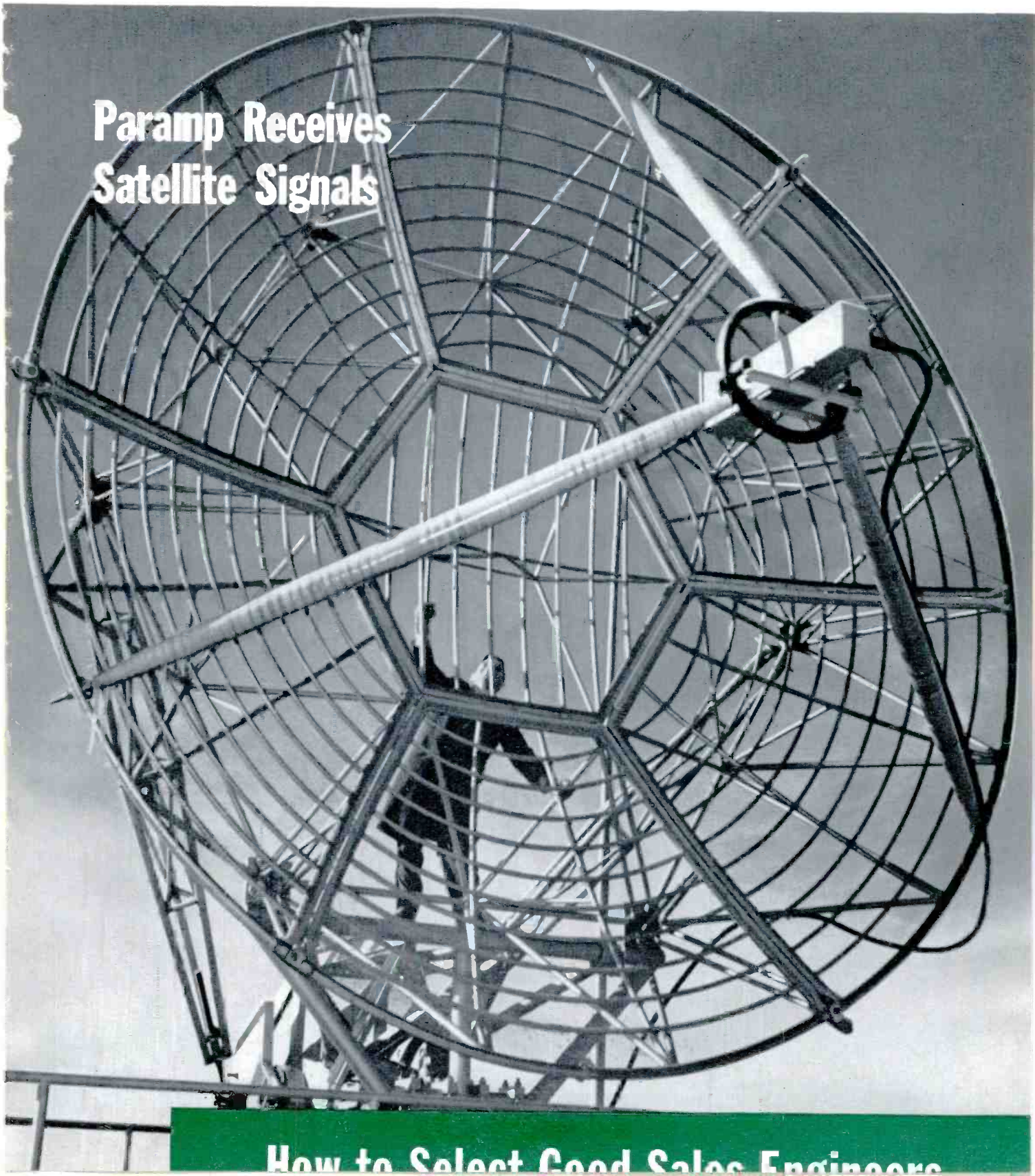
MAY 1, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 18 PRICE SEVENTY-FIVE CENTS



Paramp Receives Satellite Signals

How to Select Good Sales Engineers

LOOK! one new instrument useful 2 ways

① Microvoltmeter-Micromicroammeter measures to 1 μv, 1 μμa!

② Sensitive high-impedance voltmeter

input values to approximately 400 megohms!

New hp 425 Microvolt-Ammeter

This versatile new hp instrument serves you in many ways. It is a high sensitivity microvoltmeter measuring to 1 μv, and a micromicroammeter measuring to 1 μμa with sensitivity 10 times that previously available. Drift is less than ± 2 μv/hour and noise is less than 0.2 v RMS.

Or, with a simple factory modification offered at no extra cost, the input impedance can be increased to approximately 400 megohms. This insures accurate measurement without loading on most high impedance circuits. In many situations, the 425A thus performs measurements for which expensive electrometers were previously required.

Model 425A also serves as an ohmmeter, measuring resistances from milliohms to 10 megamegohms in conjunction with an external constant current.

Other unique features include a photoelectric chopper replacing the conventional multi-vibrator, heavy ac filtering, protection against momentary overloads up to 1,000 volts, and a new probe minimizing thermocouple or triboelectric effects.

HEWLETT-PACKARD COMPANY

5514A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
DAVENPORT 5-4451 • CABLE HEWPACK
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

SPECIFICATIONS

MICROVOLT-AMMETER

Voltage Range: Positive and negative voltages from 10 μv end scale to 1 v end scale in an eleven step, 1-3-10 sequence.

Current Range: Positive and negative currents from 10 μμa end scale to 3 ma end scale in an eighteen step, 1-3-10 sequence.

Input Impedance: Voltage Ranges: 1 megohm ± 3%. Current Ranges: 1 megohm to 0.33 ohm, depending on range. (With factory modification, over 200 megohms. Please specify Model H 01-425A in ordering; no extra cost).

Accuracy: Within ± 3% of end scale.

AMPLIFIER

Ac Rejection: At leost 3 db at 0.2 cps, 50 db at 50 cps, approx. 60 db or more at 60 cps.

Gain: 100,000 maximum.

Output: 0 to 1 v for full scale reading, adjustable.

Output Impedance: 10 ohms, shunted by 5000 ohm potentiometer.

Noise: Less than 0.2 μv rms referred to input.

Drift: After 15 minute warm-up, less than ± 2 μv per hour referred to the input.

Power: 115/230 v ± 10%, 60 cps, 40 watts.

Dimensions: Cabinet Mount: 7½" wide, 11¼" high, 14" deep.

Weight: Net 17 lbs.

Price: hp 425AR (rack mount) $505.00. hp 425A (cabinet) $500.00.

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

hp Quality and value standard in test instrumentation

electronics

MAY 1, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 18

Issue at a Glance

Business

Engineering

Departments

North Carolina Plant Location Engineers

Show Documentary Proof of Your Opportunity In a Multi-Million Dollar Component Market

These men invite you to study their latest survey of the Electrical Machinery and Equipment Industry in North Carolina. It reveals an amazing record of growth continuing by leaps and bounds.
They are ready to show you opportunities for your expansion into a ready-made market in the South's pace-setting state —

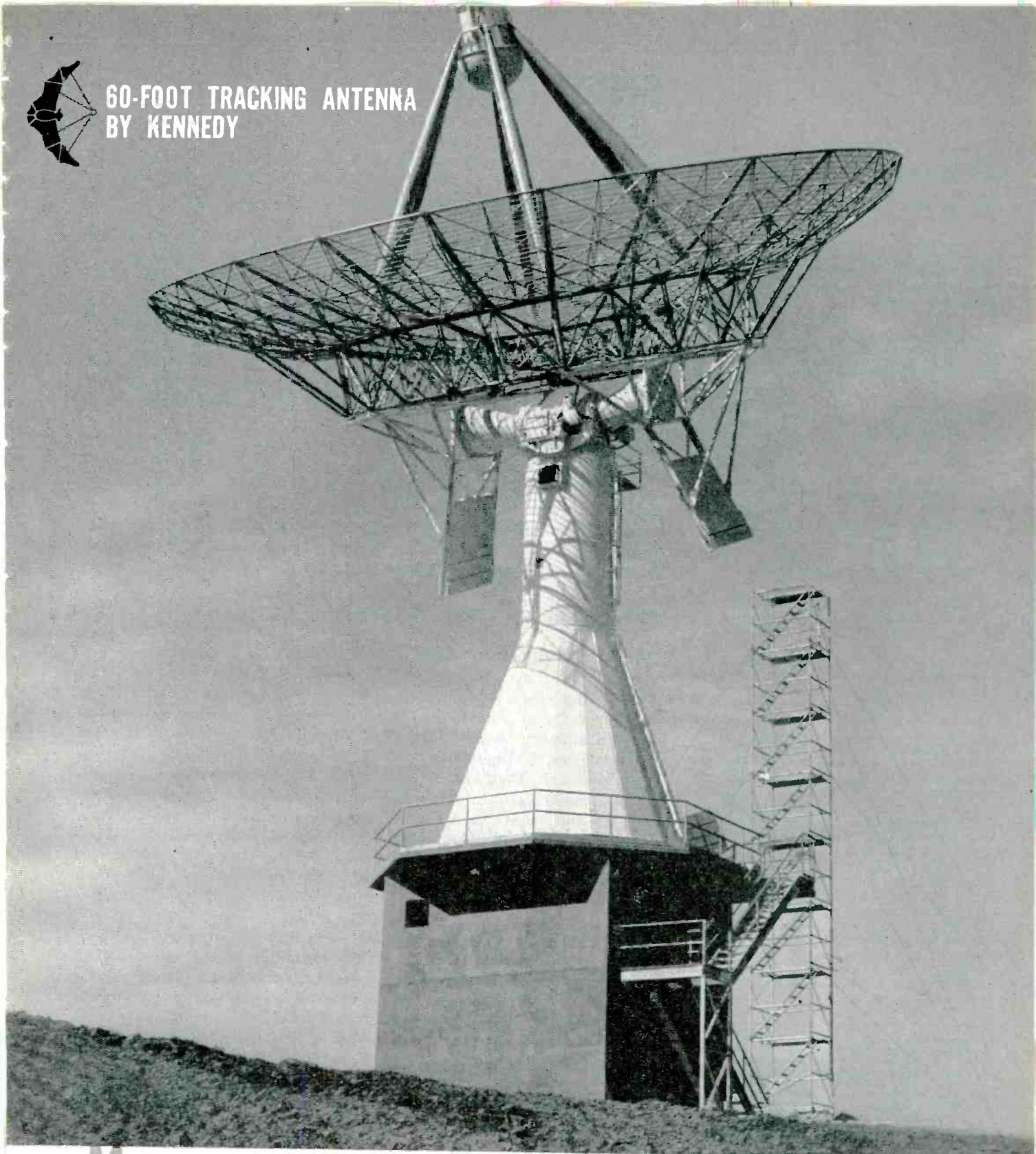
NORTH CAROLINA

Where it's Profitable to Produce and Wonderful to Live

If you are interested in discussing confidentially "A Market Survey of the Electrical Machinery and Equipment Industry of North Carolina," write or phone Wm. P. Saunders, Director, Dept. of Conservation and Development, Raleigh, North Carolina.

CIRCLE 1 READERS SERVICE CARD

CIRCLE 2 READERS SERVICE CARD →



Mainstay at the missile test ranges . . . Kennedy's 60-foot tracking antenna systems at the Atlantic and Pacific Missile Test Ranges track and receive telemetry signals from both test missiles and satellites orbiting thousands of miles from the earth. These optically-precise instruments come from the only company where efforts are concentrated entirely on microwave antenna development, manufacture and installation.

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Down-To-Earth **SOLUTIONS** *to*
Out-Of-This-World **PROBLEMS**

Tracking Antennas
Radio Telescopes
Radar Antennas
"Trans-Horizon" Antenna
Tropospheric Scatter

electronics

May 1, 1959 Vol. 32, No. 18

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Postmaster: please send form 3579 to Electronics, 330 W. 42nd St., New York 36, N. Y.

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SHOPTALK . . .

HIRING HINTS. Everybody looks for good men—especially electronics company executives searching for top sales engineers. Several weeks ago, our Pacific Coast Editor, Hal Hood, joined in the search. But he wasn't looking for men. His target: realistic, crisp, documented information.

That he found it is proven on p 24, where he tells "How to Pick Sales Engineers." Part of the proof he offers this week uncovers an interesting development taking place in our industry. It's this: more and more electronics firms are giving aptitude and psychological tests to their prospective sales engineers. No one is saying personal interviews no longer count. They do. But in today's manhunt, tests are counting more than they ever did. There are good reasons for this—reasons that can save your company considerable money—and we believe you'll find it profitable reading them.

MOSCOW NEWS. Our story on p 32 this week bears a Moscow dateline—and it's no accident. It is the product of McGraw-Hill's worldwide news-gathering organization. A six-man U.S. electronics delegation was touring Soviet factories and institutes. Moscow bureau chief Bob Gibson kept on the story and, at the right moment, interviewed the U.S. visitors at length. Their views, and more, are in the story headlined, "Soviet Production Gap Cited."

Coming In Our May 8 Issue . . .

NUCLEAR BOMB ALARM. In the event of nuclear war, our national security will lean heavily on our early warning system and other complex defense measures. But on the long chance that these measures fail, a system has been developed to protect key underground military installations from surprise nuclear attack damage.

Physicists J. Champeny and T. E. Petriken, with Engineering Technician S. Siciliano of the U.S. Army Signal Research and Development Labs in Fort Monmouth, describe the system which detects and identifies a nearby nuclear explosion and activates a warning system to close blast doors, supply radiologically filtered air and operate other protective equipment. Three units are provided to detect and identify the light flash, radiation and blast wave from a nuclear detonation.

MORE STEREO. Interest in stereo recording and broadcasting continues undiminished. Many new proposals for stereo broadcasting techniques were described in a recent ELECTRONICS survey (p 41, April 3). One of the recent proposals for compatible stereo broadcasting is the Westinghouse system which uses a combination of amplitude modulation and narrow-band frequency modulation.

Next week, Westinghouse's H. E. Sweeney describes in detail the technical features of this technique, which features the ability to furnish stereo reception using two conventional broadcast a-m receivers.

STAR SCANNER. An astronomical camera photographs in ten minutes several million stars on a plate 14 in. x 14 in. A few of these are so-called variable stars because of the variability of the light they radiate. These variable stars are important astronomical tools for distance calibration.

According to J. Borgman of the University of Groningen, Holland, special techniques are required to detect variable stars among the millions of stars present on each photographic plate. As a rule, these methods are tedious and time-consuming. Borgman describes a new system using the principles of a flying-spot scanner which overcomes these deficiencies to a large extent.

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PNP SILICON TRANSISTORS NPN

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Other significant advantages include:

- Low saturation voltage
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- Low noise type available in both PNP and NPN
- Minimum change in characteristics with temperature, current, and voltage
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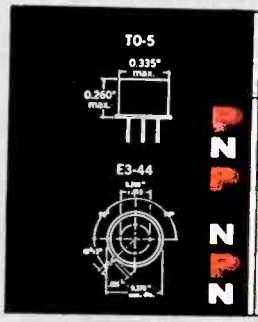
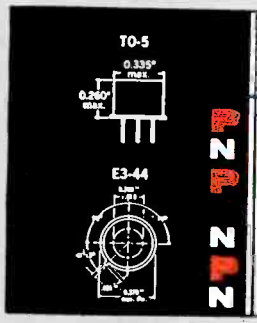


Type	I_{EO} or I_{CO} at V_{CB} = 20 V_{dc} μA	V_{CE} max. volts	H_{FE}† ave.	r_b' f = 1Mc ohms	f_c kilohms	Noise Figure db (max.)	c_{ob} f = 100Kc ave. μμf	$f_{\alpha b}$ ave. Kc
2N327A	0.005	−40	15	1200	500	30	65	200
2N328A	0.005	−35	30	1400	500	30	65	300
2N329A	0.005	−30	60	1500	500	30	65	400
2N619	0.005	50	15	2000	500	30	35	200
2N620	0.005	40	30	2500	500	30	35	350
2N621	0.005	30	60	2700	500	30	35	500

†for PNP, I_B = −0.1mA; V_{CE} = −0.5V; for NPN, I_B = 0.5mA; V_{CE} = 1.5V

FOR SMALL SIGNAL APPLICATIONS (Temperature Range −65°C to +160°C)



Type	I_{EO} or I_{CO} at V_{CB} = 20 V_{dc} μA	V_{CE} max. volts	h_{fe}* ave.	h_{ie}* max. ohms	h_{oe}* max. μmhos	Noise* Figure db	c_{ob} f = 100Kc ave. μμf	$f_{\alpha b}$ ave. Kc
2N1034	0.005	−40	15	3000	70	30	65	200
2N1035	0.005	−35	30	3000	85	30	65	300
2N1036	0.005	−30	60	3000	100	30	65	400
2N1037	0.005	−35	30	3000	85	15	65	250
2N1074	0.005	50	15	3500	70	30	35	200
2N1075	0.005	40	30	3500	85	30	35	350
2N1076	0.005	30	60	3500	100	30	35	500
2N1077	0.005	30	25	3500	85	15	35	300

*V_C = 5V; I_E = 3mA

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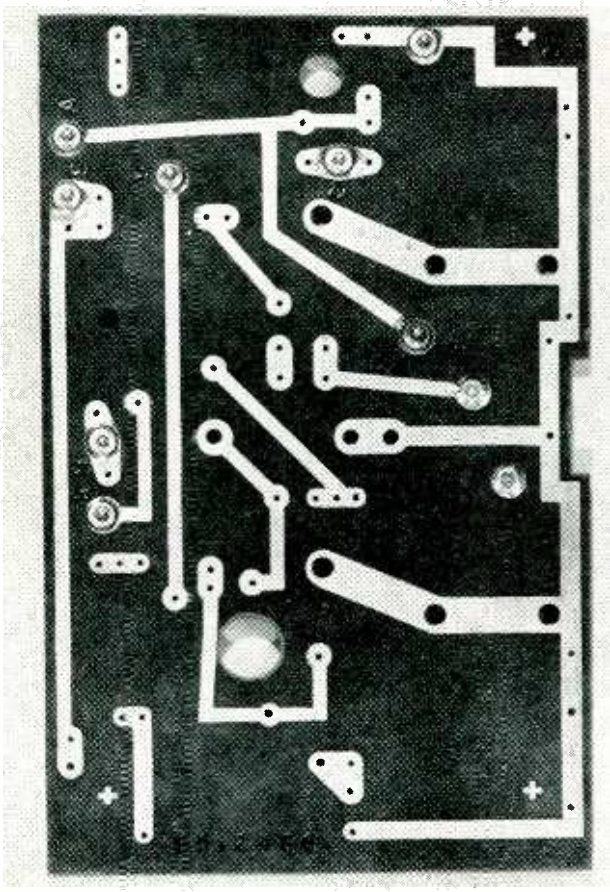

How CDF Di-Clad® can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

Di-Clad 28E. For high mechanical strength, low moisture-absorption, and good insulation resistance, CDF Di-Clad laminates of epoxy resin laminated with glass fabric offer the designer a strong, reliable combination.

Di-Clad 112T. A Teflon* glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

Send us your requirements and let our engineers help you select the right grade for your application.

*Du Pont trademark for its tetrafluoroethylene resin.

Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed-circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

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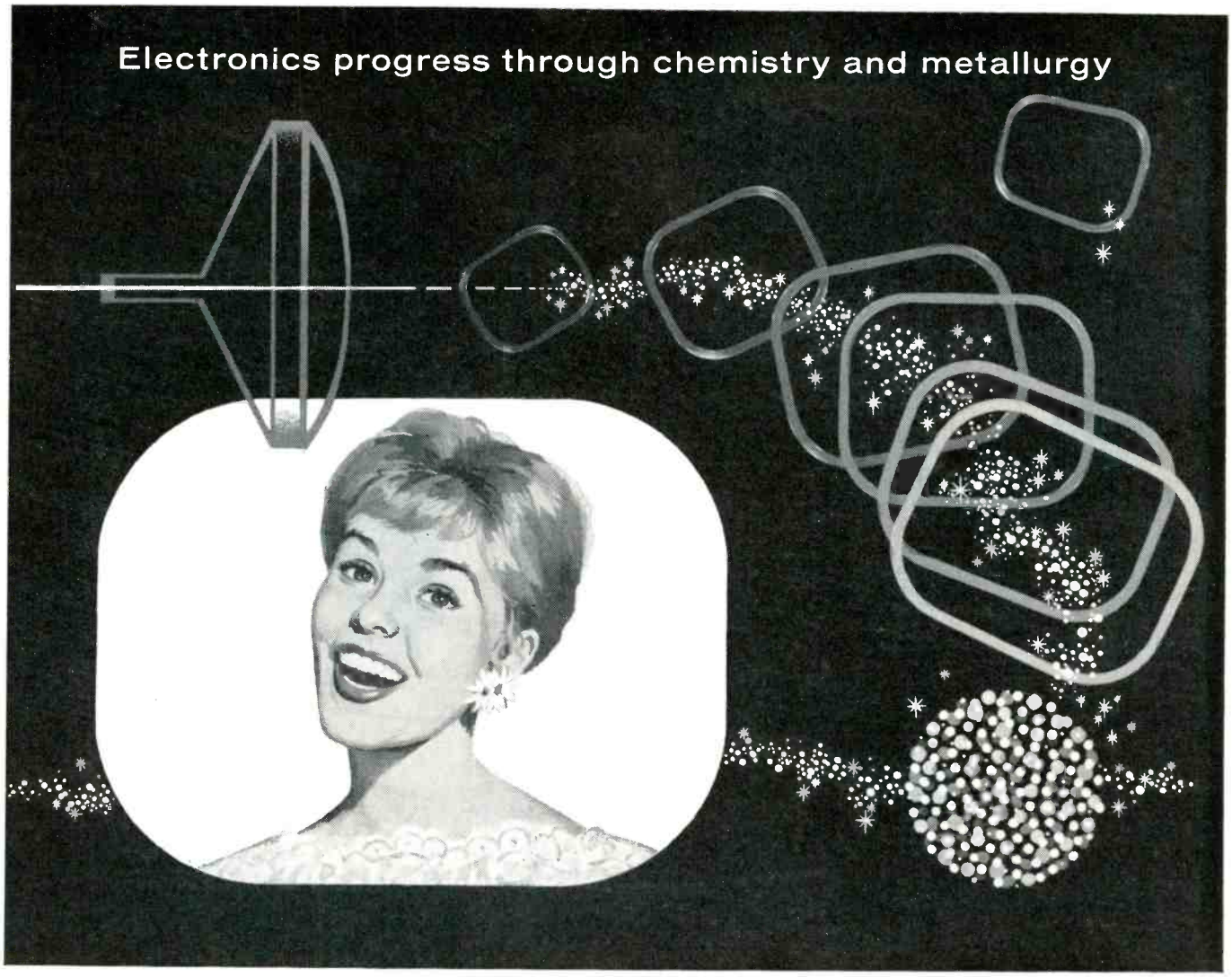
TYPICAL Di-Clad PROPERTY VALUES

	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark



How Sylvania Phosphors put brighter pictures on TV

The increased brightness and clarity of today's TV pictures over those of just a few years ago have been due in large part to progressive improvements made in the TV screen itself—its phosphor coating.

Sylvania, through its Chemical and Metallurgical Division, has played a leading role in this improvement. Engineers and scientists of the division have developed new cathode-ray tube phosphors with superior brightness, color and stability. They have engineered the industry's only integrated screening systems of complementary phosphors and settling solution chemicals to insure maximum screen adherence, strength, and brightness maintenance.

As a result, Sylvania phosphors are not only brighter initially but stay brighter longer. In recent competitive tests, a Sylvania phosphor maintained at least 93% of its initial brightness after 1,500 hours under electron bombardment, a record unattained by any other commercial picture tube phosphor tested.

You can easily take advantage of Sylvania's technical knowledge and production know-how in phosphors and other chemical and metallurgical products. Contact your Sylvania representative or write the Chemical and Metallurgical Division, Towanda, Penna.

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SYLVANIA ELECTRIC PRODUCTS INC.
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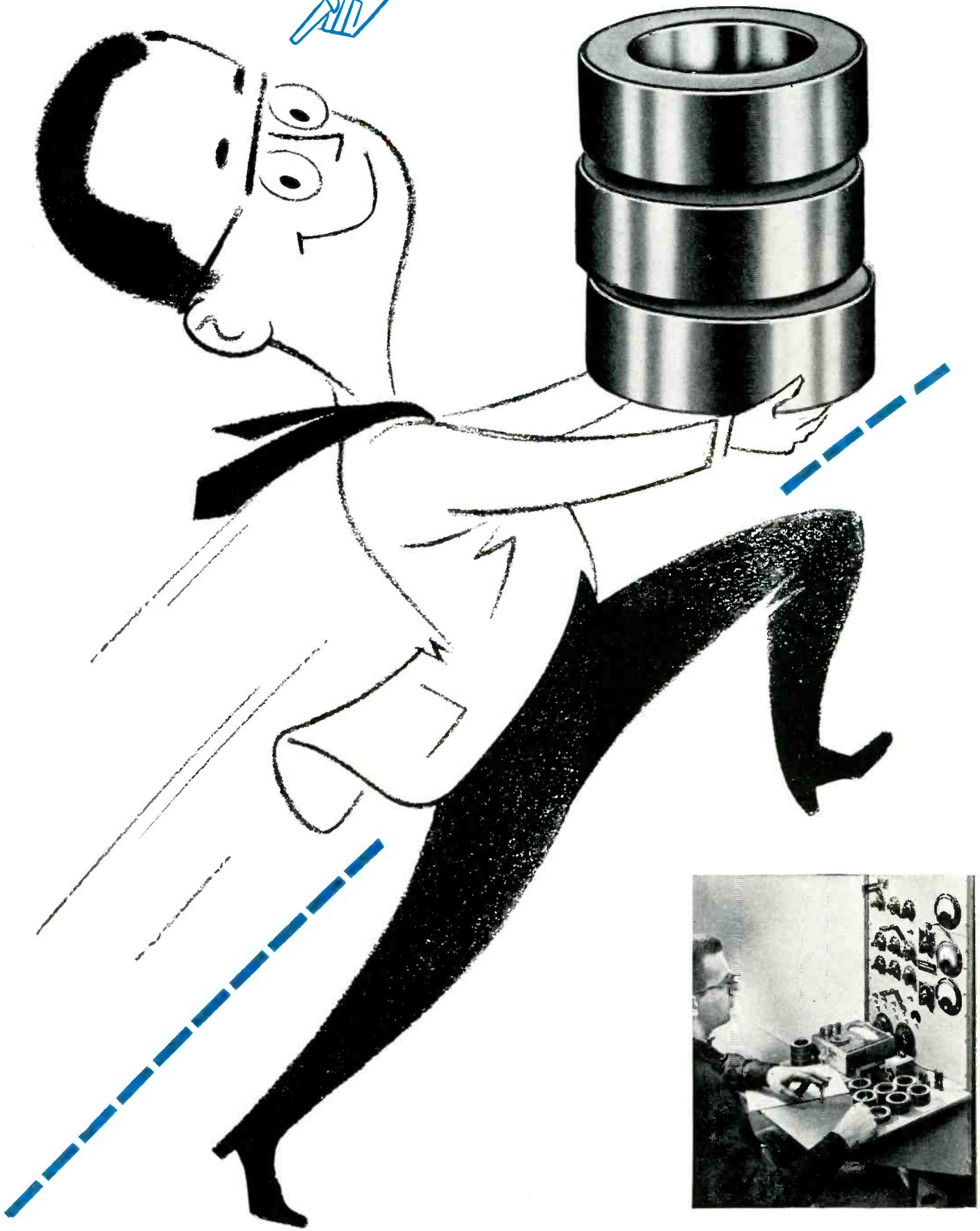
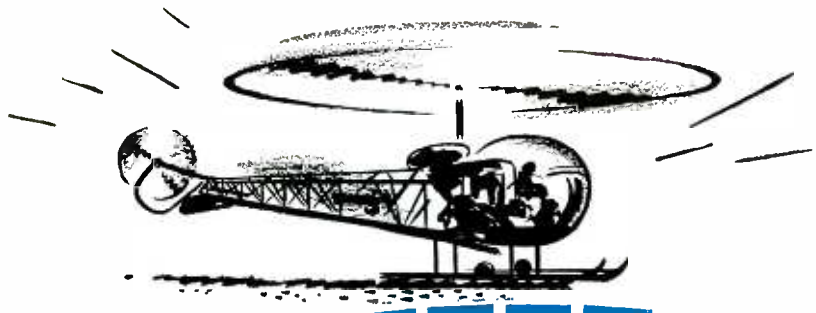
Meet Mr. Mu, the man from Magnetic Metals





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Centricores are made from thin gauge materials with such singular names as Squaremu "79", Microsil and "49" alloys.* There's a fine variety of standard sizes, in either metallic or phenolic cases, available for fast delivery.

Our large inventory of cores and raw materials permits us to adapt our shipments readily to *your* precise specifications. Selection and classification of the finest raw materials available . . . high precision winding machines . . . special annealing processes . . . all these factors contribute to the high degree of uniformity of our cores. Tell us what you need.

**Other materials include Molybdenum Permalloy, Supermalloy, Orthonic, Silectron, Deltamax, Hipernik, and Hymu.*

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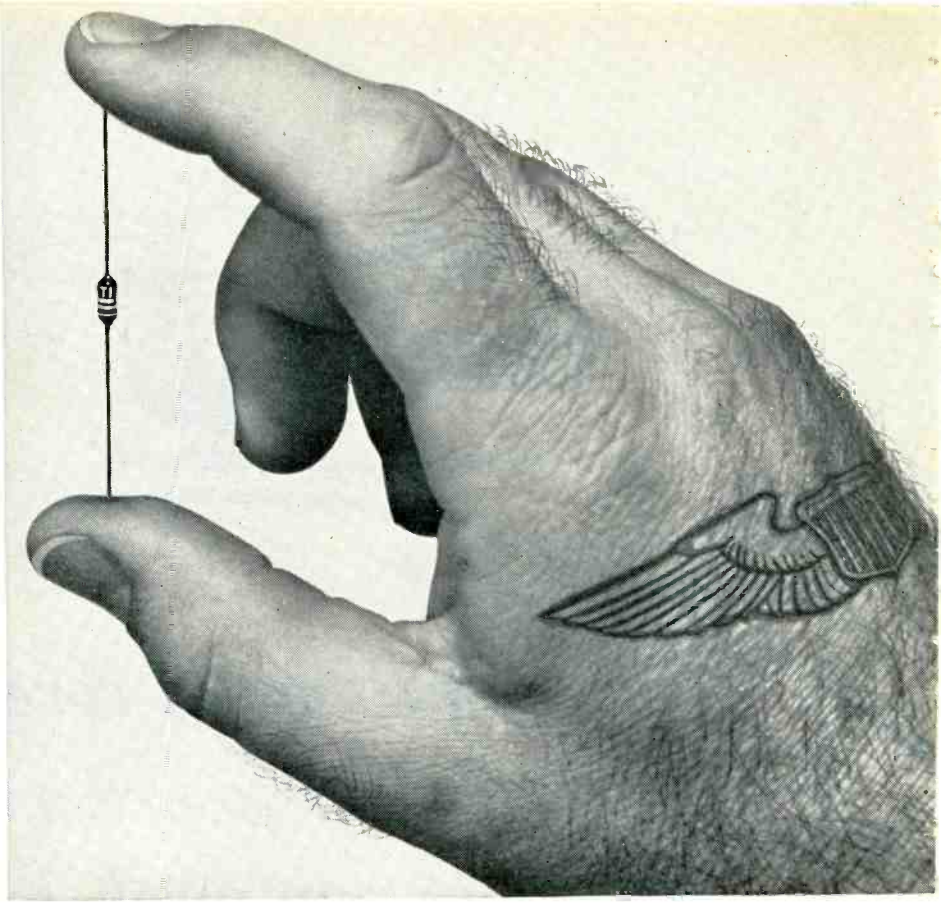

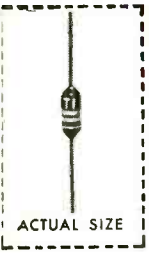

Guarantee 400 ma DC at 1 v

TI AF1N645, AF1N647, AF1N648 and AF1N649 diffused-silicon glass diodes now meet MIL-E-1/1143 . . . giving you 400 ma DC at 1 v . . . 225 to 600 v PIV . . . operation from —65 to 150°C and 600 mw dissipation. The inherently low junction temperature of these TI glass diodes provides a new high in reliability by combining the lowest forward-voltage drop with high power dissipation package.

In commercial production for more than two years, the 1N645 series is available in *production quantities* to meet *all* your requirements.

Simplify your procurement and stocking problems by standardizing on the TI 1N645 series . . . truly general-purpose high-reliability diodes. Contact your nearest TI Sales Office for fast delivery of production quantities.

maximum ratings

	AF1N645	AF1N647	AF1N648	AF1N649	
PIV	225	400	500	600	v
I_O @ 25°C	400	400	400	400	ma
I_O @ 150°C	150	150	150	150	ma
i_P	1.25	1.25	1.25	1.25	amp
P	600	600	600	600	mw
I_{DC}	3	3	3	3	amp
T_A	−65 to +150				°C

specifications

	AF1N645	AF1N647	AF1N648	AF1N649	
V_Z	275	480	600	720	v
I_{Ib} @ 25°C & PIV	0.2	0.2	0.2	0.2	μa
I_{Ib} @ 100°C & PIV	15	20	20	25	μa
E @ I_b = 400 ma dc	1.0	1.0	1.0	1.0	v
C_{typ}	9	9	9	9	μμf

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ELECTRONICS NEWSLETTER

USSR now claims a new nuclear-electronic "first" —operation of a charged particle accelerator with spatial variation magnetic field intensity. "In the near future," said the Soviet press last week, "accelerators built on this principle will yield beams of accelerated particles with intensity of thousands and tens of thousands times greater than present high energy accelerators." Working since January, the cyclical accelerator "has passed all-around tests successfully" at the Joint Nuclear Research Institute at Dubna.

NAVY BuShips has ordered a 5-kw thermoelectric generator from Westinghouse Electric. Firm says the unit is intended to be the small-scale prototype of a shipboard installation, but may be used directly as a movable power source. Generator's heat source will be a readily available fuel such as diesel oil. Unit will operate existing Navy equipment under shock and vibration conditions. Company says construction of generator is the first step in solving materials selection, fabrication, assembly, operating and control problems of a large-scale thermoelectric power plant.

MICROFILMED CENSUS DOCUMENTS in next year's decennial census will be transcribed onto magnetic tape for computer input by a new model of an electronic machine built by the National Bureau of Standards. FOSDIC III (Film Optical Sensing Device for Input to Computers) will detect pen or pencil marks in multiple-choice answer areas on documents, then code the information into computer characters for magnetic tape recording. Four high-speed computers are expected to be used to process census data microfilmed from 50 million sheets of paper. Device focuses light from a crt on the microfilm image; transmissivity of small, discrete areas on the film—corresponding to the original hand-written marks—is measured with a photoelectric cell.

Project Orion is now identified as a feasibility study aimed at possible development of a thousand-ton space platform propelled by controlled nuclear explosions. General Atomic division of General Dynamics Corp. initiated study nine months ago under ARDC contract.

DARK TRACE TUBE STORAGE technique is being developed by Skiatron under Air Force contract. Firm says 100 bits per square cm. have been obtained and much higher densities are attainable. Phosphor crystals of dark trace crt are excited to three distinct energy states. Impinging electron beam can raise the energy level of crystals, resulting in a small dark spot which remains until the original phosphor state is restored. An electron beam of higher energy restores the original state, thus erasing information. Bits are read out by directing the same electron beam to the spot on the tube face, then using a suitable beam exposure on it.

PULSE CODE modulation techniques are combined with f-m in an integrated aircraft flight test data acquisition system and companion ground processing system reported last month. Equipment will be supplied to GE by Radiation, Inc., of Melbourne, Fla., under a $300,000-plus contract. Data acquisition systems will collect aircraft test information and store it on magnetic tape; ground-based systems will reproduce data when test mission ends. Immediate presentation on visual readout devices is provided, along with simultaneous translation into high-speed computer language.

Molecular generator developed by Russian scientists produces radio waves emitted by molecules of ammonia. Output is claimed to be stable enough to power an electric clock accurate within one second in 300 years. One goal: development of compact units for earth satellite experiments.

MISSILE IMPACT PREDICTION SYSTEM that pinpoints flight position and impact area of missiles at the rate of two a second is now in service with the Air Force. MIPS was designed by Packard-Bell and uses a Bendix G-15 digital computer. System translates data from a COTAR tracking system into missile position and impact point, then gives it to plotting boards. MIPS will spot a stray for the range safety officer, signaling him to push destruct button.

FRANCO-GERMAN electronics tie-up within the developing European Common Market came last week. Agreement was signed by the French electronics giant, CSF, and Felten and Guilleaume AG, a leading German submarine cable producer. Pact sets up a joint firm, CETT, for production of electron tubes for long-distance submarine cables at a plant in Dijon, in eastern France.

INTENSITY OF RADAR ECHO PULSES as seen on a radar screen is measured by an instrument just reported in West Germany. German Ministry of Transport, which backed research for the device at Hanover Technical University, is experimenting with it as a survey tool to improve effectiveness of radar navigation gear on inland waterways. Pulses of less than a millionth of a second, to which first models could not respond, are now handled in "slow motion" up to a thousandth of a second.

