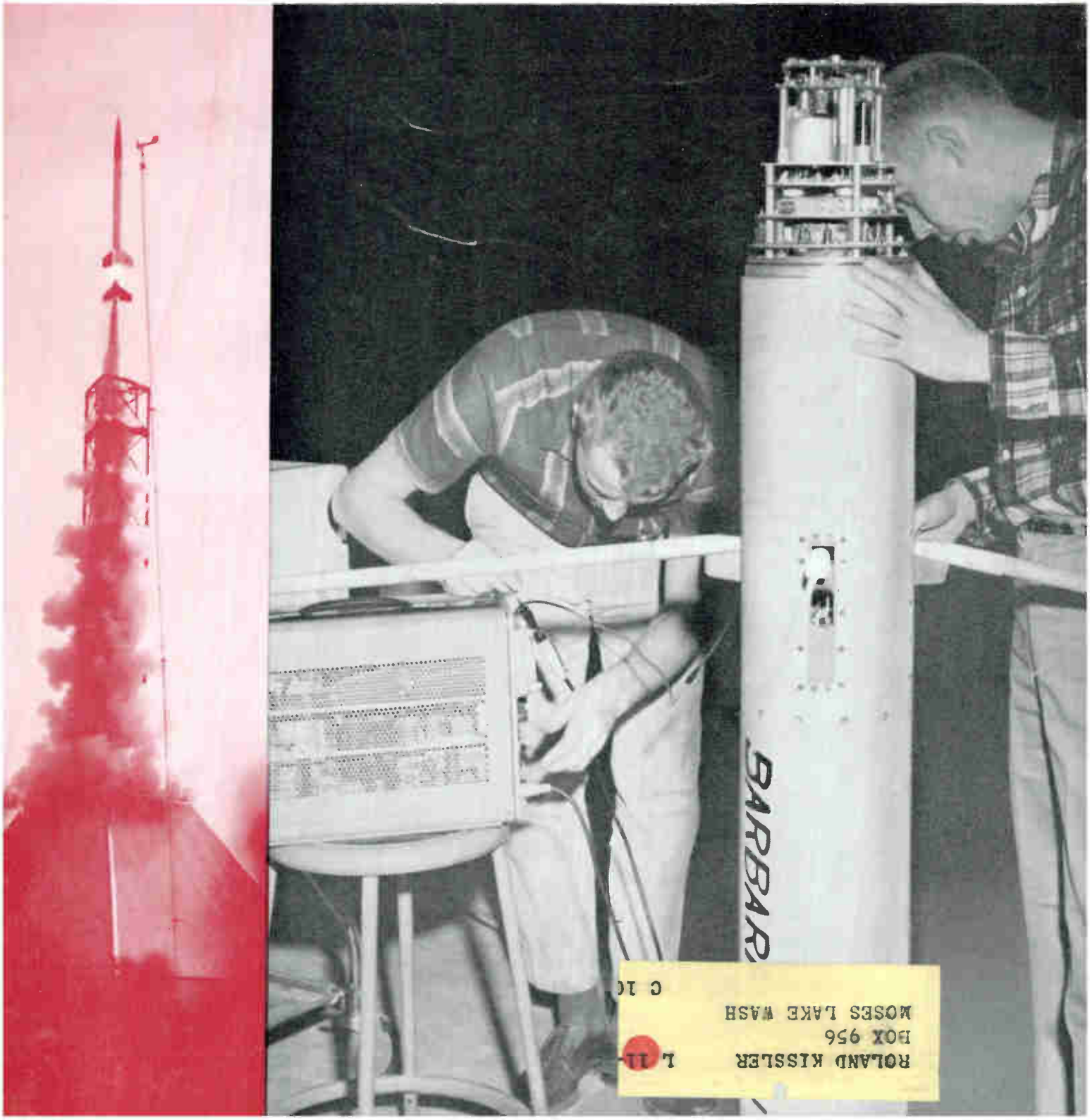
January 13, 1961

electronics

Measuring antenna impedance in the ionosphere is function of new system shot aloft in rocket, p 88

Conference reveals latest developments in magnetics, p 81

A McGraw-Hill Publication 75 Cents



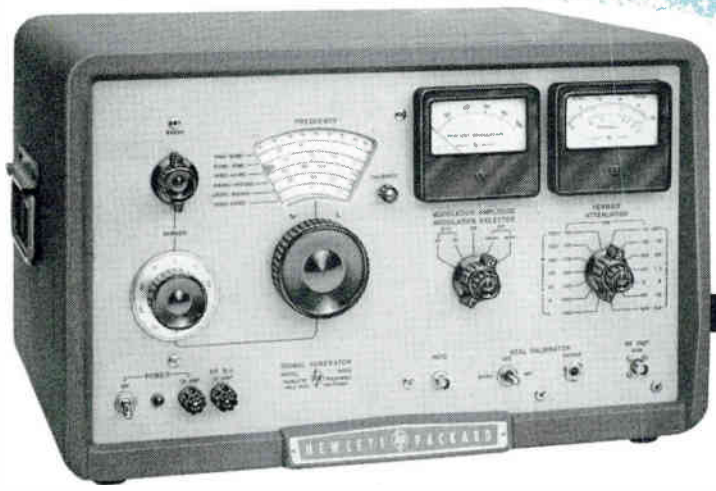
NOW!

Constant output level

Constant modulation level

3 volt output into 50 ohms

Low envelope distortion



50kc TO 65MC

New -*hp*- 606A HF Signal Generator

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

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

Output is constant within ±1 db over the full frequency range, and is adjustable from +20 dbm (3 volts rms) to —110 dbm (0.1 μv rms). No level adjustments are required during operation.

SPECIFICATIONS

Frequency Range: 50 kc to 65 MC in 6 bands.
Frequency Accuracy: Within ±1%.
Frequency Calibrator: Crystal oscillator provides check points at 100 kc and 1 MC intervals accurate within 0.01% from 0° to 50° C.
RF Output Level: Continuously adjustable from 0.1 μv to 3 volts into a 50 ohm resistive load. Calibration is in volts and dbm (0 dbm is 1 milliwatt).
Output Accuracy: Within ±1 db into 50 ohm resistive load.
Frequency Response: Within ±1 db into 50 ohm resistive load over entire frequency range at any output level setting.
Output Impedance: 50 ohms, SWR less than 1.1:1 at 0.3 v and below.
Spurious Harmonic Output: Less than 3%.
Leakage: Negligible; permits sensitivity measurements to 0.1 μv.
Amplitude Modulation: Continuously adjustable from 0 to 100%.
Internal Modulation: 0 to 100% sinusoidal modulation at 400 cps ±5% or 1000 cps ±5%.
Modulation Bandwidth: Dc to 20 kc maximum.
External Modulation: 0 to 100% sinusoidal modulation dc to 20 kc.
Envelope Distortion: Less than 3% envelope distortion from 0 to 70% modulation at output levels of 1 volt or less.
Spurious FM: Less than 0.0001% or 20 cps, which greater.
Spurious AM: Hum and noise sidebands are 70 db below carrier.
Frequency Drift: Less than 0.005% or 5 cps, whichever greater.
Price: (cabinet) $1,200.00. (rack mount) $1,185.00.
Data subject to change without notice. Prices f.o.b. factory.

HEWLETT-PACKARD COMPANY 5023A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
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hp world's most complete line of signal generators

January 13, 1961

electronics

A McGraw-Hill Publication 75 Cents

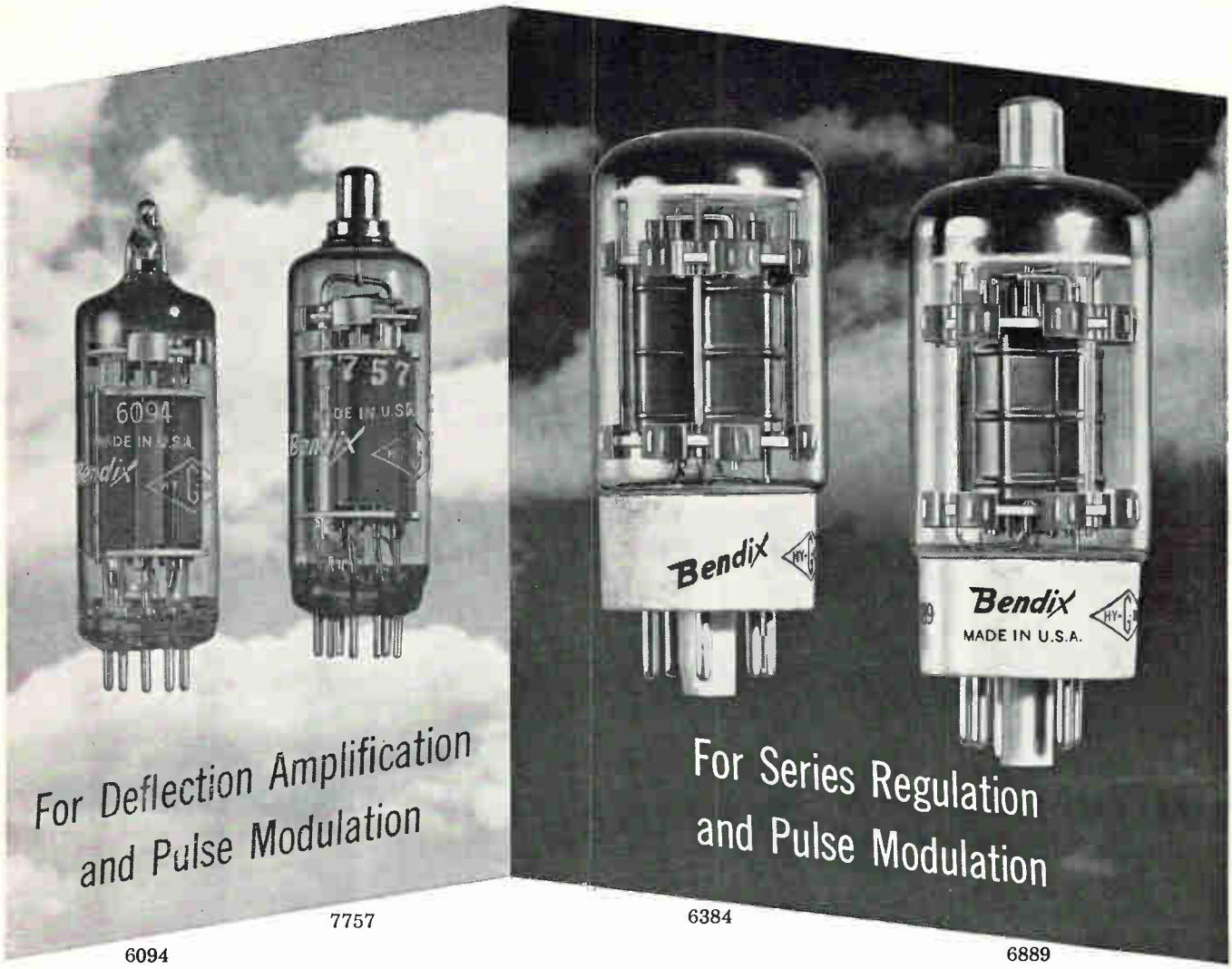
W. W. MacDONALD, Editor

BUSINESS

ENGINEERING

DEPARTMENTS

Bendix Craftsmanship at work for you



FOUR SPECIAL BENDIX® TUBES with wide voltage and power capabilities. Bendix miniature tube types 7757 and JAN 6094, high perveance beam power amplifiers, are designed to operate at high voltages during vibration and shock conditions. They are free from internal arcing in aircraft, military and industrial applications. Tubes 6384 and 6889 also operate at high voltages (up to 3,000 volts on the plate and 1,000 volts on the screen). Their characteristics include high pulse output and closely controlled high-voltage cut-off, ideally suiting them to pulse modulation and high voltage regulation. Write for complete information today.

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DIRECT READING FREQUENCY METER

a full octave and beyond

3.95 to 11.0 KMc

DELIVERY FROM STOCK

Model No. N414A Price: $495.00

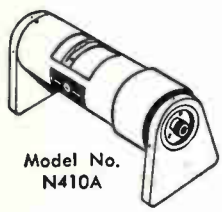
- Direct reading from 3.95 to 11.0 KMc
- Covers a full octave and beyond
- Reaction type with 0.1% absolute accuracy
- Non-contacting choke for long life and high Q
- Standard Type N Connectors for universal utilization

Meet the newest member of the FXR "family" of direct reading frequency meters. This coaxial type, Model No. N414A, has a range from 3.95 KMc to 11.0 KMc and by use of FXR Series 601 coax to waveguide adapters converts to waveguide set-ups. The unit covers "a full octave and beyond" with an absolute accuracy of 0.1% throughout its range. It is a perfect companion for the FXR Models No. C772 and X772 signal sources.

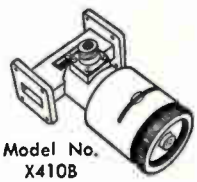
This newest direct reading frequency meter augments FXR's existing line, recognized as the largest in the industry. Direct reading, reaction type units are available for use up to 39.5 KMc while micrometer types extend FXR's coverage up to 220 KMc.

Write or call now for data sheets on Model No. N414A and other units in the integrated FXR family of precision frequency meters.

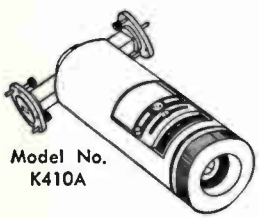
FXR "FAMILY" OF DIRECT READING REACTION TYPE FREQUENCY METERS



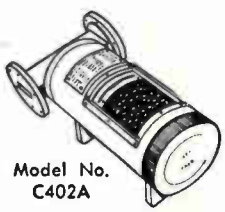
Model No. N410A



Model No. X410B



Model No. K410A



Model No. C402A

Model No.	Frequency Range (KMc)	Absolute Accuracy (%)	Approx. Q	Waveguide Type RG-( )/U	Flange Type UG-( )/U	Price (F.O.B. Woodside)
COAXIAL TYPES						
N410A	1.00- 4.00	0.10	3000	(⅜" Coax Type N)		$495.00
N414A	3.95-11.0	0.10	500 to 1500	(⅜" Coax Type N)		495.00
WAVEGUIDE TYPES						
*H410B	3.95- 5.85	0.08	8000	49	149A	250.00
*C410B	5.85- 8.20	0.08	8000	50	344	180.00
*W410B	7.05-10.00	0.08	8000	51	51	165.00
*X410B	8.20-12.40	0.08	8000	52	39	150.00
Y410A	12.40-18.00	0.10	4500	91	419	210.00
K410A	18.00-26.50	0.10	4000	53	425	230.00
U410A	26.50-39.50	0.10	3000	96	381	250.00
C402A	5.85- 8.20	0.03	8000	50	344	1275.00
X402A	8.20-12.40	0.03	8000	52	39	1275.00

* With transmission coupling probe.

DELIVERY FROM STOCK

FXR M.M. TYPES (Micrometer Reading)

Model No.	Frequency Range KMc	Price (F.O.B. Woodside)
Q410X	33-50	$325.00
M410X	50-75	300.00
E410X	60-90	500.00
F412A	90-140	750.00
G412A	140-220	750.00

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CIRCLE 3 ON READER SERVICE CARD

electronics
Jan. 13, 1961 Volume 34 Number 2

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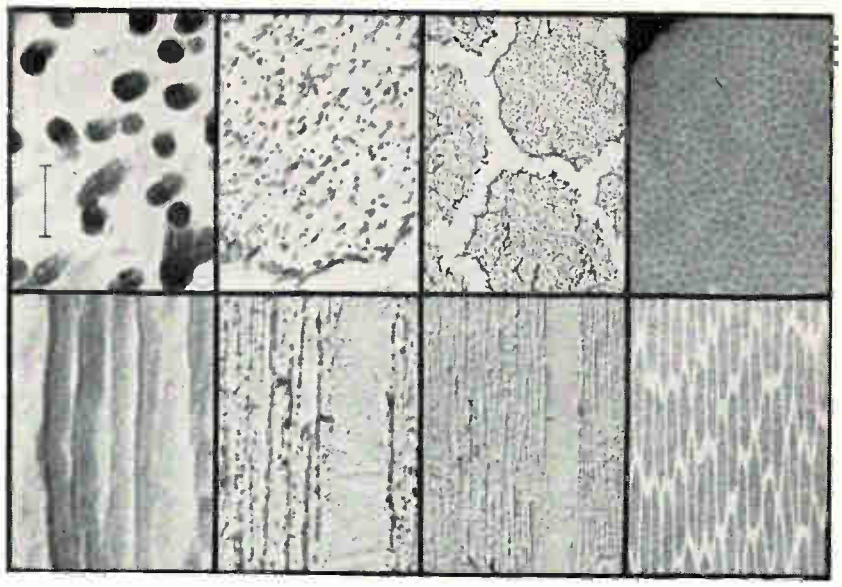


MAGNETICS. These are micrographs of longitudinal (bottom) and cross section of iron wires in a copper alloy matrix made by wire drawing. This technique is used to prepare elongated iron particles with diameters less than 1,000 angstroms. Work was recently described by F. E. Luborsky of General Electric Research Laboratory at the Sixth Annual Conference on Magnetism and Magnetic Materials. For other conference highlights, see Assistant Editor Lindgren's article (p 81).

THE SILENT WAR. In many eyes, Soviet Russia currently means rocket strength. Time and again, Nikita Khrushchev expresses his position with respect to the Free World in terms of the rockets. But the main strength of the Soviet Union continues to be a powerful land army backed by tremendous artillery, and a peculiarly balanced Navy. The peculiar balance is the submarine fleet, which now numbers in excess of 500 subs. Some of these are nuclear-powered; some carry intermediate and long-range missiles. Considering what Hitler did with a tenth that many subs, the USSR sub fleet can be considered a serious menace.

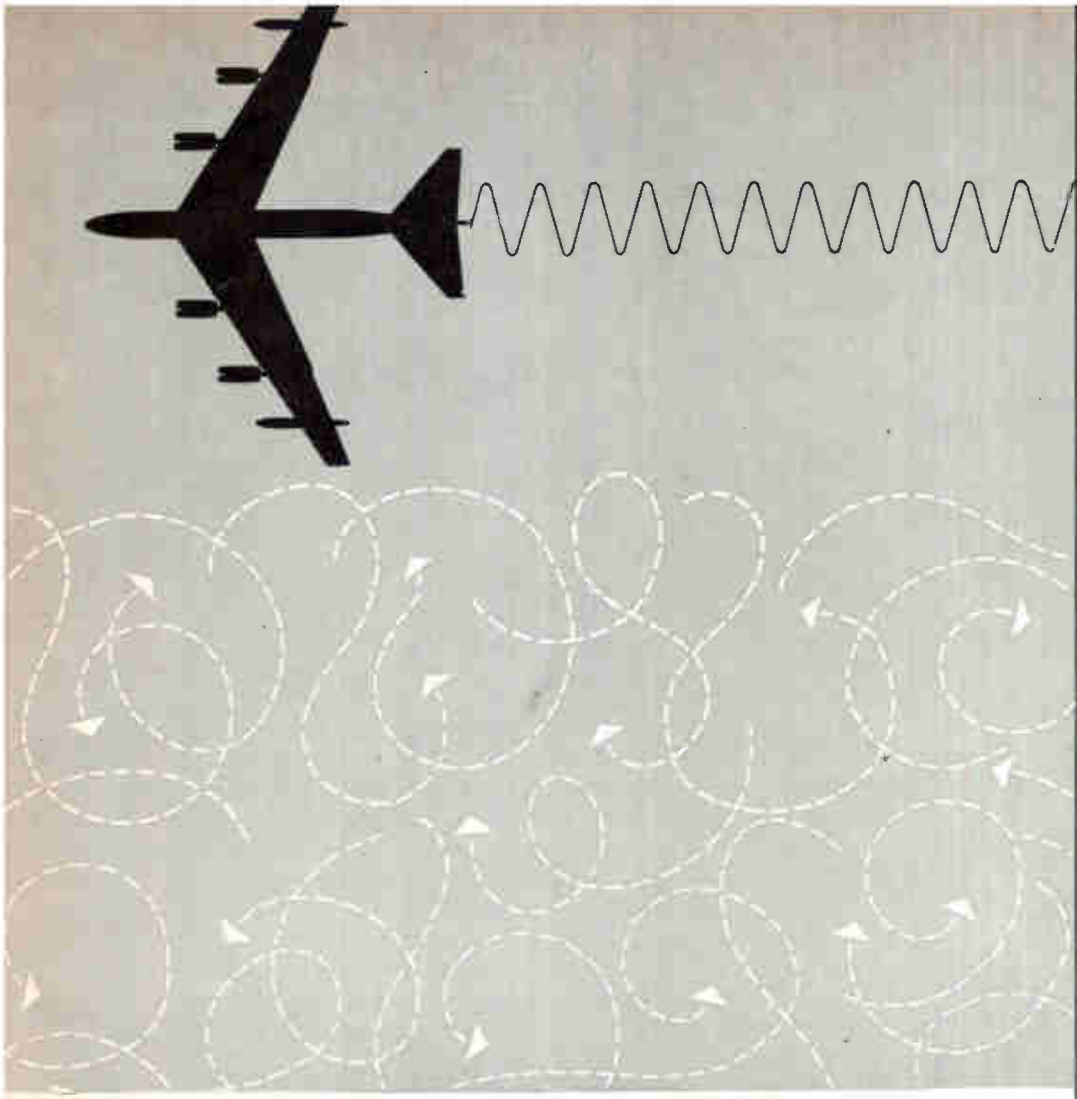
Our Navy's response to this menace is little noticed in the conversational atmosphere of rockets, missiles and space research. It presses against the frontiers of acoustics and electronics, and urgently needs the services of the electronics technology. In this issue (p 26) is a staff-gathered story on some of the strategic surveillance systems the Navy is either considering or using to keep informed of submarine intrusions.

INCOME of engineering teachers is of interest to engineers in industry as well as to the teachers. Adequate income is recognized as an important element in the instructional capability needed for turning out good engineers. Assistant Editor Bruun points out in a story this week that the average total income of all ranks of engineering teachers increased from $9,598 in 1958 to $11,013 in 1960. Contributing to such income are the fees earned by teachers in consulting services to companies. See p 32.

Coming In Our January 20 Issue

MEDICAL ELECTRONICS. Electronics has become an effective tool in the comparatively new field of applying physical science techniques to problems in medicine and biology. Since last summer, when this was brought out in an ELECTRONICS special report (p 53, July 29, '60), Associate Editor Bushor has been preparing a set of comprehensive articles on medical electronics. His first article, on measurement techniques in diagnosis, appears next week.

CIRCLE 5 ON READER SERVICE CARD→



Raytheon Subminiature Tubes Help Deliver The Message for Hughes Project Tattletale

Enemy atomic attack can scramble the ionosphere disrupting vital communications. The Air Force provides a solution in the form of Project Tattletale. A high altitude rocket containing a taped message and transmitting equipment is shot 300 miles up to provide a straight-line transmission requiring no ionospheric bounce.

PROBLEM: How to assure maximum reliability during transmission.

SOLUTION: Hughes Aircraft Company, contractor, chose Raytheon 5702WA, 5703WA, and 6021 Reliable Subminiature Tubes.

If your designs require tubes featuring reliable operation, long life, and stable performance under severe conditions of high temperature and mechanical shock or vibration, Raytheon Reliable Subminiature Tubes can offer an immediate solution. For complete technical data, please write to Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

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COMMENT

Ions and Health

One of our midwestern readers recently sent us a clipping from an unidentified publication, which read:

On the other hand, a preponderance of negative ions spices the air with exhilarating freshness. We feel on top of the world. Dr. C. W. Hansell, research fellow at RCA Laboratories and an international authority on ionization, illustrates the effect with a story about his ten-year-old daughter. "We were outside, watching the approach of a thunderstorm. I knew that clouds of negative ions were filling the air. Suddenly my daughter began to dance across the grass, a radiant look on her face. She leaped up on a low boulder, threw her arms wide to the dark sky, and cried, 'Oh, I feel wonderful!'"

To this clipping was appended the following note:

Poor, ignorant little girl! obviously she doesn't read ELECTRONICS or she would know that the air is *positively* ionized just before a thunderstorm and she should feel bad, not good.

K. R. STONE
W. ST. PAUL, MINN.

Reader Stone's rebuke is perhaps justified; we may not have made ourselves perfectly clear in discussing this matter in a previous Comment (p 6, Dec. 9 '60). *Current theory suggests that some of the positive ionization in the air derives from the emergence of "dead air" from porous soil when the atmospheric pressure is low—as it is just prior to a thunderstorm. At these times, positive ionization goes up; then the storm strikes, and the air is rendered slightly negative. Reader Stone is apparently bemused by the phrase "just before," and we can see why. Just before the storm strikes, the clouds of negative ions—in the words of researcher Hansell—are filling the air; but just before that, positive ionization is at its peak.*

Information Processing

Your recent editorial "Information Processing" (p 4, Sept. 30 '60) was a provocative presentation, but I must object to your limiting use of the expression to the automatic library. I have used this term for some time in the larger sense of meaning any operations required to convert crude information into a form in which valid number values can be assigned to its significant components.

In my particular field of physiological instrumentation, such processing is often mandatory. Crude inputs from biological systems often have signal-to-background ratios of much less than unity. Such techniques as autocorrelation, response averaging and Fourier analysis are required even to detect, to say nothing of measure, the desired response.

In addition, the activity of excitable physiological systems is usually a higher-order function of time. Crude signals, whether initially electrical in nature or transduced mechanical events, must be subjected to differential analysis for isolation and measurement of variables. In many instances the initial determination of parameters of pathologic or pharmacodynamic significance awaits such an approach, however empirically utilized.

Such requirements for prior operational analysis exist in most fields, and the term *information processing* should be used generically to describe the procedures of information-to-data conversion. Let's not restrict it to the jazzed-up all-solid-state fumbling through the reprint file.

HENRY STUDE JR.
NEWARK, DEL.

We've always felt that the derivation of meaningful data from raw information was amply described by all the terms reader Stude himself uses. We've also considered such specific techniques as autocorrelation and Fourier analysis as falling under the general heading of data-processing. Since the term "information" calls up literal rather than numerical connotations, we were suggesting that the handling of literal data should be called "information processing," while the handling of numerical data would continue to be called "data processing."

We still like the distinction.

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Vitramon® Capacitors adapt easily to the printed circuit boards used in VERDAN. Note how square configuration and axial-radial design of capacitors permits flush mounting and easy insertion. Solid-state construction — fine silver electrodes molecularly fused with dense porcelain dielectric — give Vitramon® Capacitors outstanding stability, extremely low loss, and high pulse rate.

Autonetics' air-borne VERDAN is an extremely high speed computer with relatively high capacity, great flexibility of application, and extensive input-output provisions. Occupying less than 1½ cubic feet of space, VERDAN is designed with a general purpose section and a digital differential section, both of which share a common magnetic disk memory and have complete intercommunication. VERDAN was developed by Autonetics for its air-to-ground "Hound Dog" guidance control and REINS nav-bomb systems.

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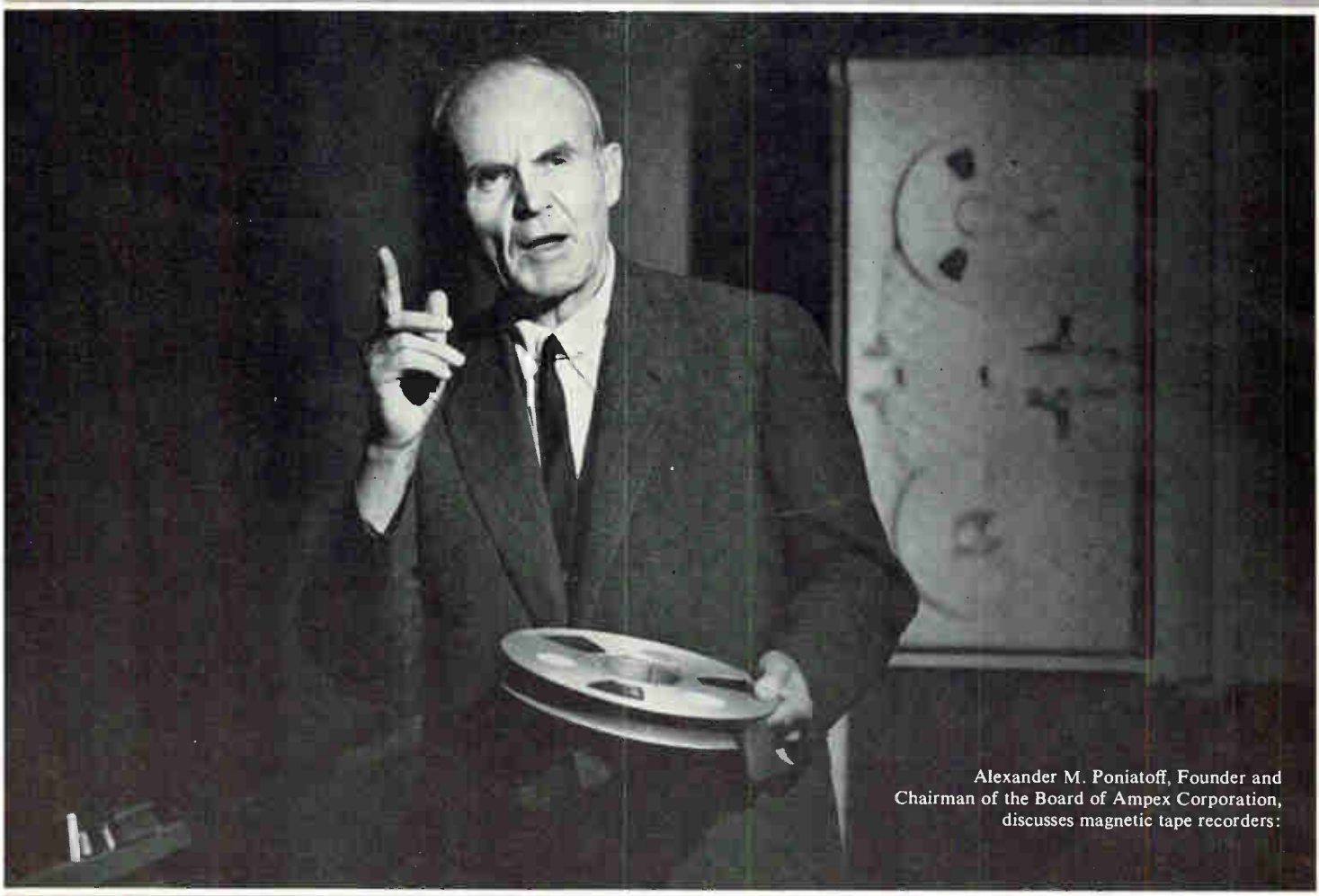
Constructive discontent at Ampex...

. . . has been setting instrumentation standards for years



Alexander M. Poniatoff, Founder and Chairman of the Board of Ampex Corporation, discusses magnetic tape recorders:

"Everything Ampex recorders stand for – service, quality, reliability, technological leadership – stems from this attitude.

"The first commercial 'live-quality' audio recorder was developed by Ampex because of the disc record's fidelity drawbacks. Discontent with the capabilities of all data recorders using visual traces spurred Ampex's evolution of special purpose magnetic tape data recorders. Frequency limitations bothered us, so we gave you the 4-megacycle FR-700.

"A need for compact equipment with high performance caused us to introduce the CP-100 – a transistorized 200 kc 14-track data recorder less than 7 cu. ft. small. Striving for versatility and high efficiency, we perfected the FR-600; it records 500 kc at 120 ips – double the previous standard, but still fully compatible.

"And we were even constructively discontented with the way we made these advanced recorders available to you. Now, Ampex instrumentation recorders can be leased or purchased on time as well as outright. You can free working capital for other projects, and invest in your Ampex data recorder as it works for you."

Some significant specifications:

AR-300, FR-700: 10 cps to 4 mc ±3 db; 12½ and 25 ips record and playback. FM recording. Two data, two auxiliary tracks. 2" tape, 10½" reels. AR-300 airborne record only.

CP-100: 300 cps to 200 kc ±3 db at 60 ips; 60, 30, 15, 7½, 3¾, 1⅞ ips with proportional response. Direct or FM recording. All-transistorized. ½" or 1" tape, 10½" reels.

FR-600: 300 cps to 500 kc ±3 db at 120 ips; 60, 30, 15, 7½, 3¾, 1⅞ ips with proportional response. Direct, PDM or FM recording by plug-in modules. ½" or 1" tape, 10½" or 14" reels.

For detailed information on the complete Ampex line of data recorders, write:

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Box 5000, Redwood City, California

AMPEX

Experienced engineers eager to contribute to Ampex's pioneering reputation are invited to write the Manager, Technical Recruiting.

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TRUE RMS Voltmeter with 1/4% ACCURACY

measures wide range of Waveforms

BALLANTINE model 350

features:

- High accuracy achieved on waveforms in which peak voltage may be as much as twice the RMS. **Not limited to sinusoidal signals.**
- Left-to-right DIGITAL READ-OUT. Fast, simple nulling operation consists of selection of decade range by push-button, and adjustment of four knobs for minimum meter indication. These operations attenuate the input signal to a predetermined value, causing a bridge circuit to be balanced by changing the current through a barretter.
- Temperature-controlled oven contains the barretter and an ambient temperature compensating resistor. Effect of ambient temperature changes is less than 0.005%/° C from 20° C.
- Proper NIXIE® digit is lighted automatically while bridge is being balanced. No jitter.
- Rugged, accurate. Doesn't require the extreme care of many laboratory standard instruments. No meter scales to read. Useful for laboratory, production line, and in the field.

$720

specifications:

VOLTAGE RANGE: 0.1 to 1199.9 v

FREQUENCY RANGE: 50 cps to 20 kc

ACCURACY: ¼% 0.1 to 300 v, 100 cps to 10 kc;
½% 0.1 v to 1199.9 v, 50 cps to 20 kc

INPUT IMPEDANCE: 2 megohms in parallel with 15 pF to 45 pF

POWER: 60 watts, 115/230 v, 50 to 400 cps

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Look at the many different

POWER MEASURING INSTRUMENTS

Sierra offers you now

Model 160 50-ohm Coaxial Loads

Now including Models operating to 11 KMC, Sierra 160 Series low VSWR terminations may be used when stable 50 ohm loads are required. Featuring rugged design, high stability at full rated power, the loads have a typical VSWR of 1.2. All models are air-cooled and complete shielding insures personnel safety. Models with power capacities of 1, 5, and 20 watts are available with N, C and BNC connectors. 100 and 500 watt models are provided with Type N connectors. $20.00 to $170.00.

Model 185A Average-Reading Termination Wattmeters

Sierra 185A series are particularly useful in terminating rf coaxial transmission systems, measuring average powers between 20 and 1,000 MC, and as dummy loads for testing and adjusting CW and FM transmitters and oscillators. Three models with maximum power dissipation of 15, 100 and 500 watts, and power ranges of 0 to 5/15, 0 to 30/100 and 0 to 150/500 watts, respectively. Accuracy is ± 5% and VSWR is 1.2. Female Type N connectors. Model 185A-15FN, $170.-00; 185A-100FN, $260.00; 185A-500FN, $315.00.

Model 164A Average Power Monitors

Sierra 164A Series Bi-Directional Power Monitors are now available with plug-ins down to 2 MC. Four plug-ins provide full scale ranges of 1, 5, 10 and 50 watts through frequencies 25 to 1000 MC. Two medium-power units provide full scale ranges 10, 50, 100 and 500 watts, 25 to 1000 MC. Two high-power units provide full scale ranges of 50, 100, 500, 1000 watts, 2 through 75 MC. Model 164 is now available with Type N, C, HN, UHF and LC connectors. Model 164, $115.00; plug-ins, $70.00 to $170.00.

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

Model 194A-A Bi-Directional Peak Power Monitor

Covering the range 200 to 1,215 MC, Sierra 194A-A Peak Power Monitor offers two important, time-saving features—peak power is read directly without computation and a reversible directional coupler permits incident or reflected power readings simply by turning one knob. Peak powers to 30 Kw are covered in 4 ranges. Measurement accuracy is ± 10% full scale at pulse widths down to 0.1 μsec or repetition rates as low as 10 pps. Minimum duty cycle 0.04% for specified accuracy. $460.

Sierra

For complete details, see your Sierra Representative or write direct.

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6561

ELECTRONICS NEWSLETTER

Study Advanced Techniques For Early Missile Warning

ROME AIR DEVELOPMENT CENTER has contracted separately with five companies for studies of new techniques for early detection of hostile ballistic missiles. The contracts are cost-sharing type, have gone to Loral, RCA, Raytheon, Sperry and Cutler-Hammer's Airborne Instruments Laboratory division.

Each company is attacking the whole problem individually. Two detection means known to be under investigation are infrared and an unconventional application of radar, perhaps of the Teepee type. Studies aim to balance effectiveness vs cost.

Loral is teamed up with Barnes Engineering for i-r, Smyth Research for upper-atmosphere studies, and A. D. Little for operations research and probably cryogenics. AIL is teamed with Aerojet-General for i-r and Jansky & Bailey for communications.

Portions of the system may be airborne, may take advantage of the fact that supercooled infrared sensors high in the stratosphere can see a hot body at quite a distance. Successful techniques developed by the studies are expected to augment the existing ballistic-missile early-warning system and the planned Midas detection satellite rather than replace them.

Loop Antennas to Probe Low-Frequency Earth Currents

BURIED LOOPS six feet in diameter and wound with 130 miles of nylon-coated copper wire will be used by scientists at National Bureau of Standards' Boulder, Colo., laboratories to pick up faint low-frequency electromagnetic pulses in the earth. Pulses were first detected more than a hundred years ago, are of unknown origin, are probably associated with influx of electrically charged particles in the upper atmosphere. The pulses are found all over the world, but with highest concentration in the Arctic and Antarctic auroral zones.

Giant loops will also be used to study extra low-frequency sferics caused by lightning, and high-amplitude earth currents occurring from one to three minutes apart which are thought to result from bombardment of the upper atmosphere by charged solar particles.

First of the loops will be used near Boulder. Second will be sent to Peru for use by another NBS experimenter. Another half-dozen are being assembled for use in two portable stations. Information picked up by the loops may help trace the complicated sun-earth energy exchange, closely linked to global weather patterns.

Chicom Tv Network Adds Ten Stations

PEKING RADIO said last week that the Chinese Peoples Republic now boasts a total of 29 television stations, of which 10 were completed in 1960. Seven of the stations are on a regular broadcast schedule; 16 others are still in the experimental stage. Besides conventional programming, the Peking station has started a Tv University offering courses in math, physics, chemistry, as well as preparatory courses.

Microwaves Will Change Some Industrial Processes

MICROWAVE HEATING engineers were predicting this week that new applications of microwave will radically change some industrial processes before the end of 1961.

Raytheon's applications development group is building a conveyor-belt microwave irradiation system for sterilizing animal foods used in a Boston breeding laboratory. Also being developed are units for making skinless frankfurters, curing rubber, drying lumber, softening plastics for extrusion.

Food processors have been continually interested in microwave heating as a means for partial defrosting of bulk-frozen foods which have been transported a long distance and must be repackaged for consumer sale.

Principal stimulus to the industry comes from lowering of equipment costs to meet competition of other heating methods. Another stimulus is discovery of more materials that conduct heat badly but absorb microwave energy. Raytheon now concentrates on equipment in the 2,450-Mc region, may move to 915 Mc for applications requiring greater depth of penetration.

Station WWV Changes To Pulse Time Code

AT 0000 UNIVERSAL TIME on Jan. 1, National Bureau of Standards retarded the time signals broadcast from radio stations WWV and WWVH by five milliseconds, and at the same time resumed broadcasting on WWV a special timing code which gives day, hour, minute and second (UT) in binary code. The 5-ms retardation brought the time signals into closer agreement with other standardized frequency broadcasts. The pulse timing code had been tried out for several months in 1960, is now permanent.

United Kingdom and the U. S. have been coordinating time and frequency transmissions since early in 1960. The correction matches the UK and U. S. transmissions; further corrections will be made as infrequently as possible and preferably at the start of a new year. Time signals are locked in the broadcast frequency. In 1961, NBS plans to maintain the frequency stable to 1 part in 10^{10} and at the same offset value as before: -150 parts in 10^{10} with reference to the U. S. frequency standards.

New Industrial Instruments Developed in USSR

SOVIET CONCENTRATION on direct application of scientific achievements to industry produced two new instruments last week.

One was a portable spectrometer using radioactive thulium-170 which can determine the chemical composition of a mineral in 15 or 20 minutes. USSR Academy of Sciences Institute of Geology says the unit's chief value arises from its small size and its simplicity by comparison with conventional X-ray spectrometers. Thulium-170 is valuable in gamma radiography.

The other instrument, reported

by researchers of the Machine Building Institute of the Soviet Academy, was an X-ray microscope with a magnifying power of 2,000 diameters.

Advisory Group Studies Space Frequency Allocations

SPECIAL STUDY of the frequency allocations problem in space communications has been undertaken by the Joint Technical Advisory Committee at the request of the Federal Communications Commission. JTAC, which is sponsored jointly by Institute of Radio Engineers and Electronic Industries Association, will look into both national and international aspects of the problem. Chairman of the study committee will be retired Army general J. D. O'Connell of General Telephone & Electronics.

Study will deal specifically with the problems posed to the industry by FCC's inquiry into the allocation of frequencies for space communications.

Seek New Power Sources In Sun, Wind, Tides

SCIENTISTS on both sides of the Iron Curtain are pursuing the search for exotic power sources. A. N. Nesmeyanov, who, as president of the Soviet Academy of Sciences, is the top scientific bureaucrat in the Soviet Union, last week outlined 1961's scientific goals in *Pravda*. He said "Research work should be done on power generation from the sun, wind, tides and geothermic phenomena, but the main effort must go to harnessing the potential energies of nuclear transformations."

He mentioned controlled thermonuclear processes as the "new task," added that other huge energy-releasing processes in nature must be studied, such as cosmic rays, antimatter reactions.

Meanwhile, in the U. S. ITT had trouble suppressing speculation about the success of its project in electrostatic confinement processes for thermonuclear plasmas, and National Aeronautics & Space Administration contracted with General Electric to force a breakthrough in high-temperature materials to find a way to store heat energy collected from the sun. The energy is needed to produce electrical power in satellites while they pass through earth's shadow, might also lead to a transducing material to change the fierce heat of reentry into some more needed form of energy such as lift or propulsive power. Silicon is among materials to be investigated; the heat storage method is being sought for use in solar thermionic conversion systems.

Soviets Develop Biostimulator

SOVIET MEDICAL RESEARCHERS are working on development of a "universal biostimulator" which would use tape-recorded signals to stimulate activity in the heart, brain and other organs. The device is a further development from an electrical cardiostimulator now in use in Moscow clinics.

Rhythmic action of the heart is due to pulses of current generated in the cardiac muscle, transmitted from the atria to the ventricles. Pulse recurrence is from 70 to 76 pulses a minute in normal healthy activity; the cardiostimulator can simulate this electrical driving signal at a rep rate varying from 20 to 200 cps in cases of malfunction or dysfunction where the heart is stopped.

The expanded version will not use artificially produced square waves, as the cardiac device does. Pretaped action potentials tapped off healthy organs in various functional states will be taken from donors and used to stimulate or regulate muscular activity for any or all body organs.

Automatic Grid Flights Check Air Navaids

FEDERAL AVIATION AGENCY last month released details on its SAFI project (semiautomatic flight inspection) by which electronic techniques will help ensure the safety of air travel. System was devised by Airborne Instruments Laboratory division of Cutler-Hammer.

Five Convair aircraft operated by FAA are jampacked with electronic gear—11 vhf omnirange receivers; 11 Tacan sets; 4 distance-measuring equipment sets; a range-beacon receiver; vhf and uhf communications gear; two input-program tape readers; one analog and two digital output-data tape recorders; digital control and conversion equipment. Multi-couplers and commutators permit three common antennas on each craft to handle all basic system functions.

Program tapes are prepared by a groundbased IBM704 computer; these tapes work into AIL control devices to navigate the planes along a grid which covers the U. S. The same tape works into other automatic devices to tune the navaid receivers to the proper channel at preselected points along the way and compare the received signal with precomputed signal values to detect gross bearing errors. The received navaid signals are sampled and recorded in digital form for later detailed analysis on the ground by the groundbased data-processing system.

Electronic Vote-Count System Enters Production Stage

ELECTRONIC TECHNIQUES count the ballots in a system developed by a Butler County, Ohio, election official and tested in Ohio last year. The system lets a voter check his choices and change his mind.

Voter slips a punch-card ballot into the 36-lb machine, turns a knob to bring the name of the candidate he favors into view, then pushes a button to punch a hole indicating his choice. An audible click reports the punch. Voter may remove the card to check his vote. He may substitute and repunch a fresh ballot to replace a spoiled card. Control of ballot stays in his hands until he deposits it in box.

After polls close, cards may be run through any standard tabulating machine. One such prepared 87-page analysis of one Ohio county's 80,000 votes in 37 minutes last month. System was officially used in two Ohio precincts last spring.

Large-scale production began last month with unit cost set at $625. Small size of the device means low storage costs, high mobility. Machine provides individual physical record of all votes, in case of demands for a recount.

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WASHINGTON OUTLOOK

INCOMING ADMINISTRATION of President-elect Kennedy will continue the military-civilian division of the nation's space program. The Pentagon will retain control over projects related to the national defense; National Aeronautics & Space Administration will remain in charge of all other projects. Proposals to merge both aspects of the program under a common management have been rejected—at least for the time being.

The new administration intends to improve the coordination between the Defense Department and NASA, and to halt the costly rivalry and duplication of effort between the two agencies, by clamping a strong central direction on the overall program. The centralization will come from the National Aeronautics & Space Council, an interagency body authorized by Congress over two years ago.

Vice President-elect Lyndon Johnson, who has shown considerable interest in the space question in the Senate, will head the revivified council. An executive director and technical staff will also be named. Council membership includes the Secretary of State, Secretary of Defense, NASA Administrator, Atomic Energy Commission chairman, one member appointed by the President from another government agency, and three nongovernment scientists or engineers.

The Space Council was first set up in the furor following the Soviet launching of the first sputnik. It met once or twice in 1958, but never played the decisive policymaking role that Congress intended. Kennedy advisors see the council as a means of meshing the military and civilian sides of the space program into an integrated operation while avoiding a heated argument over domination of space efforts by the military.

MAJOR DECISION the Space Council will have to come to grips with right away is the role government should play in commercial space projects. Industry wants a quick decision on several questions. One is which microwave frequencies are to be assigned for space use; Federal Communications Commission decisions so far have irritated both common-carrier communications companies and users of private microwave. Other questions: who will be allowed by the federal government to put up satellites; how much of the cost should be borne by the government.

The council will also have to settle the feud between the Pentagon and NASA over who is to handle what aspects of communications satellite development. NASA is pushing heavily into active communications satellite work, hitherto the Army's concern. The space agency has been authorized a $50-million supplemental appropriation request for the current year to finance its program.

NASA wants to put a 120-lb active satellite in orbit during the 1962-63 period. The initial plan is for only one vehicle in orbit at that time, but a backup satellite has been ordered.

The space agency's plan for a passive communications satellite system calls for orbiting 20 spheres equally spaced in two orbital planes. The passive systems are scheduled to be launched by 1963 into 1,500-mile orbits, are expected to have a 15-20-year life. NASA anticipates a reliability figure for the network of 99 percent.

FIRST SIGN of an intensified Pentagon campaign to terminate so-called marginal research and development projects is the Army's cancellation of Republic Aviation's contract for development of the SD-4 unmanned aerial surveillance system. About $34 million has been spent on the project since 1957. The Army says some of the ground and airborne guidance packages and radar equipment will be used in other surveillance projects.

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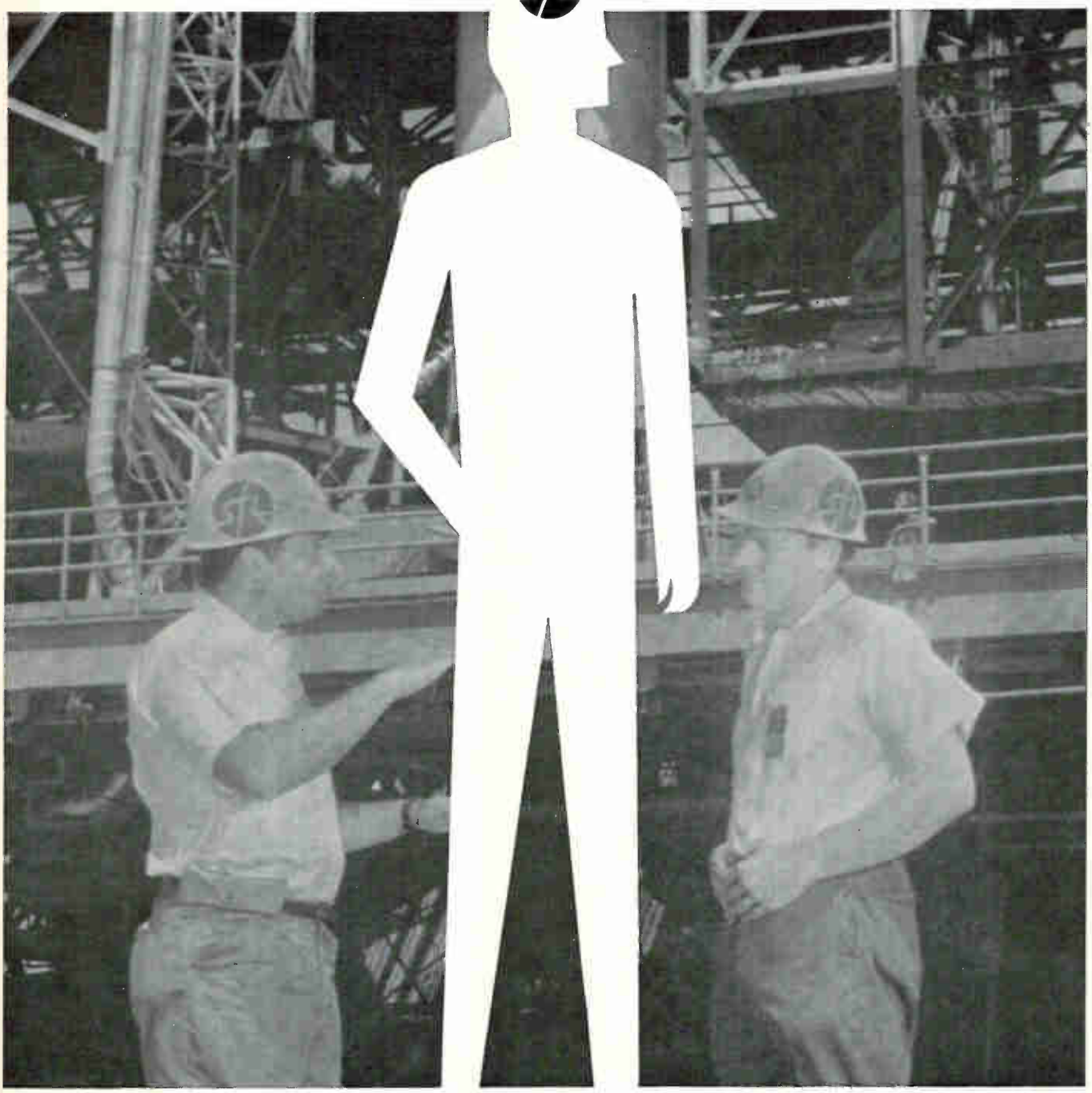

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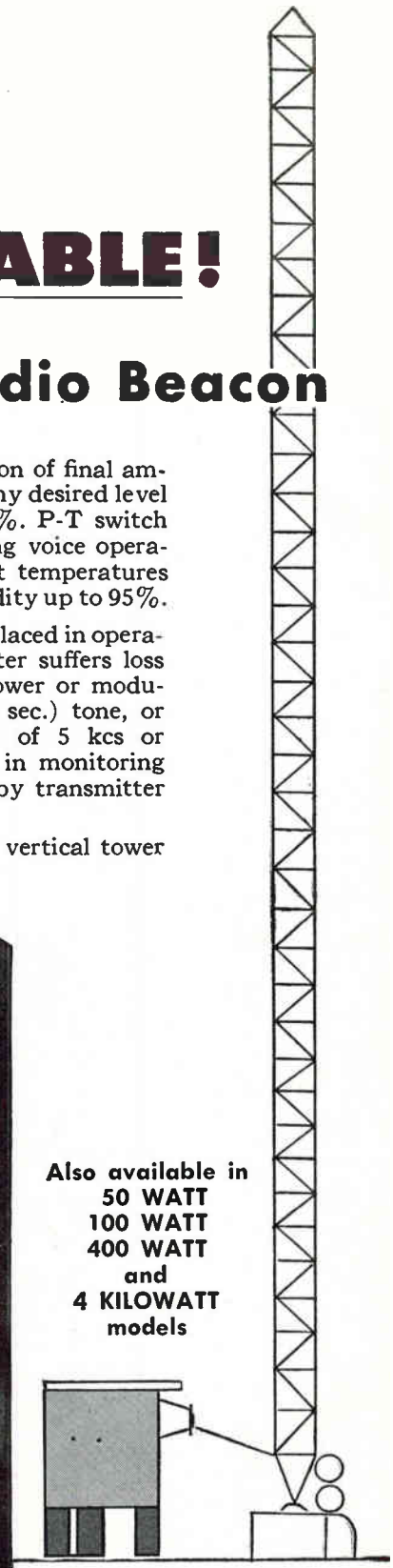

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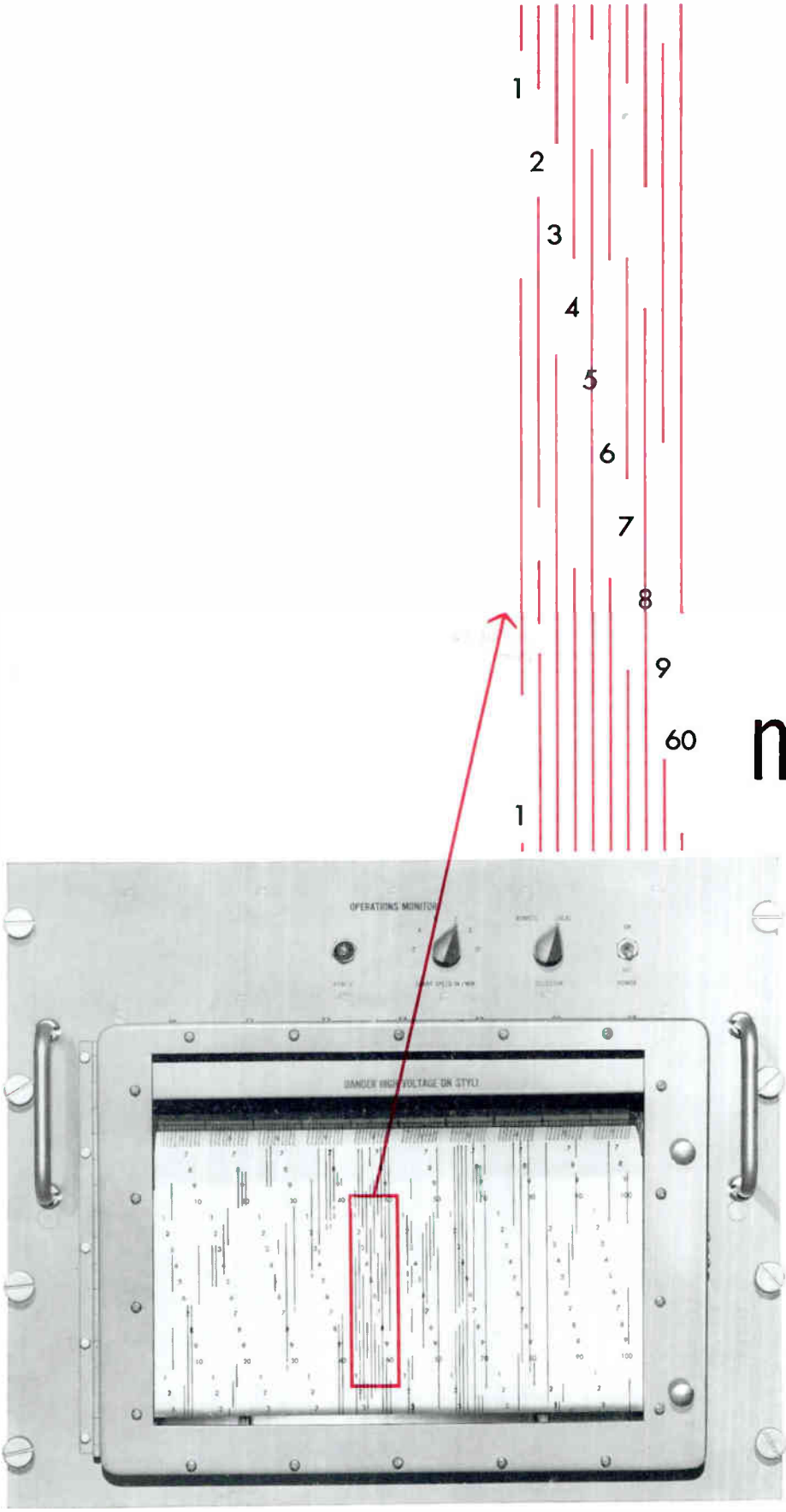

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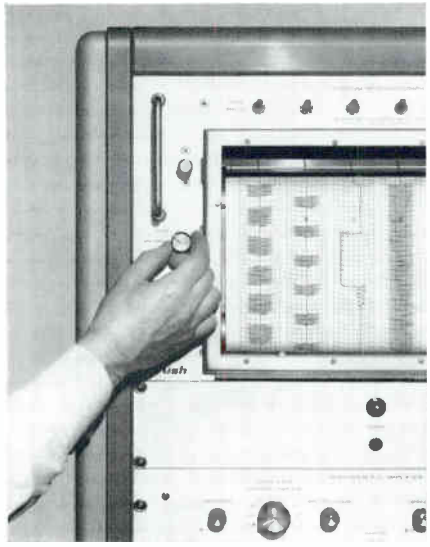

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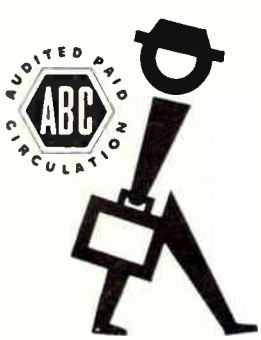

electronics

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EIA Head Sees 6% Sales Rise In '61

WHAT LIES AHEAD in electronics production and marketing is brought into focus by the 1960 yearend statements of L. Berkley Davis, president of Electronic Industries Association.

