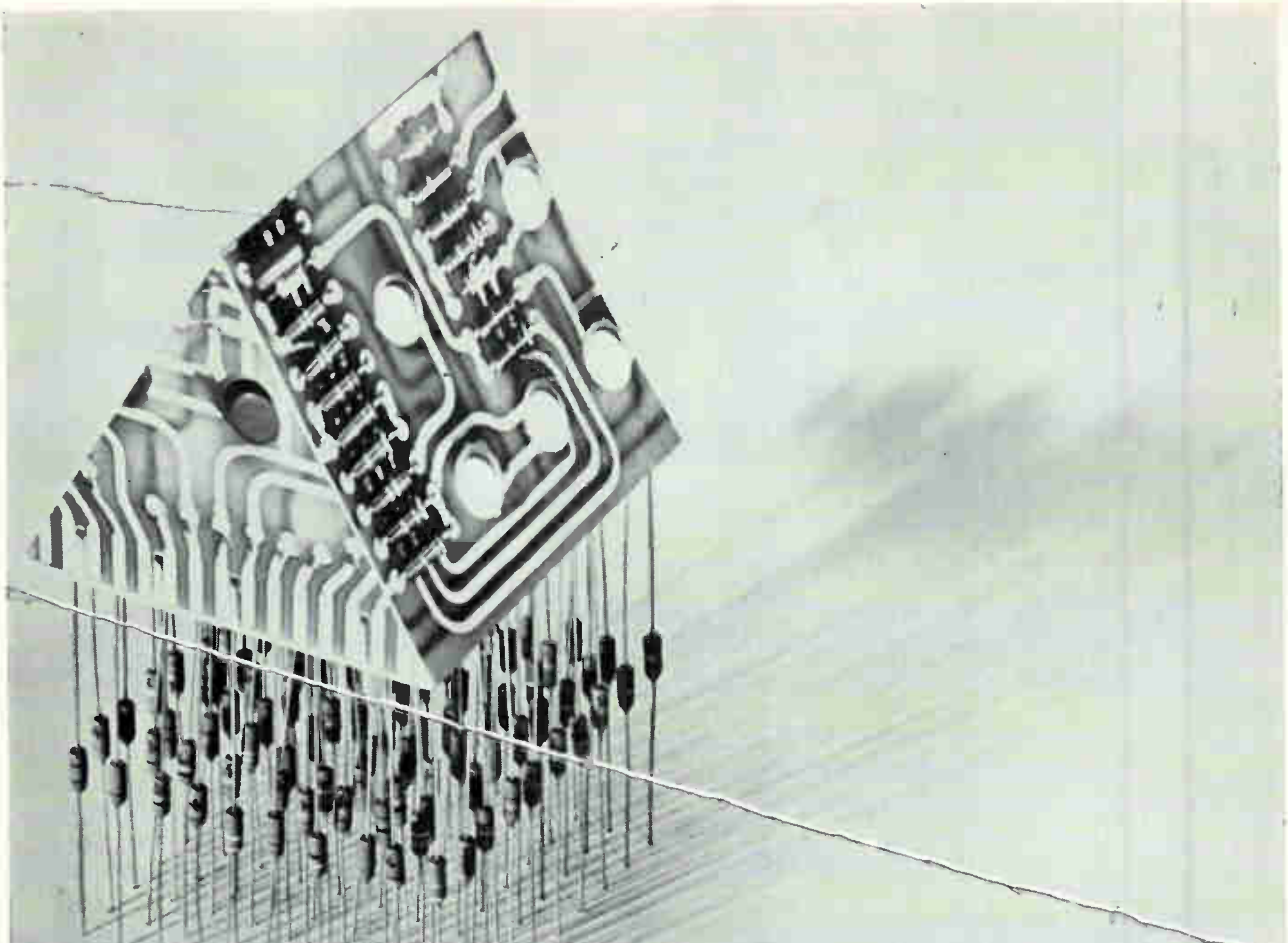

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1N935A	8.55 – 9.45	±.01	–55 to +100	20
1N935B	8.55 – 9.45	±.01	–55 to +150	20
1N936	8.55 – 9.45	±.005	0 to +75	20
1N936A	8.55 – 9.45	±.005	–55 to +100	20
1N936B	8.55 – 9.45	±.005	–55 to +150	20
1N937	8.55 – 9.45	±.002	0 to +75	20
1N937A	8.55 – 9.45	±.002	–55 to +100	20
1N937B	8.55 – 9.45	±.002	–55 to +150	20
1N938	8.55 – 9.45	±.001	0 to +75	20
1N938A	8.55 – 9.45	±.001	–55 to +100	20
1N938B	8.55 – 9.45	±.001	–55 to +150	20
1N939	8.55 – 9.45	±.0005	0 to +75	20
1N939A	8.55 – 9.45	±.0005	–55 to +100	20
1N939B	8.55 – 9.45	±.0005	–55 to +150	20

†Measured by superimposing .75 mA rms AC on 7.5 mADC

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Type 1N430, introduced by Hoffman in 1955.

Type 1N1530, introduced by Hoffman in 1957.

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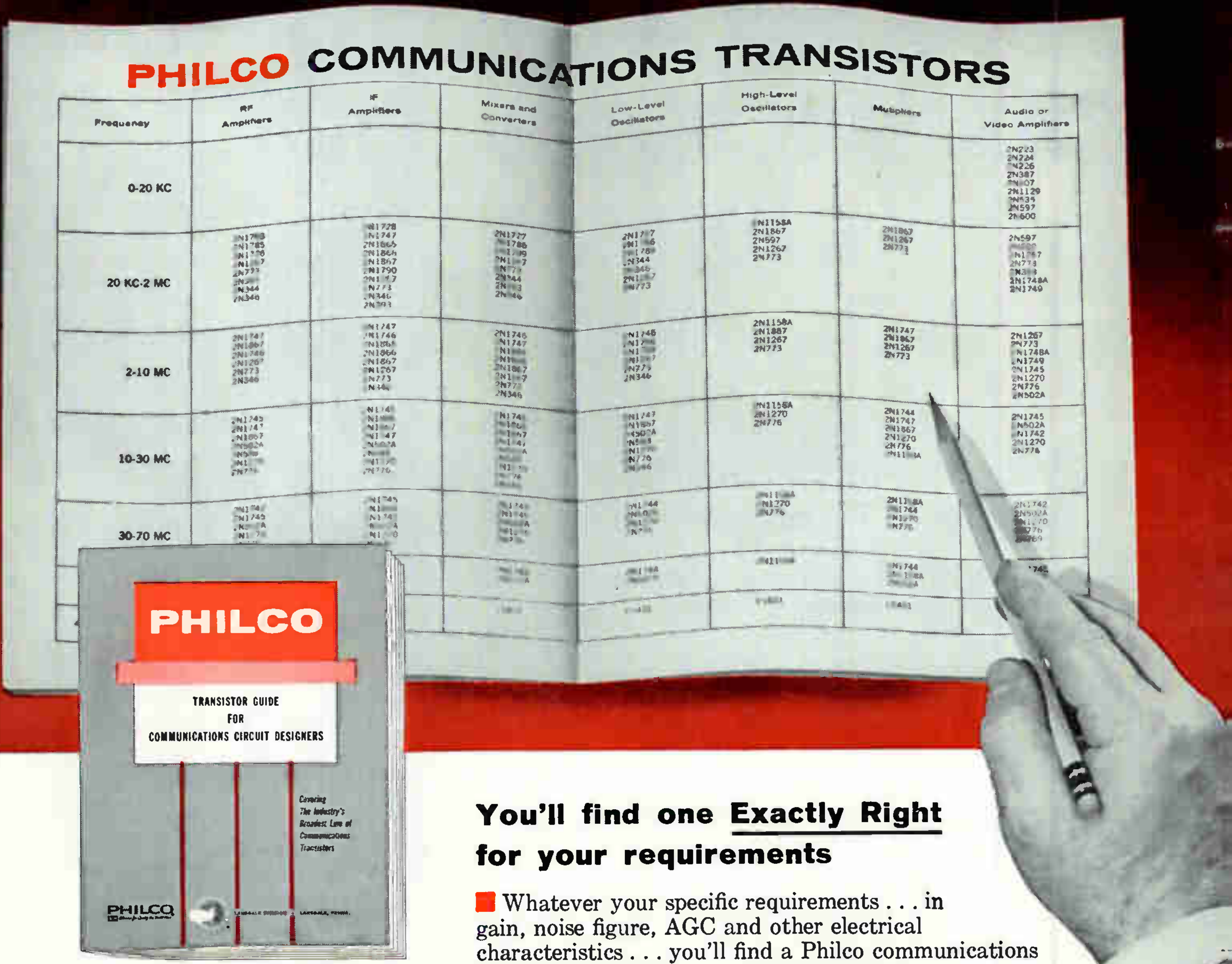

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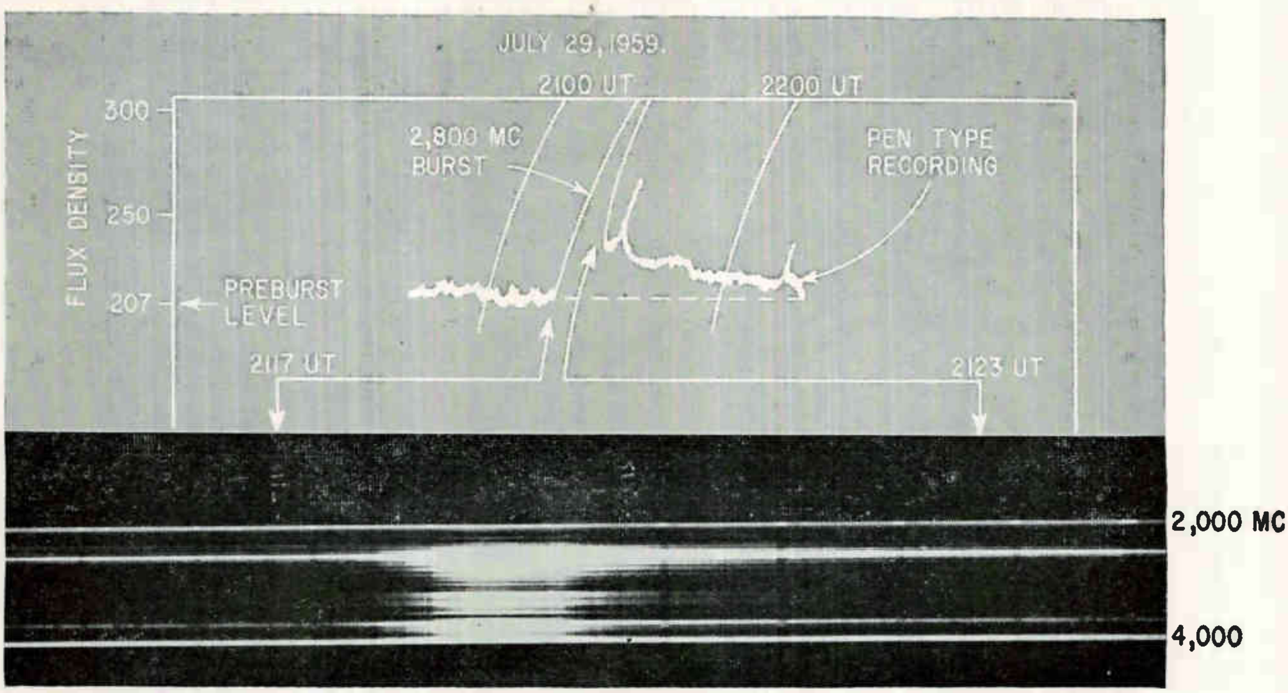

Strip film recording made with swept frequency receiver (bottom) compared with pen type spot frequency recording (top) showing typical solar storm

Microwave Swept Receiver Uses Zero Intermediate Frequency

Swept frequency receiver allows observation and display across a broad microwave frequency spectrum. Use of a zero frequency i-f improves the noise figure, eliminates images and permits use of simple video i-f amplifiers

By DWIGHT W. CASEY II,
Senior Engineer,
Kellogg Space Communications Laboratory, ITT, Fort Wayne, Indiana

PREVIOUS swept-frequency solar radiation measurements were conducted to frequencies of approximately 600 Mc[1], while S-band measurements have been carried out on a spot-frequency basis[2] only. The S-band swept receiver permits continuous reliable measurement of solar radiation throughout the range of 2,000 to 4,000 Mc. The system was designed and built for the Observatory of the University of Michigan, Ann Arbor, Michigan, under contract 311929 (NONR-1224(16)).

The S-band swept receiver is a wide-band superheterodyne with an electronically swept local oscillator and zero-frequency i-f. A sweep rate of 10 cps is provided, although the receiver can be switched to manual operation for spot frequency observations. Some features of the receiver include high sensitivity (−97 dbm for a 5-Mc r-f bandwidth), extreme gain stability with time and uniformity over the band, minimum noise figure, maximum noise figure versus frequency stability, elimination of image-frequency rejection through the use of zero-frequency i-f and accurate noise figure and system gain calibration.

The equipment consists of an r-f head, high-voltage sweep control unit and control and display racks.

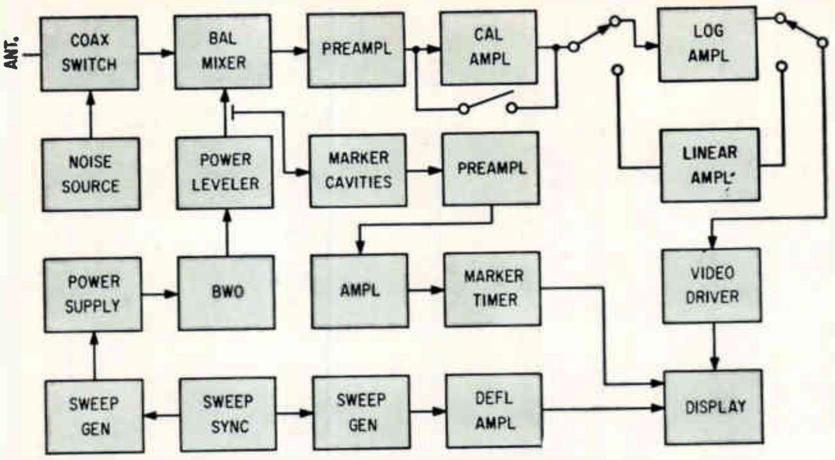

FIG. 1—Block diagram of the S-band swept receiver

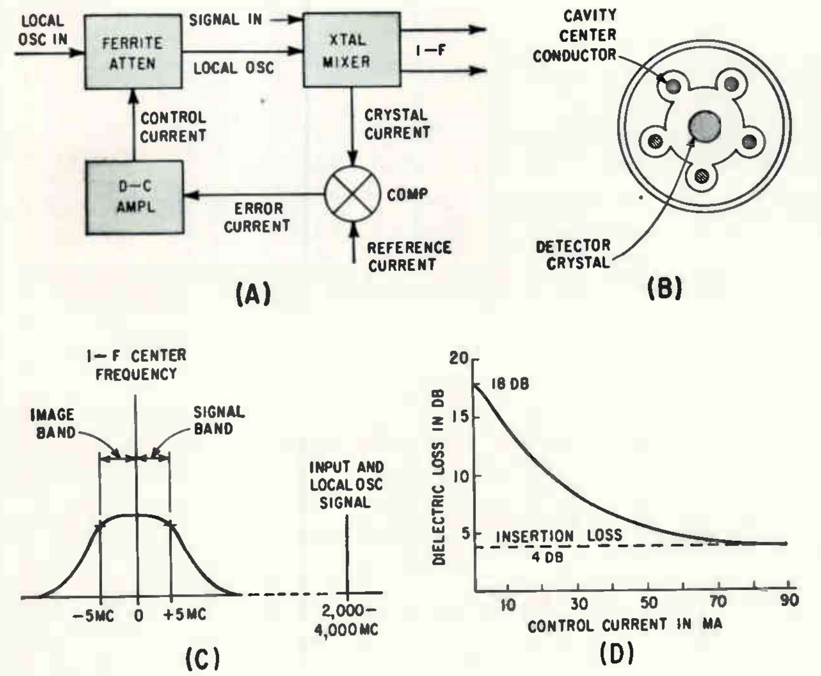

FIG. 2—Crystal current control circuit (A), arrangement of frequency marker cavities (B), i-f bandwidth and center frequency curve (C) and ferrite attenuator loss curve (D)

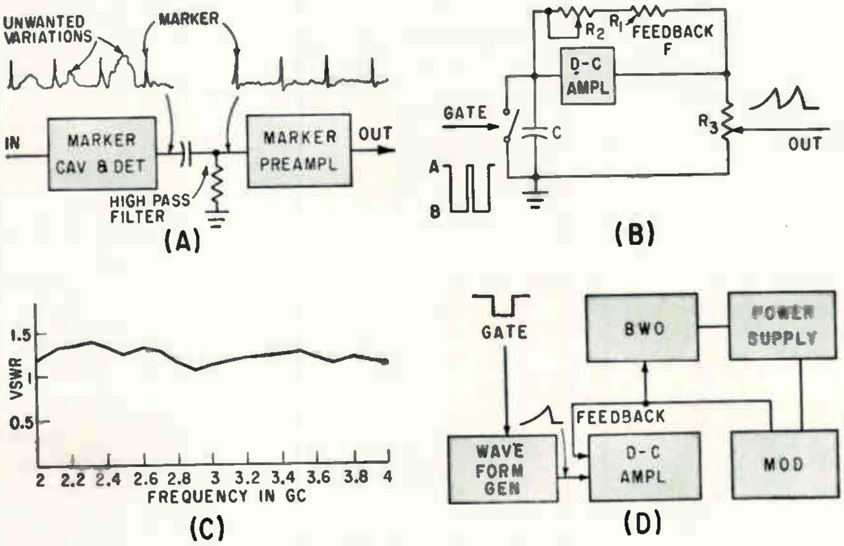

FIG. 3—Marker R-C high-pass filter (A), exponential sweep waveform generator (B), noise source (C) and local oscillator sweep control (D)

A functional **block diagram** is shown in Fig. 1.

The r-f head unit, packaged for mounting at the feed point of a parabolic-reflector antenna, consists of an S-band calibrated noise source, coaxial switch, balanced hybrid mixer, zero-frequency i-f preamplifier, ferrite-electronic local oscillator power leveler, marker cavities and detector and marker preamplifier. Video and marker signals are transmitted through coaxial cables to the remote control and display racks. The control rack contains a calibration video amplifier, switch-selected log and linear-video amplifiers, video driver amplifier, marker amplifier and timer system, sweep synchronizer, deflection sweep generator and amplifier, system low-voltage power supplies and manual system controls. The display rack holds two high-resolution cathode-ray tubes and high-voltage power supplies and a system low-voltage power supply.

The high-voltage sweep-control unit at the base of the antenna pedestal houses the backward-wave local oscillator and all high-voltage power supplies and control circuits for automatically or manually sweeping or tuning the local oscillator. Local-oscillator power is fed through a low-loss cable to the r-f head.

Protective circuits and devices are provided to guard against equipment failure or malfunction.

The main functions of the r-f head unit are to convert r-f energy to i-f energy and provide for system calibration. The unit also contains marker and video i-f preamplification. Location of the r-f head at the antenna, and i-f preamplification are necessary to maintain minimum system noise figure.

A broadband coaxial switch, with 0.1-db insertion loss and 60-db isolation, couples power to the receiver either from the antenna or from the calibrated noise source. The switch is manually and remotely controlled from the control rack.

A balanced mixer, consisting of a 3-db hybrid directional coupler and 1N21E and ER crystals, accepts signal power from the coaxial switch. Although crystal mounts represented a difficult design problem, the mixer provides a response that is flat within 0.5 db across the band.

Mixer crystal current is stabilized against conversion loss variations (gain and noise-figure variations) due to local oscillator power fluctuations. An electronic control circuit with a current-sensitive ferrite attenuator insures constant and stable crystal current. The ferrite attenuator is a ferrite dielectric, the conductivity, or loss, of which is determined by an induced electric field. The field strength depends upon the amount of direct, or control, current passed through a coil surrounding the dielectric. Figure 2D is a graph of the dielectric loss, in decibels, as a function of control current in the coil. When the current is zero the attenuator loss is approximately 18 db. At maximum current the loss approaches a constant value of 4 db, this being the insertion loss of the attenuator. Thus, a dynamic S-band attenuation range of 14 db is realized as the control current is varied from 0 to 80 milliamperes.

The crystal current control circuit is shown in Fig. 2A. The current is compared with a predetermined reference current and the error drives a transistorized chopper-stabilized d-c amplifier. The amplifier output current controls the ferrite attenuator. The attenuator, depending on the error polarity, increases or decreases the local oscillator power to the mixer, thus stabilizing the mixer crystal current.

Operation of the mixer is such that the separate i-f outputs are in phase with desired signals, but are 180 degrees out of phase with local-oscillator contributed noise. Signal addition and local-oscillator noise cancellation are performed in the first stage of the zero-frequency i-f preamplifier.

To eliminate the problem of image rejection, zero-frequency i-f techniques are used. Zero-frequency i-f connotates an intermediate center frequency of zero cycles a second or a local-oscillator frequency coincident with that of the incoming signal. Figure 2C is a diagram of bandwidth and center frequency. The signal band extends from zero to 5 Mc (the bandwidth of the video i-f amplifier). The image band extends from zero to minus 5 Mc. Although the image band still introduces system noise, it now contributes the same desired signal as the signal band. It is as if the image and signals bands were folded, yielding a maximum of 3 db more signal over that of a conventional receiver while causing no increase in the apparent receiver noise level. This method allows up to 3 db improvement in noise figure, eliminates the image rejection problem and permits the use of simple video amplifiers in place of conventional i-f amplifiers.

The separate i-f outputs of the crystal mixer are each transformer coupled to separate video cascode amplifiers. The cascode configuration, consisting of type 6688 tubes triode connected, in both the grounded-cathode and grounded-grid sections, is used to obtain minimum noise-figure. The cascode units share a common load resistor. Desired signals are added while local oscillator noise is cancelled. The lower frequency cutoff of the amplifiers is 75 Kc to prevent the noise-figure deterioration effects of inverse-frequency crystal noise.

The cascode output signal is amplified by two feedback-pair video amplifiers to a level suitable for coaxial-line transmission to amplifiers in the control rack.

Frequency markers are obtained at 500 Mc intervals in S-band from five resonant cavities. The cavities and crystal mount are integrated into a unit that measures 1¾ inches in diameter by 3⅝ inches long. The layout consists of a coaxial crystal mount surrounded by five coaxial resonant cavities as shown in Fig. 2B. The resonators (cavities) are inductively coupled to the central coaxial line such that each resonator acts as a bandstop filter at resonance. Each cavity is independently tuned to a marker frequency, hence, the detected output exhibits a sharp dip when the input frequency from the local oscillator sweeps across a cavity frequency.

Since unwanted, although slower, voltage variations appear at the detected output with the markers, an RC high-pass filter shown in Fig. 3A passes the markers and attenuates the slower unwanted variations. The markers are amplified by the marker preamplifier of three feedback-pair video amplifiers to a level suitable for coaxial-line transmission to the control rack.

A noise source was designed for this equipment using a fluorescent light as a gas discharge tube. The unit consists of a waveguide mount for the discharge tube that impedance matches generated noise to the H_{10} waveguide mode. A transition from the waveguide mode to coaxial line furnishes a good impedance match over the entire range of 2,000 to 4.000 Mc. The overall vswr of the noise source is shown in Fig. 3C. The noise source is operated from the control rack.

The first noise source tried was the coaxial type using a neon gas discharge tube. Three units of the same model were tried in succession, but each exhibited the same detrimental characteristic. The gas discharge arc was not stable but moved cyclically at 50 Kc. Local oscillator power entering the noise source from the mixer was modulated at this rate and fed back to the mixer whereupon a 50 Kc component was added to the noise entering the preamplifier. This component completely masked the calibration noise. Varying the noise source current and/or changing the gas pressure of the discharge tube had no effect.

To cover the range of 2,000 to 4,000 Mc continuously, a local oscillator of the backward-wave type is swept electronically at 10 sweeps a second in synchronism with the cathode-ray tube display sweep.

A backward-wave oscillator requires that the helix voltage be varied exponentially to insure a linear frequency-time relationship. To provide this characteristic, an exponential waveform generator is used and is shown in Fig. 3B. The generator is a gated bootstrap circuit using positive feedback to derive the exponential waveform. The switch in Fig. 3B is a gated triode. When the gating pulse is at level B the switch (triode) is open and capacitor C starts to charge. The rate of charge is determined by the time constant $(R_1 + R_2)C$ and the amount of positive feedback F. The amount of feedback is greater than unity and is chosen such that the charging current increases as a function of time. For the duration of the gating pulse, capacitor C charges in an increasing exponential manner and the voltage waveform is that shown at the output. During the time the gating pulse is at level A however, the switch (triode) is closed and capacitor C rapidly discharges. Potentiometer R_2 controls the charging rate of the capacitor, hence the exponential waveform, insuring the correct sweep waveform for a linear BWO frequency-time variation. Potentiometer R_3 is a sweep amplitude control; the amplitude being variable from zero to 30 volts. Adjustments R_2 and R_3 permit replacement of BWO's whose characteristics vary somewhat from tube to tube while maintaining a linear frequency sweep to within ±5 percent.

Since the sweep voltage range is about −3,000 volts, a fixed high-voltage power supply (−4,000 volts maximum and regulated to 0.1 percent) is provided. A block diagram of the backward-wave oscillator control is shown in Fig. 3D. The backward-wave oscillator and sweep control tube (modulator) are series connected across the high-voltage supply. The collector of the backward-wave oscillator is at ground potential while the cathode of the modulator, a constant-current device, is returned to the high-voltage tap. Thus the helix voltage of the backward-wave oscillator is controlled by varying the control-grid level and hence the plate voltage of the modulator. To accomplish this in a stable manner, a d-c amplifier is provided between the bootstrap waveform generator and the sweep-control tube (modulator), with voltage feedback from the backward-wave oscillator cathode to the input of the d-c amplifier. A large amount of d-c, and sweep signal stabilization is realized, thus insuring minimum frequency drift and maximum sweep linearity.

Power-supply ripple and control-loop pickup have been minimized to prevent undesirable frequency modulation of the backward-wave oscillator power output. The output power, which varies approximately 8 to 10 db over the frequency range, is coaxially coupled to the r-f head.