WASHINGTON OUTLOOK

NATIONAL AERONAUTICS & SPACE ADMINISTRATION is studying a plan to liberalize the tight policy on patent rights written into the Space Law by Congress last year.

NASA's patent right rules now are more restrictive than the Defense Dept.'s, run in the same tight lines as the Atomic Energy Commission's: the government acquires title to inventions which develop from all work performed under NASA contract.

NASA's legal staff has drawn up an interim set of regulations under which patent right restrictions may be waived. The new rules will be discussed at an open hearing scheduled for May 18 at NASA's Washington headquarters.

The new regulations will exempt NASA contractors from the requirements that title to inventions be acquired by the U.S. in these cases:

(1) When the invention was "conceived prior to and independently of, but was first actually reduced to practice in the performance of work under a (NASA) contract, and the invention is covered by a U.S. patent issued or application filed by or on behalf of the contractor prior to the award of the contract."

(2) When the invention has "only incidental utility in the conduct of activities with which (NASA) is particularly concerned and has substantial promise of commercial utility."

(3) When the invention is "directed specifically to a line of business of the contractor with respect to which the contractor's expenditure of funds in the field of technology to which the invention pertains has been large in comparison to the amount of funds paid to . . . the contractor under the contract in which the invention was made for research or development work in the same field of technology."

(4) The waiver is for a "nonexclusive, nontransferable, royalty-free license under an invention which does not qualify for waiver" under the above rules.

(5) The waiver is for an invention in a foreign country in which NASA "does not desire to file an application for patent for such invention."

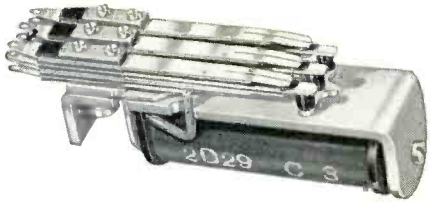
- **The Pentagon** has released first details on electronics contractors in the Discoverer series of satellite tests.

  Philco is subcontractor for the ground-space communications and tracking system: Gulton Industries, for the power subsystem; Bendix for the reaction control which keeps the satellite oriented in the desired orbit; Reeves Instrument on key elements of the combined inertial and radio-radar guidance and tracking system; American-Standard on a horizon infrared scanning device for navigation aid. Lockheed, prime contractor on the project, designed the telemetry system.

- **Federal Communications Commission** will get from Congress the legislation it wants to legalize the hundreds of tv booster stations that dot the sparsely-settled areas of the country.

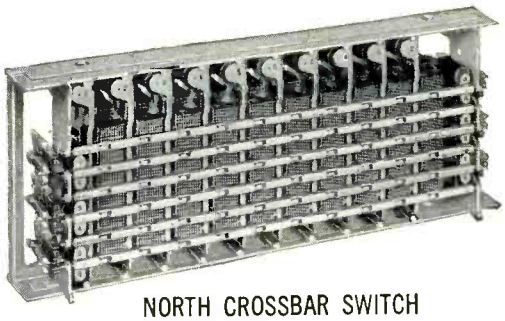
  FCC did a turnabout. Not long ago it had notified some operators of the 1,000-odd booster stations that they'd have to get off the air or become translator stations—that is, convert the vhf signals they receive into uhf before retransmitting.

  Reaction from the western Congressmen, particularly, made FCC change its mind, and there's little doubt that Congress will legalize the boosters. FCC however wants Congress to approve only those in operation as of January this year, and to require that they retransmit their signal on a channel different from the one they receive. Also, FCC wants their power kept to one watt.



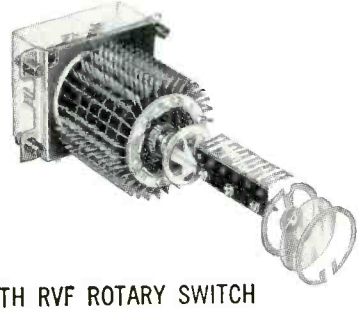
NORTH FLAT SPRING RELAYS

Time tested and proven telephone dependability for universal application.



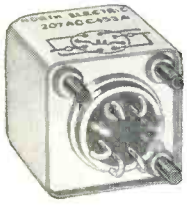
NORTH CROSSBAR SWITCH

The most economical means of providing maximum switching capacity (inputs to outputs) with relay reliability.



NORTH RVF ROTARY SWITCH

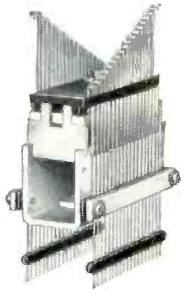
Advanced bank and wiper design affords new flexibility in rotary switch application.



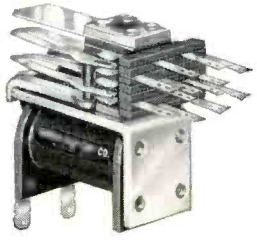
NORTH IR 207 & IR 226

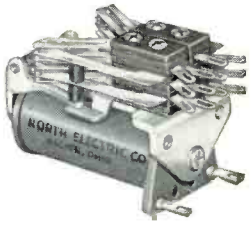
Hermetically sealed general purpose and sensitive relays - high shock and vibration resistance meeting Mil. specs.

NORTH REED ARMATURE RELAY



Exceeds critical requirements in data switching systems where high speed, low level signals must be handled with minimum interference between channels.





NORTH "M" AND "E" TYPE RELAYS

Telephone type dependability in miniature size where space requirements are critical.

In system design...

THERE IS A **NORTH** COMPONENT THAT IS **RIGHT** FOR EVERY APPLICATION

North engineers, specialists for over 75 years in the design, production and application of relays and switch gear, can take over your control system design problems and solve them beyond your specifications. The accumulated know-how of three quarters of a century in this specialized field can be applied to help you - in design, in component specification, and in complete system manufacture.

INDUSTRIAL DIVISION

NORTH ELECTRIC COMPANY

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Available in Canada through
Ericsson Telephone Sales of Canada, Ltd., Montreal 8, P. Q.

New Issues Finance Growth

NEW OFFERINGS of electronics securities continue prominently featured in this month's market. The majority of these offerings are for expansion financing.

• **Philco Corp.,** Philadelphia, has registered, issued and completely sold out its recent bond offering of $20 million in convertible subordinated debentures to be due April 15, 1984. The company intends to use proceeds of the sales for purposes which include capital expenditures through 1961. Some funds will be used to establish programs for transistor and computer manufacture.

• **Loral Electronics Corp.,** New York, is seeking to register 250,000 shares of common stock. Offering will be through Kidder Peabody & Co. and Model, Roland & Stone, according to SEC reports. The underwriters have purchased warrants from the firm exercisable through September 1964 to purchase 50,000 shares of the issue. A substantial portion of the new capital will be used to purchase land, erect a new plant for production of military electronic gear.

• **Precon Electronics,** a new firm, proposes to issue 175,000 shares of common stock for public sale at $5 a share. The offering is to be made on a best-effort basis by underwriters who will receive $1 a share commission as well as $30,000 of the underwriting expenses. A portion of the sales proceeds will be used to fabricate dies, jigs and models for making an automation controller, a tv programmer and a data recording pulse camera. The new firm expects to establish its plant site on the West Coast.

• **General Telephone & Electronics,** New York, proposes a public offering of 800,000 shares of its $10 par common stock. Funds will be used to finance construction of new telephone facilities here and abroad. The firm has operating companies and manufacturing subsidiaries in Belgium, Canada and Italy, as well as holdings in the Philippines and the Dominican Republic.

• **DeJur-Amsco Corp.,** Long Island City, N. Y., has filed a registration statement with SEC for $1 million in convertible debentures due 1974, and 225,000 shares of its $1 par class A stock. The firm, which manufactures electronic and photographic equipment, will use a portion of the funds for plant expansion.

OVER THE COUNTER

1958 BIDS LOW	1958 BIDS HIGH	COMMON STOCKS	WEEK ENDING April 10 BID	WEEK ENDING April 17 BID	WEEK ENDING April 17 ASKED
3¾	20½	Acoustica Assocs	31	34	38¾
1⅝	3	Advance Industries	3⅜	3½	4⅛
3⅛	6⅝	Aerovox	7⅜	7⅜	8¼
5½	15	Appl'd Sci Princet	9	9	12¼
1⅛	8⅞	Avien, A	8½	8¼	9½
6¾	24	Baird-Atomic	29	28¾	32
9¾	13⅜	Burndy	15	16	18⅜
6¾	9	Cohu Electronics	7⅜	7⅜	8⅞
11	22½	Collins Radio	32¼	33½	39⅞
32½	49	Cook Electric	48	47	53½
4	7	Craig Systems	9⅞	9⅝	11
17⅝	25⅜	Eastern Industries	19	18¾	20⅝
1¾	8⅜	Elco Corp	7¾	7¾	8¾
10½	21	Electro Instr	27	26	30⅞
34	49	Electronic Assocs	39	42	49¼
5	11	Electronic Res'rch	18	17½	19⅜
8½	12¾	Electronic Spec Co	14⅞	15	16¾
15¼	49½	Epsco, Inc	38	43	48¼
5½	9⅜	Erie Resistor	9½	9¼	10½
10	17½	Fischer & Porter	15	14	16
5½	10½	G-L Electronics	13	12¾	14⅜
12	27	Giannini	29¼	29½	34⅝
...	...	Haydu Elec Prod	5¼	5¼	6⅜
30	39½	Hewlett-Packard	44¾	44½	47¾
23¼	48	High Voltage Eng	52½	56½	65
1¾	3	Hycon Mfg	3⅝	3⅝	4⅛
1⅛	5⅛	Industro Trans'tor	3¾	4⅜	6¾
...	...	Internat'l Rec'f'r	24½	24½	27¾
...	...	Interstate Engin'g	31½	34	37¼
1½	4¾	Jerrold	6⅜	6⅝	7¼
21	30	D. S. Kennedy	31½	30	33¾
3¾	29	Lab For El'tronics	30½	31	36¾
19¼	28	Leeds & Northrup	28	28¾	30¾
2	3⅛	Leetronics	3½	3¼	4⅜
5	18¾	Ling Electronics	26½	26¼	29⅛
3¼	8¼	Magnetic Amplifiers	9	8½	9¾
2⅞	4½	Magnetics, Inc	5⅛	5	5½
4⅝	12	W. L. Maxson	14½	14⅝	16⅞
10⅝	29	Microwave Assocs	35	40	51⅜
5¼	11¾	Midwestern Instr	12¼	12¾	14¼
1⅛	7	Monogram Precis'n	10⅞	10½	12⅛
3½	7¼	Narda Microwave	10⅛	10¼	11¼
...	...	Narda Ultrasonics	9¾	9⅜	10⅞
9¾	16	National Company	20¼	22	26¾
14¼	56	Nuclear Chicago	36	33	38¾
4½	7⅜	Pacific Mercury, A	11¾	13¼	15⅝
10⅛	27½	Packard-Bell	35½	37	42
4¼	9⅜	Panellit, Inc	7¾	7¾	8⅝
21	53¾	Perkin-Elmer	42	42½	57½
11⅜	19½	Radiation, A	19¾	19¾	22¾
2⅛	7⅜	Reeves Soundcraft	6¾	6⅛	7⅜
13	32½	Sanders Associates	27½	27½	32½
...	...	Silicon Transistor	9⅜	9	10½
7	12	SoundScriber	17¾	17½	19
22¾	40	Sprague Electric	47	50	55
26	35	Taylor Instruments	34½	33½	37½
5½	15	Technical Operat'ns	20	20	26¼
5½	15¾	Telechrome Mfg	26	25	32
3¼	7¾	Telecomputing	10⅞	10½	12⅜
1⅛	2¾	Tel-Instrument	2½	2¾	3
8¾	16⅓	Topp Industries	13½	13¼	14¾
3¾	10⅓	Tracerlab	11¾	11½	14⅛
1⅛	3⅜	Universal Trans'tor	1⅜	1⅜	1¾
14¼	40	Varian Associates	51	59¾	64¼

The above "bid" and "asked" prices prepared by the NATIONAL ASSOCIATION of SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.

"We grew too fast for our bank"

When he was fourteen years old, Jim McClain earned pocket money by rewinding motors and transformers. Thirteen years later James Ernest McClain, with very little capital but lots of know-how and drive, started his own business, specializing in the repair of distribution transformers.

In its first year, ESCO Manufacturing Company, of Greenville, Texas, consisting of 27 years old McClain and a hired mechanic, grossed $35,000, netted $7,000. Last year, gross was several millions, and net profit, correspondingly substantial.

In the early years the local bank was able and willing to supply all the credit that Esco needed. But the growth was so rapid and the matching need for working capital so great, the local bank wasn't quite able to go along. So Mr. James Ernest McClain, then head of a company grossing better than a half million dollars, and not willing to dilute his equity or surrender any voice in management, turned to Textile Banking Company for financing cooperation and advice.

Mr. McClain says: "In addition to the advantages we enjoy in using TBC's funds as equity capital, and the savings we effect in eliminating credit losses and the cost of a credit department, there is perhaps an even greater advantage. Though we are far away from the industrial and financial centers, we have the privilege of being able to call on TBC's experienced executives for advice in solving many problems, financial and otherwise. Their experience, their contacts, their ability to supply us with nation-wide credit information usually give us the right solution."

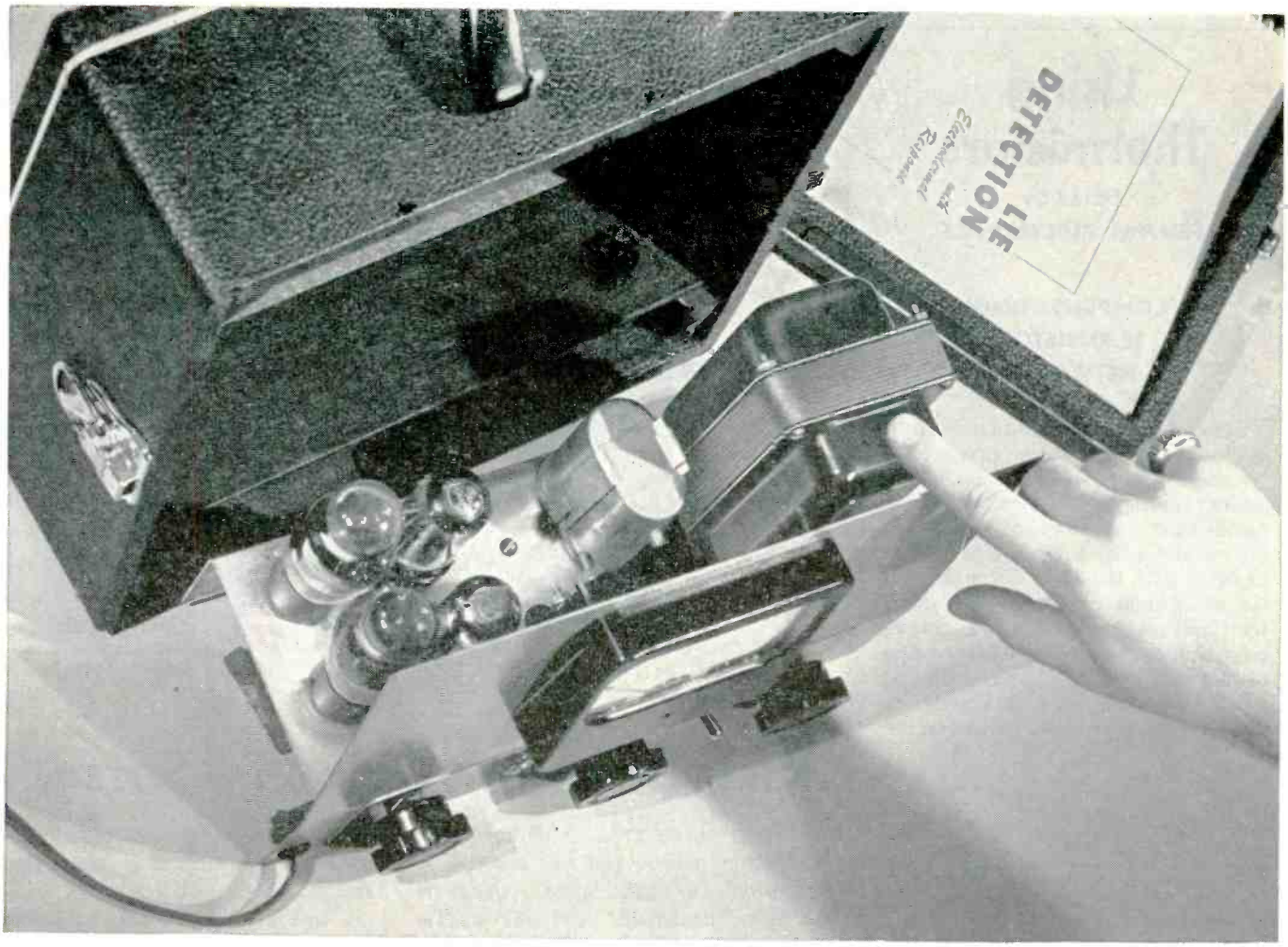
At TBC, we don't work miracles. We help growing companies, whose sales exceed $500,000 annually, meet all the capital needs of rapid expansion, without surrendering any management control, or without any dilution of profits. If you want to know more about how we do it, write for a free copy of our new booklet, "How to get the *cash* to keep your business growing."

How to get the *CASH* to keep your business growing!

Textile Banking Company, Inc.

55 Madison Ave., New York 10, N. Y.

Subsidiaries: T. B. C. Associates, Inc., New York, N. Y.
Southwest Texbanc, Inc., St. Louis, Missouri



B & W Associates built in a Sola regulated plate-filament power transformer as an integral component in their portable lie-detection apparatus.

Portable lie detector operates accurately with Sola-regulated plate and filament voltages

This sensitive polygraph operates by picking up and immensely amplifying tiny electrodermal responses. It's small wonder that line voltage variations encountered in field operation must be corrected if the responses of the witness are to be measured accurately.

The lie detector's built-in power supply transformer is a Sola Constant Voltage Plate-Filament Transformer which performs this dual function: (1) it supplies plate and filament voltages just as an ordinary power supply transformer would do; (2) it regulates these supply voltages within ±3% even when the line voltage varies over a 100 to 130-volt range.

Besides providing regulation which assures accurate polygraph operation, the Sola transformer protects tubes and components from cold inrush current and from fault currents.

This simple, reliable component costs little more than ordinary, non-regulating transformers. And compared to other types of regulating circuitry used with conventional power transformers, it is considerably cheaper.

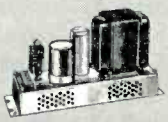
The plate-filament regulator is only one of the complete family of Sola Constant Voltage Transformers including such special types as filament and adjustable-output units. More than 40 models are available from stock, and Sola manufactures custom-designed units in production quantities to meet special needs.

For additional information write for Bulletin 7E-CVE

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.

SOLA

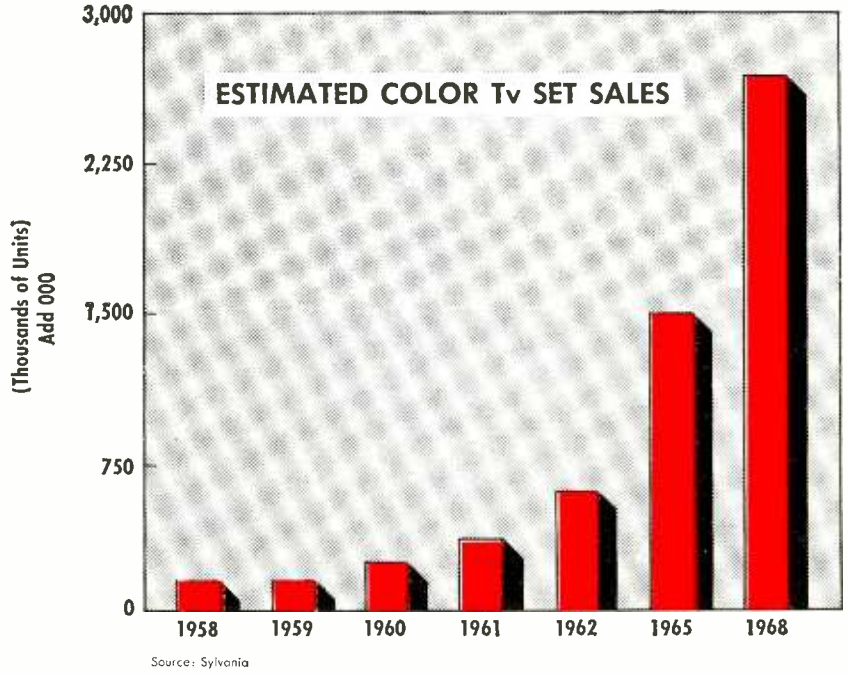

CONSTANT VOLTAGE TRANSFORMERS


REGULATED DC POWER SUPPLIES


MERCURY LAMP TRANSFORMERS


FLUORESCENT LAMP BALLASTS

A DIVISION OF BASIC PRODUCTS CORPORATION



Source: Sylvania

Rise Seen for Color Tv Sets

PACE OF COLOR TV sales will quicken starting in 1960 and will accelerate rapidly through 1968, predicts Frank Mansfield, Sylvania's director of marketing research.

He looks for sales of 240,000 color sets by dealers in 1960, a 50-percent increase over estimated sales of 160,000 sets in both 1959 and 1958.

At year-end, 1960, sets-in-use are expected to total 830,000 as against 435,000 at end of last year. From 1962 on, sales should increase by 300,000 units annually, reaching 1.5 million in 1965. During the 1965 to 1968 period, predicted sales increases will amount to 400,000 sets per year. In 1968, final year of the forecast, there will be sales of 2.7 million sets and an estimated 11.87 million sets-in-use.

Several receiver manufacturers note a marked improvement in sales of color tv receivers. One executive's prediction that sales of color sets will account for a substantial part of tv business within the next two years is in accord with Mansfield's projection.

Other manufacturers are awaiting the predicted upsurge of interest in color. One company in the television components field is already tooled up and prepared for large-scale production of deflection systems. But until an appreciable number of sets makes its way into consumers' homes, firm has taken a wait-and-see position.

A producer of color broadcast equipment mentions slight increase in sales, but nothing phenomenal. One equipment manufacturer feels the push for color broadcasting apparatus will come after the increase in receiver sales, not before. Stations bullish on color have equipped themselves and are waiting for enough sets to be sold, before beginning transmission.

Reports of strong interest in color television emanate from Japan. Although the present cost of color tv receivers is well beyond local consumers' means, the Japanese are grooming themselves on color broadcasting techniques. Japan's nationally owned tv station has already begun experimental color transmission.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Apr. 10, 1959	Mar. 13, 1959	Change From One Year Ago
Television sets	106,691	96,653	+38.6%
Radio sets (ex. auto)	254,390	275,592	+38.7%
Auto sets	99,188	109,063	+62.5%

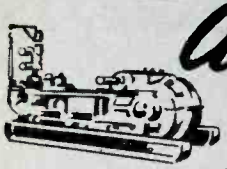
STOCK PRICE AVERAGES

(Standard & Poor's)	Apr. 15, 1959	Mar. 18, 1959	Change From One Year Ago
Electronics mfrs.	86.91	82.42	+70.9%
Radio & tv mfrs.	99.36	99.04	+122.0%
Broadcasters	99.11	94.79	+70.0%

CIRCLE 18 READERS SERVICE CARD→

Century OF TULSA

INDUSTRIAL INSTRUMENTATION



Anything FROM PUMPS - TO MISSILES - TO AUTOMOBILES

CAN BE MADE BETTER WITH . . .

CENTURY INSTRUMENTATION

INDUSTRIAL

. . . The recording of static and dynamic phenomena such as strains, vibrations, pressures, accelerations, temperatures, and impacts . . .

. . . Monitoring and recording reference signals in control applications . . .

. . . Response measurements in dynamic production tests . . .

. . . Brain studies . . . electro-cardiograph work . . . studies in physiological and medical research . . . Any place where high sensitivity and/or high frequency data are required.

. . . We know of slush pump manufacturers, automobile manufacturers, and many other types who have found that they can make better products and save on production costs by the use of oscillographs and other instrumentation of the Century type.

It can be greatly to your advantage to modernize to meet these new advances in industrial instrumentation . . .

Technical literature and engineering assistance on specific problems and applications are available from our engineering department. Just call the representative nearest you.

It is possible to decrease obsolescence in some of your present equipment by the addition of new instrumentation and procedures. Century oscillographs have high adaptability and low comparative cost.

Send for the Century story today.

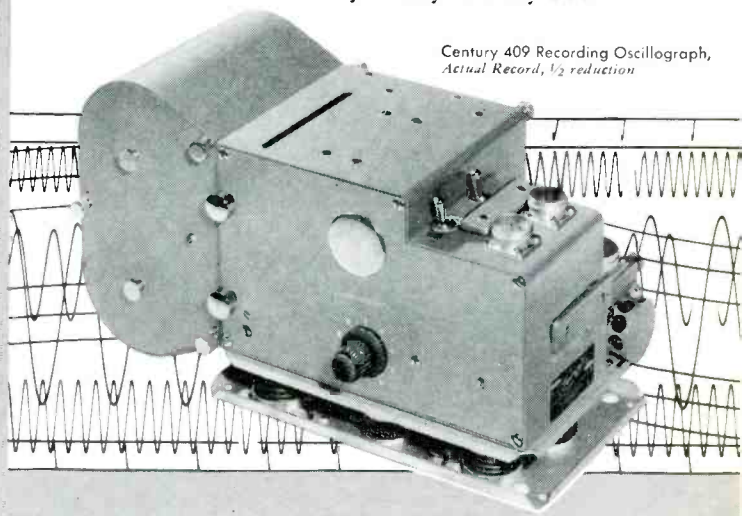
CENTURY

AIRCRAFT

. . . The combination of compactness, thirteen pound weight, rugged dependability and simple design with uniform frequency response to 2,000 cps. makes the 409 Century oscillograph an ideal unit for airborne test recording in airplanes, rockets, missiles. It has had wide usage on an expendable basis in units being tested to destruction.

. . . Century has records of dramatic case histories wherein little has remained of either the vehicle or its instrumentation but where complete, accurate, permanent test records have been salvaged from badly wrecked, even totally mutilated 409 units.

. . . Its amazing resistance to impact and vibratory shocks which are totally destructive of the vehicles and most internal mechanisms is known in military circles. These same features make it an ideal unit for *earth bound vehicles and marine applications.* Extreme portability and simplicity of design and control permit fast set-up of tests, carrying, and operating on board the tested vehicle. The 409 has been called the "work-horse" of the instrumentation field. Of course Century equipment is designed from the start to meet military specifications. Get the Century Story Today . . .



Century 409 Recording Oscillograph,
Actual Record, ½ reduction

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and Metallurgy...

...Mallory *Research In Depth* Applies Metallurgical Science to Improve Capacitor Performance

One of the reasons why you're sure of long life and high uniformity with Mallory capacitors is the specialized metallurgical know-how that goes into them.

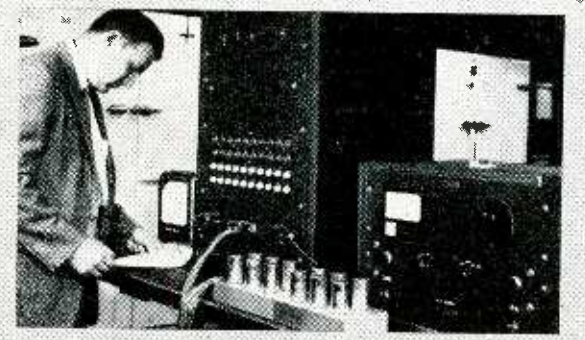
Take electrolytic capacitors, for example. Characteristics such as DC leakage current, life expectancy and capacitance stability depend to a considerable extent on the purity of aluminum foil. Developing specifications for high purity foils, and checking quality of foil being used in production is a joint effort of Mallory capacitor and metals specialists. Scientific tests in our laboratories, using the latest spectrographic equipment, enable us to analyze metals and detect impurities to a precision measured in parts per million.

In tantalum capacitors, too, Mallory experience with unusual metals has been the foundation for design and production innovations that have made extreme temperature ratings possible. The sintered pellet construction . . . still the only 200°C capacitor design . . . grew from our long background in powder metallurgy techniques.

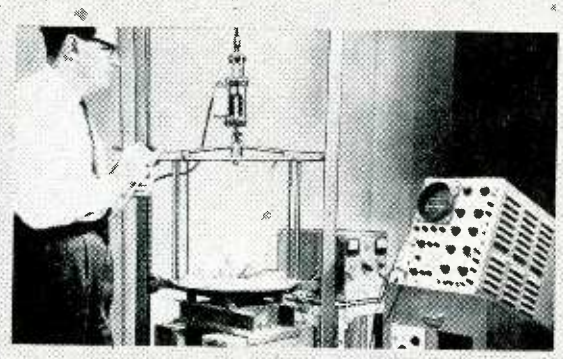
That is what "Research in Depth" by Mallory puts into the components you use. A combination of ingenuity and knowledge in the basic sciences of electronics, special metallurgy, electro-chemistry, and semi-conductors, all in one organization constantly works to improve present components and to make tomorrow's products even better.

SPECTROGRAPHIC ANALYSIS of metals, in Mallory Corporate Research Laboratories, assures high-purity foil for long life in electrolytic capacitors . . . aids testing of powder for tantalum capacitors . . . contributes to research in special alloys for resistors . . . as well as metallurgical contacts, welding electrodes and high density metals.

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA



Checking Capacitor Characteristics, using automatic test apparatus like this to eliminate human error, gives Mallory engineers data vital to analysis of new developments. One of the most recent products of this program is the new THR capacitor shown here . . . a miniature unit with the high stability and life qualities of Mallory computer grade capacitors.



Shock Tests at accelerations of 50 G and more evaluate the ruggedness of new products from the Electromagnetic Department of Mallory's Elkon Division. Typical of new developments in this line is the miniature 1900 Series Vibrator, which has survived shocks of 9000 G and up.

How to Pick Sales Engineers

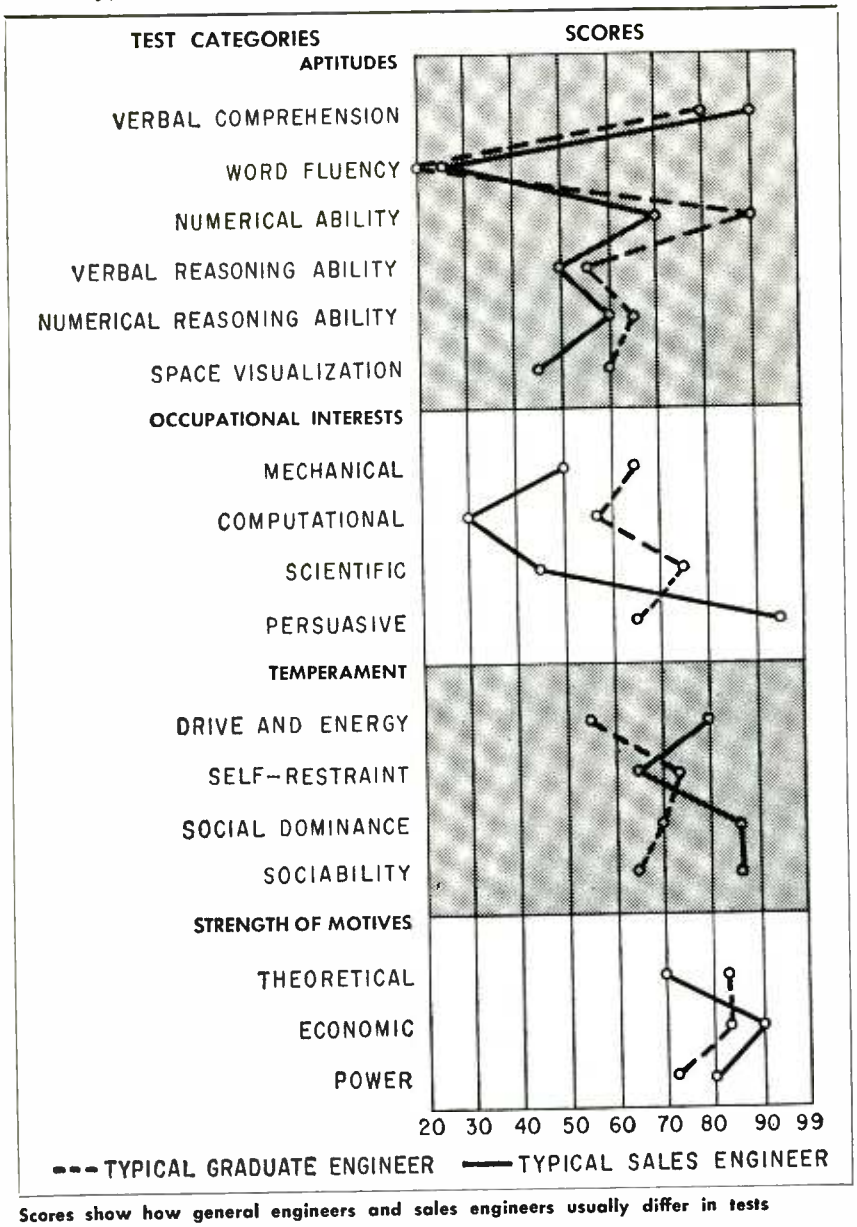
Of course, personal interviews count. But more firms are giving aptitude and psychological tests, too—and finding them worthwhile

LOS ANGELES—Good sales engineers must possess contradictory traits.

The typical engineer favors the direct approach, is facts-oriented, becomes impatient with the emotional. Top salesmen are past-masters at dealing with emotion, know how to make the most of irrational thinking by prospects.

Los Angeles firms report that they lose upwards of $8,000 on each new hire who doesn't pan out in one year. The personal interview is a necessity, but far from infallible in selecting the right man. In a recently conducted test, 12 sales managers were asked to interview 57 applicants. The same man judged likely to succeed by one was often labeled poorest risk by another.

Several personnel managers told ELECTRONICS that by administering batteries of tests to applicants they have cut down on the number of misfits by 25 to 50 percent. And while professionally administered tests cost between $75 and $100, they're less expensive than men who are hired and don't work out.



Scores show how general engineers and sales engineers usually differ in tests

Psychological Services, Inc., of Los Angeles, has developed a series of tests measuring traits in four categories: aptitudes, occupational interests, personality or temperament and strength of motives (see chart).

The best applicant should rate high in drive and energy, verbal comprehension and persuasiveness. On the other hand, if he rates too high in social service areas, he'll tend to get too absorbed in customers' problems and give away too much free service. Nor should he show too keen an interest in basic research and development. Employers don't want sales engineers who become so fascinated with a new circuit that they forget where their order blanks are.

A good salesman should have a certain amount of self-restraint and mental discipline, but not as much as a top executive engaged in long-range planning. He should not be too much of a worrier. A healthy ambition is desirable, but not so much that the man will soon strike out in competition with the boss. For an electronics engineer to become a top salesman, he should get away from his tendency to deliberate on every move.

Test Results

Tests indirectly come up with answers to these questions: Will the applicant enjoy the work? Can he take turndowns and disappointments? Will excessive travel bother him? Does he have basic sales ability? Does he have confidence?

Aptitude tests have built-in lie detectors to thwart the efforts of those who try to beat the tests. Only about one percent of test takers try to present a false picture and subtle cross-checks readily identify such individuals.

Personal interviews are more effective than tests for telling whether a man has troubles at home, or has alcoholic tendencies. Such questions as "Are you generally lucky" may point up the whin-

ing, hard luck guy. And "What is your wife's chief criticism of you?" may bring out persecution complex tendencies and show up problems such as drinking and gambling.

An important maxim: Accept or reject a man as he is. Don't expect to appreciably change him after he's hired.

Raser: New Solid Amplifier Reported

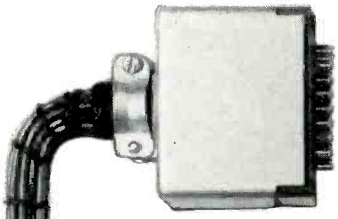
ST. LOUIS—The solid-state Raser will get three years' theoretical study under a $28,500 contract awarded the physics department of St. Louis University by the Air Force Office of Scientific Research, AF Research and Development Command.

The Raser, a quantum mechanical amplifier, is an abbreviation for Radio Amplification by Stimulated Emission of Radiation. The principal investigator of the project is William A. Barker, associate professor of physics, who told ELECTRONICS that the study will consist of detailed work in nuclear theory. Prime advantage of the Raser would be its low noise content, which would extend radio communications range.

The proposed Raser is a solid-state quantum mechanical amplifier. The basic physical principle involved is the Overhauser effect. If a conductor or a nonconducting paramagnetic is placed in a static magnetic field and the electron spin system is saturated by a time-varying magnetic field, electrons which relax to their ground-state energy level, induce nuclear spin transitions.

Under certain conditions these nuclei will occupy higher rather than lower energy states. If this takes place, another time-varying signal whose frequency is the nuclear resonance frequency will induce emission and be amplified. This proposed amplifier may be operated at very low temperature. The gain and the signal-to-noise ratio are improved as temperature is reduced. The Raser is a device similar to the solid-state maser. The maser is a quantum mechanical amplifier which operates in the microwave region. It makes use of transitions between electron-spin levels only.

Thanks to you . . .
CTI SETS A NEW STANDARD FOR WIRING-HARNESS TESTERS



After carefully reviewing customer requests received during the past few years, CTI has designed an automatic tester incorporating every feature desired by the manufacturer or user of wiring harnesses and cables. Compact, inexpensive, and simple to operate, the new Model 165 Cable Tester can handle the most complex wiring test problems. Test capacity can be increased indefinitely by adding small switch-unit modules to the basic equipment.