"The electronics industry generally should have another good year in 1961," said Davis. "While its short-term outlook is somewhat obscured by uncertainties over the state of the national economy, we can expect total electronics sales to be strongly supported by increases in defense requirements and steady expansions in the industrial electronics market."

Davis also expressed the belief that the sales prospect for consumer goods will be substantially brightened if the Federal Communications Commission soon establishes transmission standards for stereophonic f-m radio broadcasting.

According to the latest information gathered by the EIA marketing data department, electronics as an industry will run counter to trends in some major U. S. industries by establishing a new all-time high in factory sales when all yearend reports are tabulated for 1960. This year's record will continue the trend of the last decade, which has seen every year end with higher sales totals irrespective of the general national economy.

According to the Association president, total 1960 electronics factory sales are estimated at $9.75 billion, a rise of six percent over 1959 and 3.75 times the figure of 1950. Davis believes 1961 will see a six-percent rise to $10.3 billion.

Three of the industry's principal segments set new sales peaks during 1960 while the fourth matched its 1959 levels. EIA, in releasing these figures, estimates the 1961 pattern will be about the same. Figures in millions of dollars are:

	1959	1960	% Change	1961	% Change
Consumer	$2.0	$2.1	up 5%	$2.2	up 5%
Industrial	1.6	1.75	up 9%	1.9	up 8%
Military	4.7	5.0	up 6%	5.3	up 6%
Replacement	0.9	0.9	None	0.9	None
	$9.2	$9.75	up 6%	$10.3	up 6%

Television set sales, traditionally the largest part of the consumer electronics market, account for approximately 40 percent of this segment of the industry, the EIA statement says. About 20 percent of the dollar volume of consumer sales was chalked up by phonographs; another 20 percent represents radio set sales.

The report indicates that radio sales are substantially ahead of last year, with auto radios up perhaps as much as 15 percent. Radios with f-m tuners continued to grow in popularity and to increase the f-m share of the market. Stereo phonograph sales jumped substantially, said Davis, offsetting the 1959 decline in sales of monaural gear. The 1960 increase put the record-player business ahead of its 1959 sales totals.

Davis said EIA does not share the common view that consumer electronics offers few opportunities for growth beyond what might be expected from population expansion. He said new products on the verge of commercial reality offer promising opportunities, specifically mentioning electronic ovens, electronic home safety devices, and what he termed "electronic devices of convenience such as equipment for rapid automatic defrosting of refrigerators."

"We are just beginning to think creatively about new opportunities in the non-entertainment home electronics field," he said. "For instance, experimental equipment now exists which will enable the housewife to prepare meals without effort by feeding punch cards into household versions of industrial process control systems.

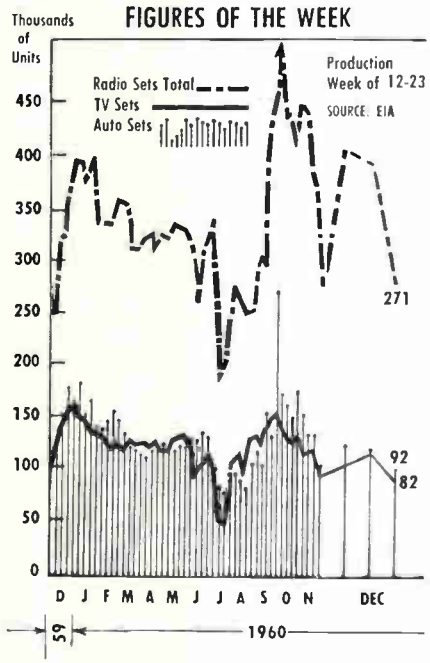
The nine-percent rise in industrial electronics in the year just ended was due in large part to gains in sales of computing and data-processing equipment for business and scientific applications, according to Davis; he added that sales volume in this area is approaching the half-billion dollar point. Navigational aids, industrial controls and testing equipment also con-

tributed importantly', he said.

More than half of the industry's sales continue to be in military products. The year 1960 saw only a moderate increase from $4.7 billion to $5 billion, however. EIA attributes this to a variety of factors such as the substantial completion of DEW line, the Mid-Canada Line, the Pine Tree Line, and other elements of continental defense.

"On the other hand," says Davis, "introduction of new weapons systems in larger quantities, such as Polaris, Atlas and Titan, constitute a major pressure toward growth." Although military spending for 1960 was little changed from 1959, the outlook, according to EIA, is for increased military products sales during 1961 and into the foreseeable future because of demands for more sophisticated missile systems and control communications nets, and developments in civil defense and exotic weapons.

Davis said that the industry's gain in business, although falling short of expectations, would see a breakthrough into the $10-billion level when the 1960 tally is completed. He attributed the less-than-optimum gains to softening U. S. business and severe competition from "low-wage foreign producers, particularly the Japanese." He said imports of consumer goods from Japan should be regarded as an initial assault and predicted further market penetration.



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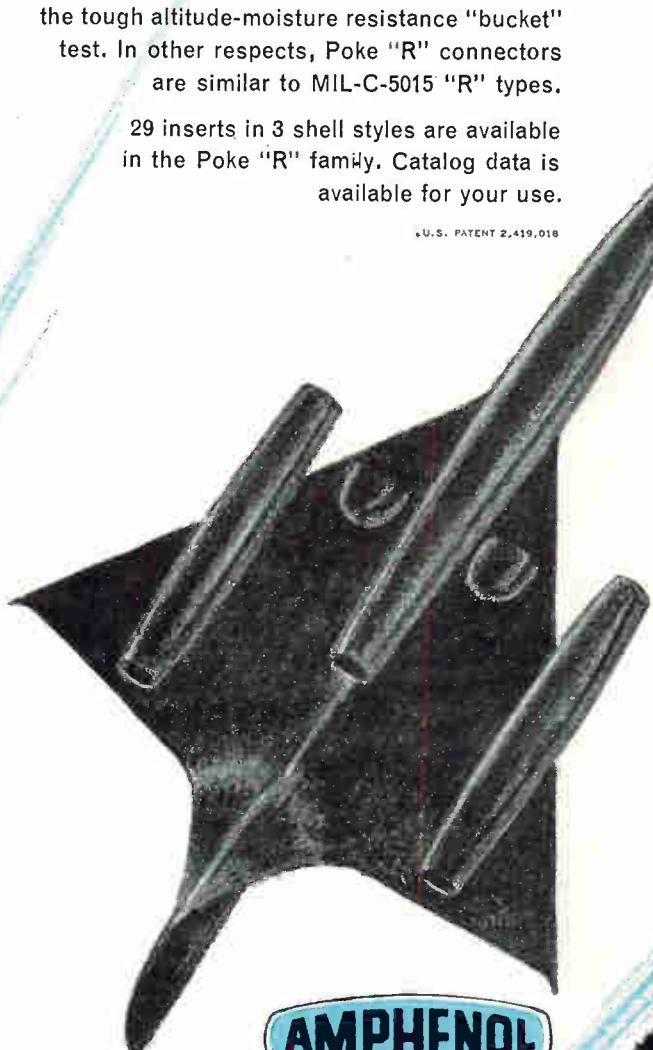

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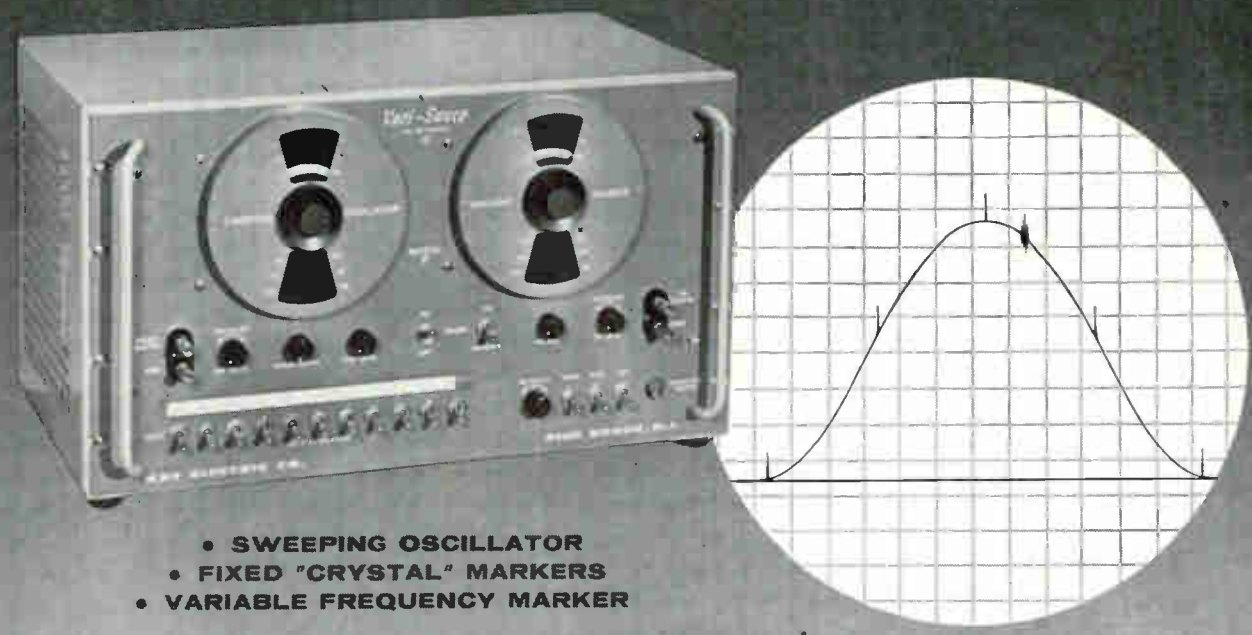

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Will Nike-Zeus Go Into Production

By JOHN F. MASON
Associate Editor

BURLINGTON, N. C.—An early decision on the future of the much-debated Nike-Zeus program is now more likely than any time in the antimissile missile's five-year history.

Whatever the conclusions reached by Congress, implications for the electronics industry are big.

For the foreseeable future, observers say, salvation from attack lies in Zeus or nuclear-proof shelters. Zeus is the only system in an advanced development stage for protecting the U. S. from enemy ballistic missiles.

Cost of protecting the entire country has been estimated at $8 billion.

The Zeus project is a gigantic industrial complex. Prime contractor Western Electric has 34 major subcontractors, and over 7,500 suppliers. The program presently requires the efforts of approximately 11,000 employees at first tier subcontractor level, operating in 41 states.

Decision to put the Zeus system into production would involve more than 100,000 employees in the total effort. Responsible for the system is Army Ordnance Missile Command with the Army Rocket and Guided Missile Agency acting as technical supervisor.

S. C. Donnelly, prime contractor Western Electric's project manager for Zeus, told ELECTRONICS in an exclusive interview where Zeus stands today, what more needs to be done before production, and how he is participating in hardware procurement for the R&D program now underway.

Donnelly feels this to be a highly crucial moment for the Zeus program.

"There has never been a doubt on the part of Congress that we must have a defense against enemy ICBMs. And," he added, "there's no doubt in our minds that Zeus can knock down an ICBM and is ready to go into production. No component nor capability required by Zeus is beyond the present state of the art."

The program is on schedule, Donnelly said. A minimum amount of ground guidance and launch equipment is now ready and will be set up at the Army's missile range at White Sands, N. Mex., by the middle of 1961 to test the guidance and missile as an integrated system. Due to the limited range at White Sands, the missile can not be turned loose to its full range.

Concurrent with the White Sands development tests, a complete muscle flexing of the bird itself will be carried out in the upper atmosphere over the Pacific Ocean from the Navy's Pacific Missile Range at Point Mugu, Calif.

In mid-1962, Zeus will be launched from the Navy's test site on the Kwajalein Island in the Pacific to intercept Atlas missile targets fired from USAF's Vandenburg AFB, Calif.

Kwajalein will have a complete Zeus installation including launching equipment, the four radars—acquisition, target tracking, discrimination, and the Zeus missile tracking radar—data processing, telemetry, communications, and the elaborate test gear required for all this.

Concurrently, a group in the Ascension Islands will continue to take advantage of all targets of opportunity (including decoys) fired down the USAF Atlantic Missile Range from Cape Canaveral, Fla. The targets are monitored with radar, taped and fed into the target tracking radar at White Sands for study.

Western Electric's contracts for R&D at the Bell Laboratories to date come to about $600 million. By 1964 the total for R&D will probably hit $¾ billion.

The big question is: when will production begin? And with what objectives—an all-out crash program to defend the entire U. S. at a cost of some $8 billion or a stretched-out, piecemeal plan, requiring less immediate appropriations?

To hold up production until the system is completely checked out would cause a serious delay, says Donnelly. The decision may be to initiate an interim production program to begin in April and utilize the years that would otherwise be lost waiting for final test results. Cost over these years would run less than $2 billion to complete the probable sites started during this interim period.

There are several advantages to the interim approach, according to Donnelly: we could defend a few strategic areas while building production facilities and welding the nucleus of a field operational team.

Western Electric has two production planning contracts. Purpose of the first was to determine what kinds of plans and machinery

MAJOR NIKE-ZEUS R&D SUBCONTRACTORS

Subcontractor	Area of Effort
Allis-Chalmers Mfg.	*Target tracking antenna*
Air Products, Inc.	*Refrigerator for maser*
Armstrong Cork Co.	*Acquisition radar dielectric*
Avco-Everett Research Lab. Div. of Avco	*Optical discrimination*
Bell Telephone Labs.	*System design*
Bomac Laboratories	*High power duplexer*
Burns and Roe	*Facility design*
Continental Can	*Tracking antenna mounts*
Continental Electronics	*Acquisition radar transmitter*
Douglas Aircraft	*Missile, booster, missile-handling and test equipment*
Doehler-Jarvis Div. National Lead Co	*Wave guides*
Dow Chemical	*Acquisition radar dielectric*
F.X.R., Inc.	*Rotary joints*
Goodyear Aircraft	*Acquisition radar antenna*
I.T.E. Circuit Breaker Co.	*Rotary joints*
Kaydon Engr. Corp.	*Bearing assemblies*
Lear	*Stable platform*
Arthur D. Little	*Refrigerator system*
Messinger Bearing, Inc.	*Radial bearing*
Minneapolis-Honeywell	*Accelerometers*
Narmco Mfg. Co.	*Target track antenna*
Remington Rand Univac	*Computers*
Sperry Gyroscope	*Target track radar transmitter*
Steel Products Engineering	*Missile track radar antenna*
Stromberg-Carlson	*Test equipment*
Texas Instruments	*Tactical displays*
Thiokol Chemical	*Booster*
Vickers, Inc. Div. of Sperry Rand	*Target track antenna*
Waterman Products	*Oscilloscopes*
Western Gear Corp.	*Gear reduction unit, drive gear*
Westinghouse Electric	*Hydrodynamic bearing*
Wheeler Laboratories	*R-F plumbing*

Source: Western Electric

This Year?

would be needed to produce the equipment being developed. A number of specific problem areas were identified, calling for completely new production facilities.

This led to a second production planning contract to evolve manufacturing techniques for new state-of-the-art components and for components never before produced in quantity. The latter includes such items as precision traveling wave tubes, super power klystrons, and high reliability transistors. Equipment is being developed to automatically wire circuit module assemblies by programmed controls.

Manufacturing Zeus equipment will provide a market for computer supplies, resistors and transistors; for lens media for radar antennas and klystrons for transmitters, Donnelly said.

A short and stocky, keenly alive, genial man, Donnelly is only content when dealing with the heart of the matter.

Every three months, he holds a meeting with all subcontractor team managers. The conference is used as a guidance group which gives Zeus the benefit of the collective experience of all the companies represented. "We want to make sure we're all singing off the same sheet of music."

One of the biggest problems in the Zeus program, Donnelly said, is keeping interest alive among his production engineers while waiting for production contracts.

"You've got to give a man more than money to take home." Donnelly said. "You've got to give him a sense of accomplishment, a challenge so he won't let down."

Donnelly is exploring the use of data processing as an aid to managing the program. For the past six months the discrimination radar system has been handled in this way.

The task Zeus must accomplish is formidable. It must detect and track small objects at great range and traveling at 15,000 mph. It must discriminate against decoys among clouds of targets. It also must control the Zeus missiles it sends up to intercept the targets.

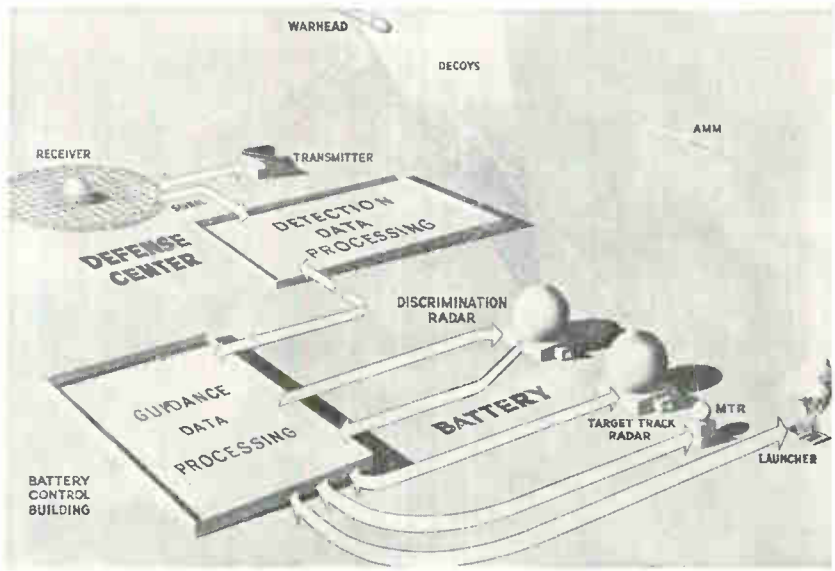
The acquisition radar at a Zeus Defense Center consists of three arrays in a horizontal, triangular arrangement rotating 360 degrees in azimuth. Turning in synchronization with the transmitter, the separate receiver is a large Luneberg lens with multiple, independent receiver horns. The Luneberg lens focuses the radar pulses returning to the receiver from the incoming warhead.

The large antennas used in the acquisition radar will bring to practical use for the first time the theories and concepts of focusing radar energy of great magnitudes, Western Electric says. The lens enables simultaneous tracking of a number of targets.

The transmitter building is topped by an 80-ft wide triangular transmitter surrounded by a 660-ft diameter fence. The receiver is eight stories high. Forty-two railroad freight cars are needed to transport the Luneberg lens material for each receiver.

The rapid data handling required in the Zeus system is achieved with high-speed switching transistors. The computer's permanent memory device, called a "twister," is made of bar magnets and hair-thin wires wrapped with magnetic metal tape in barber pole fashion. The computers use precision deposited-carbon resistors in quantity and quality far in excess of any previous requirements.

Nike-Zeus project manager S. C. Donnelly discuss R&D procurement



Main elements of a Nike-Zeus Defense Center

Navy Testing Antisub Alarms

Strategic defense against growing Soviet submarine menace requires extensive ocean surveillance

SOVIET ROCKET-RATTLING has been an effective red herring since the Summer of 1957 to mask the quiet buildup behind the Iron Curtain of an enormous submarine fleet. Latest issue of Jane's *Fighting Ships* figures the USSR sub fleet at more than 500, with about a dozen of these capable of carrying Polaris-type missiles. A couple at least are known to be nuclear-powered.

The U. S. Navy has been moving quietly but effectively to counter this threat. Since the Soviet masters have chosen to keep this a silent cold war, Navy brass has matched them. The antisubmarine effort—to which a large part of the Navy's energies are committed—is not as widely publicized as other defense projects. But its seriousness colors most of the Navy's plans.

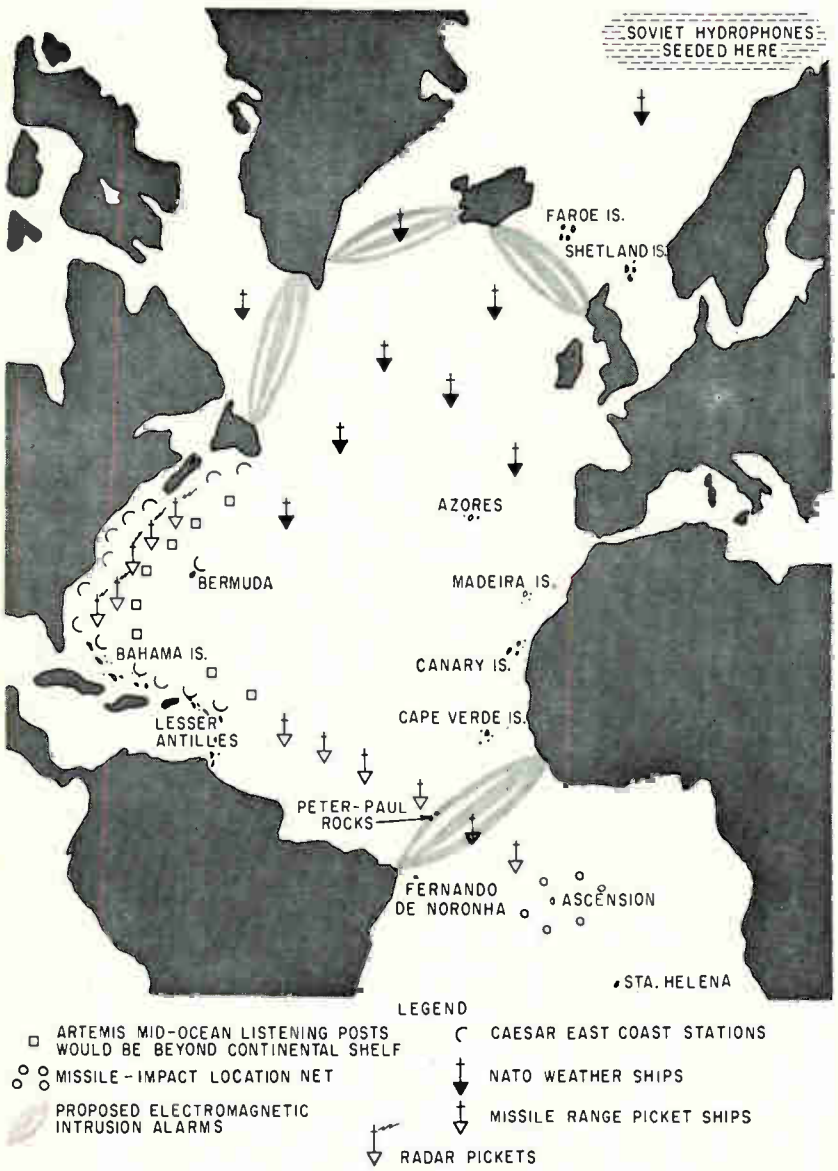
ASW efforts divide into traditional categories of strategic and tactical defense. Strategic defense includes a number of heavily cloaked projects aimed at providing a warning of submarine intrusions to the fleet. Details of these plans are carefully and rigidly guarded—even the code names of some projects are referred to by code names—but some aspects of the role played by the electronics technology in helping the Navy meet the Soviet sub threat are becoming fairly clear.

To protect the exposed shoreline of the continental U. S., the Navy has attempted to install—with the cooperation of the North Atlantic Treaty Organization—antisubmarine early-warning systems. Although some approaches to this problem have been less than successful, they have marked out the way to development of new techniques that are now being tried.

Several years ago, the network of shelf-water sonar listening posts of the Caesar project began working. Caesar involved a curtain of fixed hydrophone arrays encapsulated in a plastic that is transparent to sound, dropped below surface turbulence and connected by cable to shore control stations. Western Electric was prime contractor. Sound returns to Caesar listening posts were correlated and analyzed by a lofar-type system called SOSUS, which involves the analysis of the low-frequency end of the sound spectrum for patterned sound.

Lofar developed from sofar, originally a fixing-and-ranging technique for sea rescue in which a downed flyer released from his liferaft an explosive charge that exploded at a preset depth and permitted surface and subsurface ships to locate him. Lofar coupled this system with autocorrelation techniques for long-range analysis of patterned sound.

Caesar provided a certain degree of security as far as the Atlantic and Pacific shelf waters were concerned, but it left much to be desired as an early-warning system. Judging from all available data, it requires the release of depth charges or other explosive sound source for passive ranging. Its range is limited to about 100 miles. Further, it cannot guard such undersea alleys as the Hudson and Hatteras Canyons, which cut through the continental shelf and



Besides putting in networks of listening posts, Navy may close off North Atlantic basin by putting intrusion alarms across its access channels

provide deepways to within miles of the shore.

One step in the improvement of Caesar's efficacy was to hang low-frequency hydrophone arrays onto the radar pickets that guard the East Coast some 200 miles out. These ships extend the range of Caesar by the amount of their distance from shore, and augment the listening post in Bermuda, providing in effect a comprehensive coverage of the East Coast to about 500 miles out. Another supplementary station was hung onto the Texas Tower that stands almost over the mouth of the Hudson Canyon.

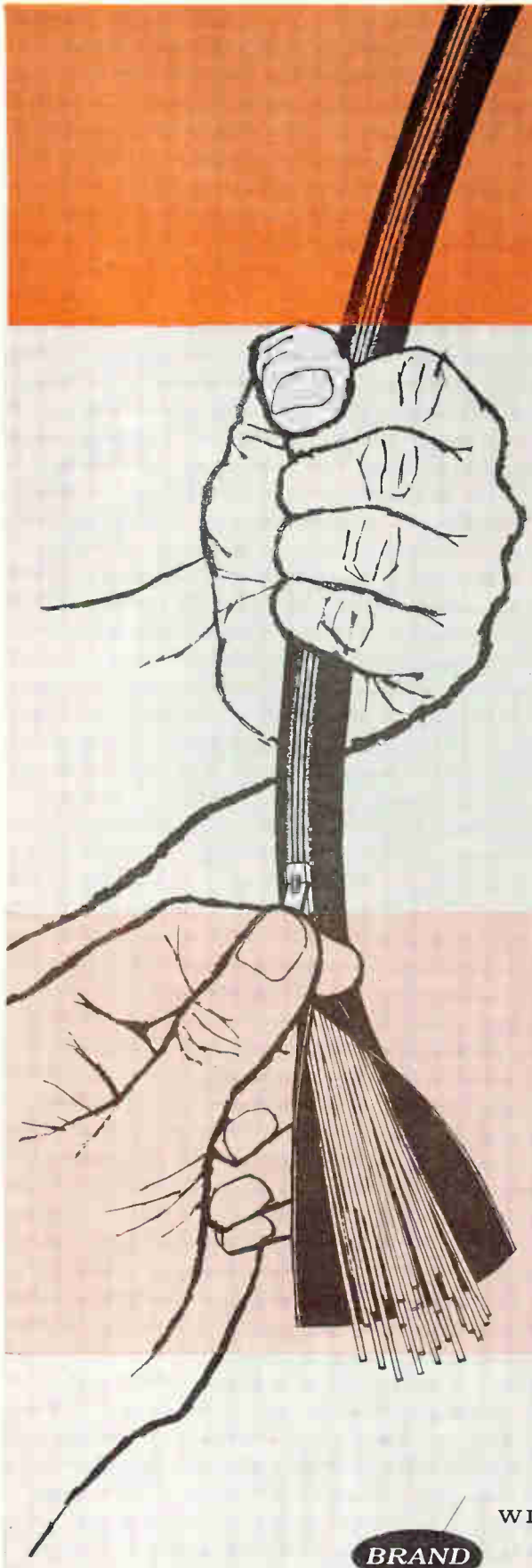
In 1959, Navy financed project Atlantis, a study of the feasibility of large-area long-range ocean surveillance systems. Another project —Trident—is now underway to pin down the results of Atlantis. Philco is prime contractor on Trident, with Simplex Wire & Cable and Chesapeake Instrument Corp. as subcontractors.

CIC is now developing highly sensitive hydrophones for the project; the company's work in acoustic devices for severe environments is necessary to Trident, which will be the forerunner of a comprehensive early-warning network called Artemis. Navy, recognizing the need for a system in being, is doing what it can now and aiming toward Artemis; each of the so-called study projects has contributed some hardware to a warning system in being.

Artemis is meant to be a fixed underwater surveillance system that will use all the latest techniques. It will make use of big multiple listening posts weighing tens of tons, moored beyond the continental shelf. Hydrophone arrays stacked at intervals along the buoyed mooring cable will monitor sound in each thermocline interval at each site. (The thermoclines—interfaces between warmer and colder water—bend sound so badly that submarines can easily escape detection by hiding under them.)

For active ranging, a technique is under test that will use hydraulic rams to drive diaphragms at the extreme low end of the sound spectrum. Acoustic resonant chambers made of concrete will reverberate at the frequency of the transmitted ping (or thump), boosting the

(Continued on p 29)



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Antisub Alarms . . .

(Continued from p 27)

sound level of the echo at the resonant frequency. A 32-cycle pinger, for instance, would work into a resonant cavity less than 30 ft long.

Power for each installation is to be provided by a miniature nuclear reactor. Maintenance of the sites will be handled remotely by Navy's new remote underwater manipulator (RUM; see ELECTRONICS, p 31, June 17 '60). RUM, built onto an Ontos tank body, includes four tv cameras and an electromechanical manipulator capable of lifting 5,000 lb, can withstand pressures at greater than 3,000 fathoms.

Among other strategic warning systems, Navy is considering beds of listening sonobuoys which would have long-life power packs, to do the same type of work as Artemis but with shorter range. These sonobuoys could be seeded across channels of great strategic importance to act as burglar alarms.

Navy is also contemplating an electronic burglar alarm that could alert the fleet whenever any ship crossed one of the several gateways to the North Atlantic basin, or crossed the line between the Aleutians and Japan (many of the USSR pigboats are penned at Petropavlovsk, behind this line).

These systems might employ patterned electromagnetic fields which the metal body of the ship would distort. Low-frequency electrical or electromagnetic fields in a pattern across the access routes to the North Atlantic basin would work like a doppler intrusion alarm, which recognizes a change in the pattern of an ambient field and sounds the alert.

ITT, Loral Electronics, GE and Admiral are all known to be investigating the feasibility of underwater detection and surveillance systems using electromagnetic phenomena. Both the intrusion-alarm type and a kind of low-frequency radar are under investigation. An active underwater radar-type system would present the advantage of being usable aboard ship, where the intrusion-alarm systems are necessarily fixed stations.

The Omega system being designed by ITT Laboratories for the Navy may also find use as an antisubmarine system. Omega is a vlf navigation system by which Navy ships all over the world will be able to fix their own positions within a mile. It will be a hyperbolic system similar to loran, will need only eight sites for global coverage.

Naval Electronics Lab in San Diego, Calif., and ITT Labs. are both studying ways of using Omega as an intrusion alarm. The carrying power of vlf energy in water is excellent (submarines the world over can hear the vlf transmissions from Navy headquarters), and distortion of stable field patterns can provide intrusion data. The Omega system can also be easily adapted to function as an identification-friend-or-foe system, which the Navy needs for efficient undersea tactics.

Early-warning systems are sometimes made to do double duty, both for efficiency's sake and to mask their real purpose. For example, the hydrophones of the southeast end of the Caesar-Atlantis-Artemis complex function as a missile-impact locating system for the Atlantis Missile Range, to help range officers find where a reentering nose cone hit the ocean's surface.

Similarly, the concrete acoustic cavities of Artemis will be surveyed precisely into position, were at one time being considered as a backup for the ship's inertial navigation system (SINS) by which the deep-running Polaris submarines are now navigated.

In this backup system, the network of resonating chambers would echo back a sub's ping; sub-borne instruments would interpret the returned signal and derive ship's position data. Navy officially says the system has been tried and found wanting; unofficially, ELECTRONICS learns that the system may still prove fruitful.

Railroad Will Install Microwave Communications

NEW YORK CENTRAL railroad plans to replace 140 miles of overhead wires between Buffalo and Syracuse, N. Y., with a microwave system. Installation will be the first along the Central's main line.

System will have 30 channels initially, with connections at Rochester, N. Y. Decision to build it follows successful experiment with microwave between Indianapolis offices and the Central's Big Four marshalling yard at Avon, Ind. Central spokesmen say the Buffalo-Syracuse setup is forerunner of a system-wide microwave complex of 240 channels, half for voice, half for data.

Installation of the new system may be started this year "depending on availability of funds."

Engineer Climbs

Corrosion check on chimney stack is made by field engineer in bosun's chair. He is using Magnaflux ultrasonic unit

Venezuela May Spend $200 Million in Japan

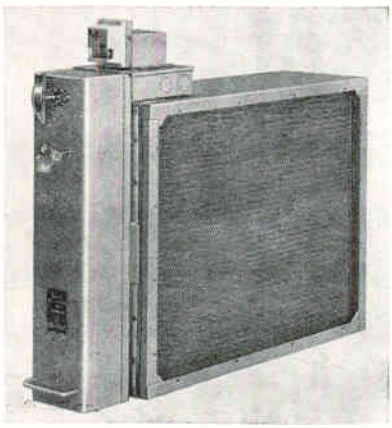
VENEZUELA'S coordinator of radio communications, Miguel A. Tejeda, said recently that Japanese manufacturers would be considered as a possible source of supply for a $200-million telecommunications project now being planned in Venezuela.

Tejeda, visiting Tokyo after the International Telecommunications Conference, said seven engineers would be sent to Japan from Venezuela in February to survey the industry. The Caracas government recently bought seven shortwave systems from a Japanese manufacturer. The South American country last year imported $48 million worth of goods from Japan.

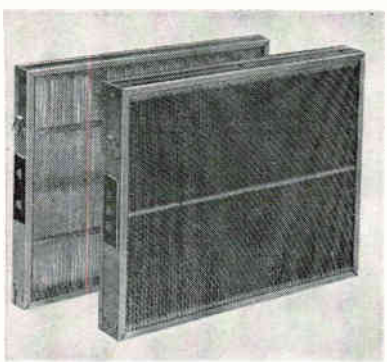
Large market predicted for new systems using two-stage precipitation

Wall panel indicates when precipitation cell should be cleaned

Electronic Air Cleaning Planned for Homes



Electronic air cleaner unit can be installed in any type forced-air heating or air-conditioning system



Two-stage precipitation cell (foreground) and additional collector stage

MARKET FOR electronic components such as selenium rectifiers and special transformers may get a healthy boost with the introduction early this year of an electronic air cleaner for use in the home. The electrostatic unit, which charges and collects particles as small as tobacco smoke, was developed by Minneapolis-Honeywell.

Two-stage precipitation, a common technique in commercial electronic air cleaners, is used. On the air-inlet side of the precipatation cell, a 1-in. thick ionizer consisting of a series of tungsten wires between grounded aluminum plates receives a 6,000 volt d-c charge. Dust particles traveling in the return air stream from the home are charged positively.

Down stream, a 2-inch thick collector also receives a 6,000 volt d-c charge. This section consists of a series of aluminum plates spaced between other aluminum plates, which are grounded. Combined electrostatic attraction and repulsion of the positively charged dust particles entering the second stage forces them towards the grounded plates. The combined reaction is said to create a collection force that is as much as 4,000 times greater than gravity. Thus, the unit is able to remove from 70 to 90 percent of foreign particles in all the rooms of a home using a forced-air heating cooling system.

Constant charging voltage is maintained on the electrostatic elements by a leakage transformer. Selenium rectifiers provide d-c current.

Designed for installation in a home with an air-flow rating of 1,400 cubic feet a minute, the unit can handle increased air flows up to 2,200 cfm with a second collector stage.

The system is being life-tested for a minimum of ten years because many of the systems may be included in 25 and 30 year home mortgages, and also in 5 to 7 year home-improvement loans. Complete package including installation will cost the home-owner approximately $350.

The 2-inch collector will cost approximately $75.

Within 30 days after the new year, Honeywell will have available smaller capacity system handling up to 1,000 cfm, or 1,300 cfm with additional collector. This system is intended to provide an answer to close-space requirements especially closet-type heating and air conditioning installations.

As for potential sales: there are 700,000 forced-air, centrally air-conditioned homes in the United States and by 1965 this will become 1,800,000. Furthermore, there are 13,300,000 homes with forced-air heating systems (that can be converted to central air conditioning) and that these will be 15,700,000 in 1965.

Siegler Cloud Analyzer Radar fills the critical gap in air safety in the airport terminal area!

Until recently, airport weathermen could only *guess* depth and density of clouds *directly above the airport*—the most critical area in guidance of today's high performance aircraft.

Now a unique new radar—the new Cloud Analyzer developed by Siegler's Olympic Radio and Television Division—eliminates this gap in air safety. Provides continuous *knowledge* of height, density and upper limits of clouds directly over the airport, up to 60,000 feet.

Cloud Analyzer Radar, developed for the U.S. Air Force, is now in operation by the U.S. Weather Bureau at the National Airport in Washington, D.C., Hanscom AFB, Bedford, Massachusetts, Cape Canaveral, and will soon be in operation for the Department of Defense and the Federal Aviation Agency in the 433L Automatic Weather System.

The Olympic Division of The Siegler Corporation also produces the monitor and transfer system for the important TACAN program, and the AS-111 Radio Direction Finder.

Selection of Siegler for these and other major projects shows recognition of the superior performance of all Siegler divisions, under the basic corporate concept: *Progressive management of diverse activities with outstanding military, industrial, commercial and consumer capabilities — in order to bring to each of these fields the strengths of the others.*

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Engineering Teacher Pay

Rank	Average Total Income 1958	1960	Changes 1958–1960 Dollars	%	Basic Teaching Salary 1958	1960	Changes 1958–1960 Dollars	%
Instructor	$5,955	$6,633	$678	11.1	$5,009	$5,392	$383	7.6
Asst. Professor	7,801	8,828	1,027	13.2	6,209	6,869	660	10.6
Assoc. Professor	9,502	10,815	1,313	13.8	7,419	8,299	880	11.9
Professor	12,672	14,373	1,701	13.4	9,581	10,836	1,255	13.1

Average annual income and teaching salaries of engineering teachers by rank

ENGINEERING TEACHERS lead other members of the teaching fraternity in remuneration, according to a study by S. E. Harris of Harvard that was published recently by McGraw-Hill Book Co. But the level of teacher salaries still lags badly behind other income in this country.

Harris's study, *Financing Higher Education* 1960-70, points out that while salary levels for full professors at Harvard (where he is chairman of the department of economics) have trebled in the last 90 years, prices have risen 220 percent and national per-capita income levels have risen 1,300 percent.

In the Soviet Union, a value system has been set up in which the average professional salary is several times the salary of the average nonprofessional worker. On that basis, Harris says, the average U. S. college salary—now something in excess of $6,000—should be at least $25,000 by 1970.

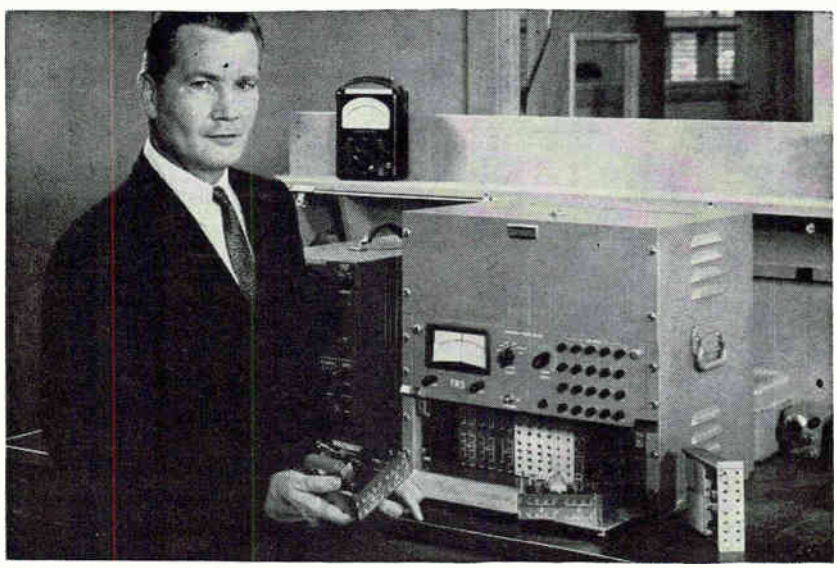
The situation in the Soviet Union probably reflectes the strong emphasis on technology. In the U. S., a similar emphasis has been incubating during recent years, placing engineering teachers on a higher salary plateau than other teachers. Besides, many engineering teachers do part-time outside work, such as consulting; outside opportunities for the bulk of other educators are extremely limited.

According to a recent study by M. A. Horowitz of Northeastern University, the average total income of engineering teachers of all ranks increased from $9,598 in 1958 to $11,013 in 1960, a gain of 14.7 percent. The average salary of all other ranks of educators is $6,711, which is $696 more than the 1958 figure.

Engineering teachers are not seriously affected by the statistics recorded in a 1960 National Education Association report entitled *Financing Professional Salaries for Professional Teachers:*

As many as 14,000 teachers are reported to be receiving less than

Do-It-Yourself Special-Purpose Computer



TR-5 mounting unit built by Electronics Associates makes it possible to assemble special-purpose analog computers using Pace plug-in units

Leads All

$5,000 for nine months of full-time service. Twenty-two thousand teachers are reported to be receiving salaries between $5,000 and $6,000. In one geographical region (including 11 states), the average salary of teachers of all ranks is only $6,043, with one-fourth of them receiving $5,035 or less.

Among private colleges the average salary for assistant professor in the small college is $4,600; in the medium size college, $5,363; and in the larger colleges, $5,770. For instructors (the teachers usually carrying the largest teaching loads, while often studying for advanced degrees), the nationwide average is only $5,095—for men $5,161, and for women $4,855. One fourth of all instructors receive $4,599 or less. In one region (11 states), half of all instructors receive $4,640 or less, with a quarter receiving $4,176 or less.

The national average for university and college presidents is $13,827, but as many as 142 are reported to receive less than $10,000. College deans have an average salary of $10,723, but 10 percent of them get less than $7,000.

Encouraging trends in education are largely led by engineering teachers:

More than 300 teachers command salaries above $18,000 for nine months of service. Salaries in more than a thousand teaching positions range upward from $15,000. One teaching position in 25 pays $12,000 or more. Just over 10 percent of full-time teaching positions carry salaries of $10,000 or more.

Almost 10 percent of full professors are at or above the $13,000 level. In two universities, the average salary for full professors is $16,000. In 25 institutions, the median salary for full professors is at or above $12,000. Annual salaries for presidents range above $40,000, with as many as 20 reported at $30,000, or above. Fifty are at or above $25,000, and almost 75 others are reported to be in the $20,000-$25,000 range. Vice-presidents range up to $33,000 and college deans up to $23,000.

Poland Cites Gains In Electronics

ELECTRONICS IN POLAND has become a major industry, according to that nation's recent press pronouncements.

Present production reportedly covers a line of products ranging from small components to complete systems for broadcasting, production control and other functions.

The country's present electronics output is said to satisfy the major demands of internal consumers and leave some margins for export. Claims are that technical progress has placed Poland's electronics products into competitive positions with those of other nations.

Attribution for this is given to the close cooperation between the state-owned and operated production facilities and the state-owned and operated technical and scientific institutes. The four main academic technical organizations in the country are the Industrial Institute of Electronics, Television and Radio Institute, Industrial Institute of Telecommunications and the Communications Institute. Close contact is also maintained between the industry and the Polish Academy of Science.

Eight Polish companies carry on the bulk of electronic production. Telpod manufactures hermetic capacitors, layer and wire potentiometers and wire and layer resistors. Omig Radio produces miniature radio components, resistors and transformers. At Elwa Radio, both miniature and conventional electrolytic capacitors are manufactured. Loudspeakers, microphones, loudspeaker transformers, synchros and sound columns are made at Tonsil Loudspeaker. Eltra Electrotechnical's factory produces tube sockets and pushbutton switches. The Radio Ceramics factory produces ceramic rods, capacitors, trimmers and plates. Also made there are magnetoceramic capacitors. Junction diodes, point-contact diodes and some other semiconductor types are made in the Pewa plant. Vacuum tubes and lamps are made by Telem.

Equipment manufactured in Poland includes the ALFA industrial tv gear, a line of high-frequency dielectric furnace equipment, impulse welding gear used in polyethylene foil manufacture, and several types of high-frequency welding equipment for plastics.

Among newer products is the Swierszczyk radiotelephone. This unit operates in the 30 to 41-Mc region with an output power of 300 mw. It is powered by 1½-v and 67½-v dry batteries and has an effective range of about 1.8 miles. It weighs slightly less than 8½ pounds.

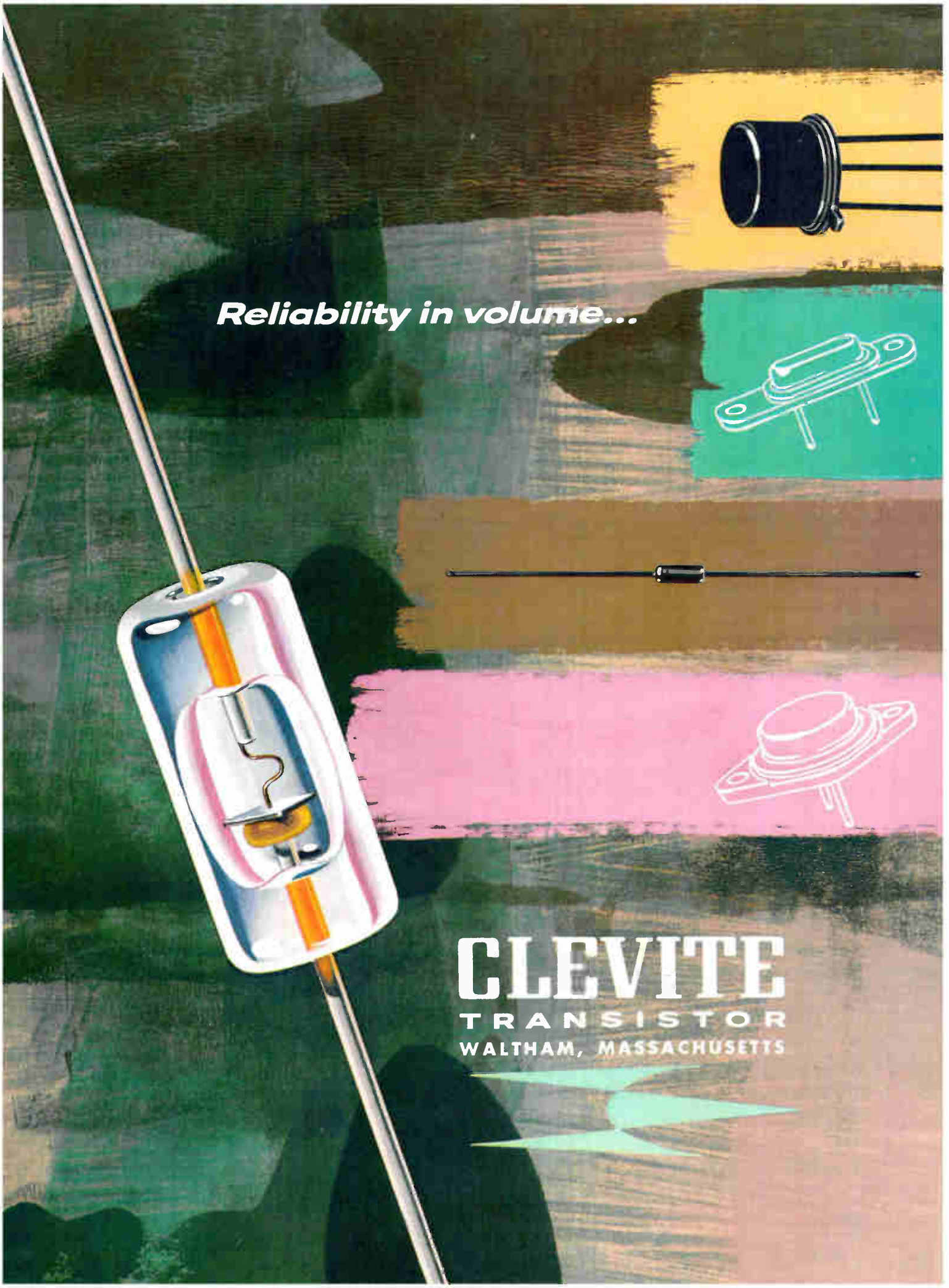
Estonians Studying Electroluminescence

LABORATORY for the study of electroluminescence problems is being set up at the University of Tartu in Estonia. Photoluminescence and semiconductor phenomena in phosphorus will also be studied at the new lab.

It was at Tartu that Fyodor Klement worked out sublimation techniques that permitted development of thin layers and top-quality luminophores. Soviets believe electroluminescence has a great future, figure the work will take hold in Estonia.

Measuring Speed

General Radio Strobotac checks running speed of turbo supercharger on diesel engine at Atlas Polar Co., Toronto. Twelve-blade turbo fan rotates at 42,000 rpm. Using Strobotac at 21,000 rpm, a stationary pattern is obtained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DIFFUSED SILICON RECTIFIERS

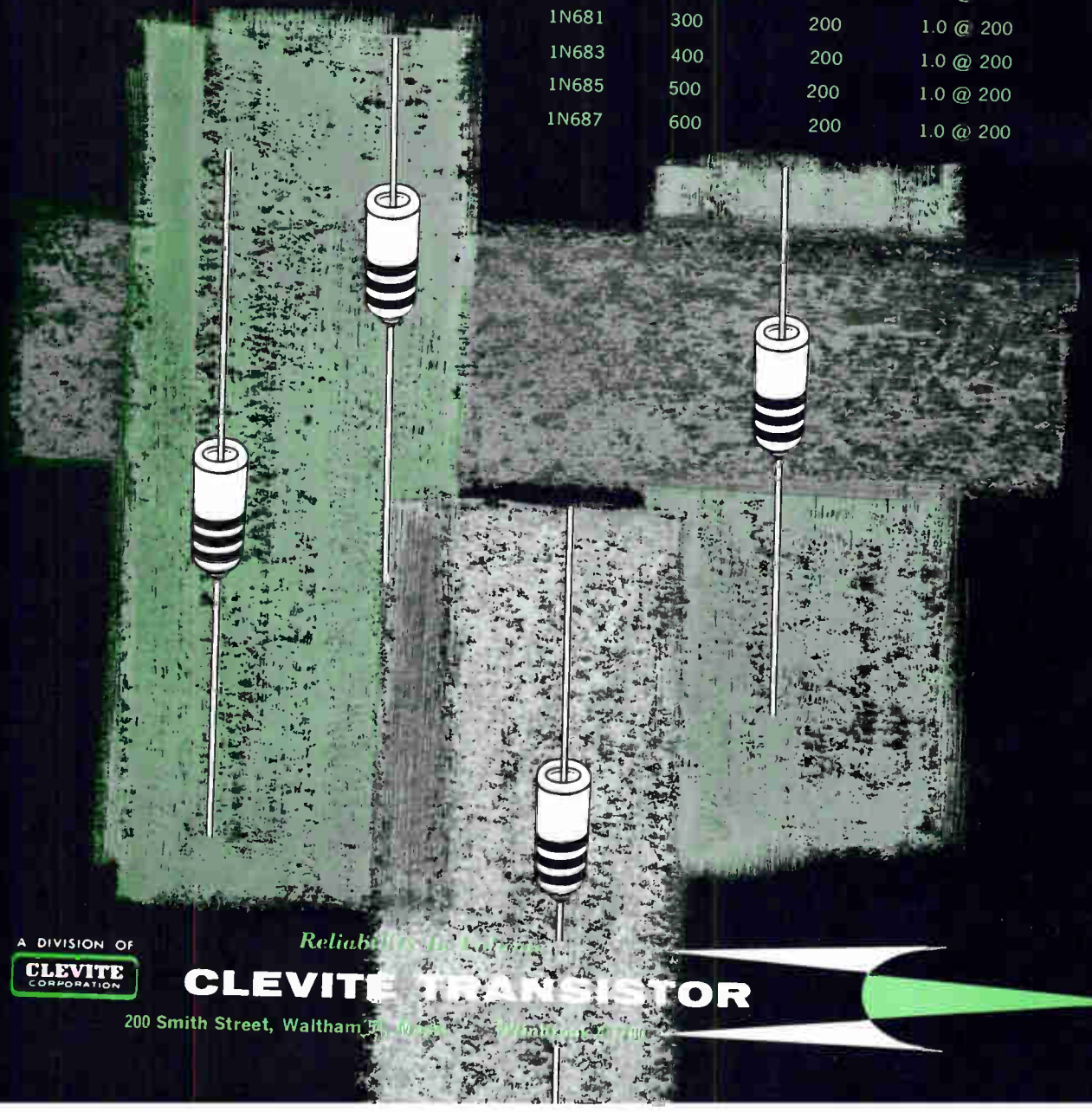
Clevite's rectifiers find broad use as general purpose diodes in computers and as rectifiers in magnetic amplifiers, dc to dc converters and power supplies.

They are particularly useful in airborne applications where switching of equipment may generate high voltage transients in the line which would burn out ordinary diodes. Designed for maximum reliability, Clevite rectifiers provide high dissipation — 600 mw . . . high voltage — up to 600 v . . . high temperature — up to 150 ma at 150°C.

Where fast switching is not required, these rectifiers offer definite advantages in size, costs and superior overload protection. They are available in military types conforming to MIL-E-1/1143 (USAF).

Send for bulletin B217-3B

Diode Type	Maximum DC Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (ma)	Maximum Forward Voltage Drop @ 25°C (volts @ ma)
1N645	225	400	1.0 @ 400
1N647	400	400	1.0 @ 400
1N649	600	400	1.0 @ 400
1N677	100	400	1.0 @ 400
1N681	300	200	1.0 @ 200
1N683	400	200	1.0 @ 200
1N685	500	200	1.0 @ 200
1N687	600	200	1.0 @ 200



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Honeywell International Sales and Service offices in all principal cities of the world.

Honeywell

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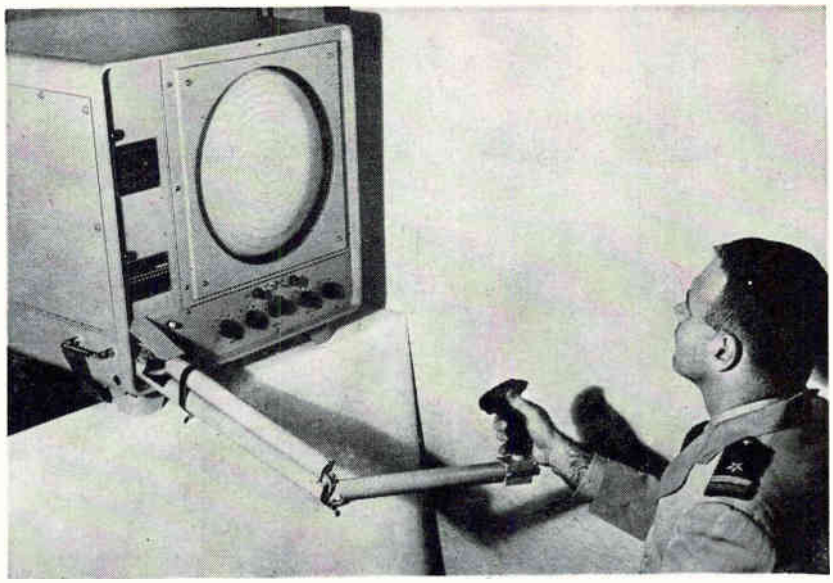

Pilot watches results of his visual-manual guidance on cathode ray tube

Navy Using Bullpup Missile Trainer

NAVY is employing electronic simulators to increase pilot skill in using the air-to-surface Bullpup missiles.

In actual operation, the pilot watches the missile visually as it drops from the plane headed towards its short-range target and guides it by radio command signals with what looks like a modified joy stick.

In the trainer, the pilot will use the same joy stick but will watch the effects of his controls on a cathode ray tube. Missile characteristics not under his control are electronically generated within the trainer.

An analog computer produces real time simulation of the missile dynamics. The computer output voltage that is analogous to missile motions is displayed as a deflection on the face of the cathode ray tube.

Several non-linear functions of time associated with missile characteristics and all automatic controls are performed by an electromechanical function generator and programmer assembly that is accurately driven as a function of time.

