SEPTEMBER 4, 1959

electronics

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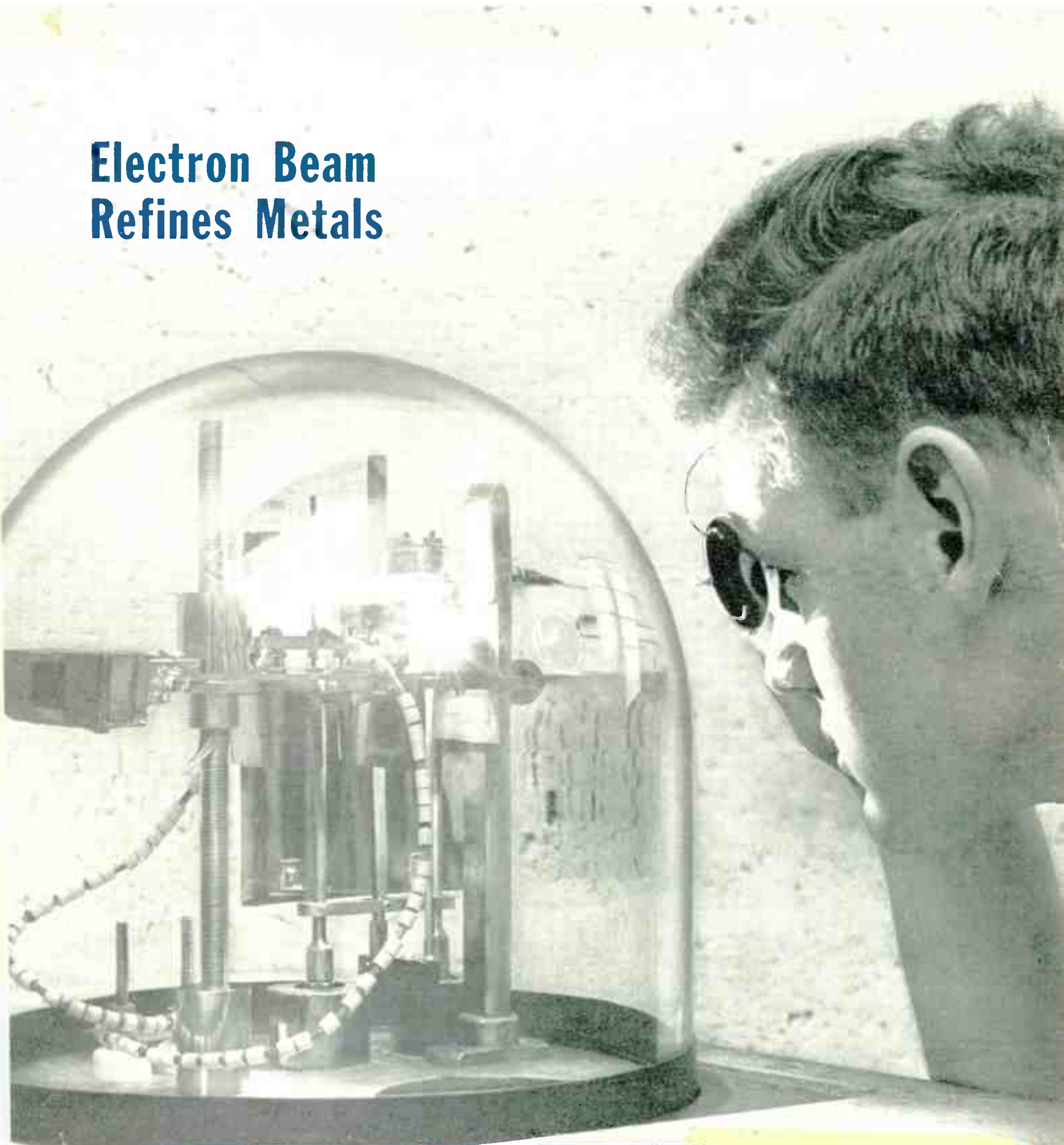
Electron Beam Refines Metals