Only the CTI Cable Tester offers all these features:

- Completely automatic
- Simple operation, go/no-go readout
- Simultaneous continuity, leakage, and hi-pot measurements on each test
- Leakage measured from the circuit under test to all others
- Self-testing and fail-safe — validity of tests is assured
- Wide choice of test parameters from calibrated, front-panel controls
- Simple programming without complex patchboards
- Branch circuits can be programmed without sacrificing additional test points
- Precision bridges assure accuracy and stability of measurements
- Provides control of relays in the circuit under test
- Accessory printer lists rejects
- Manufactured by a company that has pioneered automatic testing

SPECIFICATIONS

Continuity test currents: Off, 0.1, 0.5, 1.0, and 2.0 amps d-c

Continuity accept limits: 0.1, 0.5, 1.0, 5.0, and 10.0 ohms (maximum test current on the 1-, 5-, and 10-ohm ranges is 1.0 amp.)

Hi-pot voltages: Off, 28, 100, 500, 1000, and 1500 volts d-c (hi-pot current limited to approximately 1 ma)

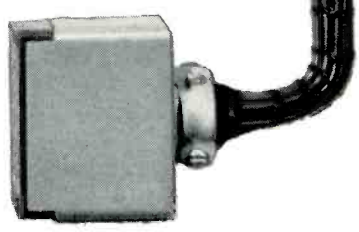
Leakage-resistance limits: 1, 5, 10, 100, and 500 megohms

Hi-pot dwell time: continuously variable from 0.2 secs to 100 secs

Test rate (maximum): 5 circuits per second (0.2 seconds dwell time)

Test capacity: 200 tests plus 200 for each complete, additional Switching Unit used. Switching Unit panel may be supplied with 50-test switch modules as needed.

Each of the above test parameters can be selected independently of the others. All values are set with front-panel selector switches.



Engineers: Career opportunities are currently available at CTI

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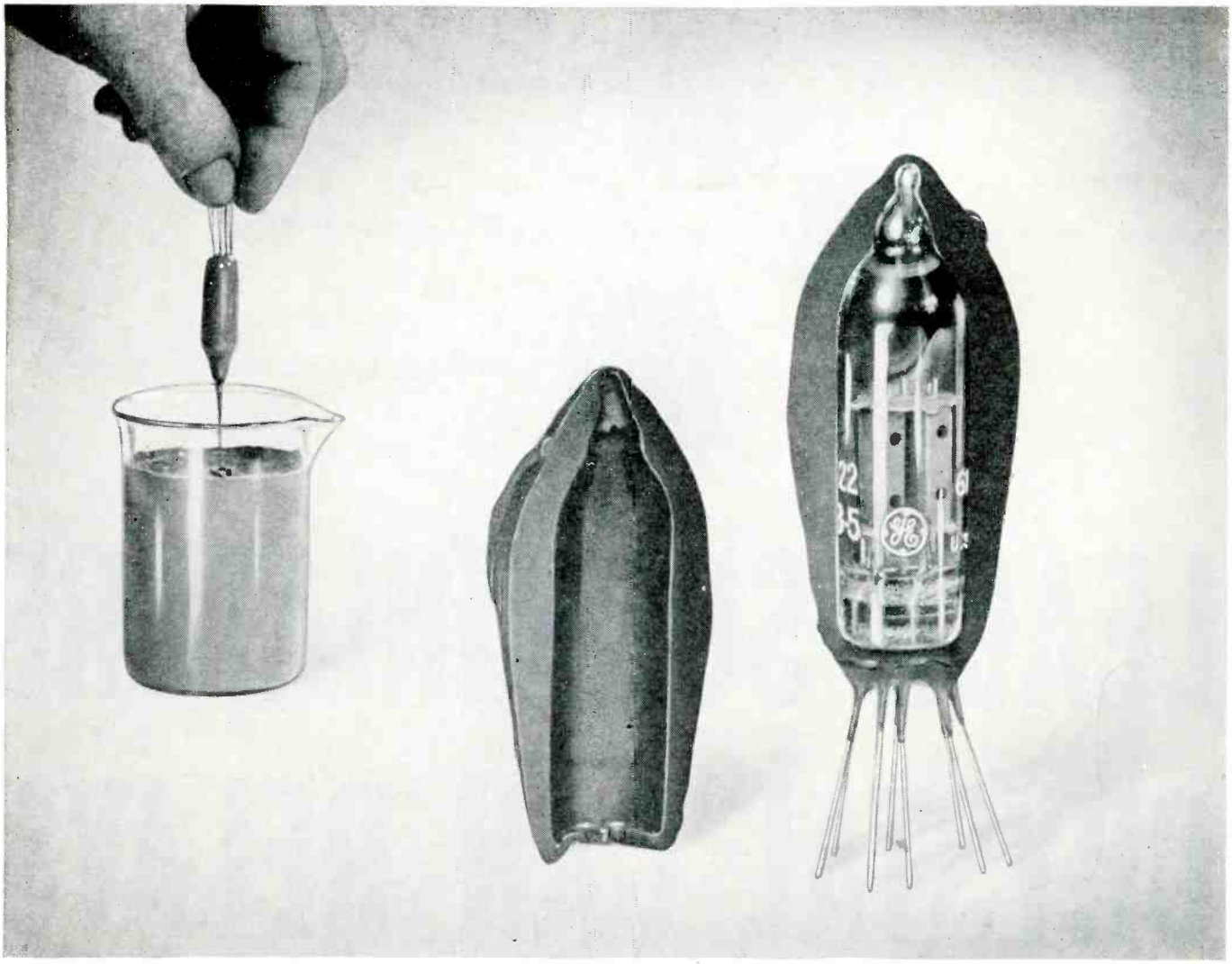


G-E RTV is an easily applied potting and encapsulating material. Tough, heat-resistant, resilient, it does not shrink or form voids during cure.

New RTV silicone rubber from G.E.

CURES WITHOUT HEAT • LOW VISCOSITY • SOLVENT-FREE • NO VOIDS OR SHRINKAGE

CURES WITHOUT HEAT G.E.'s RTV (room temperature vulcanizing) silicone rubber cures at room temperature in any time you select up to 48 hours. It comes in a wider viscosity range than any similar compound—from 250 poises (pourable) to 15,000 poises (spreadable). Easily applied by pouring, dipping, spreading or with a pressure gun.

WON'T SHRINK, VOID-FREE RTV compounds are 100% solids (no solvents). They cure without shrinkage; form no voids; provide resilient, shock-absorbent protection against physical damage or moist and corrosive atmospheres. Tensile and tear strength exceed those of previously available materials and are retained after prolonged heat aging.

RESISTS HEAT ABOVE 300°C General Electric RTV silicone rubber keeps its high dielectric strength at temperatures above 300°C. It has the well-known properties of silicone rubber, such as ability to withstand moisture, weathering, ozone, corona, oxidation and exposure to fuels and solvents.

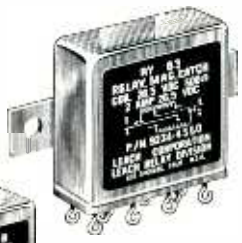
IDEAL FOR POTTING AND ENCAPSULATING General Electric RTV compounds flow easily into and around complex shapes. They are ideal for potting and encapsulating. Other uses include caulking and sealing in hard-to-reach places, performing "on-the-spot" rubber repairs, model making and molding in low-cost plastic tooling.

For complete application data, check Reader Service Card. If you'd like a sample for evaluation, drop us a note telling us about your proposed application.

GENERAL ELECTRIC

Silicone Products Dept. Section R6CC5, Waterford, N. Y.

TYPE 9234-4550 2PDT, 2AMP, MAGNETIC LATCH RELAY



(BRACKET MOUNTING, SOLDER HOOK TERMINALS, HERMETICALLY SEALED)

TYPE 9200-5091 2PDT, 2AMP, RELAY

(STUD MOUNTING, SOLDER HOOK TERMINALS, HERMETICALLY SEALED)

TYPE 9200-5072 2PDT, 2AMP, RELAY

(PLUG-IN OR PRINTED CIRCUIT MOUNTING, HERMETICALLY SEALED)

LEACH SUBMINIATURE CRYSTAL CAN RELAYS

(SHOWN ABOVE...ACTUAL SIZE)

torture-tested to perfection for big relay performance

These sensitive Leach subminiature relays deliver big relay performance... in a crystal can size that makes them ideal for use in missile control circuits in airborne or ground equipment and in computer and printed circuits.

Torture-tested to perfection in the Leach Production Reliability Center, these subminiatures are designed to meet the critical extremes of vibration, shock and other stringent environmental requirements in military and commercial applications.

They meet the specifications of both MIL-R-25018 and MIL-R-5757C—as well as MIL-R-6106C, *including the minimum current test requirements.*

Uniform contact pressure and overtravel are guaranteed for the life of these balanced-armature relays. They are available in a wide range of socket, stud and bracket mountings to meet specific customer requirements.

Write today for Leach Crystal Can Relay Brochure containing specifications, typical ratings and other information on these subminiatures! Or contact your nearest Leach sales representative to discuss your specific subminiature relay requirements.

LOOK TO LEACH

RELAY DIVISION...LEACH CORPORATION

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DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA • EXPORT: LEACH CORP., INTERNATIONAL DIVISION

Doppler Backs Up Air Nav-Aid

Federal Aviation Agency plans Doppler-type vhf omnirange installations that will be compatible with present airborne receivers

FEDERAL AVIATION AGENCY is backstopping the Vortac (vhf omnirange-Tacan) short-range air navigation system by installing new Doppler-type vor equipment at certain locations where vor siting problems exist.

Natural and man-made obstructions reflect the vor signal at certain sites. These reflected signals go in and out of phase with the direct signal from the point source and give a pilot a bearing error of as much as 20 or 30 degrees. His direction-indicating needle swings erratically from right to left as an interference pattern is formed between the direct signal and reflected signals.

Doppler-type vor gear reduces such siting problems by producing a narrow cone from a large commutated antenna. The antenna pattern decreases course-deviation-sensitivity as the vor station is approached.

The Doppler-type vor equipment will be compatible with an estimated 104,000 airborne receivers presently operating on 108 to 118 mc. FAA says the Doppler-type gear will be an extension of vor with some component changes and a different antenna system. Where no siting obstructions exist, conventional vor stations will not be replaced.

Tests were made of Doppler-vor equipment built at the CAA's Indianapolis Technical Development Center, now incorporated into FAA's experimental facility at Atlantic City, N. J. Results were disclosed at February's meeting of the International Civil Aviation Organization in Montreal.

The ICAO meeting voted to continue use of vor and to supplement it with Tacan-compatible distance-measuring equipment. The combination, known as Vortac, has thus been accepted as the international airways' short-range navigation standard.

FAA and industry sources feel evidence of improvement in navigation near difficult sites through the use of compatible Doppler-type vor equipment was influential in the ICAO vote for Vortac.

The new gear was evaluated at seven sites, including Rikers Island near LaGuardia Airport in New York, and Charleston, S. C.

FAA's bureau of R&D is now going ahead with design refinements at its Atlantic City, N. J., experimental facility.

Prototype equipment is expected to go into regular operation some time this year in four to six cities. New York (Rikers Island), Los Angeles, Jackson, Mich., and Daytona Beach, Fla., will probably be the first installations, in addition to Charleston, S. C., where an original test model is still located. Some small component contracts have been let, others should be let soon.

FAA Seeks Funds for Gear

FAA seeks fiscal 1960 funds to contract for about 20 Doppler-type vor installations. An agency source estimates that an installation will cost about $38,000 or 50 percent more than a conventional vor station. Another source puts the estimate around $50,000.

The agency's R&D bureau is trying to reduce the size of the antenna system, which now has a diameter to 150 ft, without sacrificing compatibility with airborne gear.

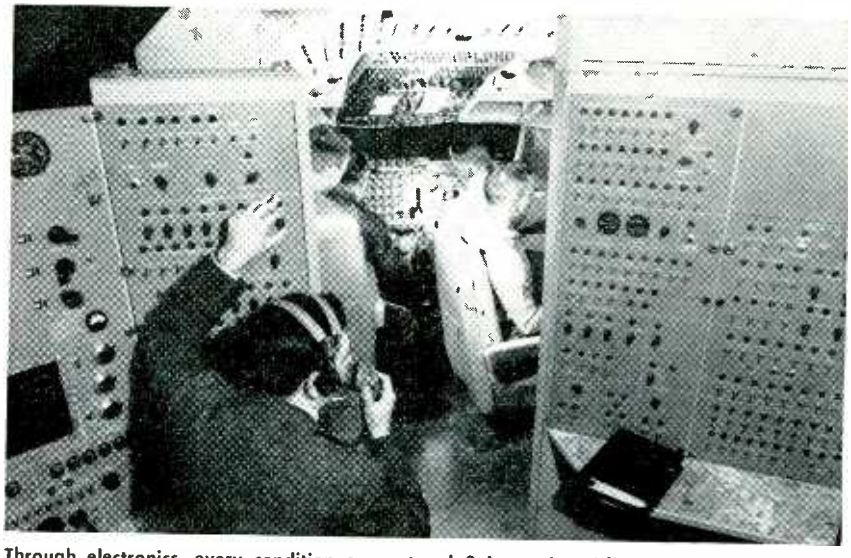
Meanwhile, Servo Corp. of America, New Hyde Park, N. Y., announced this month that it is marketing compatible quasi-Doppler-type vor equipment.

Equipment consists of 50 antenna elements in a circular 43-ft diameter array and a single antenna element in the center, plus a counterpoise around the antenna array.

The antenna elements of the Doppler array are uniformly spaced around a circle with a diameter of 5.1 wavelengths. To this antenna array is applied an unmodulated, crystal-controlled signal. The signal steps around the elements simulating antenna rotation. Radiated signal carries direction-dependent f-m information.

To achieve vor compatibility, the system transmits a second carrier from an independent fixed antenna, 9.96 kc apart from the first. This signal is amplitude-modulated with a reference signal synchronized to the antenna commutation.

Simulates Jet Airliner Flights



Through electronics, every condition encountered flying a jet airliner is produced by this American Airlines 707 jet flagship simulator for flight crew training. Curtiss-Wright's electronics division built the unit, which is in a trailer

Soviet Production

Six-man U. S. electronics delegation returns from USSR tour of eight factories and six institutes

MOSCOW—Soviet gap between equipment design and plant production was reported here last month just before a six-man U. S. electronics industry delegation returned home.

The group was interviewed by the McGraw-Hill World News Bureau in Moscow following a three-week tour of eight factories and six institutes that make and design telephone equipment and consumer products such as radio, television and their components.

Ray C. Ellis, Raytheon vice-president, headed the delegation which included Frank W. Mansfield, chairman of the marketing data policy committee of Electronic Industries Association and market research director for Sylvania Electric Products, New York; Julian K. Sprague, president of Sprague Electric; Imre Molnar of General Telephone Laboratories, Northlake, Ill.; Charles P. Marsden, Jr., of the National Bureau of Standards; and Conrad H. Ziedt of GE, Syracuse.

Observing that gaps exist between work at the institutes and plant production, Ziedt asserted that the institutes lack an appreciation of production problems, such as cost.

"We wondered whether some designs might not have to be redesigned at the production levels," he said. Outstanding designs brought to the attention of the delegation included: modular television broadcast equipment, industrial tv camera, portable tv camera and some transistor circuits.

"They design heavier than we do," Ziedt said, "with larger components. They might save 15 percent with redesign.

"They also have longer design cycles—some apparently years long—compared with some of ours of six months."

Chief delegate Ellis observed that some plants visited were "much more integrated than ours with facilities for making their own parts. Most radio and television plants are equipped to make their own plastic moldings, or coil springs or speakers."

However, Ellis noted that Soviet plant management is moving closer to U. S.-type decentralization (Electronics, p 11, Apr. 24).

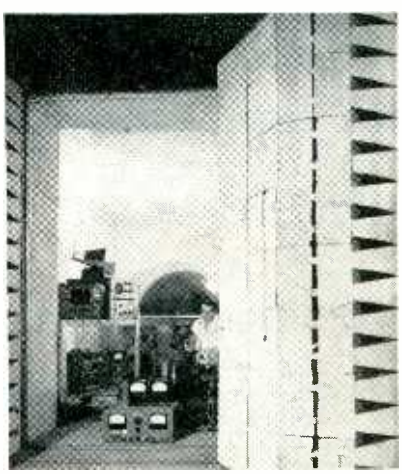
"This gives more independence to management in overall industrial operations and should result in all-around savings." One principal gain should be a more efficient supply setup, he said.

"In no plant was productivity per worker greater than in America," Ellis added. "They are not as tooled up as we, nor as modern." But he was impressed with the energy of individual workers, whom he thought were stimulated by bonus incentives.

Although there were some individual cases where the Russians showed ingenuity, Ellis said, there were no technical breakthroughs. "No plant was particularly startling on the whole."

The delegation, whose visit followed one last November to the U. S. by a Soviet delegation, is expected to recommend that future exchanges of electronics experts

Testing Antennas



Anechoic chamber for testing satellite antennas at Convair-Astronautics

Gap Cited

consist of more units and fewer people with more specialization, and longer stays—"more depth and less breadth."

New Orders Due For USAF Gear

SUBCONTRACTORS and suppliers will soon feel the impact of Philco's recent $18,715,140 contract with Rome Air Materiel Area for modernization work on USAF's world-wide communications system.

The contract is divided into three main projects. Work on all three will begin simultaneously, and take place at 16 sites.

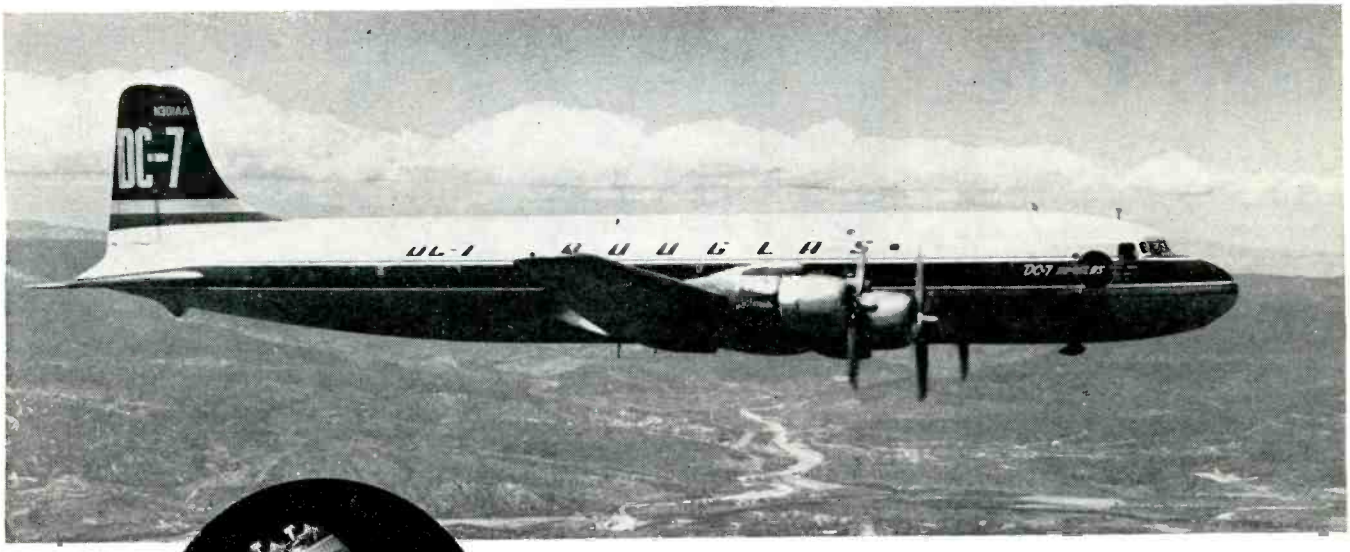
The first work project covers modernization of circuit quality control and traffic patching. This calls for decentralization of equipment patching facilities, separation of traffic patching from the equipment patching function, segregation of clear and coded circuitry, and the provision of high impedance bridged monitoring and testing.

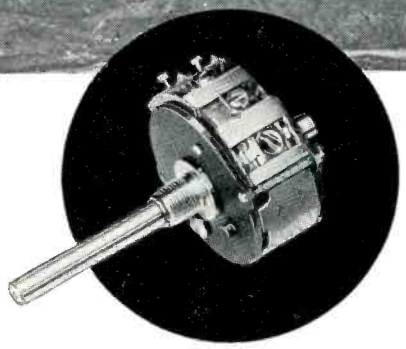
Second project covers disassembly of existing intersite radio frequency terminals, associate voice frequency multiplex terminals and their movement to other locations. The station combination distributing frame will be upgraded to provide terminations for new intersite channelization. Line amplifiers, equalization equipment, microwave radio frequency terminals and voice frequency multiplex terminals will be engineered and installed.

Third work project covers conversion from a high-frequency four-channel time-division multiplex system to a frequency-division multiplex system utilizing single-sideband techniques. Terminal equipment will be transistorized.

Presently installed equipment will be adapted to augment point-to-point and air-to-ground voice circuits as well as facsimile ssb circuits.

Existing air-ground a-m channels will be converted to AIRCOM trimode systems.



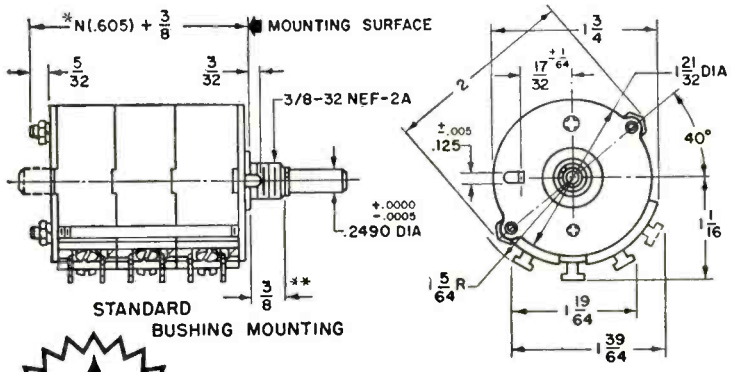


Demonstrated Precision and Reliability

"Workhorse" of the world's airlines, the famed Douglas DC-7 employs Clarostat Series 42 Precision Potentiometers for flap-position indication. This is one more example of Clarostat precision, proved under day-in day-out working conditions.

CLAROSTAT PRECISION POTENTIOMETERS
Series 42

Series 42 potentiometers are wire-wound and offer resistance tolerance of ±5%, linear or tapered. Closer tolerances on special request. They are available in a wide variety of electrical and mechanical characteristics to meet application and environmental conditions. Standard units are rated at 3 watts @ 40° C., while special high-temperature units are available for operation up to 230° C., with a rating of 0.25 watt. Units may be ganged by means of threaded rods and end plates. Switches for limited or continuous rotation models are available.



SPECIFICATIONS

Power Rating: 3 watts @ 40° C.
.25 watt @ 230° C. (high-temperature type)

Typical Weight: 0.196 lb.

Insulation Breakdown Tests:
Between terminals and ground for 1 minute, 1000 v.a.c. @ 3.4 Hg.

Resistance Range: Linear, 1 to 100,000 ohms Tapered, 350 ohms per degree of rotation.

Resistance Tolerance: ±5%.

Taps: To requirements.

Rotation: Mechanical and electrical, 291°, ±3%. Effective, 280° to ±3%.

Torque: 1 to 6 oz./in.

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Clarostat Means Precision You Can Count On

Tv Checks Deep-Sea Pipes

Closed-circuit tv acts as eyes during big pipeline installation 200 ft under water

Twin viewing screens located in control house aboard tower barge

CLOSED-CIRCUIT TELEVISION is providing the "eyes" for connecting lengths of 12-ft diameter concrete pipe in the largest, longest, heaviest and deepest pipeline ever assembled underwater. The line will extend six and one-half miles to sea at a depth of 200 ft and will carry hygienically treated effluent from Los Angeles' Hyperion Sewage Treatment Plant.

Measuring 192 ft in length and weighing four tons per linear foot, strings of the mammoth pipe will be lowered from the world's largest Texas Tower-type mobile platform and joined underwater. To insure that strings are properly lined up and that mating joints are waterproof, a specially built saddle, mounting two Kin-Tel tv cameras and eight 500-watt spotlights, travels along the pipe and scans pipe joints.

Cameras are heavily brass coated and utilize water-resistant glass eyes. A third standby camera can be carried below by a diver. Built by Underwater Survey, Inc., of San Diego, the monitoring rig is designed for depths up to 2,500 feet. Monitoring screens, mounted aboard the 4,500-ton self-jacking barge, will enable inspectors to continuously watch underwater operations. Placement of rock ballast, used to backfill under the pipe after it has been laid on the ocean floor, will also be under the scrutiny of television cameras.

Lead-covered neoprene cables connect cameras to monitoring sets and control panels aboard the barge, and house power lines to specially built focusing motors on the camera lenses. The cables are designed in such a manner that if they are accidentally severed, capillary action will not take place. Hence, wires and insulation in the vicinity of the sections to be spliced will not be damaged.

If fog precludes visual triangulation methods for spotting the movable tower during any of the estimated 170 moves required to lay the pipeline, a radar-like Tellurometer system will be used. This instrument, utilizing a uhf transmitter and having a spotting accuracy of plus-or-minus 2 inches in 12 miles, transmits continuously on a frequency of 3,000 mc to a similar device located on shore. The bounce of the microwaves is translated into sounds and distances, and by triangulation, the course of the ocean outfall pipe will be kept straight.

Communications between barge, work boats, and land crews is by means of Kaar ship-to-shore sets, and GE ET24-A radio links.

Saddle rig mounting two tv cameras and eight 500-w spotlights. This device travels along the pipe as it is being connected under water

MEETINGS AHEAD

May 3-7: Electrochemical Society, 115th Annual Meeting, Hotel Sheraton, Philadelphia.

May 4-6: Aeronautical Electronics, National Conf., PGANE of IRE, Biltmore Hotel, Dayton, O.

May 4-7: Instrumentation Flight Test Symposium, ISA, Seattle, Wash.

May 4-8: Society of Motion Picture & Television Engineers, Annual Convention, Fontainebleau Hotel, Miami Beach, Fla.

May 5-7: USA National Committee, URSI, PGAP, PGCT of IRE, Willard Hotel, Wash., D. C.

May 5-7: Electromagnetic Relays, National Conf., NARM, Oklahoma State Univ., Stillwater, Okla.

May 6-8: Electronic Components Conference, AIEE, EIA, IRE, WCEMA, Benjamin Franklin Hotel, Philadelphia.

May 6-8: Seventh Region of IRE, Technical Conf. & Trade Show, Univ. of New Mexico, Albuquerque, N. M.

May 11-13: Power Instrumentation, National Symposium, ISA, Kansas City, Mo.

May 11-13: Automatic Techniques, Joint Conf., PGIE of IRE, AIEE, ASME, Pick-Congress Hotel, Chicago.

May 12-14: Assoc. of American Railroads, Communications Meeting, Netherland-Hilton Hotel, Cincinnati, O.

May 18-20: Instrumental Methods of Analysis, ISA, Shamrock-Hilton Hotel, Houston, Tex.

May 18-20: Electronic Parts Distributors Show, EISC, Conrad-Hilton Hotel, Chicago.

May 21-27: Transistors and Assoc. Semiconductor Devices, International Convention, Institution of Electrical Engineers, Earls Court, London.

May 22-26: Materials Symposium, ASTM, ASEE, Atlantic City, N. J.

May 25-27: National Telemetering Conference, ARS, IAS, AIEE, ISA, Brown Palace & Cosmopolitan Hotel, Denver.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 74.

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

AUTOMATIC silicon rectifiers

all the available JAN TYPES to meet MIL-E-1 specifications

Maximum Values for AUTOMATIC Military Type Silicon Rectifiers

Type No.	Peak Reverse Voltage (VDC)	DC Output Current (MA) Av. @ 135° C. Case Temp.	@ 25° C. Ambient	@ 150° C. Ambient	Maximum Reverse Current (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
1N253	100	1000	—	—	0.1*	Stud	1024A
1N254	200	400	—	—	0.1*	Stud	989B
1N255	400	400	—	—	0.15*	Stud	990B
1N256	600	200	—	—	0.25*	Stud	991B
1N538	200	—	750	250	0.350†	Axial Lead	1084A
1N540	400	—	750	250	0.350†	Axial Lead	1085A
1N547	600	—	750	250	0.350†	Axial Lead	1083A

*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current; case temperature 135° C.

†Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150° C. ambients.

Without qualification, these rectifiers are the finest available today, designed and manufactured to meet stringent government requirements and the exceedingly high quality control standards of General Instrument Corporation.

These JAN types are offered in volume quantities for *on time delivery* at prices that reflect General Instrument's years of production experience. Data sheets on these and other AUTOMATIC silicon rectifiers are available upon request.

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GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC. AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

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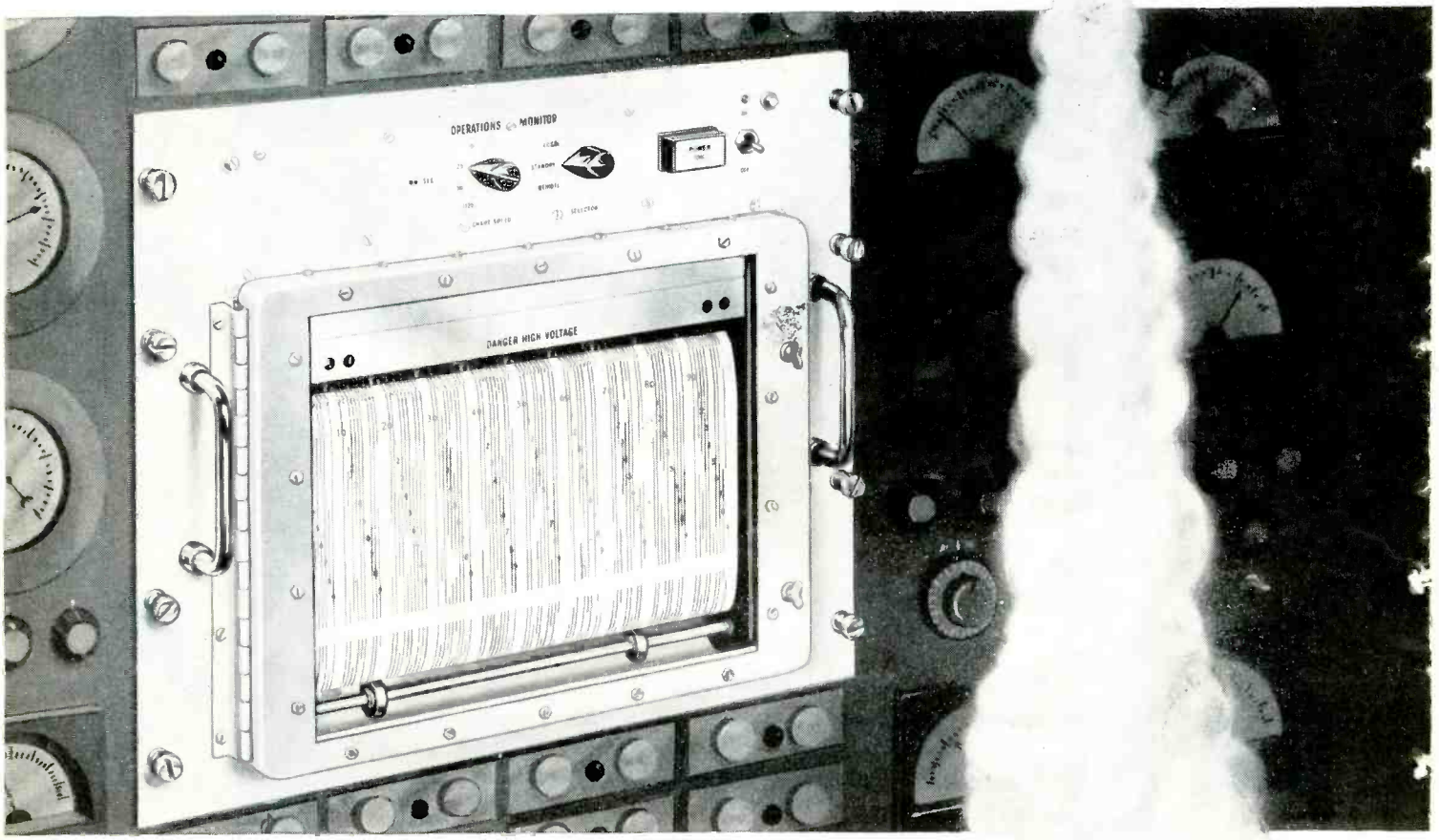
BUILT TO MIL SPECS...

one Brush Monitor records 100 countdown operations simultaneously!



Built to military specifications and performing to extremely rigorous military requirements, the Brush Operations Monitor can prevent aborts and destructs costing millions of dollars.

For quick, accurate and immediately visible go and no-go information, 100 operations are recorded simultaneously on a 500′ moving chart only 12″ wide. You have an *immediate* picture of an entire situation with each event shown in a time relationship to all other events. It is now being used for major check-out of propulsion systems, electrical test racks, fault isolation programmers and launch control vehicles.

Brush is now in production on this Mil Operations Monitor and prompt delivery can be made to your requirements. Phone or wire Brush for complete information and application assistance.

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electronics
MAY 1, 1959

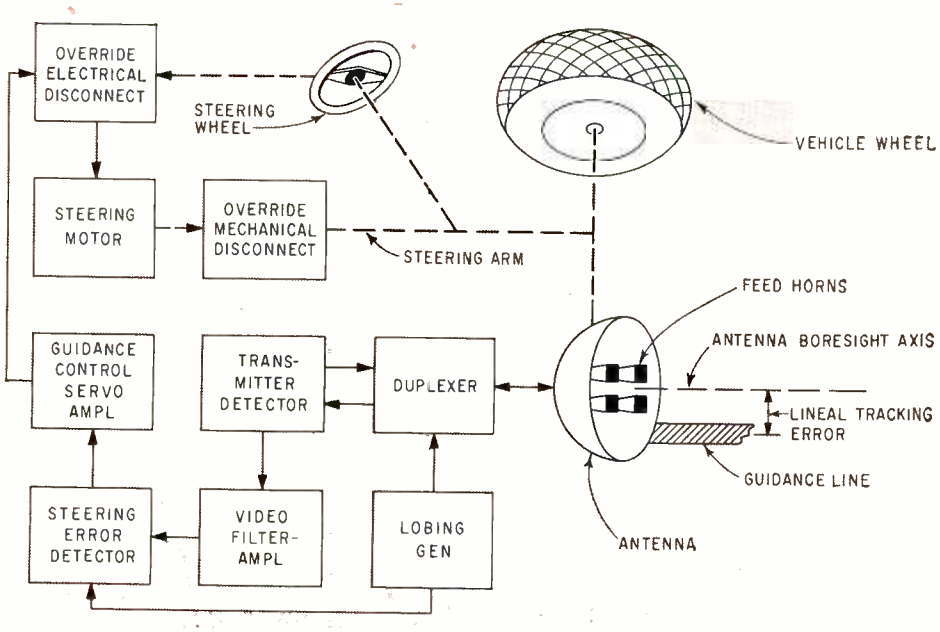

FIG. 1—Land-vehicle guidance system uses conductive strip on roadway as radar reflector

Highlights of '59 IRE Show

Papers describe land-vehicle guidance by radar, portable cardiac pacing equipment, microwave computers, missile miss-distance indicator, space-ship tracking plans, electronic countermeasures, inertial navigation and use of microwaves to measure minority carrier lifetime in semiconductors

By JOHN M. CARROLL, Managing Editor; WILLIAM E. BUSHOR and SAMUEL WEBER, Associate Editors

LAND-VEHICLE RADAR guidance not requiring special highways has been proposed.[1] The system tracks a reflective line on the road surface to produce steering error signals as shown in Fig. 1.

A klystron transmitter-detector sends a pulsed microwave signal through a duplexer to antenna feedhorns which illuminate the highway. The lobing generator drives the duplexer causing the beam to sweep left and right across the highway. When boresight axis and guidance line are misaligned, a small lineal tracking error is produced. Reflections from the guidance line are fed through the duplexer to the transmitter-detector.

The detected signal flows to the steering error detector where its phase is compared with that of a reference signal from the lobing generator. Thus a steering error signal is developed which is proportional to the lineal tracking error. The error signal is used to drive the steering mechanism until the tracking error is corrected. An override switch disengages the system whenever the driver turns the steering wheel.

TRANSMITTER DETECTOR—A block diagram of the transmitter-detector is shown in Fig. 2. The dual-cavity regenerative amplifier klystron used serves as a modulator, r-f amplifier and video amplifier. The tube contains a buncher, cathode, catcher, bias grid, focusing grid, collector and an attenuated feedback path from catcher to buncher.