Designated the AN/ARW-T2 Ground Pilot Trainer, the unit is about the size of a home tv set. Trainers are being installed on land and aboard ships. Radiation Inc. built the trainers for Bullpup prime contractor Martin under a $400,000 contract.

Bugs Hit Providence's Automated Post Office

IN THREE MONTHS of operation the Post Office Department has been able to get a bead on the troubles of an automatic postoffice and figure out ways of solving them. The trial system, which is situated in Providence, R. I., opened in October and has been shaking out the bugs since.

Difficulties were compounded by the Christmas season. High-speed electronic facer-cancelers, which look for and cancel the stamps, were thrown by letters carrying Christmas seals, rejecting all such letters for hand treatment. Foreign stamps, and even trading stamps, pass through the cancellation machines—if they're in the right position.

About 30 or 40 letters a day are damaged because postal workers don't remove them quickly enough from the electronic sorting mechanisms, causing a backup into the conveyors.

Low leakage and useful h_{FE} at very low collector currents permit low power operation – as low as 30 microwatts per stage. High performance PLANAR transistors and diodes use simplified circuitry (see illustration), keep costs down, reduce power requirements, and permit high-density packaging. Prime applications: missile and space vehicle guidance and instrumentation.

For your down-to-earth needs, where weight, space and power are less critical, similar logic circuits will operate with switching rates greater than 5 mc.

mμA leakage in Fairchild **PLANAR** transistors and diodes permits

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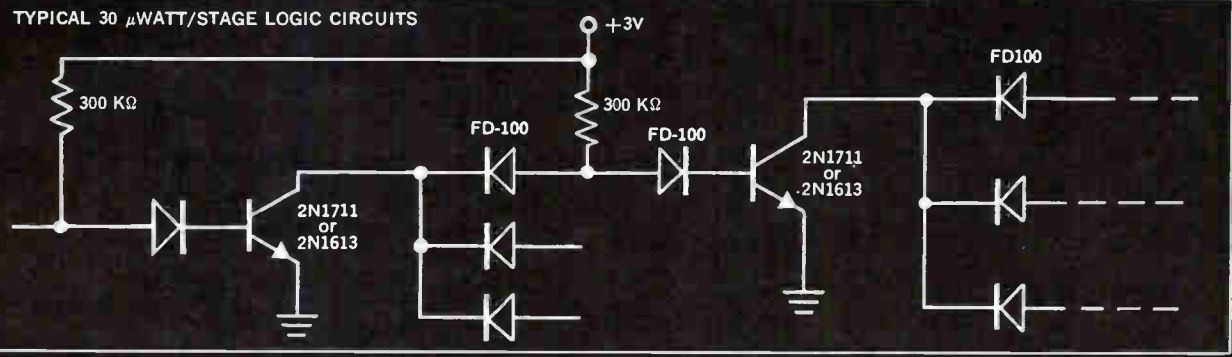
FOR SPACE VEHICLES

TYPICAL 30 μWATT/STAGE LOGIC CIRCUITS



MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS (25°C except where noted)

	Total diss.	V_{CBO}	V_{EBO}	h_{FE} (I_C=150mA) (V_{CE}=10V)	h_{FE} (I_C=0.1mA) (V_{CE}=10V)	C_{ob} (I_E=0) (V_{CB}=10V)	I_{CBO}	I_{CBO} (V_{CB}=60V) (T=150°C)	I_{CBO} (V_{CB}=50V) (T=125°C)
2N1613	3.0W	75V	7.0V	40-120	20 min.	18pf typ. 25pf max.	0.8mμA typ. 10mμA max. (V_{CB}=60V)	1.0μA typ. 10μA max.	–
2N1711	3.0W	60V	7.0V	100-300	35 min.	25pf max.	10mμA max. (V_{CB}=50V)		10μA max.

FD100	WIV	P diss.	T_A	T_{stg}	I_R (V= –50V)	R_E (100 mc)
	50V	250mW	–65° to +175°C	–65° to +200°C	0.1μA	45%

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MEETINGS AHEAD

Jan. 16-18: American Astronautical Society, Annual; Sheraton-Dallas Hotel, Dallas.

Jan. 17-19: Instrument Automation Conf. & Exhibit, ISA; Sheraton-Jefferson Hotel, Kiel Auditorium, St. Louis, Mo.

Jan. 24-27: Society of Plastic Engineers, Annual; Shoreham and Sheraton-Park Hotels, Washington, D. C.

Jan. 31-Feb. 2: Cleveland Electronics Conference; Engineering and Scientific Center, Cleveland.

Feb. 1-3: Military Electronics, PGMIL of IRE; Biltmore Hotel, Los Angeles.

Feb. 1-4: Electronic Representatives Assoc., Annual Convention; Ambassador Hotel, Los Angeles.

Feb. 7-9: Electrical Manufacturers Assoc.; Veterans Memorial, Columbus, O.

Feb. 14-16: Nondestructive Testing of Aircraft and Missile Components, Southwest Research Institute, South Texas Section of the Society for Nondestructive Testing Inc.; Gunter Hotel, San Antonio, Tex.

Feb. 15-17: Solid State Circuit Conf., International, PGCT of IRE, AIEE; Univ. of Penn. & Sheraton Hotel, Philadelphia.

Feb. 17:21: Electronic Components Exposition, International, French Federation of Electronic Industries; Port de Versailles, Paris.

Feb. 20-25: Semiconductor Exposition, International, Societe Francaise des Electroniciens et Des Radio-Electriciens; Maison de L'Unesco, Paris.

Mar. 9-10: Engineering Aspects of Magnetohydrodynamics, PGNS of IRE, AIEE, IAS; University of Penn., Philadelphia.

Mar. 20-23: Institute of Radio Engineers, International Convention, All PG's; Coliseum & Waldorf-Astoria Hotel, New York City.

Mar. 21-22: Institute of Printed Circuits; Annual, New York City.

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In the Model CM-100, Mincom's latest instrumentation recorder/reproducer, the series elements

THE MINCOM CM-100

before data storage have been reduced to recorder and mixer only, one step from the antenna.

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With the CM-100's 1-megacycle response and constant phase equalization at all speeds, an original

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IF signal of 5.0 megacycles thus can be heterodyned so that the carrier swing and its sidebands

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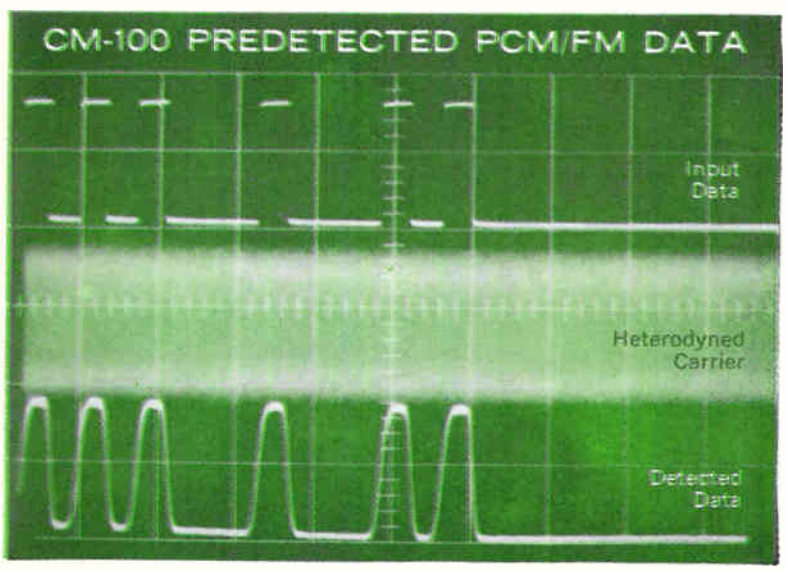
fall within the Mincom CM-100's frequency range – in FM, FM/FM modulation, PCM and PCM/FM.

...and actually doing it at defense facilities as you read this page.



5.0-mc IF carrier heterodyned down to 750 kc. Random-spaced pulses, 20 μs on-20 μs off-type information. Sweep rate: 50 μs/cm.

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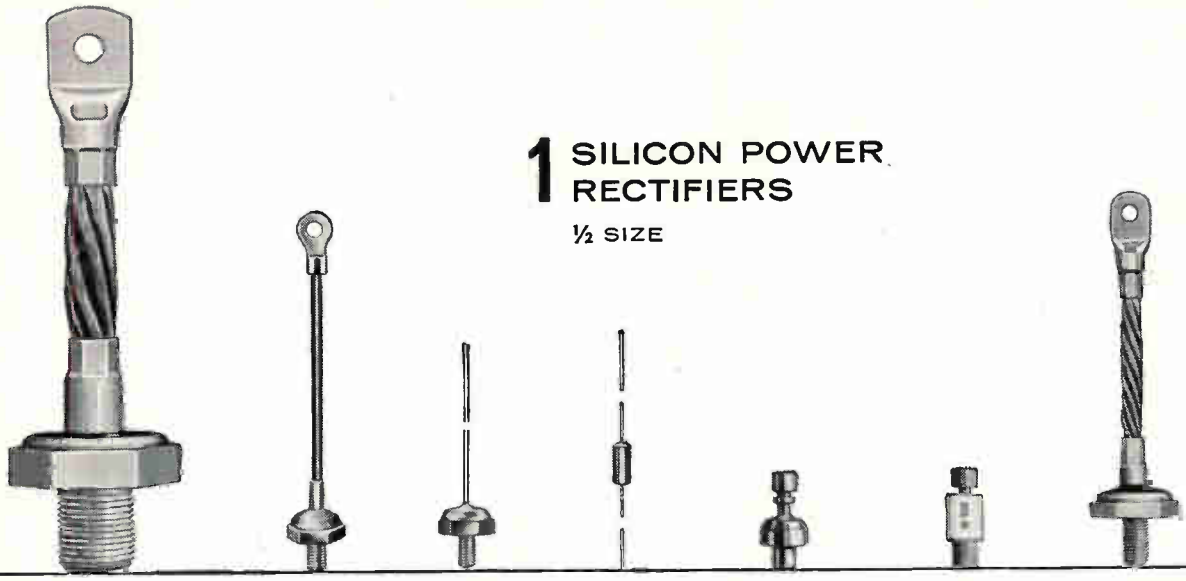
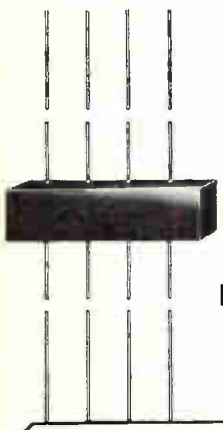


1 SILICON POWER RECTIFIERS

½ SIZE

Over 100 types for low, medium, and heavy current applications, with ratings from 150 ma to 1000 amperes; 50 to 2800 piv.



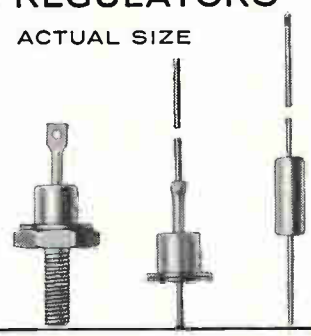
2 MODULAR SILICON RECTIFIERS

ACTUAL SIZE

For printed circuits or terminal strips—2, 3, and 4 section modules of 500 ma diodes, 100 to 600 piv.

3 SILICON VOLTAGE REGULATORS

ACTUAL SIZE



Over 90 units in three power classifications—¼, 1, and 10 watts; 5.6 to 100 volts breakdown.

4 HIGH VOLTAGE SILICON CARTRIDGE RECTIFIERS

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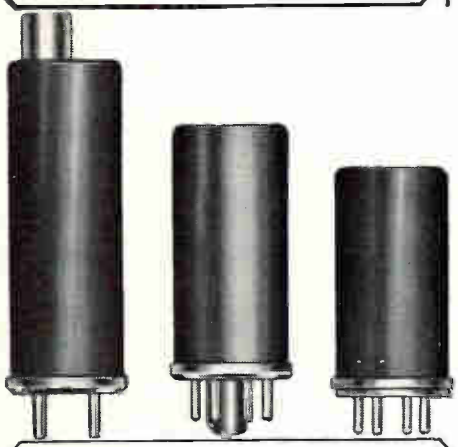
Ferrule mounted and axial lead series, each in 18 different types; 600 to 16,000 piv.



5 SILICON TUBE REPLACEMENT RECTIFIERS

½ SIZE

Nine standard tube replacement units directly interchangeable with more than 95% of all vacuum tube rectifiers; two full-wave replacement units for Citizen's Band radios. Special types on request.

In selecting and specifying these silicon rectifiers and voltage regulators, you can depend on Tarzian experience and ingenuity in manufacturing to deliver high performance devices at realistic prices in the quantities you require, whether for testing or full production.

Competent application engineering service is offered without obligation.

Catalogs and data sheets on all products are available, and will be sent promptly on request.

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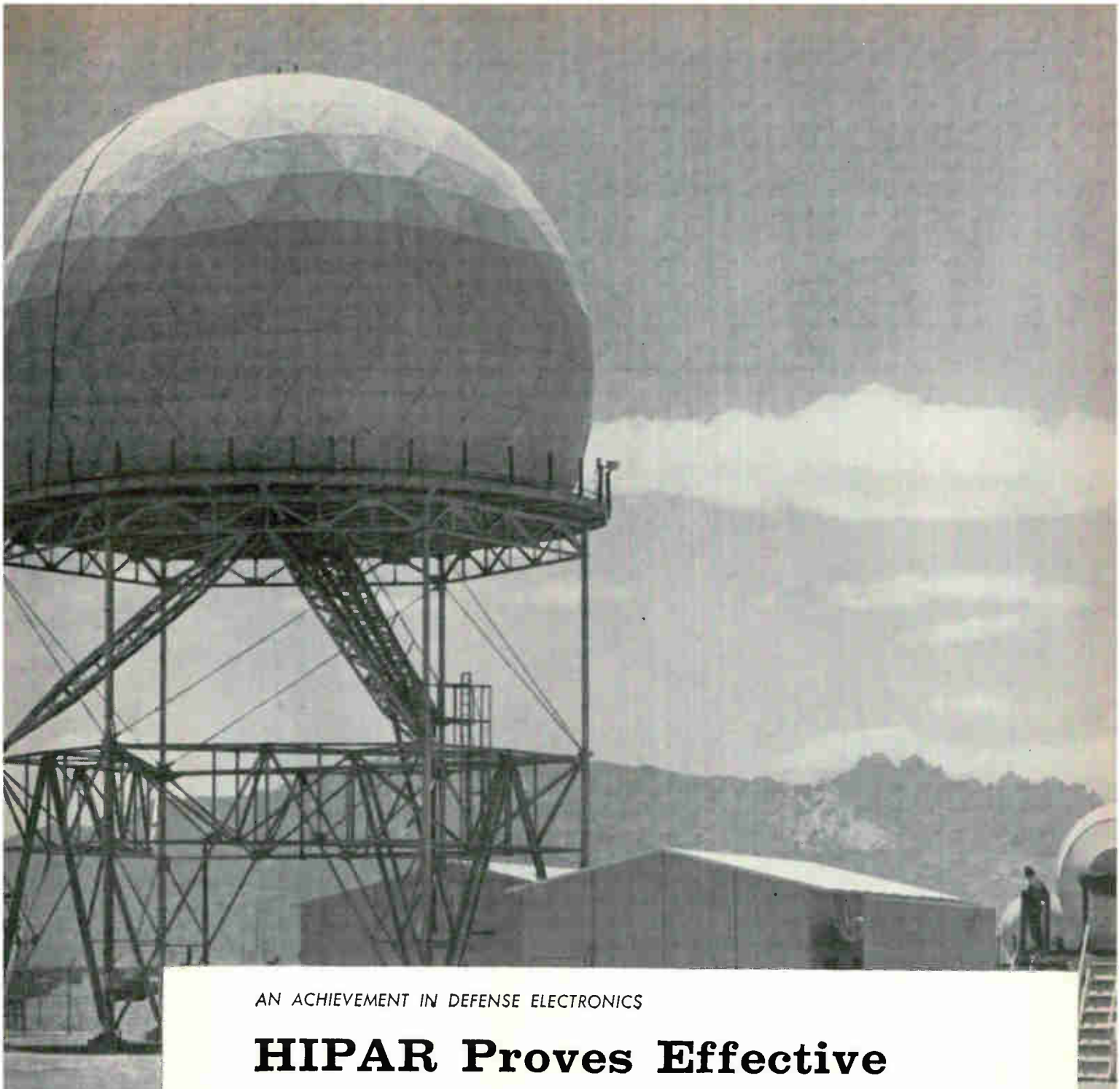
CIRCLE 43 ON READER SERVICE CARD→



AN ACHIEVEMENT IN DEFENSE ELECTRONICS

HIPAR Proves Effective In Hercules Anti-Missile Test

This new General Electric *High Power Acquisition Radar* (HIPAR) more than triples the detection capability of the U. S. Army's Nike-Hercules System. Produced for Western Electric, Nike-Hercules System Prime Contractor, this General Electric radar provides high resolution target data at long range and high altitudes on bomber and fighter aircraft, air-launched missiles and tactical ballistic missiles. The effectiveness of this Improved System was demonstrated at the White Sands Missile Range on June 3, 1960, with the successful intercept and destruction of a Corporal Missile, and in August and September, 1960, when target Nike-Hercules Missiles were destroyed by their defending counterparts at altitudes to almost 100,000 feet and closing speeds near Mach 7.

176-06

HEAVY MILITARY ELECTRONICS DEPARTMENT
DEFENSE ELECTRONICS DIVISION • SYRACUSE, NEW YORK

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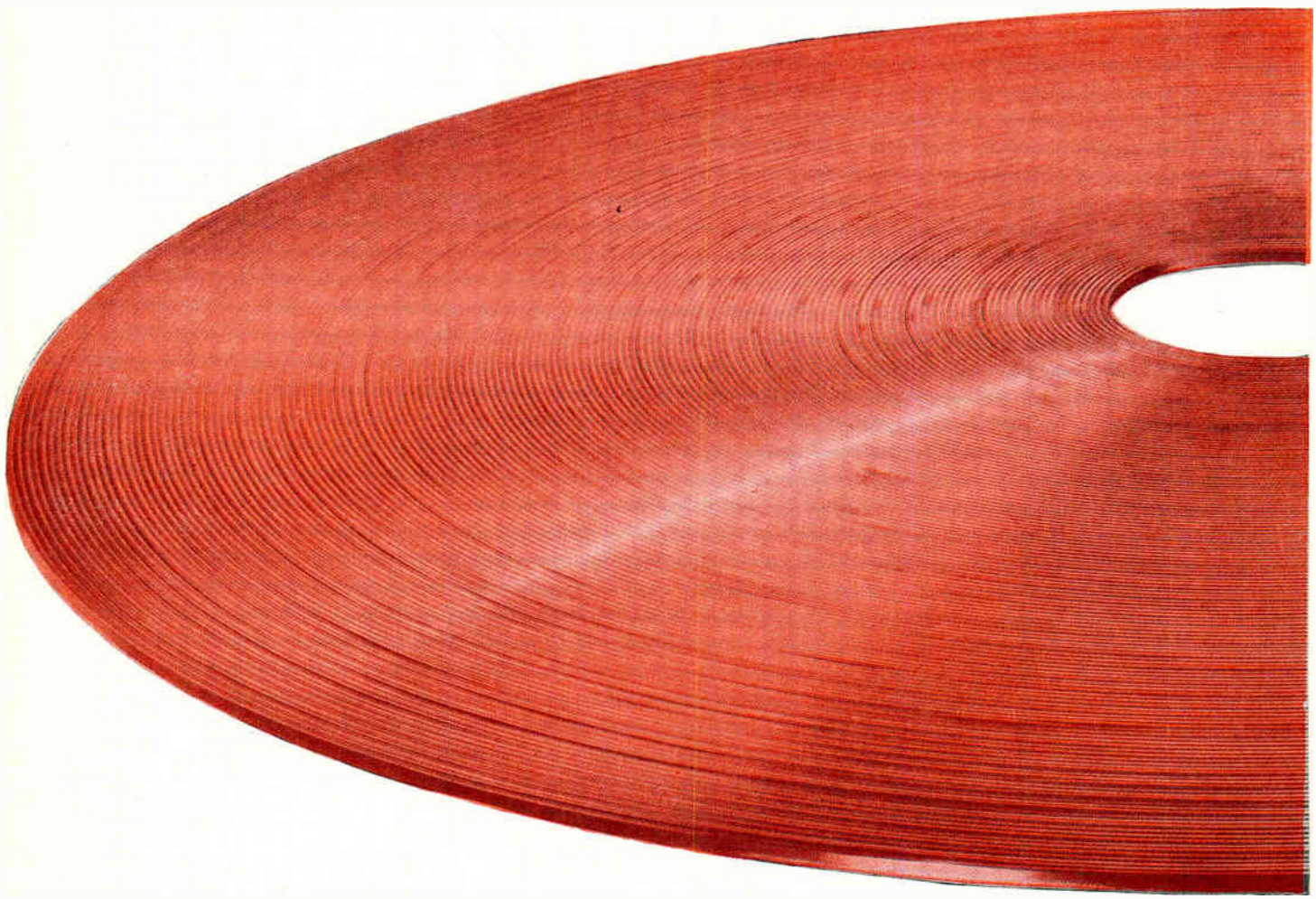


new CEMENT-COATED EPOXY magnet wire makes possible coils

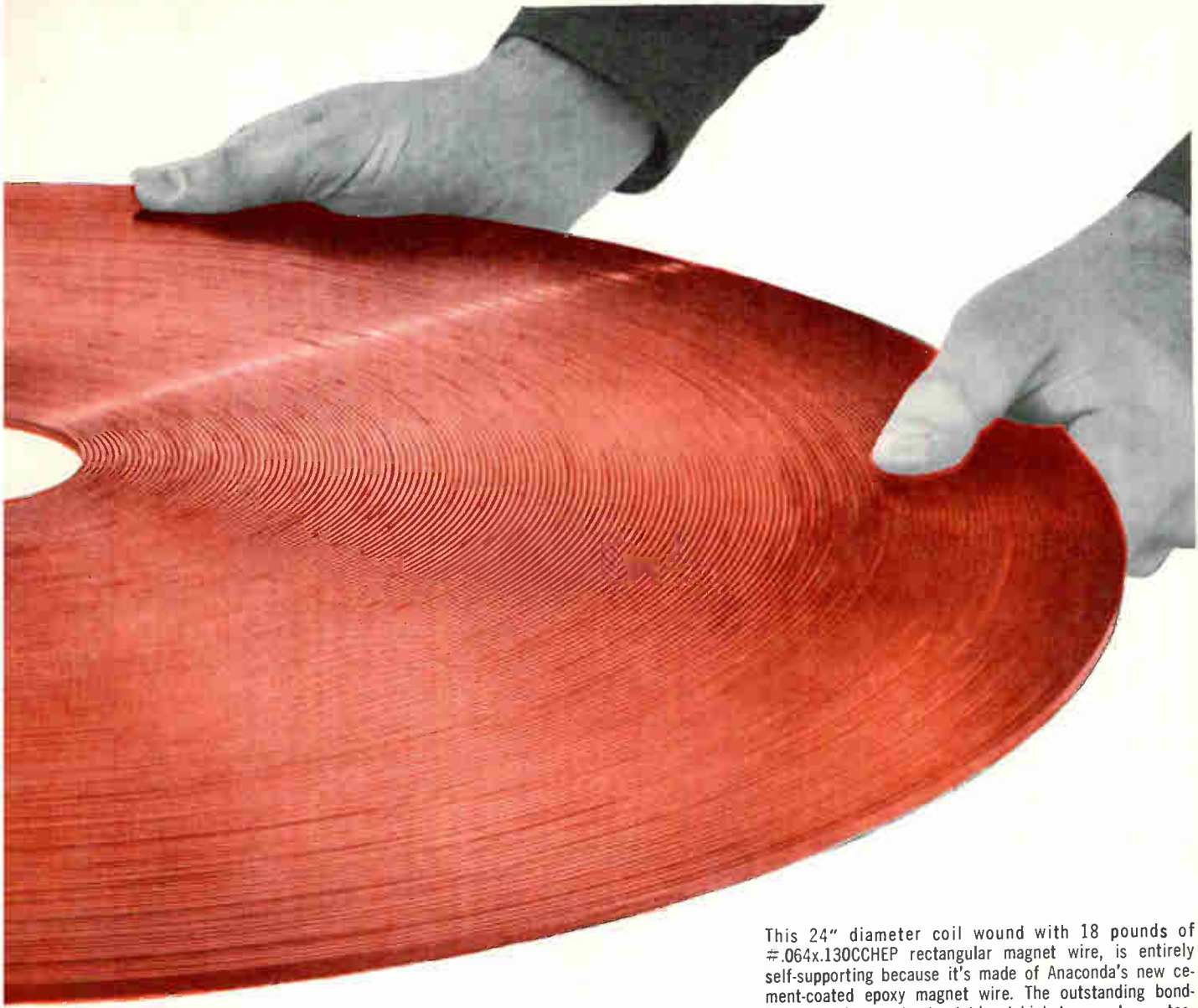
The secret's in the bond strength. Anaconda's new 130 C (class B) cement-coated epoxy magnet wire forms a bond so strong that the coil is completely self-supporting.

Cold, it holds its shape perfectly without ties or braces; hot, it can be removed from the oven at 200 C and dipped in encapsulating materials without deforming or losing its shape. Both ways you save on production costs. The cement can be activated by resistance heating, oven heating or solvent.

The unique Anaconda Epoxy cement coating makes all the difference. It softens just enough to bond each wire in the coil firmly to adjacent wires. The higher the heat (up to 200 C), the stronger the bond—it is a contact bond with minimum flow.

Because of its *inherent dielectric properties* and because of limited flow, the epoxy cement overcoat actually contributes to the electrical strength of windings. Thus, it is often possible to employ cement-coated epoxy film with little or no increase in over-all diameter of the wire.

And here are some other advantages: Anaconda cement-coated epoxy magnet wire won't hydrolize in closed systems because the cement is an epoxy type



This 24" diameter coil wound with 18 pounds of #.064x.130CCHEP rectangular magnet wire, is entirely self-supporting because it's made of Anaconda's new cement-coated epoxy magnet wire. The outstanding bond-strength of this wire is stable at high temperatures, too. Coils can be removed from oven and handled while still hot without danger of deforming—as shown in picture below.

that hold their shape without support ...both cold and hot...even at 200 C

and the base coat is Anaconda's well-proven epoxy enamel. It is completely compatible with standard transformer oils, varnishes, insulation and encapsulating materials you are most likely to use. It's available in all sizes of round, square and rectangular, packed in spools, reels, pails and drums.

For more information about Anaconda cement-coated epoxy magnet wire, contact Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York, Department EFL-2E.

ASK THE MAN FROM

ANACONDA®

FOR CEMENT-COATED EPOXY MAGNET WIRE 60257

CIRCLE 45 ON READER SERVICE CARD 45

Astropower, Inc. has been formed as a subsidiary of Douglas Aircraft Company with Mr. Y. C. Lee, internationally noted propulsion expert, as president.

In offering its services for research and development of advanced space propulsion systems to system contractors and government agencies, Astropower will operate as an independent company. The proprietary interests of major systems and sub-systems contractors will be respected and protected by both Douglas and Astropower.

A balanced engineering and research program is now being formulated to advance the state of the art in—

- Ultra-high energy propulsion systems in the nuclear, chemical and electrical fields
- Solid state devices and energy conversion equipment

Mr. Lee is now staffing key positions in Astropower, Inc. and will welcome inquiries from qualified engineers and scientists having advanced degrees in the areas of nuclear physics, plasma physics, solid state physics, thermodynamics and high temperature materials.

Astropower's permanent scientific and engineering center will be located in one of Southern California's ideally situated research communities.

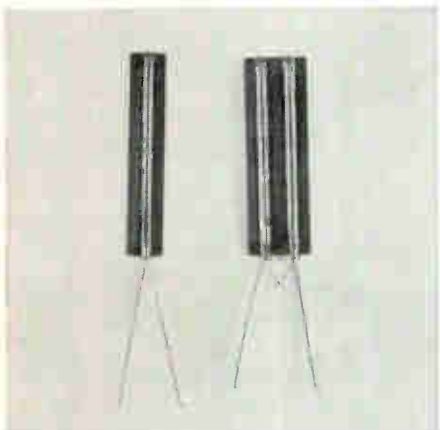
ASTROPOWER, INC.

Temporary headquarters: 3801 Lakewood Boulevard, Long Beach, California

Microdot Acquires Micro-Test

Los Angeles — Microdot Inc. has entered the field of strain measurement devices through the acquisition of Micro-Test, Inc. of Santa Monica, California. Through this move, Microdot will manufacture and market the only weldable strain gage in the U.S. — a device that is capable of continuous operation at 800°F and dynamic test to 1500°F.

The weldable strain gage, used extensively in missile, space, and atomic projects, will be integrated with Microdot's existing pressure, force, and acceleration measurement capabilities.



Weldable strain gages, one-piece, etched wire filaments in swaged stainless steel tubes, are suitable for use from cryogenic to elevated temperatures. Photo shows typical gages in actual size.

The Micro-Test acquisition is in line with other current moves by Microdot to enhance and broaden the company's instrumentation capabilities. Other Micro-Test products to be offered by Microdot include: temperature sensors in 60 and 120 ohm resistances that are completely insensitive to strain, and hermetically sealed load cells with adjustable temperature sensitivity offered in ranges of from 5,000 to 50,000 pounds for both compression and tension-compression.

Microdot sees great potential for the application of these new devices wherever physical phenomena can be measured and controlled. The weldable strain gage is already being used in atomic reactors, the exterior of submarines, inside chemical vats, on pilings sunk into the St. Lawrence Seaway, and a wide variety of airborne defense projects.

MICRODOT INC.

220 Pasadena Ave.
South Pasadena, California

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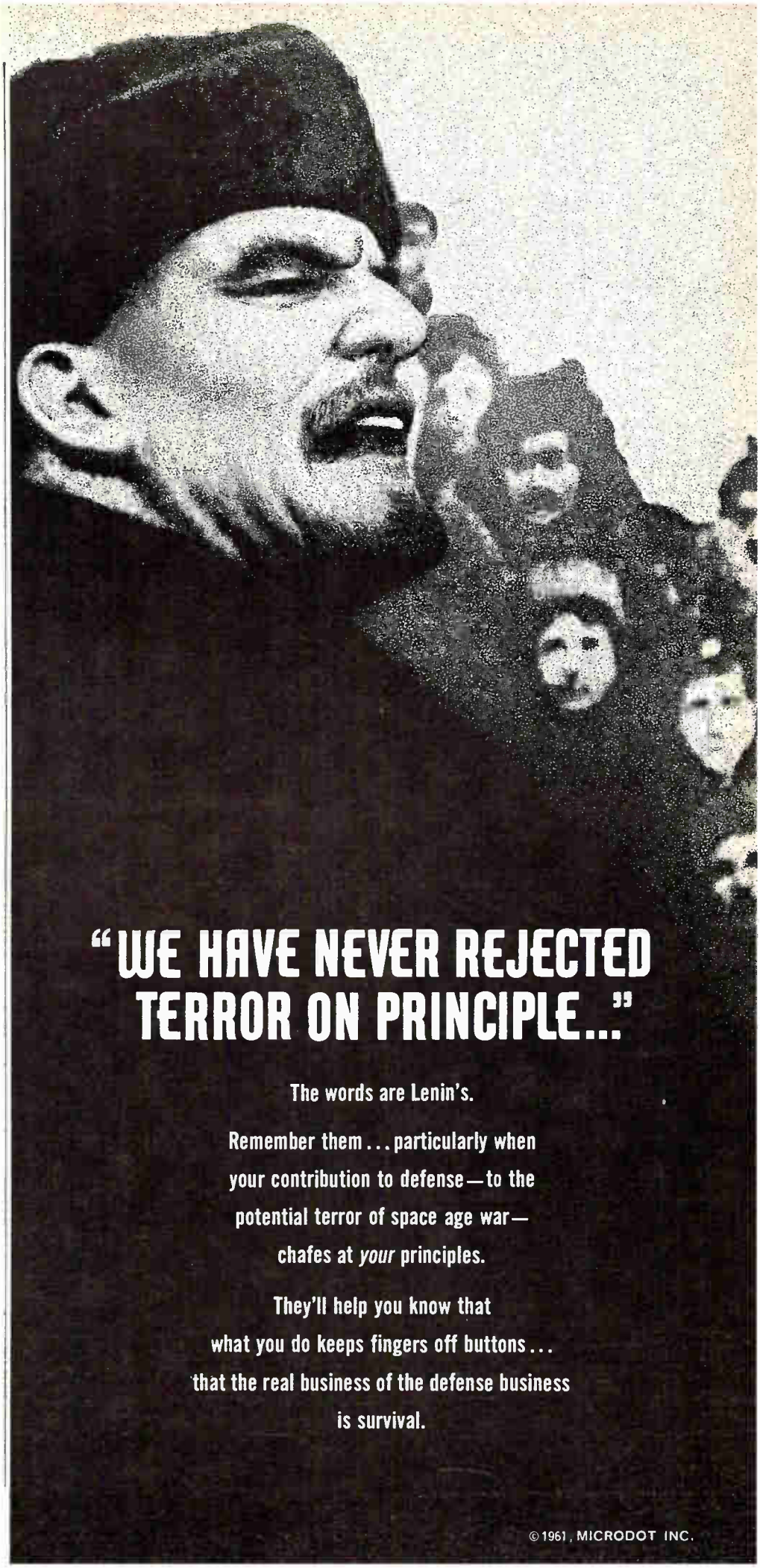

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WESTON Model 901 Group
Now better than ever

Weston's matched line of Model 901 portables are well known for sustained accuracy and dependability under general test conditions. This modern group of AC and DC multi-range instruments consists of ammeters, voltmeters and wattmeters covering a wide range of measurement.

Designed for critical use, the Model 901 DC series is now accurate to 0.25%. Hand-calibrated mirror scales are combined with knife edge pointers to eliminate parallax errors. Widely-spaced markings on 5.5-inch long scales facilitate readability. The Model 904 AC series is now stocked in multi-range, frequency-compensated versions only.

Excellent for field use, these portables are housed in rugged plastic.

Other features include wide, shadow-reducing windows which are specially treated against electrostatic effects, and self-shielded mechanisms that offer positive protection against external magnetic influences.

Call your Weston representative for complete information, or write for Catalog 06-203. Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey. *International Sales Division, 100 Empire St., Newark 12, New Jersey. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.*

Weston Model 901 Group consists of: Model 901 DC Instruments; Model 904 AC Instruments; Model 902 AC Rectifier-Types; and Model 905 AC and DC Single Phase Wattmeters. Protective leather carrying cases are available for all models.

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STACKPOLE

EL34 6CA7

25W output pentode

Output pentode rated for 25W anode dissipation, intended for use in a.c. mains operated equipment.

Characteristics

V_a	250	V
V_{g2}	250	V
V_{g3}	0	V
I_a	100	mA
I_{g2}	15	mA
V_{g1}	−12.2	V
g_m	11	mA/V
r_a	15	kΩ
μ_{g1-g2}	11	

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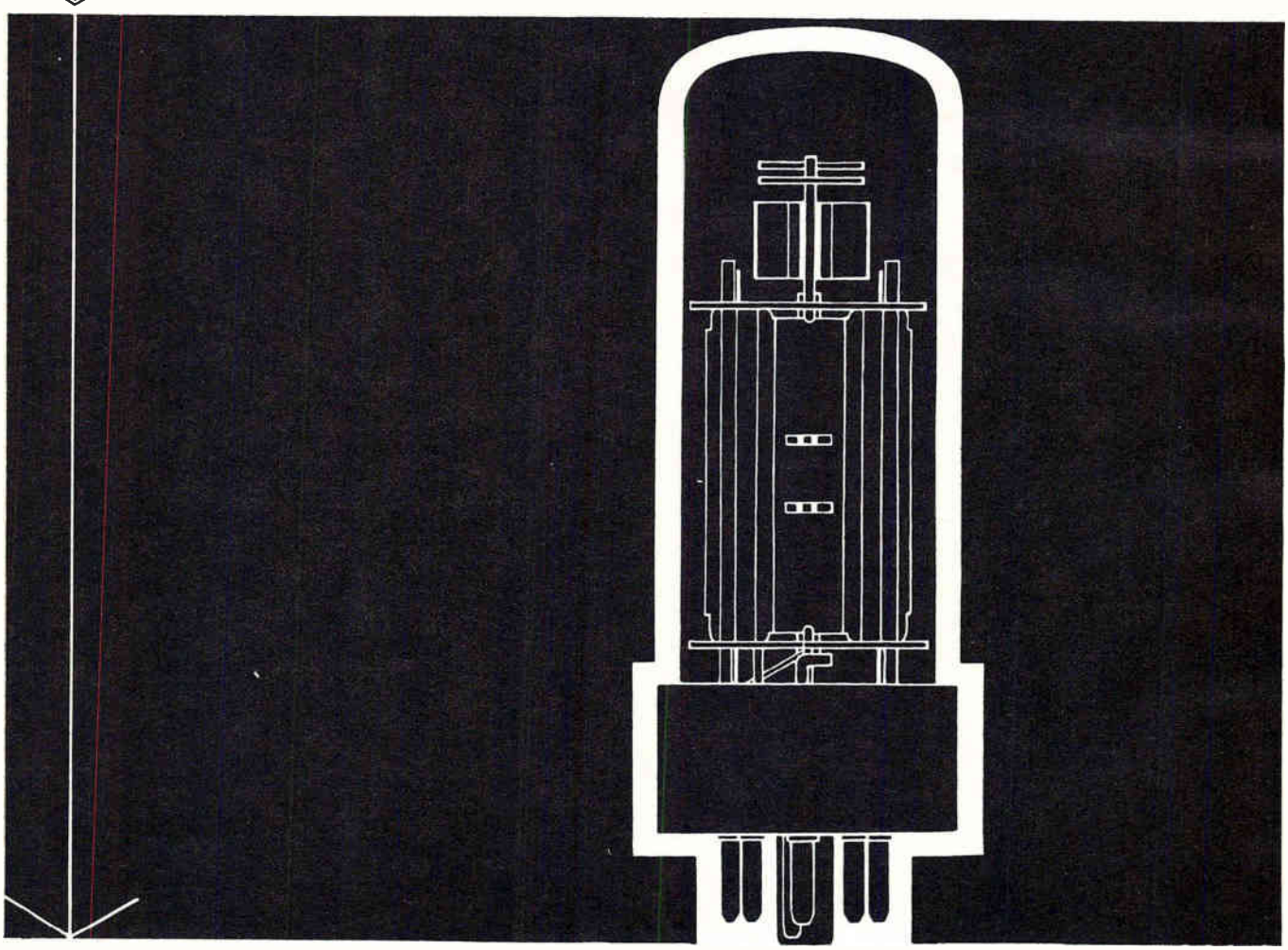


BRITAIN'S FIRST CHOICE FOR FIRST EQUIPMENTS

Mullard ELECTRONIC TUBES

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

MEV 104

Now...12-Nanosecond Total Switching Time with CBS MADT* Transistors

Total switching time for typical CBS 2N501 and 2N501A transistors in this circuit is less than 12 nanoseconds. The basic circuit can readily be cascaded to form fast-switching ON and OFF stages for computers. Since the transistors have a high gain-bandwidth product at only -3 collector volts, the size and cost of your power supply can be substantially reduced.

The economical CBS 2N501 and 2N501A also offer a wide choice of design possibilities in other fast-switching circuits. Consult the table for high switching rates permitted in the variety of circuits shown.

Order engineering samples for your prototype design. Call or write for technical data and delivery information, today, from your local sales office or Manufacturer's Warehousing Distributor.

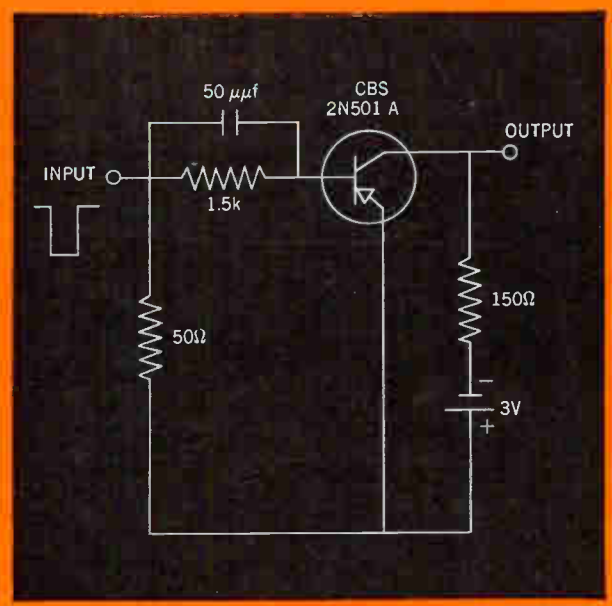
Wide Choice of Fast Switching Circuits
With CBS 2N501 and 2N501A

Logic Circuits	*Switching Rate*
Special non-saturating	140 mc
Emitter follower coupled	140 mc
Base gating	140 mc
Transformer coupled pulse	140 mc
Diode transistor logic (DTL)	20 mc
Resistor capacitor transistor logic (RCTL)	20 mc
Direct coupled transistor logic (DCTL)	7 mc
Resistor transistor logic (RTL)	1 mc
Pulse Generators & Shaping Circuits	
Blocking oscillators	10 mc
Regenerative amplifiers	10 mc
Schmidt trigger circuits	10 mc
Monostable multivibrators	5 mc
High Current Pulse Amplifiers†	
Line drivers	10 mc
Core drivers	10 mc
Read-write amplifiers	10 mc

†Switching current, 35 ma.

*Micro Alloy Diffused-base Transistor, trade-mark, Philco Corp.

Semiconductors for Computer Circuitry



IN THIS NEW CIRCUIT, CBS 2N501 and 2N501A transistors achieve delay, rise, storage and fall times of 2.0, 3.7, 3.2, and 2.3 ns respectively.

CBS ELECTRONICS, Semiconductor Operations,
Lowell, Mass. • A Division of Columbia Broadcasting System, Inc.
Semiconductors • tubes • audio components • microelectronics

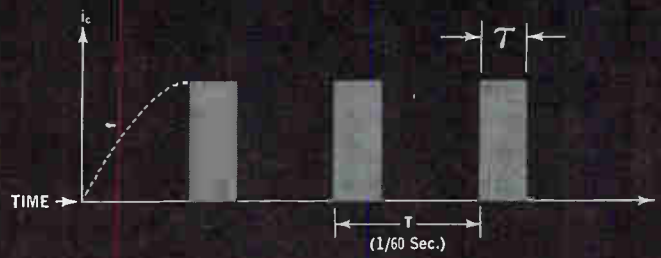
Sales Offices: Lowell, Mass., 900 Chelmsford St., GLenview 2-8961 • Newark, N. J., 231 Johnson Ave., TAlbert 4-2450 • Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAymond 3-9081 • Minneapolis, Minn., The Heimann Co., 1711 Hawthorne Ave., FEderal 2-5457 • Washington, D. C., 1735 Desales St., N.W., EMerson 2-9300 • Dayton, Ohio, 39 North Torrence St., CLearwater 2-1972 • Toronto, Ont., Canadian General Electric Co., Ltd., LEnnox 4-6311.

CBS semiconductors®

More Reliable Products through Advanced Engineering

New B/A Model NC-1

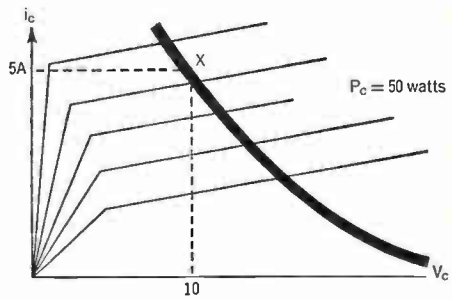
TESTS POWER TRANSISTORS BY VARYING DUTY CYCLE



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

EXAMPLE

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



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

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

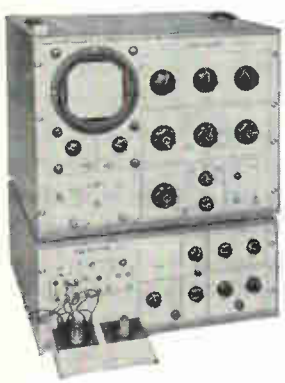
For the current pulses 100 μsec. wide at 1/60 Sec. repetition, the average power is:

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

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

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

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



CURVE TRACER MODEL MW-1

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

B A

BAIRD-ATOMIC, INC.

33 University Road, Cambridge 38, Mass.

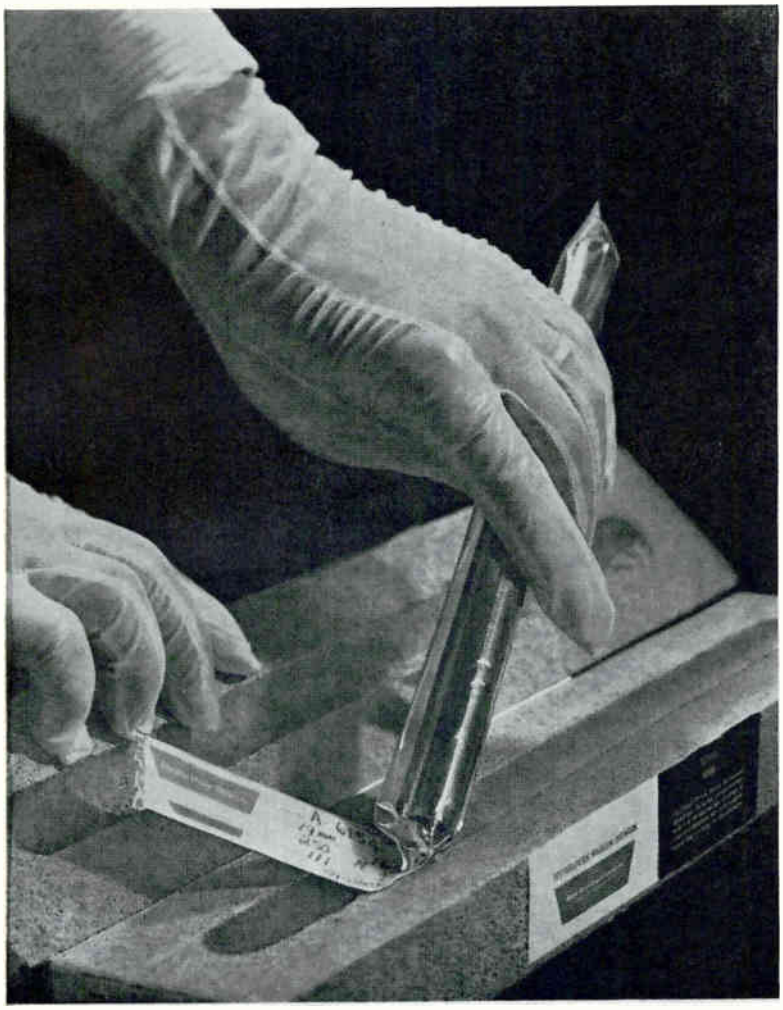
BAIRD-ATOMIC HAS THE MOST COMPLETE LINE OF TRANSISTOR TEST EQUIPMENT

SILICON NEWS from Dow Corning

(PART 2)

The Untouchables

Single Crystal Silicon... the "Pinnacle of Purity"



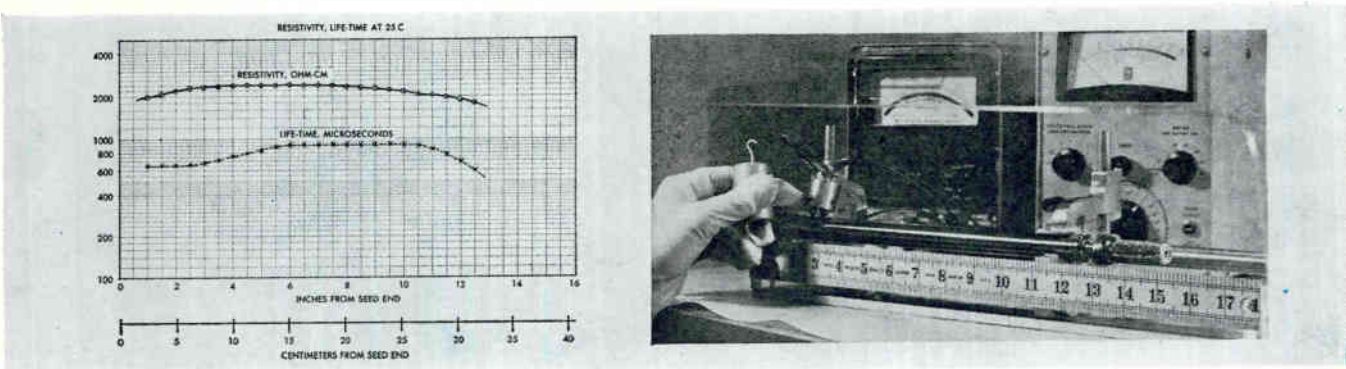
Dow Corning single crystal silicon is produced by vacuum zone refining hyper-pure polycrystalline rod. Result: The purest silicon produced! Typically, impurity content is only 0.15 part per billion of boron for crystals that are consistently above 1000-ohms centimeter resistivity. Boron content is even lower for crystals of 2000-ohms centimeter and above . . . available on a selective basis.

This highest purity P-type silicon is the result of a completely integrated processing facility that starts with the production of trichlorosilane and ends with the crystals heat-sealed in airtight polyethylene envelopes. Purity and quality control dominate every step — in producing the basic chemicals . . . in growing polycrystalline rod . . . in vacuum zone refining . . . in product evaluation and in packaging.

Purity pays off . . . in rectifiers and diodes having higher peak inverse voltage ratings — in maximum utilization because of uniform lateral and radial profiles over the entire length of the rod. With Dow Corning single crystal rod, you're assured of maximum yield and minimum waste per rod. Rod diameter variation is controlled to less than 1.4 mm (0.055 inches)— simplifying mechanical preparation for either the diffusion or alloying process.

Hyper-pure silicon for every need is now available from Dow Corning. If you grow your own crystals from polycrystalline chunk using the Czochralski method . . . if you zone refine polycrystalline rod . . . if you need 1000-ohm centimeter or better resistivity in single crystal P-type — Dow Corning should be on your preferred source list.

Each Dow Corning single crystal rod is checked for resistivity over its entire length. Resistivity and lifetime profiles, like those shown below, are supplied with each crystal.



Write for "Hyper-Pure Silicon for Semiconductor Devices." Address Dept. 3513a.

HYPER-PURE SILICON DIVISION
Address: HEMLOCK, MICHIGAN

Dow Corning CORPORATION
MIDLAND, MICHIGAN
ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

. . . Specify Silicones

For Constant Capacitance

Dow Corning silicone fluids are, in themselves, excellent dielectrics. In capacitors and RF filters, silicone fluids boost the performance of the paper dielectric . . . substantially increase permissible operating temperatures, decrease electrical losses. Highly stable to changing environments, silicones show little drift in electrical or physical properties over a broad range of temperature and frequency conditions . . . often eliminate costly compensating circuit. To assure an almost constant capacitance vs. temperature relationship for their specialty capacitors . . . and the lowest possible power factor for their RF interference filters . . . The Filtron Co., Inc., of Flushing, N. Y., impregnates their RF interference filters and capacitors with Dow Corning silicone fluid.

CIRCLE 290 ON READER SERVICE CARD

Silastic RTV Packages . . . Protects

Built by Vitro Laboratories, Silver Spring, Md., this preamplifier consists of a vacuum tube and three transistor stages containing a total of twenty-five parts. Design specifications called for a package no larger than 1-7/16" diameter by 5" . . . plus operating requirements of high insulation strength, heat stability, resistance to shock, vibration and moisture. These were met conveniently and easily by mounting the components on a printed circuit board, encapsulating the unit with Silastic® RTV, the Dow Corning room-temperature vulcanizing silicone rubber.

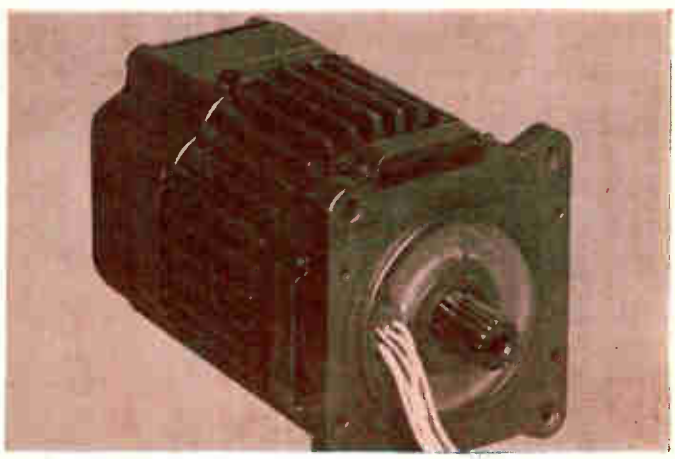
Silastic RTV is poured over the unit until the mold is completely filled. It exerts a firm grip on components, eliminating clamps and brackets . . . soaks up shock and vibration, dissipates heat, locks out moisture.

CIRCLE 291 ON READER SERVICE CARD

To Save Space . . . Cut Weight

Airborne Accessories Corporation, Hillside, N. J., uses a variety of miniaturization techniques in designing power drives for actuators and other devices. One of their most important tools in making smaller, more reliable drive motors is silicone insulation, including Dow Corning Silicone Varnish impregnation. Its use on these high performance motors assures utmost reliability under almost continuous on-off-reverse operation . . . helped designers provide up to 50% more power per pound.

This 400-cycle silicone insulated actuator motor has a 4.25 inch frame, weighs only 13.2 pounds with brake, is rated 2.5 hp, 11,000 rpm continuous duty; to 6 hp, 9,000 rpm intermittent duty.



CIRCLE 292 ON READER SERVICE CARD

CORPORATION MIDLAND, MICHIGAN

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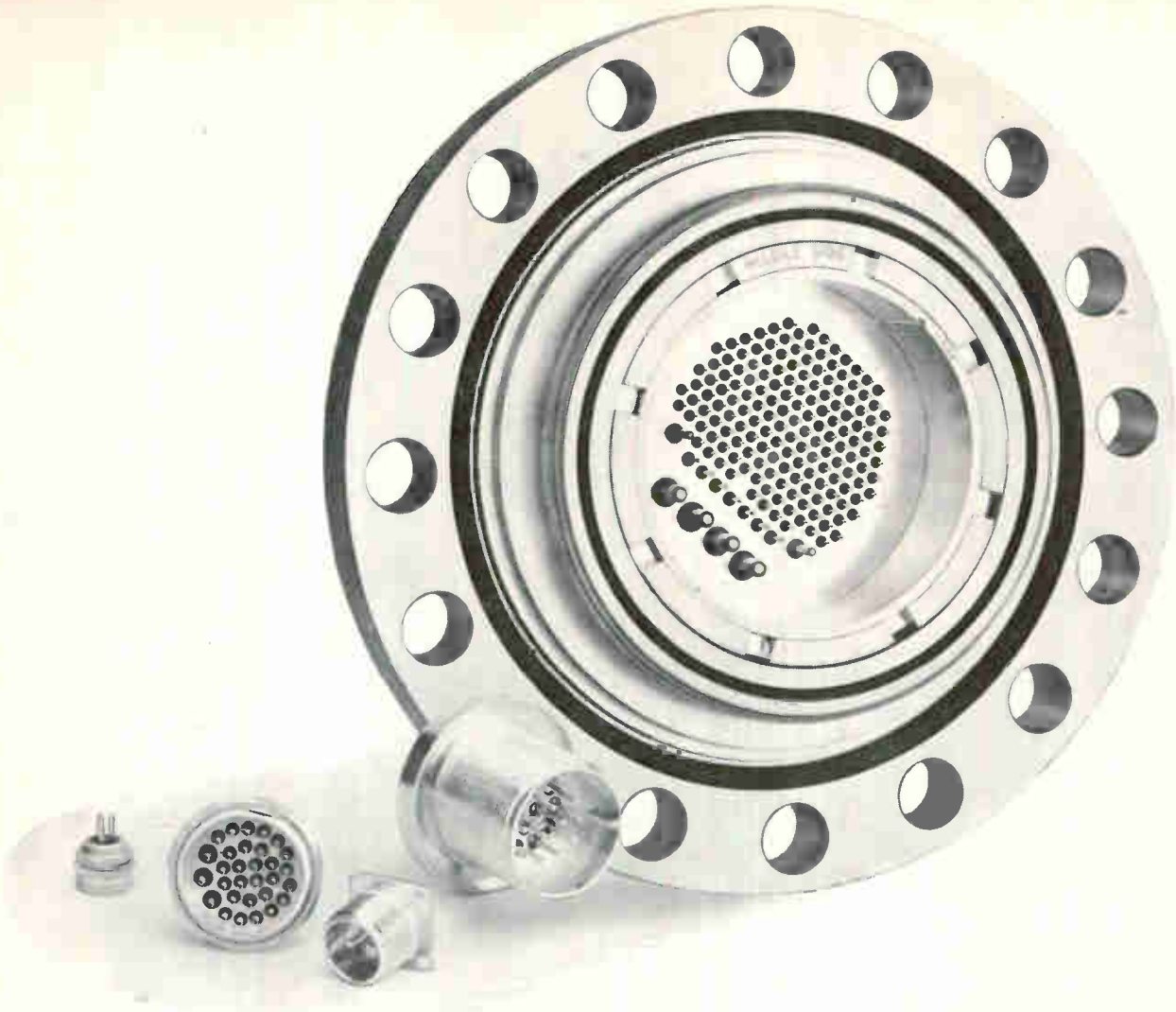


CANNON HERMETICALLY SEALED PLUGS

INCLUDING THE ONLY SERIES APPROVED TO MIL-C-25955! Cannon Hermetic Seals meet low leakage rate requirements under the most extreme pressures and environments. The Cannon KH Series are the *only* approved receptacles to MIL-C-25955, which requires leakage rates of less than .001 micron cubic foot per hour (1.5×10^{-8} cc/sec). Our Phoenix Plant is staffed with hermetic seal specialists—combines in one location every phase of engineering, manufacturing, and testing to produce hermetically sealed plugs with the highest standard of performance in the industry. Hermetically sealed receptacles are available for most popular plug lines... with some series designed to withstand intense thermal shocks—temperatures from –100°F to 1000°F—pressures above 2000 psi!