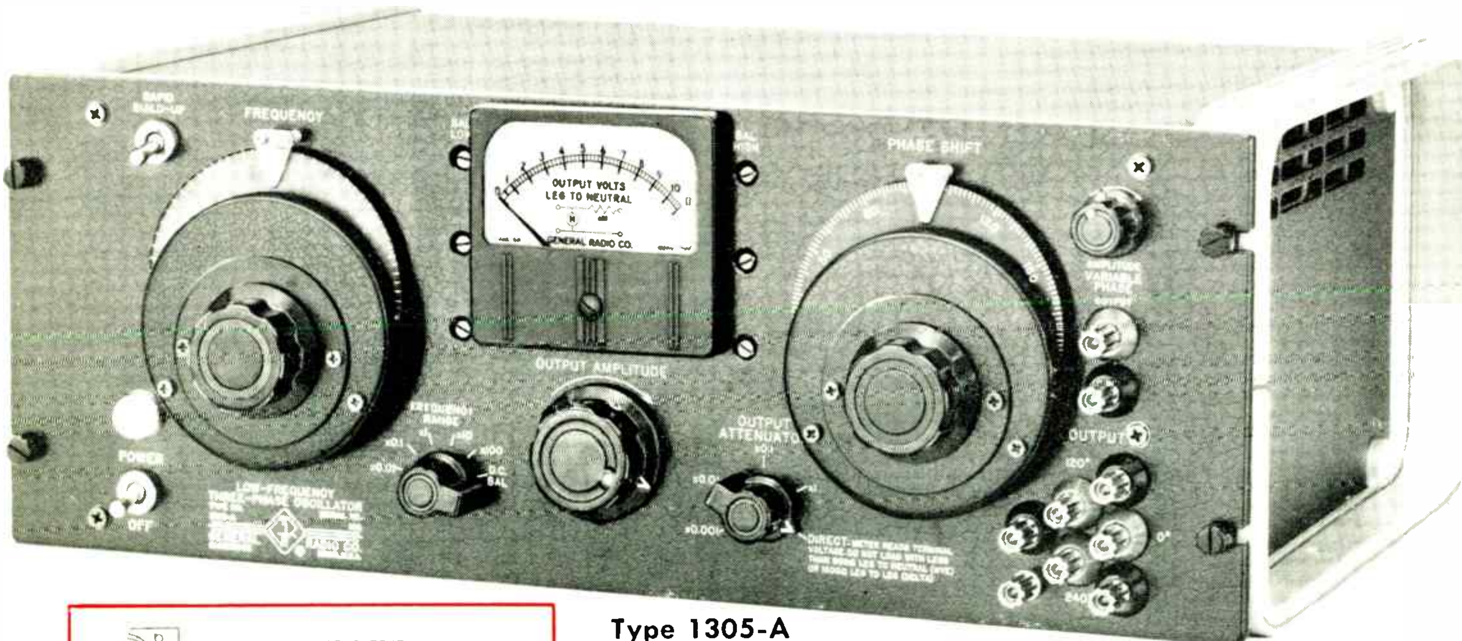


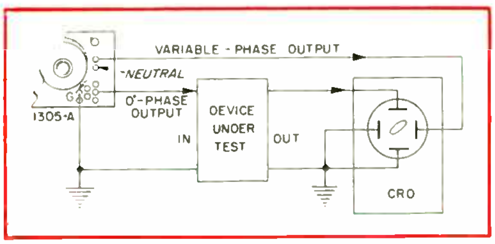
Survey Shows Executiv

New LOW-FREQUENCY OSCILLATOR

for the direct measurement of GAIN and PHASE SHIFT

★ Frequency range: 0.01 to 1000 cycles per second ★ Built-in phase shifter: 0° to 360° ★ Direct reading in phase shift, *independent* of frequency . . . no charts or calculations necessary ★ Output amplitude stabilized ±½ db over entire frequency range ★ Three-phase output available . . . four-phase output from accessory adaptor ★ Especially useful for the phase-gain measurement of Servo Systems • Recorders • Medical Instruments • Networks • Passive Sonar Equipment • Low-Frequency Amplifiers • Geophysical Equipment • Electrical Analogs of Mechanical Systems • Two-, Three-, and Four-Phase Devices • Seismographic Devices.





Complex transfer characteristics of devices or systems are readily measured with the Type 1305-A Low-Frequency Oscillator. With the setup above, you need only adjust the Oscillator's continuously-adjustable phase shifter until the Lissajous ellipse on the oscilloscope is closed — the dial setting then gives phase shift directly. Gain is readily determined by calibrating the scope face with the aid of the Oscillator's panel meter, and then comparing vertical height of the oscilloscope pattern before and after the device under study is connected to the test setup.

Type 1305-A
Low-Frequency Oscillator

Frequency Range: 0.01 to 1000 cycles in 5 ranges. **Accuracy** ±3%

Three-Phase Output: 10-volts rms, open circuit, line-to-neutral, behind 600Ω in each phase. Output constant with frequency to ±5%. Phase voltages are equal to within ±2%.

Four-Phase Output: (using 4-phase adaptor) 5-volts rms, open circuit, line-to-neutral, behind 600Ω, phase voltages equal to within ±2%.

Variable Phase Output: 1-volt, rms, taken from a 50,000Ω output control. Accuracy of phase calibration is ±3°

Waveform: Total harmonic content is less than 3% at all output attenuator settings and at all frequencies. Line-frequency hum in output is less than 10 mv.