When the 1,000-cps prf generator pulses the klystron collector at a particular voltage, the electron transit time from cathode to collector is made optimum for transfer of r-f energy in electron bunches to the catcher. Although most of the r-f energy in the catcher is fed to the antenna, a

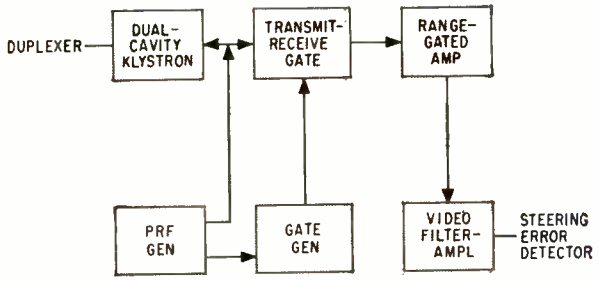

FIG. 2—How dual-cavity klystron is used as both transmitter and detector in land-vehicle radar

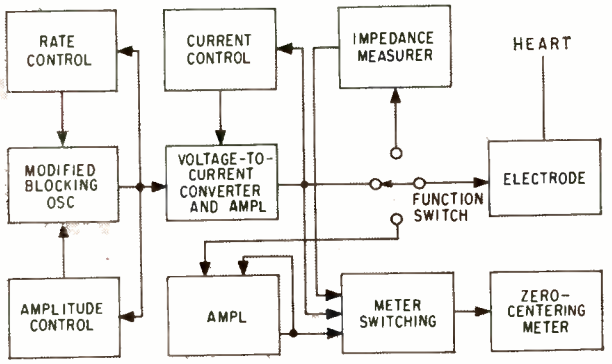

FIG. 3—Transistor oscillator-amplifier regulates heart beats and monitors heart action

Artificial pacemaker shown on table at left with lid open is readily available to surgeons for restoring patient's heartbeat

small amount is coupled to the buncher by the attenuated r-f path. Since the energy bunches the electrons, the oscillation is sustained as long as oscillator voltage is maintained at the peak of this klystron mode.

As the prf generator signal changes to a lower voltage after completion of r-f transmission, self-oscillation in the klystron ceases and it can act as a r-f amplifier. When a return signal appears, it is channeled to the buncher where some bunching occurs. The bunched electron energy is amplified and collected in the catcher cavity. Part of the energy is fed back to the buncher causing increased bunching of electrons. During the receiving mode, sustained oscillation is prevented by maintaining the collector at a voltage which moves the klystron off the peak of any oscillation mode.

To detect the r-f signal, the klystron bias grid is maintained slightly positive. When no excitation is applied to the buncher, most of the electrons emerging from the catcher strike the collector. If the buncher is excited by the input r-f signal, the r-f field in the catcher is built up slowing down some of the electrons and causing them to travel toward the klystron wall instead of the collector. This reduces collector current to a degree approximately proportional to the envelope of the r-f signal.

GATING CIRCUITS—The video signal passes through the transmit-receive gate which is gated on by pulses from the prf generator. This gate serves to isolate the video circuits from the klystron during the transmitting mode. The video signal is then applied to the range-gated amplifier. Following each transmitted pulse, the prf generator opens the range gate and then closes it at a specific time interval in the pulse repetition period. Thus, selection of the return signal coming from a particular range interval ahead of the vehicle is permitted. Opening of the gate is delayed to prevent ground-clutter signals from entering the error detector. Closing of the gate after an interval prevents reception of unwanted echoes.

A video filter removes the prf frequency components and permits the lobing frequency signal to pass. The filtered video signal is sent to the steering error detector.

ANTENNA ARRANGEMENT—Four feedhorns are mounted on the antenna disk; the lower two are used for guidance; the upper two for obtaining range and range rate signals from vehicles ahead.

One guidance feedhorn is offset from the antenna boresight axis in the aximuth plane at 1.70 deg; the other is similarly offset but in the opposite direction. A cosecant squared pattern with a beam width of 10 deg in the elevation plane is radiated by the antenna to make the return power independent of range.

The lobing generator drives the guidance feedhorns through the duplexer at 50 cps but in opposite phase. This action produces a 5 deg beam from the freehorns which is lobed in the azimuth plane. Returns from the guidance line are detected and converted into a-m video signals.

Guidance lines need only be capable of reflecting or backscattering electromagnetic radiation. Materials that could be used include metal strip or foil; metallic paint, powder, or oxides; low grade ores or special chemicals impregnated in the road surface.

Based on a 0.4 sec manual tracking loop lag, linear tracking accuracy of system is ±2.5 in. while angular accuracy is ±0.25 deg. Maximum range is 500 feet at 85 mph. Power consumption is estimated at 200 w using ordinary tubes, 50 w using miniature tubes and 10 w using transistors. System may be in experimental use within two years.

PORTABLE CARDIAC PACEMAKER—Last year, experiments indicated that transistor amplifiers con-

nected directly to the heart muscles could aid heart block patients (ELECTRONICS p 24, Mar. 7, '58 and p 80, Nov. 21, '58). A portable, transistorized device has been designed to act as an artificial cardiac pacemaker and to monitor heart activity.[2] The device, shown in Fig. 3, provides internal stimulation and control of the heart with or without surgery.

Impulses are applied directly to the heart by a wire passing through the chest wall and into the myocardium or muscular tissue of the heart. Movement of the monitor pointer is similar to movement of the stylus on an electrocardiograph and indicates both polarity and rate of the QRS heart wave. Movement of the wire electrode during insertion into the body is monitored on the meter by watching the changes in polarity and magnitude of the QRS wave as the electrode tip passes through various tissues.

When the electrical activity of the heart is too weak for monitoring, the meter cannot be used as an insertion guide. This situation is overcome by measuring the physiological circuit impedance (lead, tissue and connection impedance) instead. The monitor pointer now deflects to maximum for a high impedance, or poor connection, to the myocardium. A slight deflection indicates an impedance of a few hundred ohms, typical of a good connection.

When proper connection is made, stimulation is started. Since impedance of the physiological circuit is different from person to person and changes with time, the pacemaker adjusts its voltage output automatically to insure that the proper magnitude of current is delivered to the heart. The physician determines the correct stimulation current.

The stimulation impulse is 3 millisec long with currents varying from 0 to 24 ma. Pulse rate is continuously variable from 25 to 120 ppm as desired.

The instrument is powered by a battery with a 120-day life when used continuously.

The pacemaker is useful in stimulating the heart during Stokes-Adams seizures, in accelerating slow heart rates, and in supplementing heart massage to restore cardiac beating. In cases where the chest is opened, a suturing electrode can be used to connect this instrument to the myocardium.

MICROWAVE COMPUTER — Computer circuits capable of adding two digits together at frequencies approaching the speed of light are presently being developed.[3] Coded numerical information is formed by r-f pulses using basic microwave techniques.

One system is based on phase addition in a traveling-wave tube and use of nonlinear passive transmission lines. Another system is based on storing, amplifying and switching with a phase-locked subharmonic oscillator.

The first system uses superposition of phase and can generate 500 million binary bits a sec using a 3,000-mc carrier. The bit rate increases as higher carrier frequencies are used. This system requires wide-band amplifiers capable of handling 2 millimicrosec pulses.

Although not now practical for building complete computers because as many as 100,000 twt's might be required, this scheme can be used where simple logic functions must be performed extremely fast. Since impulses travel at slightly less than the speed of light, interference resulting from time lag in movement of information could be created by overly long circuit connections. Thus, circuits must be miniaturized as much as possible. A typical NOT gate design is shown in Fig. 4. Presence or absence of r-f pulses at given time intervals represents the binary information content.

SUBHARMONIC OSCILLATOR — The second scheme uses a self-sufficient subharmonic oscillator fed by a 4,000-mc pump. The oscillator is a small, point-contact diode that can detect, amplify and store digital signals at bit rates exceeding 100 mc.

The oscillator generates two oppositely phased subharmonic frequencies of the fundamental pumping frequency as shown in Fig. 5. Since the generator is locked to the energizing source, it produces

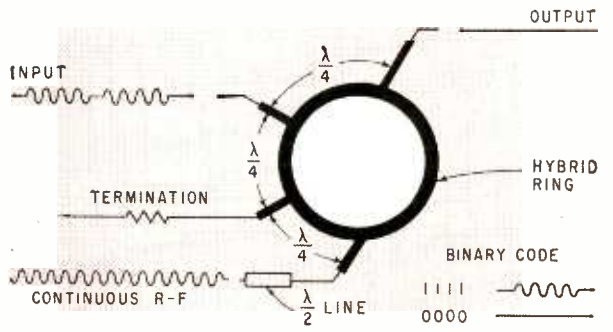

FIG. 4—Typical NOT circuit for microwave computer. Presence or absence of r-f pulses in given time interval conveys information

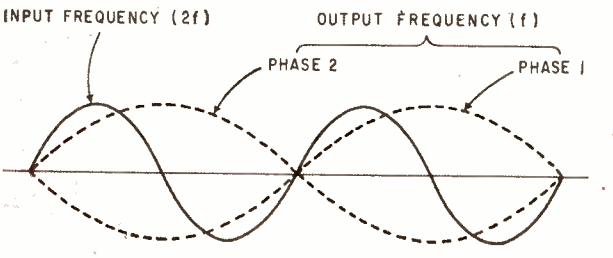

FIG. 5—Output of subharmonic oscillator used in microwave computing circuits

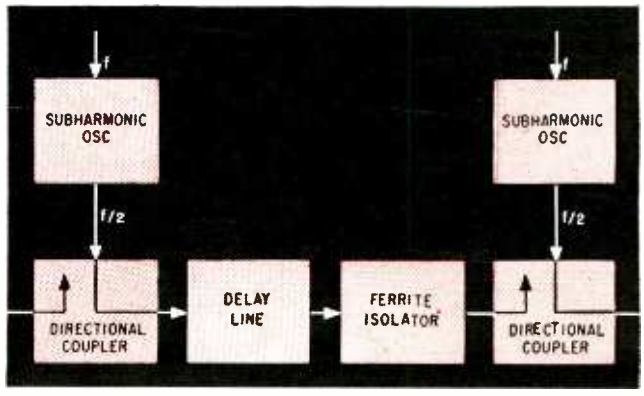

FIG. 6—Shift register of microwave computer uses subharmonic oscillator

a stable output. Phase 1 represents a binary one while phase 2 represents a binary zero. All numbers can be expressed by combining outputs from several subharmonic oscillators.

The oscillator can be maintained in either a ZERO or a ONE state depending on the phase of the pump frequency. Thus the oscillator can be used as a memory. Since output depends only on phase and not amplitude of the input, the oscillator also serves as an amplifier which can detect or limit.

The diode of the subharmonic oscillator is mounted on a thin copper plate and connected to input and output terminals with printed strip line. A block diagram shift register using the subharmonic oscillator is shown in Fig. 6. Since the system is operating at r-f, ferrite isolators can be used to eliminate reflection and insure that information flows in the proper direction. The delay line is a coaxial cable approximately 2 ft long which gives a 2-millimicrosec delay.

MISS DISTANCE INDICATOR—A miss distance indicator[4] assists in training with 3-in. air-to-air rockets. It provides 10-percent accuracy from 5 to 150 ft miss distance with a 2 ft fixed offset error. The indicator is located in the target vehicle. The indicator costs $150. No active parts are in the missile. The target approach data is tape recorded and played back for analysis. Extensive ground station facilities are required.

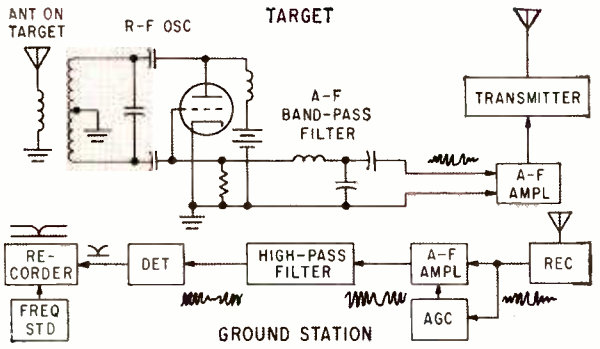

FIG. 7—Miss-distance indicator for air-to-air missiles has all electronic circuits in target not missile

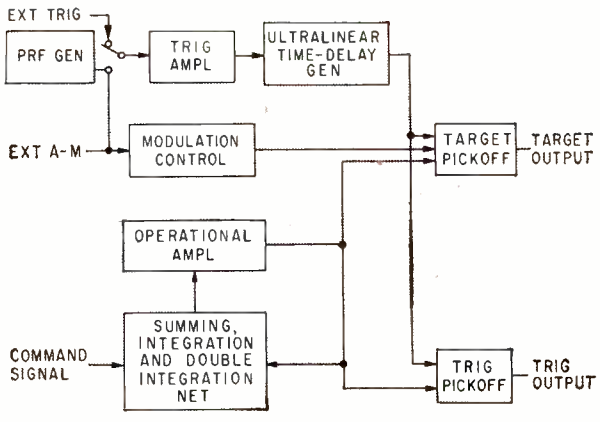

FIG. 8—Radar analyzer and calibrator functionally tests susceptibility of set to countermeasures

Table I—Countermeasures and Corresponding Anti-countermeasures

Counter-measure / Anti-Counter-measure	Fortuitous Jamming Radar	Dumped Chaff	Forward-Shot Chaff	Decoys	Range-Gate Stealing	Rail Jamming	Noise Jamming	Antenna Slewing	Inverse Modulation
PRF Jitter	●					●			
Velocity Gate	●	●	●		●	●			
Tight Range Gate	●	●	●		●	●	●		
Acceleration Gate	●	●	●	●	●	●			
Leading-Edge Trailing-Edge Lockon		●							
Tight Automatic Frequency Track			●		●				
Trajectory Examination				●					
Instantaneous Automatic Gain Control							●		
Closed-Loop Rate Memory for Correlation							●		
Monopulse								●	●
Narrow Bandwidth	●								

The system uses a grid-reaction oscillator as shown in Fig. 1 to measure the audio frequency of variation of the mutual resistance between an antenna on the missile and one on the target. The frequency of the a-f component of resistance changes from f_x when the missile and target are far apart to zero at closest approach. At times t_1 and t_2, frequency is equal to $f_x/2$. Distance of closest approach is given by $d = \sqrt{3\lambda f_x}\,(t_2 - t_1)/2$ where λ is wavelength of transmitted frequency.

SPACE TRACKING—Use of baseline or triangulation electromagnetic navigation systems for space-vehicle tracking is limited by the relatively short baselines available on earth. A proposal has been made[5] to use a ring of artificial earth satellites as tracking platforms. The Doppler system will require an extremely accurate oscillator in the space vehicle. The pulse system requires accurate measurement of time intervals. Use of atomic frequency standard clocks is suggested.

For such a tracking system, the space vehicle will require a 100-watt, c-w transmitter operating on 2,000 mc. An antenna for tracking should be 20-ft in diameter. An earth-based communications

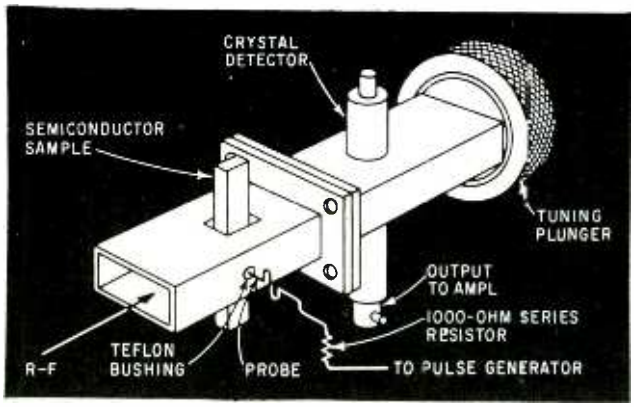

FIG. 9—How semiconductor is inserted in waveguide for minority carrier lifetime measurements

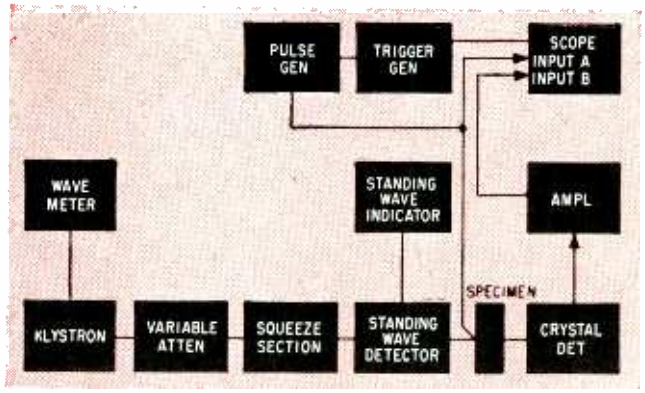

FIG. 10—Arrangement of equipment for minority-carrier lifetime measurement in semiconductors

antenna should be 60-ft in diameter. For tracking, a bandwidth of 10 cps is required. A 100-cps bandwidth would be needed for radioteleprinter communications.

An electro-optical tracking system using "light masers" is under investigation.

COUNTERMEASURES—Most means for checking out radar systems do not determine if anticountermeasures features are working.[6] Also, present checkout systems require 5 hours for a typical preflight check on an airborne, fire-control, radar system. Ninety percent of a radar's life is consumed in testing. The test set shown in Fig. 8 can provide a functional test of radar performance. The analyzer can simulate dropped chaff and forward-shot chaff. With a function generator it can simulate a repeater. Functional testing requires only 2 minutes, requires access to only r-f and video radar inputs. Table I lists some common countermeasures and corresponding anticountermeasures.

Inertial guidance systems today typically weigh 100 lb, occupy 3 cu ft and are accurate to within 1 mile.[7] Meantime-to-failure is about 2,000 hours.

In inertial components, new gyros weigh from 10 to ½ lb are from 7 to 2-in. in diameter and 10 to 3 in. in length. Gas bearings are being used for output and spin axes. New accelerometers have a threshold sensitivity of 10^{-5} g.

Computation is going full digital. Digital accelerometers make use of a translational proof mass set into oscillation. A cycle-counting technique is used to determine on which side of null most time is spent by the proof mass. Pulse rate modulation is used to apply digital correction to an analog gyro-torquing signal. Digital servos are coming into use.

For aided inertial guidance systems, new photosensors permit daylight star tracking and fast scanning. Star data is being encoded in digital form. Reliability in inertial guidance is being approached by wider use of circuit redundancy.

CARRIER LIFETIME—A new method of measurement of lifetime of minority carriers in semiconductor single crystals uses the principle of microwave absorption which occurs in the sample when a pulse of minority carriers is injected while the crystal is in an r-f field.[8] Carrier injection may be accomplished with a small probe or by use of visible light shining on the surface of the crystal.

When minority carriers are injected into a crystal of germanium or other semiconductor material, they recombine with some of the larger number of charge carriers of the opposite type, but not instantaneously. The time required for the number of minority carriers injected to decay to $1/e$ of its original value is called the lifetime of minority carriers. The lifetime is a function of the purity of a particular crystal and is one of the most important parameters involved in the design of semiconductor devices.

In conventional methods, it is necessary to use ohmic or rectifying contacts on the crystal surface which involves tedious and costly preparation. With the new techniques, these difficulties are avoided.

Figure 9 shows one technique which uses a current pulse for carrier injection through a small probe. Figure 10 is a block diagram of the equipment setup. The r-f source is a well-regulated, 24-kmc klystron oscillator with approximately 2 mw output power. The klystron is set for c-w operation and a pulse applied to the probe in the forward direction. As carriers are injected into the germanium, absorption of microwave power can be observed on the oscilloscope which is connected through the amplifier to the detector diode. Lifetime can be measured by determining time constant of decrease in absorbed power.

Elimination of the probe can be accomplished by using pulsed visible light shining through a small hole in the guide as the means of carrier injection. Lifetime measurements obtained by this electrodeless method closely correlate with data obtained with a conventional method. The electrodeless method also shows promise as a highly sensitive photodetector.

REFERENCES*

(1) Y. Chu and P. N. Buford, Land Vehicular Guidance by Radar.
(2) D. G. Kilpatrick and S. Bellet, Cardiac Pacing-Stimulation by Very Portable Equipment.
(3) D. J. Blattner and F. Sterzer, Fast Microwave Logic Circuits.
(4) A. E. Hayes, Jr., Measurement of Missile Miss Distance.
(5) H. Hoffmann, Jr., Space Vehicle Electromagnetic Communications and Tracking.
(6) R. W. Hanford, Radar Testing for a War Environment.
(7) F. Stevens, Trends in Inertial Navigation.
(8) A. P. Ramsa, H. Jacobs and F. A. Brand, Microwave Techniques in Measurement of Lifetime in Germanium.

*All papers presented at IRE Nat'l Conv., New York, 1959.

Tracking Earth's Weather

Earth satellite scans the earth and transmits television-type pictures to ground stations to track major storms. Video signal is generated by alternate optical cells as satellite orbits. Electronics package includes miniature tape recorder and necessary r-f circuits

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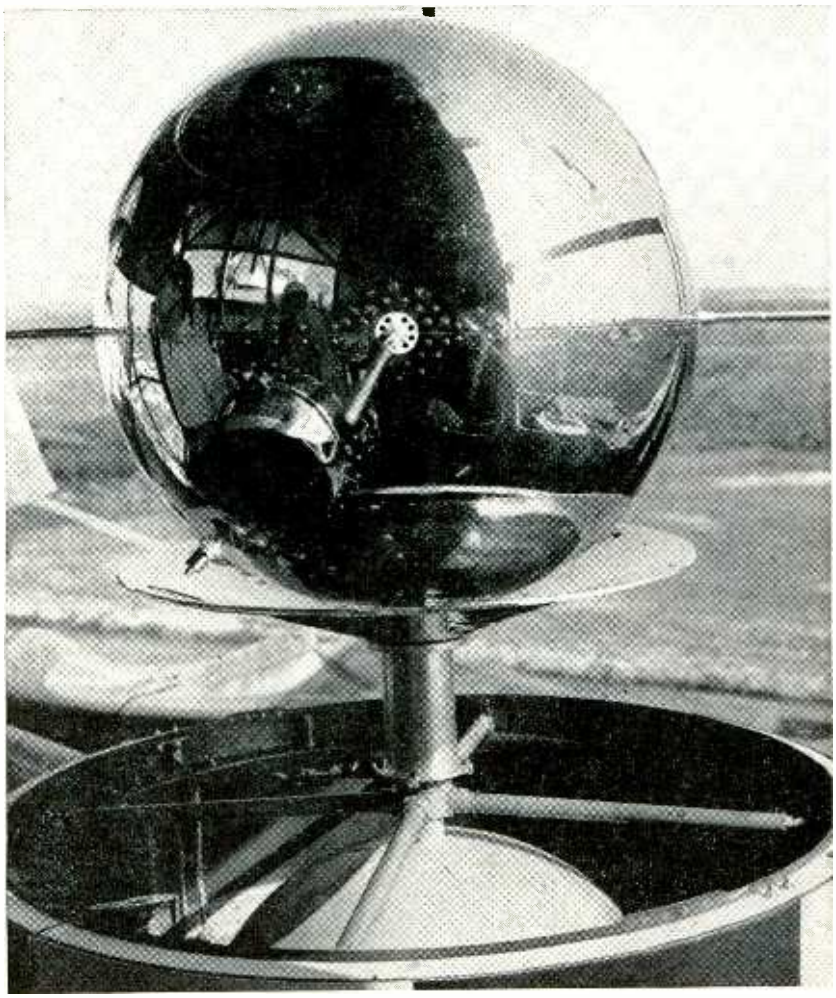
ONE OF THE MOST interesting earth-satellite experiments consists of a television-like instrument designed to record a crude picture of the earth cloud cover to locate and track major storms such as hurricanes and typhoons. The first of a series of these weather-eye satellites was carried aloft by Vanguard II on February 17, 1959.

The basic principle of the first cloud-cover satellite is similar to the Nipkow system used in the early days of television. The satellite spin provides the line sweep and its continuous flight path produces advancement of the individual lines.



Cloud cover satellite mounted to rocket. Shield under satellite is radiant heat reflector. Aperture at lower left is infrared photocell. Satellite is 20-in. diameter, weighs 21½ lb

Satellite Orbit

Mounted on the satellite structure are two diametrically opposite light-sensitive optical cells whose optical axes make a 45-deg angle with the satellite spin axis. Figure 1 shows one orbit around the earth and the various geometrical relationships between the optics and the orbital position.

When the satellite is in position 1, optic *A* views a circle of the earth's surface. Simultaneously, optic *B* is scanning the dark sky and does not collect information. In position 2, the two optics alternately sweep the earth and the function of this sweep is given by the intersection of a cone and sphere. In position 3, the picture is the same as position 1 except that optic *B* scans the earth and optic *A* views the dark sky. Position 4 gives a pattern similar to position 2. Further inspection of the geometry shows that there is no time when both optics view the earth simultaneously. At least one optic scans the earth as long as the satellite apogee is lower than 1,700 miles. The resolution varies with distance. As only one optic is illuminated at a time, dual use of one communication channel is permitted.

As sunlight must not enter the optic, the proper launching time and angle must be carefully chosen.

Orbital position of the vehicle must be known accurately at all

* Now with Foxboro Mfg. Co., Foxboro, Mass.

With Cloud-Cover Satellites

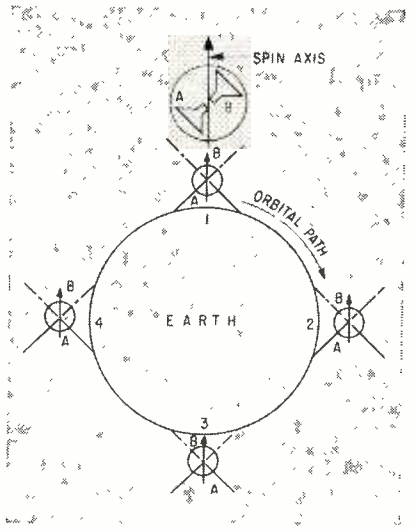


FIG. 1—Nipkow-type scan is generated by orbiting satellite. Arrow indicates satellite spin axis. Optics *A* and *B* make 45-deg angle with spin axis

times. This information is obtained through tracking stations on the American continent and elsewhere in the world. Telemetering receiver facilities are available at these stations.

Trainable antennas with 22-db gain accept signals over a 60-deg bandwidth, allowing only one minute of telemetering time if the satellite is as low as 300 miles. The receivers are designed for the reception of a-m signals and accept a bandwidth of 30 kc. Since bandwidth and duration of signals are fixed, the Shannon-Nyquist criterion shows that the channel capacity is determined by the minimum noise in the channel.

It is desired that a good telemetering signal be received when the satellite is in an unfavorable perigee. Assuming a noise figure of 3 db and a 300 K antenna temperature, a radiated power of 0.65 watt yields a signal-to-noise ratio of approximately 35 db.

For about one-half of the orbital period of about 90 minutes, the satellite observes the sun-illuminated portion of the globe while the other half is dark. The tape mechanism can be turned off during the night portion of the satellite orbit. A duration of 50-minute recording and one-minute playback has been chosen. Thus, a speed ratio of 50:1 is developed.

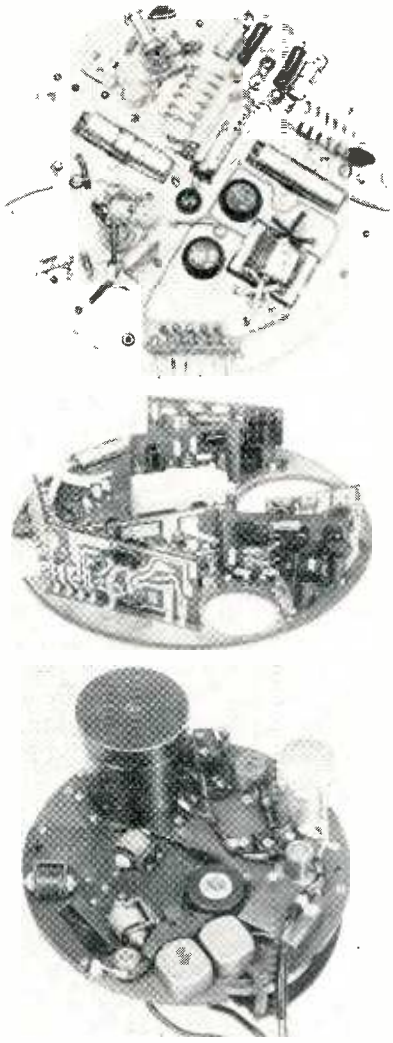
A maximum bandwidth of 15 kc minus the 2.5-kc guard band is handled by the telemetering receivers. With a 50:1 speed ratio the recorded bandwidth falls between 50 and 300 cps. Because of nonideal filters 290 cps is the uppermost frequency used. The various light intensities viewed by the optics contain a d-c component in their spectrum and range up to 240 cps. Since the choice of subcarrier frequency is determined by the maximum recording frequency and the signal bandwidth is fixed, the desired spin rate and optical resolution can be computed.

Spin Rate

As the spectrum of the video signal is now determined, the number of picture elements per unit time and consequently the satellite spin rate can be calculated. By the geometry of Fig. 2, the number of picture elements per unit time is found to be $N = 2\pi n(\sin\phi)/\alpha$, where α is the angle of view, ϕ is the angle between optical axis and spin axis, h is the altitude, d the length of picture element on the ground, l the length of travel for one revolution, and n the spin rate.

Note that $\phi = 45$ deg and an approximation for α is justified because it is small. The quantity N must equal a value smaller than the maximum signal frequency, as rigorous control of satellite spin is not possible without weight penalty. The geometry of Fig. 2 shows that l, the satellite travel for one revolution, must equal the length of a picture element on the ground so that no overlap of individual lines and no gaps between them will occur. With these conditions and for the available bandwidth the desired spin rate is 31 rpm. The linear resolution becomes better than 10 miles for altitudes lower than 500 miles. The optical angle of view is 1.1 deg.

Although the initial spin rate can



Radio-frequency deck (top), main deck (center) and tape recorder deck prior to assembly and potting

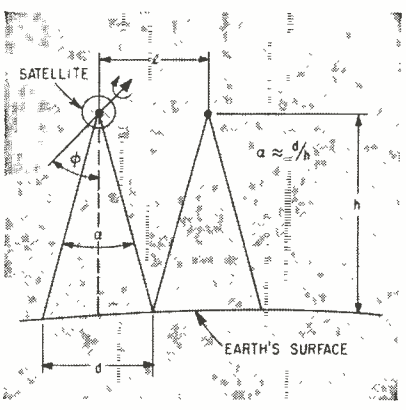


FIG. 2—Geometry of satellite showing generation of picture element length and number of picture elements per unit time

be adjusted, damping from the earth's magnetic field causes the spin rate to decay slowly. For Vanguard-type satellites, a time constant of 14 days has been computed by the U. S. Naval Research Laboratory. These variations are taken into account in the reproduction of the picture in the ground equipment.

Dynamic Range

For the design of the electronic circuits, minimum signal level and dynamic range must be known. Fig. 3 shows a sun-illuminated element d^2 as seen by the satellite optic. The received power is $P_{cell} = ad^2 A \sin\psi / \pi h^2$ where A denotes the area of the optic and a the albedo or whiteness factor of the earth including an allowance for optical filtering between 0.6 and 0.8 μ. If lead-sulfide cells of 1 by 1-mm area with a noise equivalent power of 10^{-10} watts are used, total noise power in the signal band can be computed. A parabolic mirror optic with 42-cm^2 area corresponding to $f = 0.7$ gives a signal noise voltage ratio of 60 db. A dynamic range of 40 db is easily accommodated as a 20-db signal noise ratio is still satisfactory. Larger mirror areas cannot be used since the cell is driven into saturation with higher inputs.

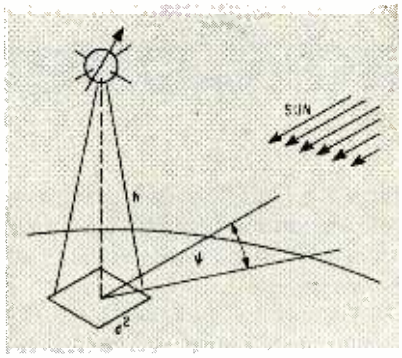


FIG. 3—Geometry for calculation of dynamic range from sun-illuminated earth element as seen by the satellite optic

In addition to the lead-sulfide cells in each optic, silicon solar cells are mounted in circular fashion around the detector. These solar cells cover a much larger angle (approximately 15-deg) than the lead-sulfide detector. When illuminated, a few tenths of a volt are available to operate the day-night switch.

Instrument Operation

A complete circuit diagram of the instrumentation is shown in Fig. 4. The day-night switch is a voltage-regulator circuit powered by a 17.4-v battery stabilized by a 12-v zener diode in a negative-feedback loop. Bias is derived from the two solar batteries in the regulator optics. Lack of bias as would occur in a night condition isolates the load from the 17.4-v battery. The voltage regulator powers the recording motor, erase oscillator and recording units. At night, only small standby power for the regulator is required. The incident light collected by the optics causes the lead-sulfide cells to change their resistance so either positive- or negative-modulated signals will be coupled to the tube depending upon which cell is illuminated.

When the satellite passes over a ground station, a coded interrogation signal is transmitted. The interrogation receiver activates a sensitive relay holding for approximately the duration of the signal.

Relay K_1 operates latch relays K_2 through K_6. The corresponding contacts initiate the following sequence: K_2 and K_3 connect the record-playback head to playback amplifier 1; K_4 and K_5 power the modulator, transmitter and driver

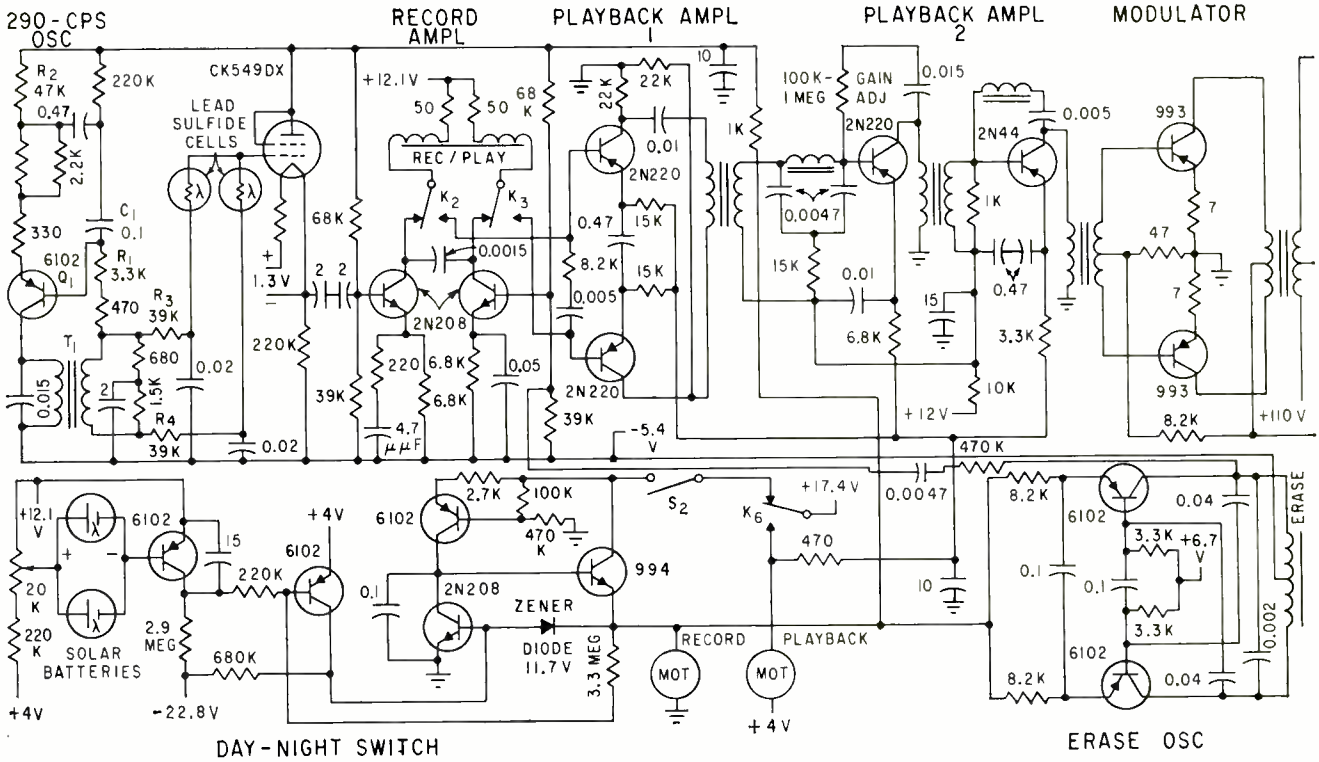


FIG. 4—Output of 290-cps oscillator is applied to bridge where optics form other arms. Resultant signal is applied through cathode interrogation by one of the ground tracking stations the output of the playback head is amplified to modulate the telemetering

circuits; K_5 also disconnects the interrogation receiver local oscillator power and K_4 disconnects relay K_1; K_6 applies voltage to the playback motor and playback amplifiers.

Upon completion of the playback cycle, reset switch S_1 is momentarily closed to apply a positive voltage to relays K_2 through K_6 to reset them to the record position.

The transmitter is a tube-transistor hybrid which uses a crystal-controlled Hartley oscillator providing more than one watt at the antenna terminal.

Mercury cells are used as a power source permitting operation up to three weeks. The circuit will operate within a temperature environment from 0 to 60 C. The equipment can withstand 25-g white-noise vibration from approximately 25 to 2,500 cps and 100-g acceleration.

Telemetry Specifications

The primary video signal bandwidth is 0 to 240 cps.[1] Use of a direct-record system dictates use of a subcarrier for reproducing the d-c component of the signal. Use of a 290-cps subcarrier results in a lower sideband of 290 − 240 = 50 cps and an upper sideband of 290 + 240 = 530 cps. Since only a 300-cps bandwidth is available, a single-sideband system is used suppressing the upper sideband to meet vestigial sideband demands.

Sideband attenuation is accomplished by utilizing the gap effect of the recording head together with filtering in the playback amplifier.[2] With the head used, a recording speed of 0.3 in./sec with a 0.5-mil physical gap yields a null in the upper sideband. The actual gap is slightly larger than 0.5 mil. The playback speed is fixed at 15 in./sec.