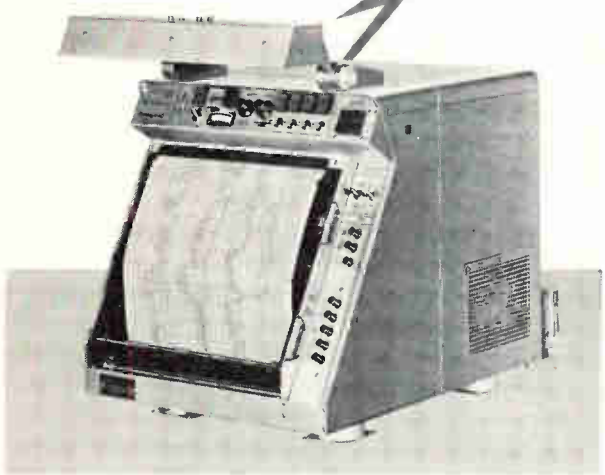
Our standard receptacles are available from Authorized Cannon Distributors. For complete information on the standards or custom designs write to:

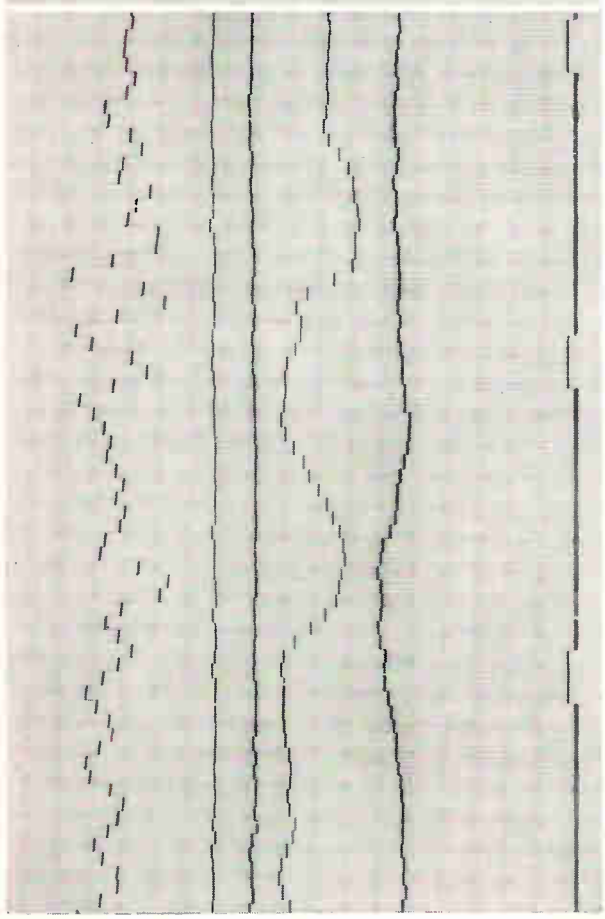
CANNON PLUGS

CANNON ELECTRIC COMPANY, 3208 Humboldt Street, Los Angeles 31, Calif.

CIRCLE 61 ON READER SERVICE CARD

Tracking a Surveillance Drone with the Visicorder





Record shown ¼ actual size.

Drone surveillance and reconnaissance gives U.S. Army combat units a high-altitude vantage point with much broader horizons from which to view battlefield action and terrain.

If effective use of the data gathered by the drone—the "eye in the sky"—is to be made, accurate instruments have to be on hand to monitor the drone's position and movement, its operational behavior and its response to flight commands. Telemetry supplies the radio link which transmits all this behavior information to a thoroughly-instrumented mobile tactical command post developed by Tele-Dynamics Division of American Bosch Arma Corp.

The Honeywell Model 1012 Visicorder has been selected as the direct readout unit in the Tele-Dynamics Drone Surveillance Telemetry system. In use with its companion instrumentation, the 36-channel Visicorder simultaneously displays the 22 channels of information required to track a drone, plus the timing traces.

In the Tele-Dynamics van, which serves as a tactical command post, the Visicorder provides both an instant "quick look" and a permanent record of the drone's operational parameters.

Signals are transmitted over a single channel by time-multiplexing. Signal and battery strength, engine speed and temperature, pitch and roll commands, altitude, airspeed, attitude (pitch and roll), yaw, acceleration (horizontal and vertical), and angle of attack are recorded by the Visicorder, along with three separate records of vibration.

Like the other units of the Tele-Dynamics system, these Honeywell Visicorders are built for rugged service . . . to deliver the data . . . when the drone is up and the chips are down.

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration of how a Visicorder Oscillograph will save you time and money in data acquisition. OEM inquiries invited.

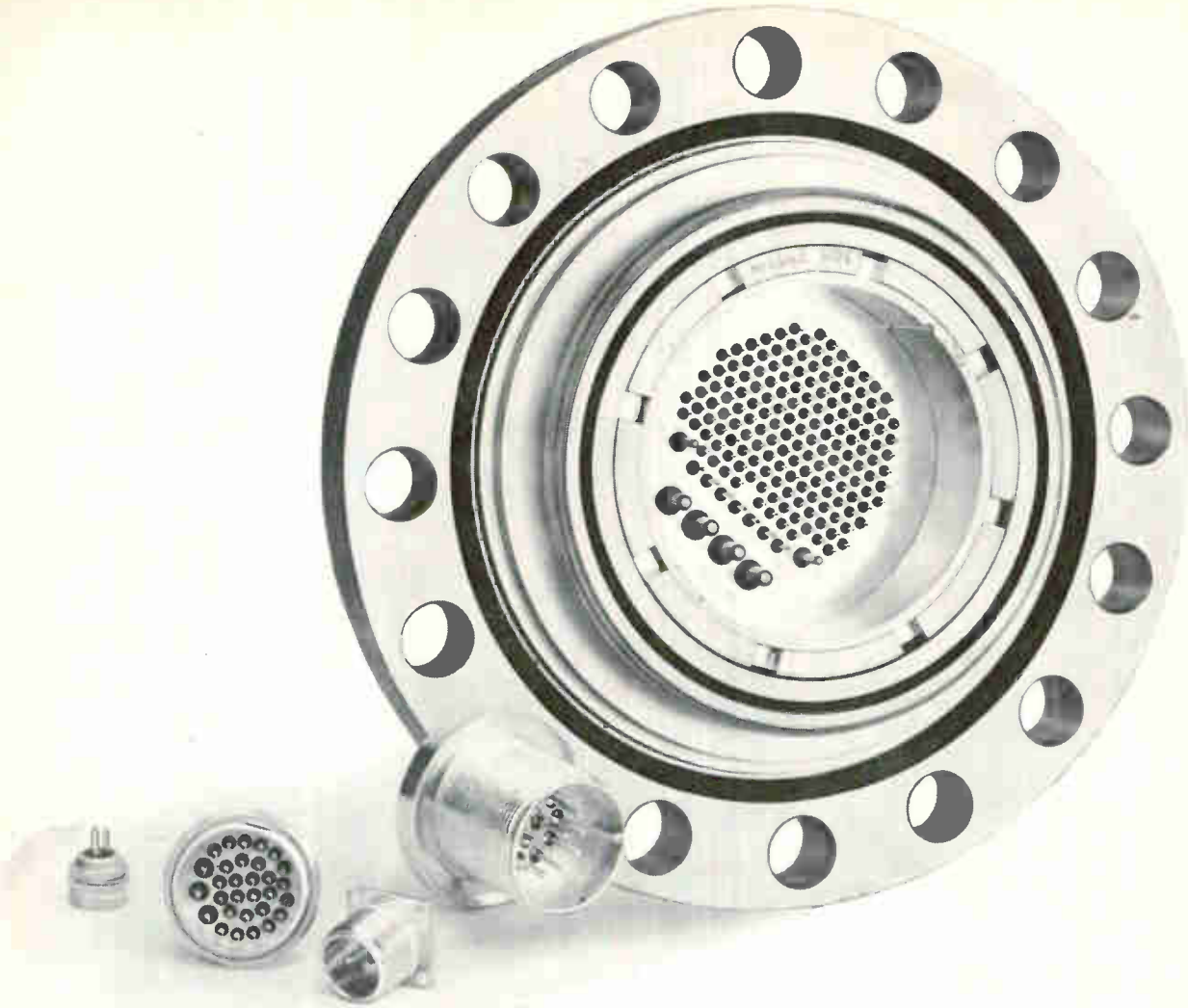
Reference Data: write for bulletins 906, 1012, 1108 and 1406.

Minneapolis-Honeywell Regulator Co.
Industrial Products Group, Heiland Division
5200 E. Evans Avenue, Denver 22, Colorado

Honeywell

H HONEYWELL Industrial Products Group

HONEYWELL INTERNATIONAL *Sales and Service offices in all principal cities of the world.*



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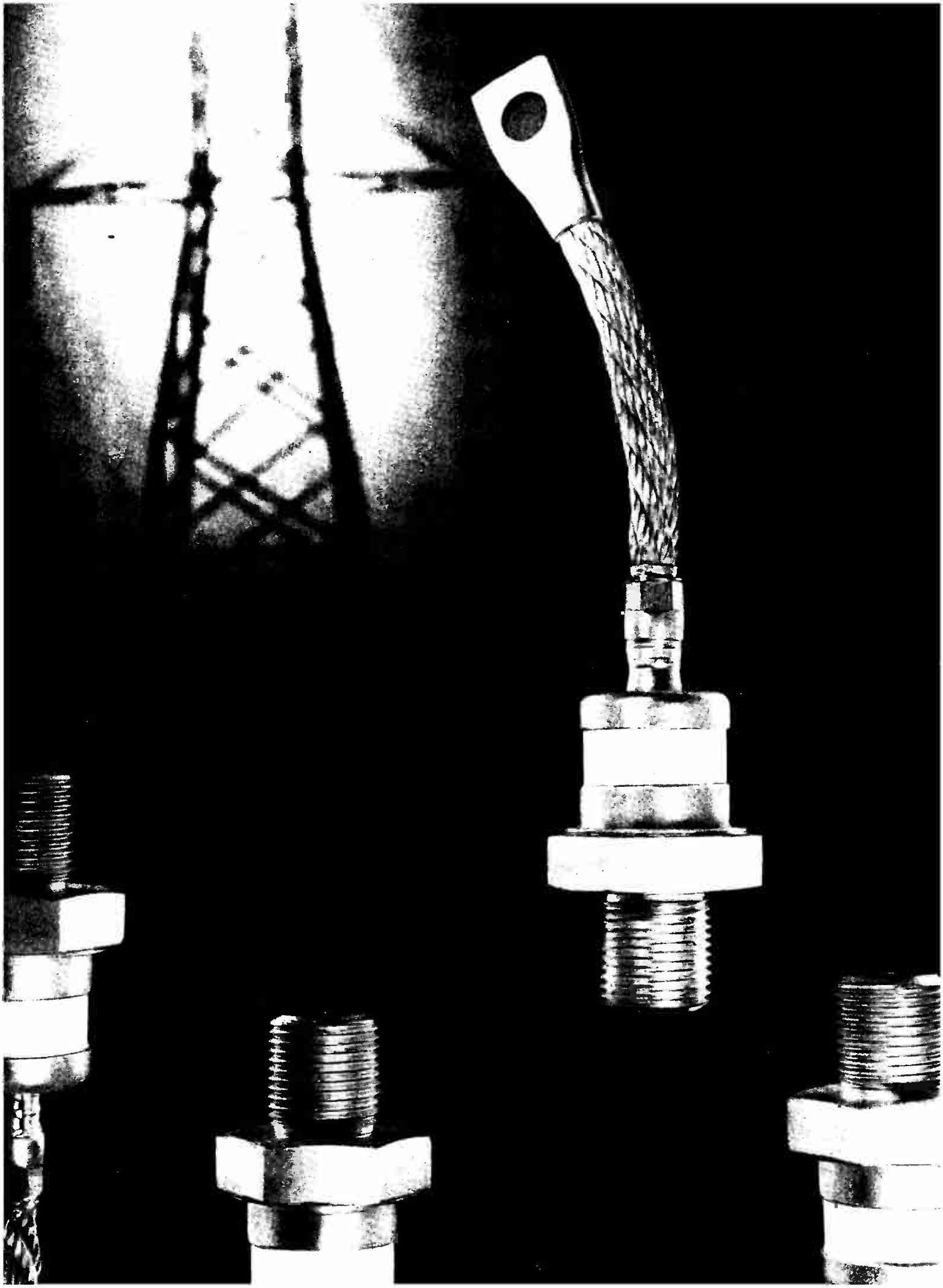

New high power silicon rectifier cells

Ratings to 600 volts... Currents to 240 amps!

Designed specifically for high-power applications, this new Type 439 Westinghouse rectifier cell features a peak reverse voltage rated at 600 volts. Another Westinghouse exclusive is the fused ceramic-to-metal construction that is hermetically sealed for extra reliability, extra ruggedness, extra-long life. Other features include:

- **Lightweight (8 oz.), small size**
- **Hard soldered connections**
- **Junction temperatures to 190°C.**
- **No thermal fatigue**

High current, high voltage applications include: Electro-chemical refining / Plating / Elevators / Cranes / D-C motors / Battery chargers / Railway traction / Welders.

For more information, call your nearest Westinghouse representative or semiconductor distributor. Or write: Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Penna.

When it comes to semiconductors . . . **you can be sure . . . if it's Westinghouse.** SC-1010

Westinghouse

For immediate "off-the-shelf" delivery, order from these Westinghouse Distributors:

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CIRCLE 61 ON READER SERVICE CARD

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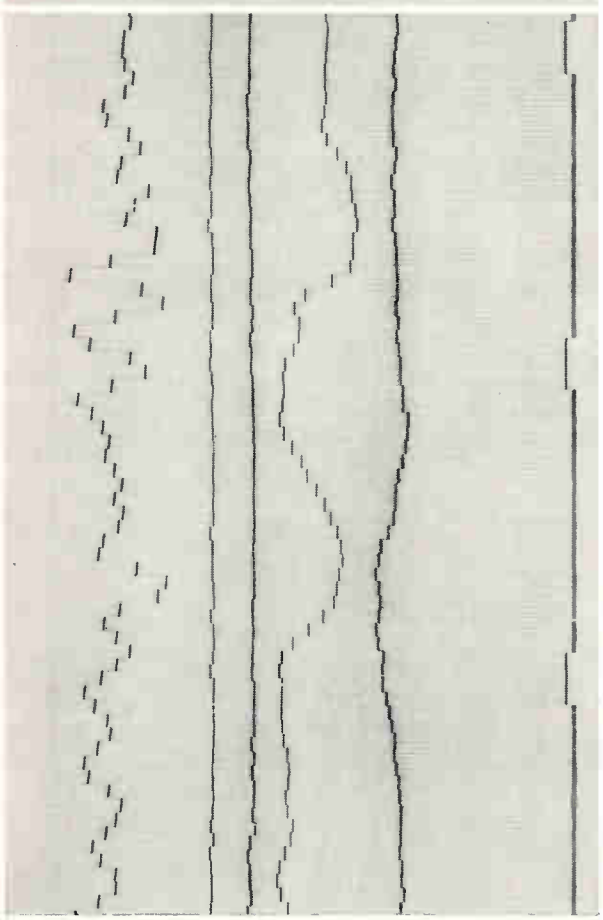

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Honeywell

H Industrial Products Group

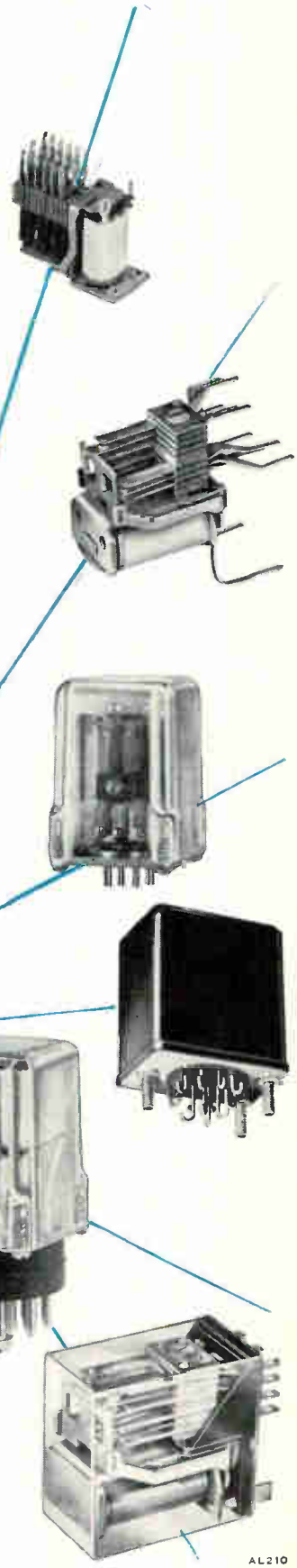
HONEYWELL INTERNATIONAL *Sales and Service offices in all principal cities of the world.*

Astounding Performance

Allied's Line of

Military and Commercial

"Cradle" Relays



Life in the hundreds of millions

Small size and weight • Low level up to 5 amperes • Sensitivity from 50 milliwatts • Up to 6-pole double-throw • Sealed, open or dust cover • Plug-in, printed circuit or solder type terminals • Stocked throughout the country • Amazingly low cost • *Write for our complete new 4-page Cradle Relay Bulletin.*

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC.
2 East End Avenue, New York 21, N. Y.

1N821A
1N823A
1N825A
1N827A

6.2 volt temperature compensated reference diodes

15 14 13 12 11 10 OHMS MAXIMUM

8 OHMS TYPICAL

ELECTRICAL CHARACTERISTICS (At 25°C Ambient unless otherwise specified)					
TYPE	V_z Zener Voltage at I_{zt} = 7.5 mA Volts	Z_{zt} Max Dynamic Impedance at I_z = 7.5 mA Ohms	Voltage Temperature Coefficient (−55°C — +100°C) at I_z = 7.5 mA %/°C	Max Millivolt Change at I_z = 7.5 mA −55°C to +25°C	Max Millivolt Change at I_z = 7.5 mA +25°C to +100°C
1N821A	5.9 — 6.5	10	0.01	50	46
1N823A	5.9 — 6.5	10	0.005	25	23
1N825A	5.9 — 6.5	10	0.002	10	9.2
1N827A	5.9 — 6.5	10	0.001	5	4.6

NEW LOW IMPEDANCE ZENERS from MOTOROLA

minimize voltage fluctuations due to current changes

Motorola brings you dramatically increased stability with this new series of 6.2 volt temperature-compensated zener diodes. Their typical dynamic impedance of 8 ohms is nearly half that of presently available units . . . greatly minimizing voltage fluctuation due to current changes.

The Motorola 2N821A series makes ultra-stable reference sources possible for many precision applications which now require complex constant-current circuits. They are ideal for digital voltmeters, high-stability oscillators, analog to digital converters and similar applications.

The new units are housed in DO-7 axial-lead glass packages and cost no more than conventional 1N821-7 types.

SUBMINIATURE 8.4 VOLT ZENERS NOW AVAILABLE — Motorola is now supplying 8.4 volt temperature-compensated zeners in DO-7 axial-lead glass packages. The new 1N3154A series is less than 1/5 the size of equivalent diodes now in use.

IMMEDIATELY AVAILABLE — All of these new Motorola temperature-compensated zeners are available at factory OEM prices in quantities from 1 to 99 . . . from your Motorola Semiconductor Distributor.

FOR COMPLETE TECHNICAL INFORMATION on the 1N821A series and the 1N3154A series, as well as the 1N821 and 1N3154 series, write for # DS 8001 and # DS 8002. Please address inquiries to MOTOROLA SEMICONDUCTOR PRODUCTS INC., Technical Information Department, 5005 East McDowell, Phoenix, Arizona. A complete line of subminiature temperature-compensated reference diodes is available from Motorola.

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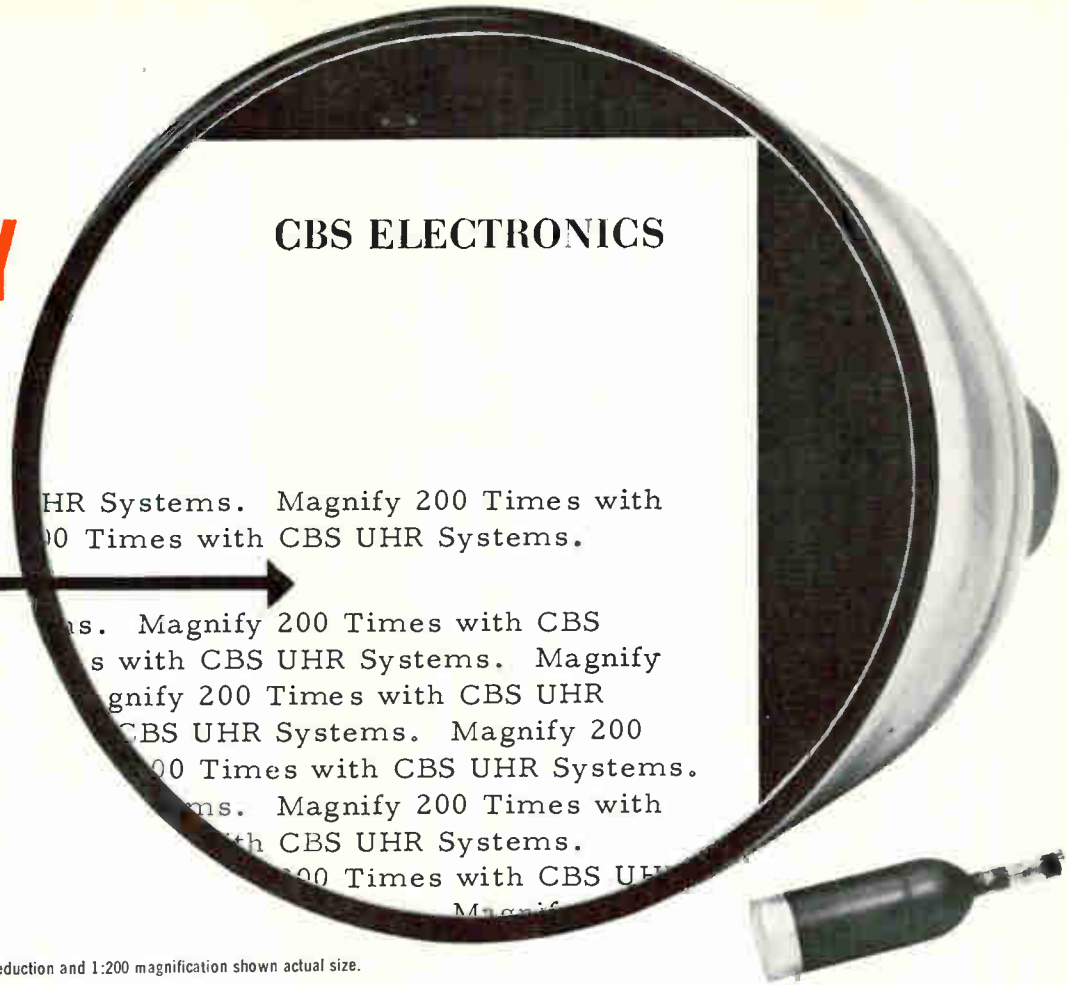
MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA, INC.

5005 EAST McDOWELL ROAD • PHOENIX, ARIZONA

YOU CAN MAGNIFY 200 TIMES* WITH CBS UHR SYSTEMS!



*200:1 reduction and 1:200 magnification shown actual size.

CBS ultrahigh-resolution cathode-ray tubes make possible the most advanced information retrieval and display applications for military and industrial use. The illustration shows a unique 200:1 readout of a typewritten letter completely legible. This advanced application is possible because of the large number of available TV elements on CBS UHR tube screens; e.g., 36,000,000 with the P12 phosphor used in the readout tube.

Twenty-seven CBS UHR types with improved screens and electron guns are now available. They offer two resolution levels and five phosphors in 3-, 5- and 7-inch diameters. Note their features, characteristics, applications. Let us discuss with you your special requirements. Write or call today . . . be sure to ask for Technical Bulletin E-333A.

FEATURES

RESOLUTION . . . up to 2600 TV lines/inch with less than 15% deterioration in the edges. LINEARITY . . . deflection linear to 1%. SPOT SIZE . . . 1 mil diameter as defined by Rayleigh resolution condition. ORTHOGONALITY . . . adjustable to zero. HARDWARE . . . advanced CBS magnetically shielded focus and deflection coil assemblies available for maximum resolution.

TYPICAL APPLICATIONS

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TYPE	RESOLUTION TV lines/inch	BRIGHTNESS Foot-Lamberts @ 5μA	FILM DENSITY At 5μA
3-INCH TYPES			
3AVP5	2000	3	.52
3AVP11	2000	23	.80
3AVP16	800	.5	.84
DP3-27P24	2000	5	1.25
3AWP5	2600	5	1.00
DP3-33P11	2600	19	1.16
DP3-34P12	2100	32	1.52
DP3-35P16	1300	.4	1.24
DP3-36P24	2400	11	.52
5-INCH TYPES			
5CQP5	2000	3	.52
5CQP11	2000	23	.80
5CQP16	800	.5	.84
DP3-25P24	2000	5	1.25
5CRP5	2600	5	1.00
DP3-23P11	2600	19	1.16
DP3-18P12	2100	32	1.52
DP3-19P16	1300	.4	1.24
DP3-24P24	2400	11	.52
7-INCH TYPES			
7AVP5	2000	3	.52
7AVP11	2000	23	.80
7AVP16	800	.5	.84
DP3-26P24	2000	5	1.25
7AWP5	2600	5	1.00
DP3-28P11	2600	19	1.16
DP3-29P12	2100	32	1.52
DP3-31P16	1300	.4	1.24
DP3-32P24	2400	11	.52

Persistence and Peak Color . . . P5: 25μs, 4200 A°; P11: 82μs, 4600 A°; P12: 2.1 x 10^5μs, 5900 A°; P16: 0.1μs, 3830 A°; P24: 1.5μs, 5100 A°.

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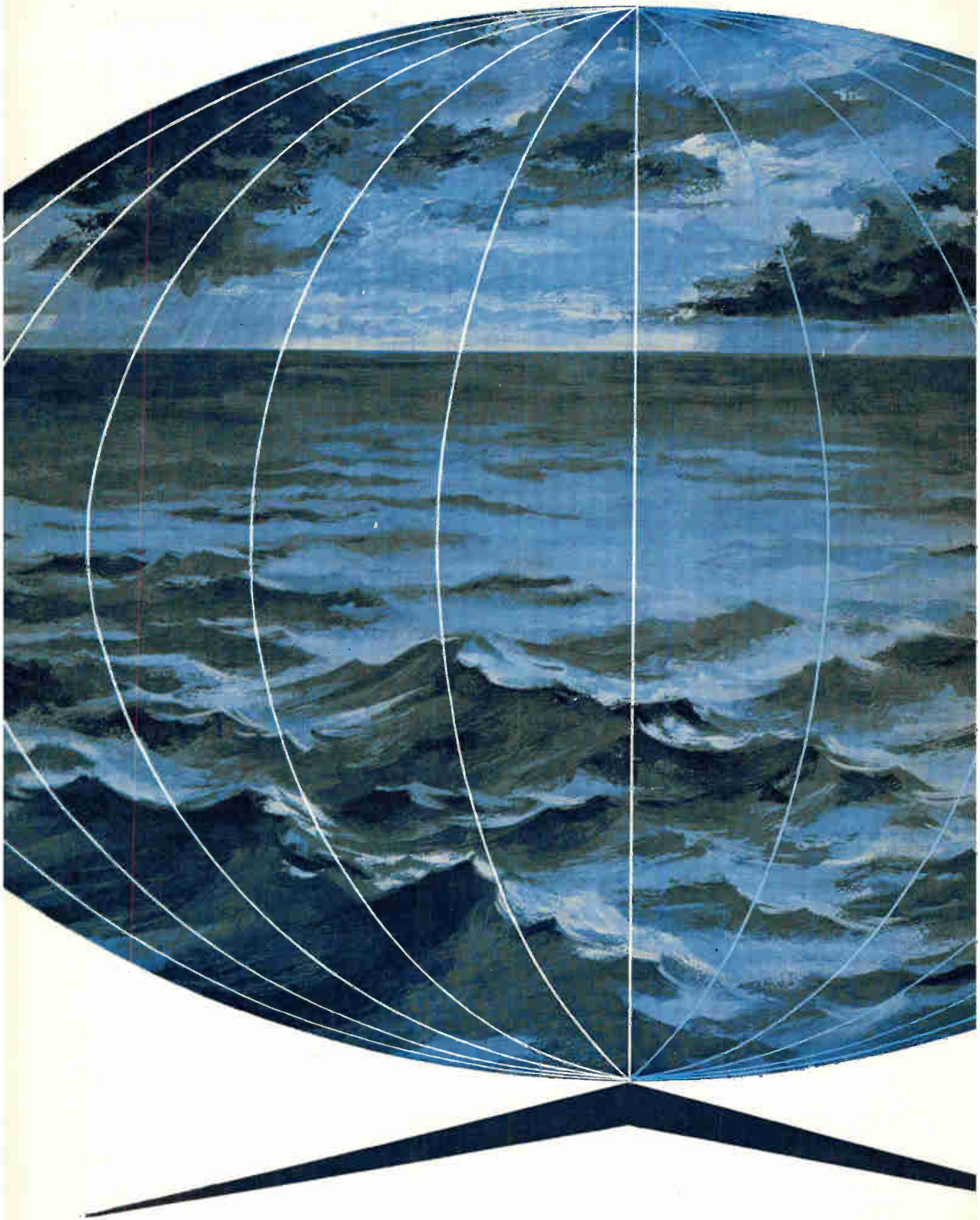

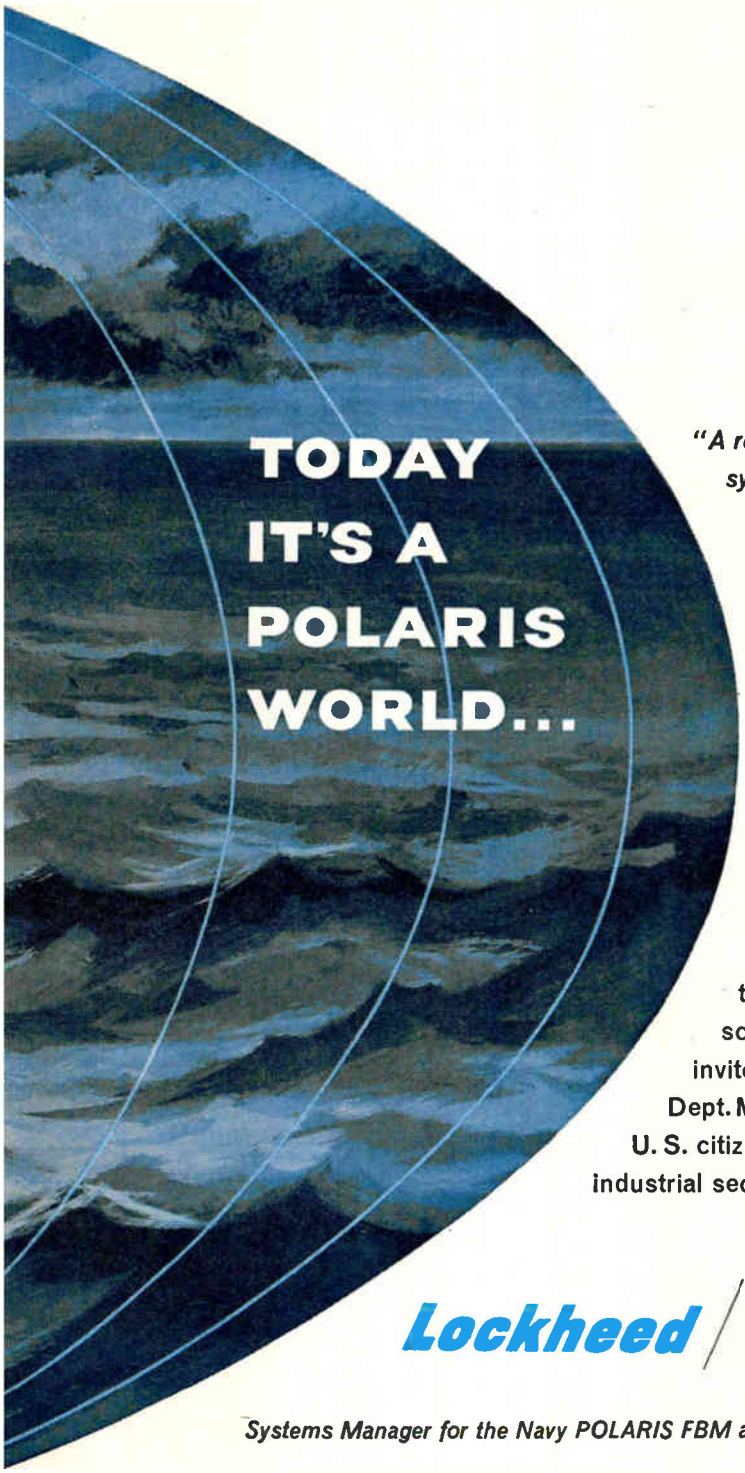

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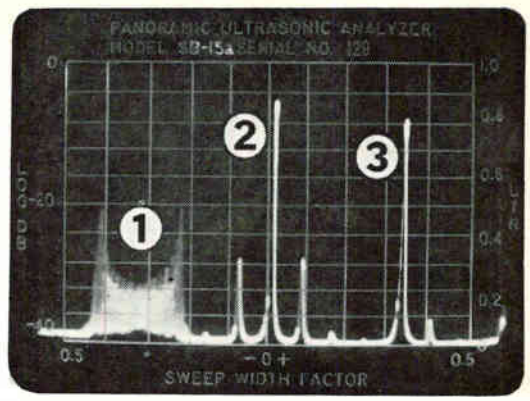

Lab setup shows SB-15a versatility. (1) FM display measures dynamic deviation. (2) & (3) are AM and SSB signals, respectively, with sine wave modulation.

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Center Frequency: Variable, calibrated from 0 to 500 kc.

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IF Bandwidth: Variable, 100 cps to 4 kc.

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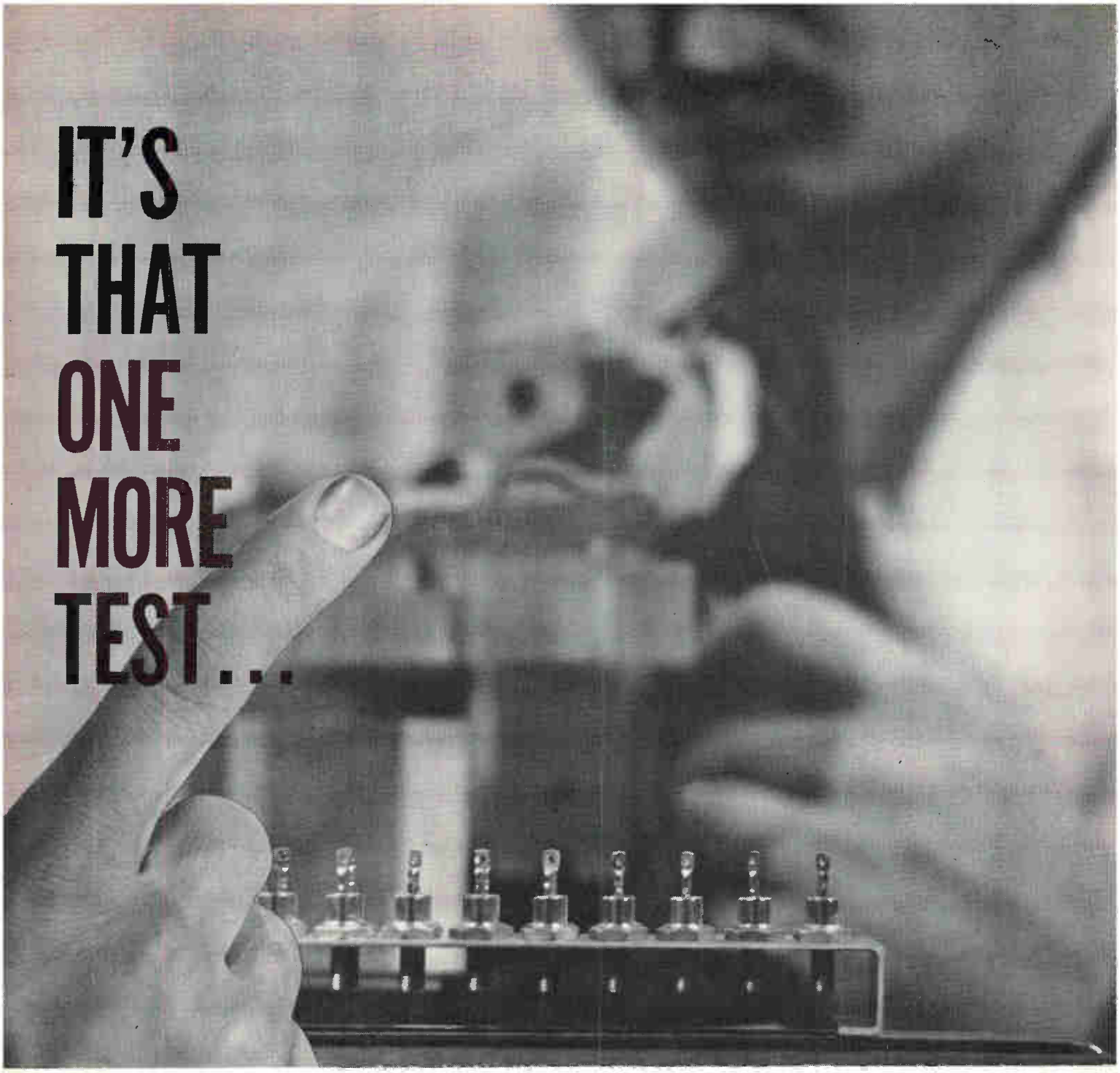

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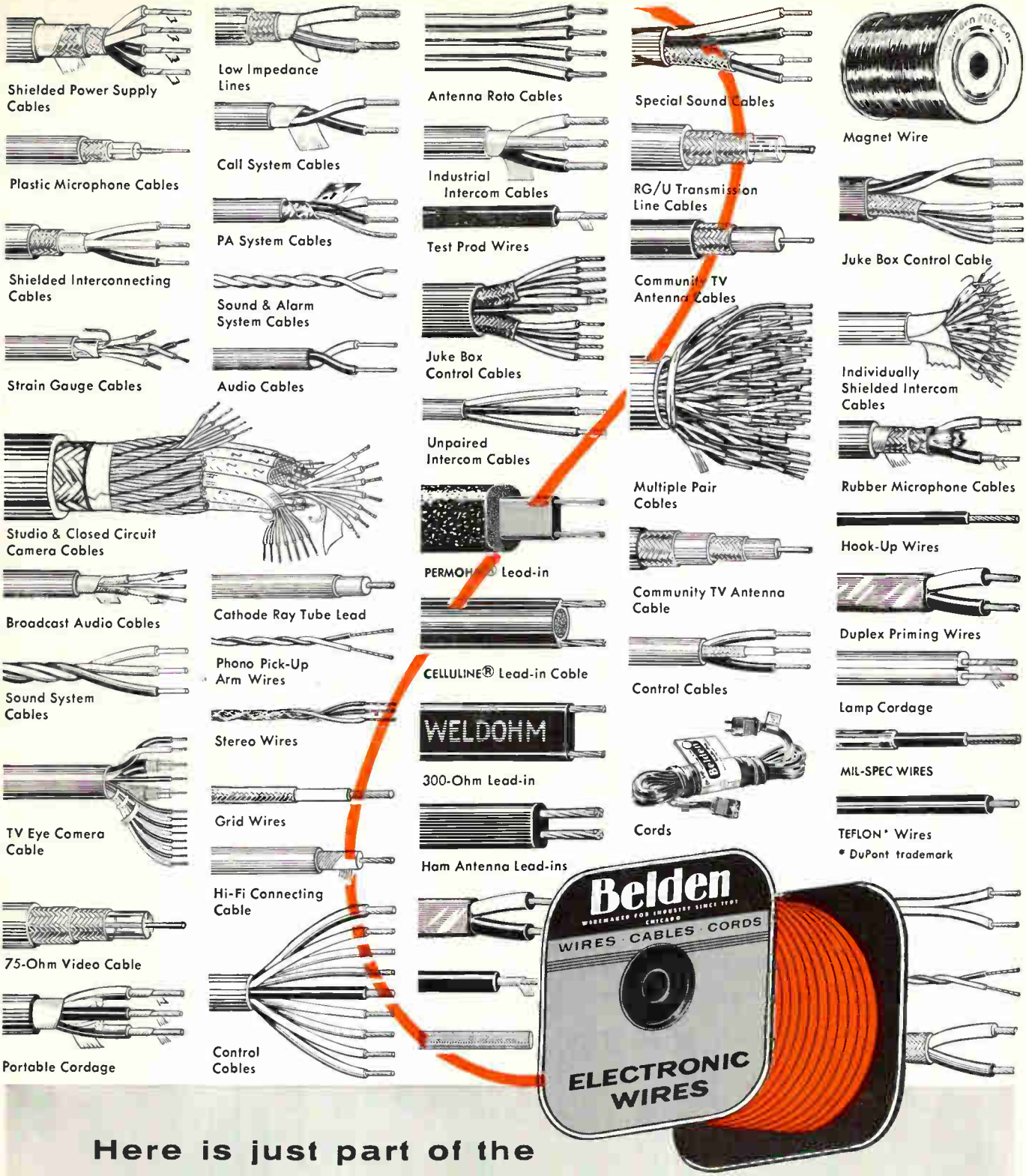

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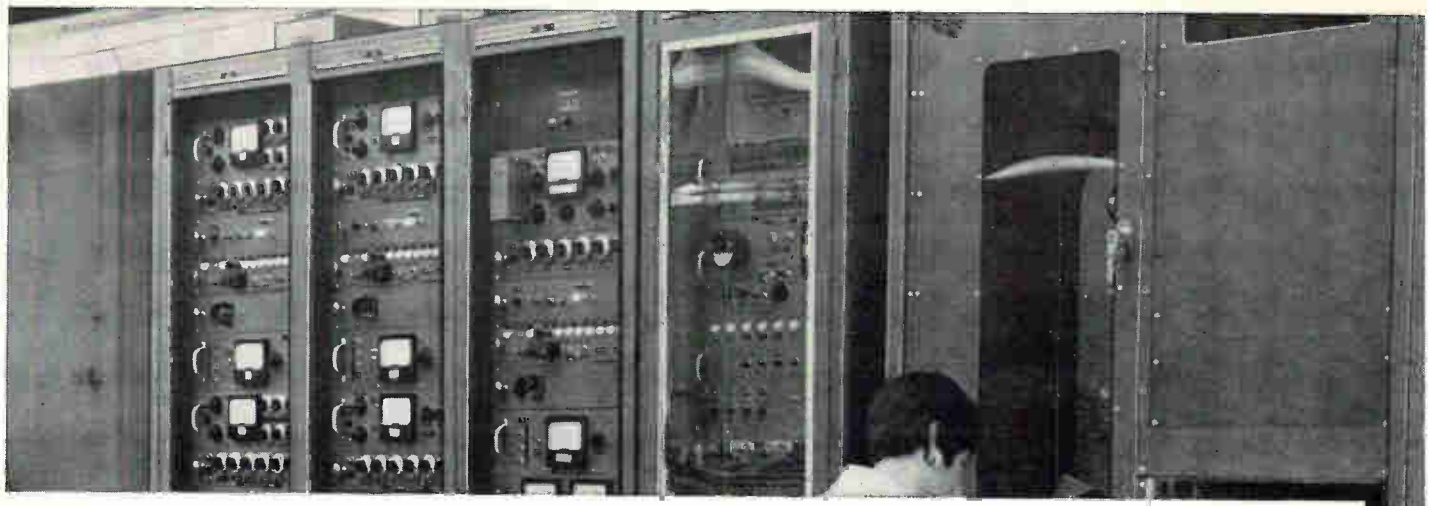

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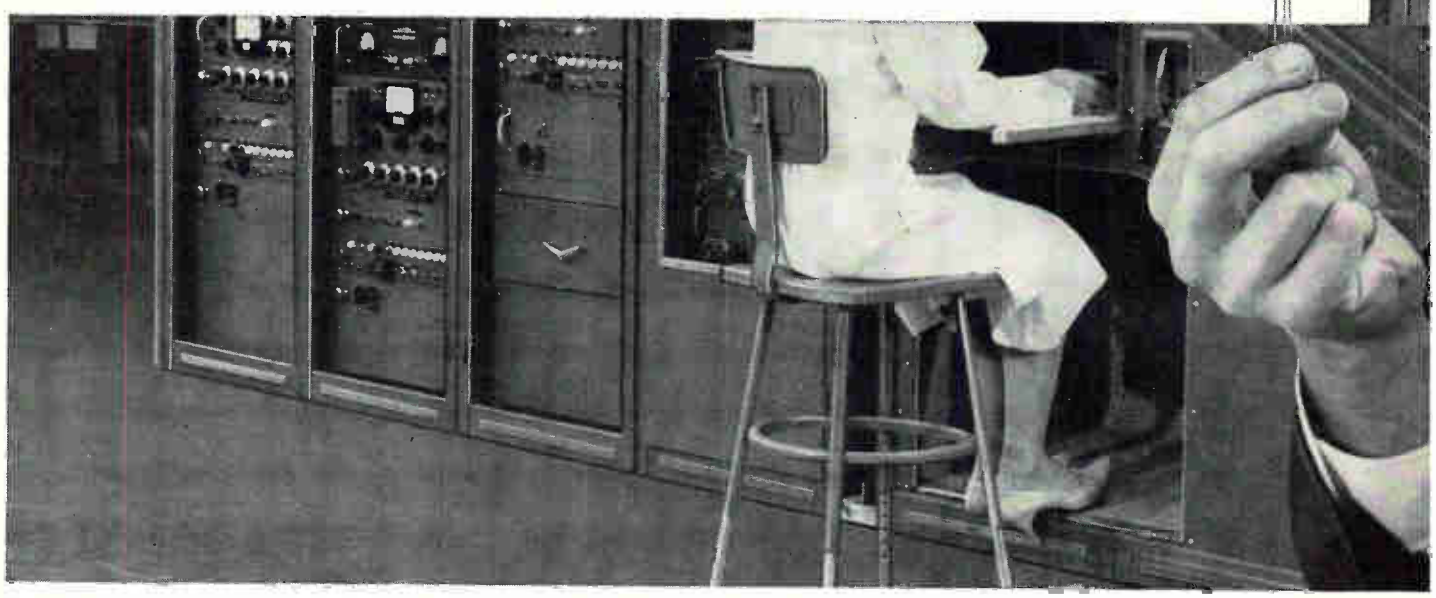
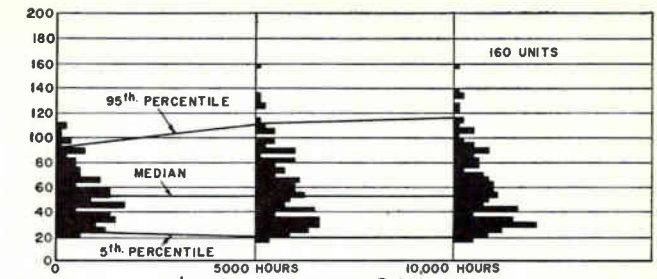
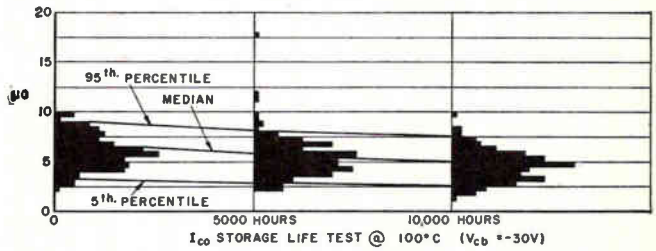
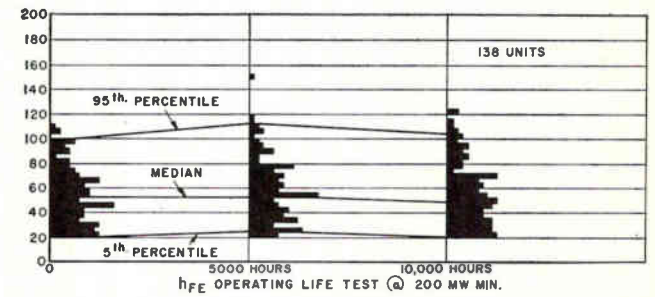


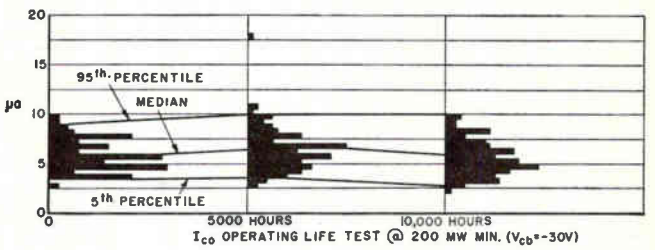
The man in the picture, Hugh Lowry, General Electric authority on semiconductor applications

TO-5 Type	Max. V_{CBO}	Max. V_{CER}	Max. I_C	Max. P_T	Max. Cutoff I_{CO} @ V_{CB}	20 ma h_{FE} Min.	Max.	h_{FE} Min.	Max.	V_{CE} (SAT)	V_{BE}	Max. C_{OB}
2N524	45v	30v	500 ma	225 mw	10μa 30	19	42	16	41	.070v	.255	40
2N525	"	"	"	"	" "	34	65	30	64	.075v	.243	"
2N526	"	"	"	"	" "	53	90	44	88	.080v	.230	"
2N527	"	"	"	"	" "	72	121	60	120	.090v	.216	"
2N1413	35v	25v	200 ma	200 mw	12μa 30v	25	42	20	41	.070v	.255	40
2N1414	"	"	"	"	" "	34	65	30	64	.075v	.243	"
2N1415	"	"	"	"	" "	53	90	44	88	.080v	.230	"









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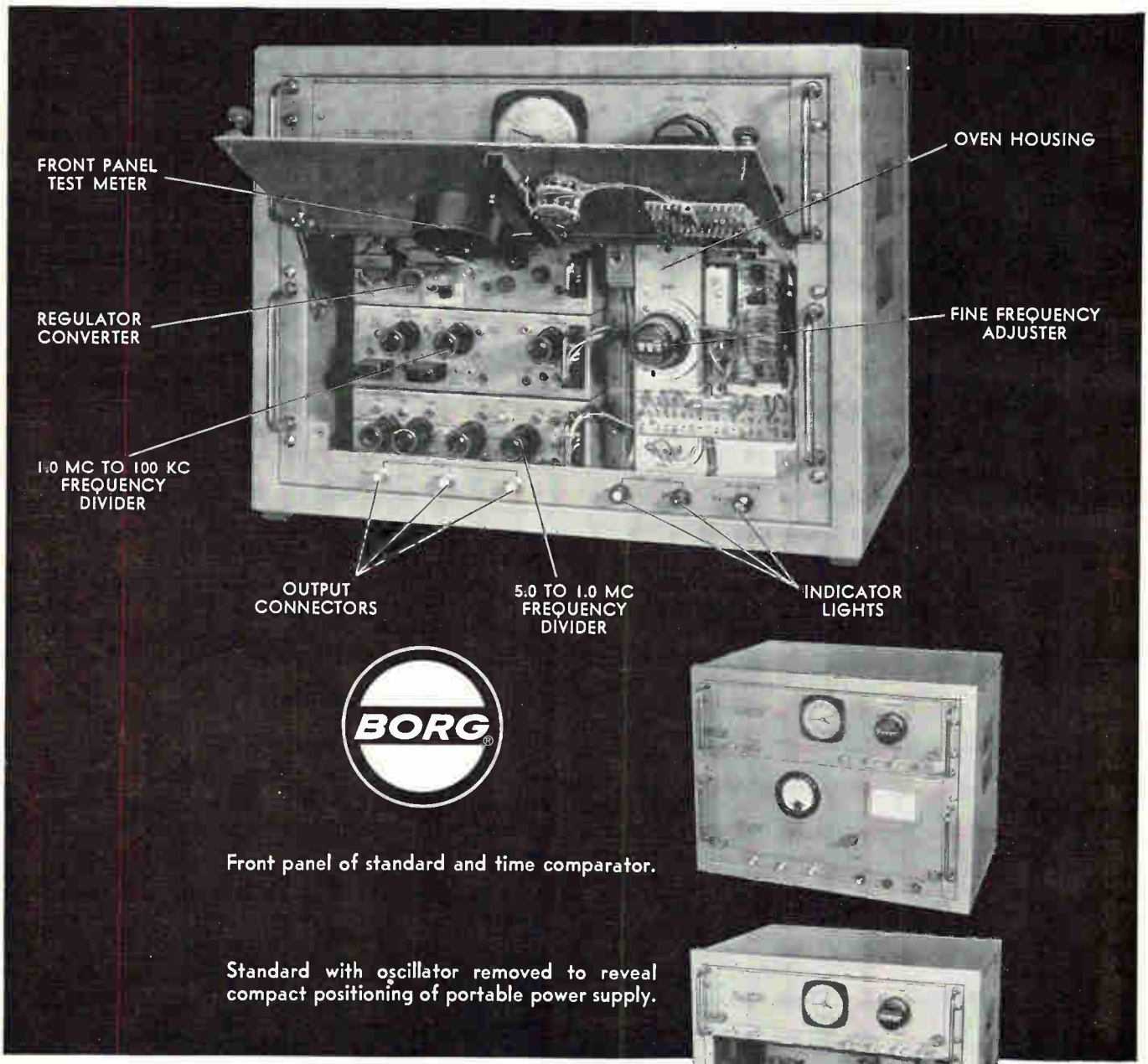

Front panel of standard and time comparator.

Standard with oscillator removed to reveal compact positioning of portable power supply.

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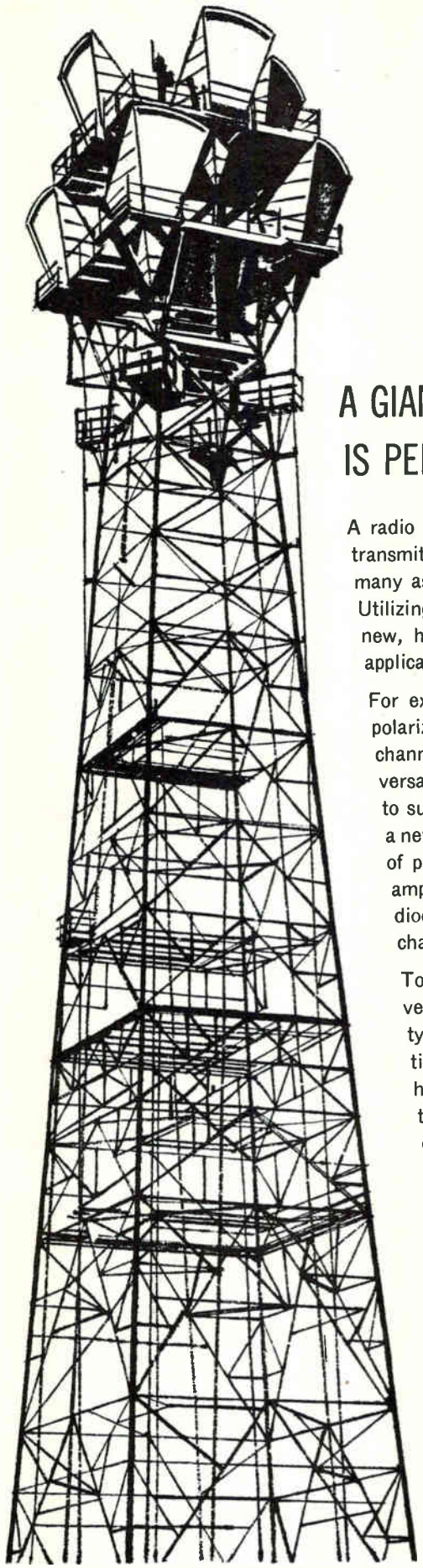

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A radio relay system operating at 6 billion cycles per second and able to transmit 11,000 voices on a single beam of microwaves—several times as many as any previous system—has been developed at Bell Laboratories. Utilizing the assigned frequency band with unprecedented efficiency, this new, heavy-traffic system was made possible by the development and application of new technology by Bell Laboratories engineers and scientists.