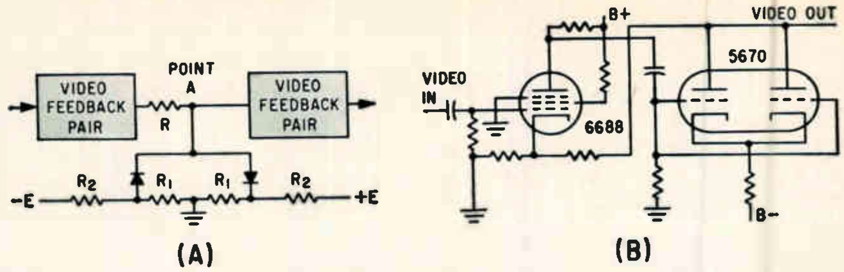

FIG. 4—Interstage diode gain switching circuit (A) and typical video feedback pair (B)

Extensive use of protective devices and circuits in the local oscillator sweep control unit prevents damage to the backward-wave oscillator and power supplies due to primary power interruptions or component failures.

Video signals from the r-f head unit are amplified by a cable-terminating unit, logarithmic or linear video amplifiers and a video driver unit. The output of the video driver is sufficient to drive the grid of the cathode-ray display tube. All amplifiers feature feedback-pair construction to insure a maximum of gain stability as a function of time. Figure 4B represents a typical feedback pair. Types 6688 and 5670 tubes make up the feedback pairs in all but a few instances where the type 5687 tube is substituted to accommodate high signal levels. The tubes have a minimum transconductance variation with time thus contributing toward long-time gain stability. The 6688 tube is connected as a pentode amplifier for maximum gain. The output of the 6688 is capacitively coupled to the 5670. The 5670 triode uses both triode sections in parallel for maximum g_m and minimum r_p to obtain a wide bandwidth at a voltage gain of approximately 2 to 1. Cathode degeneration is used in the triode amplifier to further stabilize the transconductance. Negative voltage feedback is obtained by directly coupling the plate circuit of the triode amplifier to the cathode circuit of the 6688. The feedback factor is the ratio of the 6688 cathode resistor to the plate load resistance of the 5670. A feature of the incorporated pair, due to the large amount of negative voltage feedback, is low dynamic output impedance.

Since the video bandwidth cannot be stabilized with feedback-pair techniques, each amplifier is maintained at approximately 3 to 4 times the overall video bandwidth. The cable-terminating amplifier contains three stable LC low-pass filters of constant-k configuration that provide accurate selectable video bandwidths of 5.0 Mc, 2.5 Mc and 1.0 Mc. Thus, passive filters maintain stable system bandwidths independently of amplifier bandwidth variation.

The logarithmic amplifier, designed by a derived mathematical technique, compresses a 60 db input range to a 20 db output range, approximately a true logarithmic characteristic within ±1 db. Type 6688 and 5670 tubes are used as feedback pairs (see Fig. 4B), the amplifier consisting of seven pairs. Interstage diode gain-switching techniques provide the compression characteristic. A typical diode interstage is shown in Fig. 4A. Two diodes are provided for bipolar compression. The diodes are normally biased to the off condition by voltage divider resistors R_1 and R_2. The diode bias voltages are equal, but of opposite polarity, and correspond to the signal level (point A) at which the diodes will conduct. At signal levels below that required for conduction, the diodes are cut off, presenting a high impedance, and the interstage signal voltage loss is negligible. However, when the signal exceeds the bias voltage the diodes conduct and assume a low impedance. Since the diode impedance is negligible, the interstage becomes a voltage divider consisting of R and R_1 and the ratio $R_1/(R + R_1)$ determines the compressed signal level at point A.

A maximum amplifier voltage gain of 2,000 (66 db) is realized and a gain control at the amplifier output provides better than 10 to 1 control.

The linear amplifier, for use in the presence of low-level signals, provides a 40 db dynamic voltage range, linear to within ±5 percent. This amplifier consists of seven feedback pairs. Interstage coupling is of the normal RC type. A maximum voltage gain of 18,000 (85 db) is realized and an output gain control covers better than a 10 to 1 range.

The video driver unit consisting of a feedback pair is designed for maximum gain stability and output dynamic voltage range. This feedback pair uses a 5687 dual triode with the triode sections paralleled in place of the 5670 tube. This substitution permits up to 40 volts peak-to-peak linear drive to the display tube. Two outputs are provided, one direct (nonvariable) and the other amplitude controllable over a wide range. The dual output permits simultaneous drive to the display tube and monitoring with a pen-type recorder.

Frequency markers from the marker preamplifier in the r-f head unit are fed to the marker control circuit. Three feedback-pair stages amplify the markers to a level of 5 volts. The signals are then fed to a Schmitt trigger circuit. A trigger sensitivity control is adjusted so that the Schmitt circuit will switch at a trigger level of 3½ volts. Therefore, the circuit responds to the 5-volt marker pulses but is insensitive to the lower amplitude noise and unwanted variations. The output voltage of approximately 60 volts amplitude is sufficient to drive the blocking oscillator output stage to provide well defined 10 microsecond marker pulses. The low-impedance output, provided with a gain control, is serially connected to a time-coded clock switch that passes the marker pulses at preset time intervals. Since marker signals are mixed with the video information at the output of the video driver amplifier, a series diode prevents undue loading on the driver.

A free-running unsymmetrical multivibrator synchronizer provides time coincidence between the local oscillator and display-tube sweeps. The sweep duration time is 90 milliseconds, while the retrace time is 10 milliseconds yielding a 10 cps sweep rate. One output from the multivibrator gates the sweep circuits for the local oscillator, while a second provides retrace blanking for the cathode-ray tube. A third output gates the cathode-ray tube horizontal sweep circuit. The sweep generator, a bootstrap design, provides a linear sawtooth voltage at the 10-cps rate. The sweep generator is similar to the exponential waveform generator in that positive current feedback is used. Loop gain is unity and the waveform is a linearly increasing voltage as a function of time. The low impedance output is amplitude adjustable and drives the horizontal deflection amplifier. The deflection amplifier is directly coupled and uses 40 db of negative current feedback. The feedback is required to assure that the horizontal deflection coil drive current is a linear function to within ±1 percent of the input sawtooth voltage.

The indicator tube has a resolution of 1,400 lines across the 5 inch face, and is magnetically focused and deflected. Video and marker signals are applied to the control grid to obtain an intensity-modulated display. Since the horizontal display sweep is linear and synchronous with respect to the local-oscillator sweep, the trace is calibrated directly in frequency. The display appears in a moving film as a raster thus adding time as a third dimension. Retrace blanking R is applied to the cathode.

The cathode-ray tube high-voltage power supply is regulated to better than 1 percent and is delay-relay controlled to prevent premature application of high voltage.

For absolute measurement of solar noise power over the entire frequency range, the receiver must be calibrated with respect to absolute noise level or noise temperature. A calibrated S-band noise source, a highly gain stabilized (better than 0.01 db per day) video calibration amplifier and a calibrated switch-type attenuator are used. The calibration system transfers the input to the balanced mixer through the coaxial switch from the antenna to the S-band noise source which has a well defined noise level or temperature. This known noise temperature produces a density on the output recording film. The video amplifier attenuator is decreased in steps of 1 or 2 db and the output levels are recorded as stepped calibration densities on the film. Recorded film densities due to solar radiation can be compared to the calibration densities, or gray levels, to determine absolute power.

To maintain a relatively stable noise figure and gain characteristic it was necessary to temperature control the r-f head unit because large temperature fluctuations of the mixer cause excessive conversion-loss variations and hence gain and noise-figure fluctuations. Careful design of microwave components is the main contribution to uniform characteristics over the bands while gain-time stability is realized through extreme gain stabilization of all amplifiers.

The first sweep-frequency recording of solar electromagnetic radiation covering 2,000 to 4,000 Mc made by the University of Michigan using the receiver is shown in the lead photo. The data was recorded in 1959 and was substantiated at the same time by A. E. Covington in Ottawa, where it was recorded at a spot-frequency of 2,800 Mc one minute earlier.

Although the receiver was originally designed for measurement of solar electromagnetic radiation, its use and application of incorporated techniques are not limited to solar studies or to S-band. These techniques are directly applicable to L, C, X and higher bands.

Extended applications of the developed techniques include accurate calibration and range extension of radar systems, ICBM detection, celestial navigation, measurement of absolute antenna gain, or wherever wide-band, low noise, gain stable receiver characteristics are required.

The author acknowledges his associates of the Space Communications Laboratory, Fort Wayne Division of ITT Kellogg, for their efforts in the design and development of the equipment. Special thanks are also due personnel of the Observatory of the University of Michigan who made the program possible.

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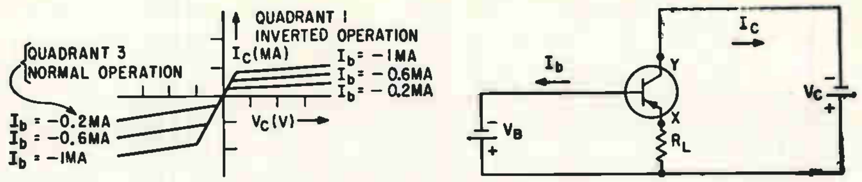

FIG. 1—Static characteristics of pnp transistor

Complementary Transistors Simplify Modulator Design

Complementary transistor modulator has carrier and signal suppression at output, gain greater than 3 db and high linearity. Used with teleprinters, speech scramblers and ssb transmitters

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THE COMPLEMENTARY transistor modulator[1] is a low powered device that offers these advantages: carrier and signal suppression at the output; available gain greater than 3 db; only one transformer necessary (complementary transistors eliminate the second transformer); high linearity; and no special power supply voltages. The ring modulator using four solid-state diodes, which has an insertion loss of at least 3 db, offers similar advantages. However, the gain of the complementary transistor modulator is approximately 7 db higher.

The developmental modulator discussed here was equipped with complementary symmetrical transistors: Sylvania small-signal, a-f experimental types GT942 and GT939. All measurements were made at low frequencies (3 Kc and 250 cps). Thus, this modulator cannot be used above approximately 20 Kc without substituting transistors suitable for higher frequencies. Requirements for complementary symmetry are not high, however. From twelve randomly selected transistors all could be balanced by adjustment of a 10K balancing potentiometer. Any set of *npn* and *pnp* transistors with comparable characteristics could have been used.

Circuits using complementary symmetry make use of two properties exhibited by *pnp* and *npn* junction transistors[2]: (1) Under normal bias, the current flowing in each electrode of a *pnp* transistor is the opposite of the corresponding electrode current in an *npn* transistor. (2) The polarity of an input signal necessary to increase conduction in a *pnp* transistor is the opposite of that necessary to increase conduction in an *npn* transistor.

In this modulator, the transistors work in both modes of operation, normal and inverted.

In Fig. 1 the *pnp* transistor is biased for normal operation in a common collector configuration. Terminal *X* designates the emitter of the transistor and *Y* designates the collector. With a negative bias on the collector and base, the current through the load is negative since it produces a negative voltage across R_L with respect to ground. Curves for normal operation are in quadrant 3.

If collector bias is reversed, the *Y*-terminal becomes the emitter, *X* the collector, and the collector current flows in the opposite direction (quadrant 1) through the load. The circuit becomes a common emitter configuration because the former (normal operation) collector-base diode is now forward biased (low resistance) and the former (normal operation) emitter-base diode is now reverse biased (high resistance direction)[3]. Current is lower because the α inverted is lower than the α normal, approximately 0.8 as compared to 0.99 (bilateral transistors with equal α's in both directions are available). Inverted and normal operation are used to achieve signal and carrier suppression in the output.

Potentiometer R_b ($R_{b1} + R_{b2}$ in Fig. 2A) is used for the balancing of *pnp* and *npn* transistors with

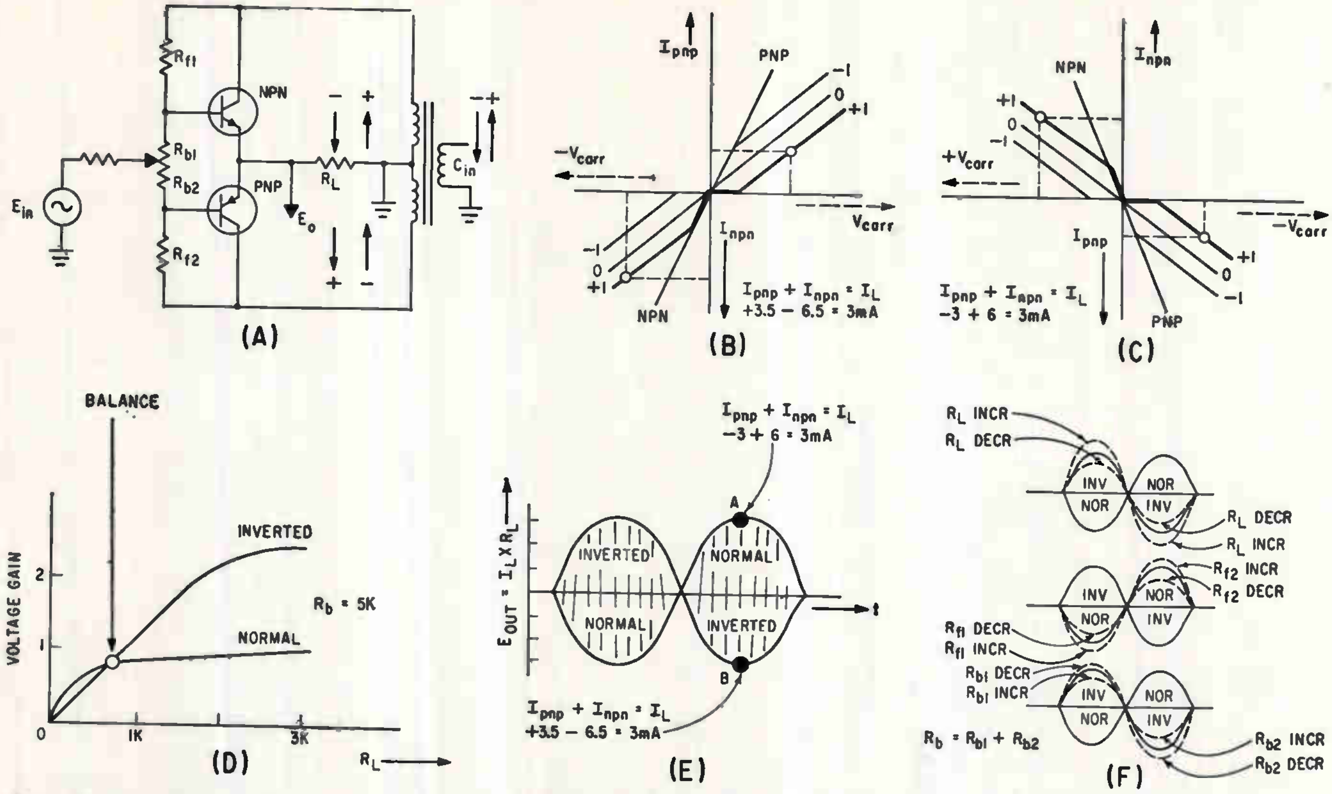

FIG. 2—In (A), R_b balances pnp and npn transistors with unequal characteristics. In inverted operation (B), each transistor works as common emitter configuration. In normal operation (C), transistors work as common collector circuit with voltage gain near one. Voltage gain of modulator is made equal in normal and inverted mode by varying R_L (D). Desired output waveshape for both modes (E). In (F), effects of changing R_L, R_f and R_b

unequal characteristics.

In push-pull, the carrier fed in always biases both transistors at the same time, either for normal or inverted operation.

Feedback potentiometers R_{f1} and R_{f2} have been inserted to adjust for fine correction of the asymmetry of the desired output envelope.

The signal is fed in single-ended to the base circuit of each transistor through potentiometer R_b. The carrier is fed in, in push-pull to the modulator, thus biasing both the *npn* and *pnp* transistors, normally for the first half-cycle and inverted for the next half-cycle of the carrier.

The slider of the potentiometer proportions the values of R_{b1} and R_{b2}. Thus, the potentiometer allows the balance of complementary transistors with unequal betas inverted, since in inverted operation each transistor works as a common emitter configuration (Fig. 2B) and the approximate voltage gain for this mode of transistor operation is: $\beta_i R_L/(R_{b1}$ or $R_{b2})$. In normal operation (Fig. 2C) the transistors work as a common collector circuit with a voltage gain near one. Resistors R_{b1} and R_{b2} (R_b = 10 Kohm) have little effect on the output envelope since a common collector configuration has a high input resistance (500,000 ohms).

By making the voltage gain of the modulator equal in the normal and inverted mode (by R_L), the input signal is balanced in the output, that is, the input signal is suppressed (Fig. 2D). Since the transistors work in common collector configuration during the normal mode and in common emitter configuration during the inverted mode, R_L has a different effect on the output voltage gain for each mode. Figure 2D shows the relationship for the transistor parameters of one transistor. The intersection of the two R_b curves delivers the desired balance (equal voltage gains) with a load resistor of 800 ohms.

Figure 3 shows the typical transistor characteristics for the normal and inverted modes of operation of a common emitter configuration. It shows the circuit characteristics for the *pnp* transistor of the modulator using the input voltage (E_{in}) as a parameter. In the inverted mode, compare the slope of the E_{in} curves (Fig. 3B) to the constant current I_B curves in Fig. 3A. This difference arises because in the inverted mode (terminal Y being the emitter) the carrier V_c is in series with E_{in} in the emitter-base circuit. As V_{GY} (V_c) increases so does I_B even though E_{in} remains constant. For the inverted mode of Fig. 3B, I_B is approximately equal to:

$$I_B = \frac{E_{in} + (V_c - I_B R_e)}{R_{b2} + r_b}$$

where R_e = source resistor of the carrier; R_{b2} = *pnp* transistor's section of R_b; V_c = carrier voltage identical to V_{GY} in Fig. 3B and 3C; r_b = transistors base resistance; and I_E = emitter current.

By increasing R_{b2}, the slope of the E_{in} curves and the differential input voltage-output voltage gain

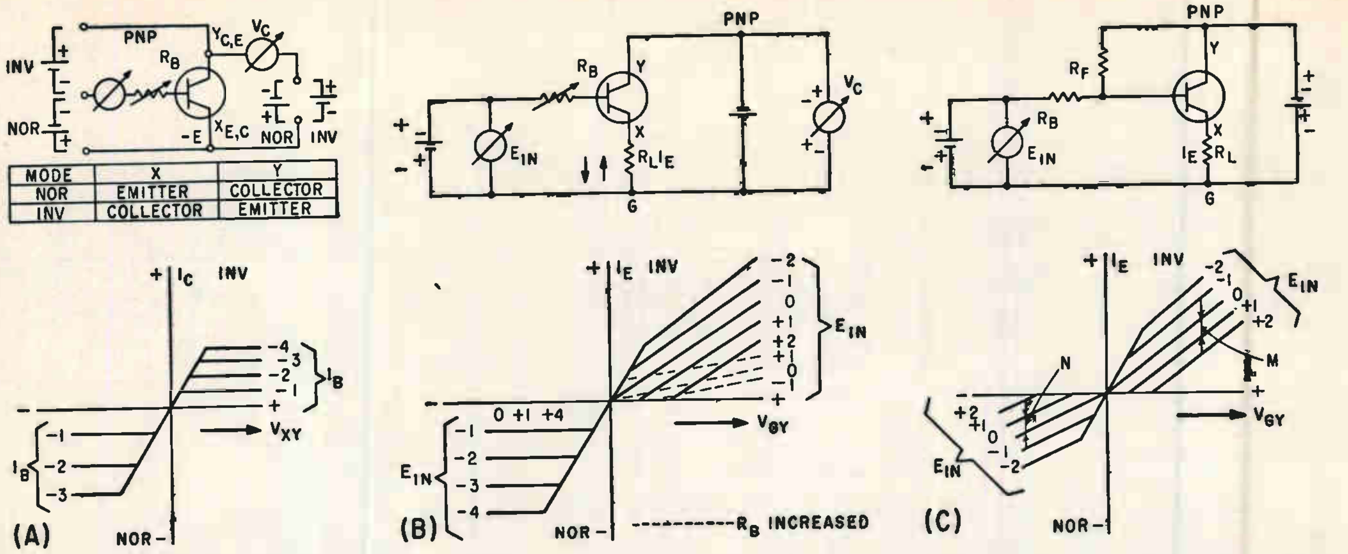

FIG. 3—Circuit characteristics of pnp transistor. Measurement of the normal and inverted mode in common emitter configuration (A); circuit and characteristic as applied in modulator (B); in (C), resistor R_f between collector and base causes normal characteristics to slope by feeding part of carrier current back to the base

can be changed (see Fig. 3B).

In the normal mode (Fig. 3B) the characteristic is still similar to that of Fig. 3A. The input voltage will, therefore, generate output currents only during the negative half period which corresponds to a duty cycle of π. This operation is not desirable because the voltage barrier of the base-emitter diode causes crossover distortion[4] in the modulation envelope. Figure 3C shows that a resistor R_f connecting the collector to the base causes the normal characteristics to slope by feeding a part of the carrier current back to the base, thus prebiasing the base-emitter diode. The duty cycle for E_{in} during the normal mode is now increased to 2π. At the same time the voltage gain of the emitter follower (common-collector) operation can be lowered by reducing R_f, while R_f and R_b act as a voltage divider for E_{in}.

Figures 2B and 2C show the characteristic curves for both the *npn* and *pnp* transistors for the Fig. 2A circuit. Figure 2B shows the characteristic curves for the inverted mode and Fig. 2C for the normal mode of transistor operation. The current corresponding to the positive or negative half cycle of the carrier is generated separately during different time intervals and then superimposed in the common load resistor.

By adjusting R_b, R_f and R_L (Fig. 2F) a balanced bridge network is realized and the output waveshape is similar to that of a switched modulator.

Input voltage controls the current in each transistor. The difference of output currents in the *npn* and *pnp* branch for every instant of the carrier voltage, applied simultaneously to the two transistors, generates a voltage across R_L. Peak amplitude will change proportionately to the input voltage. Polarity of the voltage across R_L depends on polarity of the instantaneous amplitude of the input signal and the carrier signal (see Fig. 4). In Fig. 2A assume an input signal of 1 v. During the inverted mode in Fig. 2B the current follows the heavy curve. After passing the knee the *pnp* current I_{pnp} and the *npn* current I_{npn} form parallel straight lines. The difference of currents will be a negative current of constant peak amplitude as in Fig. 2E, point B. In the normal mode two currents are generated as shown in Fig. 2C, in the same way as in Fig. 2B, but the difference of the two currents is now positive as in Fig. 2E, point A. Figure 2E gives the desired output waveshape, with equal voltage gain for both inverted and normal modes. If input voltage is zero, the characteristics of Fig. 2B and Fig. 2C form a straight line. The difference is zero for any carrier amplitude, which is an indication of a fully suppressed carrier. Changing over to negative amplitudes for E_{in}, the output phase reverses, which is typical for double side-band, suppressed carrier modulation. The process of generating the desired output waveshape for a full cycle of input signal is shown in Fig. 4.

For evaluating the modulator, a series of measurements, defined as follows, was carried out:

(1) Available power gain is the ratio of power output (modulated wave) to available signal power input. However, the signal input and output circuits were not matched for maximum power transfer (for a low power modulator, linearity and low distortion are more important than a slight additional power gain by matching). Carrier frequency source impedance was chosen in accordance with the a-f standard of 600 ohms. Signal source impedance was 1,800 ohms for the lowest distortion possible in the output product. It can be changed to 600 ohms with only a slight impairment of distortion. Voltage to the modulator from the 600 ohm signal source is then higher than the emf/2 (which corresponds to the matched condition), the input impedance of the modulator being approximately three times higher than the output impedance of the signal source. Load impedance, however, was adjusted for the best symmetry of the output wave shape. Signal input power was calculated as if the matching condition of maximum power transfer were fulfilled

$$P_{in} = \left(\frac{e\,m\,f}{2}\right)^2 / R_{source}$$

Output power was calculated by:

$$P_{out} = (E_{out\ rms})^2 / R_{load}$$

Power gain obtained is defined as:

$$\text{available power gain} = \frac{\text{modulated output power}}{\text{available signal input power}}$$

(2) Linearity of a modulator is the ratio of input signal amplitude to output amplitude, carrier voltage being held constant. This ratio stays constant over a wide range in a linear modulator

$$\text{linearity} = \frac{\text{signal input amplitude}}{\text{output amplitude}}$$

(3) Signal suppression is the ratio of the amplitudes of the desired sidebands (carrier ± signal) to the signal at the modulator output

$$\text{signal suppression} = \frac{\text{desired sideband amplitude (carrier} \pm \text{signal)}}{\text{signal amplitude at the output}}$$

(4) Carrier suppression expresses the ratio of the amplitude of the desired sidebands (carrier ± signal) to the carrier at the modulator output:

$$\text{carrier suppression} = \frac{\text{desired sideband amplitude (carrier} \pm \text{signal)}}{\text{carrier amplitude at the output}}$$

(5) The modulation distortion products comprise all the unwanted products like $f_c \pm 2f_s$, $2f_c \pm f_s$, $3f_c \pm f_s$. These distortion products were also measured. The equipment used to perform the measurements were: hp test oscillator, model 650 A; hp wide range oscillator, model 200 CD; hp oscilloscope, model 130A; hp vacuum tube voltmeter, model 400L; and GR wave analyzer, type 736A.

The first measurements show the linearity of the modulator (Fig. 5A); the output amplitude of one sideband is plotted against the input signal amplitude, carrier voltage = parameter. From a high level of the input signal, output amplitude is no longer linear. The input voltage at which this nonlinearity reaches 10 percent is a reference point for the measurements of output frequency components. The power gain is given for the linear portion of the output versus input voltage curve. Along the linear part of the curve the gain remains constant (see Fig. 5A).

The second measurements (Fig. 5B) establish the curves relating the output amplitude of one sideband versus the carrier voltage, input voltage = parameter. Since carrier voltage must be greater or equal to signal voltage, two curves for two different signal voltages have been plotted. From a certain carrier voltage up, the output amplitudes remain unchanged.

The output frequency spectrum was measured at a signal input voltage (0.7 v) at which 10 percent nonlinearity of the output voltage occurs.

To summarize the test results, some typical values of the modulator are listed: carrier frequency, 2.8 Kc; signal frequency, 250 cps; max signal voltage (rms) for 10 percent nonlinearity, E_s, 0.7 v; input impedance, R_s, 1,800 ohms; carrier voltage (rms), E_c, 1.27 v; carrier impedance, R_c, 600 ohms; output impedance, R_L, 800 ohms; available gain at the above mentioned signal and carrier voltages, 3.3 db; signal suppression as referred to the amplitude of one desired output sideband, 31.5 db; carrier suppression as referred to the amplitude of one desired output sideband, 28.5 db.