Recording System

The 290-cps oscillator is the video subcarrier generator. Its stability and distortion content determine the primary video quality. Frequency stability of 0.5 percent is necessary to insure demodulation accuracy on the ground with servo speed control of the ground station tape recorder for correcting long-term subcarrier drift. Short-term stability which contributes noise is negligible and is well under 0.1 percent. The oscillator, shown in Fig. 4, is a hybrid using a tuned collector and phase-shift. Transformer T_1 exhibits a high-temperature coefficient and when used as the primary frequency determinant results in an unstable oscillator. The phase shift network R_1C_1, combined with the compensated input impedance of Q_1, stabilizes oscillation frequency. The emitter circuit uses a negative temperature coefficient resistor to control gain and input impedance to maintain amplitude as well as frequency stability over the entire temperature range.

Resistor R_2 provides d-c bias stabilization of Q_1 by conventional emitter degeneration[3]. The base is returned to a floating ground so that its potential adjusts itself to supply voltage variations to maintain proper bias. As the operating point for Q_1 is independent of supply voltage variations, frequency is unaffected by changes in battery potential within maximum and minimum values. Power input is approximately 4 mw.

The output circuit R_3 and R_4 and the balanced low-pass filter drive the lead-sulfide cell modulator with an unbalanced voltage to obtain an a-m modulated video signal. The low-pass filters reduce the total harmonic distortion to less than 1.5 percent.

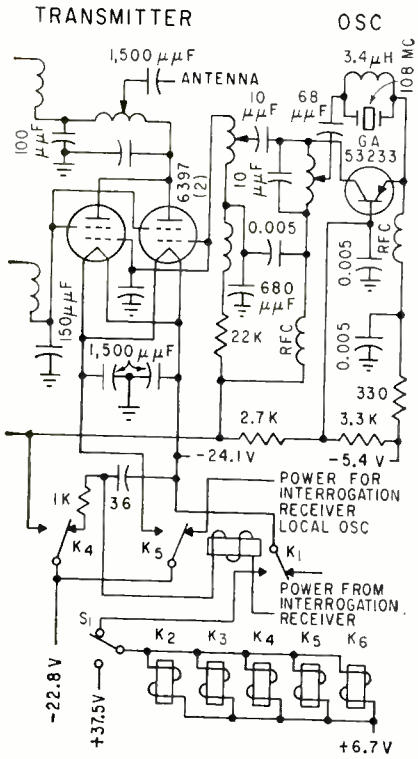
Recording Amplifier

The recording amplifier shown in Fig. 4 is a hybrid using vacuum tube input and transistor drivers. Because of the high output impedance of the modulator at medium and low temperatures, a low-filament drain vacuum tube of comparable ruggedness and power consumption was chosen as the input stage. The grounded-plate stage has an input impedance of 50 megohms at 290 cps resulting in negligible loading of the lead-sulfide cell modulator. The output drives a grounded-emitter stage used as a signal driver for the recording head. The head and tape characteristics at 0.3 ips permit a maximum recording current of 0.2 ma peak-to-peak for the full dynamic range at 290 cps. Low-frequency compensation of 6-db/octave rolloff below 290 cps provides reasonably flat response to within 10 db over the entire bandwidth.

A split-winding head is used to couple the a-c bias and signal current to the head while simultaneously providing d-c bias to the transistors. The unbalanced d-c in the head winding is held below 10 μa by using selected emitter resistors. A capacitor is used across the head winding to increase the coupling of the 5-kc bias current resulting in asymmetrical excitation of the recording head essential in minimizing distortion[2]. The bias driver amplifier is coupled to the erase oscillator through a constant-current network to insure low distortion. Erase current is provided by a push-pull oscillator with the erase head as an integral part of the circuit. Power consumption for the complete recording circuit is 220 mw.

Tape Recorder

The tape deck and associated electronics weigh approximately 1.5 lb. The tape deck shown in Fig. 5 uses an endless tape cartridge containing 75-ft of 1.5-mil recording tape. The endless cartridge allows the tape to unwind from the inner wrap of



follower to recording amplifier. Upon transmitter

the tape reel. The force created by the friction of the tape and the wrap on the reel creates a net torque on the reel and spool of tape causing the tape to wind back on the periphery of the spool. The single reel affords compact storage for the tape and allows the drive system to move the tape in one direction for both record and playback functions. No safety or slip devices are required. This characteristic is advantageous in satellite instrumentation as an interrogation may be missed or the orbit is longer than maximum design conditions.

For higher efficiency and simplicity with the large speed ratio of 50:1, a dual motor and drive system and a single capstan and flywheel assembly are used. The tape is driven between the capstan and a rubber wheel. The high-speed playback system employs a governed d-c motor mechanically connected to the capstan-flywheel assembly through a plastic belt. The basic playback speed of 15 ips is established by driving the 0.125-in. diameter capstan at 2,300 rpm.

Because of the proximity of the playback head and the motor, the motor and noise filters are enclosed in a magnetically shielded can. The motor is a conventional miniature permanent-magnet d-c motor governed at 3,300 rpm.

Recording Mode

An additional requirement of the high-speed system is to provide for resetting the electronic package to the recording mode. At the end of each interrogation cycle of approximately one minute duration, switch S_1 is driven mechanically from the cam-and-spur gear reduction assembly. Switch S_2 is incorporated in the playback system through a single-trip follower arm to hold the day-night switch off until the first interrogation is finished. Switch S_2 then closes and remains closed for the duration of the satellite life to allow normal function of the day-night switch. The purpose of this record hold-out switch is to allow a prerecorded calibration tape to be transmitted 24 hours after launch time to check the package.

The tape consists of a sweep frequency record for setting ground equalization, a staircase level recording for gray-scale calibration, and a constant-amplitude standard-frequency record to check the signal-to-noise and record-playback speed ratio. The action of these switch functions is provided by a ramp-and-drop on the switching cam.

The low-speed record drive system employs a 10-ma, 12-v d-c motor supplied with constant voltage from a transistorized regulator which is part of the day-night switch. A belt-and-friction reduction is used to drive the capstan at 46 rpm. A unidirectional clutch between the friction drive and the capstan separates the low speed system during high speed playback. The record motor is of the permanent magnet type with a seven-bar commutator having the rotor wound around the stationary magnet. This construction increases motor inertia without increasing weight and contributes to higher torque characteristics at speeds of approximately 2,000 rpm.

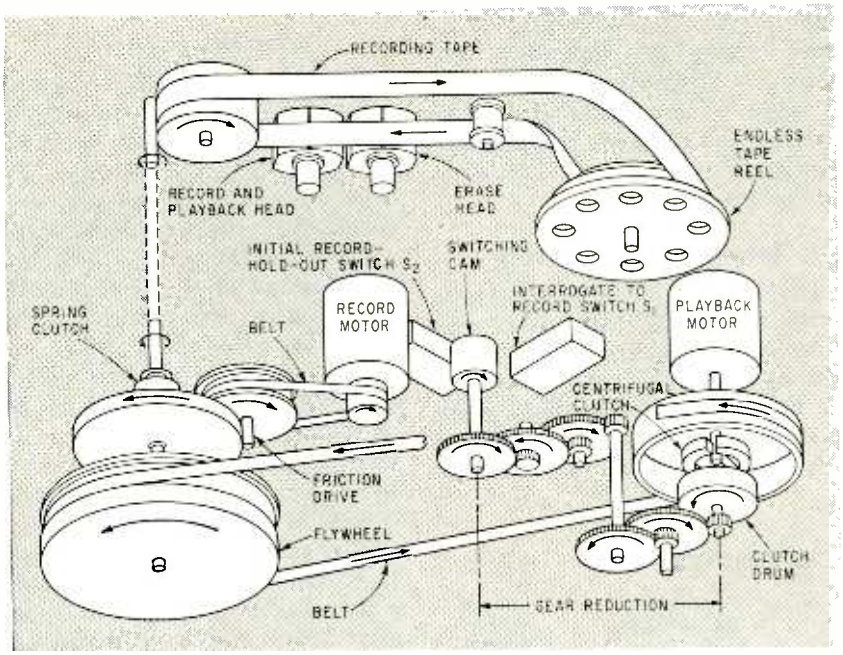


FIG. 5—Magnetic tape memory system assembly. Endless tape reel holds 75-ft of 1.5-mil tape. Playback speed is 15 ips

Day-Night Switch

The switch shown in Fig. 4 consists of a current feedback control loop in a power amplifier using a zener diode for the reference voltage. A two-stage direct-coupled preamplifier biases the control amplifier to saturation, providing a base shunt to the power stage. The control amplifier bias is removed when the solar batteries are illuminated. The feedback then takes control of the output voltage. The gain of the overall system allows full switch operation at the minimum light level. Operation having a hysteresis characteristic similar to relays is accomplished by providing a small positive feedback loop from the regulator output to the second preamplifier stage. This results in a switch action with excellent stability in either state. The rise time is less than 100 μsec.

Solar batteries used in this package provide 7.5 μa input current at minimum light level. Equivalent noise levels of 1 μa over the entire temperature and voltage range show sufficient signal-to-noise ratio to give stable operation. A storage capacitor is used after the first amplifier stage to hold the switch on for rapidly fluctuating intensity levels such as may occur over land and sea areas providing nearly six seconds delay before switching off.

Data Transmission

Vestigial sideband transmission technique allows transmission of

the d-c video component while realizing a saving in bandwidth.

The output of the tape reproducing head is 6 mv rms over the recorded frequency band. A low-noise preamplifier is necessary to preserve a 40-db signal-to-noise ratio.

Playback amplifier 1 is a pair of push-pull low-noise transistors. This circuit keeps battery fluctuations from contributing to the input noise while maintaining d-c magnetic balance in the playback head. Direct-current degeneration in the emitter circuit stabilizes the bias between temperature extremes[3]. Playback amplifier 1 is transformer-coupled to playback amplifier 2 through a bridged-T filter. The filter rejection frequency of 1.6 kc provides sharp cutoff and attenuation below 2.5 kc. The 2.5-kc guard band is thus obtained at −35 db average level on the transmitted signal to keep the tracking accuracy on the telemetering frequency of 108.03 mc. Insertion loss of the filter is 1 db when matched into 2,000 ohms.

The filter is followed by a grounded-emitter stage using temperature compensating feedback between the collector and base. The feedback holds the gain to within 1 db over the entire temperature range.

Approximately 1 watt of r-f power is generated by the transmitter at an efficiency of 40 percent; therefore 1.1 watts of modulation power is required. This calls for an overall reproduce amplifier gain of 84 db. A conservative estimate of 24-db gain at 1-watt output was made for the power amplifier stage leaving 60 db for the three-stage preamplifier.

Modulator Transmitter

The high-power modulator is a conventional class B emitter-stabilized design. A small degree of forward bias reduces the crossover distortion inherent in transistor class B amplifiers. Under full output conditions, of 1.1 watts, the total harmonic distortion is under 3 percent, although a collector efficiency of 70 percent, including transformer losses, is maintained. I_{co} variations are held to 1 ma using emitter-stabilizing resistors. The power transistors have a collector dissipation of 300 mw in free air at 25 C. As the dissipation from I_{co} variations does not exceed 50 mw, thermal runaway is avoided.

Interior of satellite is plated with about 2-oz of pure gold to maintain even temperature during flight. Photoelectric pickups are mounted on opposite sides of housing

One of the more serious problems with the vestigial-sideband technique is the effect of long and short term speed stability of the tape recorder. Wow and flutter measurements show an average of 1-percent peak-to-peak with a long term drift of 4.5-percent. This drift results in a subcarrier shift from 14.5 kc to 13.85 kc displacing the sideband symmetry and carrier amplitude. Coupled with the fundamental stability of the 290 cps oscillator, drift determines the ultimate resolution of the video system. Flutter compensation techniques are employed in the data reduction system for the cloud cover data, thus reducing the overall flutter to less than 0.2 percent.

A crystal controlled oscillator was chosen to insure high stability. The unavailability of vhf transistors capable of producing the required power level prescribes hard-tube techniques. A pair of CK6397 tubes in parallel serve as the output stage of the transmitter. Push-pull configuration imposes a difficult problem in the layout of the grid and plate tank circuits.

Analysis of the tube characteristics reveals that 1 watt cannot be obtained for class B operation. However, by a slight shift in the point of operation considerably more power output is delivered to the load with a small sacrifice in efficiency.

The oscillator is a Hartley crystal-overtone circuit with grounded-base design. Stabilization of the operating point for temperature and supply voltage variations is obtained through a high degree of d-c feedback and a floating ground system for base bias. The coupling network between oscillator and final amplifier is derived empirically for optimum driving.

Approximately 1 db loss is apparent between oscillator collector and final amplifier grid. High Q piston capacitors and tank coils are used for maximum efficiency. Because of the limited driving power, the modulation characteristic is linear up to only 80-percent modulation at all temperatures.

References

(1) R. Hanel and R. Stampfl, An Instrumentation System of Measurements of the Earth's Cloud Cover, *IRE Nat'l Conv Record*, Part 5, 1958.

(2) S. J. Begun, "Magnetic Recording", Rinehart Books, Inc., New York, N. Y., 1949.

(3) R. F. Shea, "Principles of Transistor Circuits", J. Wiley and Sons, Inc., New York, NY, 1953.

(4) R. Hanel and R. Stampfl, Transistor Amplifier with Extremely High Input Impedance, *Proc of Nat'l Electronics Conf*, p 67, XI, 1955.

Bibliography

W. G. Stroud and W. Nordberg, "Scientific Uses of Earth Satellites", p 113, Univ. of Mich. Press, 1956.

J. T. Mengel, Tracking the Earth Satellite and Data Transmission, *Proc IRE*, 44, 1956.

Rectangular and Circular

Roundup of waveguides used in the 26 to 350-kmc range includes nonstandard and military types not yet available commercially

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RECTANGULAR AND CIRCULAR waveguides are now commercially available for the frequency range 26.5 to 350 kmc, 11.5 to 0.857-mm wavelength, covering the upper range of applicability of conventional microwave techniques.

In Table I, JAN and special types of rectangular waveguides are given along with their mechanical and electrical characteristics. The RG-96, 97, 98 and 99/U sizes have been used for many years. They can be obtained from a number of manufacturers.

NEW TYPES—Most workers in the millimeter field are using the nonstandard G, F and E rectangular waveguides. The RG-135, 136, 137, 138 and 139/U are not available commercially at the present time. These smaller guides are planned to have a circular exterior geometry and are probably to be made by electroforming rather than by extrusion or drawing.

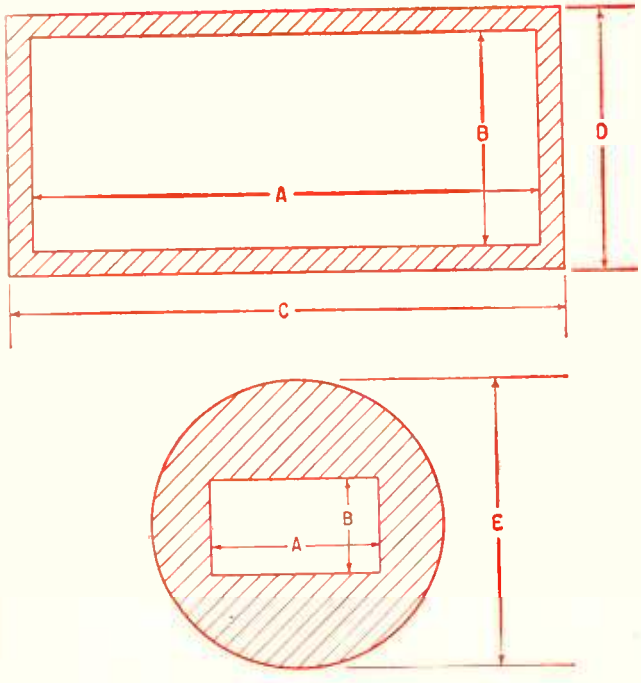


FIG. 1—Key to dimensions given in Table I. Cross sectional views of two types of rectangular waveguide are shown

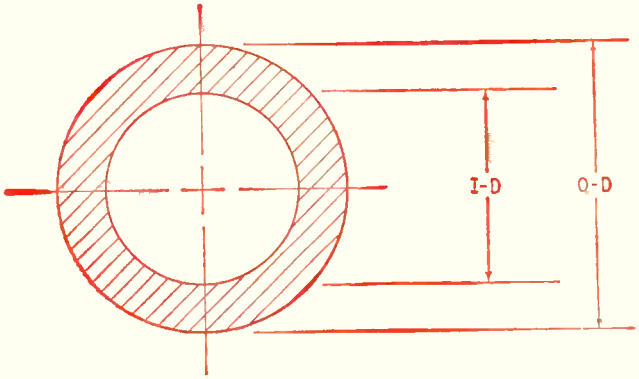


FIG. 2—Key to dimensions given in Table II. Cross sectional view of circular waveguide

JAN rectangular waveguides for the 30 to 300-kmc range are given in the "Armed Services Index of R-F Transmission Lines and Fittings."

Table II presents Electronic Industries Association WC designated circular waveguides for the frequency range 29.3 to 256 kmc.

The problems encountered by conventional microwave guides operating in the dominant mode at these ultramicrowave frequencies are quite evident. Physical size, mechanical tolerances and electrical attenuation are becoming so severe that beyond one millimeter wavelength, microwave techniques must be modified in the direction of infrared, physical optics methods.

WIDENING USE—Low millimeter waves are assuming increasing importance as a diagnostic tool in physics research in such areas as plasma physics, solid state physics, spectroscopy and superconductivity.

The small size and weight of these waveguides and their associated components lend themselves to many electronic system applications. The development of suitable signal sources for these very short wavelengths will undoubtedly increase the present use of millimeter waveguides many times in the near future.

While work on low millimeter components is presently handicapped, new techniques will be forthcoming to handle the new ranges.

Millimeter Waveguides

Table I—Rectangular Millimeter Waveguides

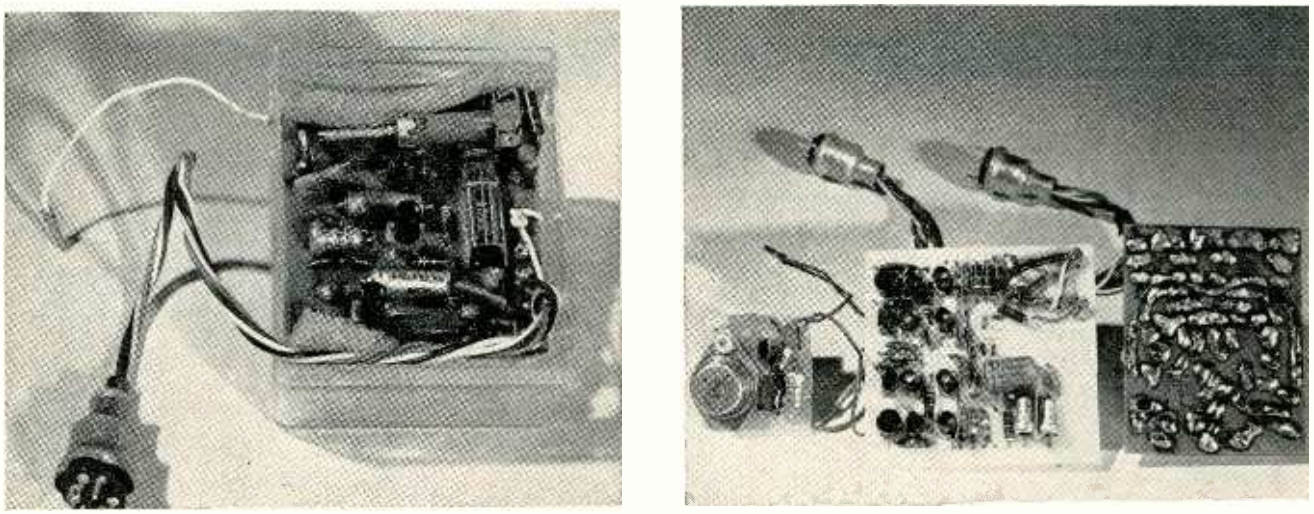
JAN TYPE	Operating Range—TE_{10}		Inside Dimensions[c]		Outside Dimensions			Cutoff of TE_{10} Mode (kmc)	Theoretical Attenuation[a] (db/100 ft)	Theoretical C-W Power Rating[b] (kw)
	Frequency (kmc)	Wavelength (mm)	A (in.)	B (in.)	C (in.)	D (in.)	E (in.)			
RG-96/U	26.5–40	11.3–7.5	0.28	0.14	0.36	0.22		21.1	21.9–15	22–31
RG-97/U	33–50	9.09–6	0.224	0.112	0.304	0.192		26.35	31–20.9	14–20
RG-98/U	50–75	6–4	0.148	0.074	0.228	0.154		39.9	52.9–39.1	6.3–9
RG-99/U	60–90	5–3.3	0.122	0.061	0.202	0.141		48.4	93.3–52.2	4.2–6
RG-138/U	90–140	3.3–2.14	0.08	0.04			0.156	73.84	152–99	1.8–2.6
G*	100–150	3–2	0.075	0.034	0.135	0.094		78.8	165–117	1.5–2.1
RG-136/U	110–170	2.73–1.77	0.065	0.0325			0.156	90.85	163–137	1.2–1.7
RG-135/U	140–220	2.14–1.36	0.051	0.0255			0.156	115.75	308–193	0.71–1.07
FR*	140–220	2.14–1.36	0.051	0.0255	0.111	0.0855		115.75	308–193	0.71–1.07
F*	150–230	2–1.3	0.049	0.022	0.107	0.08		120.61	329–224	0.61–0.88
RG-137/U	170–260	1.77–1.15	0.043	0.0215			0.156	137.52	384–254	0.52–0.75
RG-139/U	220–325	1.36–0.92	0.034	0.017			0.156	173.29	512–348	0.35–0.47
E*	230–350	1.3–0.85	0.033	0.016	0.097	0.08		179.09	541–377	0.31–0.44

*Indicates other than a JAN standard designation. (a) Computed for silver having a resistivity of 1.62×10^{-6} ohm/cm. (b) Based on the breakdown of air to be 15,000 v/cm (safety factor of approximately 2 at sea level). (c) Inside-dimension tolerance ranges from ±0.0015 for RG-96/U through ±0.0005 for RG-99/U, to ±0.0002 for RG-139/U. All sizes are available in silver or copper

Table II—Circular Millimeter Waveguides

EIA Type	TE_{01} Mode				I-D[c] (in.)	O-D (in.)	TE_{11} Mode			
	Operating Range		Cutoff Freq (kmc)	Theoretical Attenuation[a] (db/100 ft)			Operating Range		Cutoff Freq (kmc)	Theoretical Attenuation[a,b] (db/100 ft)
	Freq (kmc)	Wavelength (mm)					Freq (kmc)	Wavelength (mm)		
WC 59	29.3–40.4	10.24–7.42	24.2	4.87–2.13	0.594	0.674	13.4–18.4	22.4–16.3	11.6	(2.52–2.48)
WC 50	34.8–48	8.62–6.25	28.8	6.36–2.77	0.5	0.58	15.9–21.8	18.9–13.8	13.9	(3.28–3.22)
WC 44	39.8–54.8	7.54–5.47	32.8	7.70–3.33	0.438	0.518	18.2–24.9	16.5–12	15.8	(3.96–3.9)
WC 38	46.4–63.9	6.46–4.69	38.4	9.83–4.28	0.375	0.435	21.2–29.1	14.1–10.3	18.5	(5.04–4.96)
WC 33	53.1–73.1	5.65–4.1	43.9	12–5.22	0.328	0.388	24.3–33.2	12.3–9.04	21.1	(6.17–6.05)
WC 28	61.9–85.2	4.85–3.52	51.2	15.2–6.58	0.281	0.341	28.3–38.8	10.6–7.73	24.6	(7.81–7.6)
WC 25	69.7–95.9	4.3–3.13	57.6	17.9–7.91	0.25	0.29	31.8–43.6	9.43–6.88	27.8	24.2–12.6 (9.3–9.13)
WC 22	79.6–110	3.77–2.73	65.7	22.3–9.35	0.219	0.259	36.4–49.8	8.24–6.02	31.6	28.9–15.1 (11.28–11.09)
WC 19	92.9–128	3.23–2.34	76.4	27–11.8	0.188	0.228	42.4–58.1	7.08–5.16	36.8	36.3–18.9 (14.2–13.98)
WC 17	101–139	2.97–2.16	83.7	31.7–13.8	0.172	0.212	46.3–63.5	6.48–4.72	40.3	42–21.8 (16.3–15.8)
WC 14	124–171	2.42–1.75	102	41.7–18.2	0.141	0.181	56.6–77.5	5.30–3.87	49.2	55.9–29.3 (21.9–21.5
WC 13	139–192	2.16–1.56	115	50.2–21.9	0.125	0.155	63.5–87.2	4.72–3.44	55.5	68.3–35.2 (26.2–25.7)
WC 11	159–219	1.89–1.37	132	63.1–27.4	0.109	0.139	72.7–99.7	4.13–3.01	63.7	85.4–43.6 (32.2–31.8)
WC 9	186–256	1.61–1.17	153	76.6–33.4	0.094	0.124	84.8–116	3.54–2.58	74	105–54.4 (40.4–39.6)

(a) Computed for silver having a resistivity of 1.62×10^{-6} ohm/cm. (b) Numbers in parentheses indicate attenuation for the frequency range of the TE_{01} mode in the given waveguide size. (c) Nominal inside-dimension tolerance ranges from ±0.0006 for WC 59 through ±0.00025 for WC 9. All waveguide sizes may be obtained in silver or copper



Eleven meter superregenerative receiver (left) controls the decoding and servo circuits (right)

Transistors Simplify

Pulse symmetry and repetition rate control servos which drive rudder and elevator. Pulses modulate the transmitted carrier, which is picked up and detected by a superregenerative receiver on the plane

By **G. B. HERZOG,** R. C. A. Laboratories, Princeton, N. J.

IN SIMPLE FORMS of pilotless aircraft control, two separate and continuous control channels are sufficient, one for the rudder and one for the elevator. The control system described here (Fig. 1) transmits two completely separate and continuous pieces of information over one radio link. A third bit of information is transmitted by momentarily interrupting the transmission, thus operating a digital control.

One continuous channel of information is conveyed by varying the symmetry of a pulse waveform and the other channel of information is conveyed by varying the repetition rate of the waveform. Advantages of this form of transmission are that nonlinearities in the transmitting and receiving equipment are unimportant and a constant signal amplitude can be obtained by clipping. Furthermore, selective filtering or synchronization between receiver and the transmitter is not necessary as with more complicated forms of frequency or time multiplex transmission.

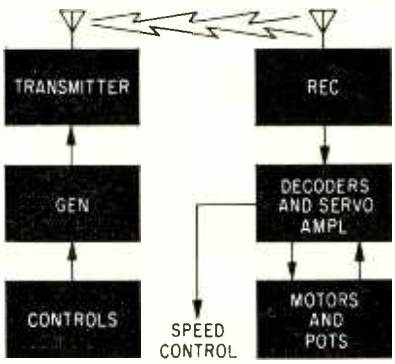


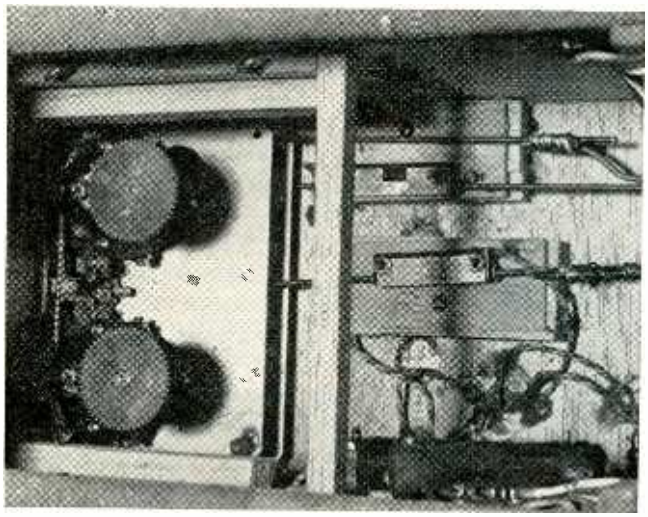
FIG. 1—By controlling the modulation of the carrier, an operator guides the plane

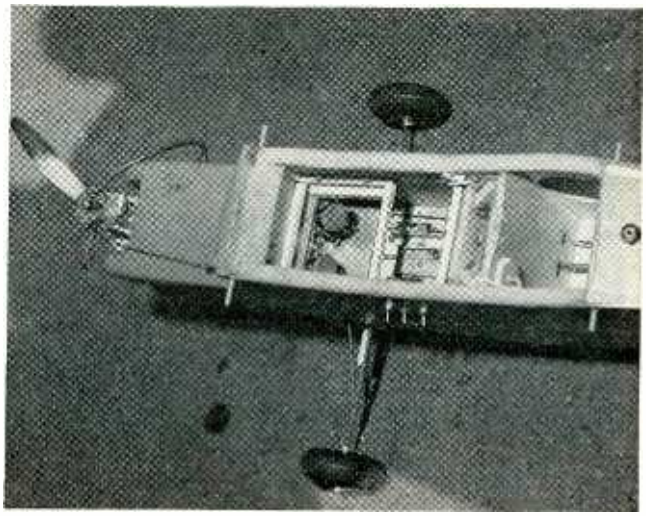
The control signal is obtained by generating a sawtooth waveform of variable repetition rate for the frequency controlled. This wave is then clipped to a desired nonsymmetrical waveform for the symmetry-controlled channel.

Signal Generation

A sawtooth voltage is generated across capacitor C_1 by blocking oscillator Q_1, Fig. 2. The oscillator time constant is in the emitter circuit of Q_1, whose charging capacitor, C_1, is fed by transistor Q_2. Frequency is varied directly by rotating linear potentiometer R_1, which feeds Q_2.

Since the collector impedance of Q_2 makes Q_2 essentially a constant-current source, the sawtooth is linear. This reduces any possibility of the frequency affecting the sym-





Closeup shows motors, gear box, linkage and potentiometers. In both photos the servo circuit has been removed to show the servo motors

Control of Target Drone

metry channel.

The sawtooth is amplified by d-c amplifier Q_3, which has sufficient emitter degeneration to minimize loading on the sawtooth generator.

The following stage, Q_4, has a variable emitter bias which clips the waveform to the desired symmetry. The bias is controlled by potentiometer R_2.

Since the waveform is d-c coupled from the sawtooth generator, the frequency of the sawtooth will not affect the point on the wave at which the clipping transistor begins conduction. Therefore, variation of the bias point sends a second bit of information which is completely independent of the first piece of information carried by the frequency of the waveform. Because a linear sawtooth is clipped, the resulting nonsymmetrical waveform is a linear function of the bias point, hence linearly related to the potentiometer setting.

Stage Q_5 further shapes the wave, squaring the sawtooth portion of the input wave at the point that this wave crosses the clipping level. The output, Fig. 3, whose peak is 13.5 v, modulates the transmitter carrier wave.

Signal Reception

The transmitted signal is received by a logarithmic mode (self-quenching type) superregenerative receiver (Fig. 4). A stage in the audio section limits the signal to a constant level regardless of reception conditions. By operating in the logarithmic mode, the receiver rejects brush noise interference from the servo motors. The audio

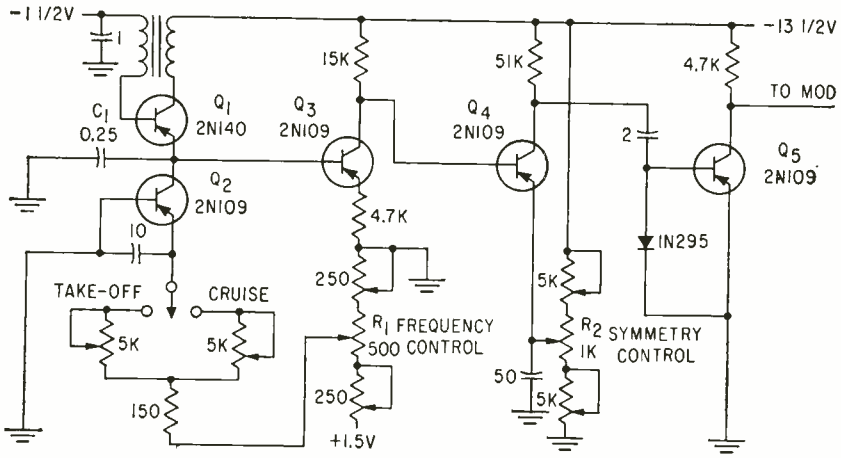


FIG. 2—Potentiometer R_1 sets the frequency of the sawtooth and potentiometer R_2 adjusts the symmetry of the output to the modulator grid of the transmitter

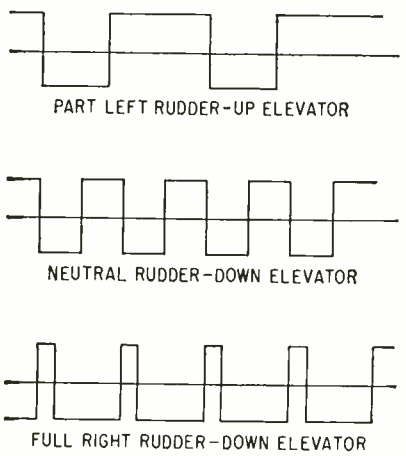
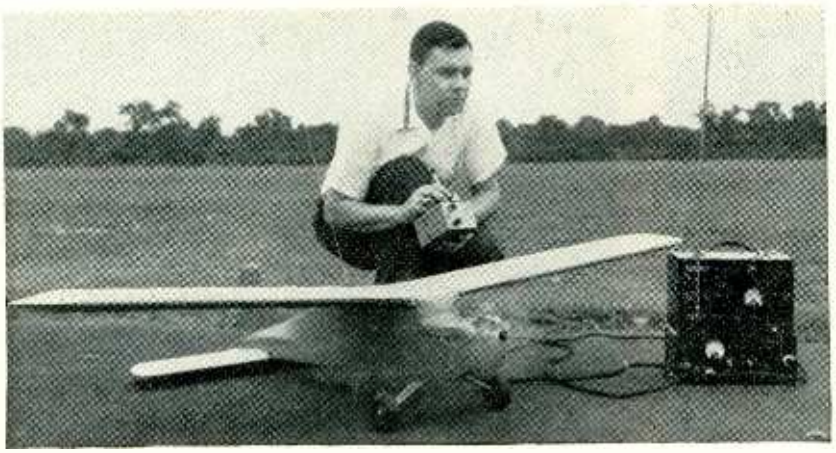


FIG. 3—Repetition rate positions elevator. Pulse shape positions rudder



Robot plane ready for takeoff

part of the receiver consists of amplifier Q_1, clipper amplifier Q_2 and complementary-symmetry emitter followers Q_3 and Q_4, which drive the signal decoding circuits.

Signal Decoding

The two continuous channels are separately demodulated by frequency and symmetry detectors which are unaffected by the information in the opposite channel.

The symmetry detector consists of average voltage detectors, D_1 and D_2. When the pulse shape deviates from a symmetrical form, the detectors change the voltages that they apply to the divider that contains R_1. The tap of R_1 signals transistor Q_5 of the amplifier that drives servo motor No. 1. This motor rotates the tap of potentiometer R_1 until the tap finds the reference voltage. When a signal is absent, the reference potential brings the servo to its center position.

Diodes D_3 to D_6 form a balanced pulse counter detector which demodulates the frequency channel information. A change in the repetition rate changes the voltages applied to the divider that contains R_2. The tap of R_2 signals transistor Q_{11}, which drives motor No. 2 until the tap finds the reference potential. The motor is centered when a signal is absent.

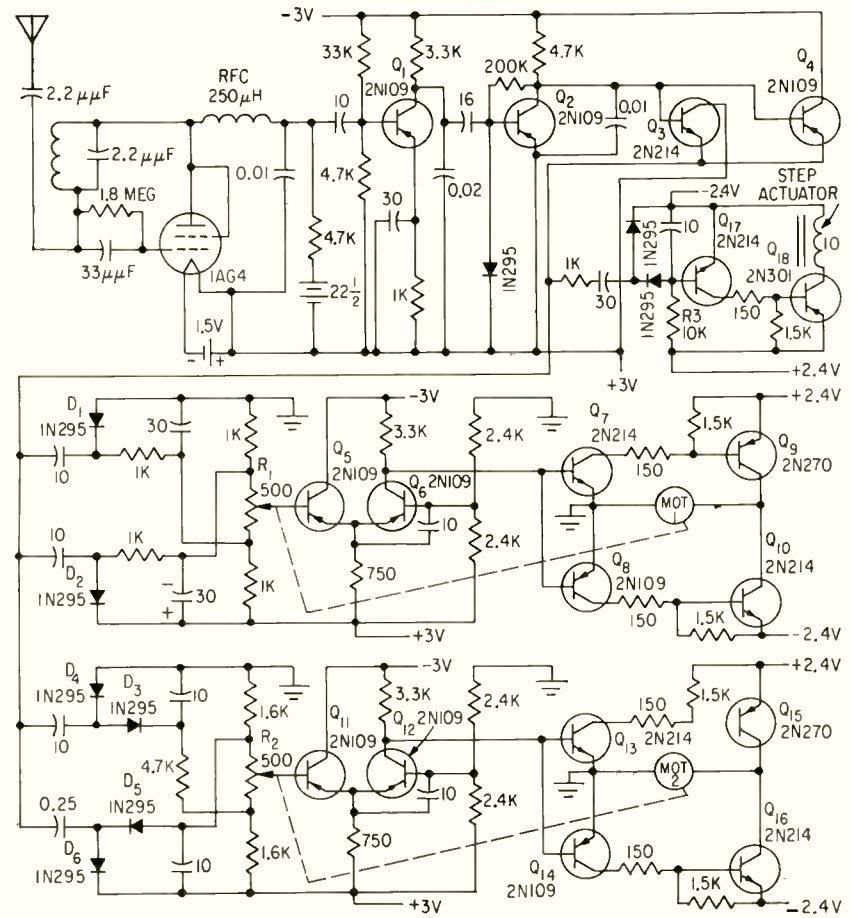


FIG. 4—Receiver output transistors, Q_3 and Q_4, simultaneously signal the symmetry and frequency decoders and the detectors that control the step actuator

Servo Amplifiers

Since the symmetry and frequency servo amplifiers are identical, only the symmetry servo amplifier will be described. Transistors Q_5 and Q_6 are biased so that zero voltage appears at the bases of transistors Q_7 and Q_8 when R_1 is at its reference voltage point. A change in the symmetry of the transmitted pulse changes the reference point of R_1. Transistors Q_7 and Q_8 form a complementary-symmetry input arrangement which drives transistors Q_9 and Q_{10}. Motor No. 1 is a miniature p-m field type which requires a low driving current.