For example, they arranged for the waves in adjacent channels to be polarized 90 degrees apart, thus cutting down interference between channels and permitting the transmission of many more telephone conversations in the same frequency space. They developed ferrite isolators to suppress interfering wave reflections in the waveguide circuits; and a new traveling wave tube that has ten times the power handling capacity of previous amplifiers and provides uniform and almost distortionless amplification of FM signals. They devised and applied a new high-speed diode switching system which instantly switches service to a protection channel when trouble threatens.

To transmit and receive the waves, the engineers applied their invention, the horn-reflector antenna. Elsewhere, this versatile antenna type is brilliantly aiding space communication research in the reception of radio signals from satellites. For radio relay, a single horn-reflector antenna can efficiently handle both polarizations of the 6000 megacycle waves of the new system; at the same time it can handle 4000 and 11,000 megacycle waves used for existing radio relay systems. Thus it enables all three systems to share economically the same radio towers and routes.

Produced by the Bell System's manufacturing unit, Western Electric, the new system is now in operation between Denver and Salt Lake City, and will gradually be extended from coast to coast. This new advance in radio technology is another example of how Bell Telephone Laboratories works to improve your Bell communication services.

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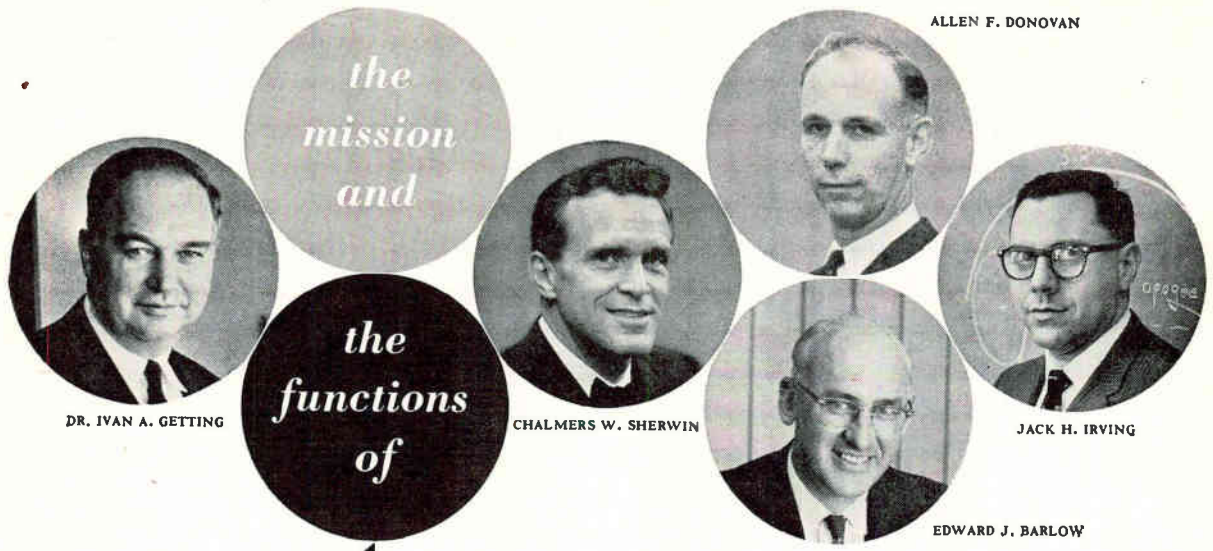

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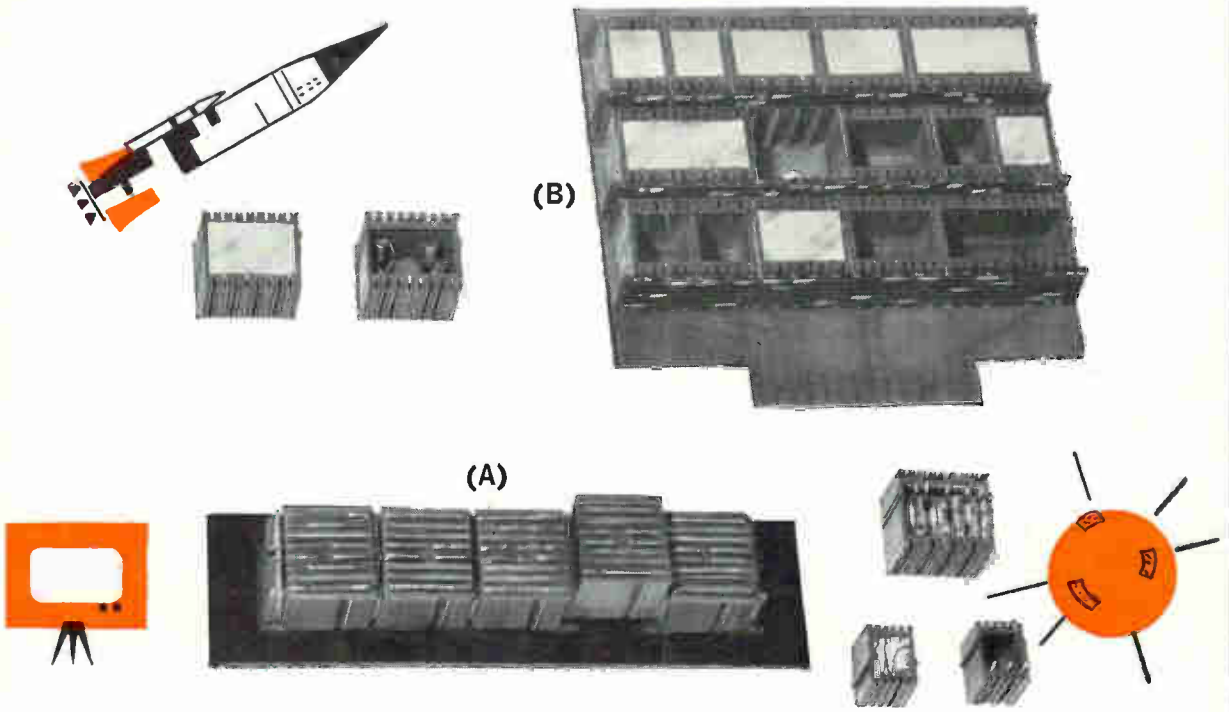

Shown above (A) series, and (B) parallel circuits.

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electronics
January 13, 1961

Advances in all-magnetic logic, comparisons of ferrite cores and thin film submicrosecond memory elements, preparation of thin films, ferromagnetic devices and studies of spiral walls in permalloy films are among features of conference on magnetics

By NILO LINDGREN,
Assistant Editor

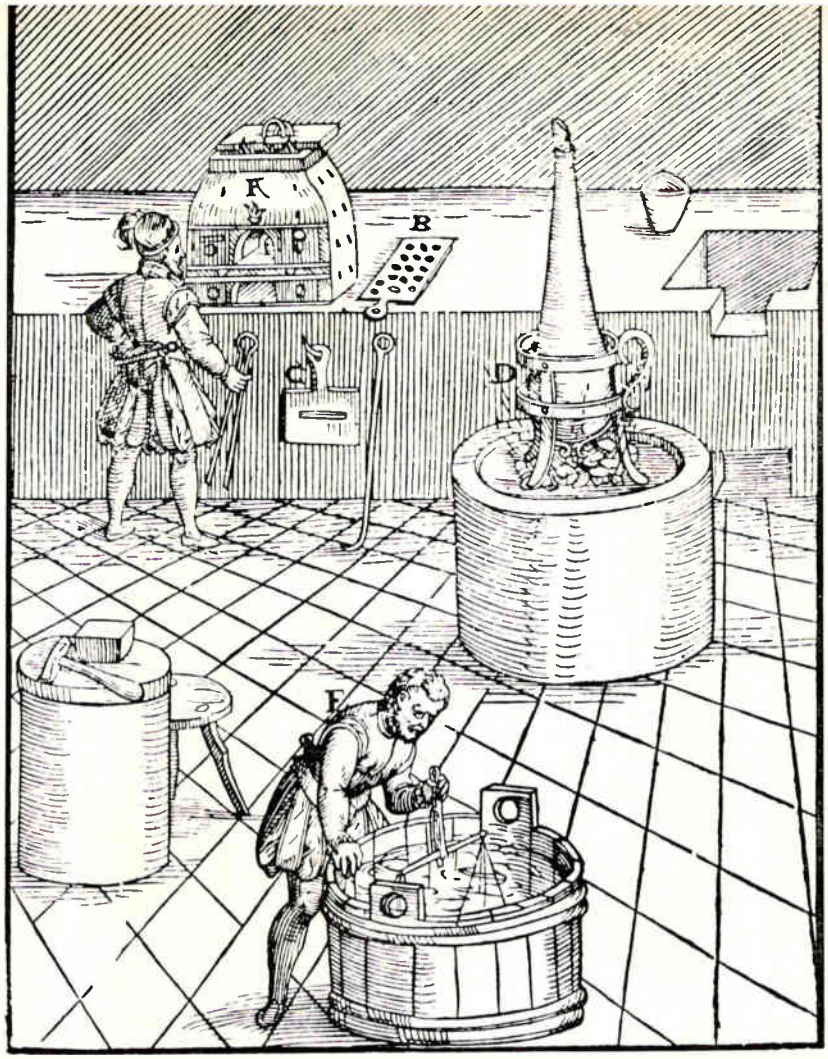

FIG. 1—Although he did not recognize them as such, Gowin Knight succeeded before 1779 in making fine particle permanent magnets. Such work, depicted here, was in some ways not far removed from medieval alchemy

Recent Progress in Magnetics

AN INCREASED theoretical understanding of magnetic behavior linked with an ever-broadening program of systematic study of materials has brought rapid progress in many branches of magnetics work in this century. Recent advances reported at the Sixth Annual Conference on Magnetism and Magnetic Materials in New York include an impressive amount of work on basic magnetic phenomena, material studies and magnetic devices. Two sessions, one on computer devices, the other on microwave devices, are of particular interest to electronic engineers.

Some of the milestones in unraveling of the mysteries of magnetic behavior, especially in the development of fine particle magnets, were reviewed in a paper by F. E. Luborsky.[1] Synthetic permanent magnets were made sometime before 1779 (Fig. 1). Iron filings were stirred in water until a fine suspension developed; this suspension was allowed to settle and dry, mixed with linseed oil to a thick paste and baked. Conscious recognition that the result of this process was fine particle Fe_3O_4 in an organic matrix had to wait until the twentieth century, as did domain theory. During the intervening years, hardened steel magnet alloys, discovered around 1600, had been developed in strength, but domain theory pointed the way towards a new class of permanent magnets with high coercive force derived from small single domain particles.

The emergence of domain theory in 1949 led to the concept of the single domain particle and the magnetic anisotropy contributions giving rise to the permanent magnet behavior of magnetic materials. In general, magnetic materials containing domain boundaries are magnetized and demagnetized by the movement of domain boundaries in response to relatively weak applied fields. To achieve high coercive forces, desired in permanent magnets, boundary motion is impeded with inclusions and strains delib-

erately introduced into the lattice. Another approach to developing high coercive forces is to eliminate completely domain boundaries by subdividing the material into single-domain particles.

There have been postulated four major anisotropy forces that oppose rotation, thereby increasing particle coercive force: crystal anisotropy; strain anisotropy; exchange anisotropy, discovered in 1956; and shape anisotropy, proposed almost simultaneously by several researchers in 1947.

A commercial magnet resulting from these concepts was developed by Néel in 1947 and was composed of spherical iron or iron-cobalt particles compacted together with an organic binder. Since that time, many other ferromagnetic materials with a high magnetocrystalline anisotropy have been discovered.[1]

The possibilities of all-magnetic logic circuits for computers has been receiving more serious attention recently, and a general review of such developments was the lead-off paper in the computer devices session of the conference.[2] All-magnetic circuits are those composed as far as possible of compatible magnetic devices, and include, for example, parametrons and ferroresonant circuits.

Many present logic circuits combine cores and diodes, and although such circuits are satisfactory, they require multiturn windings and large cores for electrical compatibility between the magnetic and semiconductive components. If such circuits could eliminate or reduce multiturn windings and large cores, then they could be made more reliable and economical in certain applications. Magnetic components perform well under temperature changes, humidity and nuclear radiation, and although they suffer from a speed limitation, methods for achieving increased speeds have been proposed.[3]

There are a number of ways of satisfying the requirements for an all-magnetic synchronous sequential logic using toroidal cores, multiapertured cores, partial switching techniques, as well as thin-film approaches. At the present time, core logic circuits are in an advanced state of development—both toroidal and multiapertured cores

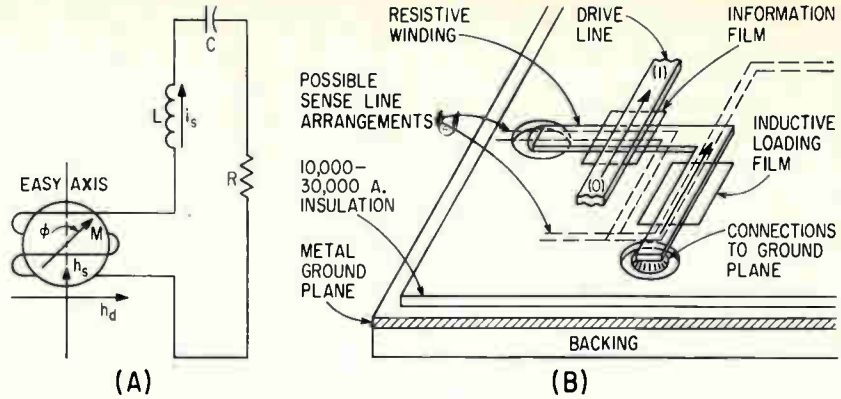

FIG. 2—With proper film and circuit parameters, this circuit (A) may be used as a flip-flop in which the magnetization M in the film is switched from either one of its rest orientations to the other by successive drive field pulses, h_d. Reliability of magnetic-film memory can be increased by passive R-L loading (B)

are commercially available. Thin-film approaches, however, though appearing to offer many advantages over core approaches, require considerable development to attain suitably uniform materials, and thin films are now generally regarded as second-generation components.

Little information is available on practical speed limitations of magnetic logic, but all-magnetic shift registers have been operated at bit rates of the order of 10^5 a second and bit rates as high as 10^6 a second may be possible. A representative figure for the average power requirement is 10^{-6} watts per bit times the stepping frequency. Reduction of an order of magnitude might be possible with core size and saturation flux density reductions.

The burden of building all-magnetic computers is now on the shoulders of the systems engineer. Initially, the paper concluded, this would involve close cooperation between device and systems engineers, and special-purpose all-magnetic computers will be forthcoming. In fact, during the Conference week, Stanford Research Institute announced the development of an all-magnetic computer.

In another paper on computing logic circuits, an examination was made of the chief commercial characteristics of submicrosecond storage systems—function, speed, capacity and cost.[3] The author stated that the cost of the magnetic memory now was considerably less than the cost of associated circuits, and that this predominance prevailed even with more sophisticated types of magnetic memories, such as multiaperture core types. Speed and capacity limitations were found to depend on associated circuits and on memory element size for memories using both ferrite and metal devices. The type of memory access and the writing capability requirement restrict the design of high-speed memories.

During the past few years, a large number of new magnetic devices for random access memory have been developed. However, significant increases in word reading rates are needed. Such increases could come from the elimination of cycle time required for writing—a read-only type memory might have an interrogation rate from five to eight times the speed of a ready-write memory. It is expected that designs of submicrosecond magnetic read-only memories will be forthcoming.[3] Partial switching techniques can further reduce switching times.

To compare applications for cores and thin films, drive circuits, sensing circuits, device availability and required capacity must be considered. Below 2-Mc read-write speeds, cores have the advantage; at these speeds thin films would require more costly sense amplifiers. Furthermore, film arrays of reasonable capacities (greater than 1,000 words) are not yet available. Performance of core arrays is expected to improve with smaller cores. In the 2 to 10-Mc range, thin-film devices begin to find application, though at 10 Mc both cores and films offer the same promise. Above 10-Mc read-write frequencies, the high-speed capabilities of thin films

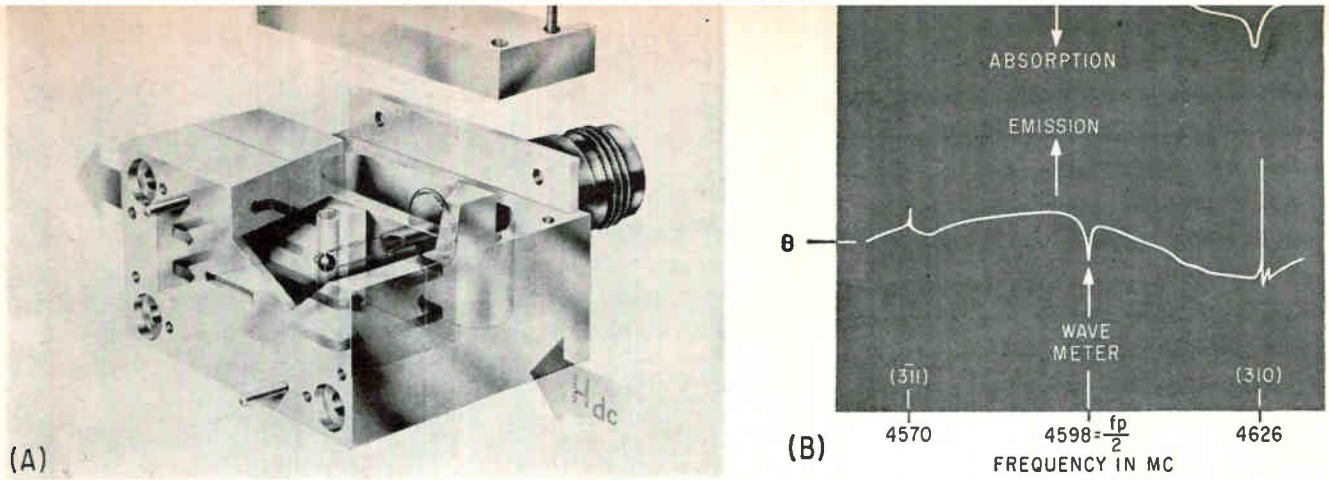

FIG. 3—Developmental design of ferromagnetic parametric amplifier (A), and the effect of longitudinal pumping on a pair of magnetostatic modes (B). Curve A is without pumping; curve B is with pumping

should begin to pay off, giving them an advantage over present ferrite core devices. Table I summarizes these estimates of device commercial applicability as a function of cycle time.[3] For military applications, other considerations enter the picture, such as weight, volume, power and environmental requirements.

A magnetic film device using passive loading was described in a paper from Iowa State University.[4] Magnetization in a single-domain thin magnetic film has two stable orientations in the absence of external fields—it is directed in either of two directions along an easy axis of magnetization. Thus, such films can be used for binary storage with the two remanent states corresponding to ZERO and ONE. For nondestructive read-out (NDRO), a pulsed transverse field (h_d in Fig. 2A) is applied to the film so that the magnetization M will move either clockwise or counterclockwise depending upon the film's initial state. Polarity of the output voltage across an easy-direction winding indicates this initial state. When the transverse field is removed, the magnetization rotates back to its original position. However, if the magnetization rotates beyond a critical angle ϕ, which is small and which varies from film to film, the film breaks up into a multiple-domain structure, destroying the stored information. Thus, thin-film memory reliability is poor.

However, it has been found that by winding a passive R-L loading loop on the film (Fig. 2A with C short-circuited), that an interrogation pulse will induce a current i_s in the loading loop. If the interrogation pulse is removed while this induced current is still large, it produces during its decay a sizable restoring field (h_s) tending to rotate the magnetization in the film back to its original state, regardless of its angle of rotation. By use of both evaporated winding and thin insulating layers (Fig. 2B) it appears possible to incorporate this technique into memory design. One drawback seems to be that the loading current decay time reduces speed. Experimental studies with 3,000 A, 80-20 permalloy film have shown that the technique is feasible and does increase the reliability of these film memories.

Experimental studies on thin ferrite films reported by The Polytechnic Institute of Brooklyn elicited a high degree of interest at the conference.[5] Thin films, about 1,000 A thick, of iron, nickel, cobalt, magnesium, copper ferrites, mixed ferrites and mixed ferrite-aluminates, as well as yttrium iron garnet, have been prepared. Object of these studies is to determine the physical, especially magnetic, properties of the films and to investigate areas in which they might be superior to bulk materials, either in devices or for theoretical work.

Attempts are being made now at

TABLE I—ESTIMATE OF DEVICE APPLICABILITY FOR VARIOUS CYCLE TIMES

Application	Memory Device	Basis of Judgment	Major Limitation
0.1–1 μsec Read-write 1–10 K words	Ferrite core	Less severe sensing problem. Device availability.	Driving circuits
<0.1 μsec Read-write <1 K words	Metallic film	Less severe driving problem. High speed capability, T_s < 10 nanosec	Sense amplifier
0.05–0.1 μsec ND read cycle 0.2–0.5 μsec Write cycle	Ferrite core	Device availability.	Transmission delay

TABLE II—EXPERIMENTAL RESULTS ON TWO FERROMAGNETIC AMPLIFIER MODELS

	Pump Freq (Mc)	Loaded Q	Pump Power (mw)	YIG heated to (deg K)	Midband Gain	Bandwidth (Kc)	Single-Sideband Noise Fig.
1st	9,180	2,420	450	400	20 db at 4,560 Mc	100	13.5 db
2nd	11,063	2,260	500	370*	20 db at 5,575 Mc	50	13.1 db

YIG sphere with ΔH = 0.3 at 3,300 Mc was used
* Attempt was made to reduce spin-wave heating by immersing cavity in liquid nitrogen

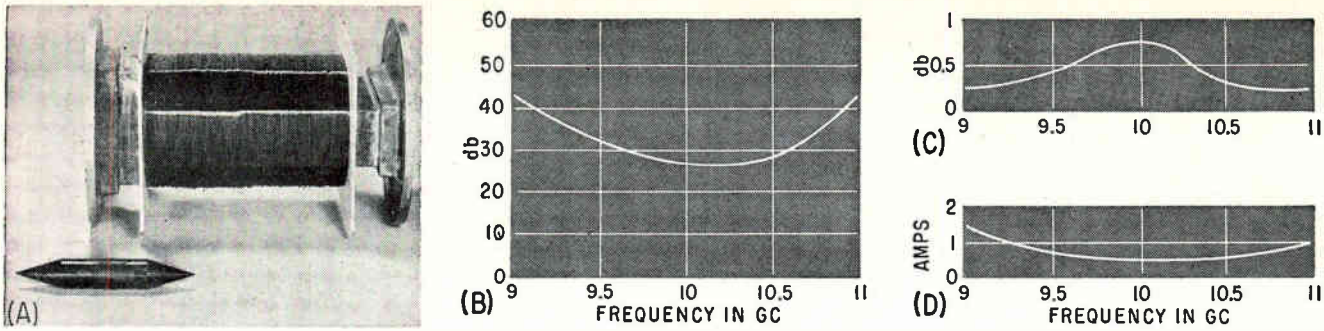

FIG. 4—Tetrahedral junction switch (A) from Caswell Electronics. When nonenergized, insertion loss is high at all points of the normal waveguide operating band (B); minimum insertion loss with current optimized (C); and current required to minimize insertion loss (D). In this switch, energy not transmitted is reflected rather than absorbed

BPI to grow epitaxial single crystal films that may be used to study spin-wave resonances. A spin wave is a spatial variation of the direction of magnetization that can be described by a single Fourier component. Investigation of switching properties of films for computer and microwave device applications is also planned.

A ferromagnetic parametric amplifier using longitudinal pumping (r-f magnetic field parallel to the d-c magnetic field) was described in a paper from Bell Labs.[6] Previous ferromagnetic amplifiers have used transverse pumping (r-f magnetic field perpendicular to the d-c magnetic field), but they have required large pump powers and in the magnetostatic mode the spin waves become unstable and block pumping at a low level. In this new amplifier, signal and idler resonances are provided by magnetostatic modes; small pump powers are required, and even though spin waves may be pumped to instability they are not effective in blocking pumping and therefore do not prevent amplification.

Figure 3A shows the developmental design. Core of this amplifier is the small dark sphere of narrow linewidth yttrium iron garnet (YIG) shown mounted in a quartz tube inside a half-wavelength microwave cavity at a point of maximum magnetic field. A Teflon post behind the sphere spaces it away from the cavity wall to prevent line-broadening due to perturbation of the r-f fields by the wall. The coaxial line to the right is coupled to the sphere by a wire loop extending from the center conductor through a hole in the rear wall of the cavity, around the sphere, and terminating on the cavity wall. The quartz tube spaces the loop away from the YIG sphere so that coupling from the external line to the modes can be controlled by adjustments of the tube wall thickness. The pump field is the magnetic field of the cavity and is parallel to the d-c magnetic field.

Figure 3B shows the effect of longitudinal pumping on a pair of magnetostatic modes. It shows the reflection of a swept-frequency signal from the coaxial input to the amplifier with and without pumping. Curve A exhibits a series of absorptions by the YIG without pumping; a wave meter notch appears at 4,598 Mc, half the pump frequency. These absorptions occur at the resonant frequencies of the modes to which the loop couples. Curve B shows that, with pumping, two modes (311 and 310) whose resonant frequencies add up to the pump frequency have their losses

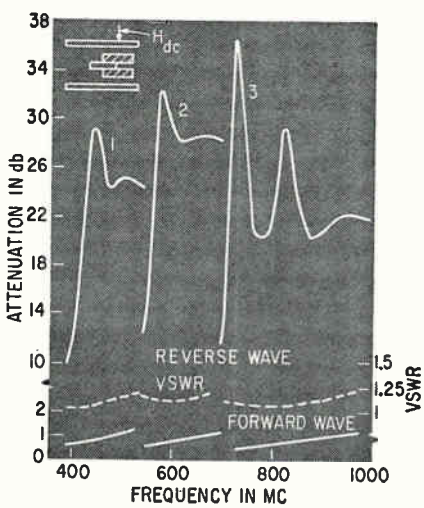

FIG. 5—In the isolator depicted, upper left, curves 2 and 3 resulted from a small change in position of the same YIG slab; for curve 1, slab was in the same position as for curve 3, but was thicker by a factor of 1.5

reduced and become emissive.

Measurements on two experimental models of the amplifier are shown in Table II. The amplifier begins to saturate at a power output of 30 μw at 400 K and 125 μw at 370 K. Saturation appears due to heating and might be eliminated by controlling the heating. Sources of noise in the amplifier have not been positively identified. Results show that the amplifier can operate continuously and with low power, and there is no fundamental limitation on operation at high microwave frequencies. The author concludes that though the gain-bandwidth product is small, it might be increased if the sphere were cooled, and that the development of materials with narrow linewidths and larger values of saturation magnetization would also increase gain-bandwidth.

In the direction of such narrower linewidths, it was announced during the conference by the Microwave Chemicals Laboratory, Inc. that they had produced highly polished single crystal YIG spheres with a ferrimagnetic linewidth of less than 0.1 oersted, which would be available in early 1961. In addition to parametric amplifier applications, such YIG spheres could be used in narrow-band tunable filters, power limiters and all devices using gyromagnetic coupling.

Efforts in recent years to extend the useful range of the electromagnetic spectrum to the millimeter and submillimeter wavelengths have brought more attention to antiferromagnetic materials. The high internal fields of these materials make them suitable for waveguide resonance isolators, phase shifters, circulators and modulators in this frequency region.

FIG. 6—Powder patterns of spiral walls in thin magnetic films, left, consist of a pair of antiparallel domains wrapped about a central point through many revolutions. Ellipticity results from the uniaxial anisotropy of the film; the easy axis lies along the major axis of the elliptical patterns. Corresponding magnetization distribution is depicted in center. Photo at right shows the effect of vertical applied field on spiral wall pattern

The properties of antiferromagnetic materials that make them potentially important for device application were reviewed in a paper from the MIT Lincoln Labs.[7] Based on theoretical derivations of figures of merit, the prediction was made that resonance isolators and phase shifters made from antiferromagnetics would exhibit characteristics comparable to the usual ferrite devices. Although there are many antiferromagnetic materials, resonance has been observed in relatively few. Of these, Cr_2O_3 and MnF_2 appear useful for the 2-mm and 1-mm regions respectively, at or below liquid helium temperatures. The addition of aluminum to Cr_2O_3 raises its critical field, making devices near 1.3 mm possible. The report concludes that by such additive methods it may be possible to tailor-make new materials for given frequency ranges.

Two papers in the microwave device session on ferrite frequency doublers came from Stanford University. One dealt with a correlation of experiment and theory[8], and the other dealt with several saturation mechanisms that occur in these devices[9]. Ferrite frequency doublers are important in that they produce high power output and have high conversion efficiency.

Also included in the microwave device session were papers on the performance of tetrahedral junction switches for the S- and X-bands[10], and a strip transmission line isolator that operates as low as 200 Mc.[11]

The microwave switch (see Fig. 4A) consists of two waveguides butted together on a common axis, but with their E-planes oriented at 90 degrees. The ferrite pencil shown in the photo is located at the junction of the waveguides. Without a magnetic field, energy is reflected from the cross-polarized junction; with longitudinal magnetic field, energy is transmitted across the junction with little attenuation and low vswr. The high insertion loss of this switch makes it adaptable as a shutter in the non-energized condition for protection of radar. Some performance data of this switch are shown in Fig. 4B, Fig. 4C and Fig. 4D.

Unlike conventional isolators that use dielectric loading the uhf isolator described achieves good isolator characteristics in a compact package over a broad range of frequencies below 1,000 Mc by using an asymmetrical arrangement of ferromagnetic material (YIG) on the center conductor. A cross-section of the structure appears in Fig. 5 along with typical characteristics. The slab of YIG is mounted with its broad side flush on the center conductor and is magnetized perpendicular to the broad dimension. Different isolation peaks, as shown, are obtained by changing the size of the YIG slab or its position on the center strip. Dimensions of the isolator are less than $1\frac{1}{2}$ in. × $2\frac{1}{4}$ in. × $6\frac{1}{2}$ in.

Efforts to develop uniform thin films have intensified investigations of basic phenomena occurring in magnetic materials. Of these, the formation of domain walls and domain wall motion have been interesting. At the Laboratory for Electronics in Boston, experimental studies have been carried out on spiral walls that form in thin permalloy films when the films are subjected to an a-c demagnetizing field.[12]

These wall formations (see Fig. 6) appear around minute imperfections in the films. It has been deduced that the distribution of the magnetization takes the form of a pair of antiparallel domains that spiral in toward the central imperfection. By rotation of a bar magnet just under a saturated film, the walls can be coiled in either direction around the fixed imperfections and can be uncoiled by reversing the direction of magnet rotation. These experiments indicate that the film imperfections are regions of abnormally high unaxial anisotropy where the magnetization is constrained to lie in one direction along the easy axis while the magnetization of the surrounding regions can be rotated by the applied field. Certain of these spiral patterns (Fig. 6, right) take on the spectacular beauty of the spiral galaxies of our outer universe.

REFERENCES

All papers were presented at the Sixth Annual Conference on Magnetism and Magnetic Materials, Nov. 14-17, 1960, New York City.

(1) F. E. Luborsky, General Electric Research Laboratory, The Development of Elongated Particle Magnets.

(2) U. F. Gianola, Bell Telephone Laboratories, The Possibilities of All-Magnetic Logic Circuitry.

(3) W. Lee Shevel, Jr., IBM Research Center, Submicrosecond Magnetic Memories.

(4) J. M. Daughton, et al, Iowa State University of Science and Technology, Magnetic Film Devices Using Passive Loading.

(5) E. Banks, L. M. Silber, et al, Polytechnic Institute of Brooklyn, Preparation and Properties of Thin Ferrite Films.

(6) R. T. Denton, Bell Telephone Laboratories, Theoretical and Experimental Characteristics of a Ferromagnetic Amplifier Using Longitudinal Pumping.

(7) G. S. Heller, et al, Lincoln Laboratory, M.I.T., Antiferromagnetic Materials for Millimeter and Sub-millimeter Devices.

(8) B. A. Auld, et al, Microwave Laboratory, Stanford University, Traveling Wave Frequency Doubling in Ferrites.

(9) B. A. Auld, Stanford University, Saturation Effects in Ferrite Frequency Doublers Operating in the Uniform Precession Mode.

(10) D. A. Caswell, Caswell Electronics Corp., Performance of Tetrahedral Junction Switches.

(11) D. B. Swartz, Sperry Microwave Electronics Corp., A Compact UHF Isolator.

(12) H. W. Fuller, et al, Laboratory for Electronics, Spiral Walls in Thin Magnetic Films.

Glass under stress has different refractive indices for light polarized parallel to and perpendicular to the direction of stress; since the magnitude of these differences is proportional to stress optical monitoring of a stress wave is possible

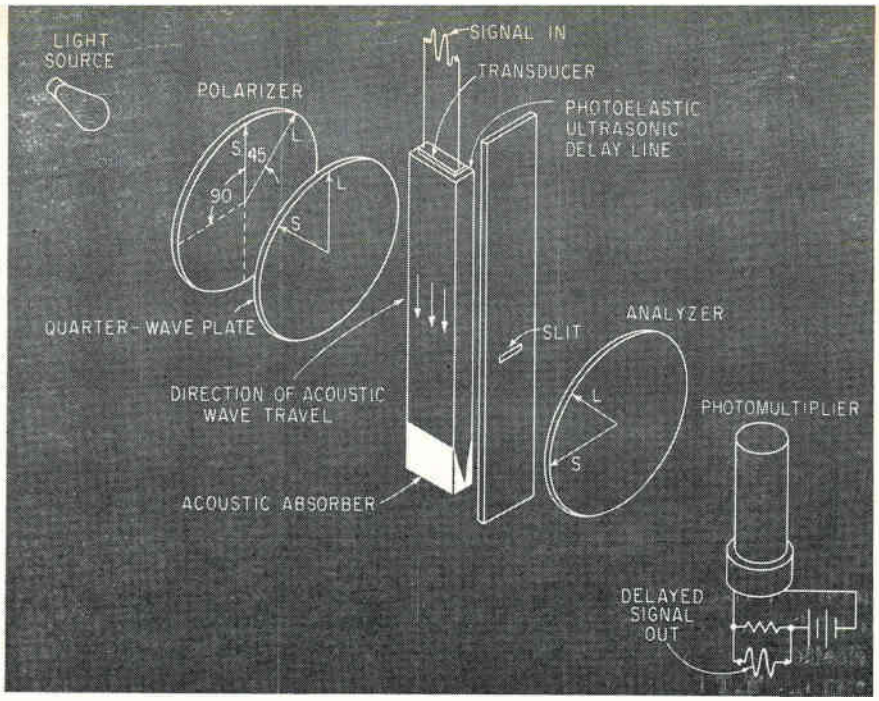

Fig. 1—Schematic arrangement for reading out the acoustic wave data as it passes down the glass delay line

CONTINUOUSLY-VARIABLE

By H. A. BROUNEUS
W. H. JENKINS
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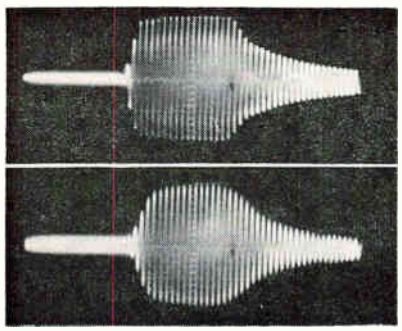
FOR FREQUENCIES above two megacycles and time delays greater than ten microseconds, solid ultrasonic delay lines using glass as the acoustic transmission medium are almost universally used. Although they perform well in most respects, they suffer the shortcomings of being neither readily tappable nor readily variable.

In 1948, Arenberg[1] described a scheme for circumventing this difficulty by reading out the acoustic signal optically as shown in Fig. 1, where the delay line is a transparent glass bar. When glass is stressed it becomes birefringent; that is, it presents two different refractive indices to light polarized parallel to and perpendicular to the direction of stress. The magnitude of this difference varies with the stress, and so produces a variation in phase retardation (γ) between the two mutually perpendicular components into which plane-polarized light transmited through the glass may be resolved.[2] Since a traveling acoustic wave introduced at the transducer and propagated along the length of the bar is actually a stress wave, it will produce birefringent effects throughout the bar.

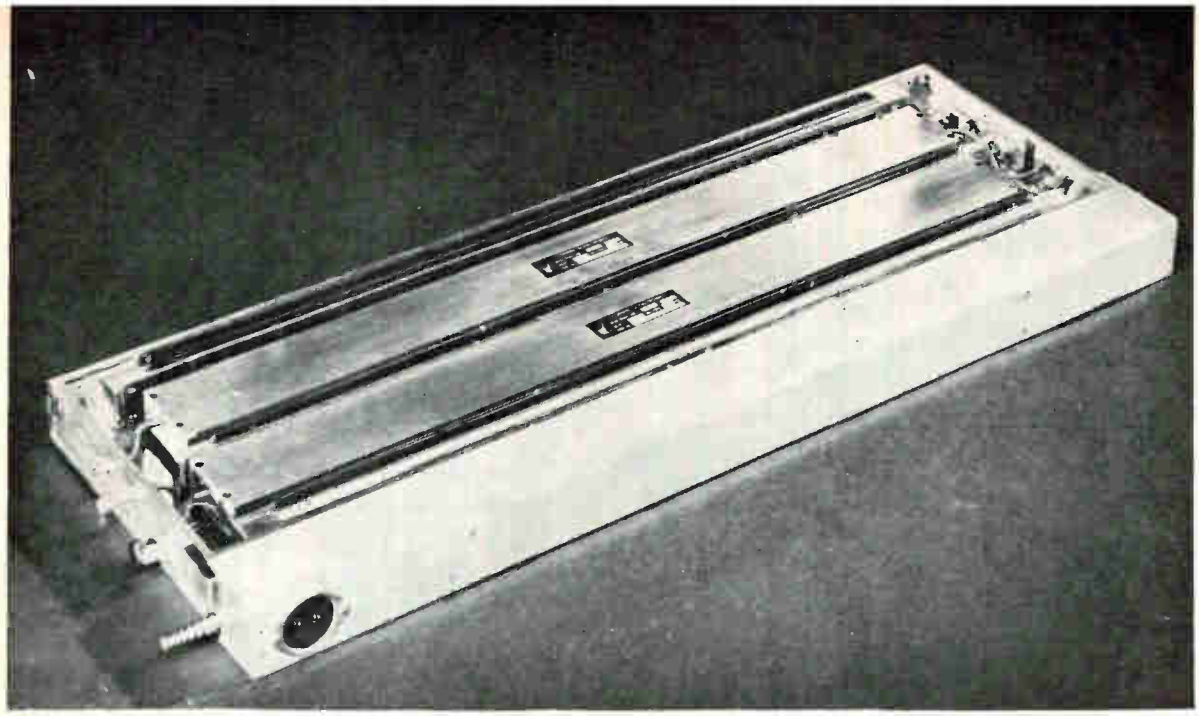
As the wave passes the slit shown in Fig. 1, the varying retardation produces variations in elliptical polarization of the light reaching the second polarizing screen, labeled analyzer, so that the intensity of light falling on the multiplier phototube varies in sympathy with the acoustic wave. A linear relationship is obtained by introducing an optical bias through the interposition of a birefringent element of fixed retardation (a quarter-wave plate) into the system. This establishes an operating point at 50 percent of maximum obtainable output light intensity, as shown in Fig. 2. The signal appearing across the multiplier phototube load re-



Upper oscillogram is the 10-Mc input to a shear-mode delay line, while the lower one shows the output delayed by 80 microseconds

TABLE—CHARACTERISTIC OF DELAY LINE

Parameter	Performance
Delay time per cm of bar length	2.66 μsec
Signal-to-noise ratio at 30 percent 3-db bandwidth	18 db at 10 Mc operating frequency; 8 db at 30 Mc
Power input	1.7 watts
Transducer temperature rise in 25 deg C free air, 1.7 watts continuous input	10 deg C



Delay line with optics package, but shown without the photoelectric readout equipment

GLASS DELAY LINE

sistor is then a faithful reproduction of the signal applied to the delay-line transducer, but delayed in time, as shown in the oscillograms.

Most satisfactory results, such as illustrated in the oscillograms, are obtained with recently-developed large-area ferroelectric ceramic transducers. These are highly efficient in piezoelectric energy conversion.

Either the shear or longitudinal modes of acoustic energy propagation may be used; required orientation of the principal axes of the polarizing screens and quarter-wave phase delay plate are indicated by the letters *S* for the former and *L* for the latter in Fig. 1. Because of ultrasound reflections from the walls of the delay line, as well as of power input, shear mode is by far the better.

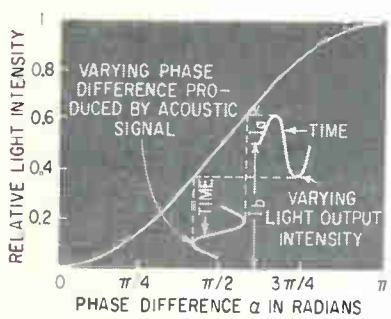


Fig. 2—Relationship between optical phase retardation and intensity of light reaching the multiplier phototube

Performance obtained is tabulated for 50 percent modulation, defined as I_a/I_b in Fig. 2. System noise arises entirely in the multiplier phototube, and signal-to-noise ratio is determined by the bandwidth of a filter used in the multiplier phototube output circuit.

At present, only straight-bar delay lines with delay maxima of 160 microseconds have been used in the photoelastic setup. Should long time delays or more compact arrangements be desired, two or more physically parallel bars could be coupled with acoustic prisms; similarly, a photoelastic line could be attached to one of the familiar polygonal lines (which are made with delays up to 5,000 microseconds) or it could be welded between two such polygons. In this way, time delay would be continuously variable over a portion of the total time delay of the assembly.

The photoelastic delay line may or may not find its widest application as a variable or tapped time-delay device. If, in the arrangement of Fig. 1, a second line were to follow the first in the optical path, the output of the multiplier phototube would contain the sum of any two signals fed the individual lines. If another polarizing screen and another phase delay plate were placed between the two lines, the output would contain the product. Thus exist possibilities for computation functions.

Wilmotte[4] discussed in detail use of the last-described arrangement for correlation. This is done with an extended light source and a light-sensitive device capable of viewing the entire length of the glass bars. The photograph shows the delay line and optics package for an optical cross-correlator under development at the General Electric Advanced Electronics Center, Ithaca, N. Y. The delay lines are contained in aluminum cases fitted with positioning adjustments and air cooling inlets for transducers and absorbers.

REFERENCES

(1) D. L. Arenberg, Ultrasonic Solid Delay Lines, *Jnl Acoust Soc Am*, **20**, p 13, Jan. 1948.

(2) E. B. Shand, Glass Engineering Handbook, McGraw-Hill, New York, p 58, 1958.

(3) H. A. Brouneus and W. H. Jenkins, Photoelastic Ultrasonic Delay Lines, *Proc Natl Elec Conf*, p 837, 1960.

(4) R. W. Wilmotte, Instantaneous Cross-Correlator, Final Report, Sept. 1957, RADC Contract No. AF 30 (602)-1494, ASTIA No. AD215485.

Rocket-borne impedance measuring system is being used in research on antenna impedance changes in the ionosphere. Equipment continuously measures both resistive and reactive components of antenna impedance as rocket moves through ionosphere

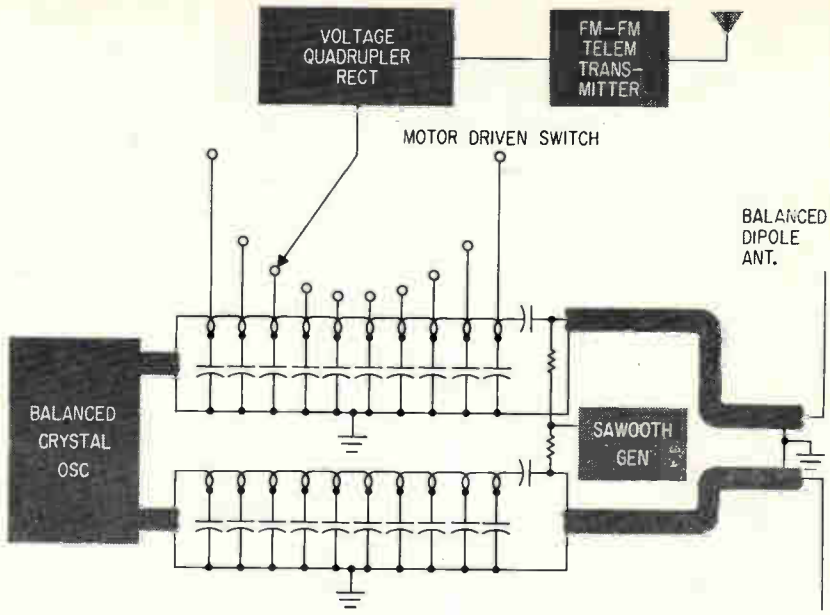


FIG. 1—Impedance measuring system consists of an r-f oscillator, dipole antenna and two artificial transmission lines

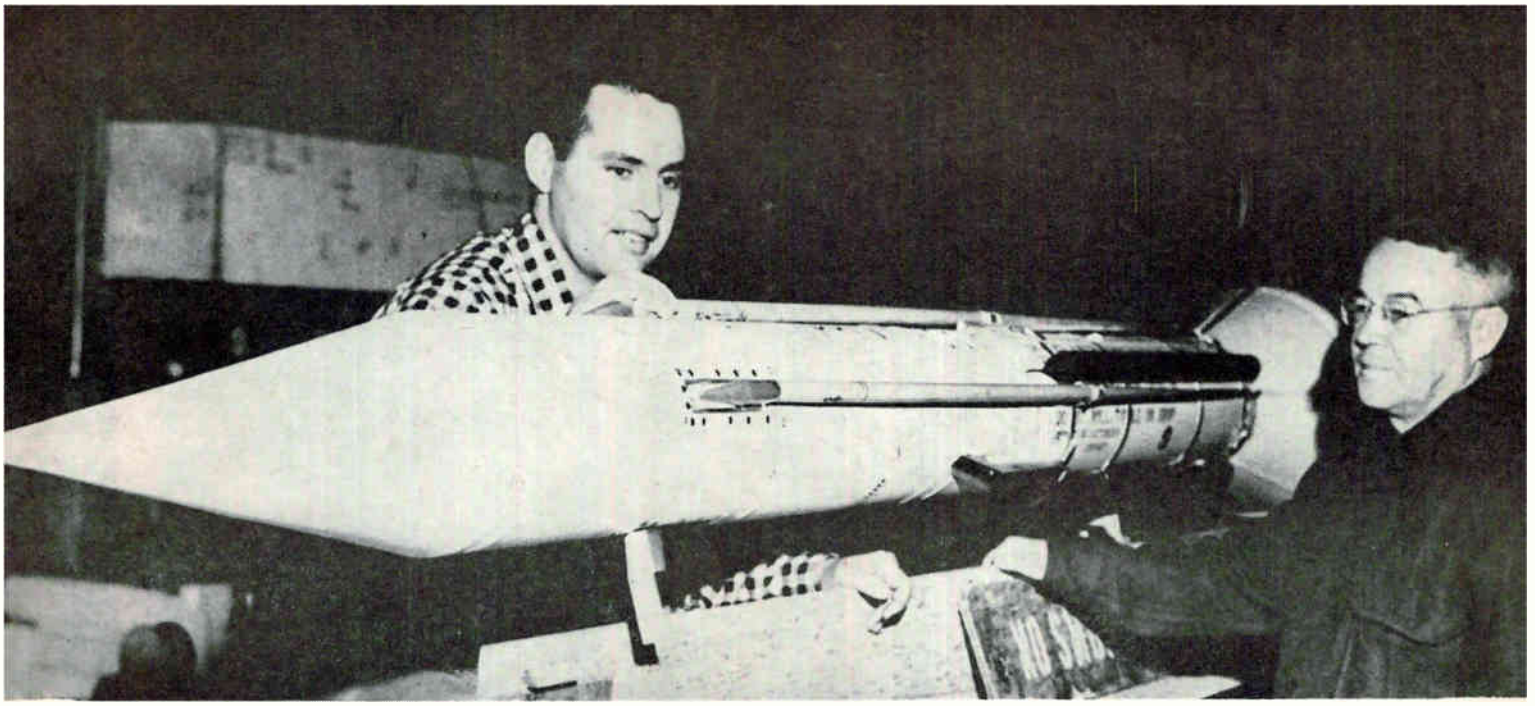
Measuring Antenna Impedance in the

ANTENNA FLOWN on rockets undergo an impedance mismatch on entering the ionosphere. This is conceptually evident if the ionosphere is thought of as a lossy dielectric whose properties are functions of the charged and neutral particle concentrations. The induced movement of the charged particles modify both the resistive and reactive components of the antenna impedance. Electrons are believed to account for most of the change because of their small mass. Antenna engineering would be greatly advanced if data were available to permit the calculation of antenna impedance in the ionosphere from known electron densities; and conversely, the study of electron densities in the ionosphere would be advanced if changes in antenna impedance were measured and from these changes the electron densities calculated.

This article reports research in which antenna impedances have been measured continuously throughout rocket flights. The Geophysics Research Directorate, Air Force Cambridge Research Laboratories and the Upper Air Research Laboratories, University of Utah, have cooperated in this program. The impedance measuring system used is the low-frequency lumped circuit equivalent of the slotted-line method, commonly used at higher frequencies. This system, shown in Fig. 1, consists of an r-f oscillator, dipole antenna and two artificial transmission lines. The signal is fed through the artificial lines to the antenna. The two lines are electrically equivalent, and one is used to feed each element of the dipole antenna, making a balanced system. The magnitude of the r-f voltage is sampled at sections along one of the lines by a commutator, and then rectified. This information is transmitted from the rocket to the ground through an f-m/f-m telemetry link. The standing-wave pattern on the antenna feed line is thereby recreated on the ground. This standing-wave pattern is sufficient to define the driving-point impedance of the antenna.

In addition to the r-f voltage on the antennas, it was found desirable to place a slowly varying sawtooth voltage on the dipole elements. This voltage varies linearly from 0 to +4 volts with respect to the rocket skin, drops to zero, then repeats the sequence with a period of two seconds. This d-c bias voltage is desirable because it makes the antenna neutral with respect to the surrounding plasma at some point during this cycle since the rocket experiences a charge build up resulting in a voltage of approximately 2 volts negative. Also, if an ion sheath is dragged with the rocket, the measured antenna impedance should be some function of this d-c bias voltage. The r-f measuring voltage is kept small compared to this bias voltage so as not to disturb the ion concentration and placement in the ionosphere. A resistor was placed in series with the feed of this sawtooth voltage so that any d-c current flowing between the antenna elements and the rocket skin would be measured by monitoring the voltage at both ends of the resistor.

The electron and charged-particle motion in the ionosphere will be somewhat dependent upon the magnetic field of the earth; therefore, the orientation of the probe antennas with respect to the terrestrial magnetic field should be known at all times during the impedance measuring. Aspect sensors of either the solar aspect or magnetometer type have been included in the rocket instrumentation. This



Authors Baker (left) and Haycock examine Spaerobee rocket with antennas mounted

Ionosphere

By OBED C. HAYCOCK, Director, Upper Air Research Laboratory.
and KAY D. BAKER, Research Engineer, University of Utah, Salt Lake City, Utah

information plus other performance and miscellaneous information are sampled by an electronic solid-state commutator and applied to a separate subcarrier oscillator of the f-m/f-m unit.

The electronics used in the standing-wave detector is shown schematically in Fig. 2. The oscillator unit (Fig. 2A) develops an r-f signal of 1 volt rms into the two balanced 50-ohm transmission lines. The output of this oscillator must be balanced and matched to the 100-ohm impedance of the balanced transmission line system. Crystal oscillator Q_1 is matched to the lines by emitter-follower Q_2 and the unbalanced-to-balanced transformer T_1.

The generator (Fig. 2B) develops a linear sawtooth signal with a 4-volt amplitude and a 2-second period. This voltage is applied to the antenna elements as described above.