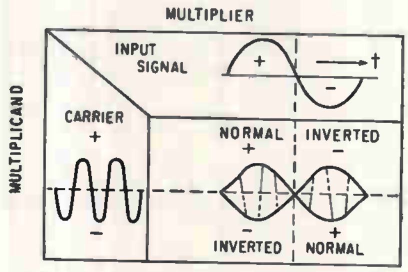

FIG. 4—Process of generating output wave shape

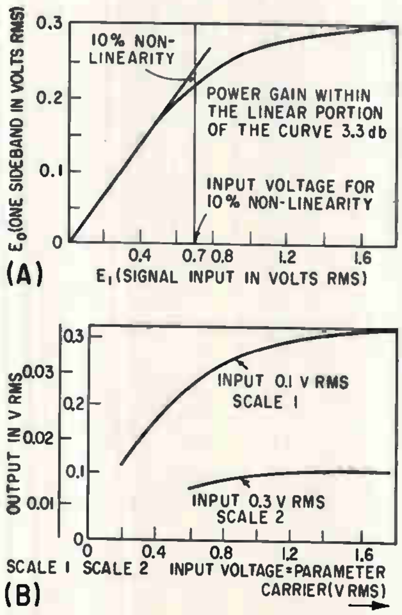

FIG. 5—Measured linearity of the modulator (A), and output voltage of one sideband (B) measured against carrier voltage

The complementary transistor modulator can in many applications replace other carrier and signal suppressed modulators. Some possible applications are:

(1) To convert rectangular teleprinter signals into carrier frequency signals with 180-deg phase modulation without a change of the carrier amplitude. No limitations with respect to baud length or teleprinter speed. Accurate and jitter-free switching is obtained.

(2) With respect to its possibility of single ended d-c input and output: (a) Pulse transmission containing d-c components over a-c channels. Tests are being conducted. This application may be of importance on digital coding and decoding as well as scrambling of speech. (b) Direct-current amplifier for negative and positive input voltages (currents): two modulators cascaded and fed with the same carrier deliver some gain (approximately 6 db) and have a higher stability than d-c amplifiers. Only a carrier supply is needed; no additional d-c supply.

(3) In connection with its good carrier and signal suppression: The modulator has been tested experimentally in a speech inversion experiment. The inverted sideband was located below a carrier of 5 Kc in the frequency range of the input signal. Up and down modulation was accomplished with two modulators. In this difficult carrier frequency application (ssb) this modulator could bring considerable savings on components and a reduction in size and weight as compared to standard techniques.

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Pickup Devices for Very-Low-Frequency

by only 7 db over the frequency range 10 to 10,000 cycles. Loop

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COMMUNICATION and navigation systems, such as Radux-Omega, operate at frequencies below 10,000 cycles because these low frequencies permit considerable operating range. Research into low-frequency pickups has led to the Hall device as a receiving element, rather than loop and whip antennas conventionally used.

Applications[1, 2, 3, 4] of the Hall device include measurement of air-gap magnetic fields in motors and generators, leakage flux of solenoids, the earth's magnetic field and other related uses where magnetic fields are intentionally created as part of the design. Figures 1A and 1B show commercially available Hall sensors. To improve sensitivity the basic Hall device is frequently equipped with flux collectors as shown in Figure 1C. Sensitivities neighboring 1 microgauss (equivalent to 0.03 volt per meter field intensity) are attainable using such flux concentrators.

Sensitivity is measured by providing a signal-to-noise ratio of unity in the input circuit of the receiving equipment. This sensitivity is dependent upon the incident flux density, the noise-ratio (N_R) of the device (which is frequency dependent), and the square root of the input-circuit bandwidth. Similar functional relationships for the whip and the air core loop are presented as Eq. 3 and 4. With these equations, a Hall sensor equipped with flux collectors to increase the incident flux on the sensor, is compared with a small air-core loop antenna and a short vertical whip antenna. The results are summarized in Table I. These results show that the Hall sensor, unlike the whip and the loop, has a sensitivity that is nearly frequency independent between 10 cps and 10 Kc. Figure 2 shows the spatial relationships of the field vectors for several distances from the antenna: only the electric field vector changes its relative direction, while the magnetic vector remains constant so that reorientation of the Hall sensor, with distance, is not necessary.

Hall voltage and incident flux density are related by

$$V_H = h_H B \qquad (1)$$

where $h_H = RI/t$, is the transfer constant, R is Hall coefficient, I is bias current in the sample, t is thickness of sample and B is flux density incident on sample.

Response is a function of flux density and not a rate-of-change of flux linkages, so that d-c reception is possible; moreover, the device is nonreciprocal, and cannot be used

CHARACTERISTICS OF THE HALL DEVICE

(1) The Hall Device is best suited for extremely low frequency applications requiring Q of unity or less. The extent to which circuit Q may be reduced at these low frequencies is limited, imposing a further restriction on the application.

(2) The relation between signal level and induced voltage for the Hall device exceeds that for conventional pickups. Hence, for unity signal-to-noise ratio, signal level must be higher, other factors assumed constant.

(3) In conventional pickups sensitivity is independent of frequency for constant Q operation. This is not so for the Hall device.

(4) Excess noise (above thermal noise) in the InSb wafer is an important factor below 1 Kc.

(5) Partial compensation of the interrelated design factors provides a nearly constant sensitivity for the Hall device from d-c to 10 Kc.

(6) Both the Hall device and loop are orientation sensitive. With flux collectors, the Hall device is still more directional

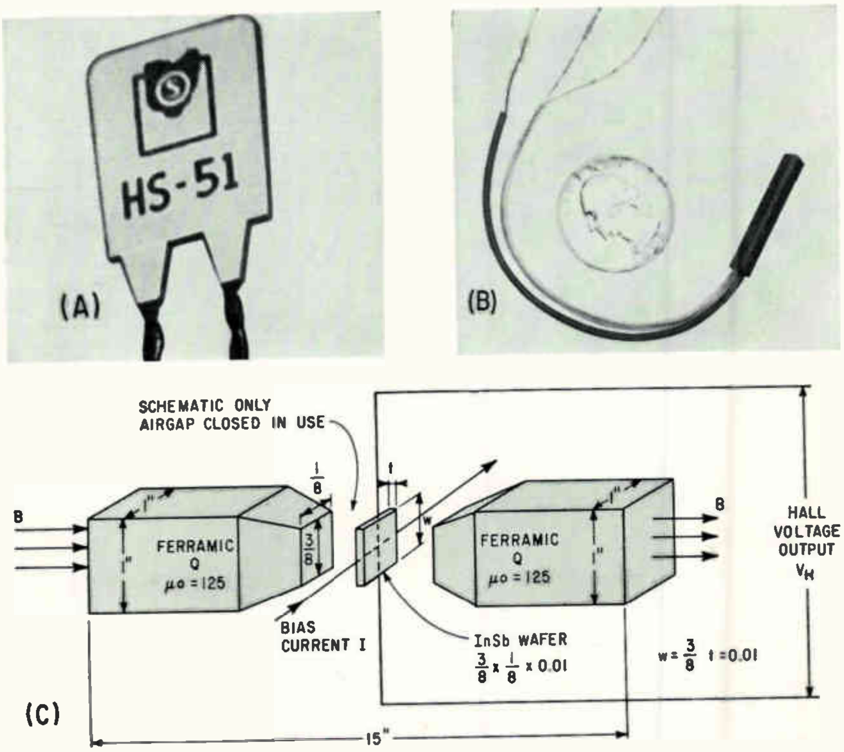

FIG. 1—Examples of available Hall sensors (A) and (B). Method of increasing effectiveness of the Hall sensor by using flux collectors (C) to concentrate the magnetic field

Reception

The Hall device's sensitivity changes and whip antennas experience a 60-db sensitivity change over the same range

as a radiating source. Pickup can be enhanced by using flux collectors.

The sensitivity of the device is $S \propto w/t$ where w = length of sample in the direction of the Hall voltage and t = thickness of the sample.

Increasing w for better sensitivity causes the source resistance, typically about ½ ohm, to increase. This resistance is frequency insensitive except for skin effects and change-in-resistance with temperature for the semiconductor.

The relationship between electric field intensity E_S and Hall voltage V_H then internal noise E_n for the device is found. Finally, the ratio of V_H to E_n is set equal to 1 to determine a minimum value of electric field intensity $E_{s\,(min)}$ required to ensure this unity signal to noise ratio.

Observe that $V_H = h_H B$ and $B = CE_S$, so that $V_H = h_H\ (CE_S) = (h_H\ C)\ E_S$, where C = conversion constant uniquely specified in far field only. Thermal noise at room temperature is

$$E_n = (4\,KTR\,BW)^{1/2} = 1.26 \times 10^{-10}(R\,BW)^{1/2}$$

where K is Boltzman's constant, T is the temperature in degrees Kelvin, R is the Hall device source resistance and BW is the bandwidth. Adjusting for the excess noise[5], $E'_n = N_R\,E_n$ where N_R is the noise ratio.

Using the above relationships and measurement data[1], numerical values for a particular InSb wafer (with flux collectors) are computed as follows: $V_H = 17.7 \times 10^{-8}\ E_S$, $E'_n = 13.3 \times 10^{-11}\ (N_R)\ (BW)^{1/2}$ from which

$$E_{S(min)} = 7.5 \times 10^{-4}\,(N_R)\,(BW)^{1/2} = 7.5 \times 10^{-4}\,(N_R)\,(f/Q)^{1/2} \qquad (2)$$

where BW = input circuit bandwidth in cps, f = frequency and $Q = f/BW$ = input circuit merit factor.

Equation (2) compares the Hall device with the loop and whip. Since the source impedance is resistive, bandwidth is set external to the sensor. Therefore, the required electric field intensity for unity signal-to-noise ratio should be frequency independent except for (N_R) variation which approaches unity above 1 Kc. Reference 1 reports a measured flat response from 30 cps to 15 Kc supporting the theory.

Similarly, the following relationships are found for the loop and whip

$$\text{(Loop)}\ E_{S(min)} = L^{1/2}/66.3\ NAQ = L^{1/2}BW/66.3\ NAf \qquad (3)$$

$$\text{(Whip)}\ E_{S(min)} = 1/10^{10}HQC^{1/2} = BW/10^{10}HfC^{1/2} \qquad (4)$$

where L is the inductance of the loop in Henries, N is the number of turns in the loop, A is the area of the loop in square meters, H is the whip length in meters, C is the whip capacitance in farad $\times 10^{-12}$, Q is the input-circuit merit factor and f is the operating frequency.

Equations 3 and 4 show that improved loop and whip sensitivity is obtained as the frequency is increased, provided the input circuit bandwidth is held constant. Since the internal impedance of the loop and the whip are highly reactive, external tuning is required in the input circuit. At these frequencies the Q's are high, so that additional damping resistance is frequently required in the input circuit to ensure the desired bandwidth. Loop and whip pickup elements differ from the Hall sensor, which has a resistive source impedance, and is hence better suited for broadband applications.

FIELD INTENSITY TO GIVE UNITY OUTPUT

Operating Frequency (CPS)	Bandwidth (CPS)	Input in Microvolts Per Meter		
		Hall Sensor	Loop [a]	Whip [b]
10,000	10	2,100	0.15	0.13
1,000	10	2,100	1.5	1.32
20	10	5,200	76	66
10	10	5,300	153	132

[a] Where H = 5 in, W = 15 in and N = 2 turns
[b] Where H = 15 in

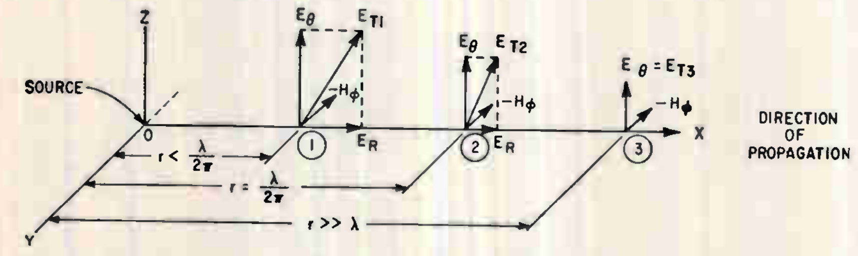

FIG. 2—Diagram shows that only the electric vector's position in space changes with distance from antenna; this effect does not necessitate changing the Hall sensor's alignment as operating range is altered

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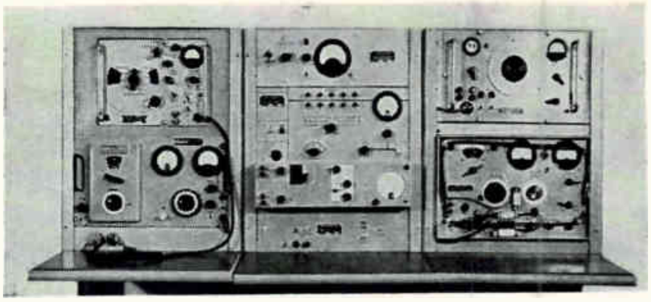
Test procedures and equipment show how to compare the abilities of radio receivers to function in a crowded or artificially jammed spectrum



Test equipment for evaluating receivers

Evaluating Radio Receiver

By B. T. NEWMAN, General Electronic Laboratories, Inc., Cambridge, Mass.,

THE EVER-INCREASING dependence upon radio communication and the ever-mounting crowding of the radio spectrum have accelerated the demand for high-performance receivers that can operate with maximum resistance to interference. Thus, there is a need for testing specifications, methods and standards by which a receiver can be graded. This paper describes methods for testing voice-communication receivers—a-m, f-m and single sideband (ssb)—and for objectively grading receiver performance in interference.

These methods and techniques have been reviewed by Signal Corps receiver and communications engineers to obtain their criticism and advice. This article is a summary of work performed over a period of five years at General Electronic Laboratories (GEL).

The following discussion describes objective testing and scoring methods that are helpful to the design engineer in grading receiver performance by comparing performance with idealized standards. These standards are based upon an ideal receiver that does not necessarily have the best possible characteristics but, rather, those which are easily definable.

The ideal receiver is given the following characteristics: (a) a rectangular selectivity curve and a bandwidth equal to that required for perfect intelligibility of the message; (b) no depression of the desired signal; (c) perfect amplitude linearity in all amplifiers, and perfect limiting in all (f-m) limiters. Since the definition of the ideal receiver also defines its performance, the ideal receiver provides criteria upon which to base test results of practical receivers. A standard such as this allows the comparison of any one receiver with any other receiver. Furthermore, if the interference environment is known, it is possible to select the optimum receiver, basing the selection on test results that can be referred to a universal standard.

One of the aims of the standardized test procedure is to remove complications from the procedure. It is most desirable to test a receiver without removing it from its case or rack, and to not require a great amount of special equipment. Receiver performance will be studied in the presence of interference, examining these characteristics and effects: selectivity, dynamic amplitude range, depression, impulse suppression and audio response.

Frequency Bands of Equal Contribution to Articulation Index (Male Voices)

No.	Limits in cps	Mean in cps
1	200 to 330	270
2	330 to 430	380
3	430 to 560	490
4	560 to 700	630
5	700 to 840	770
6	840 to 1,000	920
7	1,000 to 1,150	1,070
8	1,150 to 1,310	1,230
9	1,310 to 1,480	1,400
10	1,480 to 1,660	1,570
11	1,660 to 1,830	1,740
12	1,830 to 2,020	1,920
13	2,020 to 2,240	2,130
14	2,240 to 2,500	2,370
15	2,500 to 2,820	2,660
16	2,820 to 3,200	3,000
17	3,200 to 3,650	3,400
18	3,650 to 4,250	3,950
19	4,250 to 5,050	4,650
20	5,050 to 6,100	5,600

The selectivity of a receiver determines the extent to which the receiver can differentiate on a frequency basis between several signals at the input. Since interference involves the reception of two or more signals, selectivity does in part determine the susceptibility of a receiver to degraded performance.

Operation of receiver circuits should be linear with respect to the desired signal over the amplitude range of expected signals. If not, cross-modulation effects can decrease the signal-to-noise ratio at the output terminals. This decrease is due to the mixing of the desired and interfering signals to generate new frequencies.

Another effect due to nonlinear amplitude range is desensitization. Desensitization refers to the reduction in gain of an amplifier when operating at nominally high signal levels. An undesired signal may shift the operating point of an amplifier to a nonlinear operating region, thereby reducing the gain of an amplifier for weaker signals.

A by-product of interference is depression. Also known as capture, this occurs in certain portions of a receiver when two signals are present. Depression is characterized by the reduction in level of one of two input signals by the receiver cir-

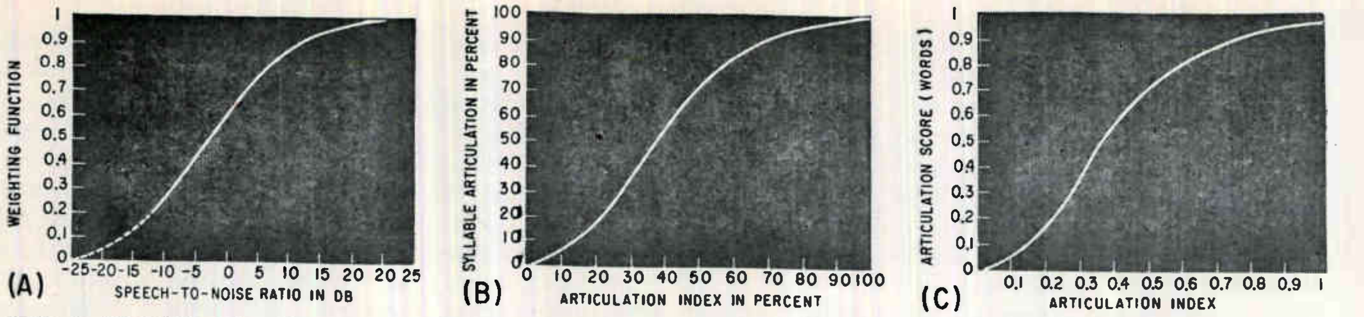


FIG. 1—Weighting function versus S/N (A). Syllable (B) and the word (C) articulation against articulation index

Susceptibility to Interference

H. CAHN and R. KEYES, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J.

cuits, due to the presence of the other. Depression is undesirable if the stronger signal is the interference. Depression occurs primarily in the detector of a receiver.

Impulse suppression is necessary because of disturbances caused by impulsive interference. These disturbances can be effective over periods that are much longer than the duration of the original impulsive disturbances because of pulse lengthening effects caused by the narrow bandwidth of the receiver. Thus, impulse suppression should take place early in the receiver.

Another effect that may be caused by impulsive interference is overhang. Overhang effects can be produced by interfering pulses of sufficient amplitude to cause one or more tubes to draw grid current. The charge produced on coupling capacitors is then sufficient to reduce the gain radically or even cut off the tube for a period following the removal of the pulse. Overhang can be reduced or eliminated by direct coupling, discharge diodes or small coupling time constants.

A voice communications receiver should be capable of passing all of the frequency components in the transmitted message. The output low-pass filter should pass the entire spectrum of speech frequencies that contribute to intelligibility; this spectrum extends from 200 cps to about 6,000 cps. Beyond these limits, the response should drop off rapidly. A wider audio bandwidth will allow interference, cross-modulation and harmonic components generated in the detector and components falling outside the transmitted speech band, as well as random noise, to pass and reduce the output S/N (signal-noise ratio).

In the design of speech transmission systems, a knowledge of the factors that influence the intelligibility of a speech signal is important. While the present understanding of these factors is by no means complete, some important results were obtained by French and Steinberg of the Bell Telephone Laboratories. Using word scores obtained from listener tests performed with audio filters inserted between speech source and listener in an otherwise high-fidelity audio system, French and Steinberg introduced the concept of articulation index. This index equals unity in a communications channel that passes all of the speech frequencies required for 100-percent intelligibility. The passband of the channel can be divided into an upper and a lower frequency range by sharp-cutoff high and low-pass filters. If the cutoff frequencies are adjusted to result in equal intelligibility in the two ranges, the intelligibility in each range corresponds to an articulation index of one-half. This measurement defines the frequency limits of two bands of equal intelligibility. For a composite of men's and women's voices, a cutoff frequency of 1,900 cps yields a word score of 68 percent. No frequency in the audio range makes an indispensible contribution to intelligibility since either half of the audio spectrum will yield the same word score and articulation

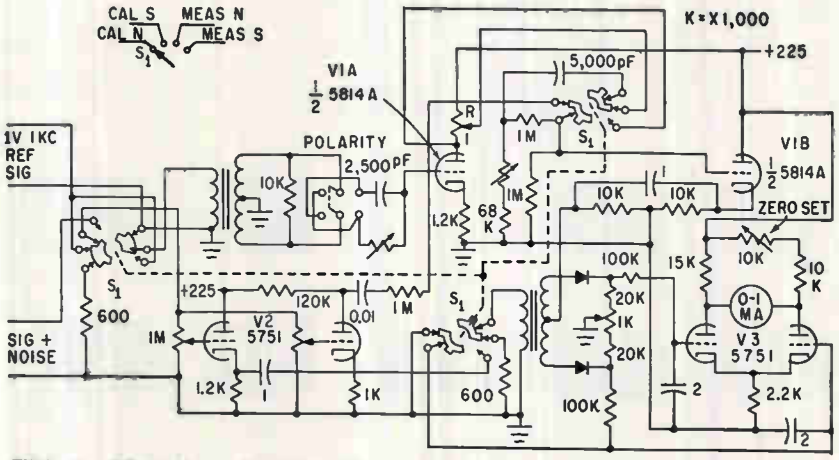


FIG. 2—With S_1 at the indicated position, the correlator calibrates noise

index. Division of the audio spectrum with filters has yielded 20 frequency bands of which each contributed 0.05 to the total articulation index. These bands of equal contribution to intelligibility have become known as French and Steinberg bands. The frequency limits of each of these bands are shown in the Table. Frequency components outside the range from 200 to 6,100 cps do not contribute noticeably to intelligibility. To determine the expected intelligibility of the output of a system with known audio frequency response characteristics, count the number of contributing bands of equal intelligibility to determine the articulation index. Each band contributes a maximum of 0.05 to the articulation index as long as the speech-to-noise ratio exceeds or equals 30 db within that band. If this is not true, a weighing factor that depends upon the speech-to-noise ratio in the band must be applied to 0.05. Figure 1A shows the amount of weighting that must be assigned to each band as a function of speech-to-noise ratio in the band. The speech-to-noise ratio is determined from the long-term average of both speech and noise voltage. Summation of the weighted contributions yields the articulation index of the output speech. The articulation index is related to syllable articulation (Fig. 1B) and to the articulation word score (Fig. 1C). The computation yields correct results only when interference consists of random noise and there is no amplitude distortion.

Although most of the equipment in these tests is conventional laboratory apparatus, a noise generator, correlator, and impulse generator had to be designed.

The noise generator provides a signal source for simulating broadband noise jamming. A nominally 300-Kc-wide noise spectrum is provided, and this spectrum is tunable to any portion of the frequency spectrum in the range 500 Kc to 55 Mc. Noise is generated by a 60-Mc i-f strip having a bandwidth of 300 Kc. Output of the i-f strip is mixed with a local oscillator tuning the range 60.5 Mc to 115 Mc. The difference frequencies fall in the range of 0.5 Mc to 55 Mc, this range being fed through a wideband amplifier and used as the noise output spectrum.

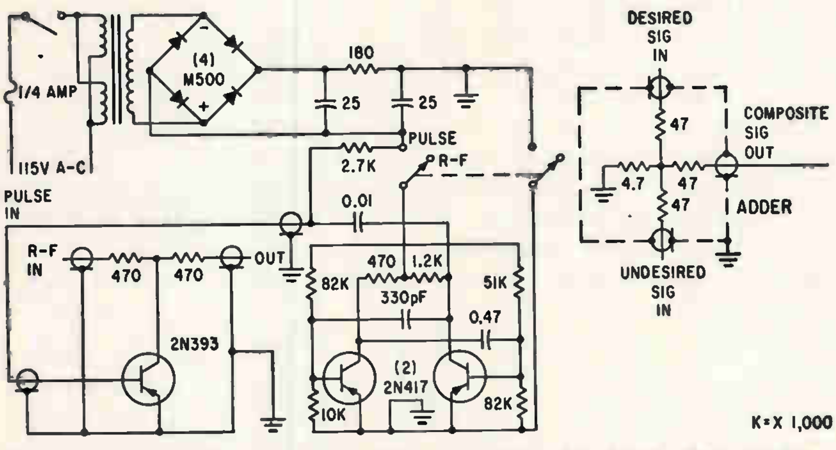


FIG. 3—The impulse generator (left) modulates r-f input, thus producing an undesired signal for the adder (right)

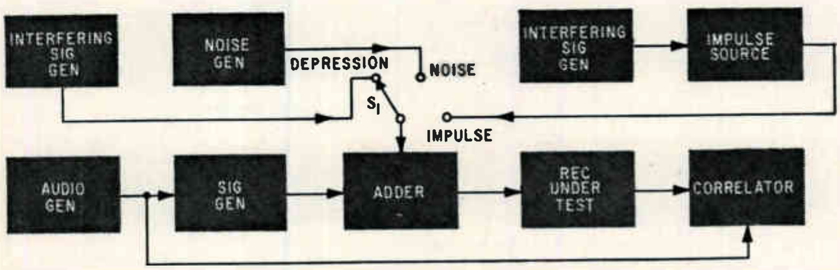


FIG. 4—Simplified arrangement shown by positions of S_1 indicates setups for depression, noise and impulse tests

The correlator (Fig. 2) facilitates meaningful measurements of S/N ratios in active networks under two-signal conditions. It measures the output signal or the output noise, without either the signal or the noise from the input of the system under test. The correlator is a phase-sensitive detector and requires two inputs, a reference signal derived from the modulating source, and the signal-plus-noise input to be obtained from the output of the system. The noise component in the signal-plus-noise spectrum is isolated for measurement by cancelling the signal component. This is done in a resistive adder by adjusting the reference signal to the same amplitude as the signal component of the signal-plus-noise input. The phase opposition adjustment is made with a phase-shifting network. The signal component is measured by synchronous detection in a balanced modulator wherein the noise components cancel and only the d-c component due to the signal is metered.

The impulse generator evaluates the performance of a receiver by providing a source of high peak-to-average pulsed interference. For effective impulse-suppression evaluation, a pulse source capable of close to 100-percent modulation is necessary. The impulse generator (Fig. 3) reaches this degree of percentage modulation. This generator is a transistor electronic switch driven by a multivibrator. The pulse rate is 1,500 pps with a pulse duration of 10 μsec. Choice of the 10-μsec pulse duration was made because this pulse length represents a spread of frequency components over a greater bandwidth than the acceptance band of most receivers. The 1,500-pps repetition rate was arbitrarily chosen.