Third Channel Information

A third bit of information, engine speed control, is transmitted by momentarily interrupting modulation. Signal interruption removes the detected voltage across R_2, which counteracted the forward bias of Q_{17}. Transistor Q_{17} conducts, switching Q_{18} on, thus pulsing the step actuator. The actuator advances the engine speed by one step each time the modulating signal is interrupted. Momentary interruption of the modulation signal does not interfere with the information conveyed by the other two channels. Should the receiver fail to receive a signal continuously, the servos center and the engine control advances to a stop position.

Application Data

Tests have shown that the transistors impose a ceiling of 140 F for safe operating temperature.

The transmission system might be used to control the autopilot of a target-drone airplane.

Laminated Core Sizes

Optimum core configurations and sizes for 400-cps coils and transformers

OPTIMUM-WOUND laminated or cut core shapes recommended by the Electronic Industries Association are listed in Table I. The list is based on open construction, 400-cps usage and practical manufacturing. Shell types may be used in simple construction.

Table II lists cores taken from the ML-16 list designed in 1951 to fit into MIL-T-27 cases. These cases are not of optimum shape for Table I cores, but may be used as indicated. Fig. 1 illustrates core shapes and dimensional factors.

Standard tests, performance and dimensional tolerances are also contained in RS-217, February, 1959, available from EIA's New York office.—G.S.

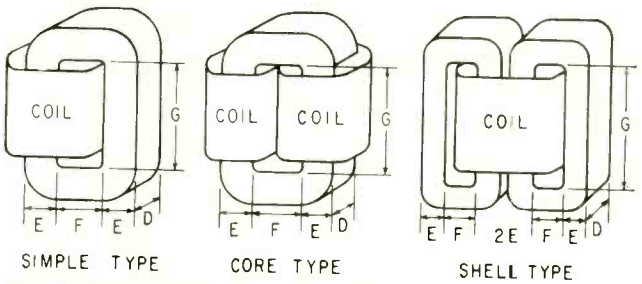


FIG. 1—Measurements and methods of using standard cores

Table II—Recommended Numbers, Dimensions, Use and MIL-T-27A Cases for Cores in 4-Mil Materials, Taken from ML-16 List

Core No	Nom Dimensions (inches) D	E	F	G	Use and Cases[a] Simple Type	Shell Type	Core Type
250*	1/2	1/4	3/8	1			EA
382	5/8	1/4	3/8	1			EA
407	3/4	1/4	3/8	1 1/8			FA
380	7/8	1/4	3/8	1 1/8			FA
381	7/8	7/16	3/8	1 7/16	GB		GA
408	7/8	7/16	7/16	1 11/16	HB		
376	1	7/16	7/16	1 11/16	HB		
409	7/8	13/32	7/16	1 15/16			HA
379	1	13/32	7/16	1 15/16			HA
411	7/8	7/16	5/8	2 1/2			JA
410	1 1/8	7/16	5/8	2 1/2			JA
413	1 1/8	17/32	5/8	2 1/2			KA
412	1 1/4	17/32	5/8	2 1/2			KA
415	1 1/4	5/8	5/8	2 5/8			LA
414	1 3/8	5/8	5/8	2 5/8			LA
417	1 3/8	11/16	11/16	3			MA
416	1 5/8	11/16	11/16	3			MA
419	1 1/2	3/4	3/4	3 1/2			NA
418	1 7/8	3/4	3/4	3 1/2			NA

(a) Same notation as Table I * Oriented material only; use for 112 super-oriented material

Table I—EIA Recommendations on Core Numbering, Dimensions, Use and MIL-T-27A Cases for 4-Mil Oriented and Super-Oriented Materials

Core No	Nom Dimensions (inches) D	E	F	G	Use and Cases[a] Simple Type	Shell Type	Core Type
568	1/4	1/8	1/4	5/8	X		X
231*	3/8	3/16	1/4	5/8	X		X
549	1/2	3/16	1/4	5/8		X	AH
530	1/2	7/32	1/4	5/8	XAH		X
550	5/8	7/32	1/4	5/8		XAJ	AH
569	3/8	1/4	5/16	7/8	X		X
531	1/2	1/4	5/16	7/8	X		X
551	5/8	1/4	5/16	7/8	X	XEA	AJ
360	5/8	5/16	5/16	1	XEB		
552	3/4	9/32	5/16	1		X	XAJ
553	7/8	5/16	5/16	1		XFA	XEB
533	5/8	5/16	3/8	1 3/16	X		
554	7/8	5/16	3/8	1 3/16		XGB	XEB
361	3/4	3/8	3/8	1 3/16	X		
555	1 1/8	3/8	3/8	1 3/16		X	FB
254*	3/4	3/8	1/2	1 5/16	X		X
129*	7/8	7/16	1/2	1 5/16	X		X
556	1 1/8	3/8	1/2	1 5/16		X	FA
557	1 1/4	7/16	1/2	1 5/16		X	GB
372	7/8	7/16	5/8	1 9/16			XGA
223	1	1/2	1/2	1 1/2	X		
558	1 1/2	1/2	1/2	1 1/2		XJB	HB
369	1 1/8	7/16	11/16	1 3/4			XHA
224	1 1/8	9/16	9/16	1 11/16	X		
559	1 5/8	9/16	9/16	1 11/16		X	JB
370	1 1/8	1/2	3/4	1 15/16			XJB
18*	1 1/4	5/8	5/8	1 15/16	X		
560	1 7/8	5/8	5/8	1 15/16		X	KB
540	1 1/8	9/16	13/16	2 1/8			XJA
531	1 3/8	11/16	11/16	2 1/16	XJA		
561	2	11/16	11/16	2 1/16		X	KB
541	1 1/4	5/8	7/8	2 5/16			XKA
23*	1 1/2	3/4	3/4	2 5/16	XKA		
562	2 1/4	3/4	3/4	2 5/16		XNB	LB
29*	1 1/2	5/8	15/16	2 1/2			XKA
542	1 5/8	3/4	1	2 9/16			XLA
563	2 1/2	13/16	13/16	2 1/2		X	MB
543	1 3/4	13/16	1 1/8	2 7/8			XMA
564	2 1/2	15/16	15/16	2 11/16		X	NB
544	1 3/4	7/8	1 5/16	3 1/2			XNA
545	2	1	1 3/8	3 5/8			XOA
546	2 1/2	1	1 1/2	4			X
547	2 1/2	1 1/8	1 5/8	4 3/16			X

* Oriented material only in this number. Corresponding numbers for cores of same dimensions in super-oriented material are: 231—2, 254—147, 129—215, 18—213, 23—214, 29—61

(a) EIA recommended use shown by "x"; MIL-T-27A case designation shown in capital letters

Frequency Analyzer Uses

Useful from subaudio to r-f, this stable unit provides two reference signals, in a phase-shift network, to analyze periodic waves or random noise at the reference signal frequency

By **THOMAS B. FRYER,** Ames Research Center, Moffett Field, Calif.

THIS FLEXIBLE INSTRUMENT for frequency analysis allows a wide range of filter bandwidths with as narrow a bandwidth as desired. High order filters for a sharp cutoff are made practical. The unit is useful from subaudio frequencies to radio frequencies, the only limits being the frequency limits of the oscillator and multipliers.

A block diagram of the system is shown in Fig. 1. The unknown signal to be analyzed is multiplied independently by each of the two reference signals from the two-phase oscillator.

In addition to the d-c signals which result if the unknown contains a component of identical frequency to that of the reference oscillator, there will be present in the multiplier output, a component of twice reference frequency and also sum and difference frequencies caused by each of the other components of the unknown.

For frequencies in the unknown signal close to the reference frequency, difference frequency components will pulsate slowly from maximum to minimum. The low-pass filters following the multiplier pass only the d-c components and a narrow band of low frequencies corresponding to a narrow band of frequencies in the unknown signal.

The outputs of the two filters are then squared and summed to give an output proportional to the power spectral density. To obtain an output proportional to voltage rather than power, the square root may be taken before recording.

Oscillator

One way to obtain the two phases required is by the use of a standard oscillator and a phase-shift network. An integrator, for example, will give a 90-degree phase shift at all frequencies; however it would require amplitude regulation as the oscillator frequency is changed. Passive networks would, in general, require changing the component values to maintain 90-deg phase shift over a wide frequency range.

A circuit incorporating the phase-shift network directly in the oscillator seemed most desirable and was devised. The result is a circuit that has unique features, and could have other uses.

The oscillator circuit, Fig. 2, uses two 90-deg phase-shift networks and 180 deg of phase shift in the amplifier. A gain of approximately 0.98 in the cathode follower makes this circuit accurate over a 10 to 1 frequency range. Additional frequency coverage requires switching capacitors. A continuous-turn potentiometer was used with a clock motor to sweep the frequency. The frequency band was changed with each revolution of the potentiometer.

For frequencies above 20 to 100 cps, the oscillator circuit can be simplified by substituting transformers for the 180-deg phase-shift operational amplifiers.

The thermistor regulates amplitude with low distortion. It is important that the oscillator output

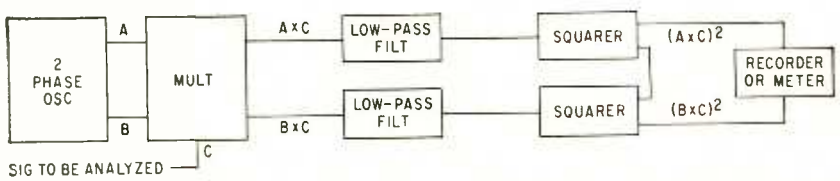


FIG. 1—Block diagram of frequency analyzer shows that the frequency to be analyzed, C, is multiplied independently by each of two reference signals, A and B

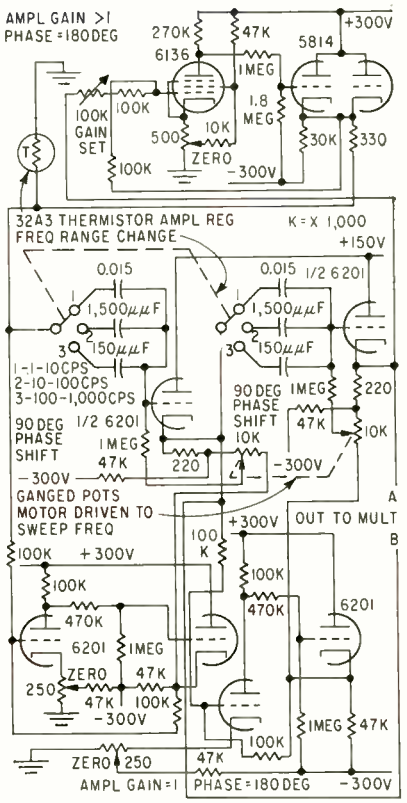


FIG. 2—Oscillator circuit incorporates two 90-deg phase-shift networks and 180 deg of phase-shift in the amplifier

Two Reference Signals

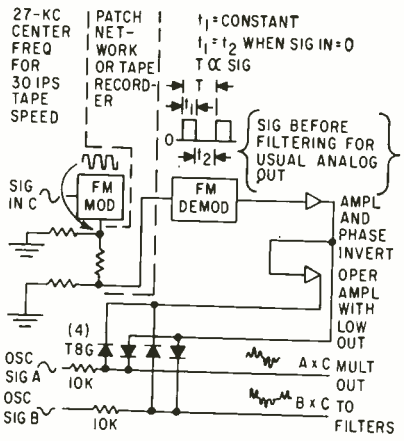


FIG. 3—Circuit for multiplier modification requires only two computer amplifiers and a few diodes

be a pure sine wave, since harmonics can introduce errors in analysis. The amplitude of the oscillator is stable to one percent over the entire frequency range. Frequency stability is about ±0.02 percent over short intervals with the stabilized operational amplifiers and regulated power supplies.

Multiplier

The spectrum analyzer was designed to study dynamic data recorded as frequency-modulated signals on magnetic tape. This method of handling data is in general use[1,2]. Because of the form of the data on the tape, a pulse-width, pulse-height analyzer was useful.

A pulse-width modulated signal of constant amplitude was available from the f-m demodulator provided with the tape system. Normally, this signal is filtered in the demodulator unit to obtain an analog output. By extracting this signal from the demodulator before filtering and amplitude modulating the signal, it is possible to make a good multiplier simply. The circuit required for this modification, Fig. 3, required only two computer amplifiers and a few diodes.

When the signal to be analyzed is available as a variable voltage, rather than a variable frequency, the f-m modulator and demodulator, normally available as a part of the tape recorder, can be connected through an attenuator. An extra set of diodes is required to obtain the second multiplier. Typical waveforms, shown in Fig. 3, indicate the circuit operation. The accuracy of the multiplier is usually about one percent.

The low-pass filter, Fig. 4, does not require large inductors. Circuit values result in a 1, 2 and 4-cps bandwidth in the analyzer[3]. The bandwidth is changed by scaling the R-C constant for a different frequency. An L-C filter will work well but it is difficult to obtain elements for cutoff frequencies below 10 cps. If a sharper cutoff is desired, a higher order filter can be used.

Squarer

The thermocouple in the squarer has a time constant of about one sec, so that the output is filtered as well as squared. The insulated outputs of the thermocouples are connected in series to provide the summing operation. Direct-current amplifiers prevent loading the filters and provide gain steps for different output sensitivities.

References

(1) S. Chang, On the Filter Problem of the Power Spectrum Analyzer, *Proc IRE*, p 1278, Aug., 1954.

(2) H. Press and Houbolt, Some Applications of General Harmonic Analysis to Gust Loads on Airplanes, *Jour. of the Inst. of Aero Sci.*, p 17, Jan., 1955.

(3) R. P. Sallen and E. L. Key, A Practical Method of Designing R-C Active Filters, *Trans. of the IRE on Circuit Theory*, CTZ, No. 1, p 74, Mar., 1955.

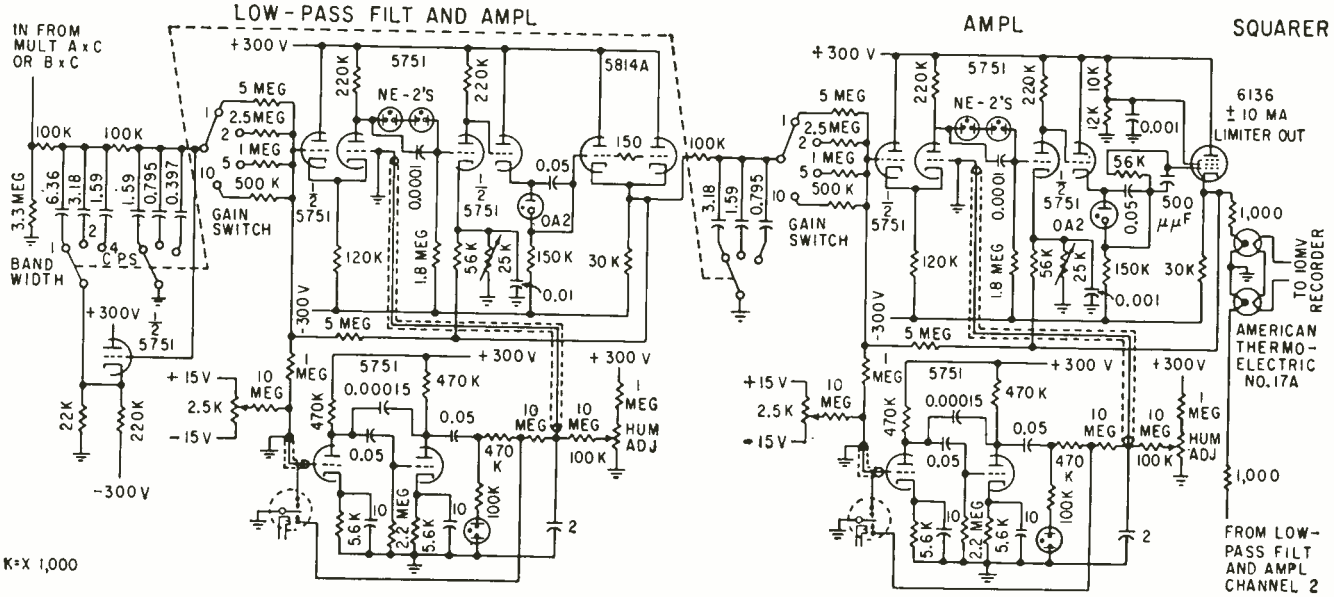


FIG. 4—Filter, amplifier and squaring circuits. Values are given for analyzer bandwidths of 1, 2 and 4 cps

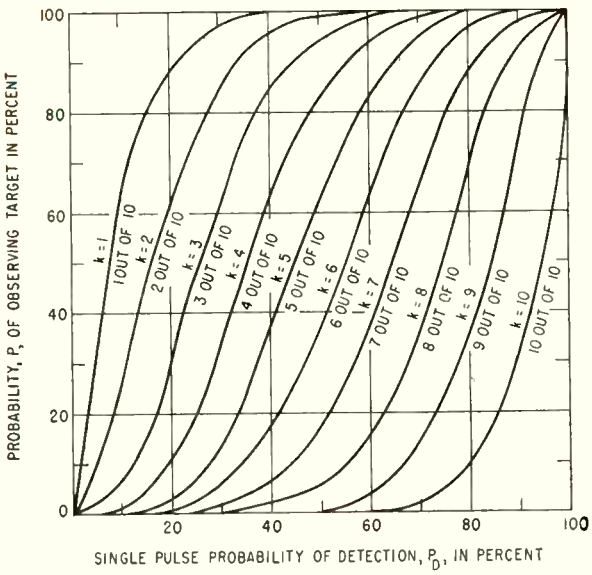


FIG. 1—Graph for finding the probability of observing a radar target if P_D and k are known

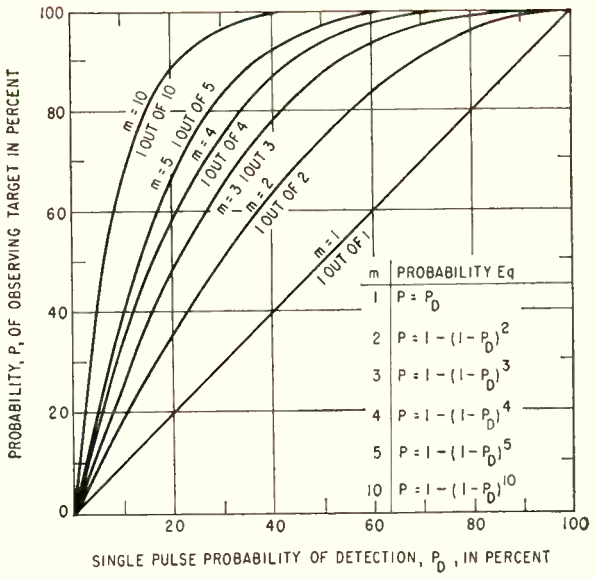


FIG. 2—Graph for finding the probability of observing a radar target when at least one out of m pulses must be detected

Radar Detection Data

Curves are given and radar design factors summarized for determining the probability of observing a radar target

By **MELVIN LERMAN,*** W. L. Maxson Corp., New York, N. Y.

SIX FACTORS in radar design affecting the probability of observing a radar target are: peak transmitter power output, repetition rate of pulses transmitted, pulse length, scanning rate, screen decay time, and antenna horizontal beam width.

Probability Curves

Figure 1 can be used with a great saving of labor and time to solve for the probability of observing a radar target if the single pulse probability of detection, P_D, of each individual radar pulse is known and the least number of radar returns that must be detected at each spot on the radar screen, k, is given. The graph is based on a radar set which puts out 10 pulses per beam width, a common value used in long-range search radar sets.

As an example let $P_D = 50$ percent and $k = 3$. A line drawn vertically from $P_D = 50$ on the horizontal axis intersects the $k = 3$ curve at a point equal to $P = 94.6$ percent on the vertical axis. Figure 1 can be used to solve for the necessary value of k to observe the radar target with a desired probability if P_D is known.

Figure 2 gives the probability of observing a radar target when at least one out of m pulses must be detected to observe the target. The graph also can be used to solve for the necessary value of m to observe the target with a desired probability if the probability of detection, P_D, is known.

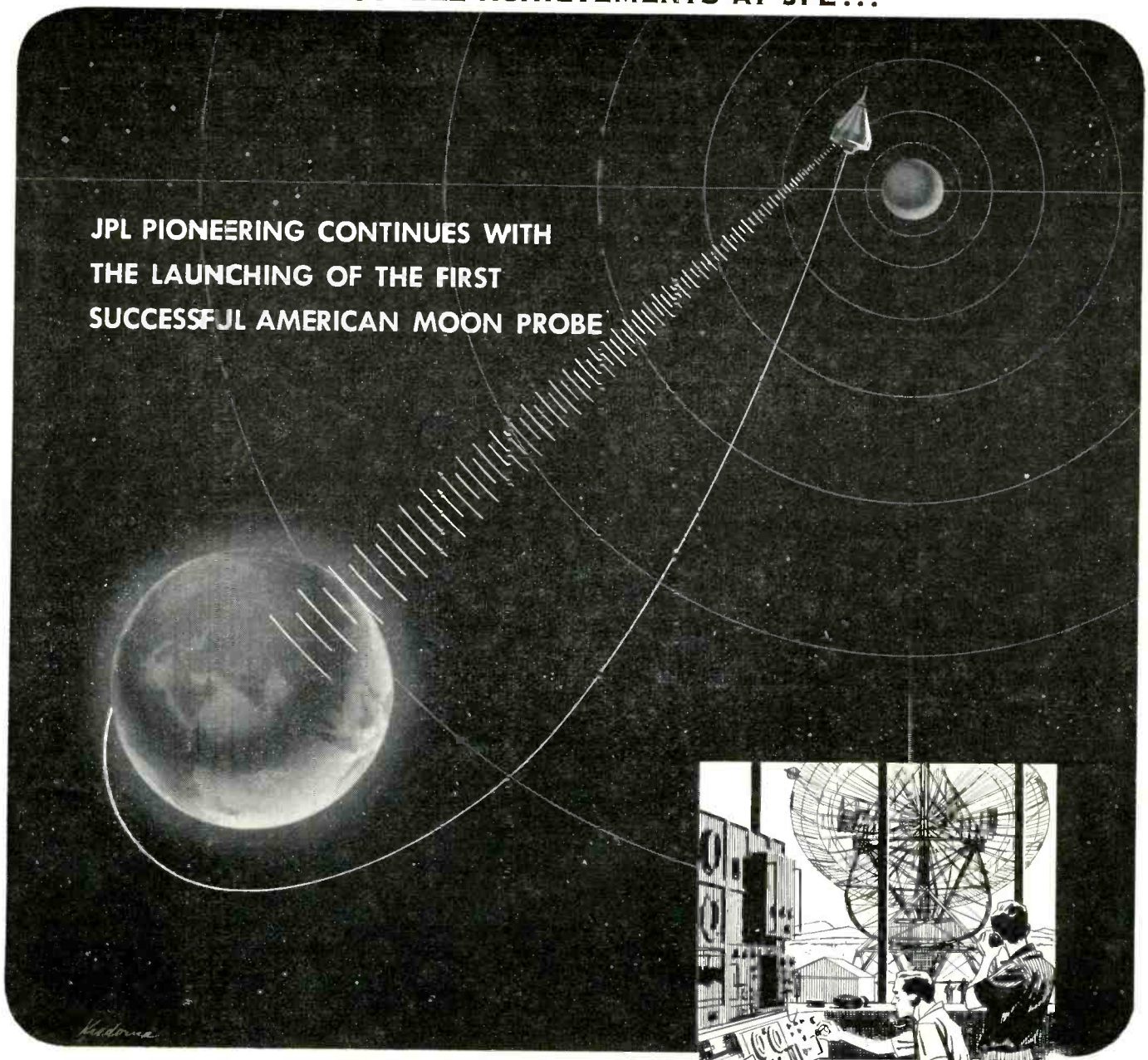
As an example, the single pulse probability of detection of each individual radar pulse, P_D, is 50 percent. Since there are two pulses per beam width, at least one radar return must be detected on a particular spot on the radar screen to be observed as a target ($k = 1$).

A line drawn vertically from $P_D = 50$ on the horizontal axis will intersect the $m = 2$ curve at a point equal to $P = 75$ percent on the vertical axis.

If the probability of detecting the radar beacon is not high enough or is higher than required, the factors that go into the radar design must be altered

* Now with American Bosch Arma Corp., Garden City, N. Y.

NOTABLE ACHIEVEMENTS AT JPL...



The JPL tracking station at Goldstone in the Mojave Desert in Californic

Early on March 3, 1959, Pioneer IV space probe was launched from Cape Canaveral, Florida to become America's first deep-space vehicle capable of escaping the earth's gravitational pull. On its way past the moon and out into orbit around the sun, this new man-made planet sent back valuable information on the radiations present in space. Several Free World tracking stations clearly received its transmitted signal and helped to establish its distance, velocity, and direction.

Under the sponsorship of the National Aeronautics and Space Administration, JPL designed and built not only the conical payload of Pioneer IV but also the three upper stages of the Juno II launching vehicle, containing new high-performance JPL solid propellant rockets.

Over a year ago the same JPL team, in cooperation with ABMA, gave America its first earth satellite, Explorer I, using a similarly reliable vehicle – the Jupiter C.

Now, more advanced space vehicle programs are under way at JPL — programs which include development of guidance and propulsion systems for accurate maneuvers many million miles from the earth.

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to either increase or decrease the single pulse probability of detection, or the number of pulses per beam width.

If the single pulse probability of detection versus signal-to-noise ratio data of a particular receiver is known, it is also possible to construct a family of useful curves for various values of k.

For example, Fig. 3 shows this family of curves for a radar set whose single pulse probability of detection data is the dotted line. The uses of this graph are numerous since, for any signal-to-noise ratio, the probability of observing a radar target on the particular radar set may be determined graphically.

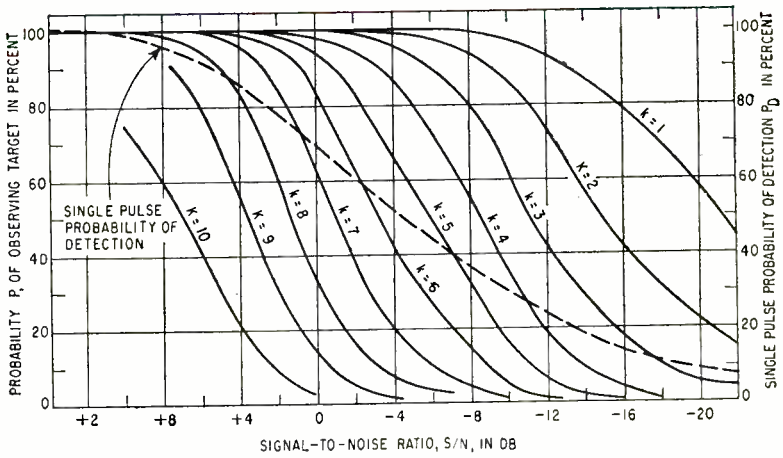

FIG. 3—Probability of observing target is plotted against signal-to-noise ratio when at least k out of 10 pulses must be detected

Factors in Radar Design

Peak transmitter power output is usually chosen from the basic radar range equation after determining the maximum range coverage

$$P_t = \frac{R_o^4\,(4\pi)^3\,(kTN)\left(\frac{1.2}{\tau}\right)}{G^2\,\tau^2\,\sigma}$$

where P_t = transmitter pulse peak power in watts; G = antenna power gain in beam maximum, assumed to be the same on transmit as on receive (if separate antennas are used to transmit and to receive, G is the geometric mean of their respective gains); R_o = free space range of radar in meters; k = Boltzmann's constant = 1.37×10^{-23} watt-sec per deg Kelvin per cycle; N = receiver noise figure; T = equivalent noise temperature seen by receiver input terminals, usually assumed to be 290 K; τ = pulse length in sec; λ = radar wavelength in meters and; σ = effective target area in square meters.

Repetition rate is chosen to give a sufficient number of pulses per beam width to insure a high probability of observing a radar target. The upper limit is determined by the average power capability of the radar transmitter, since the average power transmitted by the radar set is directly proportional to the repetition rate, radar pulse length and peak transmitter pulse output.

Pulse length is chosen to be as short as possible to obtain good range resolution and also keep the average power transmitted by the radar set low.

Scanning rate is chosen low enough to transmit a sufficient number of pulses per beam width and yet not so slow that the radar operator has trouble remembering the display from one scan to another.

Screen decay time is chosen so that the display takes several seconds to decay to allow for screen integration and yet completely erase the display element by element during each scan period. For example, in long range search radars employing a scan rate of 6 rpm—12 sec per scan—a screen decay time of 7 sec is commonly employed.

The azimuth resolution of a radar set is primarily dependent upon the antenna's horizontal beam width. The antenna beam width is inversely proportional to the size of the antenna and to the operating frequency used. To resolve individual targets it is desirable to make the antenna as large as possible and employ as high a frequency as is possible, thereby making the antenna beam width as narrow as possible.

The antenna horizontal beam width also affects the number of pulses that are transmitted to each spot on the radar screen. For example, if a radar set has a beam width of 1.2 deg, a scan rate of 6 rpm, and a pulse repetition rate of 300 pps, the number of times a target corresponding to each spot on the radar screen is hit with a radar pulse is 10 pulses per beam width as found from

$$n = \frac{pps \times bw}{rpm \times 6}$$

where n = pulses per beam width; pps = pulses per second transmitted; bw = antenna horizontal beam width in deg; rpm = rotation of antenna about azimuth axis in revolutions per minute.

To summarize, the probability that a radar target will be observed on a particular radar receiver depends on the number of pulses transmitted to the area represented by each individual spot on the radar screen; probability of each pulse being returned, defined as P_D; and the least number of radar returns that must be detected, k.

Sentry that spans a continent

The pre-eminence of Radio Engineering Laboratories, Inc., in specialized radio communications is again underscored by the selection of its equipment for the gigantic tropospheric scatter network being constructed by NATO.

This network, with more than a continental span, will stretch from Norway to Turkey. It is larger by far than any other tropo communications complex yet conceived. REL has designed and is constructing one hundred fifty-three transmitter modulators, one hundred nine 10-kilowatt amplifiers, and seventy-seven quadruple diversity receivers with combiners.

With millions of lives at stake, only supremely reliable equipment could be considered. REL, which has developed and manufactured more tropo scatter radio apparatus than all other companies combined, was awarded the contract after international competitive bidding in accordance with NATO infra-structure procedure.

The imagination and facilities which have won REL world leadership in military and civil tropo scatter can help solve *your* specialized radio problems.

REL

Radio Engineering Laboratories·Inc

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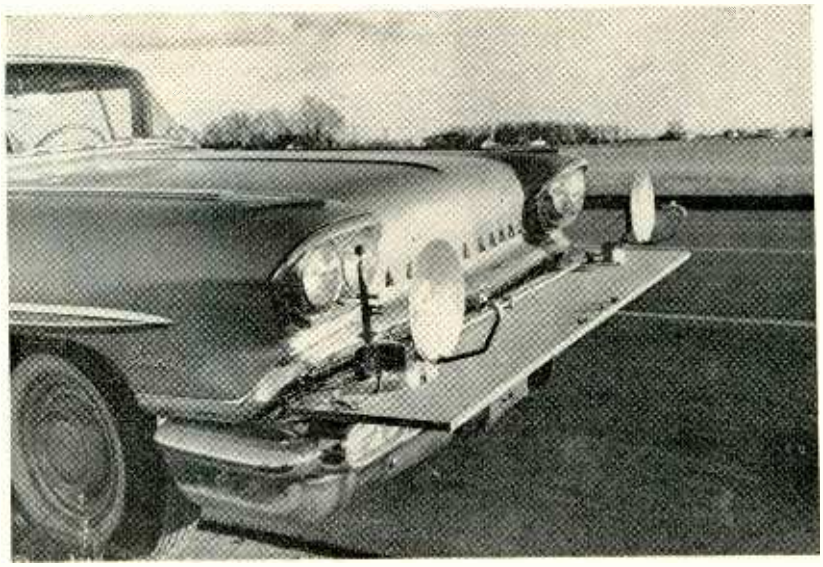
Proximity Radar Warns Drivers

DETAILS of another experimental proximity warning radar for automobiles were given Electronics by M. Caserio, general manager of Delco Radio division of General Motors, and J. H. Guyton, chief radio engineer. (See ELECTRONICS, Nov. 21, 1958.)

The unit transmits a narrow unswept c-w beam in front of the car. The beam is reflected by any solid object in the car's path. The warning signals can be conveyed to the driver either aurally or by indicator lights—green for clear, flashing red for danger.

The radar is being used on a new Cadillac experimental car. Caserio believes the system will be valuable in preventing accidents on turnpikes, super highways and expressways, where it would warn a driver when he is approaching a car or object too closely or too rapidly.



Breadboard of Doppler radar developed by Delco Radio warns drivers when they are approaching objects too closely or too rapidly

The Doppler radar is sensitive to objects up to 1,000 ft ahead of the car, and it has been designed to increase frequency of the warning tone with increasing rate of approach and to increase volume with proximity. For example, if a car traveling 55 mph were approaching one ahead going 50 mph (5-mph rate of closure), the warning would be low in pitch. However, if the same car were approaching a stalled car (55-mph rate of closure), the warning would have higher pitch. Similarly, volume would be greater if the object were 200 ft ahead than if it were 800 ft ahead.

The radar has two 10-in. aluminum reflectors mounted behind 10-in. long nose cones about 4 ft apart on the front of the car. Transmitter and receiver are concealed in the front fenders.

A reflex klystron is used to generate power at 16,140 mc, which is piped through wave guides to the feed horn of the transmitting antenna. The reflected energy is collected by the other reflector and its frequency is compared to that of the transmitter. The difference frequency, detected by a crystal detector, is amplified by a transistor amplifier.

Another transistor circuit uses amplitude and frequency data to switch a green light off and a red light on for dangerous conditions.

A total of five transistors are used in the combination amplifier-computer. Two other transistors are used in a d-c to d-c converter to provide power for the klystron.

Circuit Provides Dual Relay

By **H. P. BROCKMAN** Westinghouse Electric Corp. Baltimore, Md.

TWO-TRANSISTOR circuit produces pulses of finite width starting a finite time after a reference pulse.

Initial delay of the output pulse is determined by the time constant involving R_1, R_2 and C_1 in Fig. 1. Width of the output pulse is determined by the time constant C_2-R_4.

Key waveforms are shown in Fig. 2. Initially, Q_2 is saturated because of base current supplied through R_4 and CR_2, and Q_1 is cut off. Point B is at a bias level of about −10 v established by voltage divider R_1-R_2.

Reference Pulse

Upon application of the reference pulse at point A, voltage at point B rises exponentially toward a positive potential determined by the amplitude of the pulse at A and the bias network R_1-R_2. The effective R-C time constant of the circuit is equal to the parallel combination R_1 and R_2 times C_1. As the potential at point B rises to about plus one v, diode CR_1 conducts, providing base current to Q_1. At this point, regeneration occurs causing Q_1 to saturate and Q_2 to be cut off.

The second R-C time constant, R_4-C_2, determines duration of the output pulse at point D as in a conventional multivibrator. Although the input pulse at point A used in this illustration extends beyond the output pulse, this is not essential. It is only necessary that the input pulse extend beyond the start of the

output pulse for proper operation.

The circuit illustrated was designed to operate over a temperature range of −55 to 85 C with minimum drift in time delay and pulse width. Therefore silicon transistors and diodes were used.

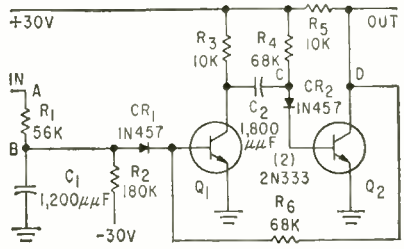


FIG. 1—Time constants of R_1, R_2 and C_1 and of R_1 and C_2 provide two delays of two-transistor circuit

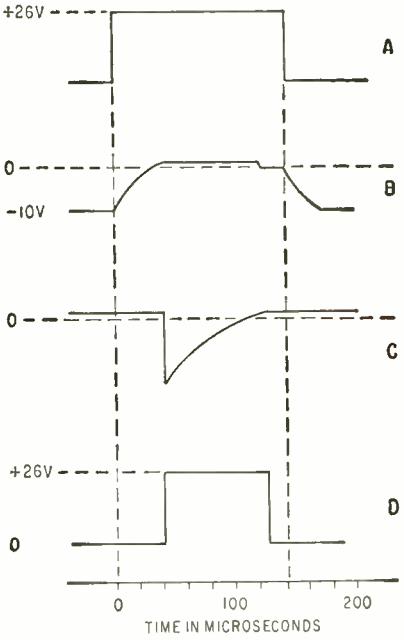


FIG. 2—Waveforms are taken at points A, B, C and D in Fig. 1

Care was also exercised in selecting low temperature drift resistors and capacitors in the timing circuits.