The artificial line that samples the standing wave on the antenna line is shown in Fig. 3. It is a 50-ohm, 24-section line with a total electrical length of 0.6 wavelength at the operating frequency. The line is constructed on a 60-section printed circuit commutator plate with each of the sections tied to a segment of the commutator. A wiper arm driven by a small 12-volt d-c motor transfers the voltage on the segments of the commutator to a slip ring in the center. Mounted on the opposite side of this commutator disk is the artificial line. A diode-capacitor voltage quadrupler raises the low level of the r-f line voltage to the standard telemetering signal range of 0 to +5 volts d-c. It is then applied to the input of a subcarrier oscillator of an f-m/f-m telemetry transmitter. Thus, the modulating voltages sent to the telemetry unit will be a 0

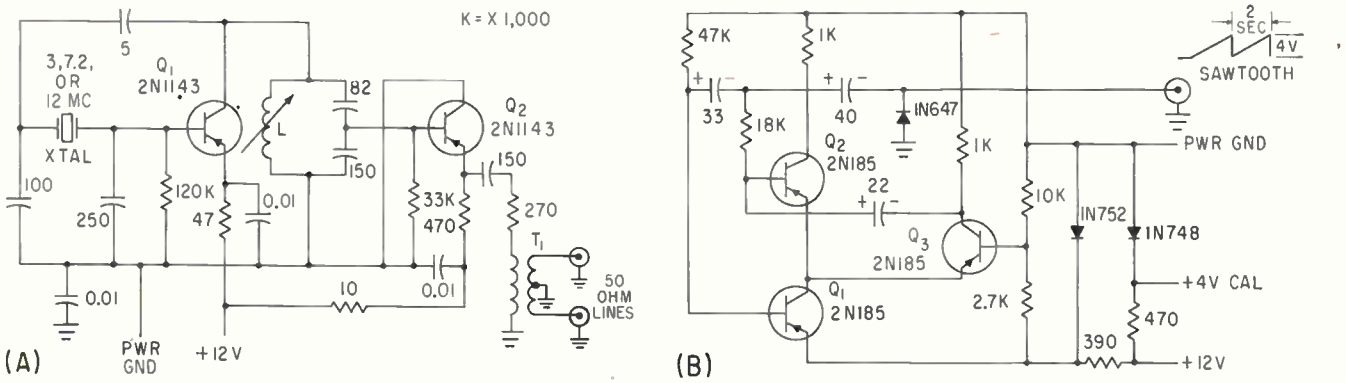
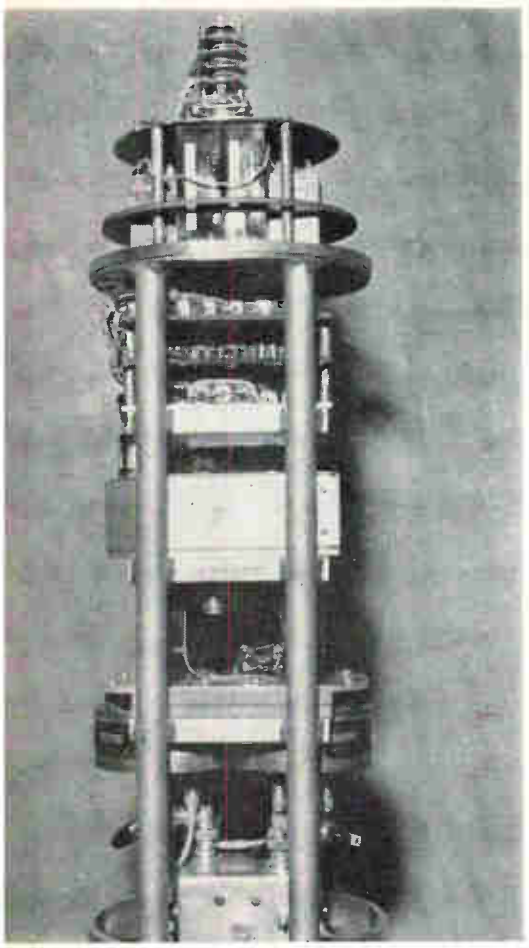


FIG. 2—Circuits used in standing-wave detector: oscillator (A) develops an r-f signal of one volt rms into two balanced transmission lines; generator (B) develops the linear sawtooth signal (shown) that is applied to antenna elements



Impedance probe instrumentation for Nike Cajun rocket (Air Force Cambridge Research Center)

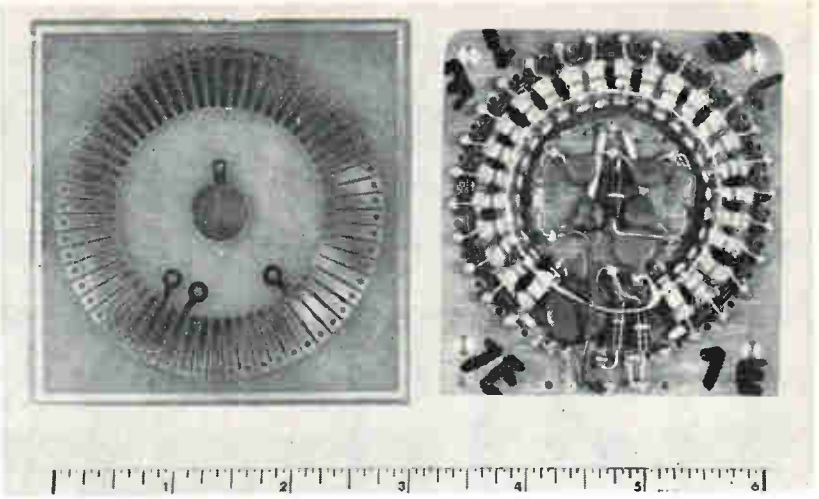


FIG. 3—Twenty-four section commutated line (right) is constructed on a sixty-section printed circuit commutator plate (left)

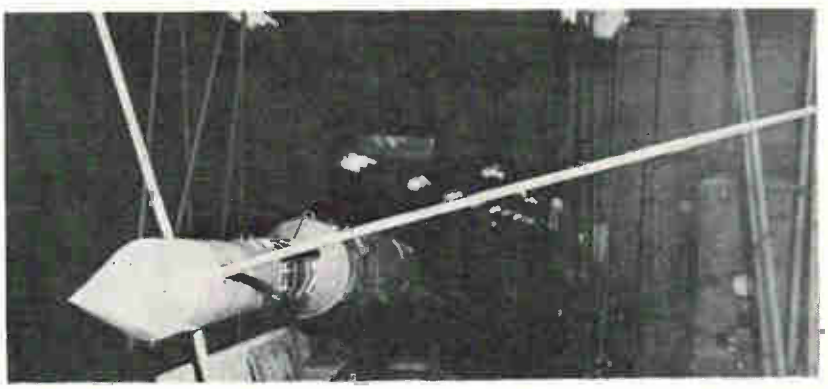


FIG. 4—Hinged dipole remains folded during early phase of rocket flight, then opens normal to rocket axis as shown here

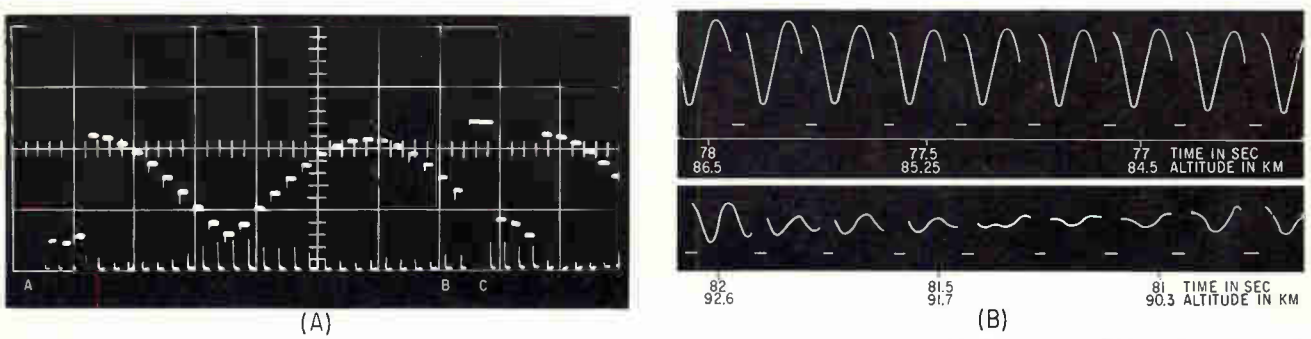


FIG. 5—Typical telemetry record (A) using automatic decommutation; and standing-wave patterns (B) taken on Aerobee rocket S/N-37 White Sands Missile Range, New Mexico, August 28, 1959 (automatic decommutation system not used): left record is with 3-Mc antenna, right with 7.2-Mc antenna

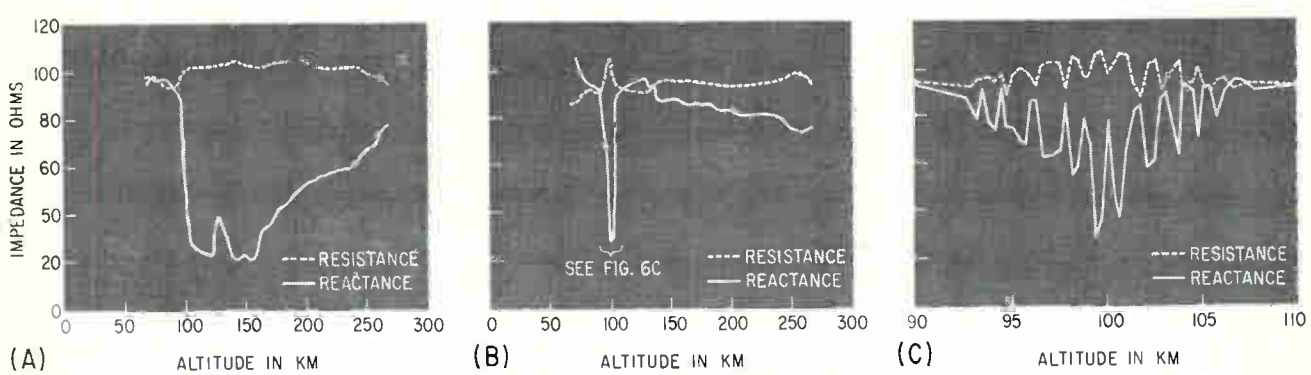


FIG. 6—Antenna impedance curves at 12 Mc; rocket ascent (A) (Aerobee 150 IGC No. AA3.183C) flown from Eglin Test Range, Florida, May 24, 1960; rocket descent (B); and expanded scale of (B) for 90 to 110-Km region (C)

to +5 volt signal whose amplitude is proportional to the standing-wave envelope along the r-f transmission line connecting the oscillator to the antenna.

The antennas for a rocket-borne ionosphere experiment present serious problems. To observe the effect, the operating frequency must be in the realm of the plasma frequency or in the range from about 1 to 20 Mc. (The plasma frequency of the E layer is presently between 3 and 4 Mc.) A dipole antenna should be on the order of a half wavelength in physical dimensions to be efficient. This is difficult and usually impossible to achieve when many of the rocket vehicles are themselves small in comparison to the necessary wavelengths. An example of the comparatively small rocket is the Spaerobee rocket, which is 8 inches in diameter and about 10 feet long. At 3 Mc, the wavelength is about 300 feet, and at 10 Mc about 90 feet. Some compromise is necessary in the electrical characteristics of the low-frequency antenna used on these rockets.

The extreme environmental conditions are further complicated because the antenna must conform to restrictions of light weight and low aerodynamic drag. It must also withstand the high temperatures caused by aerodynamic heating and be rugged enough to withstand high accelerations.

In view of these restrictions, the antenna considered best from physical and electrical standpoints is a hinged dipole (see photo, Fig. 4) or a telescoping antenna. The former consists of two 8-foot elements that remain folded back and held against the rocket during the early powered portion of the rocket flight. Later, when the rocket has passed up through the dense portion of the atmosphere, the antenna will erect so that the two elements are diametrically opposite and normal to the rocket axis to form a balanced dipole (Fig. 4). The photographs show two such dipole antennas perpendicular on a Spaerobee rocket; however, only one element of each dipole is mounted.

These antenna elements consist of 8-foot heat-resistant glass-fiber-whips in which a conductor is embedded. The conductor is wound into a helical coil approximately ¾ inch in diameter extending from the antenna base about one half of the length of the whip, and is a straight conductor for the remainder of the antenna. This coil is required to nearly resonate the antenna at the operating frequency since a short dipole will be highly capacitive. The distributed loading coil is made more effective and tuning is adjusted by inserting a ferrite material within the coil. The length of ferrite is chosen to tune the antenna to the desired reactance.

The second type of antenna telescopes into a tube 20 inches long and ¾ inch in diameter. The tube is carried in a recessed compartment of the rocket during the early rocket flight. It is then released and extended by an explosive charge. When extended the antenna is a straight, tapered, tubular element 10 feet long (20 feet for a dipole). It must be tuned with a lumped coil at its base.

The measurement of the free space antenna impedance presented a problem, since at these frequencies it is virtually impossible to remove the antenna system a sufficient distance above the earth and surroundings to achieve isolation. This was solved by observing that the antennas were symmetrical with respect to the rocket body. Accordingly, a neutral plane perpendicular to the dipole antenna exists through the center of the rocket. This made it possible to measure the impedance of one antenna with respect to the neutral plane and double the values for the dipole antenna impedance.

The impedance-measuring equipment in the rocket is capable of detecting voltage standing-wave ratios of 10 to 1. Standing-wave ratios of higher magnitudes than this result in impedance determinations of questionable accuracy. It is important then that the system be set up such that the impedance variations during rocket flight stay within the region of impedances that keep the standing-wave ratios less than about 10.

The ionospheric effect on the impedance of the antenna is to make it more negatively reactive. Therefore, the antenna is adjusted so that its free-space value of impedance is in the positive reactance quadrant. Then as the rocket ascends into the inosphere and the impedance starts to change, the positive reactance of the system decreases from its initial value, passes through zero reactance or resonance to some negative value. As the rocket starts to descend, the impedance should return to its original value.

A typical telemetry record for this system using automatic decommutation according to IRIG standards is shown in Fig. 5A. One complete revolution of the commutator is from *A* to *B* inclusive. Every other commutator segment is returned to a negative 1 volt for channel synchronization in the automatic decommutation system. The first data point at *A* represents the d-c bias voltage applied to the antenna ahead of the current monitor resistor. The second is the antenna bias voltage with respect to ground on the antenna side of the resistor. Any difference in voltage between these two points represents a d-c current in the resistor. The third bar is produced by the grounded (zero voltage calibration) commutator segment. Following this is the standing wave on the line produced as the commutator samples each tap point on the line from antenna to oscillator. The long bar at *B* is produced by three commutator segments connected together and carrying a voltage of 5 volts. This point serves as a calibrating voltage for the telemetry record and for frame synchronization on the automatic decommutator unit. At *C* a new record is starting. The d-c antenna voltage has risen slightly from conditions at *A*. This is a measure of the sawtooth voltage on the antenna.

The first successful flight of the impedance probe experiment was on USAF Aerobee rocket S/N-37 launched August 28, 1959 at White Sands Missile Range.

On this flight two glass-fiber dipole antennas were used. The operating frequency of one dipole and the impedance measuring system was 3 Mc. A similar system was used with the other dipole, at 7.2 Mc.

A section of the telemetry record from this flight is shown in Fig. 5B. Automatic decommutation was not used on this flight. This shows a series of standing waves for a

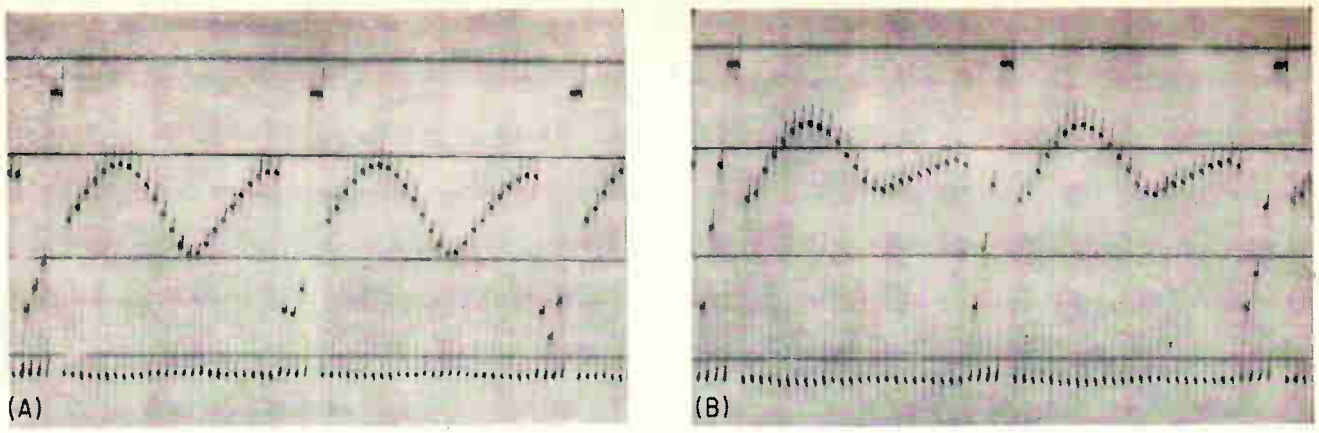


FIG. 7—Record at 7.2 Mc (Aerobee 150 IGC No. AA3.183C) : normal standing wave (A) taken at 65 seconds, and abnormal standing wave (B) taken two seconds later. Fig. 8 shows corresponding impedance changes

period where large changes were taking place in antenna impedance. The standing-wave pattern is traced from oscillator end of the line to antenna (going right to left). On the 7.2 Mc antenna, the standing-wave pattern changed from highly inductive to nearly flat and then to highly capacitive in a few seconds. The altitude at which this occurred was about 90 Km. A similar change took place on the 3-Mc antenna

The standing-wave pattern stayed in the high capacitive regions throughout the major portion of the flight, resulting in limited data. Larger impedance changes were observed than had been anticipated.

Modifications were made to make the impedance probe less sensitive for a later flight (Aerobee 150 IGC No. AA3.183C) flown from Eglin Test Range May 24, 1960. First, the frequencies were raised to 7.2 Mc and 12 Mc. Secondly, the balanced system shown in Fig. 1 was used.

Also, since it is primarily the antenna reactance that changes in the ionosphere, a 50-ohm resistor was placed in series with each antenna element at the feed point. This meant that the reactive changes would not modify the standing-wave pattern as much, thus providing greater dynamic range of measurement.

The impedance curve for the 12 Mc antenna on the second flight is shown in Fig. 6A and 6B. These curves are preliminary and subject to further evaluation. The antennas were released at approximately 58 Km but were held close to the missile body due to air drag for a few kilometers. Then they started to erect with the erection essentially complete at 75 Km. The rocket entered the E-layer experiencing sufficient electron densities to produce a major impedance change at an altitude of approximately 94 Km. Here the reactance of the antenna took an abrupt change in the direction of negative reactance. Between 120 and 135 Km, the missile passed through a less ionized region, then again entered a region of higher intensity, with peaks coming at 140 and 155 Km. From this point, the reactance is not exactly as expected. The antenna reactance should have gone more negative in the higher altitude regions where the electron density becomes greater. This did not occur and the descent curves did not approximate the curve until 100 Km was reached.

The descent curves shown in Fig. 6B are unusual until 110 Km was reached. Here the telemetered data seemed to be good and results were interesting.

Figure 6C shows on an expanded scale the impedance between 90 to 110 Km on the descent curves of Fig. 6B.

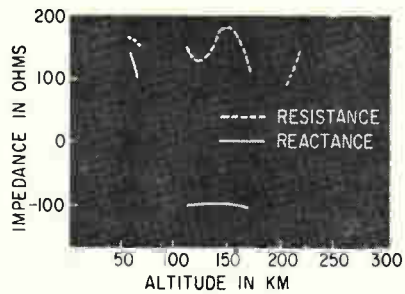


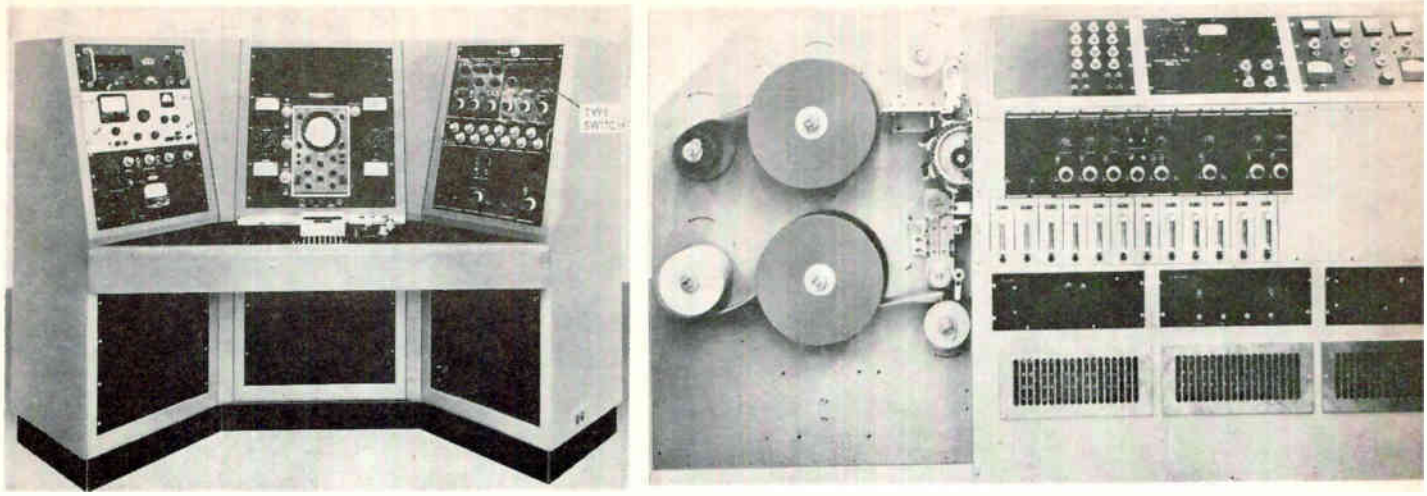
FIG. 8—Antenna impedance curves at 7.2 Mc (curves are shown where conditions permitted data reduction)

In this flight the 7.2 Mc record indicated an unusual and unexplained phenomenon. Up to a height of 70 Km the standing-wave shape was normal. A sample taken at 65 seconds is shown in Fig. 7A. Figure 7B shows an abnormal type of standing wave that was taken 2 seconds later. This abnormal condition occurred between 70 and 100 Km, 160 and 205 Km, and above 216 Km on the rocket ascent and down to 74 Km on the descent. In the region of 100 to 160 Km the antenna impedance had shifted through resonance to a negative reactance.

Figure 8 shows corresponding impedance changes for this frequency. In this case the antenna reactance became negative from 102 to 160 Km. The resistance curves showed an unusual and unexplained hump between 130 and 170 Km. These data were taken from that portion of the flight data that seemed to be reasonably good; however, some of it may be in doubt. The phenomenon that caused the unusual result has not yet been explained.

Further studies are being made to determine if it has resulted from some malfunction of equipment or some phenomenon external to the rocket.

The authors acknowledge the help of W. Pfister and J. C. Ulwick of Air Force Cambridge Research Laboratories. Numerous people connected with the Upper Air Research Laboratory of the University of Utah have also contributed to the work.



Manual diode tester (left) checks 1,200 diodes per day while automatic tester (right) checks up to 18,000 diodes per day

High-Speed Automatic Diode Tester

Ten diode parameters are tested by plug-in test packs and faulty diodes are rejected immediately following detection

By E. V. MARROTT and V. S. ZUCCO, Federal Systems Division, IBM, Kingston, New York

TO ACCURATELY test a diode, each parameter must be individually evaluated. If each parameter evaluation is made on a separate tester, the process becomes inefficient. To overcome this difficulty, an automatic diode tester was built that completely and automatically tests as many as 18,000 high-usage diodes per day and a manual tester was built that is capable of testing up to 1,200 relatively low-usage diodes per day.

At one time, a separate tester was required for each diode parameter and when an operator wished to test a diode, it was necessary to move from one tester to another. This caused the testing rate to be low (approximately 700 diodes per day) and in addition, every time that a new diode was released, a new piece of testing equipment had to be designed.

Modular construction techniques were used in designing a pluggable test pack for each parameter to be tested. The test packs are interchangeable for both manual and automatic testing. This increased versatility makes the equipment less vulnerable to obsolescence.

The manual tester is flexible enough to test germanium, silicon and Zener diodes in one console. The electrical circuits are easily programmed to meet changing diode requirements with only a short time needed for setup. An operator can easily test 1,200 diodes per day in five tests.

There are 12 test parameters simultaneously available with the sensing circuits in the test packs. Back voltages for leakage currents are continuously variable from zero to 1,000 v. Constant current for forward voltage drops is continuously variable from 100 μamps to 15 amperes.

Ten test parameters are available. These parameters are: back resistance, forward voltage drop, peak inverse voltage, dynamic back resistance, forward recovery, flutter, low Zener voltage, high Zener voltage, Zener impedance and hysteresis. These parameters are divided into the following categories: constant voltage, constant current and a-c tests. Constant voltage and current tests can be performed with the same type of sensing circuit but the a-c tests require a different circuit.

The automatic tester can also check germanium, silicon or Zener diodes both in the 1- and 2-watt sizes at the rate of 18,000 diodes per day. Back voltages for leakage currents are continuously variable from zero to 500 v and constant currents are continuously variable from zero to 500 ma.

The mechanical elements of the automatic diode tester are shown in Fig. 1 and its electrical equivalent is shown in Fig. 2. The handler is

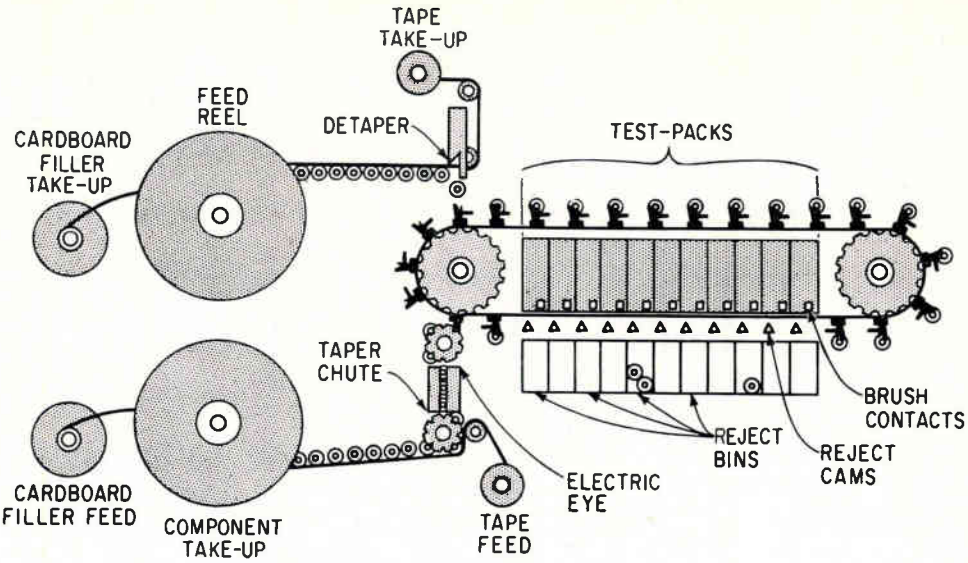


FIG. 1—Mechanical operation of automatic diode tester

designed for in-line movement by a nylon conveyor belt. The conveyer is indexed in 3-in. increments by an 8-stop roller-gear indexing unit. The conveyer is driven by a 1-hp variable-speed drive coupled by a clutch and brake to the index unit.

A reel of diodes is placed on the detaping mechanism. The diode is stripped from the tape and drops into test clips. The cardboard filler and tape is taken up and stored. The handler is started and stopped by a cam operated switch on the indexing unit. The switch operates the test relays of the test package. When a bad diode is found, the equipment pulses a reject circuit that stores the information until the next indexing period starts. Rejection occurs while the component is moving to the next station.

A solenoid-operated cam opens the test clips and allows the faulty diode to fall into the reject bins. All good diodes are counted at the last station and further indexed for ejection into the taper chute. The diodes are then rereeled on tape rolls.

The Zener voltage tester shown in Fig. 3 is typical of the test packages. The amplifier is a constant-current type using three triodes driving a magnetic amplifier. Stabilized tubes and resistors minimize amplifier drift.

One grid of the difference amplifier is programmed with the limit voltage. The other (testing) grid is either in parallel or series with the diode, depending on the type of test. When the amplifier is set up for the reject level, both grids are switched to the reference voltage and the plate circuits are balanced by a potentiometer. The reject indicator lamp will be off.

When a diode is placed in the test clips and the test start relay is energized, the testing grid is switched to the diode under test and measures its voltage. Any difference signal causes the magnetic amplifier to operate, transmit the reject signal and turn on the reject lamp. This amplifier measures back resistance, forward voltage drop, Zener voltage drop and peak inverse voltage.

Leakage currents as low as 3 μa can be detected and the testing grid can take a 500-v overload if the diode has a short circuit. Normal grid voltage is limited to about 200 v maximum.

To determine Zener impedance, specifications require that a reverse d-c current be applied to the diode. Superimposed on this d-c voltage is an a-c wave whose voltage is a function of the Zener impedance. An a-c coupled amplifier allows the a-c signal to be fed to a linear cathode follower. A range switch attenuates large signals that would ordinarily overdrive the a-c amplifier. If the input signals are too large, the a-c amplifier is switched out of the circuit and the input signal is peak detected directly.

The peak detectors feed a differential amplifier. The circuit is initially set up by impressing the specified limit of the modulated d-c current through a nominal impedance with the range switch set to a position that gives maximum output amplitude and yet does not overdrive the amplifier. The balance control of the differential amplifier is varied until the reject lamp comes on. The diode under test is then switched in place of the nominal impedance.

To check forward pulse (recovery), a pulse generator delivers a

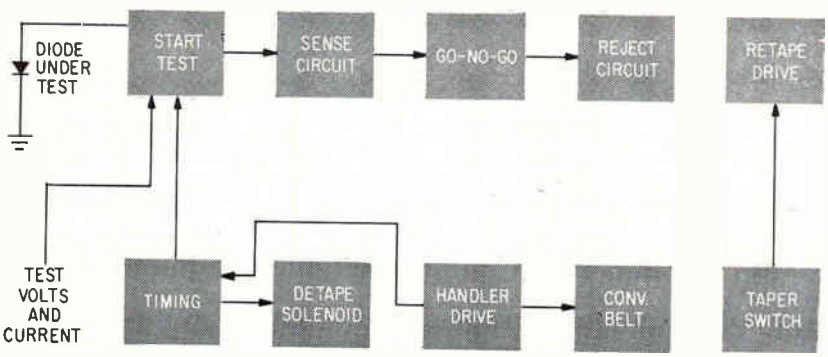


FIG. 2—Start test, sense and go no-go circuits are elements of a typical test pack. Remainder of circuits are used in all tests

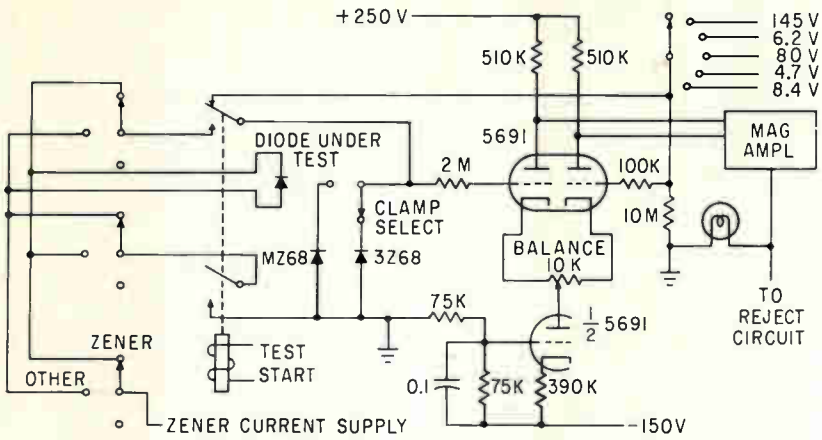


FIG. 3—Typical test circuit uses difference amplifier to trigger magnetic amplifier to signal reject

half-sine wave pulse of specified prf, pulse width and peak current to the diode as shown in Fig. 4A. The reject limit voltage is applied to the shunt bias clipper by a variable bias supply.

The pulse voltage drop across the diode is applied to the shunt bias clipper and if the peak of each pulse exceeds the preset bias voltage, they are amplified and trigger a single-shot multivibrator. In the multivibrator, they are widened and inverted and coupled to the reject circuit. The reject stage is a vacuum-tube circuit with a relay in the plate circuit. The tube acts as a switch to energize the relay upon signal application.

During testing, the reject stage is conducting. When a reject is encountered, a negative pulse appears at the input of the reject stage cutting the tube off and deenergizing the plate relay to activate the reject mechanism.

The reject stage must be conditioned for the next diode since the plate circuit was opened when the relay was deenergized. Conditioning is accomplished by closing the plate circuit through a cam-operated relay.

Using a normally conducting reject stage and requiring the tube to be cutoff when a reject is encountered, affords a practical method of checking catastrophic failure in the test pack. If circuit voltages fail in the test pack, the tube in the reject stage is nonconducting, the reject relay remains deenergized and constantly activates the reject mechanism. A series of consecutive rejects makes a test pack suspect of failure.

Diode flutter is defined as an inherent diode instability that causes a fluctuating d-c current when the diode is placed in series with a low-impedance voltage source.

The diode is placed in the test circuit as shown in Fig. 4B. The d-c component is removed from the fluctuating voltage by capacitive coupling and the alternating component is coupled to an amplifier. The amplified signal branches through two diodes. The negative half is inverted and recombined with the positive half so the shunt bias clipper input signal resembles a full-wave rectified signal.

The shunt bias clipper passes only the peaks of the signals that exceed the preset bias level. This bias (reject) level is set before testing by applying a signal of an amplitude equal to the maximum acceptable limit to the amplifier input. The pulse peaks at the output of the shunt bias clipper are applied to a single-shot multivibrator and reject circuit similar to that in the forward pulse circuit.

It now appears that the industry is turning toward testing by variables rather than a go no-go basis. While the automatic tester does not read out the value of a diode parameter, a system of band testing can be adopted. Assume that a lot plot or distribution curve of the back resistance of a large group of diodes is required. Assume further that five distinct bands of back resistance values are required. It becomes relatively simple to use three additional back resistance test packs (two are already in the automatic handler) and to program each to the desired limits. The additional test packs can be inserted in any test station not being used.

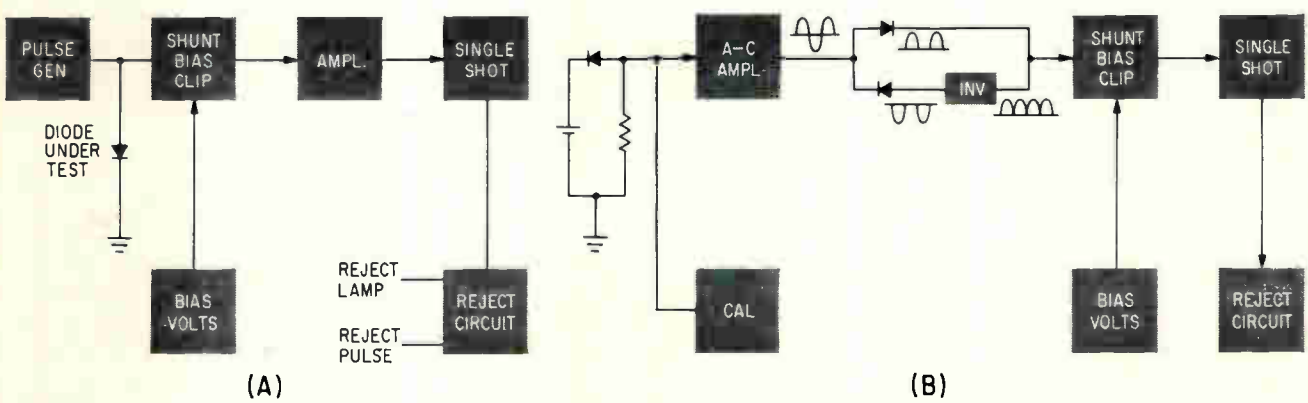
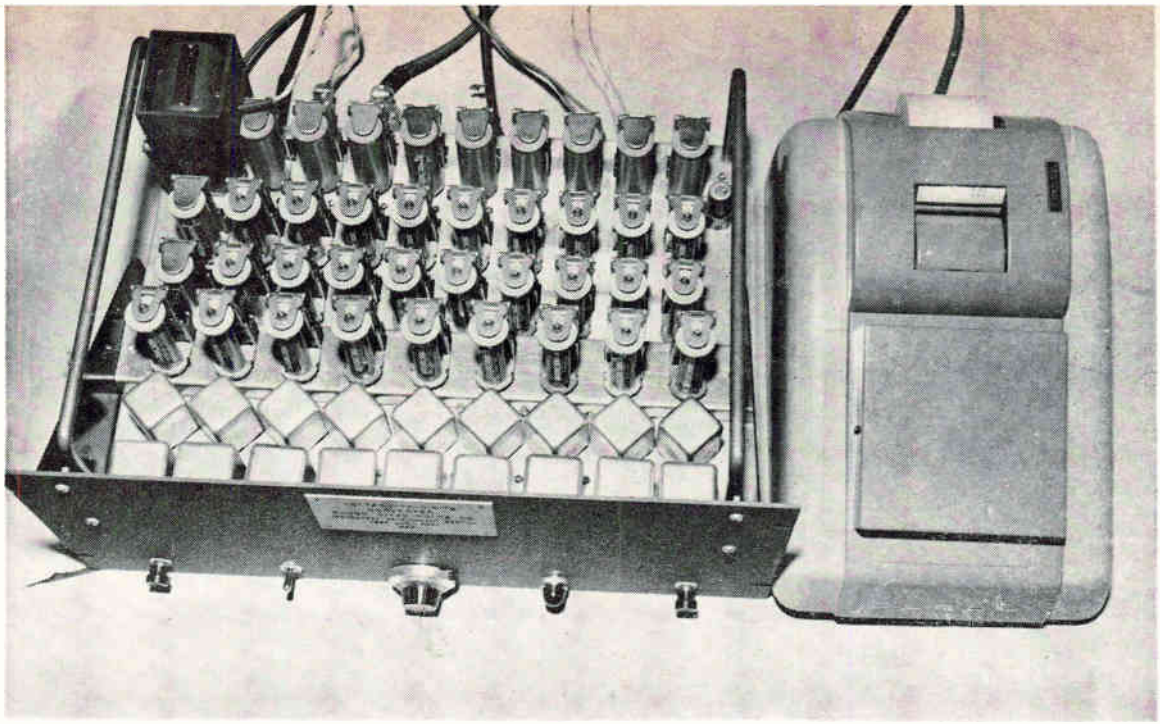


FIG. 4—Forward recovery circuit (A) compares pulse voltage drop across diode with preset reject voltage. Flutter tester (B) measures a-c component of fluctuating d-c produced by diode and battery in series



Top view of analog-to-digital converter, with solenoid-operated printer

VOLTAGE-TO-DIGITS

Unknown voltage is compared with a relay-operated sequence of decreasing known voltages from a resistance voltage divider. The comparisons operate relays that control a printer, through a binary-to-decimal translator

DURING a recent study of data-handling techniques, need arose for a volts-to-digits converter of moderate speed and accuracy, simple design and construction. An application for such a device would be in a laboratory where a large number of test voltages are recorded in a maintenance program. The range was 0 to 100 volts d-c, with a resolution of 1 volt or less. A speed of one reading a second would be considered an improvement over ordinary methods.

This application required a potentiometric measurement; that is, no power should be absorbed in the measuring device. This measurement compares a known variable voltage with the unknown voltage, and the difference between them is reduced to zero. The sequence of varying the known voltage can be done by resistance slidewire, stepping switch, relay chain or electronic flip-flop.

In considering reliability, stability and ease of maintenance, it appeared that electronic techniques were not justified in this application. On the other hand, at relatively low speeds, relays have an advantage. It appeared that a simple volts-to-digits converter could be developed using relays.

In potentiometer circuits, the characteristics of the comparison device are important. This device determines whether the unknown voltage is less than, greater than or equal to the unknown voltage. It must be sensitive to the smallest increment of voltage that the system is designed for, and in addition not be adversely affected by momentary overvoltages. A simple device for this purpose is the polarized relay, which operates on voltage polarity changes in addition to amplitude changes. It can be designed for operation at one milliwatt or less. At the impedance levels of this application, such a relay would operate on voltages as low as 0.5 volt. Figure 1A shows the basic potentiometer circuit of the converter in a digital air-pressure recording system.

Analysis of potentiometer circuit operation shows that a definite sequence of steps is necessary in balancing the circuit conditions. Some devices have smooth transistions from one step to the next, other have relatively large steps with abrupt changes from one step to the next.

It was decided to use the successive approximation technique, in which the variable known voltage is compared with the unknown voltage in a sequence of steps decreasing in value.

Mathematical quantities may be expressed as a sum of increments, as in the binary system: $A = a2^n + b2^{n-1} + c2^{n-2} + d2^{n-3} + \ldots$, where n is the exponent in the most significant term. If n is 7, the first increment would be 128, second increment 64.

In successive approximations, trials of known voltage increments are made, comparing each with the unknown voltage. Decisions are made in each trial as to whether the known voltage is less than, equal to, or greater than the unknown voltage. If less than, the voltage increment is kept in the

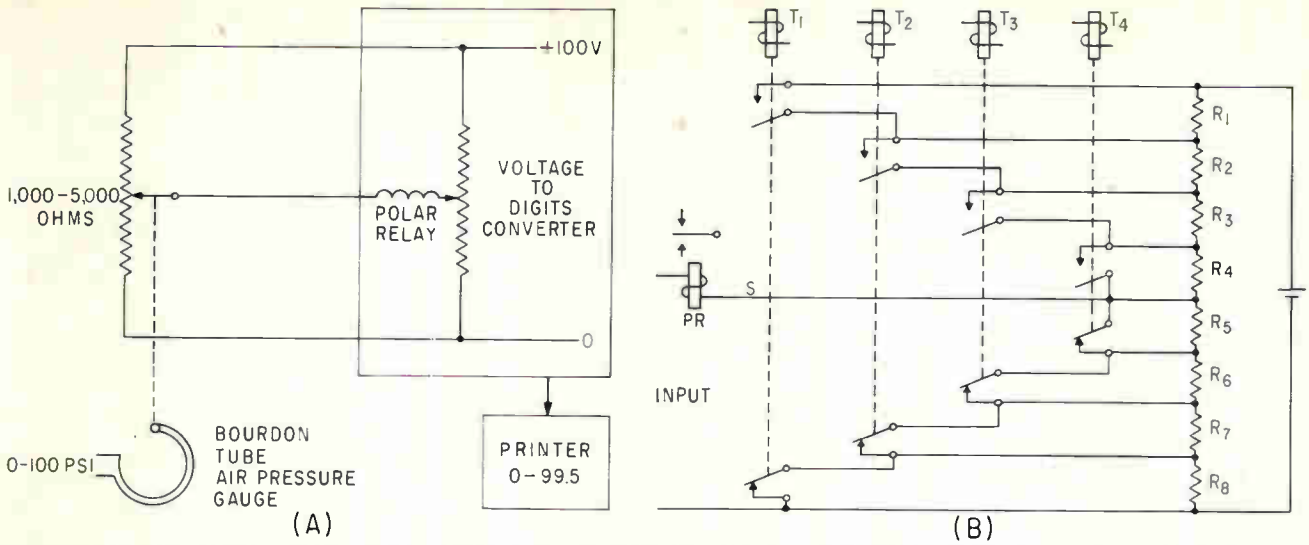


FIG. 1—Digital air-pressure recording system (A), with converter shown in simplified form. In an elaboration of the basic system (B) the T relays operate in combinations to include or short out various resistances in the voltage divider chain. For example, if relays T_1 and T_2 are operated, resistances R_1, R_2, R_3 and R_4 are shorted out, and the others remain in the circuit. The converter uses 9 T relays and 18 divider resistors

CONVERSION WITH RELAYS

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circuit, if an equal to or greater than decision is made, the increment is allowed to drop out. The coefficients $a, b, c, \ldots$ may be either 1 or 0, depending on the decision of the comparison device. These decisions are made in time sequence, and may be recorded in that manner on magnetic tape or other medium. They are also stored in the increment retention devices (relays) and may be read out in parallel at the end of the sequence.

Successive approximation is most efficient when using the binary system, considering the number of sequence devices necessary. However, the binary system is not well-suited for use by human beings. A sequence using the decimal system requires at least three times as many steps as one using binary, but produces readings more intelligible to humans. A more efficient number system uses binary coded decimal numbers, where each decimal digit is represented as the sum of binary numbers. A commonly used code is the 4-2-2-1, where the sum of increments to represent any quantity from 1 to 99 is: $A = 40a + 20b + 20c + 10d + 4e + 2f + 2g + h$. This requires 8 steps, or increments. A binary series would require 7 steps to cover 0 to 99. A decimal series would require 20 steps to cover 0 to 99.

A voltage-to-digits converter was developed using these principles, with the 4221 code. Figure 1B is a simplified illustration of the fundamental principle used. Resistances R_1 to R_8 comprise a voltage divider controlled by relays T_1 to T_4. Point S is in effect moved up and down the resistance chain by operation of the relays, thus varying the ratio between the supply voltage and the output at S. These relays are operated by a sequencing circuit, producing voltages in steps of 40, 20, 20 and 10, which are compared with the unknown voltage. The difference between the known and unknown voltages is applied across the coil of the polarized relay PR. When the unknown voltage is greater than the voltage from the resistance voltage divider, the polarized relay contact is closed and locks relay T, and then the next step in voltage is added to that already produced by the voltage divider. If the unknown voltage is less than that produced by the voltage divider, the polarized relay contact remains open and the T relay is allowed to drop open.

The voltage-to-digits converter was constructed for a balance sequence of nine steps, with a full-scale range of 0 to 99.5 volts. Figure 2A illustrates the operation of the converter. Resistors R_1 to R_{18} are in series, making up a voltage divider that produces a variable voltage of 0 to 99.5 volts, in 0.5-volt steps. These resistors are switched in the circuit by trial relays T_1 to T_9, which are controlled by relays S_1 to S_{27}. The S relays are operated in sequence and require about 0.5 second for the complete operation.

The first comparison step is initiated when relay S_1 closes trial relay T_1 through the sequence relay contact chain and resistor R_8, producing 40 volts for comparison with the unknown voltage. The polarized relay coil PR, the unknown voltage

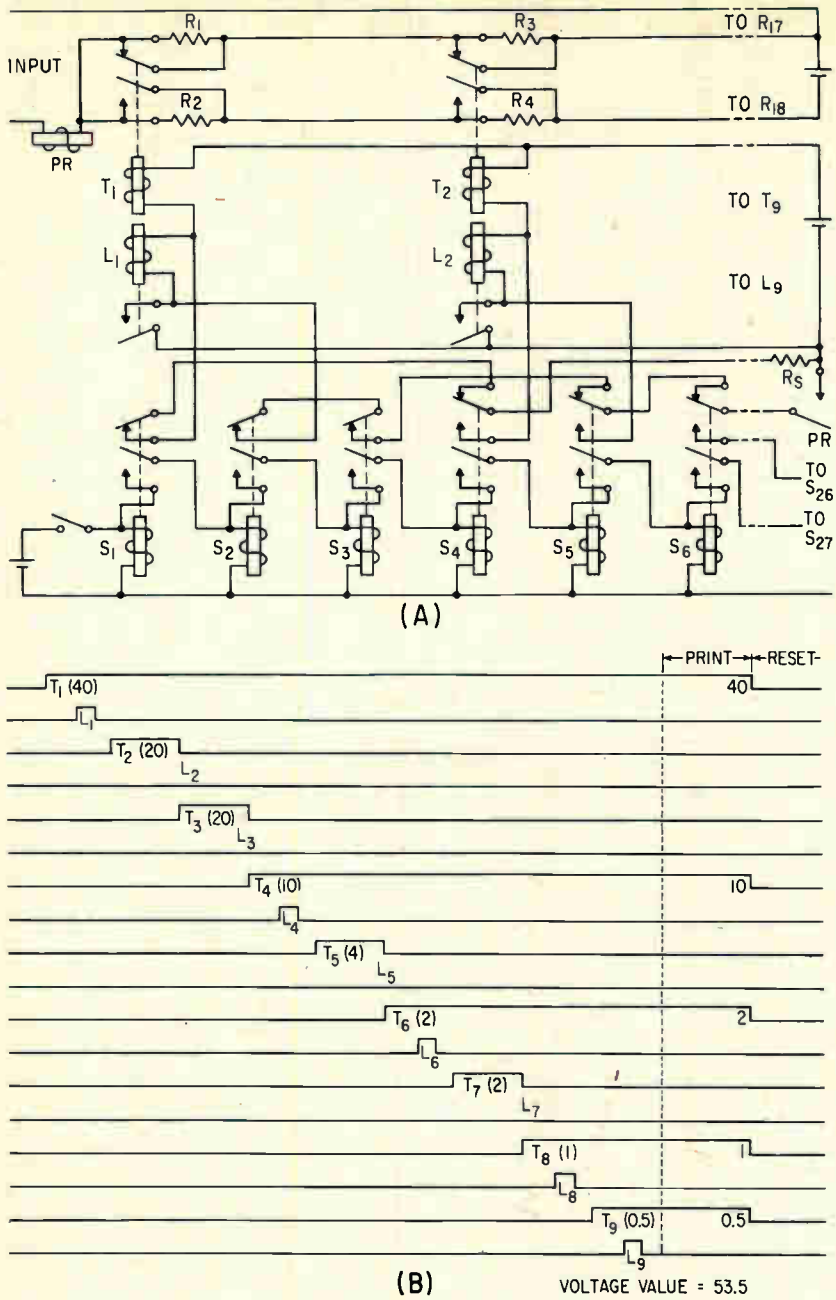


FIG. 2—The partial schematic (A) shows the first two of the nine sets of relays in the converter. The combination of locked T relays in the comparison sequence (B) determines the voltage value to be printed out

and the known voltage are all in series and the difference in the voltages is impressed on the *PR* coil. If the unknown voltage is equal to or greater than 40 volts, the *PR* contact (at lower right) remains open and the closure of S_2 fails to operate L_1. Operation of S_3 opens the normally closed S_3 contact, breaking the circuit through the sequence relay contact chain and the *PR* contact.

Operation of S_4 transfers R_S and the sequence relay contact chain to trial relay T_2. If T_1 and L_1 are not locked, T_1 drops open. Relay T_2 controls a 20-volt increment that is added to 40 volts if T_1 and L_1 are locked. If T_1 and L_1 were not locked on the first step, only the 20-volt increment is then compared with the unknown voltage. The sequence continues, comparing known and unknown voltages, in decreasing values, through nine steps.

At the end of the sequence, the locked relays will indicate the decisions made as a result of known-to-unknown voltage comparisons. Figure 2B illustrates this for an unknown voltage of 53.5.

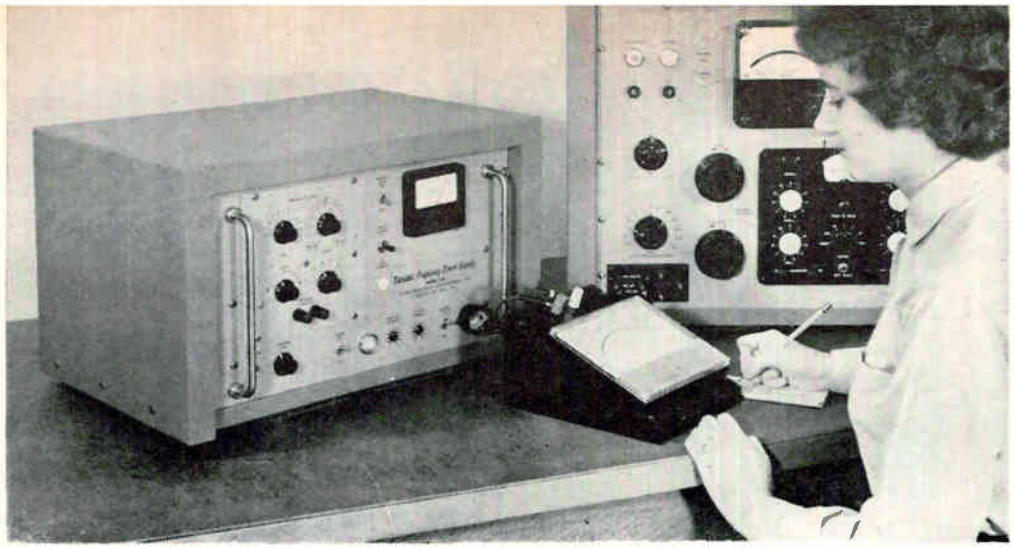
A relay translator converts the coded relay indications into decimal digit contact closures for operation of a printer. The translator relays are operated by normally closed contacts on the locking relays L_1 through L_9. Translator relays are operated one at a time when locking relays operate. The least significant figure is either 0 or 5, for the 0.5-volt step.

The sequence circuit is composed of a relay chain with three relays for each voltage step, plus printer control relays, and an error lockout relay. At the end of the print cycle, the entire sequence relay chain is opened and all relays drop back to normal unoperated status. A switch disables the automatic print circuit, and holds the digital value in the translator relays until a manual pushbutton actuates the printer. This is useful for checking overall operation.

The polarized relay coil circuit is open at all times except when comparisons are being made. This prevents heating of the coil by continuous current.

The converter components are mounted on a single chassis. Power for relay operation is supplied from external sources. In the photo, the row of relays next to the front panel is the locking relays (the *L* relays in Fig. 2A), next row is the trial relays (*T* relays). The three rows of telephone-type relays comprise the sequence circuit. The middle row (S_1 and S_4) connects and transfers trial relays to the power bus. The front row (S_3 and S_6) spaces or isolates trial relay transfers, to prevent false operation of the polarized relay. The other row (S_2 and S_5) connects and transfers polarized relay contacts to locking relays. Capacitors decrease the speed of sequencing relays. Translator relays are the last row along the rear of the chassis. The polarized relay is mounted on stilts in an iron enclosure at the left rear corner. Under it are the printer control relays. The error lockout relay is a miniature type at the right end of the chassis.

On the front panel are the operating controls. At the lower right is the pushbutton for initiating operation. Next left is the error indicator lamp. In the center is a variable resistance for padding the resistor chain. At the lower left is the switch used to disable automatic print operation, and the pushbutton for manual print control.



Operator calibrates instrument using precision variable frequency power supply

Precision Variable Frequency Power Supply

Ballast tube in thermal regulating bridge controls amplitude of the output; an adjustable filter controls the frequency from 50 cps to 2 Kc

By EVERETT A. GILBERT,
Radio Frequency Laboratories Inc.,
Boonton, N. J.

INSTRUMENT CALIBRATION usually requires a voltage or current source with stability five to ten times better than the accuracy of the meter under test. Short time source stability of ±0.02 percent is desirable for calibrating ±0.1 percent instruments. These short time source stabilities can be obtained by feedback amplifiers and improved thermal regulating bridges.

Figure 1 shows a simplified diagram of an a-c voltage regulating system for instrument calibration. The system consists of a feedback stabilized amplifier, thermal regulating bridge and filter network, with phasing such that the circuit oscillates at the series resonant frequency of the LC filter. Output voltage e_2 builds up, heating the thermal element E_1 and raising its resistance until the thermal bridge is brought to balance ($e_b = 0$). Reference voltage e_r is the regenerative voltage needed to maintain the system in oscillation. Resistors R_1 and R_3 set the magnitude of the output voltage and the thermal element regulates the voltage to this magnitude.

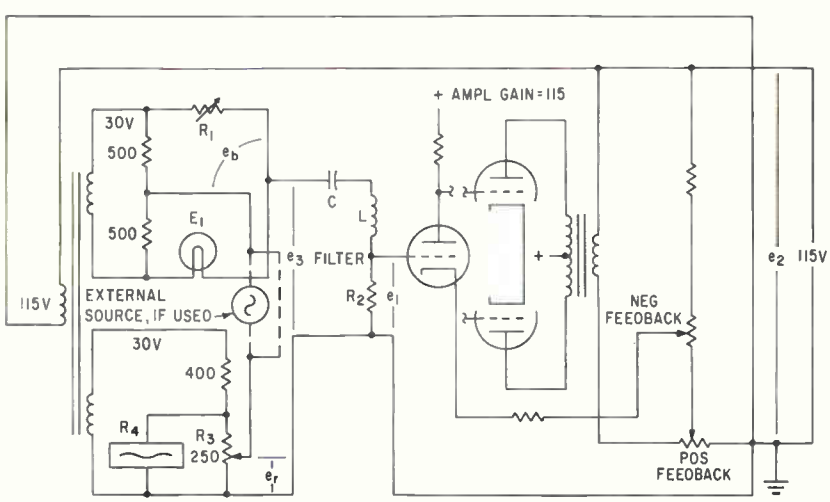


FIG. 1—Thermal regulating bridge using ballast tube operates in power oscillator to maintain output voltage constant

Lamp filaments and thermistors have been used as thermal elements in similar applications[1]. Most lamp filaments are unsatisfactory for instrument sources as their resistance is sensitive to mechanical vibrations and show a slow electrical drift. Thermistor bridges change with ambient temperature and require compensation or controlled ovens when used in precision regulator circuits. Satisfactory thermal elements for precision regu-

lators are commercially available ballast tubes.

These consist of a fine iron wire in a glass bulb filled with hydrogen. The curve of Fig. 2 shows the relationship between the voltage across the ballast tube and the current through it. With 30 volts across the thermal bridge of Fig. 1, the operating point of the tube is at *P* in Fig. 2. Bridge sensitivity is high: 10 percent change in bridge input voltage gives 5 percent change in bridge output.

The tunable filter is made up of load resistor, toroid inductor and variable capacitor. The variable capacitor consists of a decade of mica capacitors and a variable air capacitor and covers the range from 30- to 20,000-pf. Separate capacitors of 1.1- and 0.85-μf are switched across the decade capacitor to obtain oscillations at 50 and 60 cps. Besides controlling the frequency, the filter attenuates harmonics generated in the thermal bridge and nonlinear stabilizing resistor R_1. An external voltage from a source impedance of less than 100 ohms may be used to lock the system to an external standard frequency. The filter must be tuned to the frequency of this external voltage.

When the reference voltage e_r is obtained from the power amplifier output, the thermal regulating loop can become unstable and amplitude modulate the output at a low rate, but if the bandwidth of the LC filter is small and attenuates the high frequency response of the thermal bridge, the system will be stable. Stability is possible with ballast tube thermal elements from 50 to 2,400 cps but at higher frequencies it is necessary to make e_r partially independent of the amplifier output. This is accomplished by shunting R_3 with nonlinear resistor R_1.

Steady state and transient characteristics of the a-c thermal regulating loop can be determined from a d-c servo loop, provided the band-pass filter is replaced with a low-pass filter of $\frac{1}{2}$ the bandwidth. As shown in Fig. 3, the low frequency gain of the thermal bridge breaks at about 1 radian per second and falls off at 20 db per decade. The filter response is shown at $\frac{1}{2}$ the bandwidth of the band-pass filter and falls off at 40 db per decade.

Figure 4 shows the schematic of the thermal bridge and tunable filter. The output stage of the amplifier (not shown) uses two 7378 pentode tubes in push-pull class AB$_1$, transformer coupled to the output load. A small voltage proportional to the current in the load provides positive feedback to the input. To this positive feedback is added degenerative voltage proportional to the voltage across the load. The maximum feedback rate or reduction in gain is 25 to 30 db. At full load the amplifier has a gain of 66 db without feedback, which is reduced to 40 db with feedback. Positive feedback is adjusted so that a 20 percent change in output load does not measurably change output voltage. Output impedance is less than 0.5 ohms.

To insure stability with reactive loads, the frequency shaping of the open loop gain is accomplished within the frequency response of the output transformer. At low frequencies the amplifier response over the first 30-db fall off in gain is controlled by a small coupling capacitor at a rate of 20 db per decade. Above 2,000 cps the response is attenuated at 20 db per decade by a shunt capacitor.

The photograph shows a 200 v-a variable-frequency power supply for instrument calibration from 50 to 2,400 cps. Total harmonic distortion is less than 1 percent between 50 and 600 cps at 200 v-a output and about 0.5 percent between 50 and 2,000 cycles at 100 v-a output. When aligned for instrument calibration the rms stability for periods of 10 to 15 minutes is less than 0.02 percent.