To permit a meaningful comparison of receivers, the mode of operation of the receiver under test must be specified. A recommended procedure for standardizing receiver gain, signal levels and miscellaneous control settings is included in test specifications covering modulation types[1, 2, 3]. This procedure attempts to operate the receiver in the range in which it was designed to operate. The receiver is tuned, the r-f gain controls are adjusted to provide maximum output, while the audio gain control is adjusted to provide a nominal output level.

It is first necessary to know what signal frequencies present after the detector will reach the ear of the operator; this is the audio bandwidth test. These frequencies include the desired signal modulation components as well as interference components. Sine-wave output from an audio generator modulates a signal generator that produces a modulated r-f signal of the type to be received. This r-f signal is applied to the antenna terminal of the receiver. Audio voltage is measured at the audio output of the receiver, as the modulating frequency is varied.

To learn what range of radio frequencies, and at what levels, can contribute to the audio response the overall bandwidth test is carried out. A modulated carrier is applied to the receiver antenna terminals. Audio output voltage is measured as the carrier frequency of the test signal is tuned across the acceptance band of the receiver; alternately, the signal generator is maintained on a fixed frequency, and the receiver is tuned across the test signal. A second carrier is added to the test signal at the input of those receivers where the presence of such an interfering carrier affects overall selectivity.

The extent to which the desired message components at the output of a receiver are reduced by the presence of an interfering signal is measured in the depression test (Fig. 4). If the frequency separation of the desired and undesired carriers affects the results, this is taken into account in the measurements. An audio generator modulates a signal generator and provides a reference signal for the correlator that measures the desired signal components at the receiver output. The desired modulated signal is added to an interfering carrier obtained from another generator and the sum of the two signals is applied to the receiver input terminals. At the output of the receiver, the level of the desired modulation component is measured with the correlator, as the signal-to-interference ratio (S/I) at the input is varied.

The noise test (Fig. 4) gives information as to the extent to which an interfering signal, especially of the broad spectrum type, produces undesired outputs, both by itself and through interaction with the desired signal. The test result includes the effects of depression and overall bandwidth. At the receiver input, a modulated carrier is superimposed on an r-f noise band centered about carrier frequency. Modulation for the carrier is obtained from an audio generator, whose output is also used as a reference in the correlator. The correlator measures signal and noise at the output of the receiver so that the S/N can be obtained.

In the impulse test (Fig. 4), the desired signal is the same as in the noise test, but the interference consists of an interrupted, or pulsed, carrier. A standard repetition rate and pulse length is used. The S/N at the output of the receiver is determined by using the correlator to measure signal and noise.

The development of the noise, depression and impulse tests for ssb receivers has revealed that the correlator shown in Fig. 2 is not sufficiently compatible with ssb systems to be useful for output S/N measurements. This incompatibility is due to its dependence upon phase information. An alternative procedure for measuring desired signal and noise components at the output of an ssb receiver has been developed. This uses a wave analyzer for the depression test and a distortion analyzer for the noise and impulse tests.[4] The depression test is performed using the wave analyzer to indicate the level of desired signal component in the receiver output. With the receiver output connected to the wave-analyzer input, the wave analyzer is tuned to the modulating frequency of the desired signal and peaked. This is done at an input S/N of +30 db. Then the data is obtained by plotting the reduction in desired signal indicated on the wave analyzer as a function of input S/N. In this test the interfering signal is a c-w carrier.

The noise and impulse ssb tests use a distortion analyzer for determining receiver output S/N. The procedure for obtaining output S/N is similar to that developed for the wave analyzer.

In the following sections each of the four tests developed for ssb receiver susceptibility testing will be discussed and evaluated. Consult the fifth reference for the methods of performing the tests.[5]

Because of the linear demodulation technique used in ssb, the measured selectivity is a composite of the r-f and audio-selectivity characteristics. In contrast to the a-m and f-m susceptibility tests, the r-f and a-f selectivity characteristics are inseparable when the receiver is treated as a black box.

In most cases the audio filter will predominate in determining the upper cutoff frequency and slope of the composite selectivity curve. In the low audio range the degree of attenuation will be largely influenced by the sideband filter, which produces heavy attenuation around the carrier frequency.

The development of the depression test has shown that due to the linear operation of an ssb receiver, an ssb receiver should exhibit little or no weak-signal depression in the presence of a stronger c-w interfering signal.

The ssb noise test is equivalent to the a-m noise test. The major difference lies in the method for computing the input noise density as a result of the different bandwidths. Tests have shown that the effective bandwidth of the noise generator is 600 Kc. The following discussion shows how to determine the attenuator setting necessary on the noise generator to produce 100 μv of noise in a 5.9-Kc passband, as is desired to perform the ssb noise test.

Determine the noise in a 5.9-Kc passband with no attenuation. The maximum noise voltage output is 0.1 volt over the 600-Kc bandwidth when the meter reads 0 db. The noise power in a passband varies directly as the width of the passband.

$$\frac{P_1}{P_2} = \frac{E_1^2/R}{E_2^2/R} = \frac{E_1^2}{E_2^2} = \frac{BW_1}{BW_2}$$

$$E_1 = E_2\,(BW_1/BW_2)^{1/2}$$

where E_1 = noise voltage in 5.9-Kc passband, E_2 = noise voltage in 600-Kc passband = 0.1 volt, BW_1 = 5.9 Kc, and BW_2 = 600 Kc. Hence, E_1 = 9,915 μv. The attenuation is 9,915 μv/100 μv, or, 40 db. Since there is 20 db of attenuation in the adding network, the attenuation in the noise source is 20 db.

The ssb impulse test is similar to the a-m noise test. The difference is the value of the reference S/N′ at the input that is used to derive the scores. To compute the input S/N′ that gives $(S/N)_{ref} = 0$ db at the output of an ideal ssb receiver, assume that the output pulses are of 1-volt amplitude. The spectrum of the pulse train contains the 1.5-Kc fundamental and harmonics. Analysis of the spectrum shows that for the pulse width and pulse repetition rate in the impulse generator, the first four harmonics are equal at a peak amplitude of 0.03 volt. Therefore, the interference at the output is $[4 \times (0.03)^2/2]^{\frac{1}{2}} = 0.042$ v rms.

Evaluation of the test results is facilitated by scoring techniques. Scoring of the test data results in a numerical score for the result of each receiver test, and the scores obtained for different receivers permit comparison of the performance of the different receivers. Two different sets of scoring procedures are presented. The first, a short-form scoring method, can be applied quickly and results in a percentile score for each test that allows quick comparison between receivers. The scores are arranged so that unity, or 100 percent, corresponds to the performance of a postulated ideal receiver.

The second scoring method is more comprehensive, and requires slightly more work. It is based on an assumed tolerable value of degradation in intelligibility at the receiver output. For each test it yields a score which indicates the increase in the number of decibels of $(S/N)_{in}$ required for the receiver under test, over the $(S/N)_{in}$ at the input of the postulated ideal receiver, for identical performance at the output of both. The score is given in db, with 0 db representing the performance of the ideal receiver. This scoring method permits comparison of receivers on a quantitative performance basis, because signal-to-interference ratios at the receiver output determine intelligibility. The db score also makes it possible to evaluate receivers on an absolute basis.

The scores give a useful number for comparing receivers. However, to appraise an individual receiver, it is desirable that the scores of the tests be referred to some common denominator, preferably in the form of intelligibility.[6]

To facilitate the comparison of receivers, a histogram of receiver test scores is useful (Fig. 5). Each receiver is represented by a performance profile of test scores, which are based on the short form scoring method; a similar diagram based on S/N scores would differ only in the numerical scale.

Assume that one of the a-m receivers listed in Fig. 5 is to be chosen for operation in a band being interfered with by a wide-deviation f-m transmitter. The interfering signal would therefore fall within the receiver acceptance band for short intervals at a time, these intervals being determined by the overall bandwidth. The character of the interference as seen by the receiver will then be pulsed carrier. Receiver *A* has the highest impulse score but also has much excess bandwidth, so that either *B* or *C* should be considered. Of *B* and *C*, *C* is to be preferred on the basis of better audio response. However, remember that additional electrical or mechanical characteristics must also be considered.

The authors thank the U. S. Army Research and Development Laboratories at Fort Monmouth, under whose auspices these testing methods were devised, and all who were engaged in this research as well as all who gave advice and assistance. Among these are J. C. R. Licklider, Lewis Billig, Ben Newman, Kaspar Kasparian, Harry Schwarzlander and David Beaubien.

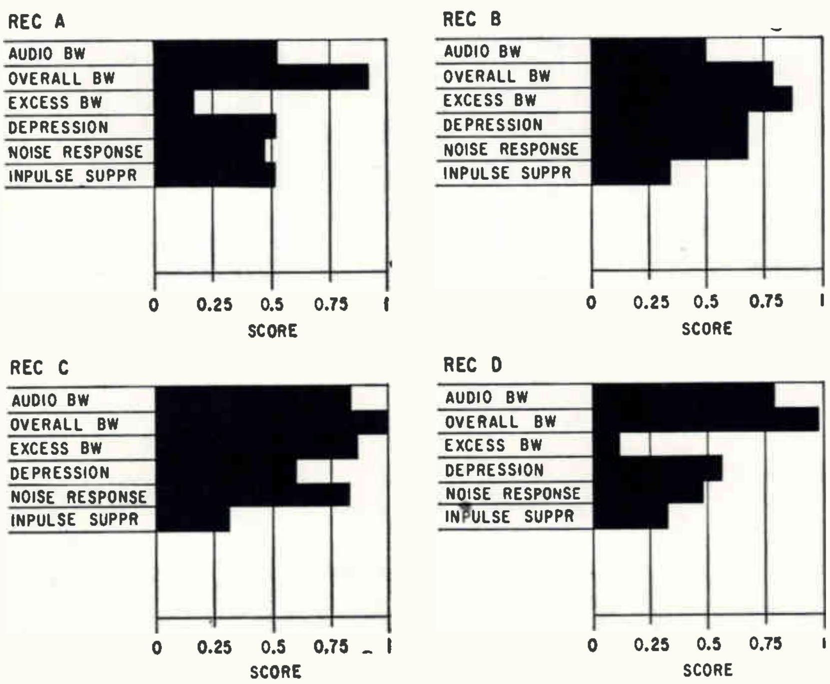


FIG. 5—Bar graphs compare four receivers by giving their short-form scores for six different performance tests

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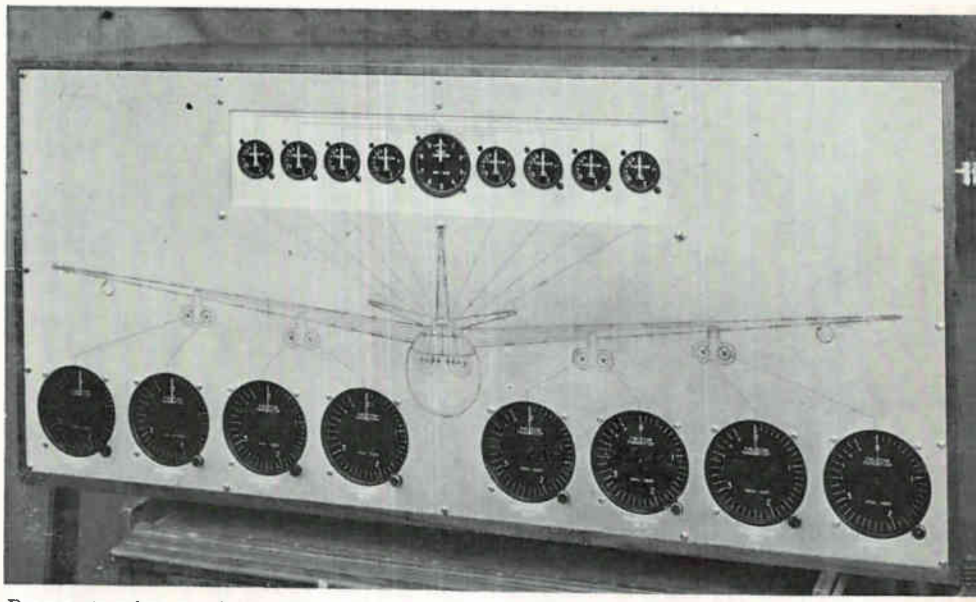
A-C Controlled Half-Cycle Magnetic Amplifier

Four self-saturating elements combined in full-wave device. Circuit is used in jet aircraft fuel-flow indicator systems



Demonstration mock-up shows the complete multiengine jet fuel flow indicating system for an eight-engine airplane

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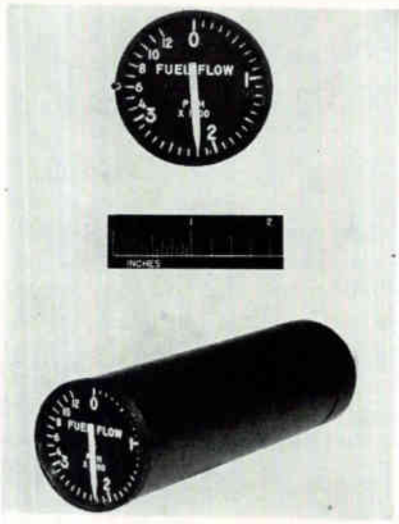
THIS MAGNETIC AMPLIFIER circuit shows advantages over previous circuits, especially in servo motor applications. This circuit has a good output waveform, low time constant and is a-c controlled. Four self-saturating elements are combined into a full-wave device; each element consists of a core and a rectifier. An a-c suppressed-carrier signal is fed to the control winding and the output across the load is also an a-c suppressed-carrier signal. By varying output connections, it is possible to get a d-c output with reversible polarity.

The output circuit resembles that of a Logan full-wave self-saturating magnetic amplifier. The Logan circuit, however, needs a large impedance in the control winding. If this impedance is resistive it reduces power gain, and if inductive, it has a long time constant.

An improvement of the Logan circuit, described by Ramey in 1950, uses the same output circuit but changes the control circuit to produce one that has a high gain with low time constant.

The Lufcy half-wave magnetic amplifier, developed later, eliminates the control-circuit rectifier. An extra winding added to the core winding biases the core flux, advances the firing of one core and retards the firing of the other. High gain with low time constant is obtained, but control is by d-c supply and the output is a half-wave voltage that can be used to drive a servo motor at reduced rating.



Fuel flow indicator unit is contained in a case two inches in diameter, 6½ inches long; magnetic amplifier is built inside each unit

Many special variations of these circuits exist.

The complete circuit of the new amplifier is shown in Fig. 1. It requires a power transformer *A*, four toroidal cores (*B* to *E*) with rectangular B-H curves having one power winding and two control windings on each core, four bias capacitors *F*, *G*, *H* and *I* used for flux setting purposes, four diodes *J*, *K*, *L* and *M* to self-saturate each core, and a ring gating circuit *N* to control the current flow in the control windings. The resistors in the ring gating circuit are current-limiting.

Faraday's law of induction states that if there is a closed path in space and the magnetic flux surrounded by it varies with time, then the emf induced around the path equals the negative rate of

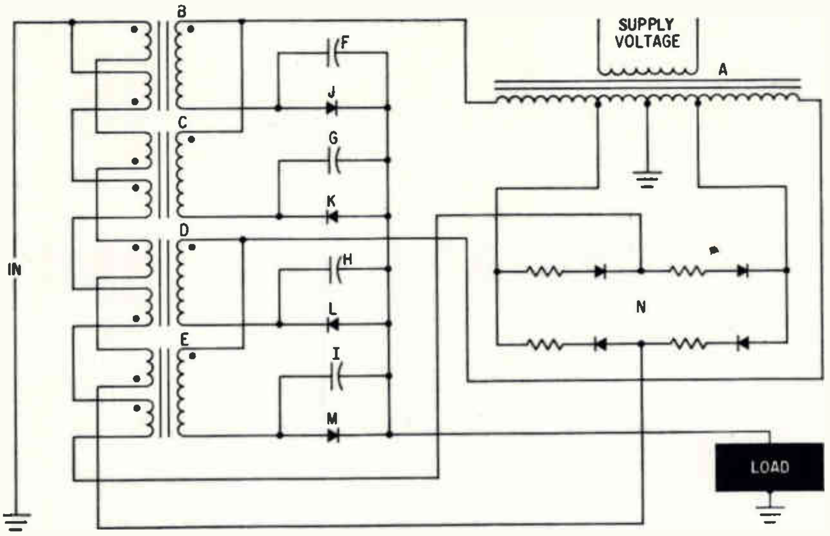


FIG. 1—Schematic diagram of basic a-c controlled magnetic amplifier. Four toroidal cores with rectangular B-H curves are used

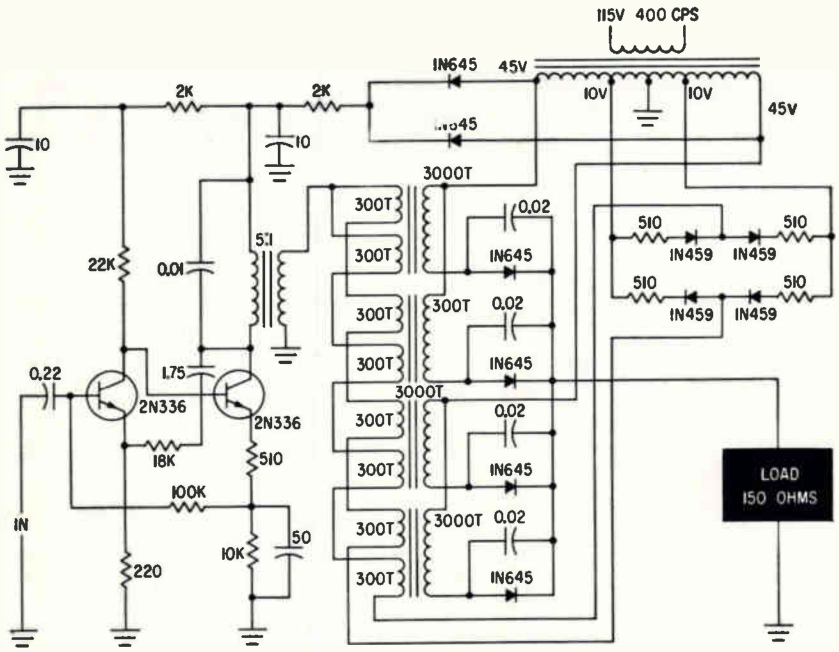


FIG. 2—Diagram of actual circuit complete with two-stage silicon transistor preamplifier at left, as used in aircraft fuel flow indicating system

change of the flux in lines or maxwells per second, or $E = -d\theta/dt \times 10^{-8}$ volts. If a coil has N turns and the flux is confined within a core and thus enclosed by all N turns, the emf induced in the coil is $\int Edt = -N\phi \times 10^{-8}$ volts where ϕ is the flux density. If ϕ is in webers, the time integral of voltage across the coil equals the negative product of coil turns and the flux in webers. The voltage time integral is basic in designing magnetic amplifiers.

Load action in a magnetic amplifier depends on the core material. Cores with oriented particles are needed to provide a rectangular hysteresis loop. With this flux current loop, a bias or control action will provide an initial value of flux retention for the instant when the power or load half-cycle begins. At this instant, the line voltage starts increasing and when the volt-seconds from the line equal the volt-seconds required to saturate the core, the core μ changes to a value of one and line voltage is impressed across the total of the coil and load impedance.

Presetting the core flux means that control action can be obtained with less power from the control source, and is the means of obtaining high-gain magnetic amplifiers. Bias can be obtained by an extra control winding, by a resistor in parallel with the power winding rectifier, or by a capacitor in parallel with this rectifier. The last method is the most efficient.

A resistance has to be added to the control winding of a d-c magnetic amplifier to limit the current induced during the prefiring interval before the core saturates. This resistance causes a power loss in the control circuit. An inductor could replace this resistor, but at the expense of time constant.

Ramey eliminated this loss by inserting a diode in the control circuit to limit the current. The circuit in Fig. 1 accomplishes this with a diode gating circuit, without requiring a voltage build-up before the control circuit operates.

A second control winding of reversed polarity increases power gain. With the reversed control windings, an a-c input produces flux changes in the same direction in both halves of the cycle. The same power gain is obtained with an a-c control signal that could be obtained with a d-c circuit, neglecting the current-limiting impedance.

In addition to high gain, the magnetic amplifier has the advantage in a-c servo work of a-c signal control and a line phase a-c output. The high gain is accompanied by a time delay of one-half cycle of the carrier and a 400-cps amplifier is only 3 db down at 125 cps. The gating circuit provides a linear control from null up to saturation. The gating circuit resistors can be adjusted for core mismatch. Substitution of capacitor bias for a bias winding simplifies adjustment, and gives more winding space on the core for active elements. Other advantages of magnetic amplifiers such as quadrature rejection, ruggedness and isolation between input and output are retained.

In the output circuit, cores B and C provide full-wave output of one phase and cores D and E provide a full-wave output of the opposite phase.

When the power half-cycle starts in any one coil, the line voltage starts increasing and when the volt-seconds from the line equal the volt-seconds required to saturate the core, the core μ changes to a value of one, and line voltage is impressed across the total of the coil and load resistance. The circuit current is then determined by this total circuit resistance. The power half-cycle starts when the line voltage changes direction to the correct polarity to have the rectifier, which has to be in series with the coil, change from a high impedance value to a low one. Before the core saturates, the line current is limited by the coercive force of the material; after saturation it is limited only by total circuit resistance. The voltage across the coil almost equals the line voltage until the core saturates, and after saturation is determined by the coil resistance.

The number of degrees of line voltage that load current flows—the conduction angle—is determined by the value of the core flux at the beginning of the power cycle.

Again, $\int Edt = -N\phi$ when ϕ is expressed in webers. The $\int Edt = E_M \int \sin \omega\, tdt = (-E_M/\omega) \cos \omega$ $B = \phi/A$ or $\phi = BA$ so $NBA = (E_M/\omega) \cos \omega t$, or $B = (E_M/\omega\, NA)$ $\cos \omega t$ so that if a voltage of E_M $\sin \omega t$ is applied to a core, the flux is a function of $(E_M/\omega\, NA) \cos \omega t$.

B_s is the value of saturation flux density of the core. E_M is chosen so that $E_M/\omega NA = B_s$ or $E_M = B_s \omega NA$. If the flux at the beginning of the power cycle is zero, then the flux at 90 deg is equal to $[(E_M/N \omega A) \cos \omega t]_0^{\pi/2\omega} = E_M/N \omega A = B_s$ so that the core saturates at 90 deg. Due to the flux retention or square loop saturation curve the flux will be at B_r (the residual flux) at 180 deg, only slightly less than B_s. Assuming the control coil is open circuited and using germanium or silicon diodes, the reverse current in too small to bring the flux from B_r back to zero in the next 180 deg. It is then necessary to bias the flux. The bias level is self-adjusting for line voltage fluctuation since an increase of E will also increase the reverse bias on the next half-cycle.

With each core firing at 90 deg on its power cycle, the control current advances the firing angle of one core and retards the firing of a second core to produce an output symmetrical around the 90 deg phase angle and to provide a linear response for the control signal.

The input circuit operation is determined by current in the input coils. Magnetizing force H is defined as the magnetomotive force F per unit length l or $H = F/l$. Quantity F in the cgs systems is measured in gilberts each equal to $10/4\pi$ or 0.7958 ampere turns. One ampere turn $= 4\pi/10$ units of mmf so that $F = 1.257\ NI$ where NI stands for ampere turns. H then equals $1.257\ NI/l$ where l is in centimeters and H in oersteds. The form most often used is $I = l\ H/1.257\ N$. For a toroidal core with a mean core diameter in inches D the expression is $I = 6.35\ HD/N$.

The ferromagnetic materials most often used are Delta Max and Orthonol. Both saturate at about 14 kilogauss, require a coercive force of about 0.5 oersteds at 400 cps, and have a generally rectangular hysteresis loop. The coercive force is one-half of the width of the B-H curve. It can be shown that square-loop material maintains the inductor current in phase with the voltage.

The control current required to vary the flux was found to be $I = 6.35\ HD/N$ in phase with the voltage. The voltage is determined by the required flux change. At zero phase angle, two cores are proceeding towards saturation and two cores to a flux values of zero. The first two cores induce equal and opposite voltages in the control winding at all times, and these two voltages cancel. There are two control windings, but due to the gating circuit only one has a closed path, the other being open. The active winding must have sufficient voltage to maintain the flux of one core at B_r and to change the remaining core to $-B_s$. Thus one core will have a flux change of zero and the other of $2B_s$. If a voltage $B_M \sin \omega t$ is applied to a core, the flux is a function of $(E_M/\omega\, NA) \cos \omega t$. The control current operates for a full half-cycle and $[(E_M/\omega\ NA) \cos \omega t]_0^{\pi/\omega} = 2E_{MC}/N_c\, \omega A$. This must equal $2B_s$ to fully reset one set of cores, or $2B_s = 2E_{MC}/N_c\, \omega A$ or $E_{MC} = N_c\, \omega\, AB_s$. The control power W_c is the product of these two values, or $W_c = N_c\, \omega\, AB_s \times 6.35 \times HD_M/N_c = \omega\, AB_s \times 6.35\ HD_M$.

Control power is thus a function of the core material, core area, core length, and operating frequency, but is independent of the number of turns on the control winding. In the next half-cycle the gating circuit opens the control winding that resets two cores and the other control winding repeats the process to reset the remaining two cores.

The schematic in Fig. 2 shows the amplifier as used in a served indicator for a fuel-flow system in jet aircraft. The complete system filter networks. The coupling in a demonstration mockup is shown in photographs. The toroid cores used are Delta Max 5340-D-2 wound with 3,000 turns of No. 40 wire on the power winding and 300 turns of No. 41 wire on each control winding. The power windings were excited by a 90-volt center-was adjusted by the 0.02-μf capacitors for firing the cores at the 90-deg phase angle with the circuit drawing 60 milliamperes at null. The power gain of the circuit was 500; 2 millivolts input caused a 2-watt output across a 150-ohm load.

The gating circuit was operated by a 20-volt center-tapped transformer with 500-ohm resistors for current limiting, and balancing the circuit at null.

The transistor preamplifier shown in Fig. 2 has two stages with d-c feedback for operating-point stabilization. The power supply uses the same power winding as the magnetic amplifier, and R-C transformer is tuned to eliminate phase shift in the transformer.