To ensure positive triggering at low temperatures, where Beta of the transistors falls off appreciably, care must be used in selecting R_1 and R_2 to get adequate base current in Q_1, thereby ensuring regeneration. In addition, base resistors R_4 and R_6 should be small enough to ensure saturation of Q_1 and Q_2 at the lowest Beta expected at low temperatures.

Since the base to emitter Zener characteristic of the growth junction transistors used in this cir-

cuit is about −1 v, diode CR_2 is required to disconnect the timing circuit, C_2-R_4, from the transistor base. If alloy junction transistors are used, the base-to-emitter Zener characteristic is higher, usually about the same as the base-to-collector breakdown voltage, so a disconnect diode is not required in the base circuit.

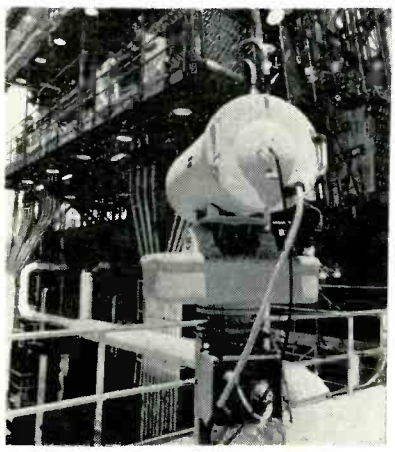
200-Kw Amplifier Tests Missile Parts

AMPLIFIER for testing Polaris missile parts provides 200-kw output. It was built by Westinghouse industrial electronics department, Baltimore, Md.

The amplifier will be used by Lockheed for testing components and subassemblies of the missile by vibrating a platform three feet in diameter. The missiles parts are attached to the platform.

It will be possible to test missile components to destruction to establish how much vibration the parts can withstand. It would also be possible to play back tape recordings of vibration from a recovered missile through the amplifier to test components on the ground under conditions that duplicate those in flight.

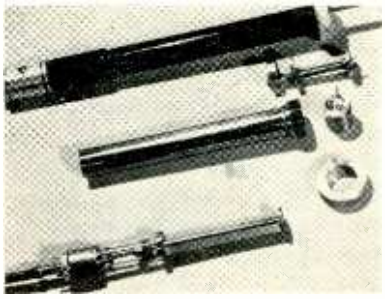
Atlas Engines Watched by Closed-Circuit Tv



Ruggedized closed-circuit tv camera made by Kin Tel division of Cohu Electronics is mounted on rocket-engine test stand at Sycamore Canyon, Calif. Remotely controlled from blockhouse, cameras let engineers monitor static firing of Atlas engines

Components of r-f circuit include ridge block, wound ladder frame, bottom plate and front end plate

Ceramic window is brazed into a partition which, in turn, is brazed into tube envelope. Pin is locating device



Final subassembly stages and the finished oscillator. Header mount assembly (bottom) prior to insertion in envelope

BWO Uses Ridge-Loaded-Ladder Circuit

By J. A. NOLAND and L. D. COHEN,
Microwave Tube Section, Physical Electronics Laboratory, Sylvania Research Laboratories, Bayside, N. Y.

MOST CONVENTIONAL backward-wave oscillators operating at frequencies below 40 kmc use either a helix or an interdigital line as the slow-wave r-f structure. Both of these circuits have broad tuning-range characteristics and are well suited to bwo applications. But the tube to be described was developed* for the frequency range of 60 to 75 kmc and these conventional structures were dimensionally impractical. As a result, the ridge-loaded-ladder type of r-f circuit was used as the slow-wave structure.

The ridge loaded ladder was first used in a bwo by Karp[1, 2] and tubes constructed similarly to the ones described here were developed by Hempstead and Yocom.[3] In development of the 60 to 75 kmc bwo, a series of six experimental tube designs were constructed to evaluate experimentally the effects of minor variations of circuit parameters. The slotted wall was formed by winding wire tape over a slotted ladder frame.

Electron-Gun Design

Backward wave interaction occurs between a wave on the circuit and an electron beam travelling in approximate synchronism with it. This beam must be directed down the length of the ladder structure and must be maintained in close proximity to the wires since the r-f fields die out rapidly with distance from the wires.

* U. S. Army Signal Laboratories Contract No. DA-36-039-sc-70178

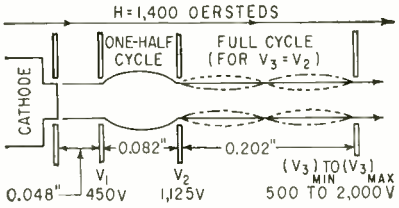
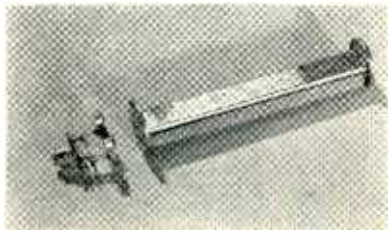


FIG. 1—Immersed flow, variable-voltage electron gun



R-f structure after assembly and a completed electron gun

In theory, two parallel strip beams having a width equal to that of the ridge width and a thickness of about 10 mils, directed down each side of the ladder wires, would be ideal. In practice, a solid parallel beam circular in cross-section is focused parallel to the plane of the wires and positioned so that the beam is centered on the ladder wires directly over the ridge. This technique is used to avoid problems of forming and accurately aligning parallel strip beams. In the circular beam technique, ladder tapes slice the electron beam in half.

A constant-current, variable-voltage, immersed-flow gun was designed according to principles set forth by King.[4] The gun contains two beam-forming electrodes operating at fixed potentials as shown in Fig. 1. Electrons leaving the cathode are confined by the magnetic field against the effects of thermal velocities and space charge. However, a radial velocity component is imparted to the electrons as they travel through the electrostatic lens created at the first anode aperture. In the presence of the magnetic focusing field, these electrons spiral and the second anode is placed at the point where the electrons return to their original radial position after one-half cycle.

When $V_2 = V_3$, the lens effect of the second aperture is such that the new radial component imparted at the second lens just cancels out the effects of the first lens. When V_3 is varied, this condition is not satisfied. But for a spacing between apertures equal to a full cycle, changes in the focusing powers of the two lenses are somewhat compensating. Therefore, spacing between V_2 and V_3 is selected to correspond to one full cycle of the electron spiral when $V_2 = V_3$. Since transit time between these apertures is proportional to $(\sqrt{V_2} + \sqrt{V_3})$, this spacing is nearly equal to that for a full cycle over the entire voltage range of V_3 if V_2 is selected according to the equation $\sqrt{V_2} = \frac{1}{2}(\sqrt{V_{3\,max}} + \sqrt{V_{3\,min}})$.

Operation of the gun has proved satisfactory. Current density of the beam may be varied from the design

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value by varying V_1. Tube performance can then be optimized by adjustment of V_2 and the magnetic field strength.

Tube Construction

Four individual components make up the r-f circuit assembly complete with its output transducer. These components are the ridge block, the wound ladder frame, the bottom plate and the front end plate. The rear end plate and the front end plate provide for alignment of the r-f assembly in the tube envelope. The slotted wall above the ridged waveguide is accomplished by winding a wire tape at the desired pitch around a grooved ladder frame. This wire is then gold-brazed to the frame to assure good electrical and thermal contact.

The electron-gun electrodes are constructed of circular apertured disks. An impregnated-type cathode pellet is employed as the emitter.

Test Results

Insertion-loss measurements were made on several of the ceramic windows after they were braced into the tube envelopes. Before metallizing, typical insertion loss is about 1.0 db. After the metallizing band is put on the window to permit brazing to the partition, insertion loss ranged from 1.5 to 4.5 db for a group of 11 windows tested.

Insertion-loss and vswr measurements were made on the r-f circuit structures prior to final tube assembly. These measurements were used in establishing an optimum r-f circuit design. In the final design, the vswr over the band was less than 2 to 1 and attenuation of the structure ranged from 4 db at the low end to 16 db at the high end of the band. Attenuation of the r-f structure used in the final design was the lowest of all structures investigated.

Tube Performance

Three factors that critically affect the tuning characteristic of the tube are ladder span, pitch and ridge-to-ladder spacing. But the actual voltage tuning characteristics of the experimental tubes are in close agreement with theoretical curves.

The effect of ridge-to-ladder spacing on the tuning characteristic should be emphasized. This dimension is small (ten mils and seven

mils were actual values used on experimental tubes). A slight variation can result in a measurable change in the tuning characteristic. For example, with some tubes there was an exhibited sensitivity of about 400 mc for each mil variation in ridge-to-ladder spacing.

In testing power output, it was found that some tubes could be tuned over a range of about 16 kmc with an average output power of several mw.

Conclusions

The Karp circuit has been shown to be a reliable circuit for use in a bwo for the 60 to 75 kmc band. The all metal-and-ceramic tube construction is well suited to this application. Further work on the ceramic wedge-type window might prove fruitful in reducing insertion loss by 1 to 2 db to increase output power. Satisfactory tube performance at a magnetic focusing field strength of 1,200 gausses indicated the feasibility of permanent magnet focusing of the tube without further tube development.

REFERENCES

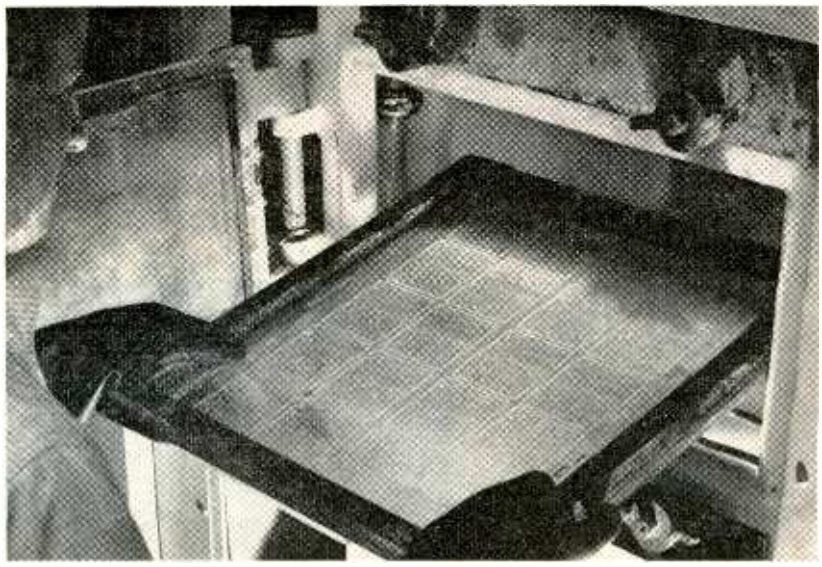
(1) A. Karp, "Traveling-Wave Tube Experiments at Millimeter Wavelengths", *Proc. IRE*, 43, p 41, Jan. 1955.
(2) A. Karp, "Backward Wave Oscillator Experiments at 100 to 200 Kilomegacycles", *Proc. IRE*, 45, p 496, Apr. 1957.
(3) C. F. Hempstead and W. H. Yocom, "A Backward Wave Oscillator for the Millimeter Range", Millimeter Wave Research, Final Report, Contract NONR-687(00), p 143, Oct. 1955.
(4) P. G. R. King, "Electron Guns for Traveling-Wave Tubes", *S.E.R.L. Journal*, p 9, Feb. 1954.

IR Detector Covers 8 to 14 Micron Range

FULL RANGE of the ZIP infrared detector developed at Naval Research Laboratories is from 2 to 40 microns with peak sensitivity at about 37 microns. Commercially available from Perkin-Elmer Corp., Norwalk, Conn., the new detector is said to be the first such device offering full coverage 8 to 14 microns.

Speed of response of the detector is less than 0.01 microsec. It has a D factor (square root of the detector's sensitive area in sq cm divided by the noise equivalent power in watts) of 4 x 10^{9} cm/watt.

A zinc-doped germanium photoconductor is the basic portion of the model 536-1 detector. High efficiency of the unit is achieved by cooling it to the temperature of liquid helium.



Glass is exposed, through negatives, to ultraviolet light

Sheet of 20 glass printed circuit boards after heat treatment. White lines and dots are board outlines and terminal holes which will be etched

Chemicals Form Printed Circuit Boards

CHEMICALLY MACHINED, high temperature printed circuit boards are being made on a production basis for military applications at Corning Glass Works' new electronic components plant in Bradford, Pa.

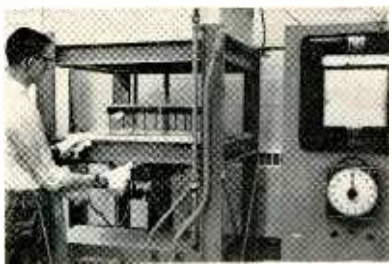
The boards are made of Fotoceram, the crystalline variety of Fotoform glass also used as film potentiometer substrates, attenuator plates, and other components. It is a modified lithium silicate made photosensitive by traces of silver and cerium compounds.

Board pattern negatives are prepared by conventional methods. However, the negatives used to expose the glass locate board holes and outlines rather than the wiring pattern. Wiring is added after boards are processed.

Multiple negatives and glass plates are placed on a translatory motion table. The glass is exposed to collimated ultraviolet light for as long as several minutes, depending on thickness of the glass. Saturation exposure results in an opalescent pattern clear through the glass after development.

Plates are etched in contral etching machine. Operator is loading a plate

Group of etched-apart parts are given final heat treatment



Heat treatment in platform furnace causes nucleation of pattern

Heat treatment develops the glass. After about 4 minutes at 500 C silver crystals form and cause nucleation of lithium metasilicate crystals in the exposed pattern. The temperature is then raised to about 600 C for about an hour to complete the crystal growth. Heat treating must be carefully controlled to avoid spreading the crystalline region, degrading tolerances. Raising the temperature speeds the processes and vice-versa. The glass will soften at about 625 C.

Dilute hydrofluoric acid is used to etch the pattern and separate the glass plate into individual boards. A 5 percent acid solution etches the pattern 40 to 45 mils an hour and the glass 2 to 3 mils an hour. Raising the acid concentration spreads the etching rates further apart. A 5 percent solution is the most efficient for production and gives a minimum pattern to base glass etching ratio of 15-1. The difference in the etching rates is caused by the greater surface area of the crystals.

Combinations of blind holes and through holes are produced by masking the blind holes on both sides with wax. Time in the etching bath to removal of the masking from one side determines the depth of the holes. Holes with a slightly conical shape can be produced by

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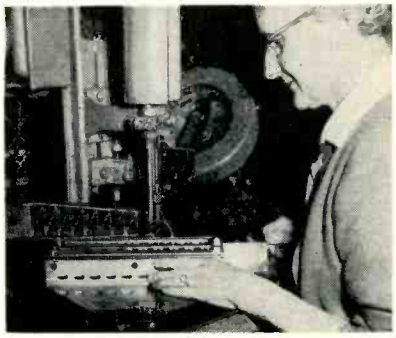
masking on one side only. Curved contours can be produced by shading the negative before exposure.

Fotoceram is formed when the etched board is totally or selectively exposed to ultraviolet light and reheated. Interlocking crystals form throughout the board. The ceramic-like board has a continuous operating temperature of 500 C and is about 3 times as strong as glass.

Plating the wiring pattern on the board completes the process. An electroless nickel base provides a mechanical bond of high adhesion. Conventional metal etching and plating processes are used to remove the nickel from nonconducting areas and to build up the wiring pattern. All holes are through plated. Center to center tolerance on the holes is about 0.003 inch per inch, on dimensions under one inch.

Holes and Stud Align Parts for Screwdriver

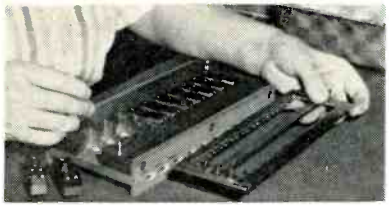


Operator slips stud in and out of holes to line up single terminal holes

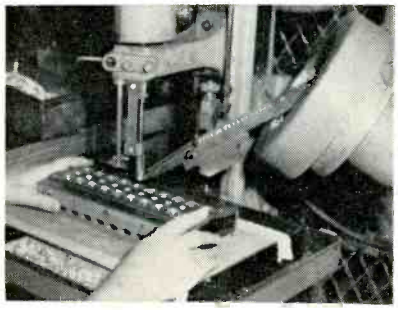
SCREW LOCATING fixtures enable screw terminals to be driven in 3 locations without resetting the power screwdriver's guide bar or judging location by eye, at Unimax Switch Division, W. L. Maxson Corp., Wallingford, Conn.

Fixtures shown in the first 2 photos are used to place 2 terminals in one end of a switch and 1 terminal in the other end. Other fixtures built along the same lines are used for other switch types.

The fixture base is a U-shaped assembly of heavy aluminum plates. The bottom plate is machined to accept the tops of the switches. The sides are the height of the switches. Phenolic slabs, machined to hold 10 switches in slots, are fastened to the aluminum sides.



Fixture cover also holds down small parts



Screws projecting from side of fixture permit change in terminal position

After the fixture is loaded, a top cover is snugged down over the switches. The cover is cut out to expose terminal areas. The covers may have various arrangements of cutouts or countersunk holes for locating or keeping lock washers and small parts held down by the terminals.

On the single terminal side of the fixture, holes are drilled with their centers bisecting the center line of the tapped terminal hole. The holes in the fixture's side mate with a stud in the power screwdriver's guide bar. The stud's center bisects the center line of the screwdriver.

The operator slips the stud into the first hole in the fixture side, drives in a terminal, slips the fixture off the stud, places the stud in the second hole and so on.

On the side with 2 terminals in each switch, slots are cut in the fixture side. The center of the radius at each end of a slot bisects the center line of the terminal hole. The slots mate with the guide stud.

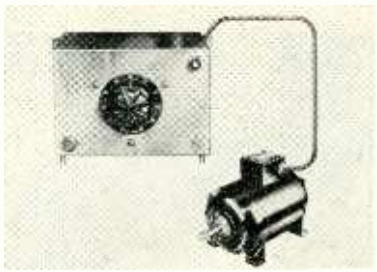
The operator pushes one end of a slot against the stud and inserts a terminal. The other end of the slot is pushed against the stud to locate the screwdriver over the second terminal. The operation is repeated for each switch.

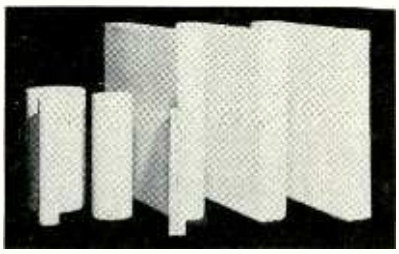
Position of the terminals can be varied by changing dimensions of the phenolic or by putting screws in the sides of the fixture. The projecting screws move the fixture out from the screwdriver guide bar.

ON THE MARKET

Fractional H-P Drive adjustable-speed

SERVO-TEK PRODUCTS Co., 1086 Goffle Road, Hawthorne, N. J. A new series of adjustable-speed drives is available in 17 different models ranging from 1/20 to ¾ horsepower. All models feature exceptionally smooth control from zero to maximum rated speed. Conservative rating of rectifiers and motors assures continuous operation at any speed. The entire controlled rectifier is contained in a compact enclosure that is designed for either bench use or wall mounting. **Circle 200 on Reader Service Card.**



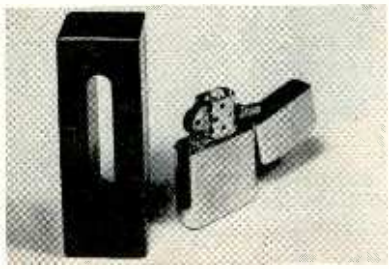


Ceramic Foam for electronic use

EMERSON & CUMING, INC., 869 Washington St., Canton, Mass., has introduced two series of ceramic foams designated Eccofoam LM-43A and Eccofoam WC-8. Both materials are light in weight and capable of use in excess of 1,000 F. The LM-43A is supplied at dielectric constants 1.3, 1.4, 1.5 and 1.6. Dissipation factor is below 0.001. The WC-8 is supplied at dielectric constants 1.7, 1.8, 1.9, 2.0, 2.5, 3.0, 4.0 and 5.0. Dissipation factor is well below 0.003. **Circle 201 on Reader Service Card.**

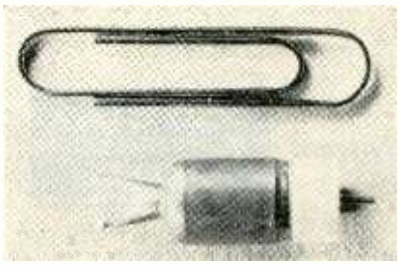
Magnetic Ceramic activating element

FERROXCUBE CORP. OF AMERICA, Saugerties, N. Y., announces a new magnetostrictive ferrite which is reportedly superior to nickel and all piezoelectric materials used previously to activate transducers performing in liquids. The 7A material features higher electroacoustic efficiency, has the ability to generate useful cavitation over long periods with a minimum of self-cavitation and maintain high piezomagnetic activity in ambient temperatures as high as 400 C. **Circle 202 on Reader Service Card.**



Servo Amplifier transistorized

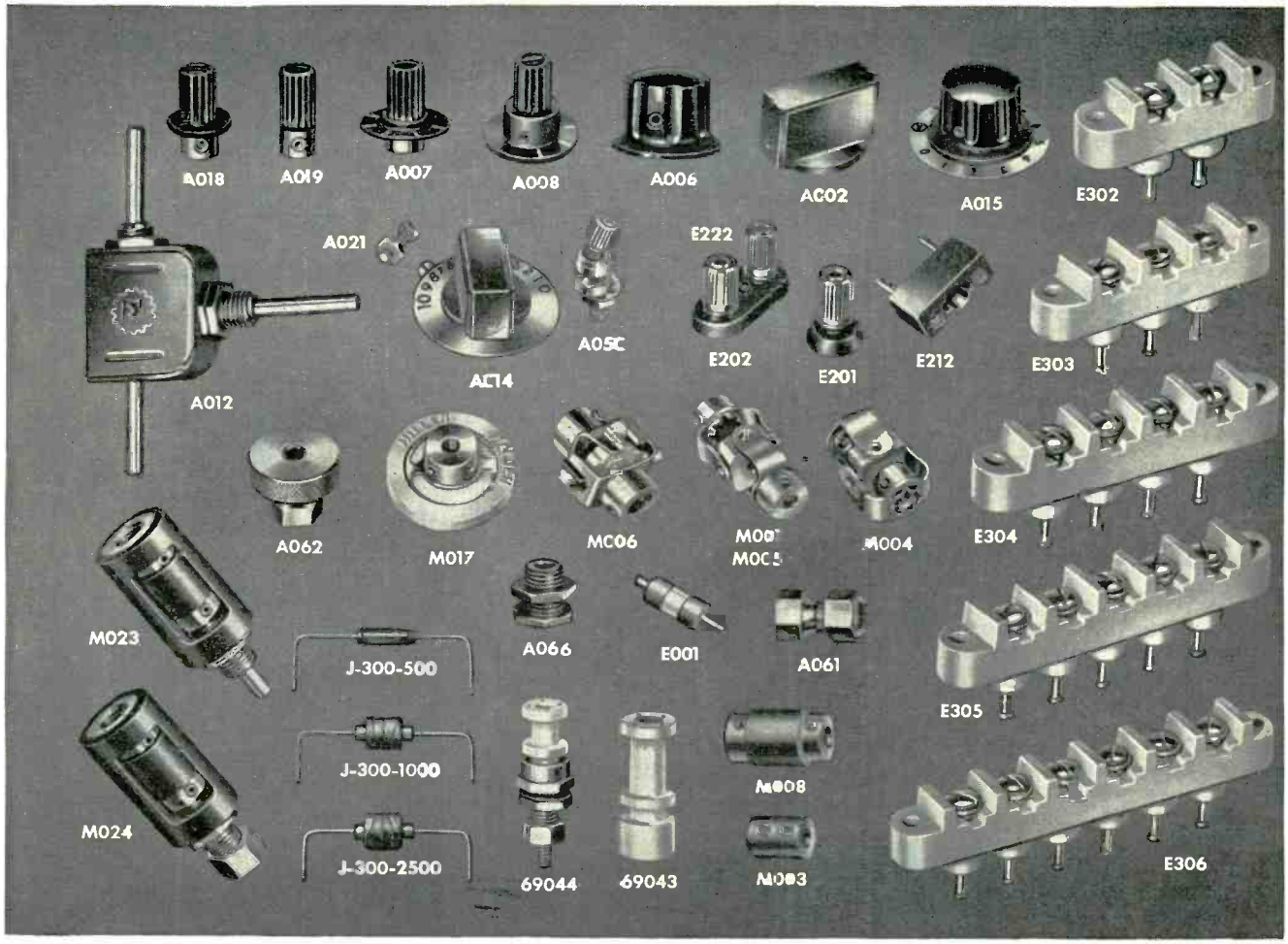
KEARFOTT CO., INC., 1500 Main Ave., Clifton, N. J., announces a versatile and reliable completely transistorized servo amplifier which is designed primarily for commercial and industrial operation from a 115 v, 60 cycle power supply. Equipped with an internal d-c power supply, this amplifier exhibits low transistor dissipation, does not require a load tuning capacitor, provides 90 deg phase shift, is rugged, long-lived, and features maximum ease of gain adjustment. **Circle 203 on Reader Service Card.**



Regulator Tube 400–4,000 v

RADIATION RESEARCH CORP., 1114 First Ave., New York 21, N. Y., announces a line of ruggedized subminiature metal-ceramic corona discharge voltage regulator tubes. Regulation of better than 1 percent is obtained over a current range of 10^{-11} to 10^{-7} amperes. The prebreakdown current is less than 10^{-12} amperes at room temperature. Tubes operate over a temperature range of −55 C to 200 C. **Circle 204 on Reader Service Card.**

(Continued on p 76)

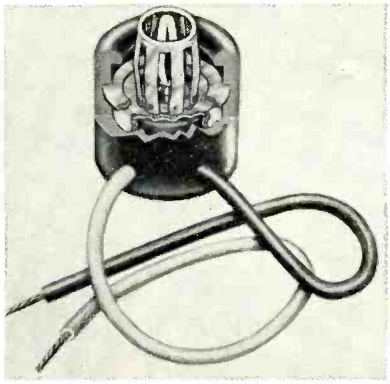


MINIATURIZED COMPONENTS

DESIGNED for APPLICATION miniaturized components developed for use in our own equipment such as the 90901 Oscilloscope, are now available for separate sale. Many of these parts are similar, in most details except size, to their equivalents in our standard component parts group. In certain devices where complete miniaturization is not paramount, a combination of standard and miniature components may possibly be used to advantage. For convenience, we have also listed on this page the extremely small sized coil forms from our standard catalog.

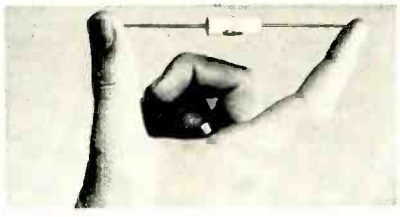
CODE	DESCRIPTION
A002	Bar knob for ⅛'' shaft. ½'' high by ¾'' long.
A006	Fluted black plastic knob with brass insert for ⅛'' shaft. ½'' high by ¾'' diameter.
A007	¼'' black plastic dial knob with brass insert for ⅛'' shaft. ⅝'' diameter dial. 9/16'' high.
A008	¼'' black plastic knob. Same as no. A007 except for style.
A012	Right angle drive for ⅛'' shafts. Single hole mounting.
A014	1'' bar dial for ⅛'' shaft. ½'' high. 180° or 280° dials for clockwise or counter-clockwise rotation.
A015	1'' fluted knob dial for ⅛'' shaft. ½'' high. Same dial plates as no. A014.
A017	1⅛'' diameter fluted black plastic knob for ¼'' shaft.
A018	Knob, same as no. A007 except with ⅜'' diameter skirt.
A019	Knob, same as no. A007, but without dial.
A021	Miniature metal index for miniature dials.
A050	Miniature dial lock.
A061	Shaft lock for ⅛'' diameter shaft. ¼''-32 bushing. Nickel plated brass.
A062	Shaft lock with knurled locking nut.
A066	Shaft bearing for ⅛'' diameter shafts. Nickel plated brass. Fits 17/64'' diameter hole.

CODE	DESCRIPTION
E001	Steatite ceramic standoff or tie-point. Integral mounting eyelet. 0.205'' overall diameter.
E201	Black or red plastic binding post plates for No. E222.
E202	Black or red plastic plates for two binding posts spaced ½''.
E212	Black or red plastic plug for two binding posts spaced ½''.
E222	Metal binding post with jack top.
E302A	to E306A Steatite ceramic terminal strips. 5/16'' wide. Terminals spaced ⅜'' on centers. Screw type or solder type thru-terminals.
J300-350	to J300-2500 Complete line of miniature inductances 3.3 to 2500 microhenries. ⅜'' long. Diameter 0.115'' to 0.297''.
M001	Insulated universal joint style flexible coupling for ⅛'' dia. shafts.
M003	Solid coupling for ⅛'' dia. shafts. Nickel plated brass.
M004	Universal joint style flexible coupling for ⅛'' diameter shafts. Inverted hubs for short length. Not insulated.
M005	Universal joint style flexible coupling for ⅛'' diameter shafts. External hub for maximum flexibility. Not insulated.
M006	Universal joint style flexible coupling for ⅛'' diameter shafts. Spring finger. Steatite ceramic insulation.
M008	Plastic insulated coupling with nickel plated brass inserts for ⅛'' diameter shafts.
M017	Plastic insulated flexible coupling for ⅛'' diameter shafts. 17/32'' long by 15/16'' diameter. Bronze yoke.
M023	Insulated shaft extension for ¼''-32 bushing and ⅛'' shaft. For mounting sub-miniature potentiometer.
M024	Locking insulated shaft extension similar to no. M023.
69043	Steatite ceramic coil form. Adjustable core. Winding space ¼'' diameter by 13/32'' long. Mounting 4-40 hole.
69044	Steatite ceramic coil form. Adjustable core. Winding space 0.187'' diameter by 3/16'' long. No. 10-32 mounting.



Input Connector for magnetrons

JETTRON PRODUCTS, 56 Route 10, Hanover, N. J. An improved magnetron input connector, model 9030, has the normally exposed metal parts encased in silicone to permit space saving in the power supply design. The connector extends only ⅛ in. beyond the input end of the magnetron and will fit the 4J50, 4J52A, 6551, and many other magnetrons having similar inputs. The heater-cathode contact is made of heat treated beryllium copper, heavily silver plated, and has eight springs making contact with tube. Heater contact is "floating" in a silicone rubber insulator which prevents strain on the tube input end. All internal connections are made with a high temperature alloy solder and friction contacts have been eliminated. **Circle 205 on Reader Service Card.**



Wire-Wound Resistor hermetically sealed

DALE PRODUCTS, INC., Columbus, Neb. The RSH-2B wire wound precision resistor is hermetically sealed in a non-hygroscopic ceramic envelope. Power rating range is from 0.75 w to 1.5 w, depending on stability level required. Four such levels are available: 1, 0.5, 0.25 and 0.1 percent respectively. Resistance

range is from 1 ohm to 4,200 ohms. Temperature coefficient is 0.00002/deg C. **Circle 206 on Reader Service Card.**

P-C Trimming Pot
high temperature

DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif. Series 318 printed circuit Squaretrim subminiature trimming pot is rated for operation up to 200 C. It mounts base-down to printed circuit board for secure mounting that withstands high vibration and shock loads. Aluminum case for fast heat dissipation permits 1.5 w power rating with low temperature rise. **Circle 207 on Reader Service Card.**

Tiny Storage Cell
rechargeable

YARDNEY ELECTRIC CORP., 40 Leonard St., New York, N. Y. The seventh-of-an-ounce HR01 Silvercel is claimed to be the world's smallest rechargeable cell. Unit is capable of a 3-ampere peak pulse discharge. It is widely used in power packs for missile instrumentation and telemetering. **Circle 208 on Reader Service Card.**

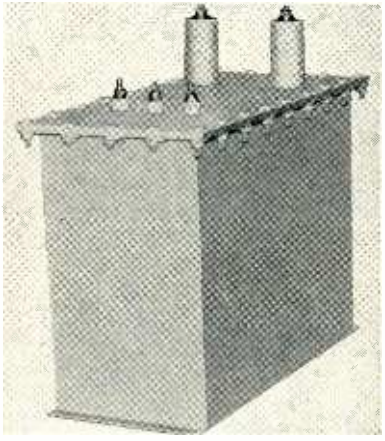
Servo Motors
sizes 10 and 11

WESTERN GEAR CORP., 132 W. Colorado St., Pasadena, Calif. New size 10 and 11 servo motors are available for 26, 55 or 115 v a-c 400 cycle operation. These are 6 pole units having a stall torque of 0.6 oz in. minimum and a no load speed of 6,500 rpm with rotor inertia Igm cm². The acceleration at stall is 42,000 radians/sec². They are designed to operate in ambient temperatures from −65 C to +125 C. They measure 1½ in. long. **Circle 209 on Reader Service Card.**

LVDT's
high output

SCHAEVITZ ENGINEERING, Pennsauken, N. J. A new series of linear variable differential transformers can be excited at 115 v 60 cps, eliminating the need for a signal generator in many applications. Full displacement output of 45 mw into a matched load can be delivered at 60 cps, with greater power output at higher frequencies. Model 200XS-H series features low "zero-phase" frequency. This is the frequency at which the phase angle between primary and secondary voltage is zero. When excited at

this frequency an lvdt has minimum change in sensitivity as a result of temperature and frequency variation. **Circle 210 on Reader Service Card.**



H-V Power Supply
oil-filled

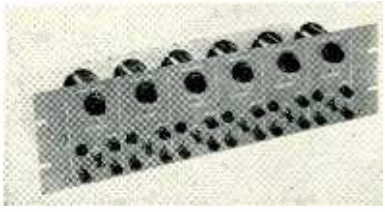
FILM CAPACITORS, INC., 3400 Park Ave., New York 56, N. Y., has added a new h-v power supply unit with an output of 30 kv d-c to its list of hermetically sealed, oil-filled power supplies. Model PS-30T full-wave voltage-doubler type operates on 117 v, 60 or 400 cycle input; delivers 1 ma continuous and 1.75 ma peak current. Ripple is 1.5 percent at 1 ma and regulation is approximately 7 percent from no load to full load. **Circle 211 on Reader Service Card.**

Gas-Filled Tube
time totalizer

BENDIX AVIATION CORP., Red Bank Division, Eatontown, N. J., announces a subminiature gas-filled tube designed for use as a cumulative time measuring device. Total nominal operating time is 1,000 hr at rated current. The tube consists of an anode, a cathode and a ceramic collector. It operates by passage of a current between anode and cathode. This part of the tube has essentially the same characteristics as any cold cathode gas diode. Complete operating details are given in Publication No. R93-6. **Circle 212 on Reader Service Card.**

Frequency Inverter
two models

CUBIC CORP., 5575 Kearny Villa Road, San Diego 11, Calif., announces inverters that convert 28 v d-c to a-c in the frequency range of 380 to 2,000 cps. One model has an output of 300 va, 3-phase, and the other an output of 100 va, single-phase. The 100-v inverter is both a d-c to a-c and an a-c to a-c device. **Circle 213 on Reader Service Card.**



Range & Balance Unit
six channels

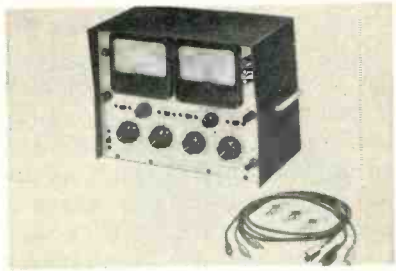
COMPUTER ENGINEERING ASSOCIATES, INC., 350 N. Halstead, Pasa-

(Continued on p 83)

scales are provided. Bolometer or crystal operation may be used. A special 2-cycle precision logarithmic meter on front panel permits vswr reflectometer readings from 1.02 to infinity, on two ranges. **Circle 216 on Reader Service Card.**

Power Supply for klystrons

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type 812 universal klystron power supply features digital read-out for beam and reflector voltages; dual outputs for simultaneous operation of two klystrons; front panel arrangement for checking calibration of reflector and grid voltage readings; and provision for external triggering of internal pulse generator. **Circle 217 on Reader Service Card.**



Test Unit for semiconductors

TRANSISTOR ELECTRONICS CORP., 3357 Republic Ave., Minneapolis 26, Minn., announces the model TDT-200 transistor-diode tester for testing the d-c characteristics of semiconductors. It contains no batteries and operates without external power supply. Unit is designed for use by engineers and maintenance personnel of computers, data processors and industrial control installations. Price is $295 in quantities up to ten. **Circle 218 on Reader Service Card.**