Power Requirements: 105 to 125 (or 210 to 250) volts, 50 to 400 cycles.

Price: **$940.**

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FIRST Broadcast Station Crystal Oscillator 1922

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SEPTEMBER 4, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 36

Issue at a Glance

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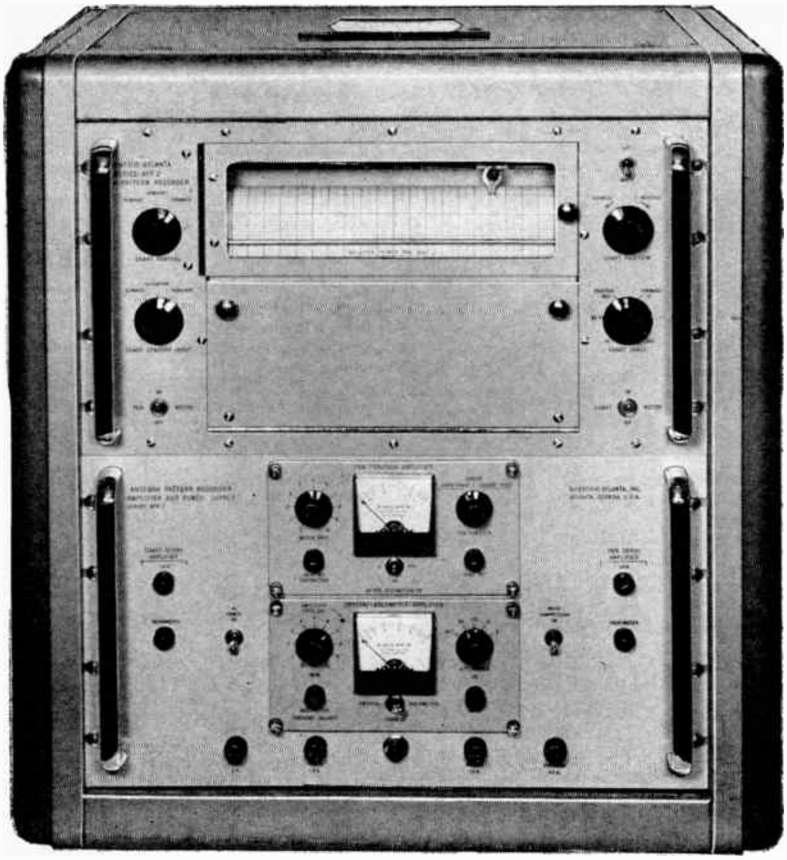

THE NEW S·A

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Scientific-Atlanta's new series of rectangular antenna pattern recorders bring you new standards of performance, reliability and flexibility.

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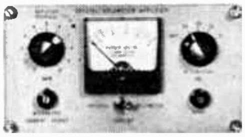
Writing speed of better than 40 inches per second • Log, linear, or square root pen response obtained with plug-in balance pots • One electronics system drives both polar and rectangular recorder heads • Overload indicator to prevent amplifier saturation • 60 db dynamic range system available • Chart scale expansion of 1:1, 6:1, and 36:1 • Page size recordings optional at extra cost • 100 db gain in bolometer amplifier • Lighted chart • Improved pen mechanism • DC input pre-amplifier available • Plug-in selective filter • Simplified controls.

PRICES, Series APR-20 Rectangular Antenna Pattern Recorders

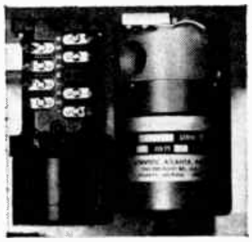
APR-21 linear, $4100 — APR-22 logarithmic, $4300 — APR-23 linear, logarithmic, $4700 — APR-24 linear, square-root, $4700—APR-25 linear, logarithmic, square-root, $5300.

THESE PLUG-INS MEAN FLEXIBILITY AND EASY SERVICE



New high gain, low noise bolometer—crystal amplifier

New pen function amplifier



New pen balance potentiometer

Call your nearby S-A engineering rep for a demonstration and complete technical information or you may write directly to the factory. Please ask for data sheet Dept. 189

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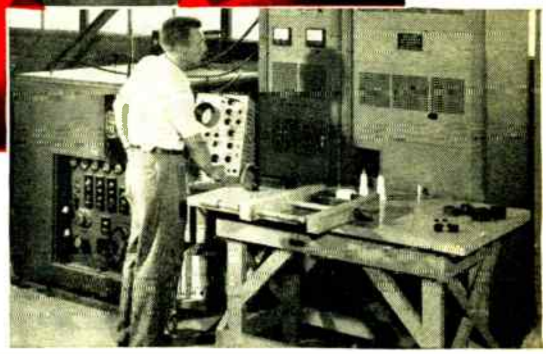
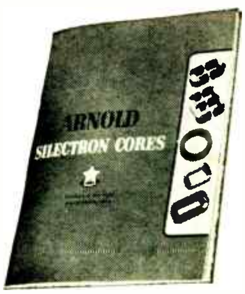