The stabilized gain of the preamplifier is adjusted to about 350. The magnetic amplifier has a volt-tapped transformer and the reset age gain of seven, but with the 5-to-1 step-down coupling transformer is essentially a power-gain device. The input impedance is over 10,000 ohms so as not to overload the input device. The amplifier consists of a high-gain amplifier using silicon transistors with a minimum number of additional components and a large amount of feedback to obtain temperature stabilization and good reproducibility on the production line. The original circuit used type 905 transistors, and recent designs are now using 2N336 transistors.

Stabilized Delay Circuit Provides High Accuracy

Timing errors are minimized in solid-state timing delay generator. Stability of better than 0.2 percent full scale is achieved over temperature range of 24 C with accuracy better than 0.7 percent

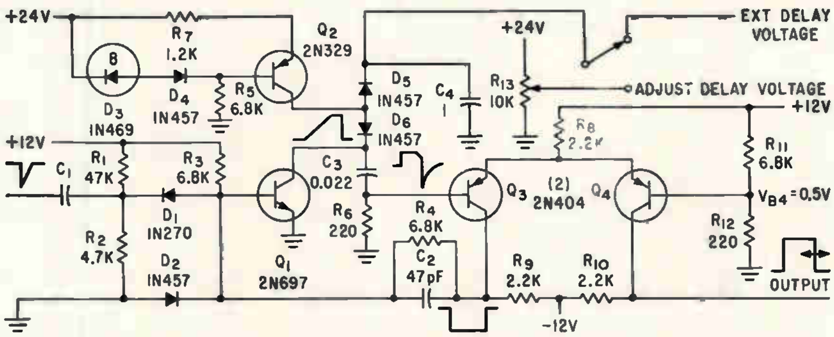


FIG. 1—Transistors Q_3 and Q_4 of time-delay circuit are mounted on common heat sink to reduce timing error

By CLIFFORD K. FRIEND
SERGEI UDALOV
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MANY ELECTRONIC CIRCUITS, particularly in radar systems, require a precise, voltage-controlled, time-delay generator. A radar range tracker must generate an accurate voltage analog of the time between transmission of a pulse and the receipt of the radar echo. The accuracy of the voltage analog in the range tracker is usually determined by a voltage-controlled time-delay circuit.

Time delay circuits usually contain a linear sawtooth generator and a sensitive amplitude-sensing circuit to form a common gate having a time duration directly proportional to an applied control voltage. A time delay circuit that achieves a high degree of accuracy and stability is shown in Fig. 1. Here the sawtooth generating function is incorporated into a gate-generating circuit. High accuracy is achieved because the timing components, consisting of a capacitor and a constant-current generator, are not connected to any load during the timing portion of the cycle.

Operation depends upon a linear rise of voltage across a capacitor being charged by a constant current. In its quiescent state, the collector of transistor Q_1 is clamped to ground by the positive bias applied to its base. This places a low initial voltage across capacitor C_3. Transistor Q_2 is a constant-current generator. Zener diode D_3 determines the current through Q_2. With a Zener voltage of 6 v and R_7 = 1,200 ohms, the current through Q_2 is about 5 ma. Transistors Q_3 and Q_4 form a differential amplifier. With the amplifier in its steady state, Q_3 is saturated and Q_4 is cut off, and collector voltages of Q_3 and Q_4 are 0 v and −12 v respectively.

Operation of the time delay circuit is started by a negative trigger through D_1 to the base of Q_1. The trigger, after being amplified by Q_1, is coupled through C_3 to the base of Q_3. Amplified again by Q_3, the trigger is fed back through R_4 to

the base of Q_1. Polarity of the voltage fed back from the collector of Q_2 results in regenerative action that cuts Q_1 off.

Fast regeneration is achieved by minimizing the time delay through Q_1 and Q_2 and by speed-up capacitor C_2 across feedback resistor R_4. Thus far circuit operation is similar to that of a multivibrator.

When Q_1 is cut off, a constant charging current of 5 ma begins to flow into C_3. This current generates a positive voltage step across R_6. The voltage keeps Q_1 and Q_2 cut off after the trigger has been removed. Amplitude of the step remains at a constant level of about +1 v as long as the charging current through C_3 remains constant.

Current flowing into C_3 generates a linear voltage ramp at the collector of Q_1. This voltage continues to rise until clamped by D_5 at the delay voltage, V_d. Clamping the collector voltage of Q_1 at V_d causes the positive voltage step across R_6 to decay to zero with a time constant of R_6C_3, or 4.8 μsec. When the voltage on the base of Q_2 drops to about 0.5 v, Q_2 begins to conduct and the regenerative action is repeated, this time returning Q_1 to its initial state of saturation.

During the active part of the cycle, a positive-going pulse is generated at the collector of Q_4. The time duration of this pulse is equal to the time delay generated by the circuit. Length of this time delay can be adjusted by varying V_d. In Fig. 1, the magnitude of V_d is limited to about +17.5 v, because at least 6 v must be maintained across Q_2. Thus, with the circuit parameter shown, the maximum time delay is about 120 μsec and the minimum time delay is about 6 μsec. Waveforms are shown in Fig. 2.

Variation of delay time with temperature is minimized by the circuit. Factors affecting the delay time of the circuit are determined by examining the expression for the total delay time

$$T_d = C_3\left[\frac{V_d + (V_{D5} - V_o - V_{D6})}{i_{ch}} - R_6\right] - R_6C_3 \log_e\left[\frac{V_{B4} + (V_{BE3} - V_{BE4})}{i_{ch} R_6}\right] \quad (1)$$

where T_d = time delay of the circuit, V_d = delay voltage, V_{D5} = junction voltage of diode D_5, V_{D6} = junction voltage of diode D_6, V_o = collector voltage across Q_1 in saturation, i_{ch} = charging current, V_{BE3} = voltage across base-to-emitter junction of Q_3, V_{BE4} = voltage across base-to-emitter junction of Q_4 and V_{B4} = voltage at the base of Q_4.

The first term on the right hand side of Eq. 1 expresses the time required by the collector voltage of Q_1 to reach delay voltage V_d and determines the major portion of the time delay.

The additional time required by the circuit to return to its initial state is expressed by the second term. The negative sign accounts for the fact that the logarithm of a number less than 1 is taken.

Assuming that the charging current, i_{ch}, is stabilized, the terms in Eq. 1 that vary with temperature are V_{D5}, V_{D6}, V_{BE3}, and V_{BE4}. Effect of V_o upon the time delay can be neglected since the magnitude of this voltage is small due to Q_1 being saturated. The junction voltage of pick-off diode D_5, however, varies by about 2.6 millivolts per deg C. Placing diode D_6 between the collector of Q_2 and C_3 compensates for the effect of the voltage drift introduced by D_5.

In an uncompensated circuit, the time delay defined by the second term of Eq. 1 is primarily determined by the phase-to-emitter voltage of Q_3. Since this voltage varies with temperature, it is a source of timing error. By adding transistor Q_4 and using a common heat sink, this source of timing error is reduced to the difference between base-to-emitter voltage of Q_3 and Q_4.

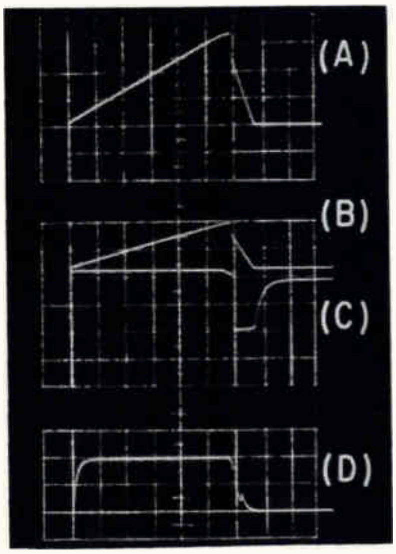

FIG. 2—Waveforms and vertical scales are: collector Q_1, 5 v/div (A); collector Q_1, 10 v/div (B); voltage across R_6, 2 v/div (C); and collector Q_4, 5 v/div (D). All have horizontal scale of 20 μsec/div

Stability of the charging current, i_{ch}, is determined from

$$i_{ch} = \frac{V_z + (V_{BE2} - V_{D4})}{R_7} \quad (2)$$

where V_z = Zener voltage of D_3, V_{BE2} = base-to-emitter voltage of Q_2 and V_{D4} = voltage across the stabilization diode D_4.

By choosing the parameters of diode D_4 to be identical to those of the emitter-to-base junction of Q_2, stability of i_{ch} is achieved.

Linearity of time delay is a function of charging current i_{ch}. Because a transistor is used as the current source, the collector-to-base resistance determines the change in the charging current versus collector voltage. Since the effect of the collector resistance of Q_1 is partially compensated by the inverse resistance of D_5, the collector resistance of Q_2 alone determines the linearity of the circuit. The deviation from linear voltage rise is determined from the expression for the voltage across C_3 during the active part of the cycle

$$V_{C3}(t) = V_o + \frac{1}{C_3}\int_0^t \left(i_{ch} - \frac{Kt}{r_{c2}}\right) dt \quad (3)$$

where V_o = initial voltage across C_3, K = average rate of rise of voltage across C_3 and r_{c2} = collector-to-base resistance of Q_2 at the value of charging current.

The term Kt/r_{c2} determines the deviation of the charging current from the value specified in Eq. 2. Using K = 0.135 v/μsec, r_{c2} = 0.5 megohm, and t = 120 μsec, the deviation from linearity resulting from the collector resistance of Q_2 being finite is less than 0.65 percent.

The time delay can be increased to more than 120 μsec by either increasing the value of C_3 or by decreasing the charging current i_{ch}. The former method is preferred, since reduction in i_{ch} will increase stability of the time delay.

The authors thank L. Sanders and L. Maggi for their assistance.

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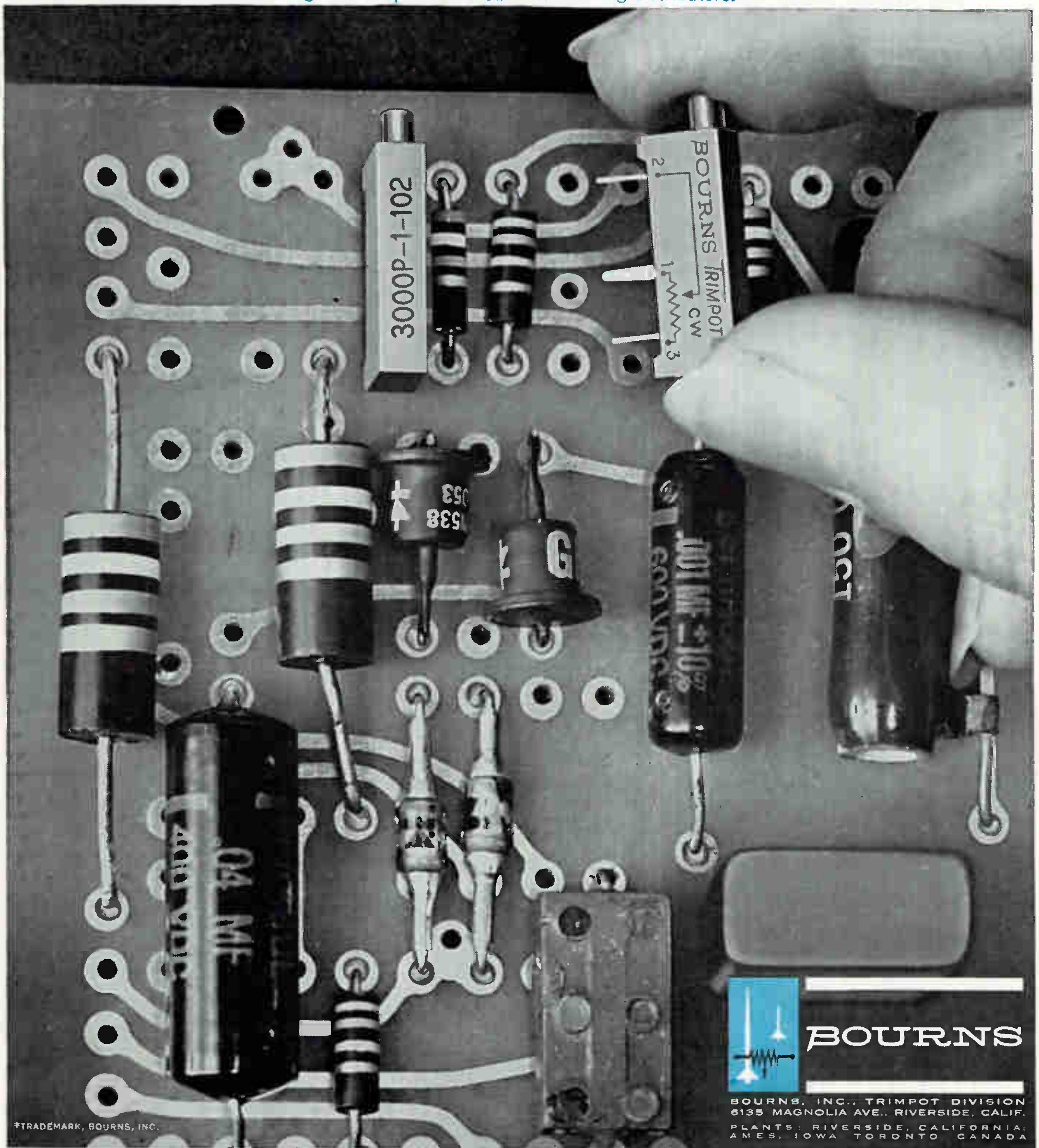

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Russians Experiment With 3-D Color Tv

EXPERIMENTAL three-dimensional color television system was described in a Russian publication.[1] Although methods for broadcasting the signal have not been developed and other problems remain, the equipment is said to permit important experimentation in technical requirements and in perception by human observers.

The following description of the project is based on a translation of the article that was prepared under contract by the United States Joint Publications Research Service. This federal government organization was established to fulfill translation and research needs of government departments.

Television broadcasting in Russia is limited to black and white, although Moscow and Leningrad tv centers are said to be making experimental compatible color television broadcasts.

Color television improves discrimination of objects and three-dimensional television has demonstrated its value in remote control of mechanisms. As a result, efforts are being made to combine the two.

An experimental apparatus called stereocolor has been constructed for three-dimensional color television. The system was developed under direction of Prof. P. V. Shmakov at the television department of the Leningrad Electrical Engineering Institute of Communications. It is being used to investigate such problems as the influence of color on perception of depth and the effects on the stereocolor picture of bandwidth and of certain types of flicker.

Stereocolor television pictures are obtained by taking two color television pictures of the same object from different points. The two pictures, called the stereo pair, differ from each other in horizontal parallax. The left and right images of the stereo pair can be transmitted simultaneously on two channels or successively on a single channel. Reproduction of color in this system is accomplished in the same manner as in other color television systems.

Use of the scanning-beam method in the transmitting portion of the system is justified by its use in color television. However, if both images of the stereo pair are transmitted simultaneously, it cannot be used in stereocolor television. Successive transmission of each image or part of an image is possible with a scanning-beam camera as well as simultaneous transmission of the three colors. Therefore it was used in the system. In addition, a control device makes possible experiments with either simultaneous or sequential transmission systems for the stereo pair.

A variety of methods of operating the two scanning tubes sequentially are possible. They could be commutated synchronously with frames, with margins or with lines. Because commutating the scanning tubes at the standard frequency of frames or margins causes flicker, commutation at line frequency was chosen.

The stereocolor signals are generated by 18LK8Zh scanning tubes spaced 180 mm apart on the camera. A special commutator was used to regulate sequential on and off switching of the scanning tubes at line frequency. To form the left and right images of the stereo pair, one line is scanned by one tube while the other tube is blanked. Then the first tube is blanked while the second tube scans a line.

A stereoscopic viewer was incorporated in the camera for the convenience of the operator. Angular rotation of the optical axis is possible within limits of 10 degrees to allow changes in the region of stereoscopic vision.

A system of multiplier phototubes that transform light reflected from the object into color-selected signals is set up in the studio. Signals from the phototubes are fed to a video mixer and then to a circuit that corrects scanning tube aperture distortion. Preamplifiers increase signal level to 1 watt and correct afterglow of the mosaic on the scanning tubes.

After preamplification, the signals are supplied to a color corrector where they are transformed into signals corresponding to the primary colors. The transformed video signals then enter the gamma corrector where they are pre-distorted according to the nonlinear modulation characteristic of the pickup tubes. The signals are then fed to the stereocolor receiving video control system, which consists of two 53LK4Ts tubes and a double set of color video control units.

Specially modified tubes are used in the receiver to obtain a stereoscopic color picture. The left and right images are combined by half transparent mirrors. Separation of the stereo pair is achieved with polaroid sheets positioned in front of the tubes with their planes of polarization mutually perpendicular. The three-dimensional image is visible with polaroid glasses when it is projected on a mirror through the two sheets.

The system operates at the standard frequency band of 6.5 Mc. The same requirements apply to adjustments of color channels as to other color television systems. A video control black and white two-dimensional unit and a control oscilloscope are included in the system.

Because the picture is obtained by scanning the scene with light beams, extraneous light must be kept from the studio. The studio is illuminated by pulsating light sources during retrace of the scanning tubes. Special pulses simultaneously blank the multiplier phototubes.

The first stereocolor television picture was demonstrated on December 10, 1959. All viewers were said to have noted depth of the picture, adequacy of brightness and the satisfactory reproduction of colors. Because of the 180 mm

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separation of the camera pickups for left and right images, the impression of depth was somewhat exaggerated when small objects were examined in the foreground. However, this characteristic is felt to be useful under certain conditions.

Efforts are being made to develop methods for stabilizing the channel and for transmitting signals from the stereo pair picture.

REFERENCE

(1) V. Dzhakoniya, *Radio*, 4, p 29, Moscow, April 1960.

Dual-Armature Voltmeter Speeds Measurements

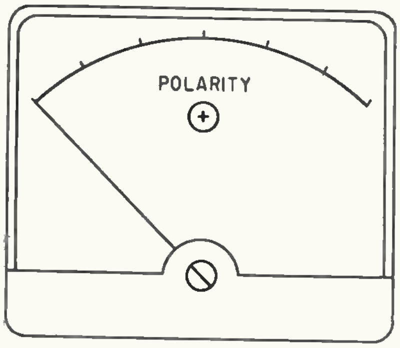
By F. W. KEAR,
Supervisor, R & D Lab.,
Lytle Corp., Albuquerque, N. M.

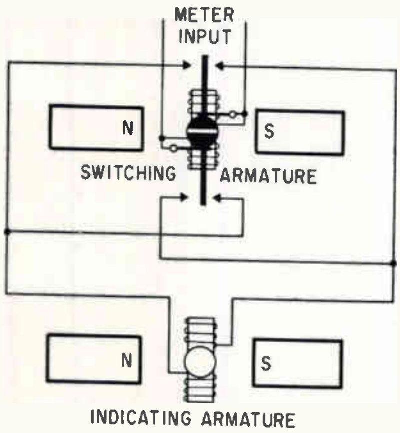
POLARITY-SEEKING voltmeter automatically switches d-c input voltages to the correct polarity for the meter movement. As well as protecting the meter from voltage of incorrect polarity, automatic polarity switching is convenient and time-saving when large numbers of voltage measurements must be made involving voltages of both polarities.

The instrument can be incorporated into test equipment that requires voltage to be measured relative to ground or to some other reference level without requiring manual operation of a polarity-reversing switch. When the voltage to be measured is applied at the meter input, its polarity as well as its magnitude is indicated on the meter face.

The dual-armature meter shown in the figure has a conventional indicating armature that deflects a pointer to the right when voltage of the correct polarity is applied to it. A second armature drives a normally open dpdt switch. An adjustable helical spring holds the switch contact arms at the open position when no current is flowing in the switching armature to avoid accidental application of incorrectly polarized voltage to the indicating armature.

When the d-c voltage to be measured is applied to the meter input terminals, the switching armature rotates in a direction determined by polarity of the voltage. The switch contact arms complete a circuit from each input terminal through slip rings to each side of the indicating armature. If polarity of the input voltage is reversed, the switching armature rotates in the opposite direction reversing the connections from the input terminals to the indicating armature. Thus voltage to the indicating armature always has the same relative polarity regardless of polarity of the voltage at the input terminals.





Dual-armature meter indicates polarity as well as magnitude of measured voltage

The switching armature also operates a polarity-indicating device. Polarity of the measured voltage relative to one input terminal is indicated by lamps or flags on the meter face.

Both armatures are balanced to limit the torque required to operate the meter. In addition, the switching armature is wound to produce maximum torque for the range of currents that will be encountered by the armature.

Filters Clear Airways of Harmonics

INTERFERENCE PROBLEMS in radio signals extend all across the spectrum. A look at microwaves indicates the magnitude of these problems. Troubles occur between high-power radars, which produce as many as a dozen harmonic frequencies in addition to their fundamentals, and sensitive microwave links. Increasing difficulties will be caused by the increase in number and power of today's 12,000-plus radar transmitters, and an estimated doubling of the current 7,000 microwave relay stations in the next five years.

Today over New York City, there are about 200,000 fundamental frequency pulses per second radiated from radar transmitters alone. Including harmonics, this number goes up to a million or more pulses per second. In this environment, many different types of sending and receiving systems are operating. These include weather radars, airport radars, air-defense systems, satellite communications, tropospheric scatter, telephone and tv, and so on. In the next decade, the interference situation could become chaotic, without careful control and planning to clear the air of unwanted harmonics.

Back in 1955, experts at General Electric, including Tomiyasu, Forrer and Williamson, and Hiebert of Rand Corporation, set out to study radio-interference problems on a modest scale. Within a year, their work attracted attention of the military, and Air Force support came from Rome Air Development Center.

An elaborate analyses center was established to predict the radio environment faced by transmitters. Objectives of the program determined the spectro-output of high-power microwave tubes, and the development of techniques to reduce unwanted harmonics to levels where interference would not occur. A redesign of power tubes was not the complete answer, and attention was turned to the control of spurious output of the tubes by means of external filters.

Much of this work has been under military wraps. But in the past year, some security has been lifted, and General Electric[1] has translated some of these filter designs into a line of filters whose work extends from the 400 mc to 10,000 mc. These filters provide increased fundamental power handling capability in the waveguide transmission line by overcoming waveguide breakdown problems prevalent in equipment generating harmonics.

The electrical ratings and mechanical data on filters developed to keep pace with the rapidly increasing utilization of the microwave spectrum are given in table.

In normal applications, these filters are located in the waveguide transmission line between the output tube and the antenna, and as close as possible to the output tube. Six of the filters cover the S, C, L and uhf bands and are relatively small and lightweight. The MPF-400 filter for the uhf range, is believed to be the largest built to date (see cover). Additional frequency coverage will be provided by new filters now under development.

The filters absorb the unwanted harmonic signals produced by the transmitting tubes, but still allow the intended fundamental frequency to pass through with power undiminished. Strength of the harmonics is reduced to 100,000 the strength of the original signal, with but 2 percent insertion loss. Types now in development meet needs as high as 40,000 mc.

Effective solution to the microwave problem lies in increasing the power handling capability of the waveguide system of the output side of the tube by eliminating waveguide arcing which results from harmonics.

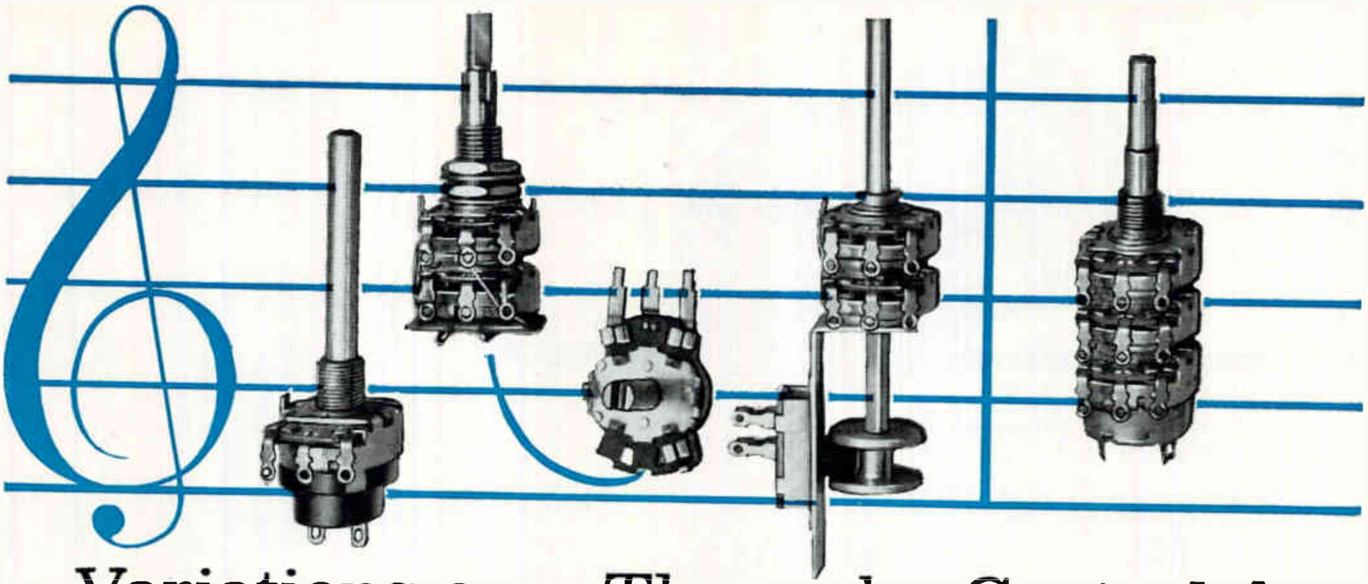
The filter itself is constructed and installed so that apertures are positioned along the inside walls of the main waveguide. Harmonic signals are leaked away by a series of coupling slots and muffled in their secondary waveguides.

The development of the filter techniques has been possible by close affiliation of General Electric with military agencies.