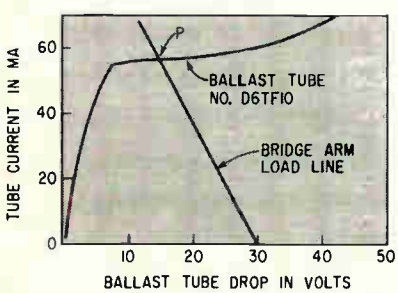


FIG. 2—Ballast tube has required characteristic for application

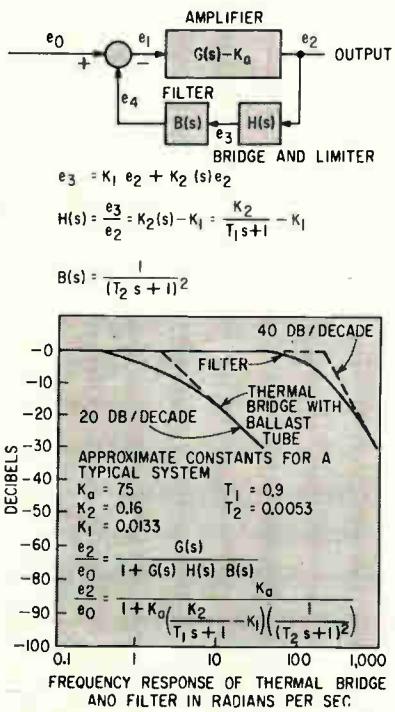


FIG. 3—Transfer function and frequency response

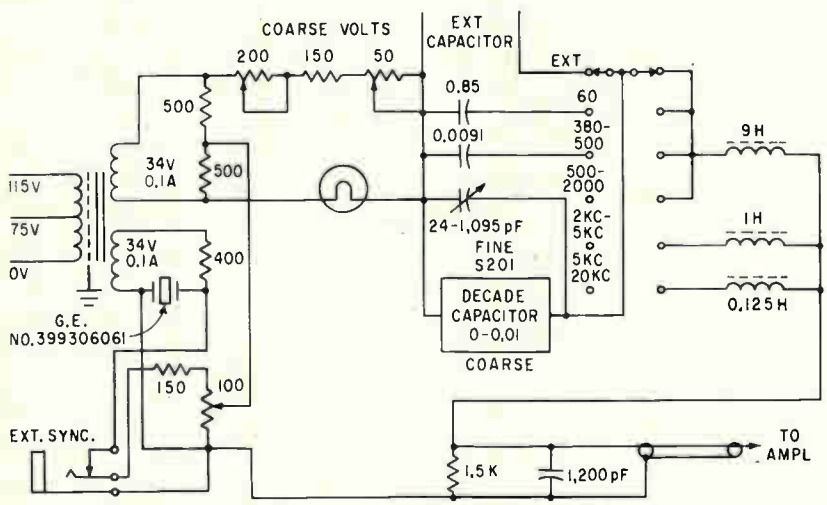


FIG. 4—Details of thermal bridge and filter for use from 50 cps to 2 Kc

REFERENCES

(1) G. N. Patchet, Precision AC Voltage Stabilizers, *Electronic Engineering*, p 371, Sept. 1960.

United Eyelets and Eyeleting Machines Keep this Princess on Constant Call

The new Princess telephone — a product of the Western Electric Company — is an achievement in communication design INSIDE as well as out, thanks in part to a United Eyeleting Machine that automatically feeds and sets six twin United Eyelets in a plastic insulating terminal board no bigger than a cigarette lighter.

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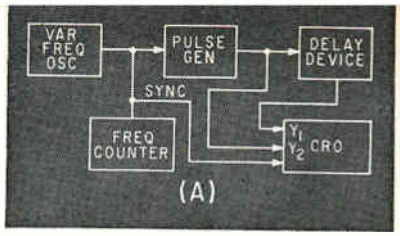
By HAROLD T. McALEER,
General Radio Company, West Concord, Mass.



Precise Delay Measurement

PRECISE MEASUREMENT of delay time has become a subject of increasing interest in the design of modern electronic equipment. This article describes a technique that permits the measurement of repetitive delays with durations ranging from less than 0.1 microsecond to more than 1 millisecond, with a precision of a fraction of a nanosecond.

A block diagram of the measuring system (A) includes a variable-frequency synchronizing oscillator, pulse generator, delay device under test, cathode-ray oscilloscope and frequency counter to monitor the repetition rate of the oscillator and pulse generator. The output of the pulse generator, either a brief pulse or a sharp voltage step, enters the delay device. Both input and output voltages of the device are observed simultaneously on the oscilloscope. The repetition rate of the oscillator is adjusted until the output pulse of the delay device coincides in time with the next input pulse. At this point the delay time of the device is equal to the time interval between input pulses, that is, the oscillation period of the oscillator. Thus if the pulse repetition rate is such that a pulse emerges from the device just as a new pulse enters, the delay time of the device is equal to the interval between pulses. The frequency of the oscillator is measured by the frequency counter, and the time delay is calculated from $t = 1/f$.

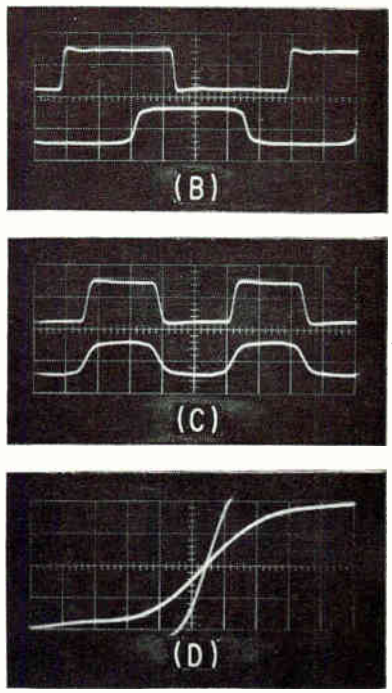
A precise measurement requires an equally precise definition. Where brief pulses are of importance, one useful convention defines delay time as the interval between the peak amplitudes of the input and output pulses. Where voltage steps are of interest, delay time is often defined as the interval between the 50-percent amplitude points of the input and output voltage steps.

The waveforms shown were observed during the measurement of the voltage step delay of a developmental 0.45-μsec delay line. The input and output voltages of the delay line are shown in (B). In (C) the repetition rate has been adjusted for approximate coincidence of input and output voltages. In (D) the maximum oscilloscope sweep rate was used and the repetition rate adjusted for the closest observable coincidence of the half amplitude points. The oscilloscope was a Tektronix 543, with the sweep rate control at 0.1 μsec per cm and the sweep rate magnifier at 10, uncalibrated. These settings produced an observed sweep rate of about 14 nsec per cm. However, the actual sweep rate is unimportant, since the oscilloscope is used only as a coincidence indicator. Measurements of the oscillator frequency indicate a delay of 0.4380 μsec with a measurement reproducibility of 0.4 nsec.

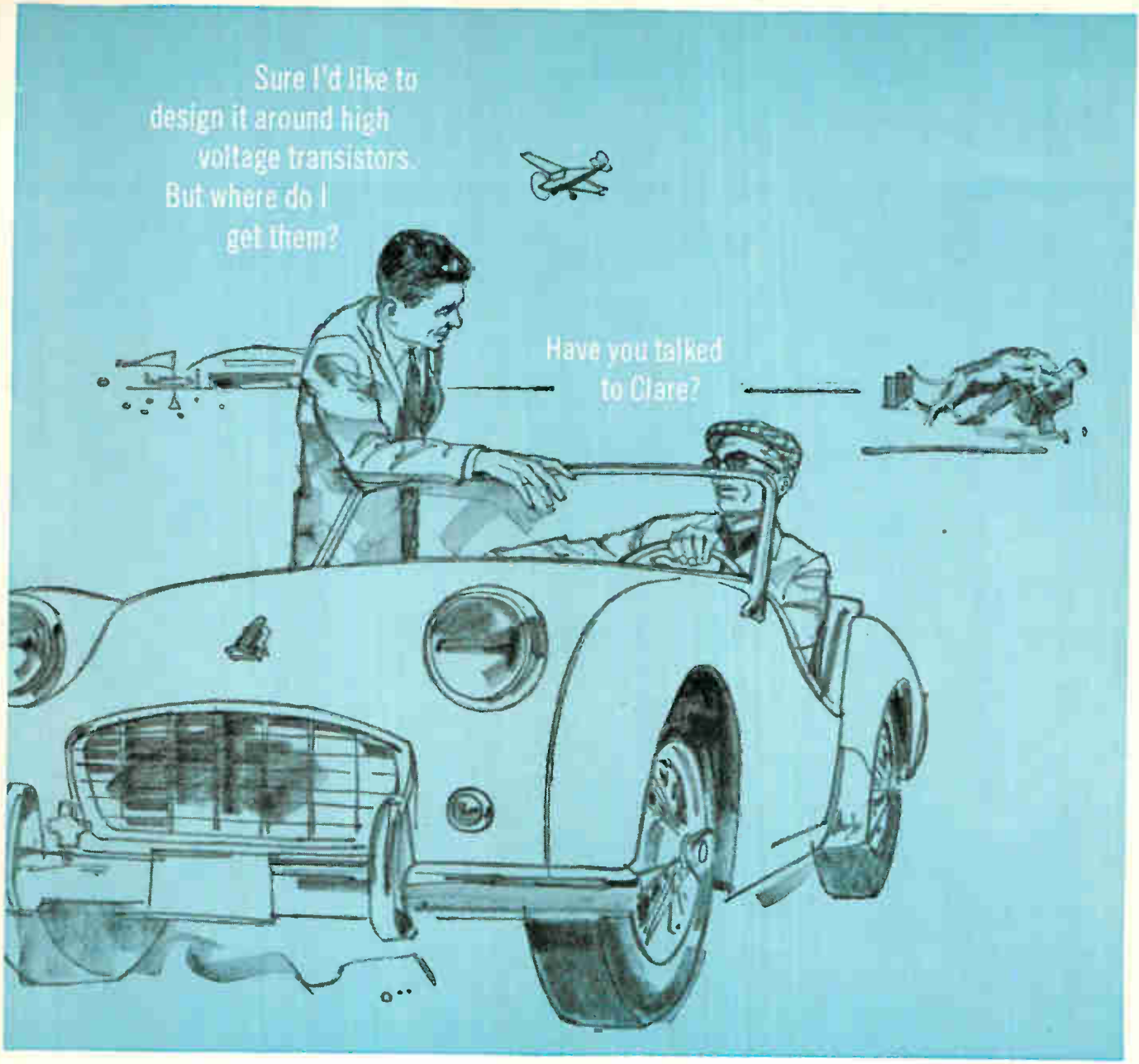
The method is obviously limited to the measurement of those delay devices having zero recovery time. That is, the device under test must be able to accept an input pulse while producing an output pulse. Delay devices with finite recovery times can be connected in cascade so that the overall combination has zero recovery time while each device has the delay time of the rest of the combination in which to recover.

The measurement precision is restricted by the precision with which coincidence of input and output signals can be determined. This is restricted by the maximum sweep rate and bandwidth of the oscilloscope and the amplitude and transition times of the signals. In the measurement examples, a dual trace oscilloscope was used. The differential delay between the two traces must be determined—for example, by observation of the same signal on both traces. Both signals can be observed on the same trace by a signal-adding network. Determination of coincidence also depends on the jitter or frequency instability of the oscillator and pulse generator and on the jitter of the oscilloscope sweep. Finally, the precision of measurement is limited by the stability of the oscillator during the interval of measurement and by the precision with which the frequency of the oscillator can be measured. With modern techniques of frequency measurement the latter is seldom a limitation—except possibly in the measurement of long delays.

The method has been used to determine the temperature coefficient of delay networks and to test delay devices.



Block diagram of delay measurement system (A). Waveforms show input and output voltage steps of delay line, at a low repetition rate (B), approximate coincidence (C), and exact coincidence (D), with horizontal scales of 0.2, 0.1, and 0.014 μsec per cm, respectively



MULTIPLE SOURCES MAKE GOOD SENSE—in design, in purchasing, in production. And when you develop an additional source which gives you prompt delivery, top quality, reasonable pricing and truly creative service...you make your whole job much easier. For example: when your circuit calls for high voltage transistors, you call for Clare. C. P. CLARE TRANSISTOR CORPORATION, 260 GLEN HEAD ROAD, GLEN HEAD, L. I., NEW YORK, or contact your nearest C. P. Clare & Co. sales office.

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2N398, CP398, 2N1310, CP98—*Characteristics at 25°C*

	Min. BV_{CBO}	Min. V_{PT}	fαb	Min. h_{FE}	Max. Rated Dissipation
2N398 (PNP)	−105Vdc	−105Vdc	—	20 at I_C=−5mAdc	50mW
CP398 (PNP)	−105Vdc	−105Vdc	1mc typ.	30 at I_C=−5mAdc	120mW
2N1310 (NPN)	+90Vdc	+90Vdc	—	20 at I_C=+5mAdc	120mW
CP98 (PNP)	−65Vdc	−65Vdc	.4mc min.	30 at I_C=−30mAdc	150mW

Horizon Scanner Has No Rotating Members

By C. V. STANLEY,
T. P. DIXON,
Advanced Development Lab.,
ITT Laboratories,
San Fernando, Calif.

EXPERIMENTAL attitude sensor for artificial satellites has no rotating members. A permanent magnet loudspeaker is used in a horizon scanner that senses orientation of the satellite relative to the earth. It enables control of the satellite or a portion of it to direct telescopes, cameras, antennas or other equipment in accordance with the mission of the vehicle.

Significance of the development is its suitibility for space applications. The absence of rotating parts increases potential life and eliminates the problem of keeping bearings lubricated in the almost total vacuum in space. A laboratory breadboard of the scanner weighs less than a half pound. It consumes only 10 mw of electrical power limiting the added weight and space required for additional solar cells and storage batteries. Selection of electronic components and design and packaging of circuits were made to withstand the environmental extremes encountered in launching and space flight.

The sensor can be used in a variety of other applications including stellar navigation, optical pickoff for gyros or as an autocollimator. Sensitivity of the breadboard horizon scanner was better than one second of arc.

The speaker is used to drive four small mirrors that scan the earth beneath the satellite. The mirrors are mounted on equally spaced leaf springs attached to the voice coil at one end and to the frame at the other, as shown in Fig. 1. A lens provides an image of the earth at the image plane except where the mirrors deflect small segments of the image at the earth's edge to detectors. As the voice coil is driven, the mirrors nod synchronously sweeping the segments on and off the detectors.

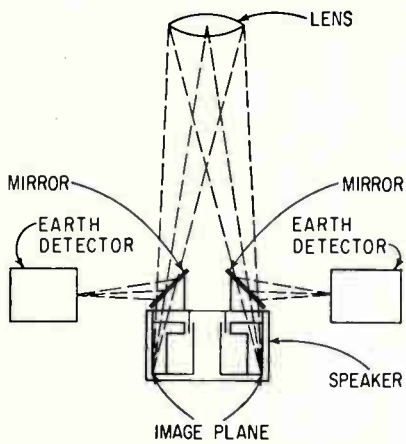


FIG. 1—Relative pulse durations from oppositely located indium antimonide detectors depend on earth's position with respect to optical axis

If the earth's image is not centered on the optical axis of the system, the times that the image is reflected to each detector are unequal. Duration of detector pulse outputs are also unequal with shorter pulses from one detector accompanied by longer pulses from the detector located opposite to it. Circuits compare pulse duration from each pair of detectors and provide an output proportional to displacement of the image from the optical axis.

One of two electronic subassemblies processes detector signals and generates error signals for the vehicle attitude control system. Pulse outputs from the detectors in Fig. 2 have a repetition frequency equal to scanning rate. However, when the scanned object is not on the optical axis, duty cycles of oppositely positioned detectors are unequal. The fractional microvolt detector pulses are amplified to the millivolt level by preamplifiers and then to several volts by amplifiers. Clippers maintain constant output amplitude regardless of object brightness, detector sensitivity, optical transmissivity or differences in gain among channels.

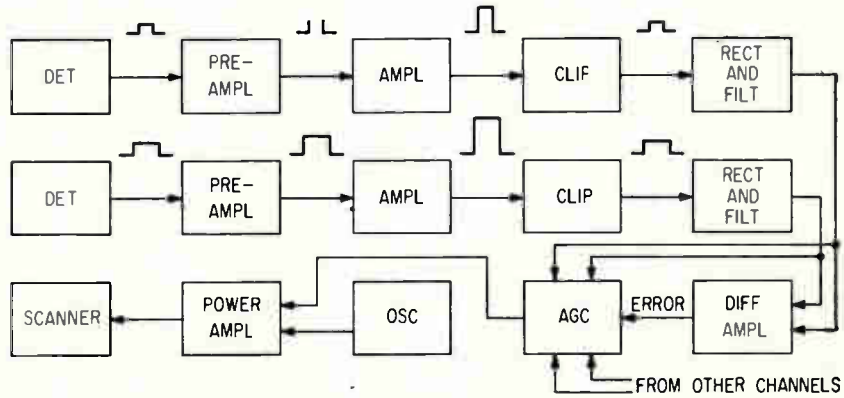
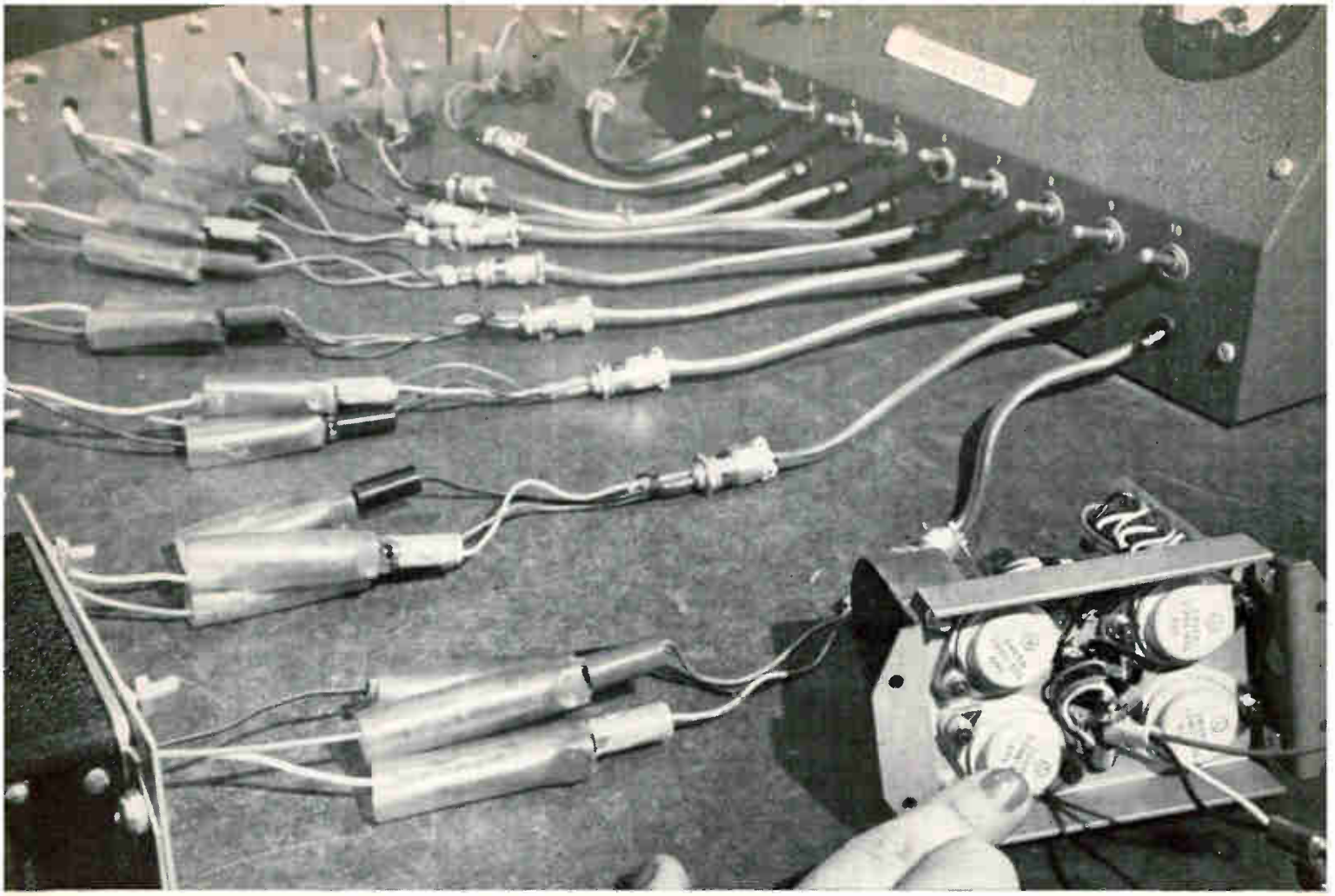


FIG. 2—Unequal length pulses from each detector of pair are converted to d-c voltages and applied to differential amplifier to produce off-axis error signal

The clipped pulses are rectified and filtered to produce d-c voltages directly proportional to detector pulse duration. Filter time constant, made compatible with vehicle requirements, should be very long compared with scanning frequency period but very short compared with vehicle oscillation period. Within these limits, a longer time constant improves signal-to-noise ratio.

The d-c voltages from a detector pair are applied to a differential amplifier that provides zero output when the object is on the optical axis. Output polarity for off-axis conditions is dependent on the direction of deviation.

Frequency of the fixed-frequency



Tung-Sol transistors meet tight specs of *FLITE-TRONICS* miniature airborne power supply

Flite-Tronics' miniaturized PC-8 airborne power supply is fast becoming standard equipment aboard many commercial, private and military aircraft. More and more aircraft designers, seeking means of eliminating the costly maintenance problems associated with dynamotors, are replacing them with these all-transistorized Flite-Tronics units. Moreover, the PC-8 provides large-scale reductions in weight and volume over rotary gear while sharply curtailing power drain losses.

Heart of these bantamweight power supplies is Tung-Sol 2N459 germanium power transistor. Tung-Sol made an all-out effort to meet the exceedingly difficult specifications laid down by Flite-Tronics for their high reliability equipment. This is how Flite-Tronics reported the results: "The ability of Tung-Sol transistors to meet the required performance levels is largely responsible for the success of the PC-8. We have had no equipment failures whatsoever from these transistors."

If you need the space-saving, power-saving features of semiconductors, or if your design calls for tubes, you can be assured of premium performance when you specify Tung-Sol. And Tung-Sol makes both to a single standard of unexcelled quality. While your equipment is in the planning stage contact Tung-Sol application engineers. They will gladly assess your circuitry and give you an impartial recommendation for the component complement that most efficiently answers your design needs. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193

Technical information available through Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. In Canada: Abbey Electronics, Toronto, Ontario.

TUNG-SOL®

scanning oscillator in the second subassembly is compatible with detector chopping frequency and is centered at scanner resonant frequency for maximum energy conversion. Oscillator output is amplified by a power amplifier, and agc regulates output level and therefore scanning amplitude. The filtered d-c outputs and all detector channel error outputs are connected to the agc circuit. Computer logic determines gain requirements based on system operating conditions.

Large amplitude scanning is permitted by the agc for large error signals in any or all channels because large off-axis deviation is indicated. High-amplitude scanning is also provided when both a zero error signal from a differential amplifier and a zero signal from one or both channels driving it exist. These conditions indicate that the scanned object is out of the field of view and large scanning amplitude is desired to acquire it.

Scanning amplitude is limited with simultaneous occurrence of small or zero error signals from all differential amplifiers and large signals from all channels driving them. These conditions exist when the object is at or near the optical axis.

Helium Test Finds Transistor Leaks

RELIABILITY of transistors is said to be improved by an unusual method of checking for leaks in hermetic sealing. Delco Radio Division of General Motors, which is using the technique to replace all other leak-testing methods, calls it the helium-bomb test.

All transistors are immersed at high pressure in a container filled with helium. If a transistor is not hermetically sealed, some of the helium will penetrate into the transistor. After removal from the high-pressure helium chamber, the transistors are washed in air and placed individually in an evacuation chamber.

Gas evacuated from the chamber following this procedure is tested for helium. A standard helium detection system is used, which can monitor leak rates as low as 10^{-10} cm^3/sec.

Because of the higher inherent reliability realized with the helium-bomb test, Delco Radio has discontinued all other leak-testing methods. Before making the decision to rely wholly on the helium test, the firm used the water-bomb test. This procedure involves immersing the transistors in water at high pressure. Then, after baking, they are tested for electrical defects. An inherent weakness of the water-bomb test became apparent. Water vapor inside a unit generally destroys it. However, it was found that some marginal leakers passed electrical tests following immersion in water and baking but failed later.

Helium does not damage the transistors. By using the helium-bomb approach, absence of leakage in hermetic sealing is assured without using radioactive gases or damaging transistors with water vapor.

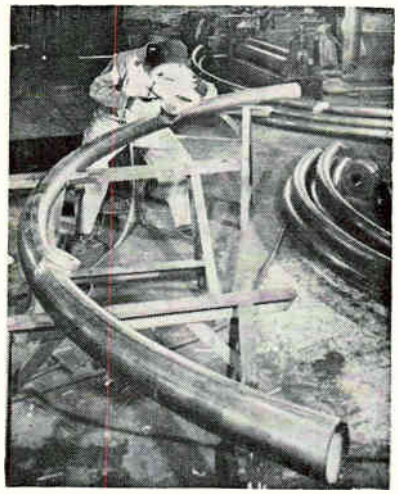
Ozone and Weather

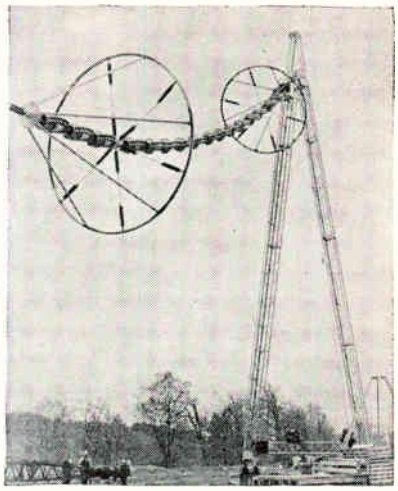
ANALYSIS of the ozone layer in the stratosphere may give clues on atmosphere circulation and thus supply information on weather previously unknown. An ozone analyzer using thermistors will be used to determine the amount of ozone in the atmosphere at various seasons of the year.

At altitudes of 40,000 to 150,000 feet the atmosphere's absorption of the sun's ultra-violet radiation brings about a process of decomposition to produce ozone. The ozone layer thus formed is heated by the process to cause turbulence in the next higher layer, the mesosphere. The resulting air currents are thought to affect atmospheric circulation.

The analyzer mounted for test purposes on a KC-135 jet tanker determines the amount of ozone by measuring the heat of the decomposition process, thus tieing-in this information with prevailing weather conditions.

Since ozone has a very definite deteriorating effect on humans, the instrument may fulfill another purpose: constant monitoring of the ozone layer as aircraft and spacecraft fly through it. An Air Force Research Division scientist, Fracois Olmer, conceived the device.





The U. S. Navy's two-million-watt radio station uses Republic Steel's stainless steel tubing to shield and grade the insulator string to prevent formation of corona and flashover. Top left photo shows welder joining a leg bracket to a section of grading ring. Center photo shows workmen attaching base plate to grading ring at Lapp Insulator's High Voltage Lab in LeRoy, N. Y. Rings and insulators are shown during final testing on dummy tower, right

Antenna Signals Blanket Entire Planet

WHAT IS believed to be the world's mightiest radio station, broadcasting with 40 times the power of any existing commercial broadcasting installation, is being outfitted with special stainless steel grading or corona rings, believed to be the largest ever fabricated, for use on antenna insulator strings. Details of this construction has just been released to this column on an exclusive basis.

This station is now being erected on a peninsula on Machias Bay, Maine, for the U. S. Naval Communications System, as a component of the Polaris FBM System. Continental Electronics Manufacturing Company is the prime contractor, and the contract is being administered by the Bureau of Yards and Docks, Navy Department. The entire installation will be a $70 million addition to the nation's defense setup.

The antenna system of the station consists of 26 supporting towers interconnected by a virtual spider web of antennae. Each antenna panel is insulated and supported from the towers at each of four points by a chain of insulator links 74 inches long. In turn each of these long strings of porcelain insulators is fitted with a pair of the giant grading rings; the rings with supporting frame work for attaching to the ends of the insulator strings straddle the insulating units like funnels strung on a washline. The rings form a safe gradient for 400,000 volts so that the station's power is not dissipated in corona losses or arcing.

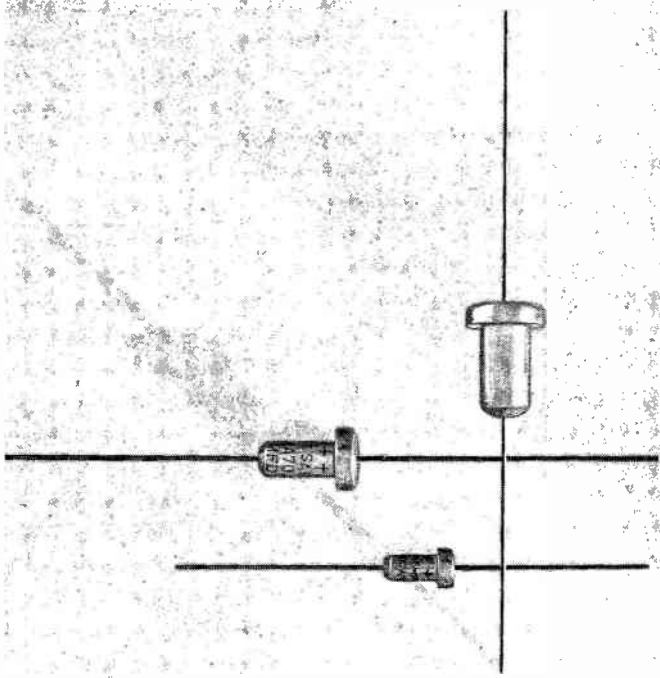
Looking like frames for mammoth funnels, the grading rings are fabricated in two sizes from Republic Steel's stainless steel tubing to give the needed non-magnetic properties, strength and corrosion resistance to salt sea air.

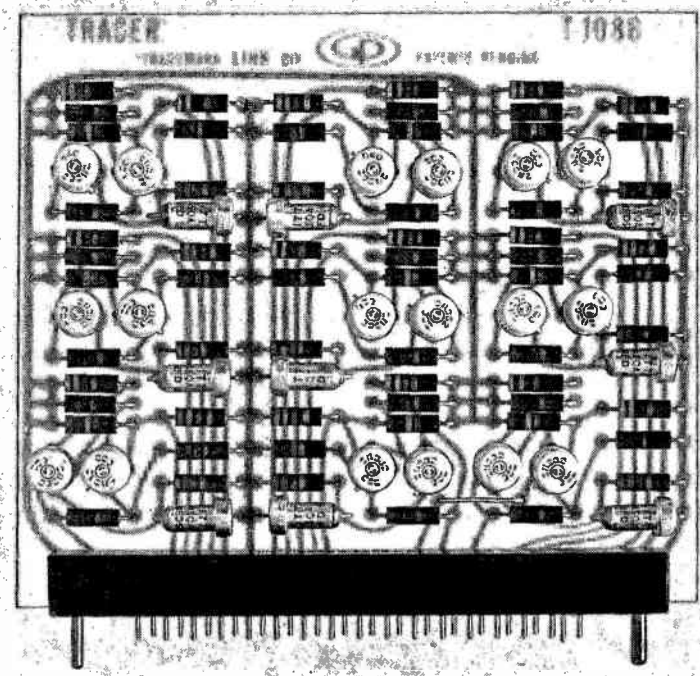
The larger of the two corona rings has a 20 ft. diameter mouth pyramided to a steel plate at the other end by six 15-foot legs. The smaller of the two rings is similar in construction with a 15-foot diameter mouth. The open end of the rings is made from Type 304 4½-inch O.D., 0.165-inch wall stainless steel tubing in three sections. The rings were designed by Lapp Insulator Co., Inc. of LeRoy, N. Y. and furnished as part of their insulator assemblies. Both Lapp and Jentsch and Company of Buffalo, N. Y., who did the actual bending, report that no difficulty was experienced in imparting the proper curvature to the tubing. Three attachment fittings to which turnbuckles and legs are attached are welded to each section of the tubular circle. The end of each section is flared for the insertion of a stainless steel plug used to connect one section of the circle to the next. The legs of the rings are of Republic's Type 304 3-inch O.D., 0.165-inch wall stainless tubing.

Completed, a ring is mounted at each end of every insulator string requiring some 96 corona rings in all. The mouth ends of the rings face each other on the insulator string and are fastened to the insulator links by six shielded barrel turnbuckles.

The insulators are necessarily located close to the towers where the voltage gradient is the greatest and where corona losses and arcing would certainly occur if the grading rings were not used.

The antennae are spread out in two arrays, each having a center tower 980 feet high, an inner circle of six towers 870 feet high and an outer circle of six towers 800 feet high. The two antennae arrays that link these towers cover an area of more than 1200 acres. The towers were fabricated by Republic's Steel





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

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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.

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- 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.

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

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Truscon Division, Youngstown, Ohio.

Generally, the station will broadcast with an input power of two million watts. The power house will be able to generate 12 million watts so that de-icing operations may be carried on simultaneously with the powerful very low frequency transmission. When completed early next year, the station will be capable of sending signals throughout the world as well as to our submarines anywhere under the sea.

Improved Battery Meets Outer Space Requirements

A RECHARGEABLE nickel-cadmium battery with a true hermetic seal, specifically designed for high reliability, long-life outer space performance was revealed by Gulton Industries, Inc., of Metuchen, N. J.

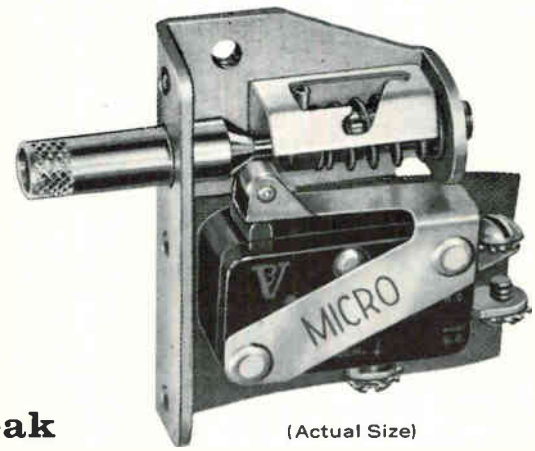
Dr. Leslie K. Gulton, president and chairman of the electronics firm, announced that the new battery has features which point to improved high-energy-density storage systems: a proprietary ceramic-to-metal seal which forms a true molecular bond; a new porous synthetic sheet separator with superior stability under the severe oxidizing conditions inside the sealed cell, even at elevated temperatures; and greatly improved electrical performance characteristics.

The improvements, incorporated in a nickel-cadmium system, are applicable to any other sealable battery, such as the silver-cadmium system.

Developed by the company for

NEW

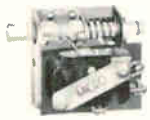
DOOR INTERLOCK SWITCH eliminates momentary circuit break during re-set



(Actual Size)


13AC Series


17AC Series


22AC Series


8AC Series


24AC Series

A few of the many different door interlock switches available. Write for Data Sheet 186 or see the Yellow Pages for the nearby MICRO SWITCH Branch Office.

A new model in MICRO's line of protective door interlock switches, the "13AC" is designed to eliminate that momentary power interruption when the interlock is re-set upon closing the door. This feature is particularly desirable on electronic equipment such as data processing consoles, transmitters or computers.

Door interlock switch assemblies automatically break the power circuit when a door or drawer is opened, make it easy to intentionally energize the circuit for check or test, and eliminate the use of dangerous jumpers or tie-downs. When the door is closed, these devices automatically re-set so that next time the door is opened, power is safely cut off.

MICRO SWITCH door interlocks are the ultimate in reliability as protective devices on cabinets and enclosures containing electronic equipment that may be hazardous to personnel. More than 150 models include environment-proof and high temperature designs, subminiature and multi-circuit assemblies and some with self-lubricating thermoplastic actuating rods.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

military and space applications, the new battery has better overcharge capabilities at lower operating pressures than prior models. The five-ampere cell is capable of absorbing a charge current of one ampere indefinitely.

The battery operates for at least 20,000 duty cycles over a period of many years. The unit will have applications in remote installations on the earth's surface where equipment must perform unattended for exceptionally long periods.

The new ceramic-to-metal seal evolved from a program encompassing the development of both materials and techniques, leading to materials of superior mechanical strength, matched thermal characteristics and resistance to severe chemical attack. The Gulton technique now makes it possible to seal large ceramic inserts to flat metal surfaces.

Improved techniques have been developed whereby large amounts of oxygen can be recombined at low pressures at active electrode surfaces. Greater uniformity in electrical characteristics between cells has been achieved in the battery.

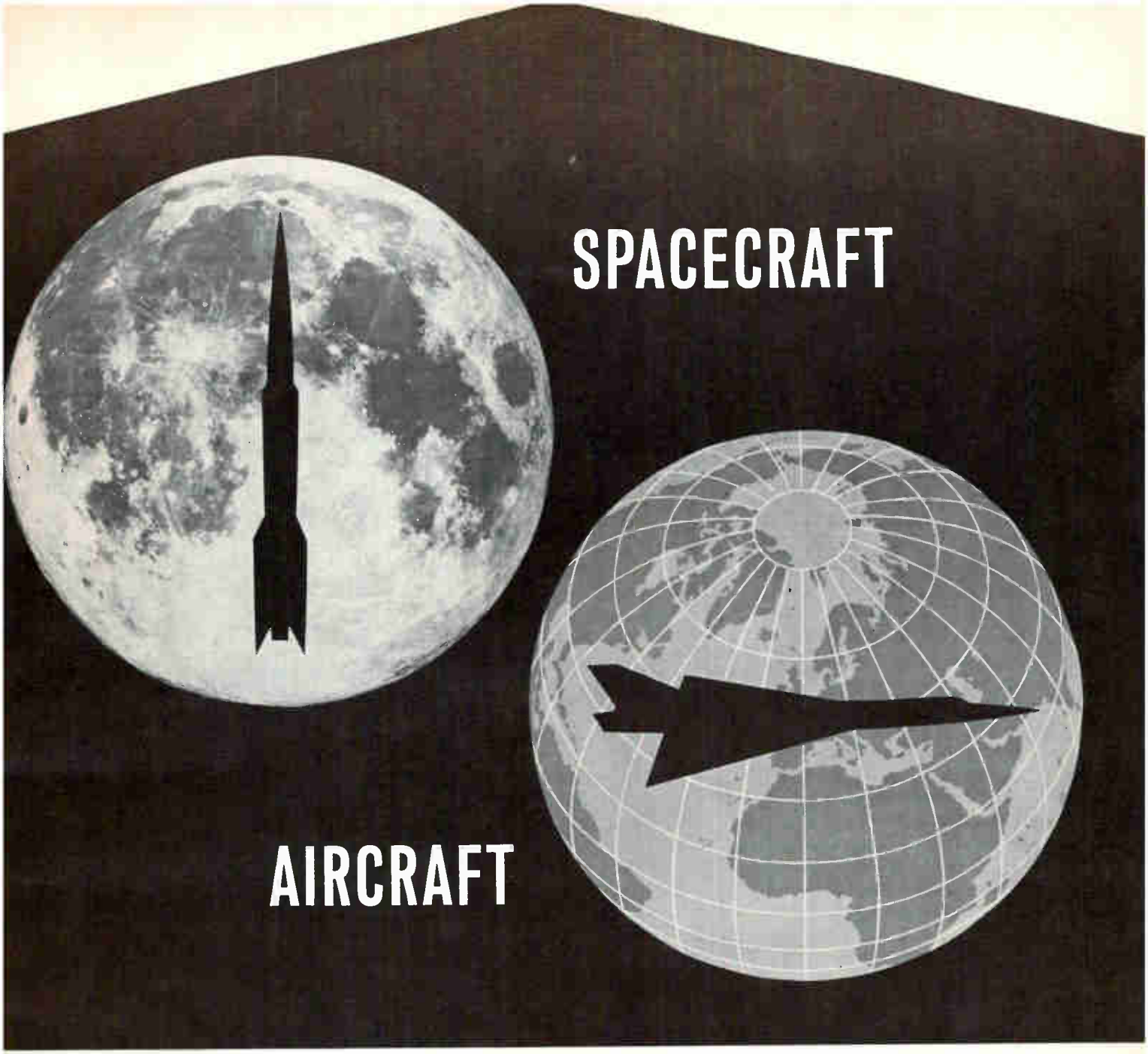
The new separator will not deteriorate at high temperatures and will hold electrolyte during shock, acceleration and spin. Special methods for integrating cell components were used to create the new battery.

The battery absorbs excess energy without leaking or bursting. Energy can now be effectively stored and limited by a single device, eliminating the need for auxiliary equipment to limit overcharge.

The battery acts as a voltage regulator and prevents overloading of the electronic circuits in periods when excessive solar energy is collected. Thus, the battery is never overcharged, but always fully charged.

The sealed nickel-cadmium battery is used in conjunction with solar cells as a power source in satellites today. Solar cells supply energy to the instruments while the satellite or space vehicle is in sunlight, but when eclipsed from the sun, power comes from the storage battery.

Gulton plans to produce these cells, using refined manufacturing techniques.



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This typifies Lockheed policy to steadily advance the state of the art through basic research in related and scientific fields.

Result? Now—more than ever—Lockheed offers Scientists and Engineers uncommon opportunities; equips them with every modern facility; gives them freedom to explore and express new ideas; makes possible greater individual recognition.

Now being designed and developed in Spacecraft and Aircraft are: Hypersonic interceptors; V/STOL; supersonic interceptors; limocopters; missiles; manned spacecraft; and satellites.

Scientists and Engineers of outstanding talent are now invited to participate in this new, dual enterprise. Immediate openings are available to: Aerodynamics engineers; thermodynamics engineers; dynamicists; electric research engineers; servosystem engineers; electronic systems engineers; biophysicists; infrared physicists; hydrodynamicists; ocean systems scientists; physio-psychological research specialists; mammalian culture research specialists; and radiation hazards specialists.

Write today to Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1501, 2408 N. Hollywood Way, Burbank, California.

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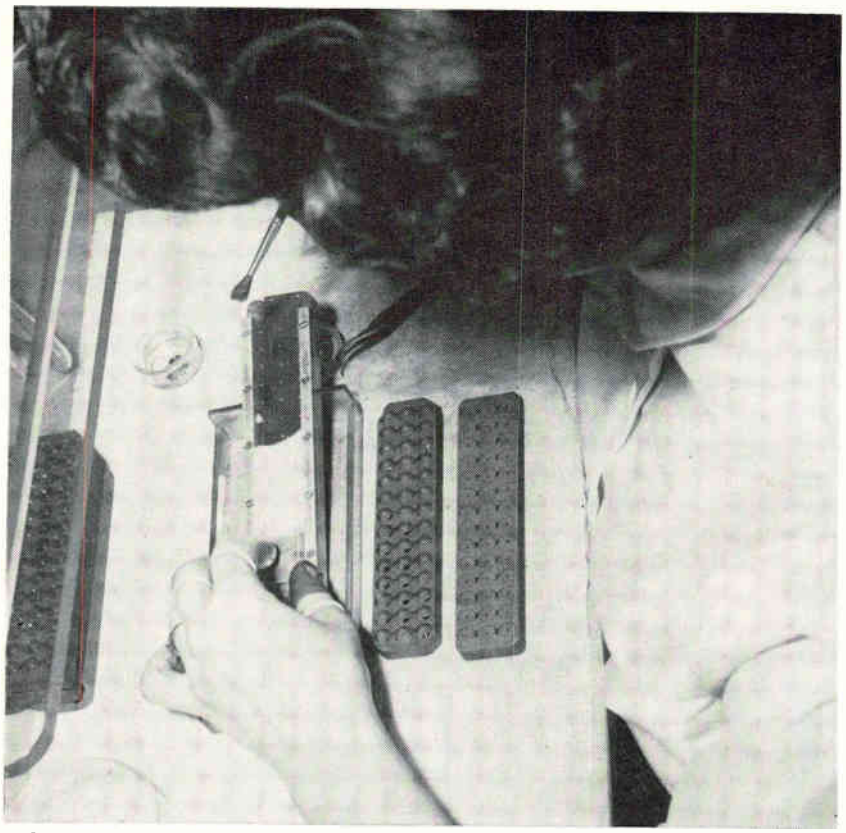
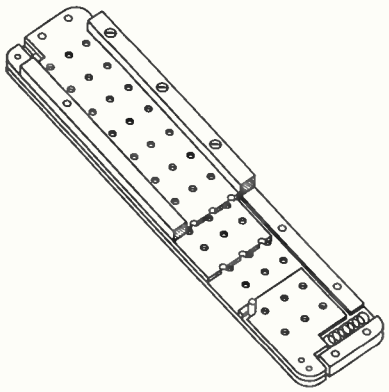
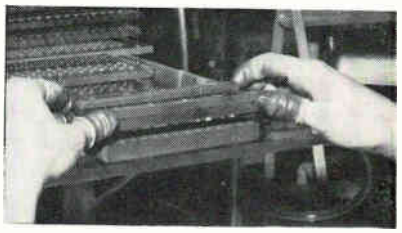
CALIFORNIA DIVISION



Alloy pellets being loaded into top of squeeze plate. Pellets fill holes as they roll down plate behind sliding metal block



Cutaway sketch of pellet loader. Holes in the three plates line up when fixture is squeezed



Operator positions pellet loader over boat, to drop 42 pellets into boat simultaneously

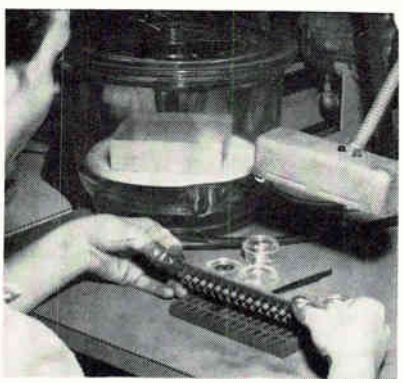
Multiple Pickups Load Transistor Parts

SQUEEZE PLATES and vacuum pickups are used extensively to load and unload boats for furnace alloying of low-voltage audio transistors at the Lansdale Division of Philco Corp., Lansdale, Pa.

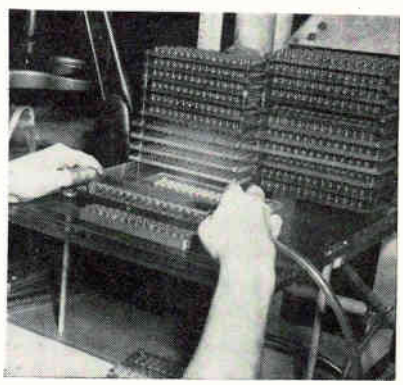
One type of squeeze plate completely loads one side of a boat with alloy pellets in a single operation. The plate is made of three pieces of sheet metal. The middle sheet is spring-loaded so it will move parallel to the top and bottom plates when the plate is squeezed. Holes corresponding to pellet positions in the boat are drilled in each sheet. However, until the plate is squeezed, the holes in the three plates do not line up. When the plate is positioned on top of the boat and squeezed, the pellets drop into the boat cavities.

To load the plate, the operator places it on an inclined rack. Pellets are poured from a vial over the high end of the plate. As the pellets roll down, they drop into the top sheet's holes, which are large enough to hold only one pellet. A soft brush is used to make sure all holes are filled and to remove extra pellets. Unused pellets fall into a receptacle at the low end of the plate.

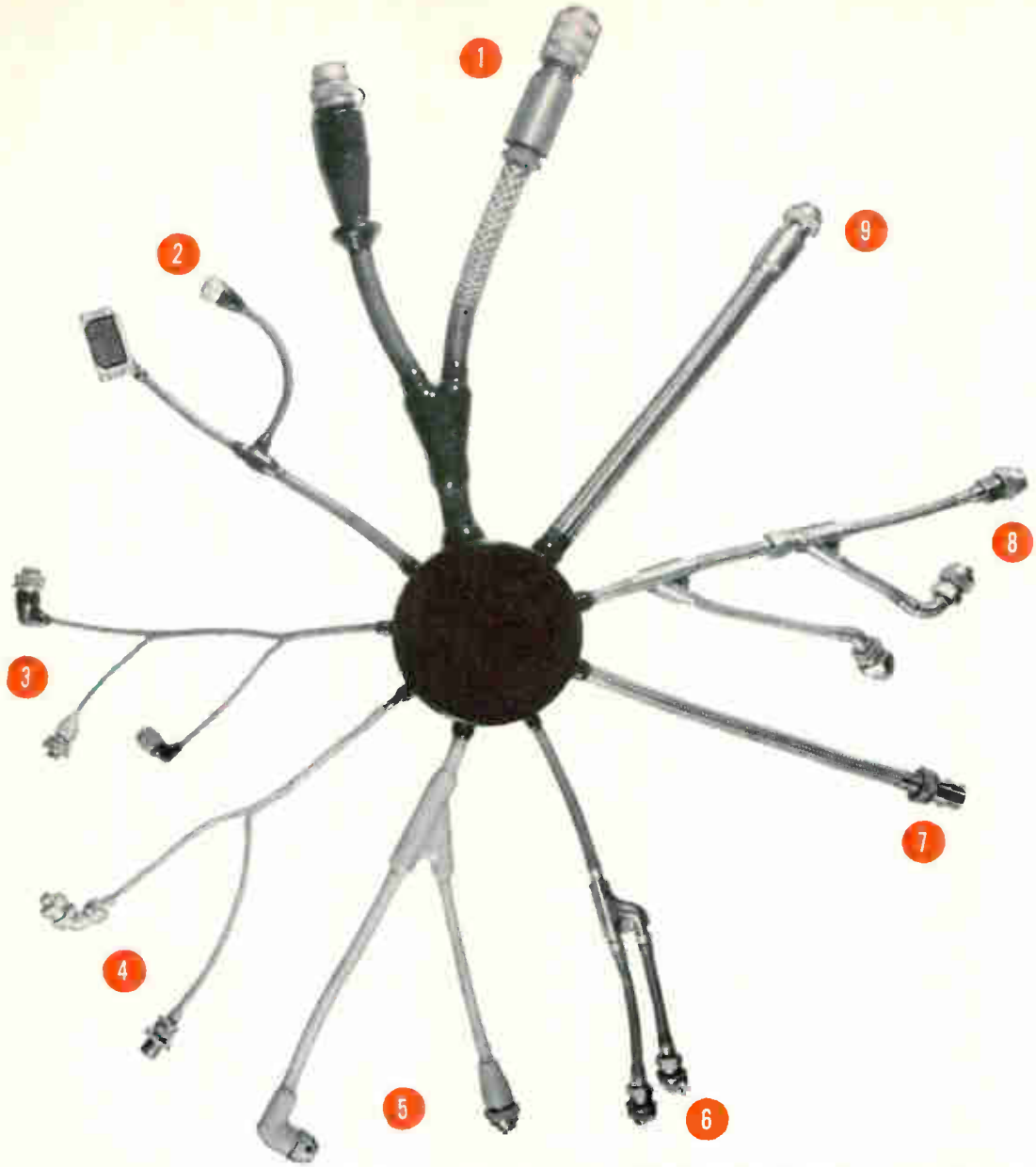
A similar squeeze plate unloads graphite sleeves from the boats used to alloy miniature hearing aid transistors. The sheets of the plate are drilled so the holes are aligned when the plate is not squeezed. The tops of the sleeves are provided with small flanges. When the plate is positioned over the boat and



Similar squeeze plate unloads graphite sleeves from boats



Vacuum bar is used to pick up pistons and drop them in boat



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Bendix cables—products of over a quarter-century of design and manufacturing experience—are proving their complete reliability in a countless variety of applications involving critical environmental conditions.

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SIDNEY, NEW YORK

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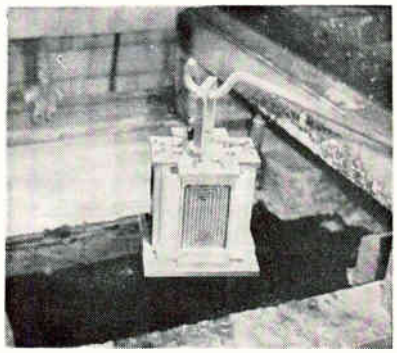
squeezed, the flanges are caught and the sleeves can be lifted out. The sleeves are transferred to holding jigs and released from the plate.

Vacuum pickups speed the loading of graphite pistons. The graphite parts are sintered in vacuum furnaces before use and then are stored in plastic carrying jigs. Loading positions in the jigs and vacuum ports in the pickup correspond to positions in a single row of cavities in the boat. The parts are transferred row by row from the jigs to the boat.

Vacuum pickups of the small, hypodermic needle type are used to load semiconductor dice individually.

Assembly by Brazing Cuts Machining Time



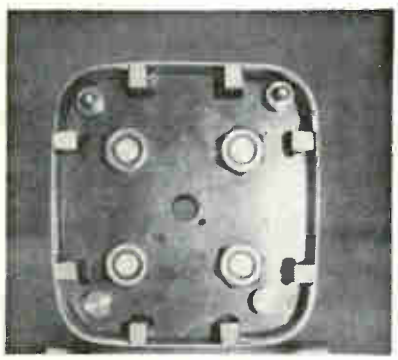
Assembly in dip-brazing fixture

DIVIDING an aircraft instrument housing into 14 pieces and assembling the parts by welding and dip-brazing has been found by John Gombos Co., Inc., Clifton, N. J., to reduce production costs.

Chief savings are in machining time. It was formerly cast in aluminum with heavy walls and hogged out. Machining took 30 hours. The curved walls are 0.04 inch thick at the sides, 0.09 inch thick in the corners and carry eight ribs.

In the assembled version, the base is milled from aluminum plate on a duplicator machine. An extra groove is milled in the base to anchor the walls. The wall is formed by wrapping aluminum sheet around a form and welding the seam. A welding fixture, consisting of two phenolic plates held apart by studs, is placed inside the wrap-around. The plates are slotted to locate the ribs and four corner fill-

Parts and completed assembly



Parts located in welding fixture (top view)

ets of 0.5 inch sheet. They are secured by tack welding them to the top and bottom of the walls.

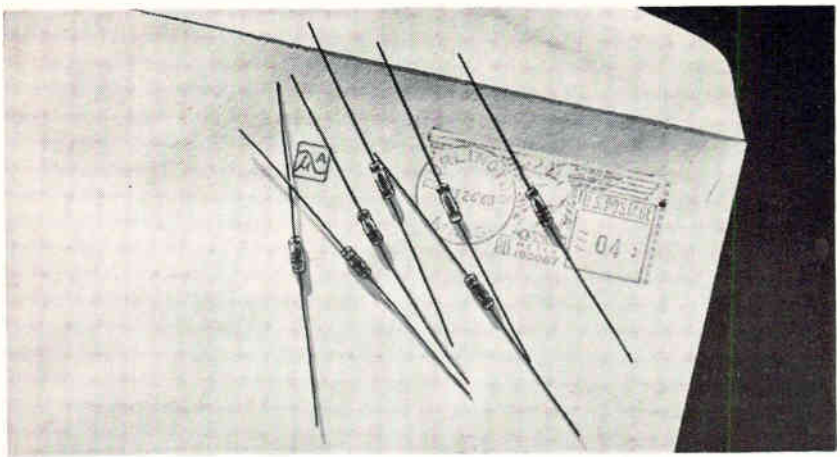
The wall assembly is fitted into the base groove and the housing is placed in a brazing fixture. The fixture preserves wall curvature by pressing curved stainless steel plates against the inside surface of the wall. The plates are chamfered at the corners so brazing wire can be placed along the wall and rib joints.

Brazing wires are precut and formed with a hook at the top so they need only be hung in the assembly. After dip-brazing in a salt bath, the assembly is heat-treated. The fixture is similar to the brazing fixture except it also presses contour plates on the exterior of the housing. The assembly is made $\frac{1}{32}$ inch too high so it can be trimmed square.

Microfilm Card Stripper

GLASSINE protective covering is removed from the adhesive edge of microfilm aperture cards by a stripper made by Dataflow, Inc., Binghamton, N. Y. The device is designed for use with mounters employed in engineering drawing reproduction systems. It is reported to be faster than hand stripping and does not bend or crimp the card or damage the adhesive.

New On The Market



R-F Diodes

ALL-GLASS, HERMETIC SEAL

A SERIES of subminiature silicon point-contact diodes with all glass construction, and designed for use in r-f circuits is available from Microwave Associates, Inc., Burlington, Mass.

All-glass construction assures a reliable hermetic seal, enables direct soldering to axial leads close to the diode's shell, and reduces shunt capacitance for improved bandwidth at microwave frequencies.

The 1N830 is recommended for uhf and vhf video detection and general purpose r-f rectification in coaxial and printed circuit applications.

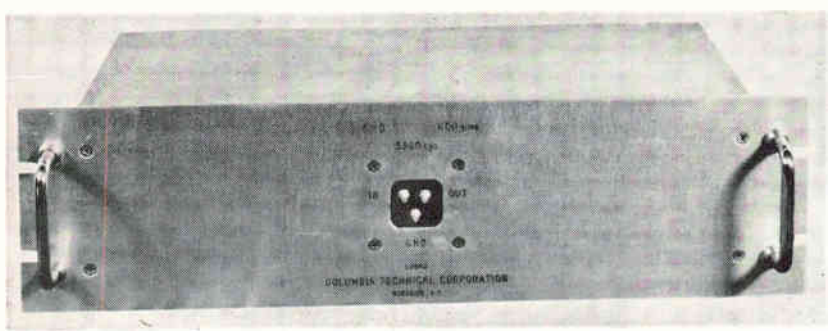
The 1N831 is designed for low-noise r-f mixer applications at signal frequencies below 4,000 Mc.

The 1N832 is intended for printed circuit low-noise broadband mixer applications at frequencies between 4,000 and 10,000 Mc.

The 1N833 type is intended for low-level r-f detector circuits at all frequencies below 10,000 Mc. Major applications include broadband receiver circuits, beacon transponders, microwave computer detection and control circuits.

All diodes of the 1N830 through 1N833 series are available in production quantities.

CIRCLE 301 ON READER SERVICE CARD



Audio Delay Line

HIGH PHASE LINEARITY

HIGH-PRECISION audio delay line with a delay of 5,000 microseconds ± 1 percent has been announced by Columbia Technical Corporation, Woodside, N. Y. Known as Type L894C, the delay line has a phase linearity of ± 0.1 percent in the center frequency band from 3,050 to 3,550 cps. The phase linearity to cut-off is ± 0.2 percent.