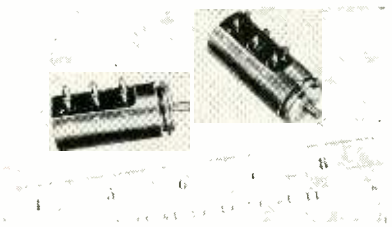
Terminals complete series

LITTON INDUSTRIES, INC., 336 North Foothill Road, Beverly Hills, Calif., announces a complete series of its new Loc-Fit terminals. These terminals, using a Teflon grommet

and matching Teflon base, may be hand or machine inserted. No precision tolerances are needed in drilling, and no camfer or counter bore is necessary before installation. Two sizes of grommets fit the entire series, reducing inventory considerably. **Circle 219 on Reader Service Card.**

Signal Generator
portable unit

MEASUREMENTS, Box 180, Boonton, N. J., has developed model 560-FM standard signal generator specially designed for the mobile communications industry. It provides frequency modulation from an internal 1,000 cps source or can be modulated externally up to 15 kc. Direct reading, individually calibrated scales cover frequency ranges of 25-54, 140-175, 400-470, and 890-960 mc. **Circle 220 on Reader Service Card.**

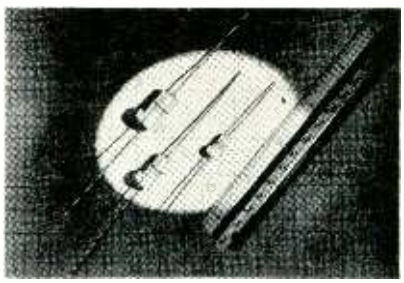


Rotary Switch
three cup

MAUREY INSTRUMENT CORP., 7924 S. Exchange Ave., Chicago 17, Ill. The 75-M49 tandem ganged switch was made to an angular accuracy of ±2 deg and with a torque of less than 0.5 oz-in. It is rated at 100 ma per cup. Unit is servo mounted and uses miniature precision ball-bearings. Except for the shaft end, the unit is completely sealed from moisture and foreign materials. Two million revolutions are guaranteed. **Circle 221 on Reader Service Card.**

Wide-Band Scope
with plug-in units

EMI ELECTRONICS LTD., Instrument Division, Hayes, Middlesex, England. Type WM16 is a wide-band oscilloscope with versatile plug-in units. It features a bandwidth of d-c to 40 mc; sensitivity, 50 mv/cm; sweep delay, 1 μsec to 150 millisec; direct time and voltage measurement, ± 3 percent; and built-in signal delay. **Circle 222 on Reader Service Card.**



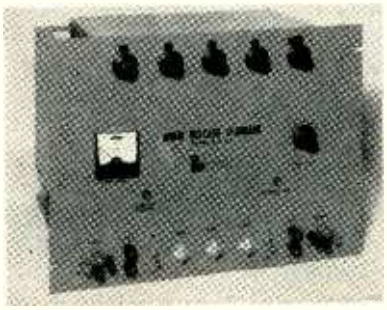
Tantalum Capacitor
special support

FANSTEEL METALLURGICAL CORP., North Chicago, Ill. Type PP tantalum electrolytic capacitor is now even further improved by a specially designed anode base support which gives it exceptional resistance to shock and vibration. It is now qualified for service under extreme environmental conditions —in mobile airborne electronic equipment, missile, rocket and similar applications—even under reduced pressures at higher altitudes. **Circle 223 on Reader Service Card.**

Tube Shield
subminiature

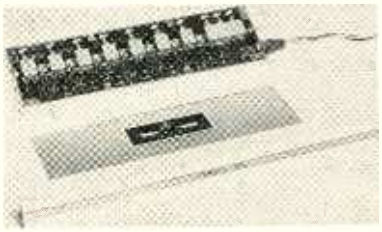
AUGAT BROS. INC., 33 Perry Ave., Attleboro, Mass., has introduced a longer-life, heat-dissipating resilient thermal conductive elastomer called Elastaclamp. It is specially designed to provide complete contact between heat transfer medium and glass envelope while protecting

tubes from severe shock and vibration. Use of a new Thermolastic material does away with dangerous hot spots and actually reduces bulb temperature in many cases up to 90 percent. Tube shield also permits continuous operation in ambient temperatures to 200 C. **Circle 224 on Reader Service Card.**



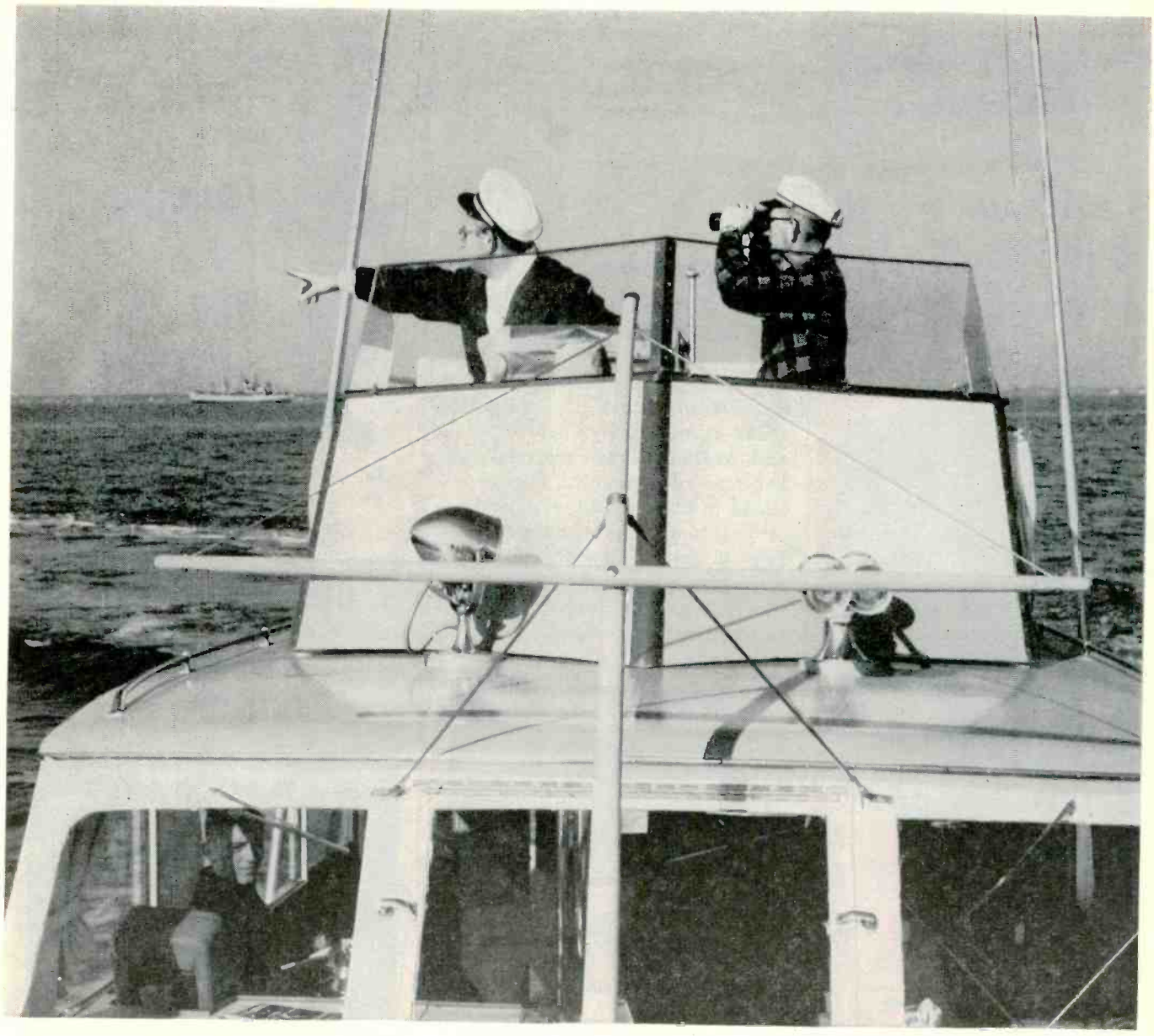
Voltage Calibrator precision unit

HOLT INSTRUMENT LABORATORIES, Oconto, Wisc. Absolute voltages accurate to 0.1 percent may be obtained by setting the digital controls of the AVS-321 a-c voltage source. This accuracy is maintained at all frequencies from 35 cps to 10 kc. Unit will provide up to 30 w of power. Output wave form is sinusoidal with less than 0.15 percent distortion. **Circle 225 on Reader Service Card.**



I-F Amplifiers transistorized

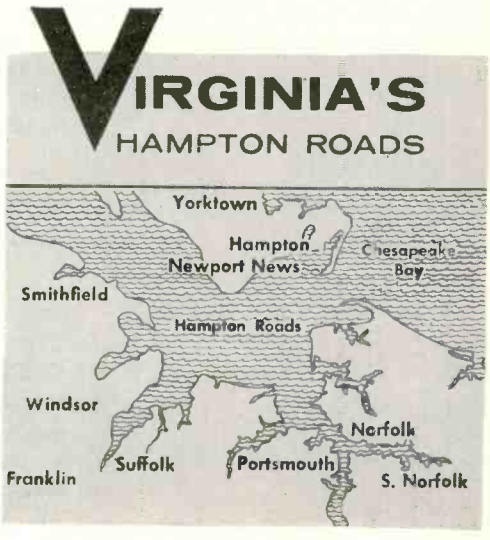
INSTRUMENTS FOR INDUSTRY, INC., 149 Glen Cove Rd., Mineola, N. Y. The T-300 series transistorized i-f amplifiers are finding application in the fields of custom communications equipment, laboratory setups, experimental communications radar and computer assemblies, and many other uses. The T-330A has a gain of 85 db (min.); center frequency, 30 mc; bandwidth, 10 mc; source impedance, 50 ohms; output imped-



You could dock the largest freighter at our new plant!

Deep water frontage on Virginia's busy Hampton Roads offers industrial advantages and living advantages in *depth*. You're central to the whole Atlantic Coast. A hundred ship lines link you with world ports. You enjoy superb, long-season boating, swimming, fishing.

Vepco serves this area with a generating capability of over 1,700,000 kilowatts, due to exceed 2,000,000 kilowatts by 1961. And Vepco *knows* this area intimately. For confidential deep-water site-finding help, write or phone



50 YEARS 1909-1959

VIRGINIA ELECTRIC and POWER COMPANY

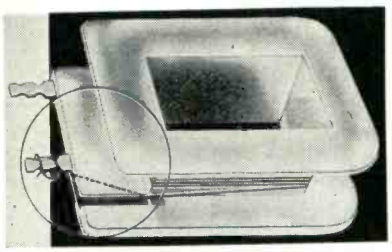
Serving the Top-of-the-South . . . in Virginia, West Virginia and North Carolina

Clark P. Spellman, Mgr., Area Development, Electric Bldg., Richmond 9, Va., MI 9-1411

ance, 50 ohms; noise figure 10 db. Circuitry is stagger-tuned. Operating temperature is —55 C to +85 C. Gain control is provided. **Circle 226 on Reader Service Card.**

Silicon uncompensated

SYLVANIA ELECTRIC PRODUCTS INC., Towanda, Pa., has available an uncompensated silicon in three semiconductor grades. Semiconductor manufacturers can obtain greater yields from doped single crystals while realizing lower material cost. The zone-refined silicon may be obtained in three grades classified according to maximum boron content. Type 43 contains less than 2.8 parts per billion boron, type 42—5.6 ppb, and type 41—11.2 ppb. **Circle 227 on Reader Service Card.**

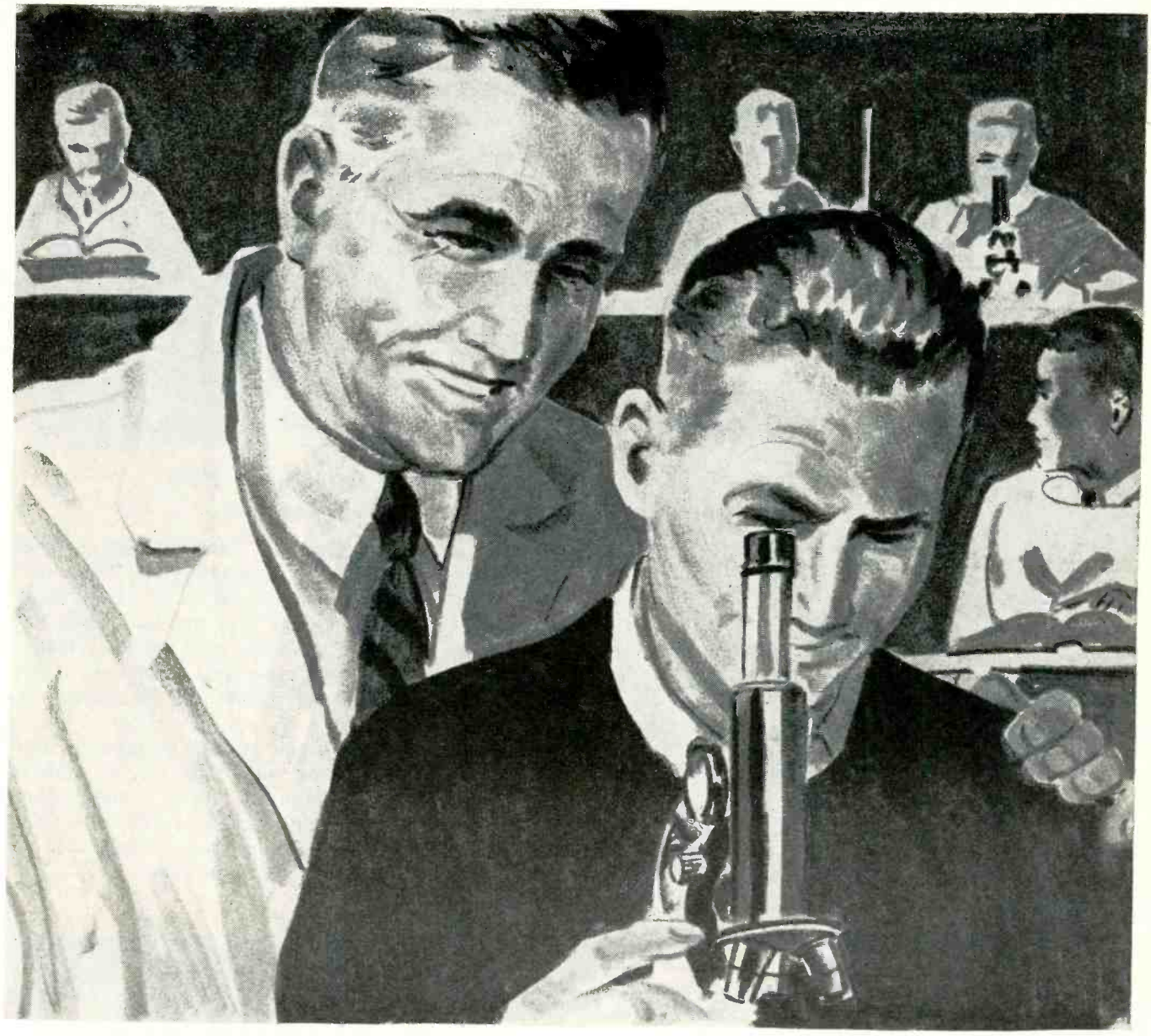


Nylon Bobbin insulated lead slot

AMERICAN MOLDED PRODUCTS CO., 2727 W. Chicago Ave., Chicago 22, Ill., offers a nylon bobbin featuring a slot for insulating starting leads as an integral part of the bobbin. This feature is particularly adaptable to automatic coil winding. The need for washers or taping of the lead has been eliminated. These bobbins can be furnished with insulated soldering lugs as shown. **Circle 228 on Reader Service Card.**

C-W Magnetron 2,425 to 2,475 mc

MULLARD LTD., Mullard House, Torrington Place, London, England. Type JP2-02 is a packaged, continuous-wave magnetron designed for low-power microwave heating applications, including diathermy. It operates within the frequency band 2,425 to 2,475 mc and is capable of delivering a c-w output



Who Discovers the Discoverers?

"A professor can never better distinguish himself in his work than by encouraging a clever pupil, for the true discoverers are among them, as comets amongst the stars." CARL LINNAEUS

Somewhere in this mighty land of ours, a gifted youth is learning to see the light of tomorrow. Somewhere, in a college classroom or laboratory, a dedicated teacher is gently leading genius toward goals of lofty attainment. Somewhere the mind of a future discoverer—in science, engineering, government, or the arts—is being trained to transcend the commonplace.

Our nation has been richly rewarded by the quality of thought nurtured in our colleges and universities. The caliber of learning generated there has been responsible in no small part for our American way of life. To our college teachers, the selfless men and women who inspire our priceless human resources, we owe more than we will ever be able to repay.

Yet how are we actually treating these dedicated people? Today low salaries are not only driving gifted teachers into other fields, but are steadily reducing the number of qualified people who choose college teaching as a career. At the same time, classrooms are beginning to get overcrowded. In the face of this, college applications are expected to double by 1967.

This is a severe threat to our system of education, to our way of life, even to our very existence as a nation. Our colleges need help—and they need it now!

HIGHER EDUCATION
KEEP IT BRIGHT

If you want to know more about what the college crisis means to you, and what you can do to help, write for a free booklet to: HIGHER EDUCATION, Box 36, Times Square Station, New York 36, New York.

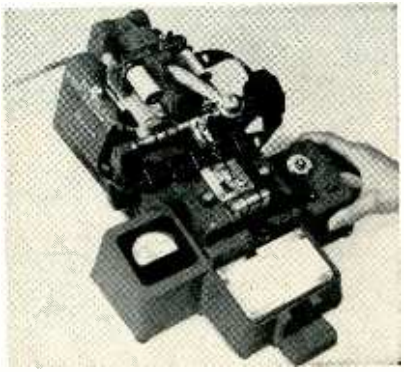
ADVERTISING COUNCIL PUBLIC SERVICE

Sponsored as a public service, in cooperation with the Council for Financial Aid to Education

power of approximately 200 w. Unit is designed for coupling to a 50-ohm coaxial line, and requires no artificial cooling when suitably mounted on a heat sink. **Circle 229 on Reader Service Card.**

Gangable Pots wire-wound

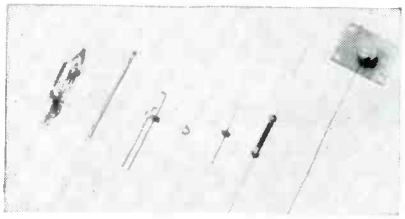
DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif. Design of the series 319 $\frac{7}{8}$ in. diameter gang type pot makes possible full 360 deg phasing and rephasing of individual resistance wipers without disturbing resistance settings of adjacent cups. Thus a unit can contain numerous individual cups that can be phased individually after installation, saving many hours of calibration and phasing time. **Circle 230 on Reader Service Card.**



Splicer for instrument tape

PRESTOSEAL MFG. CORP., Long Island City, N. Y. Working closely with General Plastics Corp. and Bendix, Prestoseal has engineered a vertical-scale-instrument tape splicer that measures, cuts, and seals the nylon-coated glass fibre tape in endless loops within precise length tolerances of ± 0.001 in. Ends of the highly durable, multi-layered tape are spliced in $2\frac{3}{4}$ sec by appli-

cation of pressure and temperature. **Circle 231 on Reader Service Card.**



Matched Thermistors close tolerance

VICTORY ENGINEERING CORP., 524 Springfield Road, Union, N. J., announces a new line of interchangeable and close tolerance matched thermistors. The more than 30 new units are classified in five major groups, each representing a specific type of matching: resistance, voltage, series-parallel, resistance-temperature, and resistance ratio-temperature matching. **Circle 232 on Reader Service Card.**

Hydrogen Analyzer compact unit

FISCHER SCIENTIFIC CO., 717 Forbes St., Pittsburgh 19, Pa. The Serfass hydrogen analyzer, compact and easy-to-operate, is designed especially for the laboratory that must measure the amount of dissolved hydrogen in metals or other solid materials. It will be equally useful to the electronics concern that makes high-purity zirconium and silicon for its transistors. It enables rapid determination of hydrogen in a typical 1-gram metal sample over a range of 0.2 to 1,000 ppm. Precision is ±0.2 ppm. **Circle 233 on Reader Service Card.**

Literature of

MATERIALS

Teflon. Tri-Point Plastics, Inc., 175 I. U. Willets Road, Albertson, L. I., N. Y. Product engineering and application considerations, dictated by the unique properties of Teflon resins, are subjects of *Plastips*, a new monthly engineering publication. **Circle 250 on Reader Service Card.**

COMPONENTS

Transformer Catalog. Acme Electric Corp., Cuba, New York. Catalog HT-325 illustrates designs of high temperature transformers produced for applications where ambient temperatures approach 350 C operational requirements. **Circle 251 on Reader Service Card.**

Rotary Components. Kearfott Co., Inc., 1500 Main Ave., Clifton, N. J. A 16-page condensed catalog deals with a wide line of servo motors, motor generators and synchros. **Circle 252 on Reader Service Card.**

Temperature Controls. Fenwal Inc., Pleasant St., Ashland, Mass. An 8-page booklet, MC-177, describes Thermoswitch controls and mounting wells. **Circle 253 on Reader Service Card.**

D-C Motor. Hoover Electric Co., Hangar Two, Port Columbus Airport, Columbus 19, Ohio, announces a bulletin describing model D-820, a new 2.0 hp, 28 v d-c motor. **Circle 254 on Reader Service Card.**

EQUIPMENT

Control Systems. Farrand Controls, Inc., 4401 Bronx Blvd., New York 70, N. Y. A 32-page illustrated bulletin explains the principles and applications of the Inductosyn numerical control systems. **Circle 255 on Reader Service Card.**

Spectrophotometer Accessories. Perkin-Elmer Corp., Norwalk,

the Week

Conn. Two new data sheets, describing the ordinate scale expansion system and the slave recorder, accessories for the model 21 infrared spectrophotometer, have been published. **Circle 256 on Reader Service Card.**

Analog-to-Digital Converter. B & H Instrument Co., Inc., 3479 West Vickery Blvd., Ft. Worth 7, Texas. Milli-V-Meter, a miniature analog-to-digital converter with a 144-in. tape-slidewire pot of 0.1 percent accuracy and digital readout, is described in a 4-page bulletin, BH100. **Circle 257 on Reader Service Card.**

Voltmeters. Ballantine Laboratories, Inc., Boonton, N. J., has available a catalog containing detailed information on a line of voltmeters, amplifiers and accessories. **Circle 258 on Reader Service Card.**

Commercial Sound Equipment. Atlas Sound Corp., 1449 39th St., Brooklyn 18, N. Y., announces a new easy-to-use short form catalog of loudspeakers, microphone stands and accessories. **Circle 259 on Reader Service Card.**

Digital Instruments. Kin Tel Division, Cohu Electronics, Inc., Box 623, San Diego 12, Calif. Catalog No. 19-36 is a four-page, illustrated bulletin describing a complete line of digital instruments. **Circle 260 on Reader Service Card.**

FACILITIES

Flame-Plating. Linde Co., Division of Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y. An 8-page booklet, "Linde 'Plasmarc' Plating", describes the new plasma arc service for metals in the high temperature range. The torch service described has been used extensively in connection with the manufacture of parts for missiles, rockets and electronic components. **Circle 261 on Reader Service Card.**

Underwood Plans New Plant

UNDERWOOD CORP., Canoga division, recently completed plans for the erection of a modern facility in Ft. Walton Beach, Fla. The new plant will have a floor space of 20,400 sq ft. It will house offices of the electronics and electromechanical engineering, manufacturing and administration personnel. Until completion of the new plant, the division will maintain its facilities at two other locations in the same city.

Efforts of the Canoga division in Florida include the development and manufacture of radar systems and components, telemetry transmitters, servomechanisms, electronic test equipment and special instrumentation for missile range applications.

Of the 65 persons presently employed by Canoga division in the Playground Area, approximately one-third are engineers. The Canoga division plant in Van Nuys, Calif., employs 300 people, and Underwood Corp. plants throughout the U. S. employ 7,000 people.

Underwood Corporation has facilities in Bayonne and Burlington, N. J.; Hartford, Bridgeport and New Hartford, Conn. Plants outside the U. S. are located in Toronto, Canada; Brighton, England; West Berlin and Frankfurt, Germany.

Name Richardson A Sylvania V-P

ELECTION of Arthur L. B. Richardson as a vice president of Sylvania Electric Products Inc., is announced.

Richardson, who is general counsel and secretary, will continue in those posts. His headquarters are at Sylvania's executive offices in New York City.

Promote Two In SRI Division

TWO promotions within the engineering research division of Stanford Research Institute, Menlo Park, Calif., are announced.

Don R. Scheuch, formerly manager of the weapons systems laboratory, has been appointed assistant division director with responsibility for supervision of research in the communication and propagation, radio systems, electromagnetics, and weapons systems laboratories.

Henry P. Blanchard, formerly head of navigation-aids research, has assumed the position vacated by Scheuch.

Ainslie Corp. Plans Move

AINSLIE CORPORATION, Quincy, Mass., designer and manufacturer of microwave antennas, has purchased three adjoining tracts of land totaling 17 acres in South Braintree, Mass., for the construction of a modern antenna laboratory and manufacturing plant.

The company's president, Henry W. Ainslie, Jr., said that building plans have not been completed, but construction is expected to be started by June 30 on an initial 20,000 sq ft of space.

Araujo Takes New Post

ARMANDO ARAUJO has been appointed to the new post of chief development engineer at Tri-Phi, Inc., Albertson, N. Y. The company, an affiliate of Tri-Point Plastics, Inc., develops and manufactures transistorized electronic equipment with printed circuitry.

Araujo joins Tri-Phi after being associated with several firms in the metropolitan New York area, including CBS, Polychrome and Stevens. He holds a number of patents, including some dealing with controls on automatic equipment.

W. J. Albersheim Joins SKL

FORMERLY with Bell Telephone Laboratories, Walter J. Albersheim has joined the staff of Spencer-Kennedy Laboratories, Inc., Boston electronics concern, in the capacity of chief engineer. He will head all engineering and development work of the organization, both in the

modern industry demands
modern work apparel

LINT FREE-ACID RESISTANT

industrial apparel
DESIGNED BY FASHION SEAL
FABRICS BY TRAVIS

To keep pace with today's rapid advance in technology, modern industry demands more and more qualities in the garment worn by its workers and technicians.

TRAVIS FABRICS, long a leader in the field of man-made fibers, has teamed with Fashion Seal Uniforms in the development of a complete line of industrial apparel...all created to offer industry the ultimate in their uniform requirements. To meets these needs, the textile engineering department of TRAVIS FABRICS has spent thousands of man hours in the development of lint-free and acid resistant fabrics. Together with Fashion Seal, garments tailored of these man-made fabrics have been use-tested in many of our largest electronics, nuclear, missile and chemical plants, so that today there is a Fashion Seal uniform, tailored of Travis Fabrics, to suit your every requirement.

Fashion Seal Uniforms made of modern fabrics by Travis mean more durability, less laundering expenses, **true** economy.

FOR FURTHER INFORMATION, WRITE: TRAVIS FABRICS, 1071 SIXTH AVENUE, NEW YORK, N. Y.
FOR INDUSTRIAL APPAREL CATALOG, WRITE: FASHION SEAL, 175 FIFTH AVENUE, NEW YORK, N. Y.

instrument division and in the closed circuit and community antenna television division.

Gonset Appoints General Manager

JOSEPH A. FRABUTT has been named general manager of Gonset Division of Young Spring and Wire Corp., Burbank, Calif., producers of radio communications equipment. He will be in command of an extensive program which includes development in low-cost ssb communications equipment as well as production in two-way Citizens' Band radios and short-wave transmitters and receivers.

Frabutt was formerly president of the industrial products division of International Telephone and Telegraph Corp.

Kaiser Sets Up R&D Group

KAISER AIRCRAFT AND ELECTRONICS has announced formation of a new electronics product research and development organization to be located in Phoenix, Ariz. James W. Schwartz, who joined the Kaiser organization a year ago, has been appointed director.

Kaiser described formation of the new organization as a step in a planned program for the development of an industrial and consumer electronics products business. A staff of electronics engineers is now being assembled for the Phoenix operation.

Kaiser Aircraft and Electronics

currently operates three electronics facilities—at Toledo, Ohio; Palo Alto, Calif.; and Phoenix. The new organization will share quarters with the present Phoenix group.

News of Reps

EFCON (Electronic Fabricators, Inc.) of New York City, announces appointment of two additional sales reps: **Specialized Electronic Corp.** to cover Florida, Georgia, North Carolina, South Carolina, Tennessee and Alabama; and **Engineering Products Associates** to cover Minnesota, North Dakota and South Dakota.

The Brush Beryllium Co., Cleveland, Ohio, producer of beryllium metal and beryllium alloys, appoints **The W. T. Peterson Co.** of Detroit, Mich., as sales reps for the state of Michigan, northern Indiana and northern Ohio.

Aerol Associates of Palo Alto, Calif., has been selected to represent Zero Mfg. Co., Burbank metal products firm, in the San Francisco Bay area.

Penn Resistor Corp., Landsdale, Pa., appoints **Walter F. Marsh & Associates, Inc.**, for Illinois, E. Iowa, E. Wisconsin, and northern Indiana; **Ernest L. Wilks Co.** for Texas, Oklahoma, Arkansas and Louisiana; **Featherstone & Salisbury** for northern California and northern Nevada.

American Electronic Laboratories, Inc., of Philadelphia, manufacturers of commercial test and microwave equipment, have appointed the following manufacturers' reps and their respective territories:

Charles W. Fowler of Berkley, Calif., covering Arizona, California and Nevada; **Landfear Enterprises** of Nutley, N. J., covering metropolitan New York City, Long Island and the counties of Dutchess, Orange, Putnam, Westchester and Rockland in the states of New York and New Jersey; **Lawrence D. Bruno** of Dayton, Ohio, covering Ohio state and western Pennsylvania.

COMMENT

Spectrum Sharing

With reference to the article titled, "Politics Clouds Spectrum Issue" (p 34, Mar. 27), it has occurred to me that you might be interested in a new technique for radio communications.

Actually, it is a system concept rather than an individual technique, and is intended primarily for military use, but is equally and possibly more applicable to civil radio communications.

The proposed system abandons the traditional concept of fixed or assigned frequency channels and substitutes electronic spectrum search, automatic frequency channel selection and lock-on, and transponder slaving. Instead of frequency channels being "owned" exclusively or otherwise, all or part of the spectrum is continuously shared on a time basis. In this respect it is somewhat analogous to AT&T's common control technique, and the TASI (time assignment speech interpolation) system for overseas cable traffic.

In operation, it will counteract co-channel interference while simultaneously promoting conservation of the radio spectrum and greatly increasing both the utilization and availability of radio-frequency channels for information exchange.

W. B. WELLS

HAMPTON, VA.

Microwave Hazards

I refer to your article concerning microwave health hazards ("Researching Microwave Health Hazards," p 49, Feb. 20).

You report some effects, like the "pearl-chain effect", which were found in our research laboratory at the University of Vienna in 1936. Later on, these were thoroughly investigated by myself, down in the centimeter and millimeter wave range in connection with biophysical and polymer research projects at the University of Brussels, Belgium, where I directed research in this field from 1946 to 1952.

I reported my findings to International Congresses in Europe, particularly concerning microwave effects and health hazards at the

BOOK NEWS-NOTES

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First International Congress of Medical Electronics in Brussels, 1948, published in French in *Acta Physiotherapica et Rheumatologica Belgica.*

Could you tell me if your information in your article refers to my publication without crediting me expressly, or to some "rediscovery" from other side?

V. T. TOMBERG, M. D.

NEW YORK

Our report on the discovery of pearl-chain formation as a result of microwave irradiation was based on research done by Dr. Julia F. Herrick at the Mayo Clinic. Dr. Herrick's report mentioned other work that had been done in Vienna and elsewhere in Europe during the '30s, but to the best of our recollection, did not specify who had done the research. Her report does mention some colloid research performed by Ernst Muth, but this work was not associated with microwave research.

Cheap Stereo

Just read your article (Recent Developments In Stereo Broadcasting," p 41, Apr. 3) and am compelled to add a little more confusion or give you fellows a solution, if you are really looking for one. I feel it's the money angle being considered instead of the technical angle.

For $100 you could solve the whole problem with a synchronous motor turning a shaft on which three magnetic drums are mounted. By properly placing recording heads, three or six in number, you could get a stereophonic effect.

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E. J. MOHR

LAUREL, MD.

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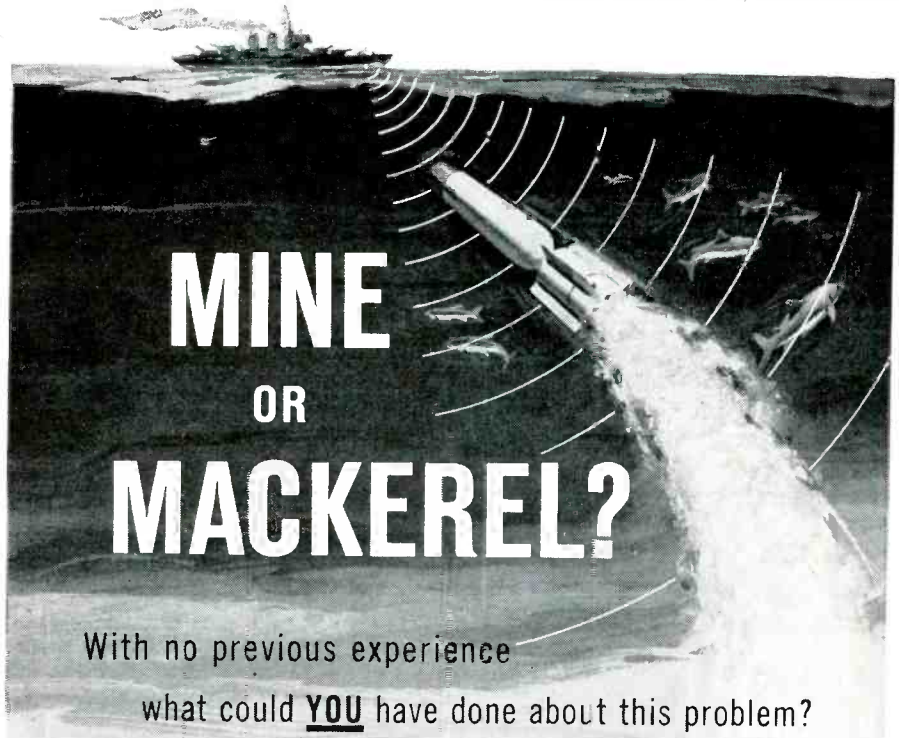

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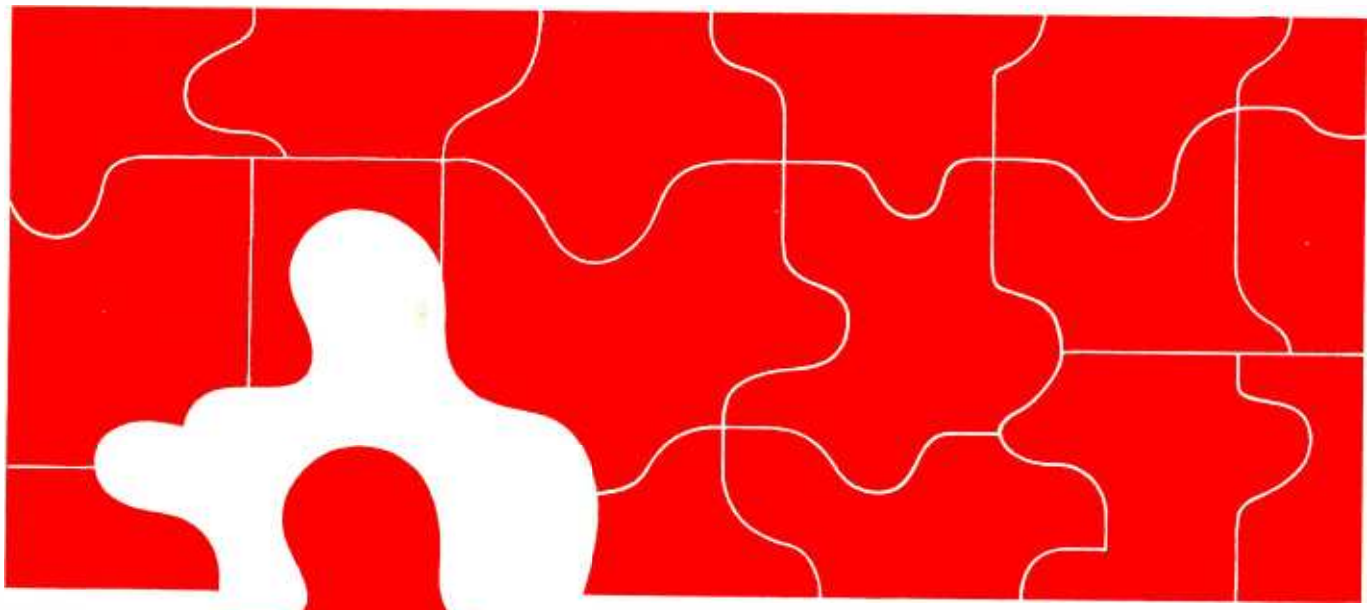

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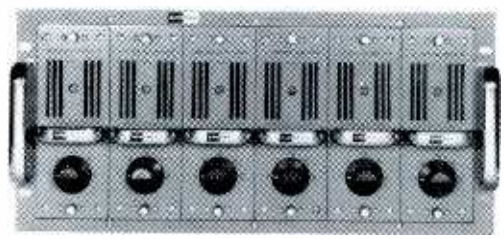

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