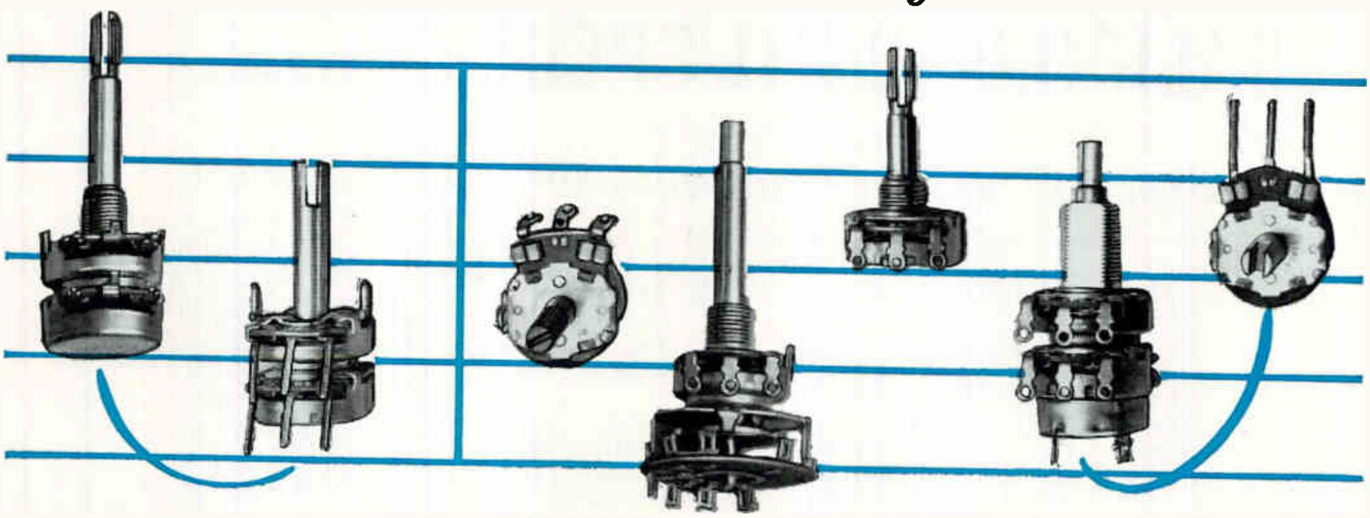
In a typical radar transmitter, filters are placed as close to the output power amplifier as practical, see diagram. As an example of how the filter can increase fundamental power handling, consider a typical high-power radar transmitter. In

CHARACTERISTICS OF HARMONIC ABSORPTION FILTERS

ELECTRICAL	MPF-2501	MPF-2502	MPF-1001	MPF-400	MPF-1000	MPF-800	MPF-2001
Pass Band Freq. Range (kmc)	2.6–3.1	2.6–3.6	1.2–1.4	0.40–0.45	5.0–6	0.76–0.98	2.35–2.7
Peak Power (megawatts)	5	5	10	5	1	0.1	20
Stop Bands Freq. Range (kmc)	4.8–6.2 7.8–9.3 10.4–12.4	6.0–7.2 7.8–10.4	2.4–2.8 3.6–4.2 4.8–5.6 6 –7	0.80–0.90 1.20–1.35 1.60–1.80	10.0–12.0 15.0–18.0	1.51–1.97 2.26–2.96	4.7 –5.4 6.75–8.1 9.4 –10.8
MECHANICAL							
Dimen. (Inches)	36 × 9.5 dia	36 × 9.5 dia	51 × 24	166 × 49 × 34.5	25 × 7 dia	72 × 25 × 12	48 × 15 dia
Weight (Approx.)	50 lbs	50 lbs	175 lbs	1,200 lbs	25 lbs	250 lbs	100 lbs



Variations on a Theme by Centralab



The Conventional Model 2 Composition Variable Resistor has 15 separate identities*... and potentially more!

Versatility is music to the ears of CENTRALAB engineering and production people—which is one of the reasons that our 15/16" composition variable resistor (known as the Model 2) is such a favorite. The basic unit, rated at ½ watt, with resistances from 200 ohms to 10 megohms, in various tapers, is highly adaptable.

It is available as a single, dual or twin control, metal or plastic shaft, with a choice of 5 types of switches (snap action, push-push, push-pull, slide, or rotary), 5 types of mountings (bushing, twist-tab, snap-tite*, "doghouse" bracket or "grasshopper"), 3 types of terminals (solder lug, wire wrap, or printed circuit), with unlimited variations and combinations.

Harmonizing with your requirements is our business. We probably make the type of Model 2 you need—if not, we can develop it for you. We're always interested in an additional variation on our favorite theme.

* **Described in our brand-new Model 2 Brochure, available free by requesting Bulletin #42-1081.**

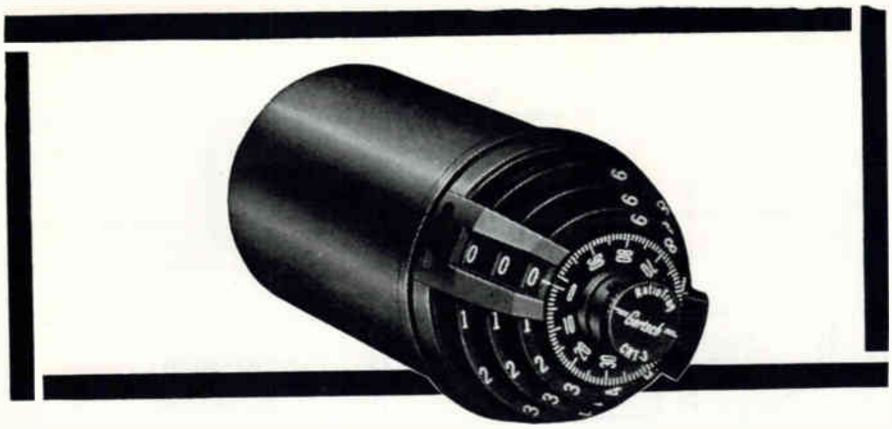
Centralab®

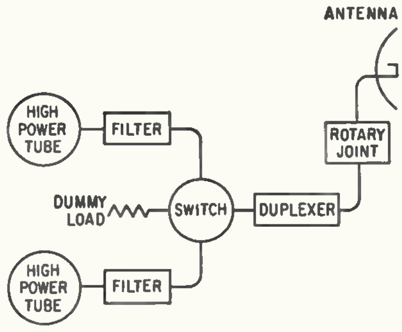
THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
914D East Keefe Avenue • Milwaukee 1, Wisconsin
Centralab Canada Limited Ajax, Ontario

*Trade Mark B-6113

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

CIRCLE 87 ON READER SERVICE CARD





Typical layout of radar transmitter using harmonic absorption filters

many systems, the *vswr* in the transmission line is as great as 1.5 : 1. If the incident electrical field is normalized to a value of one volt per centimeter, then at some positions along the line the electric field has a magnitude of 1.2. In typical systems the level of harmonic power may be as great as −20 db referred to the carrier frequency power. The normalized incident electric field (for modes well above cut-off) for a harmonic signal then is 0.1-v per cm. This signal often propagates with a *vswr* of 10 or more at some frequencies so that at some positions along the line the harmonic electric field will have a magnitude of 0.18-v per cm.

If the line is long enough for the standing wave peak of the fundamental to add in phase with the standing wave peak of the harmonic, then the equivalent electric field amplitude is 1.38-v per cm. The power corresponding to these fields may be compared by squaring as follows:

$$\left(\frac{E_f + E_h}{E_f}\right)^2 = 1.33$$

where E_f is 1.2-v per cm and E_h is 0.18-v per cm. Thus, if the above transmitter operates very close to the voltage breakdown level, then removal of the harmonics from the line will allow transmission of one-third more fundamental power before the same breakdown value is reached.

The exact increase of fundamental power capability depends not only on the filter design, but also on the layout and operating conditions of the transmission line.

REFERENCE

(1) V. G. Price, Manager, Filter Section, Traveling Wave Tube Product Section, Power Tube Department, General Electric Co., Palo Alto, Calif.

Sets Up Advisory Group For Microminiaturization

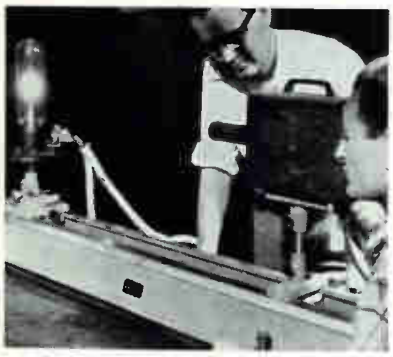
THE ELECTRONIC Industries Association's Subcommittee on Microminiature Components for Computer Use has been given full committee status within the EIA Engineering Department and will function as an advisory committee on user recommendations for discrete microminiature components for all applications, the association announced today.

The group, re-designated the Microminiature Components Advisory Committee, has been given an across the board advisory function. As in the past, it will be staffed by representatives of user groups who will prepare user requirements for referral to standardizing committees of the EIA Engineering Department.

Edward Keonjian, of the Arma Division of American Bosch Arma Corp. at Garden City, N. Y., will continue as chairman of the committee.

The committee was given the advisory function in recognition of the widespread use of microminiature components in fields other than computer. The action was taken after approval by chairman of the EIA Panels on Industrial Electronics, Component Parts, Consumer Products, and Military Products.

Calibrating Temperatures Up to 10,000 C



Automatic pyrometer that can continuously measure and control temperatures up to 10,000 C is tested by engineers of Atomics International, a division of North American Aviation, Inc. A standard lamp is used for calibrating the device during test operation. Unit will be manufactured by Pyrometer Instruments Co., Inc., Bergenfield, N. J.

CIRCLE 89 ON READER SERVICE CARD→

Prepare Semiconductor Dice in High Volume

LARGE QUANTITIES of semiconductor crystal blanks are needed to supply the automated MADT transistor production lines at the Lansdale Division of Philco Corp., Lansdale, Pa. Volume requirements have led to equipment improvements which speed up crystal pulling, dicing and etching.

Czochralski pullers used to grow single crystals of germanium (a 1-1-0 orientation is desired) have been modified to reduce downtime and make the crystals more uniform. A continuous feed enables very large crystals to be grown.

Billets of germanium are fed into the melt at the same rate as the crystal is withdrawn. Each puller is equipped with a sealable tube leading to the crucible. A billet is suspended in the tube by a clamp lowered at a rate set by the pulling controls.

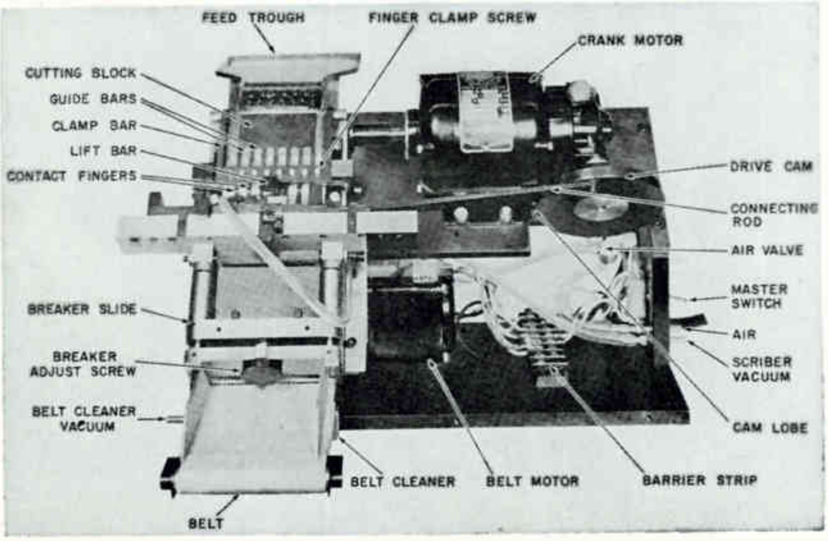
More recently, some pullers have been equipped with double feed tubes. Five crystals can be pulled from the melt before the furnace is shut down. A port, built into a chamber surrounding the pulling spindle, permits removal of finished crystals and attachment of fresh seeds without contaminating the melt.

Billets are about two feet long and weigh some 2,000 grams. They are prepared in zone refining machines which have 10 tubes ganged to the same controls and programmer.

Crucibles for germanium have a collar several inches high rising above the melt. The heat of the collar soaks the crystal as it is pulled, extending the crystal-growing period and reducing dislocations. Conventional pullers are used for silicon as the quartz crucibles employed require frequent replacement.

After crystals have been oriented by x-ray diffraction, they are butt-mounted on cantilever-type sawing fixtures. Cantilever mounting requires holding cement on only one end of the crystal, minimizing wafer cleaning and reducing impurities in reclaimed scrap. Wafering is done on conventional diamond saw indexing machines.

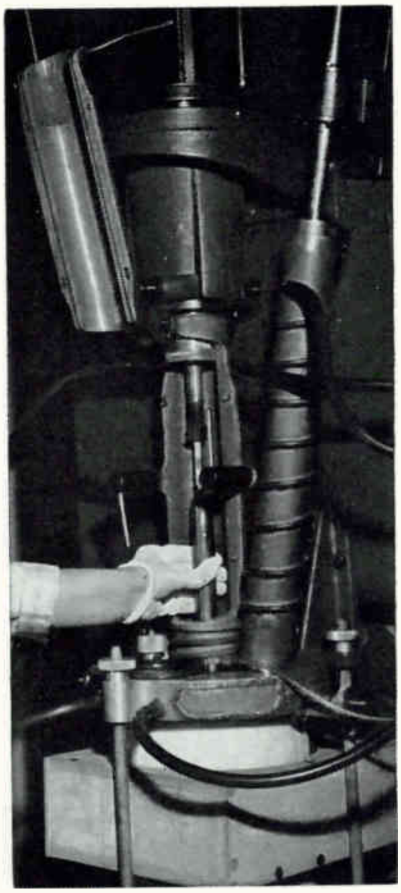
Wafer resistivities are checked with direct-reading instruments. The operator is required to adjust the test set only to the thickness of the batch being tested. Each wafer is positioned under a four-point probe which is depressed by the



Automatic scriber (strip-to-blank) with location of parts

Billet is loaded into feed tube of crystal puller

Wafer resistivity test set



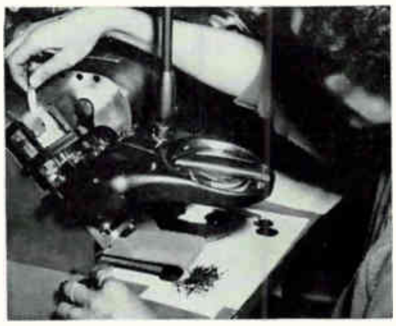
Crystal is removed through port

actuation of a hand operated lever.

Lapped wafers are polished in miniature barrel etchers. These are beakers, partially filled with etchant. After they are loaded with wafers, they are set at an angle in holders built into a rack. The holders have a mechanical drive, for rotation, heaters and temperature controllers.

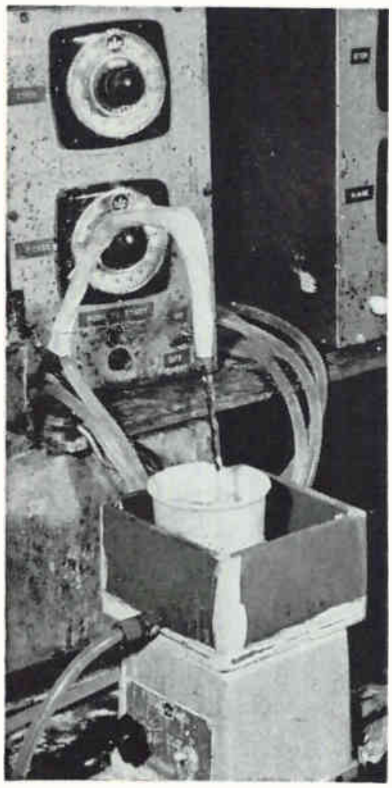
Motorized scribing machines cut the wafers into strips and dice. These machines make it unnecessary to mount the wafers on plates for dicing. After a diamond tool scribes a horizontal line, a bar breaks off the strips or dice. Feed troughs guide the material to scribing and breaking positions. Strip or dice are discharged on a miniature belt. The operator picks off scrap and the good dice drop into a conveyor as the belt goes around a roller.

Wafers are polished in miniature barrel etchers



Motorized scriber cuts wafers into strips

Philco etches the dice in a beaker with perforated sides. It doubles as a rinsing unit. Dice and a magnetic bar stirrer are loaded into the beaker. The beaker is placed in a catch basin over the magnetic stirring unit. Temperature-controlled etchant goes into the beaker. The load is stirred vigorously for the time required to achieve the desired



Dice are etched and rinsed in perforated beaker

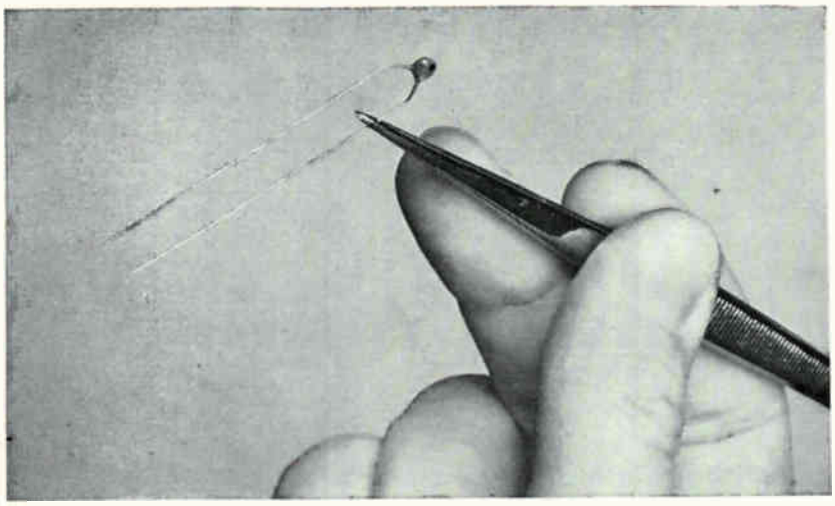
dice thickness. Then, deionized water is automatically released to stop the etching and to wash the dice.

Dice are sorted in a roller micrometer and diffused in batches in a vacuum furnace with an arsenic atmosphere. Impurity gradiants of sample dice are profiled on test equipment. The emitter and collector pits are etched and plated with equipment similar to that used on the automatic transistor production lines.

Barrel Spray Coats Electron Tube Parts

ROTATING BARREL spraying machine is reported to apply uniform coatings on small parts. It was designed by Startrite Design Ltd., Gillingham, Kent, England, to coat thermionic tube mica insulators with a suspension of magnesia in water. Parts fed into the barrel pass through a spray from a gun which reciprocates in the barrel and operates on each forward stroke. A timer, heater, fan and air cleaner are used to obtain even coating of parts in batches.

New On The Market

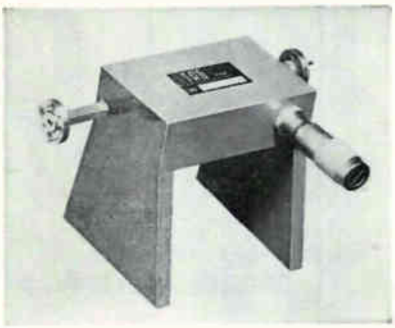


Small Capacitors
LOW VOLTAGE

COMPACT capacitor introduced by Sprague Electric Co., North Adams, Mass. is expected to find wide application in hearing aids. Only $\frac{1}{8}$ inch in diameter, it is rated at 0.02 microfarad at 3 volts.

The largest in this line of micro Hypercon capacitors is rated at 0.1 microfarad at 3 volts and is $\frac{7}{32}$ inch in diamter.

CIRCLE 301 ON READER SERVICE CARD



Tunable Isolator
MILLIMETER BANDS

TUNABLE ferrite isolator for K-band is announced by Technical Research Group, Inc., 9 Union Square, Somerville, Mass.

The Ferimat operates over the full waveguide frequency range, with performance ratings as follows: vswr 1.25 max; isolation 20 db-min; loss, 1.5 db max.

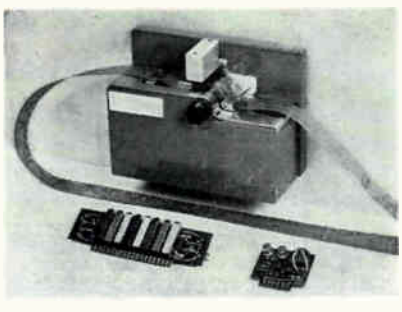
Applications include laboratory test bench equipment, experimental microwave circuits, signal generators and broadband countermeasures systems.

CIRCLE 302 ON READER SERVICE CARD

Paper Tape Reader
SLOW-SPEED USES

LOW COST, compact photoelectric paper tape reader that reads any 5, 7, or 8 hole perforated paper tape at rates up to 20 characters per second has been introduced by Invac Corp., 14 Huron Drive, Natick, Mass. Tape reader is designed for slow-speed applications where cost and size are primary requirements such as in business data processing and telemeter data reduction.

Photoelectric techniques eliminate most electrical and electromechanical components normally used in slow-speed tape readers. Features include all solid-state circuits, self cleaning, no tape access time, positive tape indexing, up to 60 percent light transmissivity, and a long life, low-temperature light source that does not affect the photocells. Reader unit is 6 by $4\frac{5}{8}$ by 4 inches.



Price of a rack-mounting tape reader, complete with amplifiers and drive circuits, is $395.

CIRCLE 303 ON READER SERVICE CARD

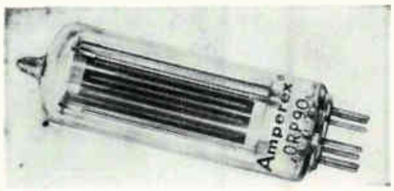
Thermionic Converter
10-WATT OUTPUT

PRACTICAL vapor thermionic converter with a 10-watt power output has been developed by the General Electric Power Tube Dept., Schenectady 5, New York. The sealed-off cesium vapor device has an integral radiator and reservoir. Power output of 2.4 watts per sq cm and efficiency of 11 percent was achieved at cathode temperature of 1,300 C.

To test seal ruggedness the converter was cycled 20 times between room and operating temperature (1,300 C). The device has 168 hours of steady-state operation.

Volume production will depend on the design and development of systems using the device.

CIRCLE 304 ON READER SERVICE CARD



Cadmium Sulphide Cell
10 MA CELL CURRENT

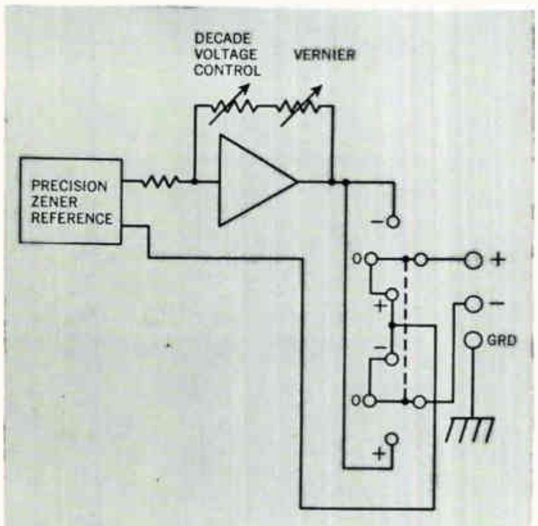
MINIATURE photoconductive cadmium sulphide cell with high sensitivity to visible light and dissipation rating of 1 watt has been announced by Amperex Electronic Corp., Semiconductor and Special Purpose Tube Division, 230 Duffy Avenue, Hicksville, L. I., N. Y. The ORP90 can actuate relays directly. It has a dark current of 2.5 microamp, and an average cell current of 10 ma with 5 foot candles illumination (color 2,700 K). The cell is

IN PRECISION CALIBRATION

EPSCO DELIVERS ITS SPECIFICATION

FEATURES:

- Selectable Voltages, in 1 millivolt steps, from 0 to ±11.112 V
- High Resolution and Selection Capability: 1 part in 10,000; with vernier adjustment, 1 in 100,000
- Close Reference Control of Zener current and load maximizing stability
- Low Output Impedance: 0.05 ohms (50 milliohms) DC
- Overload Proof
- Vernier Control. Permits operator to vary output continuously over a ±2 millivolt range for any setting
- Chopper-Stabilized, High Gain Amplifier
- Predicted Mean Time to Failure: 15,000 hours



VRS-611 BLOCK DIAGRAM

APPLICATIONS:

- Insert precisely known voltages of small magnitude for calibration of low level data gathering systems
- Calibrate precision amplifiers
- Calibrate voltmeters
- Working secondary standard for laboratories and quality control departments
- Make precision voltage measurements

NEED A LOW-RANGE, LOW-COST VOLTAGE REFERENCE SOURCE?

Absolute accuracy of ±0.025%... selectable voltages from 0 to ±11.112 V... make Epsco's new VRS 611 the most accurate and flexible voltage reference source for the money!

Designed as a "Workhorse Cousin" to Epsco's higher-range VR607, the portable "611" voltage reference source meets the needs of quality control departments, electric equipment manufacturers, research laboratories, armed forces repair facilities and component manufacturers.

Available as a portable unit (shown above), in sturdy rack mount for fixed installation . . . or with battery power for in-field calibrations. All models ready for immediate delivery. Call or write for details. **Price $625.00**

Epsco INSTRUMENTS

A division of Epsco, Incorporated, 275 Massachusetts Ave., Cambridge 39, Mass., UNiversity 4-4950 designed for relay and illumination stabilizer applications. It can be mounted directly in the probes of flame-control apparatus.

The cell is a side sensitive device mounted in a hermetically sealed glass envelope with a conventional 7-pin miniature base.

CIRCLE 305 ON READER SERVICE CARD

tics. Model 511 laser stimulator is being introduced by Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston 15, Mass.

CIRCLE 308 ON READER SERVICE CARD

File Searcher
MIROFILM SYSTEM

MACHINE that can automatically search a 32,000-page file and present desired information has been developed by FMA, Inc., 142 Nevada St., El Segundo, Calif. Called FileSearch, the machine uses optical and electronic techniques to retrieve stored information from microfilmed files.

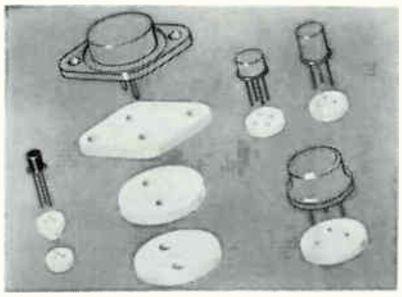
The system stores 32,000 standard-sized magazine pages on a single reel of microfilm and searches at the rate of 6,400 pages a minute. Input is by punched card and output is printed copy or film. A console (71 × 55 × 50 inches) contains all equipment except recording camera and simple indexing machine. No computers or card readers are required. Up to six input requests can be handled simultaneously.

CIRCLE 306 ON READER SERVICE CARD

Transistor Heat Sinks
ALLOW HIGHER POWER

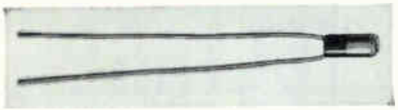
TRANSISTOR dielectric heat sinks are available off-the-shelf from National Beryllia Corp., First & Haskell Ave., Haskell, N. J. Used to insulate semiconductor devices from the chassis, the heat sinks use beryllium oxide to resist the flow of electricity but not the flow of heat. The heat sinks allow semiconductor temperatures 50 percent lower than conventional dielectric materials.