The line has an impedance of 600 ohms and a low-frequency insertion loss of 1.5 db. The attenuation is 3 db at 3.5 Kc and 6 db at 4.8 Kc. The unit is housed in a standard rack-mounting type cabinet 19 x $5\frac{1}{4}$ x $8\frac{3}{16}$ and weighs under 25 lb.

Electrical characteristics are obtained by a combination of m-derived filter networks in which m is a complex quantity. Each element is equalized and matched to assure precision performance.

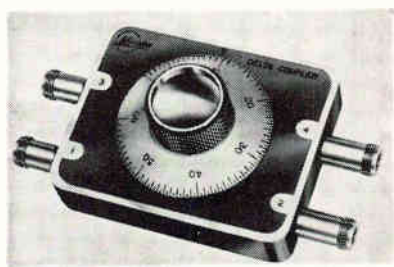
CIRCLE 302 ON READER SERVICE CARD

Bidirectional Coupler

BROADBAND, CALIBRATED

A BROADBAND, precision calibrated variable directional coupler called the Delta Coupler is announced by Kearfott Microwave Branch, General Precision, Inc., 14844 Oxnard Street, Van Nuys, Calif.

The instrument is adjustable from 5 to 70 db and may also be



used as a precision variable attenuator over these ranges. Accuracy is assured to within ± 1 db of absolute attenuation over the specified frequency range and is displayed on a direct reading dial. Maximum power handling capability is 200 watts; low vswr, low insertion loss and high directivity are inherent in the instrument. The coupler is available in frequency ranges from 500 to 1,000 Mc and through 4,000 to 8,000 Mc.

CIRCLE 303 ON READER SERVICE CARD

Variable Capacity Diode

FOR FREQUENCY CONTROL

TYPE IN3182 voltage variable capacitor silicon diode is specifically designed and manufactured for automatic frequency control applications. Featuring a high Q (typical 60), the 1N3182 will maintain a precise oscillator frequency. The variation of capacitance with bias gives high sensitivity for strong oscillator pull-in.

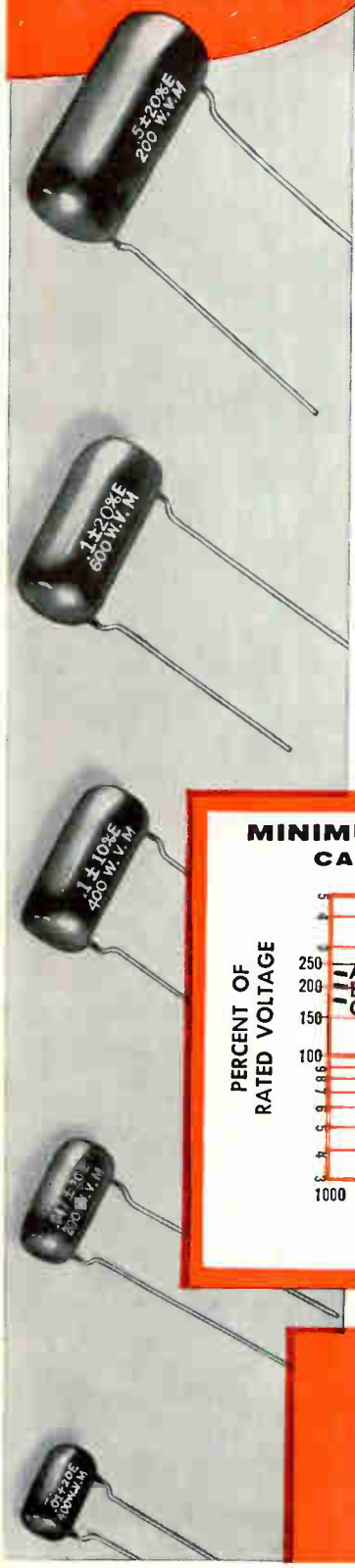
Reliable supply of a uniform afc diode is insured by design rather

Another New High Order of Reliability!

El-Menco

*MYLAR-PAPER DIPPED CAPACITORS

TYPE MPD



ASSURE A LOW FAILURE RATE OF

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

Setting A New High Standard Of Performance!

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

CAPACITANCE AND VOLTAGE CHART

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

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

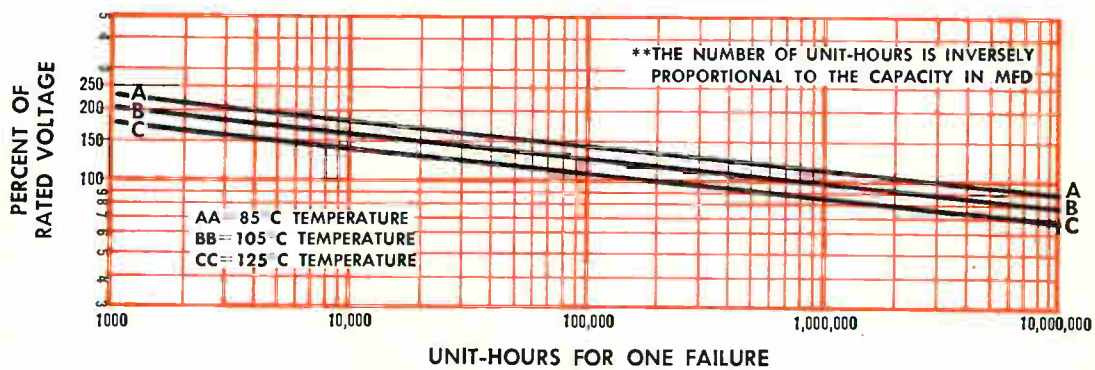
SPECIFICATIONS

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

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

Write for Technical Brochure

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



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Manufacturers of El-Menco Capacitors

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Arco Electronics, Inc., Community Drive, Great Neck, L.I., New York
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

WEST COAST MANUFACTURERS CONTACT:
COLLINS ELECTRONIC SALES, INC., 535 MIDDLEFIELD ROAD, PALO ALTO, CALIFORNIA

than selection. The glass-capsule diode is a subminiature type, with a maximum series resistance of 3 ohms, and an average capacitance of 30 pf with an inverse voltage of 4 volts.

The diode is manufactured by Amperex Electronic Corp., Semiconductor and Special Purpose Tube Div., 230 Duffy Ave., Hicksville, L. I., New York.

CIRCLE 304 ON READER SERVICE CARD

Reed Relay

TEN CIRCUITS

UP TO TEN separate switching functions can be remotely controlled with small vibrating reed relay. Each reed controls one function through a tiny secondary relay and resistance-capacitance filter. High Q (reed bandwidth selectivity) makes the switching method practically interference-free. Reed units are available in 30 to 3,000 ohm coil resistances, and impedances from 30 to 5,000 ohms. Driving voltages vary from 1½ to 15 v a-c, depending on impedance. Reed contacts will pass up to 5 ma. Reed frequencies to within plus or minus 0.05 percent are available. Price is $22.50, from W. S. Deans Co., 8512 Gardendale Street, Downey, Calif.

CIRCLE 305 ON READER SERVICE CARD

Mercury-Wetted Relays

IN MODULE FORM

MERCURY-WETTED relays are now available in self-contained units, ready for mounting on printed circuit boards in a manner similar to resistors, capacitors and other components. The switch capsule is potted in a plated steel enclosure which provides both excellent mechanical protection and magnetic shielding.

The new modules are available with standard HG switch capsules or the sensitive, high-speed HGS capsules. Coils are individually wound to meet customer's specifications.

Operating element is a mercury-wetted relay switch capsule which has proved capable of billions of maintenance-free operations.

The relays are available from C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.

CIRCLE 306 ON READER SERVICE CARD

Seven Diffused Junction Varactor Diodes

CUTOFF AT 50 TO 200 Gc

VARACTOR DIODES—voltage variable capacitors—with cutoff frequencies ranging from 50 to 200 Gc are available from RCA Semiconductor and Materials Div., Somerville, N. J.

The diffused junction mesa diodes are made from gallium arsenide and are hermetically sealed in a metal-ceramic case that is 90 mils in diameter and 60 mils high. In its package the diode has an inductance of 0.4 millimicrohenry and a capacitance of 0.4 pf. Temperature range of the unit is from −196 to 180 C.

The seven diodes have part numbers XVD100 through SVD106, assigned according to cutoff frequency. Prices range from $200 to $700 at present.

CIRCLE 307 ON READER SERVICE CARD

Power Transistor

TO MIL-SPECS

MOTOROLA SEMICONDUCTOR PRODUCTS INC., 5005 E. McDowell Road, Phoenix, Ariz. The 2N1358 (Sig. C) power transistor is a lugged-version of the TO-36 (Doorknob) transistor package available to military specifications. The unit will dissipate 150 w of power, compared to the 70 w specified on Mil-Specs. It has less than half of the maximum thermal resistance called for in the specs; 0.05 C/w (0.35 C/w typical) vs 1.0 C/w maximum. It is rated for junction operation up to 100 C vs the 95 C requirement of the military spec. Unit is an 80 w, 15-ampere power transistor, used in applications having heavy power demands.

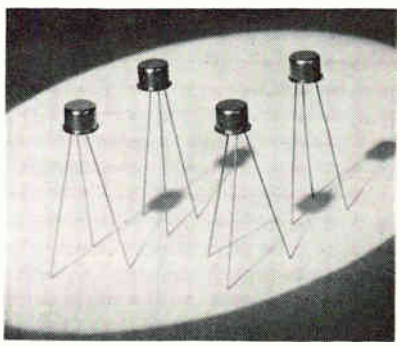
CIRCLE 308 ON READER SERVICE CARD

Silicon Transistors

MESA TYPE

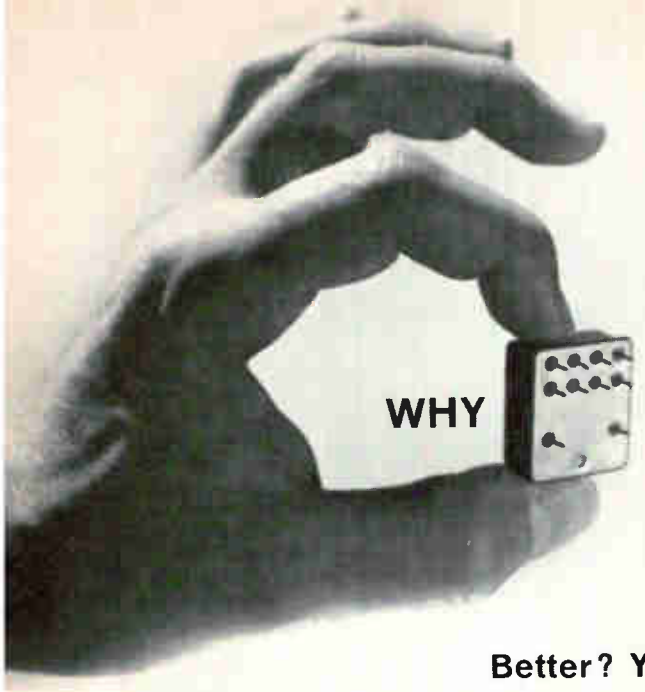
SILICON mesa transistors USN 2N497, USN 2N498, USN 2N656 and USN 2N657 meet requirements of MIL-T-19500/74.

The Mil-qualified transistors are



for general purpose, medium power, fast-switching applications. They have low input impedance, low collector capacitance (typically 14 pf), with operating range from 10 μa to 500 ma, and 4 watt power dissipation. *(Continued on page 122)*

CIRCLE 121 ON READER SERVICE CARD→



WHY THIS IS A BETTER *LATCHING* RELAY

Better? Yes, in several ways. Bifurcated Contacts, for example, give improved reliability, especially in dry circuits. Contacts will not open during vibrations of 30Gs, 55 to 2500 cps. A special method of sealing cover to base eliminates flux contamination of the contacts. And there are more. Here is Potter & Brumfield's newest member of a distinguished family of micro-miniature relays: the FL Series.

Expressly designed for printed circuit applications, this DPDT, 3 amperes (@ 30V DC) latching relay lies parallel to the mounting surface. Its height, when mounted, is only .485", thus circuit boards may be stacked closer. Mounting can usually be accomplished without studs or brackets, simplifying installation.

The FL will remain firmly latched in either armature position without applied power, a significant advantage where power is limited and long relay "on" times are required. This relay may be operated by:

1. Pulsing each coil alternately (observing coil polarity), or
2. Connecting the coils in series and operating from a reversing (polarized) source.

Write for complete information or call your nearest P&B representative.

FL SERIES SPECIFICATIONS

Shock: 100 Gs for 11 milliseconds. No contact openings.

Vibration: .195", no contact openings. 10 to 55 cps. 30 Gs from 55 to 2500 cps.

Pull-In: 150 milliwatts maximum (standard) at 25° C. 80 milliwatts maximum (special) at 25° C.

Operate Time: 3 milliseconds maximum at nominal voltage at 25° C.

Transfer Time: 0.5 millisecond maximum at nominal voltage at 25° C.

Temperature Range: −65° C to +125° C.

Terminals: Plug-in pins.

Dimensions: L. 1.100" Max.—W. .925" Max H. .485" Max. Hermetically sealed only.

SC 11 D

SCG 11 DC

SL 11 OB
(Latching)

SLG 11 DA
(Latching)

Other P&B micro-miniature relays include conventional and latching models in crystal cases with a wide range of terminals and mountings. All are made in a near-surgically clean production area under the exacting requirements of our Intensified Control and Reliability program.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

YOUR BEST SINGLE SOURCE FOR ALL MICRO-MINIATURE RELAYS

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

The transistors are in the JEDEC TO-5 outline welded package. The corrosion-resistant, solid nickel can provides a good thermal surface for attachment of heat sinks. The leads are gold plated for easy soldering.

All units are tested per Mark XII, master test specification for high reliability silicon transistors. They are stabilized before testing by 300 C storage for 72 hours and by three temperature cycles from −65 C to +200 C.

The units are manufactured by Rheem Semiconductor Corp., 350 Ellis St., Mountain View, Calif.

CIRCLE 309 ON READER SERVICE CARD

Multiple Counters
UP TO EIGHT DECADES

ROBOTOMICS CORP., 2422 E. Indian School, Phoenix, Ariz. New miniature series F multiple decade counters are suitable for a wide range of control-display applications. Up to eight decades each with 1 in. high in-plane display on $1\frac{3}{8}$ in. centers are available as complete unit for front panel mounting. Operating frequency exceeds 200 Kc at less than 2 w per transistorized decade, with electrical reset, and optional 10 line coincidence or 1-2-4-8 binary output.

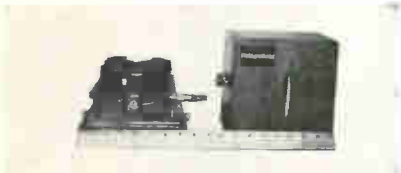
CIRCLE 310 ON READER SERVICE CARD

Control Synchros
HIGH ACCURACY

VERNITRON CORP., 123 Old Country Road, Carle Place, L. I., N. Y. High accuracy and stability over the temperature range from −55C to +125C, and availability in two types of terminal blocks are among

the features of the Vernitron size 8 control synchros. Maximum electrical errors of ±5, ±7 and ±10 minutes can be specified for all synchros with 11.8 v input, as well as synchro transmitters with 115 v input and 11.8 v output.

CIRCLE 311 ON READER SERVICE CARD



Four Point Probe

HIGHLY ACCURATE

DEVICE DEVELOPMENT, 4814 E. Virginia, Phoenix, Ariz. The Microprobe is a highly accurate constant tension four-point probe for resistivity measurements on semiconductor slices. Probe spacing is adjustable within a 0.040 in. range and is factory preset to ±0.0002 in. Probe tips are rhodium plated hard chrome steel. The device utilizes a four-way electrical plug to connect to a-c or d-c resistivity test set. Price: $600.

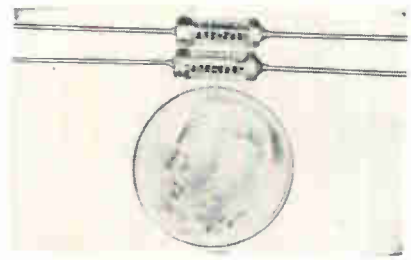
CIRCLE 316 ON READER SERVICE CARD

H-V Power Supplies

SOLID STATE

SMITH-FLORENCE, INC., 4228-23rd West, Seattle 99, Wash., announces miniature solid state h-v power supplies. Two series are available. From a 12 to 28 v d-c input, outputs from 400 v d-c to 2,000 v d-c at 20μa are provided. The second series furnishes a 28 or 12 v d-c output at 100 ma from a 117 v a-c source. Dimensions are 1⅝ in. by 1⅝ in. by 2¾ in. All power supplies are equipped with a standard octal plug for simplified mounting. Regulation is 1 percent no load to full load and maximum voltage shift is ±1 percent from 0 to 55 C. Prices range from $90 to $145 with 30 day delivery.

CIRCLE 317 ON READER SERVICE CARD

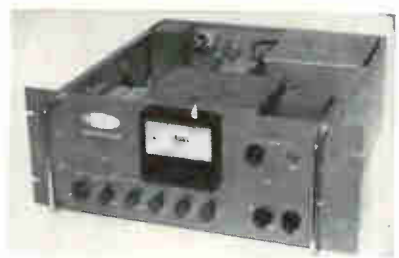


Hard-Glass Resistor

HERMETICALLY SEALED

TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas 21, Texas. Hermetically-sealed hard-glass carbon film resistors provide a wattage rating double the MIL specs for the same size package. They have high resistance to thermal shock. Type CG⅛ resistors cannot suffer case damage from lead tension as these loads are transmitted directly to the ceramic core. The glass case is sealed to the end caps of the core, and does not touch the leads.

CIRCLE 318 ON READER SERVICE CARD



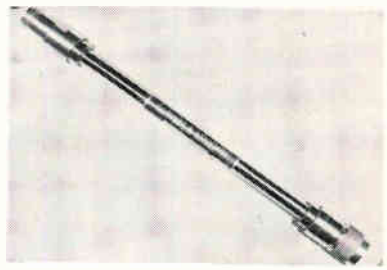
SSB Receiver

FOR A-M BROADCAST USE

KAHN RESEARCH LABORATORIES, INC., 81 South Bergen Place, Freeport, L. I., N. Y. Fixed tuned model RSSB-59-1A single-sideband receiver is for a-m broadcast use. Applications include off-the-air relay broadcasts, high quality monitoring in difficult reception areas and Conelrad. Minimum selective fading distortion, improved signal-to-noise and greatly reduced adjacent channel interference are advantages offered over conventional a-m reception. Choice of product detection, utilizing local or reconditioned carrier insertion for minimum selective fading distortion or diode detection is provided to suit local conditions. Fully transis-

torized, the unit permits upper or lower sideband reception and operates on 110 v a-c or self-contained automatic emergency d-c supply.

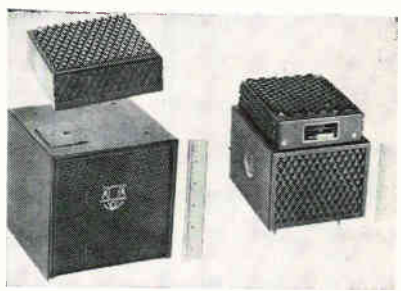
CIRCLE 319 ON READER SERVICE CARD



Coax Attenuators
BIDIRECTIONAL

MAURY & ASSOCIATES, 10373 Mills Ave., Montclair, Calif. Series AL microwave coaxial attenuators are of the lossy line type for use in the 1,000 to 4,000 Mc range. They are also useful up to 10,000 Mc. Units are bidirectional, stable and feature low vswr and accuracy of attenuation. They are useful in applications requiring fixed accurately known attenuation, isolation between components in a microwave system and in the extension of the ranges of power meters.

CIRCLE 320 ON READER SERVICE CARD

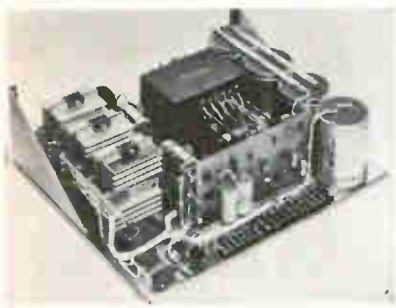


Inverters
HIGHLY REGULATED

VICTORY ELECTRONICS, INC., Westbury, N. Y. A line of 400-cycle, transistorized inverters, each controlled by the same interchangeable regulator, make it possible to increase power output from 25 to 50 or 100 volt-amperes without replacing the entire installation. The Victory Varia-Verter was designed to provide sources of 400-cycle current for testing and operation of aircraft and missile components. Offered in three models—25, 50 and 100 v-a—the user need purchase only the model adequate for his present needs. Later, as output re-

quirements increase, the old regulator is easily connected to a new and larger unit. Features include: encapsulated transformers; isolated inputs and outputs; aluminum construction; semiconductor design, and regulation within ± 1 percent into either resistive or inductive loads.

CIRCLE 321 ON READER SERVICE CARD



Power Supplies
MODULAR TYPE

INVAR ELECTRONICS CORP., 323 W. Washington Blvd., Pasadena, Calif., has available a complete line of 45 fully-transistorized, closely-regulated, d-c power supply modules. Units are manufactured in 9 voltage ranges from 1 to 37 v, and in 5 power ranges, from 0.7 to 15 amp. All models offer 15 mv maximum line and load regulation, 2 mv maximum ripple, and complete overload and short-circuit protection. The modules can be operated in series or parallel without modification, and terminals are provided for remote sensing. These units are rated for operation to 50 C and are constructed for use as integral modules or for mounting directly on 5¼ in. panels.

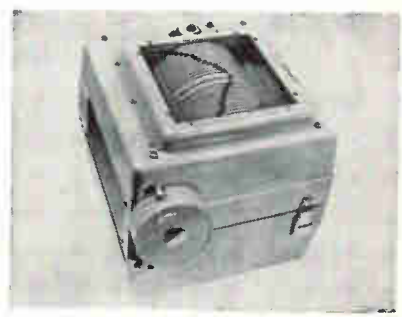
CIRCLE 322 ON READER SERVICE CARD

Circuit Breakers
GANG ASSEMBLIES

AIRPAX ELECTRONICS INC., Cambridge, Md. To protect three-phase

and two-phase systems, electromagnetic circuit breakers are now available in gang assemblies. Series 600 and series 700 explosion proof breakers provide maximum protection in these critical applications. Units are hermetically sealed, withstand 50 g shock and operate from −55 C to +100 C. All types have either a slow or fast time delay action. Instantaneous acting units can also be supplied for these gang assemblies. Continuous duty ratings from 50 ma to 15 amp. Contacts are rated for 50 d-c volts or 120 rms volts at 60 or 400 cps. Operational life is at least 10,000 operations, at rated current.

CIRCLE 323 ON READER SERVICE CARD



Tape Recorder
& PLAYBACK UNIT

ELECTRO-TECHNICAL LABS, a division of Mandrel Industries, P. O. Box 13243, Houston 19, Texas. Model D7-7 is a lightweight, direct-recording, magnetic tape recorder and playback unit completely self-contained. Static and/or dynamic time correction can be introduced on playback. Reliable operation under all field and office conditions is provided by the simplified plane-surface head carriage system. A 12-v battery supplies all required power. The DS-7 may be successfully integrated into existing seismic equipment. Electro-Tech's M4E amplifier has been specifically designed to match the DS-7 transport.

CIRCLE 324 ON READER SERVICE CARD

Cathode Follower
PORTABLE, COMPACT

UNITED AEROTRONICS CORP., Burlington, N. J. A compact cathode follower, which includes a self-contained regulated power supply, is announced. Portable unit measures 10½ in. by 5½ in. by 2¾ in. and may be mounted in model 306 rack,

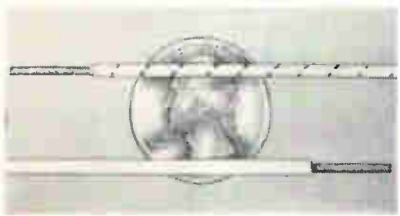
six to the rack. It weighs approximately 9 lb. Input impedance is in excess of 1,000 megohms. Frequency response is 1 cps to 500 Kc ±1 percent. Gain is 0.98. Noise level less than 20×10^{-6} v. Built-in test signal.

CIRCLE 325 ON READER SERVICE CARD

Delay Line
SONIC TYPE

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L.I., N.Y. Model FA-573 sonic delay line features excellent phase and attenuation characteristics as well as an extremely long delay of 0.1 sec. It has an attenuation of 20 db at 300 cycles and impedance of 1 K ohm. Featuring multiple taps every 1 millisecond, it has 100 taps with tap accuracy of better than 0.5 percent. Additional taps can be supplied upon request. Cut-off frequency is at 400 cycles and phase linearity is better than 0.75 percent up to 300 cycles. This delay line, which has geological autocorrelation applications, can be cascaded with some sacrifice in bandwidth and attenuation.

CIRCLE 326 ON READER SERVICE CARD



Satellite Wires
RESIST RADIATION

BOSTON INSULATED WIRE & CABLE CO., 25 Bay St., Boston 25, Mass., has developed two miniature versions of its 1000 F Super Jet instrument wire especially for satellite use. Both are highly radiation resistant. Style 1, shown above, is for use in sealed capsules. Style 2, below, withstands an environmental dielectric test of 1,500 v after 90 days immersion in tap water, indicating pre-

launching stability. These new wires are offered in sizes 24 through 16 Awg.

CIRCLE 327 ON READER SERVICE CARD

Signal Generator
MILLIMETER RANGE

STRAND LABS, INC., 294 Centre St., Newton 58, Mass. Model 100 stabilized signal generator has three performance characteristics: frequency range, 32,000 Mc to 37,500 Mc (K_A-band); frequency stability, short term—0.01 part per million; long term—1 part per million; average power output, 15 mw.

CIRCLE 328 ON READER SERVICE CARD

Lab Magnet Systems
FLEXIBLE ASSEMBLIES

MHD RESEARCH, INC., 1571 Placentia Ave., Newport Beach, Calif. New general purpose laboratory magnet systems are ideal for a variety of applications. Individually adjustable and replaceable poles and pole faces allow maximum variation of the magnetic field configuration. Coupled with the continuously variable output power supply, these magnet systems provide a most flexible basic research tool. Copper-wound coils are insulated with class B materials and are calculated for continuous duty without additional cooling.

CIRCLE 329 ON READER SERVICE CARD

Ceramic Tubulars
ULTRAMINIATURE

ELECTRAMICS CORP., P. O. Box 275, Solana Beach, Calif., offers an improved line of ultraminiature Ce-

ramin ceramic tubular capacitors. New ceramic formulation offers a lower dissipation factor. A choice of temperature coefficient curves is provided by the use of elements with dielectric constants of either 1,200 or 1,600. Improved encapsulation and lead attachments processes enable immersion of the entire capacitor in molten solder. Both 1200K and 1600K capacitors are available in capacitance tolerances of ±5 percent or 10 percent (closer tolerances on special order), and in the same dimensions: 0.098 in. diameter (0.125 in. in the larger values), 0.250 in. in length, with axial leads.

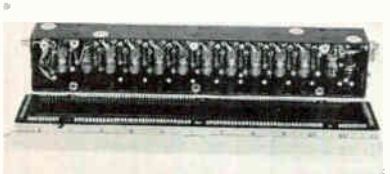
CIRCLE 330 ON READER SERVICE CARD

Panoramic Receiver

LOW FREQUENCY

MOTOROLA INC., 8201 E. McDowell Road, Scottsdale, Ariz., announces a new l-f panoramic field intensity receiver. The extremely accurate precision unit continuously monitors l-f radiation from 0.05 Kc to 100 Kc, operates unattended, and automatically produces panoramic photographic records. Designated the AN/URM-126, applications include the precision measurement, display and recording of the intensities of noise and both modulated and unmodulated c-w signals. It meets specification MIL-E-16400. Unit exhibits very high resolution, stability, and accuracy, and receives and defines signals separated by only 15 cps.

CIRCLE 331 ON READER SERVICE CARD



I-F Amplifiers

LOGARITHMIC

THE W. L. MAXSON CORP., 475 Tenth Ave., New York 18, N.Y. Types LIFV-30, 60, 90, are small rug-

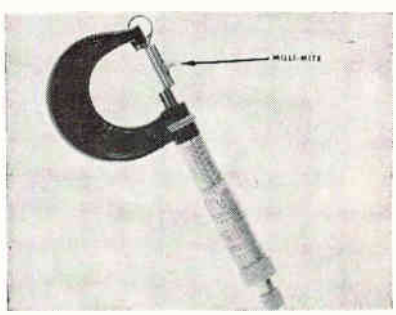
gedized i-f amplifiers at center frequencies of 30, 60 and 90 Mc with logarithmic responses, possessing the combined features of low noise figure, large dynamic range, and high gain. Special input trimmer control permits standard units to be matched to a large number of different crystal capacity outputs. Units are used as moving target indication systems, as monopulse receivers and amplitude comparision systems where amplitude match is required over a large dynamic range of operation.

CIRCLE 332 ON READER SERVICE CARD

D-C Power Supply
TRANSIENT-FREE

PERKIN ELECTRONICS CORP., El Segundo, Calif. Rated 0-36 v at 5 amperes, model MTRO36-5A regulated d-c power supply eliminates transistor-ruining transients. It is excellent for laboratory testing of transistorized loads, since it utilizes a specially designed dynamic regulation circuit with instantaneously reacting transistors. Reliable magnetic amplifiers provide static regulation. Specifications include 15 mv dynamic line regulation, 2 mv maximum rms ripple, and 50 million maximum dynamic impedance.

CIRCLE 333 ON READER SERVICE CARD



Inertia Switch
MINIATURIZED

INERTIA SWITCH, INC., 311 W. 43rd St., New York 36, N. Y. Model 6UO-200 Milli-Mite inertia switch is accurately preset to respond to acceleration forces up to 250 g within a tolerance of ±15 percent of setting. It is designed with only one moving part, a precision-ground steel ball held against a solid base by a uniform magnetic field. When the opposing force of acceleration exceeds the magnetic force, the ball moves to close a nor-

mally open electrical contact. The switch meets all environmental specifications of MIL-E-5272, including an operation range of −65 F to +200 F.

CIRCLE 334 ON READER SERVICE CARD

Polarographic Analyzer
HIGHLY FLEXIBLE

NESCO INSTRUMENTS, INC., 638 W. 17th St., Costa Mesa, Calif., announces a polarographic analyzer priced at $795. Twenty-three current ranges are supplied, from 0.5 to 300 μa full scale. There are 10 polarizing ranges, from + 1½ to − 5 v. Accuracy of the unit is ½ percent current and voltage; repeatability is ¼ percent. The recorder has a chart width of 5 in., and a chart speed of ½ in. per minute. Bridge drive is synchronous, with a rotation time of 10 minutes. Damping and suppression controls are mounted on the panel. Standardization is manual, against an internal cell.

CIRCLE 335 ON READER SERVICE CARD

Panel Indicator Light
WITH BLACK SHROUD

THE SLOAN CO., 7704 San Fernando Road, Sun Valley, Calif., announces a shrouded panel indicator light, model 855S-DS. It features a black shroud which excludes light emission from the sides. Ideal for computer applications, instruments, panels, etc., requiring a prestige appearance. Mounts in ⅜ in. diameter hole.

CIRCLE 336 ON READER SERVICE CARD

Literature of the Week

POWER SUPPLY MODULE Valor Instruments, Inc., 13214 Crenshaw, Gardena, Calif. Bulletin PS1160 describes a series of miniaturized plug-in power supply modules ideal for use as components to supply d-c voltage of extremely high regulation.

CIRCLE 337 ON READER SERVICE CARD

SERVO AMPLIFIERS Magnetic Amplifiers Division of The Siegler Corp., 632 Tinton Ave., New York 55, N.Y., has available a 16-page catalog comprising the major products of its servo amplifier line for both military and industrial applications.

CIRCLE 338 ON READER SERVICE CARD

INSTRUMENT TRANSFORMERS James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill., announces a data sheet covering the series 7100 electrostatically and magnetically shielded instrument transformers for chopper, a-c transducer and differential input.

CIRCLE 339 ON READER SERVICE CARD

MULTIPLEXING SYSTEM Lynch Communication Systems Inc., 695 Bryant St., San Francisco 7, Calif. An 8-page brochure covers the B-910 multiplexing equipment that functions to channel as many as 600 separate conversations or other types of information.

CIRCLE 340 ON READER SERVICE CARD

ELECTRON TUBE SHIELDS International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. A 22-page bound catalog covers heat-dissipating tube shield components for subminiature size electron tubes.

CIRCLE 341 ON READER SERVICE CARD

TINY LIGHT BULB Kay Electric Co., Maple Ave., Pine Brook, N.J., has published a bulletin describing the Pinlite, a low voltage, low current, microminiature incandescent lamp.

CIRCLE 342 ON READER SERVICE CARD

SERVO MOTORS Helipot Division of Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton,

Calif., has published a catalog showing new models and up-dated specs on size 8 and size 11 servo motors.

CIRCLE 343 ON READER SERVICE CARD

STATIC POWER CONVERSION Hamilton Standard, division of United Aircraft Corp., Broad Brook, Conn., offers a guide booklet to provide a better understanding to those who will be using static inverters and other static power conversion equipment.

CIRCLE 344 ON READER SERVICE CARD

COMPLETE CLEAN ROOMS Controlled Environment, Inc., 52 Pickering St., Needham 92, Mass. A 4-page folder discusses an integrated program for providing controlled environments where products involving critical precision are assembled, packaged, and tested.

CIRCLE 345 ON READER SERVICE CARD

POTENTIOMETERS Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles 22, Calif. A brochure on precision potentiometers contains 6 product data sheets describing a series of wire wound multi- and single-turn pots.

CIRCLE 346 ON READER SERVICE CARD

TRANSISTOR TESTER Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif. Engineering data concerning basic test parameters for silicon or germanium *npn* and *pnp* transistors, and specifications of the model T-340 transistor tester have been published.

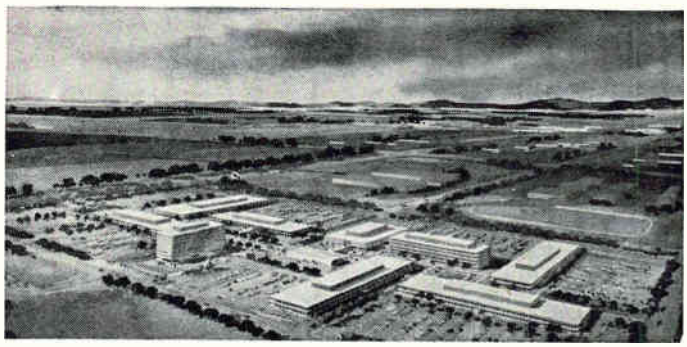
CIRCLE 347 ON READER SERVICE CARD

PRESS LOAD MEASUREMENT Niagara Machine & Tool Works, 683 Northland Ave., Buffalo 11, N.Y. Two electronic precision instruments designed to safeguard dies and presses during production runs are described and illustrated in a new product report.

CIRCLE 348 ON READER SERVICE CARD

X-Y PLOTTING BOARDS Computer Systems, Inc., Culver Road, Monmouth Junction, N.J. Form 80-392 is a 5-page technical data sheet describing transistorized X-Y plotting board, both single and dual arm, with electroluminescent panels for backlighting.

CIRCLE 349 ON READER SERVICE CARD



STL Plans Mammoth Space Center

LIEUTENANT GENERAL James H. Doolitle, USAF (Ret.), chairman of the board of Space Technology Laboratories, Inc., and Louis G. Dunn, president, announce the company soon will start construction at Redondo Beach, Calif., of one of the largest space research and engineering centers in the country. When completed, the ultra-modern complex will provide facilities for more than 5,000 persons, including more than 2,000 scientists and engineers.

First phase of the complex will consist of 10 structures, including six research-office buildings, an engineering-office building, a library-auditorium, a service building and the corporate headquarters building. Two research-office buildings are scheduled for completion by November 1961. The engineering office building will be ready a month later. An additional research-office structure, the service building, and the library-auditorium will be completed in March 1962, and the administration building in September of that year. Completion dates for remaining structures have not been set.

The new center is being built to replace the STL research and development facilities in El Segundo, Calif., which are being acquired by the government. Site of the center is a 110-acre parcel of land. The initial 10 buildings will occupy about 70 acres. The remaining land is being reserved for future expansion.

STL, a subsidiary of Thompson Ramo Wooldridge, Inc., has since 1954 provided systems engineering and technical direction for the Air Force ballistic missile program, which produced the Atlas, Thor, Titan and Minuteman weapons systems. The company also designed, fabricated, instrumented and tracked in space the Pioneer I and V, and Explorer VI satellites. Firm's scientists and engineers are currently completing for NASA a study designed to make possible the "soft" landing of an instrumented space vehicle on the moon.

Perkin-Elmer Corp. Reassigns Woodcock

EUGENE L. WOODCOCK has been appointed to the senior technical staff of the Electro-Optical Division, Perkin-Elmer Corp., Los Angeles, Calif., and will be responsible for the development of infrared systems.

Until this assignment, Woodcock was chief of the development section concerned with military infrared detecting equipment and instrumentation at Perkin-Elmer's Norwalk, Conn., plant.

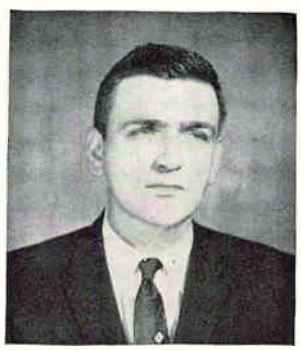
Stromberg-Carlson Ups Finkelstein

NISSON A. FINKELSTEIN has been appointed vice president in charge of research for the Stromberg-Carlson Division of General Dynamics Corp., Rochester, N. Y. He joined S-C in November 1959 as assistant vice president and director of research.

John Gombos Appoints Gino DePaola

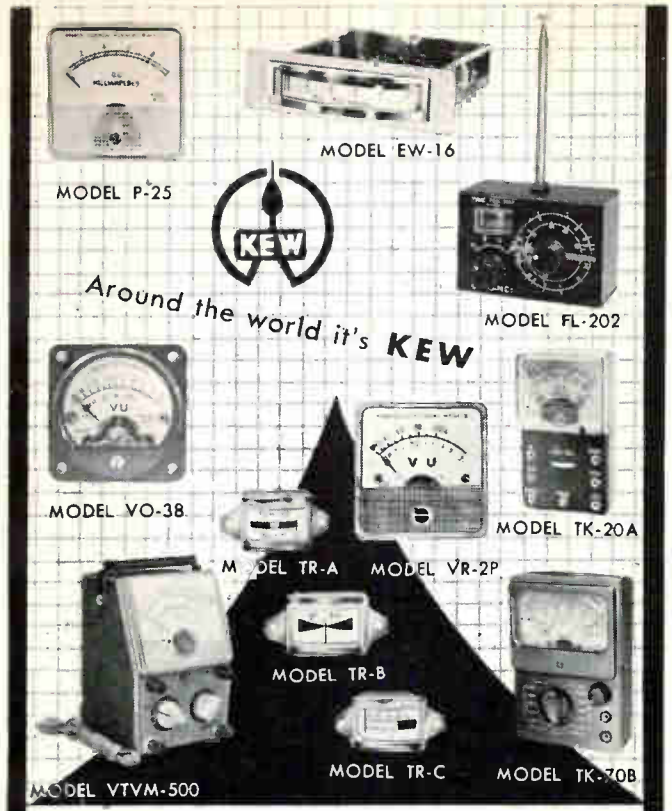
JOHN GOMBOS, president of John Gombos Co., Inc., Clifton, N. J., has announced the appointment of Gino E. DePaola as senior staff engineer. He will be responsible for the advanced design and development of microwave filters as well as active cavities.

DePaola was formerly chief engineer of Prodelin and Frequency Standards.



PRL Electronics Names Schlenker

ROBERT M. SCHLENKER has been appointed to the post of vice president of PRL Electronics, Inc., Rahway, N. J. His past experience includes



KYORITSU ELECTRICAL INST. WORKS, LTD.

No. 120, Nakane-cho, Meguro-ku, Tokyo, Japan
Cable Address: "KYORITSUKEIKI TOKYO"
Tel: (717) 0131—5

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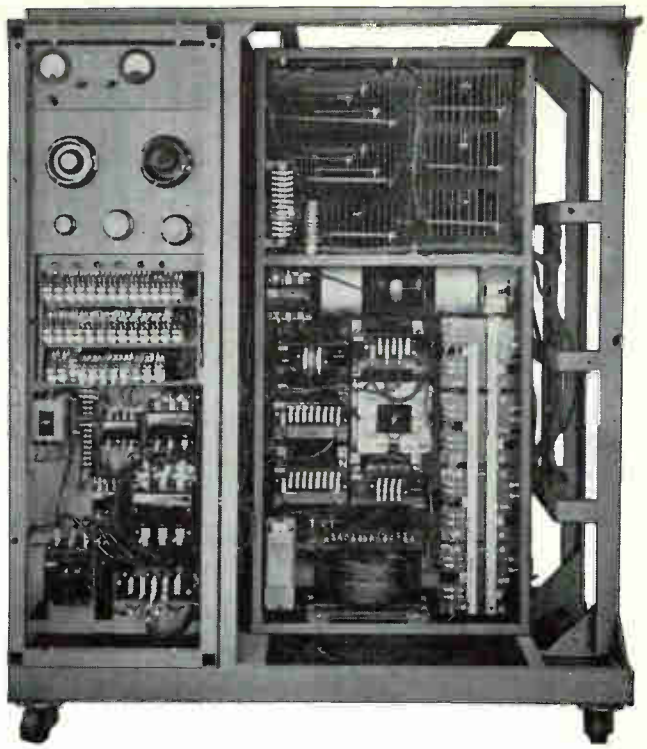

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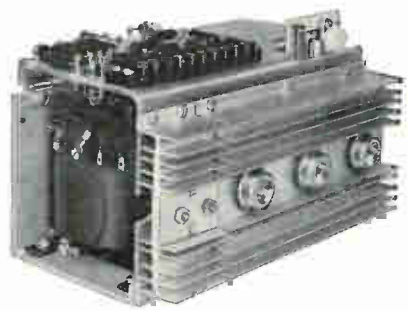

Series regulated
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positions with the NJE Corp. as production manager, Douglas Laboratories as a production supervisor, and Federal Telecommunications Laboratories as an engineering assistant.

EDP Corp. Appoints Manufacturing Head

THOMAS BELLAVIA has been named director of manufacturing for EDP Corp., Orlando, Fla. He has had over 27 years in manufacturing and engineering experience with Emerson Radio and Phonograph Corp., Jersey City, N. J.

Garr Takes Key Post At Raytheon Company

DONALD E. GARR has been named corporate director of engineering for Raytheon Company, Waltham, Mass. He has resigned as manager of engineering operations for General Electric Company's armament and control section.

Rennacker Joins Bendix Computer

HARVEY E. RENNACKER has been appointed senior staff engineer for Bendix Computer Division, Los Angeles, Calif.

He was most recently staff assistant to the head of the systems division, Collins Radio Co.

General Dynamics Appoints Dickey

GEORGE J. DICKEY has been appointed vice president and assistant general manager of the Stromberg-Carlson Division of General Dynamics Corp., Rochester, N. Y.

He comes to S-C from the corporation's headquarters office in New York, where he was assistant to executive vice president C. Rhoades MacBride.

Oak Manufacturing Rehires Olenick

OAK MANUFACTURING CO., Chicago components manufacturer, has announced the appointment of Earl Olenick as sales manager.

Olenick returns to Oak from Phaestron Instrument Co., where he served as assistant sales manager. He previously spent 10 years with Oak in various sales and sales promotion capacities.

The Hallicrafters Co. Hires Alva Todd

ALVA C. TODD, a specialist in electronic instrumentation, has joined The Hallicrafters Co., Chicago, Ill.,

as director of applied research for military products. He was previously a staff member of the Illinois Institute of Technology's Armour Research Foundation.

National Radio Advances Natkin

THE PROMOTION of Sydney W. Natkin to the post of vice president and manager of sales of National Radio Co., Melrose. Mass.. has been announced. He was employed at RCA for 19 years in various executive capacities prior to joining National Radio in 1959.

Uhle Takes Over Newly Created Post

APPOINTMENT of Richard B. Uhle to the newly created position of assistant general manager of Avco's Electronics and Ordnance Division in Cincinnati, O., has been announced.

He was formerly assistant advanced projects and planning, to the president of the division.

Sangamo Elects Wylie, Reorganizes Marketing

ROBERT R. WYLIE has been elected vice president-manager, electronic products sales of Sangamo Electric Co., Springfield, Ill. He joined San-

gamo in 1957 as marketing manager.

The company's efforts in electronics will now be integrated in an electronic products team under Wylie's direction. Sales will be channeled through direct men and manufacturer's reps for electronic components. Electronic systems sales will be handled exclusively through manufacturer's reps. To implement this sales effort the following appointments were made: Roger Miller, sales manager, electronic components; Glenn DeKraker, sales manager, electronic systems; and Clarence Burt, distributor sales manager, electronic components.

Sangamo's R&D activity in electronics is to be further expanded. Clarence Hudson was named director of components engineering and Alexander Finlay, former director of electronic research at Battelle, was named director of electronic systems engineering.

To coordinate long range marketing and R&D activities, two key men were appointed East and West Coast managers of electronic products. Kenneth McGee will coordinate operations on the East Coast, and H. L. Kunz, vice president, will do so on the West Coast.

Hall Holds R&D Post At MicroSemiconductor

THOMAS C. HALL is vice president for research and development at MicroSemiconductor Corp., a newly organized firm in Culver City, Calif.

He was previously associated with Pacific Semiconductors Inc., where he served as research program director, and with Bell Telephone Laboratories.

MK – 3 CTP vehicle on mount for antenna pattern measurement.

Unique electronic components successfully flight tested on ICBM re-entry vehicle control systems.

Analytical Studies in satellite orbit control and space navigation.

A Diversity of Current Projects

Continuing an outstanding record of achievements that includes *the first recovery of a space vehicle from orbit, and the first flight demonstration of effective space vehicle stabilization control and navigation*, MSVD electronics engineers are currently working in such areas as:

Quick-launching Support Systems • Inertial Navigation Equipment • High Density Packaging • Stabilization Controls • Space-to-ground Communications Systems • Orbit Ejection Controls • Instrumentation for Nose Cones • Space Power Supplies • Satellite Telemetry Tracking & Command • Digital Computers • Circuit Design for Space Application • Electronic Navigation Techniques

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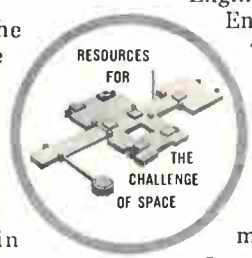
Whether or not you've had specific experience in space electronics, you may be able to go right to work at MSVD on some of the most sophisticated and technologically exciting projects in the entire space field—from ICBM re-entry vehicles to operational space craft.

The work here is at the very edge of the state of the art, transforming the latest research discoveries into workable engineering solutions. You'll be concerned with new advances in plasma physics, thermoelectric phenomena, telemetry... with radical new requirements in micro-miniaturization, space to weight reductions, performance efficiency... with an entirely new order of reliability specifications to assure systems' operation in space for a year or longer.



Excellent positions are currently open in four major areas at MSVD: Navigation and Control Engineering • Instrumentation and Communications Engineering • Ground Support Engineering • Advanced Systems Engineering

These positions will place you on the ground floor of the move of a large segment of the Department to the new Space Technology Center—located at Valley Forge Park, just 17 miles from Philadelphia.

Inquiries are invited from electronics engineers who are technically advanced in their own discipline, and are deeply interested in the related fields of space vehicle development. Write informally, or forward your resume to: D. G. Curley, Div. 69-WB.

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*commercial electronics**

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Please address Mr. Maurice Downey.

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- **Stereo High Fidelity**
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- **Telecommunications**
- **Airport Traffic Control**
- **Avionic Systems**
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Missile, Satellite	●	●	●	●	●	●
COMMUNICATIONS						
Multiplex Microwave	●	●	●	●		●
SSB Radio				●		●
DSB Transmitters	●		●	●	●	
Synchronous Receivers	●		●	●	●	
Data Links		●				●
DATA RECORDING & DISPLAY				●		●
Equipments		●	●	●	●	●
Advanced Techniques i.e. Thermoplastic Recording	●	●	●		●	
DEFENSE SYSTEMS – Underwater	●	●	●			
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PHYSICS (Military & Commercial Applications)						
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Accoustics	●	●	●	●	●	●
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TELEVISION (Broadcast & Industrial)						
Receivers	●	●	●	●	●	●
Transmitters (AM, FM & TV)			●	●	●	●
HF Video & Audio Techniques	●		●	●	●	
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12	.85	1.60	2.15	2.90
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2	1.00	1.35	1.60	1.95
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3K21	125.00	275A	4.00	845	7.50	5803/VX-55	2.50	6463	1.25
3K22	125.00	283A	3.50	866A	1.75	5814A	1.50	6517/QK358	500.00
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3K30	50.00	300B	5.00	913	8.50	5829WA	1.50	6550	4.25
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4C35	15.00	337A	3.50	1624	.75	5881/6L6WGB	1.75	8025	3.00
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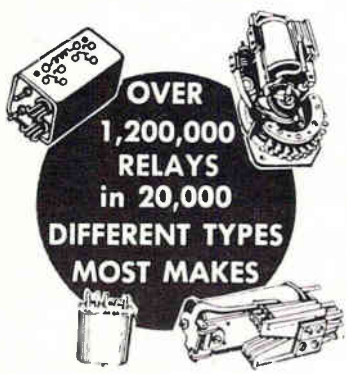

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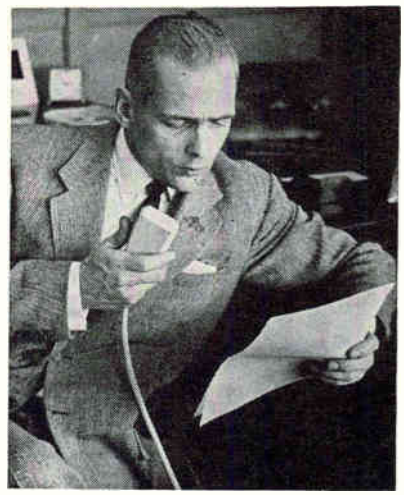

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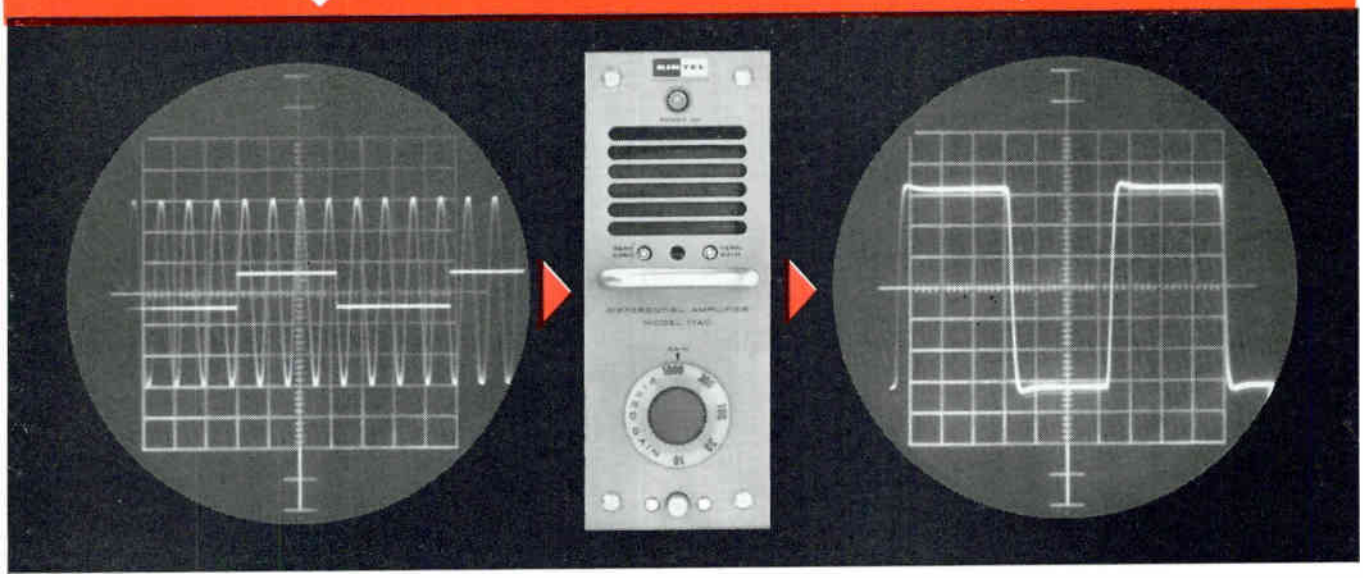
(picture of a KIN TEL differential amplifier at work)

6 volts of 60∿ common-mode noise and 6 millivolts of signal in here

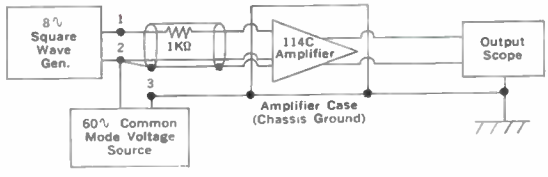
2 microvolts of 60∿ noise (equivalent input) and 6 volts of signal out here



If you measure the output of thermocouples, and the thermocouples are bonded to a rocket engine or almost any other grounded object, and the distance between thermocouples and amplifiers is more than a few feet, you should consider the above illustration carefully. While we'll admit your thermocouples probably aren't producing square waves, nine chances out of ten you *do* have a problem with 60-cycle common-mode noise. Nearly everybody does.

What can be done about it? Well, KIN TEL differential amplifiers reject ruinous 60-cycle common-mode hum and noise by a factor of 3,000,000 to 1 with any unbalance up to 1000 ohms in series with either side of the input, 1,000,000 to 1 with 10,000 ohms unbalance. Rejection for DC is practically infinite and both input and output can be floated up to ±300 volts DC or peak AC. The secret of this exceptionally high common-mode rejection in the presence of high input unbalance is isolation. Input signal terminals are isolated from chassis ground by 10,000,000 megohms and 0.6 micromicrofarads. Input and output signal terminals are completely isolated from each other. Output signal terminals are isolated from ground to almost the same extent as the input. With this virtually perfect isolation, you can rescue microvolt level signals from volts of common-mode noise, regardless of whether load and transducer are floating or grounded, balanced or unbalanced.

Before you send us that letter... the input scope photo is a double exposure. The square wave input signal was taken with the scope connected across points 1 and 2 (see drawing below) with 5 mv/division sensitivity. To show the noise, the scope was connected between points 2 and 3, and sensitivity was 1 v/division. The scope on the output was set for 1 v/division sensitivity and, of course, no noise is evident



Specifications other than common-mode rejection are equally impressive. Linearity is 0.01% of full scale (10 volt) output for either polarity, 0.02% of full scale for plus-to-minus or minus-to-plus polarities. Equivalent input drift is less than 2μv; noise at full amplifier bandwidth is less than 6μv. Input impedance is 30 megohms, output impedance less than 0.25 ohms. Standard bandwidth is less than 3 db down at 80 cps, and the amplifier settles to within 99.9% of final value within 50 milliseconds for an output change of 5 volts. Plug-in input and output filters allow bandwidth options from 3 cps to 120 cps, transient response as good as 25 milliseconds. Gain is 10 to 1000 in 5 steps. A front panel vernier control provides 1 to greater than 3.3 times continuous adjustment of each gain step. Gain stability is ±0.05%. Output capability is 10 volts at 10 milliamps. Amplifiers have integral power supplies. Enclosures include six-amplifier and single-amplifier 19-inch rack modules, and portable single amplifier cabinets.

To meet your exact requirements at minimum cost, two models are now available: the 114A at $775, and the 114C (described) at $875. Delivery on both models is currently from stock. Write for detailed technical data or a demonstration. Engineering representatives in all major cities.

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New Ultra-High-Speed Ferrite Core For Simplified Memory Plane Construction

Now RCA Offers TWO Memory Cores for Impulse Switching to 0.2 Microsecond

New RCA memory core XF4930 joins the RCA 400M1 in adding new flexibility to memory system design. Specifically developed for operation under impulse switching conditions in magnetic memory systems, XF4930 switches in 0.25 microsecond and provides excellent discrimination at relatively low driving currents.

The larger size of the XF4930, providing more than twice the effective aperture size of the RCA 400M1, permits simpler and more economical fabrication of memory planes.

Systems Engineering Service: Your local RCA field representative is prepared to furnish a completely coordinated application service, covering transistors and other semiconductor devices, ferrites, and memory systems. Call him today.

Nominal Operating Characteristics At 25 C	Type XF4930	Type 400M1	Units
Read Driving Current (I_R)	570	380	ma
Full Write Current (I_{FW})	255	280	ma
Impulse Write Current (I_{IW})	130	180	ma
Digit Write Current (I_{DW})	125	100	ma
Read Pulse Rise Time (t_r)	0.1	0.1	μsec
Full and Impulse Write Current Rise Time (t_r)	0.1	0.08	μsec
Digit Write Pulse Rise Time	0.1	0.15	μsec
Switching Time (t_s)	0.25	0.2	μsec
Response: "Undisturbed Read-1" (dV_R)	100	50	mv
"Disturbed 0" (dV_D)	15	8	mv
Size	.050x.030x.015	.030x.018x.010	inch

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