Berlox heat sinks have low capacitance, thus minimize problems in h-f circuits, are available to match JEDEC outlines TO3, 5, 8,



9, 11, 12, 16, 18, 33, 38 and 39. Standard thickness is $\frac{1}{16}$ in. Other TO size, custom shape or thickness, available on special order.

CIRCLE 309 ON READER SERVICE CARD



Tantalum Capacitors
WET-ELECTROLYTIC

OHMITE MFG. CO., 3650 Howard St., Skokie, Ill. Tantalum, wet-electrolytic capacitors, series TW (wire type) and series TS (slug type) can be supplied with single-ended lead termination. With this type of construction, both the cathode and anode leads extend from the same end of the capacitor. Leads are properly coded for easy identification. Single-ended lead termination finds use in fast assembly operations on modules and p-c terminal boards.

CIRCLE 307 ON READER SERVICE CARD

Laser Light Source
OPTICAL MASER STUDIES

CLOSE optical coupling between flash tube and crystal, and the use of a special U-shaped Xenon-filled flash tube increase the efficiency of light source by a factor of about 10 over that of the conventional spiral flash tube.

The flashhead contains from 4 to 10 flash tubes, dependent on the light requirements and diameter of crystal. Crystals approximately 2 inches long and up to ½ inch in diameter can be accommodated. Flash tubes may be connected in series or series-parallel.

The energy storage bank has a maximum output of 1,280 watt-seconds. Recycling time is 2 seconds. Flash rate is determined by crystal and flash tube characteris-

Spectrum Analyzer
50-100 GC

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. Model DA-70 spectrum analyzer covers the 50 Gc to 100 Gc range in 3 bands, all contained in one tuning head. The wide band display of up to 1,000 Mc can be used to observe a pulsed signal as narrow *this is the actual size of the*

NEW, COMPACT, PROGRAMMABLE, HALF-RACK, ®REGATRAN POWER SUPPLIES...

with continuously variable current limiter...

These new Regatrans are sparing only of space . . . delivering super-regulated, virtually ripple-free d-c power with the instant start-up and very high reliability of solid-state circuitry . . . and offering a group of features hitherto unprecedented in d-c power supplies of this size.

REGULATION, LINE OR LOAD, 0.1% OR 0.01 V			
MODEL NUMBER	DC OUTPUT		MAX. RMS RIPPLE
	VOLTS	AMPS	
TR212A	0-100	0-100 MA	250 µv
TR018-1	0-18	0-1 AMP	150 µv
TR036-0.2	0-36	0-200 MA	150 µv

For a closer look, ask your local Electronic Measurements representative for a copy of Specification Sheet 5000 . . . or write direct.

ELECTRONIC MEASUREMENTS
COMPANY OF RED BANK
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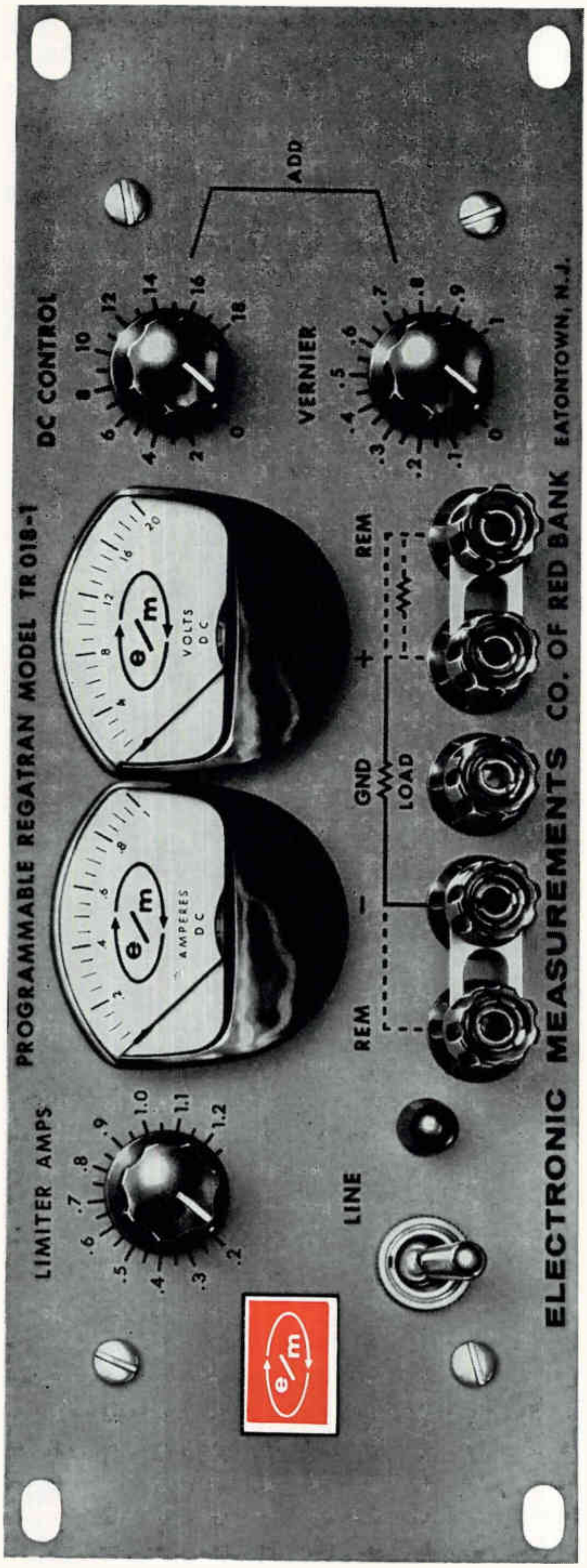
®Reg. U.S. Pat. Off. Patents Issued and Pending.



CIRCLE 97 ON READER SERVICE CARD

as 0.01 μsec. Among its many applications are measuring the spectral characteristics of pulse modulated signals, and simplifying field intensity measurements.

CIRCLE 310 ON READER SERVICE CARD

Miniature Relay

ELGIN ADVANCE RELAYS, Elgin National Watch Co., 2435 North Naomi St., Burbank, Calif. Miniature d-c relay occupies less than ½ cubic inch of space when unenclosed.

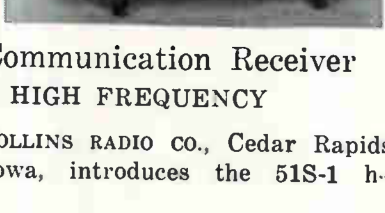
CIRCLE 311 ON READER SERVICE CARD

Test Unit

TRANSFER FUNCTION

BOONSHAFT AND FUCHS, INC., Hatboro Industrial Park, Hatboro, Pa., announces model 711 transfer function analyzer for determining frequency response measurements. It features wide frequency range, high noise rejection, fast read-out, extreme accuracy. The data are presented as in-phase and quadrature components, as well as amplitude and phase versus frequency.

CIRCLE 312 ON READER SERVICE CARD



Communication Receiver

HIGH FREQUENCY

COLLINS RADIO CO., Cedar Rapids, Iowa, introduces the 51S-1 h-f communication receiver. Continuous coverage of the 2-30 Mc range is provided in 1 Mc bands with 1 Kc increments on the main tuning dial. Additional coverage from 0.2-2.0 Mc permits broadcast monitoring or lab use. Reception of upper sideband, lower sideband, a-m or c-w signals is provided at any frequency within the tuning range.

CIRCLE 313 ON READER SERVICE CARD

Time Rate Generator

TRANSISTORIZED

BINARY ELECTRONICS CO., 824 E. Walnut Ave., Fullerton, Calif. Model 101 timing unit generates crystal referenced timing pulses as required by various test instrumentation recording devices. It is suitable for any lab or field use requiring timing rates. Outputs are available for driving instrumentation camera neon timing lights, recording oscillograph galvanometers, slow speed chart recorder timing solenoids and magnetic tape.

CIRCLE 314 ON READER SERVICE CARD

Measuring System

ELECTRO SCIENTIFIC INDUSTRIES, 7524 S. W. Macadam Ave., Portland 19, Ore. Capacitance measuring system (0.01 percent) measures two or three-terminal capacitors ranging from 0 to 0.12 μf with a resolution of 0.0001 pf on the lowest range.

CIRCLE 315 ON READER SERVICE CARD

Recorder/Reproducer

VIDEO BAND

MINCOM DIVISION, Minnesota Mining and Mfg. Co., 2049 S. Barrington Ave., Los Angeles 25, Calif. Bandwidth of the CM-100 video band recorder reproducer now is extended to 1.2 Mc at 120 ips; proportionate increase at all six speeds. Standard 7-track production model easily converts to 14 tracks.

CIRCLE 316 ON READER SERVICE CARD

Epoxy Silver Solder
LOW RESISTIVITY

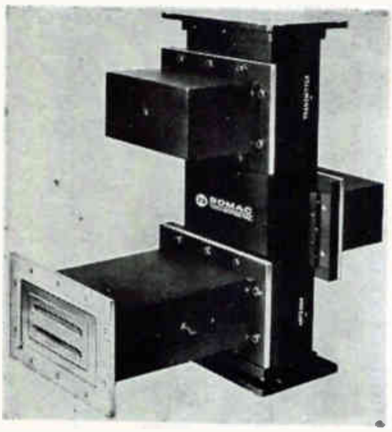
EPOXY PRODUCTS, INC., 137 Coit St., Irvington, N. J. A silver conductive epoxy with a resistivity approaching the resistance of metals—between 0.01 ohm-cm and 0.0001 ohm-cm—has been developed. Epoxy solder has two principal advantages over conventional solder or brazing: it can be used at low temperatures for components which are heat sensitive and it has no flux or residue to contaminate sensitive electronic components. It is ideal for repairing printed circuits.

CIRCLE 317 ON READER SERVICE CARD

Servo Actuator

COMPUDYNE CORP., Hatboro, Pa. A self-contained servo-actuator contains a servo amplifier, servo valve and hydraulic cylinder. Applicable to control valves or positioning tables under high speeds.

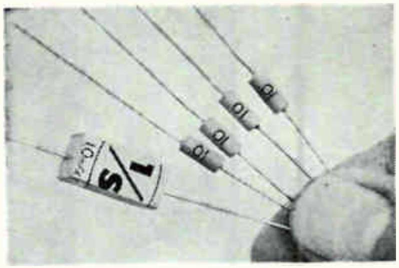
CIRCLE 318 ON READER SERVICE CARD



Waveguide Duplexers
BRANCHED TYPE

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass. Used in radar applications, this unit utilizes one TR and two ATR tubes to switch transmitter power to the antenna during the transmitted pulse while switching the incoming signal from the antenna to the receiver between pulses. Use of two ATR tubes minimizes incoming signal loss in the transmitter, and eliminates the need for a critical transmitter line length.

CIRCLE 319 ON READER SERVICE CARD



Ceramic Capacitors
SUBMINIATURE

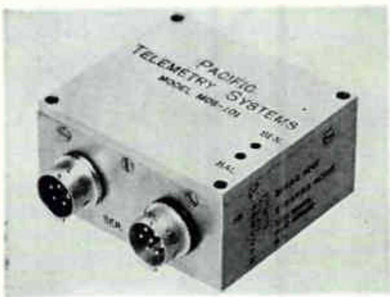
STATNETICS CORP., 5121 Weeks Ave., San Diego 10, Calif. These subminiature, hermetically sealed ceramic capacitors are designed for compact printed board use in commercial, industrial and military applications. They are suited for computer transistor circuitry where low series resistance at high pulse rates must be combined with exacting subminiature tolerances. Operating range at 100 wvdc from − 55 to 125 C.

CIRCLE 320 ON READER SERVICE CARD

Waveguides

ELECTRONIC SPECIALTY CO., Technicraft Div., 116 Waterbury Rd., Thomaston, Conn. High pressure flexible waveguides for use in high power radar utilize 45 pounds pressure for L-band application.

CIRCLE 321 ON READER SERVICE CARD



Carrier-Amplifier
MINIATURIZED

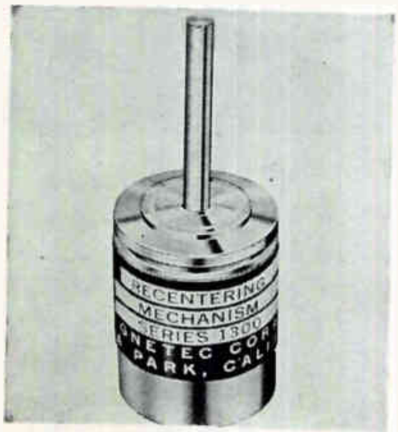
PACIFIC TELEMETERING SYSTEMS, 10810 W. Washington Blvd., Culver City, Calif. Model MCS-101 is a miniaturized carrier-amplifier system for use with low level output transducers. It features all solid-state modular construction with printed circuit interwiring. It provides the excitation to the transducer, amplifies and detects the transducer output, and provides a 5 v d-c output signal.

CIRCLE 322 ON READER SERVICE CARD

Microwave Radio

LENKURT ELECTRIC CO., INC., San Carlos, Calif. Broadband microwave radio system can be supplied with arrangements for hot standby at one millisecond and for space or frequency diversity.

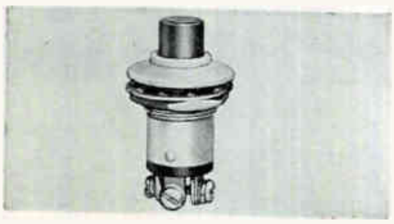
CIRCLE 323 ON READER SERVICE CARD



Recentering Device
MEETS ALL SPECS

MAGNETEC CORP., 7232 Eton Ave., Canoga Park, Calif. Series 1300 recentering mechanism is designed principally for returning to center the shaft of components such as synchros, potentiometer, encoders, commutator switches, gear trains, and the like. Units are available with standard servo-mounts, or mountings for inclusion in the original design of components. They are obtainable with adjustable stops up to 320 deg rotation, and meet MIL specifications.

CIRCLE 324 ON READER SERVICE CARD



Terminal Switch
HEAVY DUTY

CONTROL SWITCH DIVISION, Controls Co. of America, Folcroft, Pa. Model

CIRCLE 103 ON READER SERVICE CARD

C124P3 terminal switch is a normally opened switch rated at 10 amp at 28 v d-c resistance, 5 amp at 28 v d-c inductance, 3 amp at 28 v d-c lamp or 15 (0.75 pf) at 120 a-c. It requires only a $\frac{5}{8}$ in. mounting hole and features aluminum casing and adapter, 25,000 operations minimum life at rated load and requires only 4 lb operating pressure.

CIRCLE 325 ON READER SERVICE CARD

Film Capacitors
SUBMINIATURE

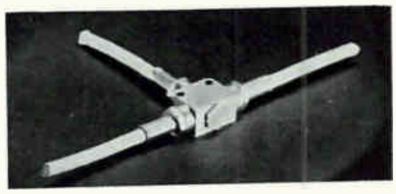
COMPONENT RESEARCH CO., INC., 3019 S. Orange Drive, Los Angeles 16, Calif., has developed a series of subminiature Teflon capacitors with low temperature coefficient and high stability for critical guidance systems in spacecraft and missile systems. Various temperature coefficients are available from zero to 120 ppm/deg C for precise matching with precision resistors and inductors. Tolerances to 0.1 percent are available.

CIRCLE 326 ON READER SERVICE CARD

Resistors

CORNING ELECTRONIC COMPONENTS, Bradford, Pa. Massive resistors for high power applications are available in a standard line.

CIRCLE 327 ON READER SERVICE CARD



Junction Block
CRIMP-TYPE

SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N.Y., has available a junction block for tapping runs of subminiature coaxial cable. This ConheX junction block features crimp-on cable connections that reduce assembly time approximately

GUDELACE®...

the lacing tape with a NON-SKID tread

You can't see it, but it's there! Gudelace is built to grip—Gudebrod fills flat braided nylon with just the right amount of wax to produce a non-skid surface. Gudelace construction means no slips—so no tight pulls to cause strangulation and cold flow.

But Gudelace is soft and flat—stress is distributed evenly over the full width of the tape. No worry about cut thru or harshness to injure insulation . . . or fingers.

Specify Gudelace for *real* economy—faster lacing with fewer rejects.

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It shows how Gudelace and other Gudebrod lacing materials fit your requirements.

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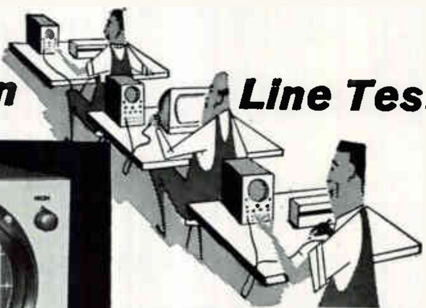
ELECTRONICS DIVISION
225 West 34th Street
New York 1, New York

WEST COAST OFFICE
2833 S. Olive Street
Los Angeles 7, Calif.

EXECUTIVE OFFICES
12 South 12th Street
Philadelphia 7, Pa.

CIRCLE 202 ON READER SERVICE CARD

For Production Line Testing...



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EICO's high quality standards and low initial cost add up to true economy: EICO units outperform scopes selling for two or three times EICO's prices. With kits, the initial cost is even lower. And the experience each operator gains in building his own, increases his efficiency, and enables him to keep his scope in better condition, with less "down" time.

	prices		freq. resp. (sinusoidal)		sensitivity (rms)	
	kit	wired	vert.	horiz.	vert.	horiz.
5" Push-Pull Scope #425	$44.95	$79.95	5 cps to 400 kc	5 cps to 400 kc	75 mv/in	0.1V/in
5" DC-4.5 MC Scope #460	79.95	129.95	DC-4.5 mc/flat	1 cps to 400 kc flat	25 mv/in	0.6 V/in

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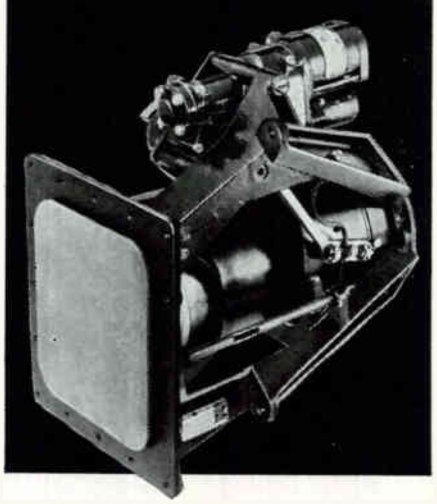
CIRCLE 203 ON READER SERVICE CARD

Another electromechanical problem solved by AiResearch



This ram air scoop is another example of AiResearch's ability to design and integrate structural and electromechanical systems for control functions.

Through its use, air is provided for emergency cabin pressurization and the cooling of electronic components. The unit is composed of a retractable aluminum ram air scoop, extended and withdrawn by a 400 cycle rotary actuator, a self-contained 350 watt heating element and an integral check valve.

The most experienced company in the development and production of control systems for airborne and ground use, AiResearch has the ideal facilities and know-how to handle problems concerning electromechanical systems and components of all types for aircraft, ground handling, ground support and missile systems.

OTHER ELECTROMECHANICAL COMPONENTS AND SYSTEMS

AC and DC Motors, Generators and Controls • Static Inverters and Converters • Linear and Rotary Actuators • Power Servos • Hoists • Temperature and Positioning Controls • Sensors • Programmers • Missile Launchers • Radar Positioners • Power Supplies • Williamsgrip Connectors

Your inquiries are invited.

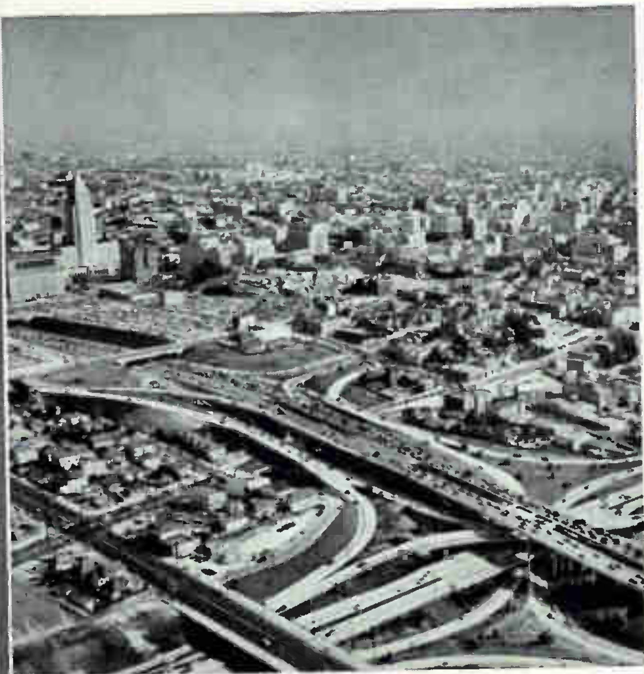
THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

CIRCLE 105 ON READER SERVICE CARD

TWA flies where the BUSINESS is!



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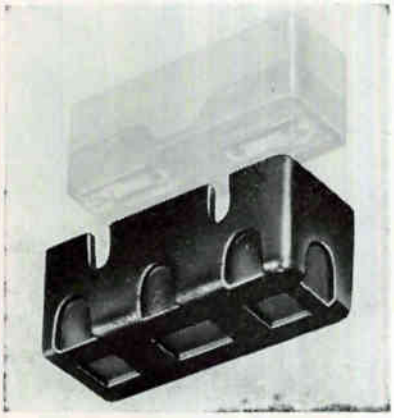
ONLY TWA carries freight between 70 thriving U. S. cities and 23 busy world centers overseas. Daily ***JETSTREAM EXPRESS*** flights . . . world's most dependable, longest-range all-cargo service . . . fly your shipments non-stop coast-to-coast and to Europe. Next time you ship, call your freight forwarder . . . or TWA Air Freight.

60 percent. Unit is designed to maintain optimum electrical characteristics in both the main cable run and the tap cable run.

CIRCLE 328 ON READER SERVICE CARD



Terminal Cover
FOR SWITCHES

UNIMAX SWITCH DIVISION, The W. L. Maxson Corp., Ives Road, Wallingford, Conn. Mechanical and electrical protection for the terminals of Unimax precision snap-acting switches is provided by the type TC-1 terminal cover. Molded of high-strength phenolic, this cover fits over the base of any series 2HB, 2HL, WHB, and DMX switch.

CIRCLE 329 ON READER SERVICE CARD

Microwave Diodes
HIGH FREQUENCY

SYLVANIA ELECTRIC PRODUCTS INC., Woburn, Mass. Microwave silicon varactor diodes, with cutoff frequencies as high as 150 Gc at −45 v breakdown voltage, have been developed through epitaxial techniques. They exhibit frequencies as high as 100 Gc and capacitance values as low as 0.15 pf at − 6 v.

CIRCLE 330 ON READER SERVICE CARD

Transistor Series

TEXAS INSTRUMENTS INC., P. O. Box 5012, Dallas 22, Texas. Three silicon power transistor series include the 2N1936-2N1937 rated at 100 watts dissipation, and two other series at 50 and 10 watts in the "thermoslug" TO-5 case.

CIRCLE 331 ON READER SERVICE CARD

Fail-Safe Switch
SOLID TYPE

ALPHA-TRONICS CORP., 1033 Engracia Ave., Torrance, Calif. Switch type FS-101 will disconnect the power source from the device under test within 1 μsec after the safe limit of current is exceeded. It is ideal for incoming inspection of electronic modules, transistors and development laboratories.

CIRCLE 332 ON READER SERVICE CARD

Cathode-Ray Tube
FAST WRITING

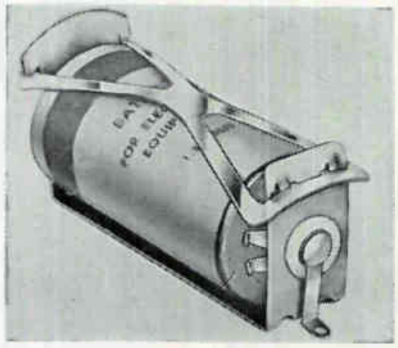
ALLEN B. DUMONT LABORATORIES, division of Fairchild Camera and Instrument Corp., Clifton, N.J. Type 12AMP is a single-beam crt with a 12 7/16-in. diameter face plate. The electrostatic focus and deflection tube features a low drive electron gun that permits use of transistorized video circuitry.

CIRCLE 333 ON READER SERVICE CARD

X-Band Isolator
MINIATURE SIZE

E & M LABORATORIES, 15145 Califa St., Van Nuys, Calif. Model XM3, a ½-in. X-band isolator covers the frequency spectrum from 9,250 to 9,500 Mc. It provides a minimum isolation of 15 db, with a maximum insertion loss of 0.5 db and max vswr of 1.2, over the temperature range of − 40 C to + 85 C. Price is $200 in single quantities.

CIRCLE 334 ON READER SERVICE CARD



Battery Holder
CORROSION-PROOF

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. The Cambion D cell carbon battery holder, No. 2890, is 3.010 in. long by 1 5/32 in. wide. A spring-loaded end allows insertion of cell in tight spots no longer than the holder itself. Special design feature is a locking strap that holds battery in place, even under the most severe conditions of shock and vibration. Price is .95 each in quantities of 50-99.

CIRCLE 335 ON READER SERVICE CARD

Rotary Joint
IN-LINE TYPE

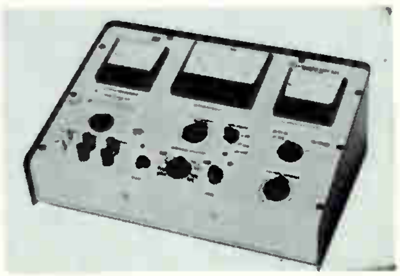
CANOGA, CORP., P. O. Box 550, Van Nuys, Calif. Model RJSL-1A is a high power microwave rotary joint of the in-line variety employing two 90 deg plane bends which convert it to a U-shaped type with coaxial non-contacting choke joints, ball bearings and an O-ring type of pressurizing seal. It operates in a frequency range of 2,240 to 2,300 Mc; vswr 1.2; power handling capacity 4 Mw peak with 25 Kw average; vswr wow 0.02; insertion loss 0.02 db; flanges UG-435A/U. Price is $2,500.

CIRCLE 336 ON READER SERVICE CARD

Terminal Assemblies
CERAMIC-METAL

THE BENDIX CORP., Red Bank division, Eatontown, N. J. Ceramic-metal terminal assemblies (called Cerameterms) are claimed to be practically indestructible. They also provide a high degree of reliability in transistors, relays, capacitor banks, and other components.

CIRCLE 337 ON READER SERVICE CARD



Transistor Tester
SIMPLE TO USE

ARMOUR STABLVOLT division of Magnetic Research Corp., 316 West

El Segundo Blvd., Hawthorne, Calif. Accurate testing of *npn* and *pnp* transistors is made rapid and simple by the model T-340 transistor tester. Ideal for incoming inspection and production line testing, it measures the four basic parameters necessary to check a transistor's performance.

CIRCLE 338 ON READER SERVICE CARD

Servo Actuator

AMERICAN ELECTRONICS, INC., 1725 West Sixth St., Los Angeles 17, Calif. An electric model for the control of missile flight surfaces features 8-millisec response. Source of motion is a constant speed miniaturized motor.

CIRCLE 339 ON READER SERVICE CARD

Silicon Diodes

COMPUTER-RECTIFIER

DELTA SEMICONDUCTORS, INC., 835 Production Place, Newport Beach, Calif., announces all purpose glass silicon computer-rectifier diodes that combine 400 ma forward conductance at 1 v, 30 nsec recovery measured on a sampling oscilloscope and 0.025 μa reverse leakage current. Designated the DW series, individual numbers are available with peak inverse voltages from 40 v to 275 v.

CIRCLE 340 ON READER SERVICE CARD

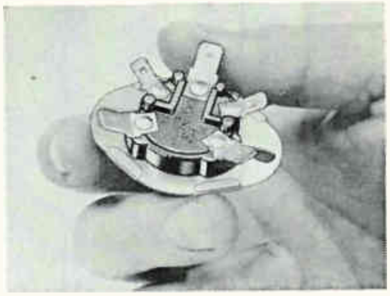
Capacitor

SOLID TANTALUM

KEMET CO., 11901 Madison Ave., Cleveland 1, Ohio, announces a 75-v solid tantalum capacitor in standard EIA capacitance values up to and including 15 μf in tolerances of ± 20, 10, and 5 percent. The capacitors are hermetically sealed in the four case sizes specified in MIL-C-26655A for CS12 and

CS13 styles. They will operate at temperatures ranging from − 55 to + 125 C.

CIRCLE 341 ON READER SERVICE CARD



Control Thermostat
INTERNAL HEATER

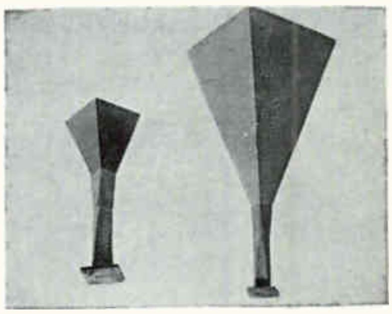
THERM-O-DISC, INC., Mansfield, O. Type 29T is a rugged, dependable, snap-action bimetal disk thermostat with an internal heater. The internal heater creates its own temperature or ambient inside the thermostat. This additional internal ambient is used to lower the operating point of the thermostat. By remotely controlling the voltage on the internal heater, the 29T can be made to operate through a range of temperatures.

CIRCLE 342 ON READER SERVICE CARD

Deviation Calibrator

ADVANCED MEASUREMENT INSTRUMENTS, INC., 109 Dover St., Somerville 44, Mass. An f-m monitor deviation calibrator combines the functions of five instruments required by the carrier-dropout method.

CIRCLE 343 ON READER SERVICE CARD



Waveguide Horn
LOW SIDELOBE

WILEY ELECTRONICS CO., 2045 W. Cheryl Drive, Phoenix, Ariz., announces a linearly polarized waveguide horn. Gains of 31 db and efficiencies of 70 percent are available

Horn design employs a square aperture with diagonal polarization. The resultant aperture illumination is tapered in all planes, which results in a circularly symmetrical pattern with extremely low side lobes and constant phase over the entire aperture.

CIRCLE 344 ON READER SERVICE CARD

Frame Grid

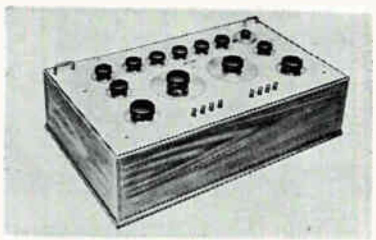
RAYTHEON CO., Industrial Components Division, 55 Chapel St., Newton 58, Mass. Five miniature tubes allow close spacing, result in high transconductance, low noise.

CIRCLE 345 ON READER SERVICE CARD

Work Table
FEATURES VERSATILITY

LEITCH-HUARD CORP., Manchester, N. H. Work table is particularly adaptable to use in industry where appearance, flexibility or mobility are required. The GP-100 versatile metal table combines Swaptop's established interchangeable top and table leveler system with a rigid table frame that is virtually free of dust traps. The tables cost less than most old-style "in plant" constructed tables and assemble quickly with just a screw-driver and adjustable wrench. They come in 4, 5 and 6 ft lengths.

CIRCLE 346 ON READER SERVICE CARD



Terminal Strip
BARRIER TYPE

ELOTEC CORP., 145 N. Lidcombe, El Monte, Calif., announces a line of barrier type terminal strips featuring miniature size, high dielectric strength, and providing savings in labor and production time. Units are designed for fast, positive connections without the need for terminal lugs or taper pins.

CIRCLE 347 ON READER SERVICE CARD

Literature of

RELAY DATA Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y. Data sheet describes RB coaxial relay d-c, single pole double throw.

CIRCLE 348 ON READER SERVICE CARD

SWITCHES Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. A 20-page catalog gives photos and condensed descriptions of over 200 items, including several types of switches and switch-circuit assemblies.

CIRCLE 349 ON READER SERVICE CARD

PLASTIC PROTECTORS S. S. White Industrial Div., 10 East 40th St., New York 16, N. Y. Bulletin offered on rectangular plastic protectors for miniature electronic pin connectors.

CIRCLE 350 ON READER SERVICE CARD

CONNECTORS Kings Electronics Co., Inc., 40 Marbledale Rd., Tuckahoe, N. Y. Several series and connector types plus telephone jacks and plugs are covered in a 120-page catalog. Included is a cross reference index, from the company's to military numbers and vice versa.

CIRCLE 351 ON READER SERVICE CARD

MAGNETIC HEAD Westrex Recording Equipment Dept., 6601 Romaine St., Hollywood 38, Calif. Data sheet describes a magnetic head designed for recording or reproducing on tape or film.

CIRCLE 352 ON READER SERVICE CARD

ACCELEROMETER Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Design features of a strain gage accelerometer family, type 4-203, are available in a 2-page bulletin.

CIRCLE 353 ON READER SERVICE CARD

TRANSISTORS, DIODES Silicon Transistor Corp., Carle Place, N. Y. A short form catalog reviews silicon power transistors, intermediate and high power, and silicon glass diodes, including military types, general purpose, fast switching, controlled forward, high power and high current switching types.

CIRCLE 354 ON READER SERVICE CARD

TWT POWER SUPPLY Watkins-Johnson Co., 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. A specification sheet features a fully solid-state, low noise traveling-wave tube power supply.

CIRCLE 355 ON READER SERVICE CARD

RECORDERS. Curtiss Wright Corp., Princeton, N. J. Miniature recorders with four inch writing widths are covered in a single sheet.

CIRCLE 356 ON READER SERVICE CARD

PRODUCT CATALOG Electro Scientific Industries, 7524 S. W. Macadam Ave., Portland 19, Ore. A short form catalog presents the company's line of precision measurements instruments, Dekaline components, resistance networks and ESIAC computers.

CIRCLE 357 ON READER SERVICE CARD

SPECTROPHOTOMETERS Beckman Scientific and Process Instruments Division, Fullerton, Calif., has published a brochure on a series of double-beam, ratio recording DK spectrophotometers and other standard instruments.

CIRCLE 358 ON READER SERVICE CARD

SCALER Radiation Equipment and Accessories Corp., 665 Merrick Rd., Lynbrook, N. Y. Data sheet reviews the transistorized G-M scaler which features cold cathode decades.

CIRCLE 359 ON READER SERVICE CARD

CAPACITORS Vitramon, Inc., Box 544, Bridgeport 1, Conn. Catalog, 16 pages, describes solid state porcelain capacitors and microminiature ceramic capacitors. Includes military and commercial part numbers, typical curves, dimensional drawings and special designs.

CIRCLE 360 ON READER SERVICE CARD

CIRCLE 113 ON READER SERVICE CARD

H. H. Smith, Inc. Gets Added Space

HERMAN H. SMITH, INC., manufacturer and distributor of electronic components, has purchased 16,000 ft of additional space adjacent to its main Brooklyn, N. Y., plant.

Ira L. Landis, president of Smith, announces the new space will be used for manufacturing and warehousing purposes. Business has climbed steadily since the company was founded in 1946, he said, and this is Smith's second expansion.

Under Landis' leadership, Smith sales have gone from $500,000 in 1954 when he took command, to almost $3 million in 1960.

The company now services over 4,000 accounts throughout the nation. It has a chain of sales reps across the nation and also exports its products. The company's new catalog lists some 4,000 standard electronic parts as well as hundreds of new components developed within the past year.

One key development in the Smith growth, the company says, was the introduction some years ago of a schematic drawing for its type of product. This enabled engineers and designers to know exactly the specifications of even the tiniest component parts and made designing their projects that much easier.

Digitronics Elects Board Member

RICHARD M. MOCK was recently elected a member of the board of directors of Digitronics Corp., Albertson, L. I., N. Y.

Mock is chairman of the executive committee of Lear Inc., and served as president of that organization for more than ten years.

Scientists Organize New Corporation

ORGANIZED by two young scientists, Ian Shivack and Allen Chertoff, a new company, Computer Techniques, Inc., recently began manufacturing logic elements for computers in Long Island City, N. Y.

Shivack is serving as president, and Chertoff as vice president. Both men were formerly with the data systems division of Harman-Kardon—Shivack as vice president, and Chertoff as vice president for R&D.

The company will be producing a complete line of micromodular encapsulated transistor logic elements as well as custom designed solid state circuitry packaged in conformance with modular concepts. Eventual product line will include analog and digital subassemblies for use in both military and industrial data systems.

Set Up New Company In Rochester

RF COMMUNICATIONS ASSOCIATES, INC., a new company formed for the development and manufacture of electronics communications equipment, has been established in Rochester, N. Y., by three engineers formerly associated with General Dynamics/Electronics (until recently, Stromberg-Carlson Division) of General Dynamics Corp.

Principals of the new firm are William J. Stolze, president; Elmer W. Schwittek, executive vice president; and Roger R. Bettin, vice president, engineering.

Sylvania Appoints Plant Manager

APPOINTMENT of Gerald E. LaRochelle as manager of the Muncy, Pa., plant of the computer products operations of Sylvania Electric Products Inc. is announced.

LaRochelle joined Sylvania in 1958 as supervisor of production of the data systems operations in Needham, Mass., and was named manufacturing superintendent in 1959.

Nonnemaker Takes New RCA Post

GEORGE M. NONNEMAKER, with RCA since 1956, has been appointed manager of signal processing products, at the Missile Electronics and Controls division, Defense Elec-

tronic Products, in Burlington, Mass.

In his new position, Nonnemaker is responsible for the technical direction and management of the division's seeker and sensor equipment, electromagnetic environment simulator equipment and general electronics equipment product lines.

Heinz Gorges Joins Cook Electric Team

COOK ELECTRIC CO., Chicago, Ill., announces the appointment of Heinz A. Gorges as director for advanced projects for the Cook Technical Center division in Morton Grove, Ill. This is a newly created post.

Prior to joining Cook Electric, Gorges was scientific assistant to the director of the aeroballistics division of the George C. Marshall Space Flight Center at Huntsville, Ala., which is under the direction of Wernher von Braun.

Garstang Takes Centralab Post

APPOINTMENT of William W. Garstang as manager, special products, at Centralab, the electronics division of Globe-Union Inc., is announced. His duties will include

(Continued on p 121)

A NEW SERVICE

NOTICE TO READERS

FREE REPRINT OF THE MONTH

Each month the editors of *electronics* are selecting a significant article and offering it in reprint form —FREE—to readers.

The April free reprint is an article by Richard P. Rufer — Designing Avalanche Switching Circuits.

It is a seven page article from the April 7th issue. Avalanche characteristics of transistors are not usually specified on data sheets so this article goes into the factors including a test set-up, that are important for this mode of operations. The basic avalanche circuits are presented and explained, and factors influencing waveshape are discussed.

Order your free copy now by checking the appropriate box on the Reader Service Card in this issue.

electronics

sales, manufacture and engineering supervision for new products and processes acquired by Centralab as a result of cross-licensing arrangements with foreign companies.

Garstang was formerly chief engineer of the electronics division of Allen-Bradley Co.

Bidermann Joins Whittaker Gyro

WILLIAM R. BIDERMANN has been appointed to the newly created position of chief production engineer of Telecomputing Corporation's Whittaker Gyro Division, Van Nuys, Calif.

Under his supervision, a product engineering section is being established to extend Whittaker Gyro's efficiency and quality control from the design stage through all phases of production on gyroscopes, accelerometers and guidance systems.

Bidermann was formerly assistant general manager of Kearfott's microwave division in Van Nuys.

Weston Appoints R. L. Shapcott

APPOINTMENT of Ralph L. Shapcott as director of manufacturing and assistant general manager of Daystrom, Inc., Weston Instruments Division, Poughkeepsie, N. Y., is announced. The Poughkeepsie plant produces recording, controlling, and electronic gaging instruments for general industry.

Prior to joining Daystrom last year, Shapcott was general manager of the industrial instruments division of Fischer & Porter Co., Hatboro, Pa.

Astrosonics Names Hughes To Top Post

ELECTION of Nathaniel Hughes, formerly with General Precision, to executive vice president of Astrosonics, Inc., New York, N. Y., is announced.

Hughes will be responsible for operations and product development for the new company, which develops and produces sonic and ultrasonic products for commercial and military use.

Radar Relay Forms Electronic Division

THE BOARD of directors of Radar Relay, Inc., Santa Monica, Calif., recently created a new division called Ratronics, which will handle the company's growing activity in the field of printed circuitry.

Kenneth Klier has been named manager of the new division.

Computer Systems Hires Pfeiffer

LOUIS JAMES PFEIFFER has joined the applications engineering staff of Computer Systems, Inc., producer of precision electronic analog computers for broad industrial, commercial, scientific and military use. He will be located at CSI's Monmouth Junction, N. J., laboratory.

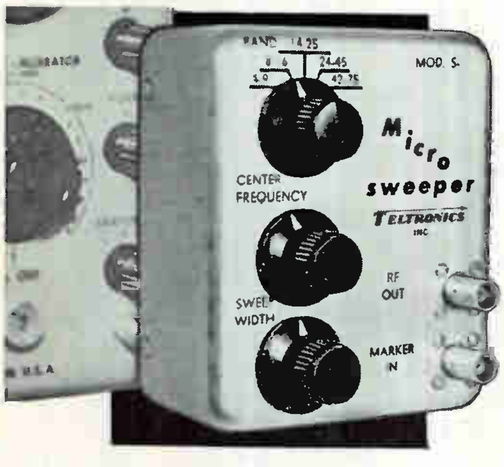
Pfeiffer was formerly a member of the management operations

SIGMUND COHN MFG. CO., INC.
121 SOUTH COLUMBUS AVENUE, MOUNT VERNON, N.Y.

CIRCLE 214 ON READER SERVICE CARD

MICRO-SWEEPER

PORTABLE PLUG-IN SWEEP GENERATOR



MODEL S-145

A small lightweight sweep generator that attaches directly to oscilloscope panels.

Increases the useful operating time of your scope.

Will sweep IF stages and wide band amplifiers for alignment.

Can be used as a fixed frequency generator, stable to one part in 10^4

Will measure transient response of filters and other circuits.

Cables and batteries not required. Ready for instant operation after plug in. Sweeps speeds up to 1 microsecond/centimeter can be used from those on your scope.

Prices subject to change without notice.
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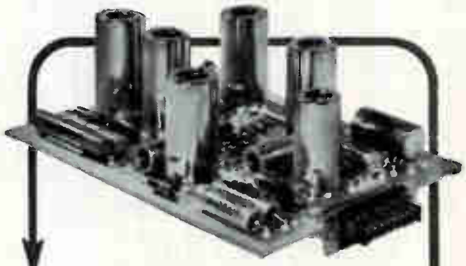

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Choose this amplifier when the need for exceptional reliability justifies the price, and enjoy the bonus of remarkably high performance. Its reliabilty statistics prove it the best buy in the industrial and process control fields, although the USA-4J was originally designed for military use.

- **LOW DRIFT AND NOISE:** well under 50 microvolts rms.
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- **COOL RUNNING:** tubes and resistors operate at a fraction of wattage ratings; capacitors operate generally below ⅓ their voltage ratings.
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team of Hess, Inc., Perth Amboy, N. J.

Narda Gets New Plant And Management

COMPLETION of the move by the Narda Ultrasonics Corp. from its former Westbury, L. I., location to a new modern plant facility at Syosset, L. I., has been announced by Stuart C. Dorman, recently elected president of the firm.

The new management team, headed by Dorman, includes Walter Venghaus, vice president; Alfred Werner, director of marketing; and John Thoren, controller.

PEOPLE IN BRIEF

Eugene A. Lawson leaves Telex Co. to become production control manager for Transistor Electronics Corp. **Lewis M. Duckor,** formerly with Colvin Labs, appointed chief engineer for electronic products by American-Standard Controls Div. **Edward P. Laffie** promoted to manager of semiconductor quality control at CBS Electronics. **Paul Schwartz** advances at Lumatron Electronics to chief engineer. **Guy B. Richardson, Jr.,** recently retired from the Air Force, has accepted the position of special consultant to the president of General Precision, Inc. **Marvel W. Scheldorf** moves up to senior engineer in electronics research at the Armour Research Foundation of Illinois Institute of Technology. **Ralph Ferry** leaves Allied Control to join the Line Electric Co. as project engineer. **William H. Fahringer** promoted to mass memory systems manager by Bryant Computer Products Div., Ex-Cell-O Corp. **Peter Wargo** of General Electric advances to manager of engineering for the cathode ray tube dept. **John A. F. Gerrard,** formerly with Texas Instruments, named director of electronics engineering for Bendix-Pacific Div. of the Bendix Corp. **Leonard G. Abraham, Jr.** transfers from the General Electric Research Labs to Sylvania Electric Products, Inc., as engineering specialist for the company's applied research laboratory.

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Designers and Manufacturers of

COMMERCIAL SERVICE "BEAMED-POWER" ARRAYS AND TWO-WAY SYSTEMS

Model illustrates a wide-spaced, 12 element circular polarized optimum-tuned skewed dipole "SPIRALRAY" antenna. Provides unusually high gain, even response, in all polarization planes, vertical, horizontal or oblique with unusually high signal-to-noise ratio.

NO OTHER CIRCULAR POLARIZED ARRAY known to the art today can provide the linear high gain and signal-to-noise ratio in all radiation planes.

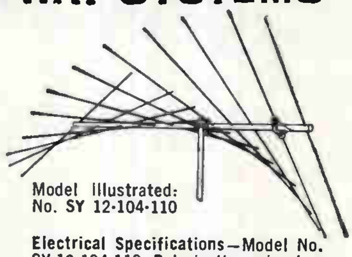
The ideal antenna for missile tracking, telemetering and no-fade response to mobile (or moving) stations.

Models available to extend the practical range of 2-Way Communication Systems.

Model SY-12-104-11 **$265.00**

Model MSY-104-110 **$390.00**

(f.o.b. Asbury Park, N. J.)



Model Illustrated: No. SY 12-104-110

Electrical Specifications—Model No. SY-12-104-110: Polarization, circular, linear within ½ db. Gain 13 db. F/B-Ratio 30 db. V/S/W/R (50 ohm cable) 1.1/1. Beamwidth at half power points 33 degrees. Max. power input 300 w, with "Balun" supplied.

Mechanical Specifications: Boom diameter 2" O.D. x 25 ft. All aluminum boom and elements. Weight approx 25 lbs. Rated wind-load 90 mph. No ice load. Available for 120 mph wind load. (Model No. MSY-104-110).

- Telrex is equipped to design and supply to our specifications or yours, Broadband or single frequency, fixed or rotary arrays for communications, FM, TV, scatter-propagation, etc.
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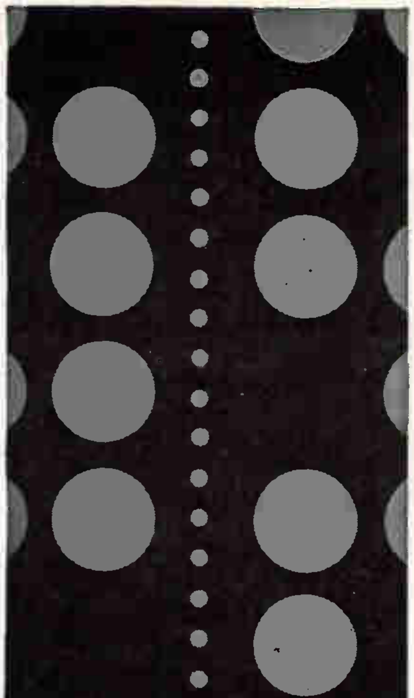

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electronics

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The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

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1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely.
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ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pa.	128	4
ESQUIRE PERSONNEL Chicago, Illinois	128	5
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McGRAW-HILL PUBLISHING CO., INC. New York, New York	128	11
NORTHROP CORPORATION Beverly Hills, California	46, 47*	12

Continued on page 128

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME ....

HOME ADDRESS ....

CITY .... ZONE ...... STATE ....

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check)

4141

☐ Aerospace	☐ Fire Control	☐ Radar
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Please indicate number of months experience in proper block(s)

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RESEARCH (Applied)	......	......
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DEVELOPMENT (Model)	......	......
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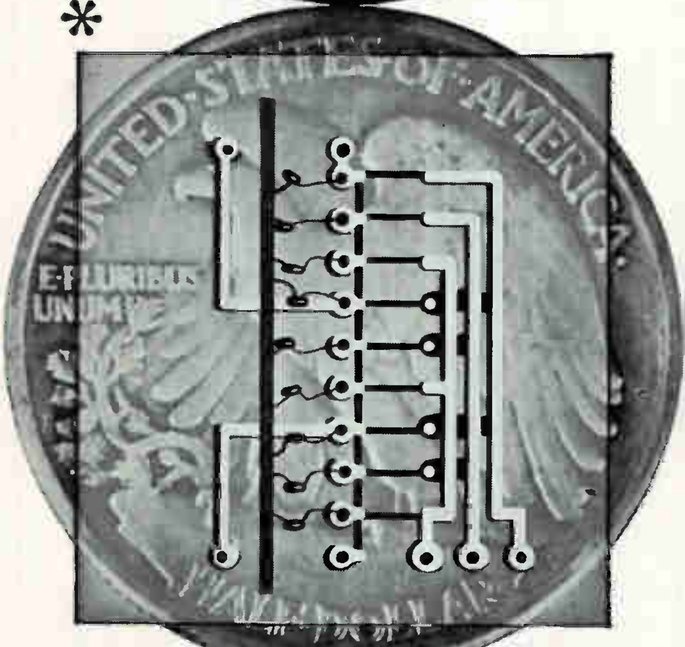

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electronics

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(Continued from page 126)

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PHILCO WESTERN DEVELOPMENT LABS. Palo Alto, California	58*	15
REPUBLIC AVIATION Farmingdale, L. I., New York	130*	16
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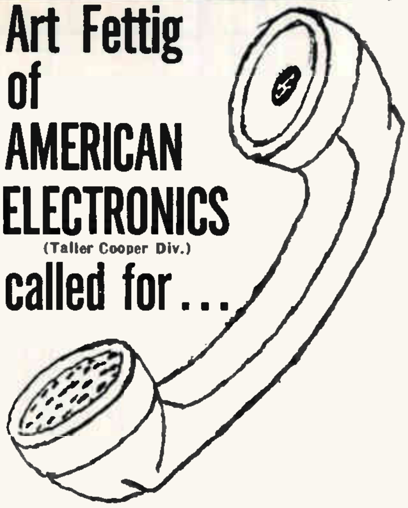

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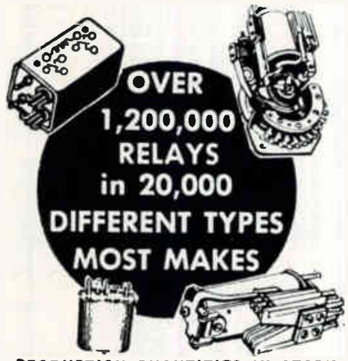

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2D21W	1.00
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2E30	2.25
2J42	50.00
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2K26	30.00
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FG-33	17.00
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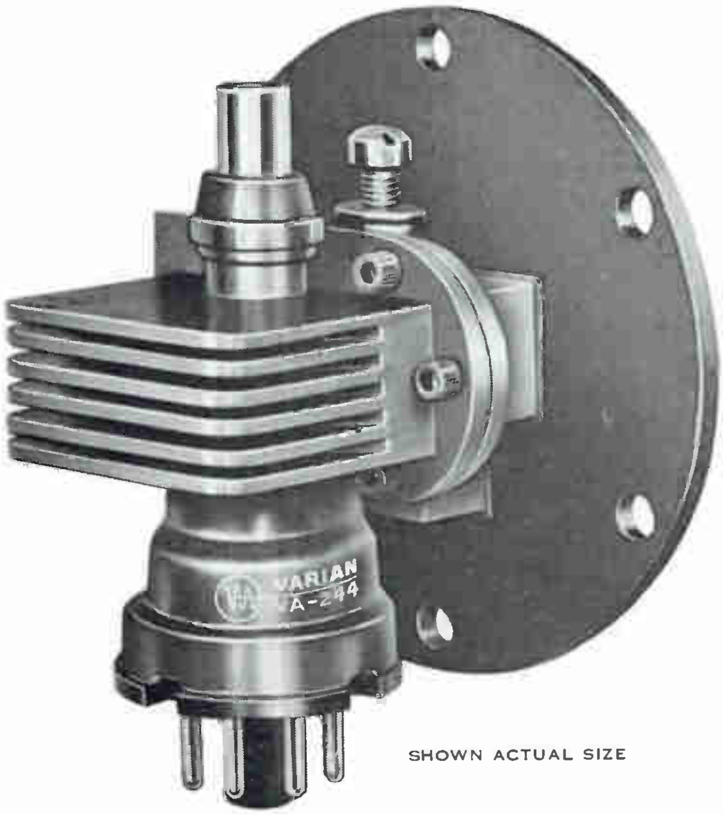

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