7372 C

Arnold Pulse Transformer Cores are individually tested under actual pulse conditions

Here's technical data on

ARNOLD SILECTRON CORES



Bulletin SC-107 A . . . this newly-reprinted 52-page bulletin contains design information on Arnold Tape Cores wound from Silectron (grain-oriented silicon steel). It includes data on cut C and E cores, and uncut toroids and rectangular shapes. Sizes range from a fraction of an ounce to more than a hundred pounds, in standard tape thicknesses of 1, 2, 4 and 12 mils.

Cores are listed in the order of their power-handling capacity, to permit easier selection to fit your requirements, and curves showing the effect of impregnation on core material properties are included. A valuable addition to your engineering files—*write for your copy today.*

ADDRESS DEPT. E-99

The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

For example, Arnold 1 mil Silectron "C" cores—supplied with a guaranteed minimum pulse permeability of 300—are tested at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gausses. The 2 mil cores, with a guaranteed minimum pulse permeability of 600, receive standard tests at 2 microseconds, 400 pulses per second, at a peak flux density of 10,000 gausses.

The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

This is just another of Arnold's facilities for better service on magnetic materials of all description. ● Let us supply *your* requirements. *The Arnold Engineering Company, Main Office & Plant, Marengo, Ill.*

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electronics

September 4, 1959 Vol. 32, No.36

Published weekly, with an additional BUYERS' GUIDE and REFERENCE Issue in mid-June, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948) Founder.

Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y. Longacre 4-3000. Publication Office: 99-129 North Broadway, Albany 1, N. Y.

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SHOPTALK . . . editorial

WESCON COMMENTS. If the 1959 Electronic Show and Convention had any one theme, it was that our industry these days is a combination of vitality, versatility and dreams. Here's why:

Show and convention budget was higher than ever—$400,000 compared to $323,000 last year and $250,000 in 1957. Exhibitors numbered 857, up from 780 last year and 750 in '57. Total number of booths climbed to almost 960.

There was marked interest in possible easing of cold-war tensions but no fear of the effects. Manufacturers are making a noticeable effort to come up with new commercial products. However, there is not yet the slightest indication of any deemphasis of military electronics.

Comments of industry leaders in the West suggest they expect the military market to hold up for some time because of the increasing amount of new defense dollars that are going into electronics.

While optimistic about the military market in the foreseeable future, many executives also indicate that the technical and economic planning for space communications now being pushed by electronics companies will keep a good slice of our industry growing in the future. There is some opinion that in the event of a general military cutback in the next few years the government would transfer much of its effort and money to space activities.

The fact that there was a number of significant technical papers at Wescon on space communication—covering antennas, telemetry and data processing in particular—suggests that the prediction of several executives that hundreds of communications satellites will be in use in five years is more than a pipe dream.

Although the West is indeed a booming area for our industry, electronics leaders are the first to tell you that this area has no monopoly on dreams or growth. In fact, all over San Francisco's hotels during Wescon and even over the ramp at the air terminal, there were signs reading: "Engineers! Looking for a change? Move to Florida."

Coming In Our September 11 Issue . . .

INSTRUMENTS FOR DESIGN AND PRODUCTION. The ability of engineers to measure basic electrical parameters is as much a part of the design and production procedure as the slide rule and soldering iron. Today's demands of military and space programs have pushed the state of the art to the point where even Bureau of Standards accuracies are inadequate in some measurement areas and nonexistent in others. The result has been some revolutionary trends in instrument design which are still gathering momentum.

Next week, ELECTRONICS brings you a special report on electronic measuring instruments by Associate Editor Bushor. This report has been in preparation for a year, is the product of comprehensive surveys and interviews and wide-ranging travels by the ubiquitous Bushor. You'll learn of the impact transistorization is making on instruments, how human engineering is changing data display techniques. You'll see how the increasing need for measuring across wider ranges of parameters is bringing about a basic change in design philosophy. You won't want to miss this important, information-laden publishing event.

JAPANESE ELECTRONICS. The Japanese electronic industry has made big strides in the last few years until it must now be considered serious competition for our industry—at least in some areas. We felt that a survey of the progress being made by Japanese engineers was in order. The result is next week's article by Associate Editor Solomon. He describes the technical details of Japanese transistor radios, portable tv, the famous Synchroreader talking book, computers and other devices.

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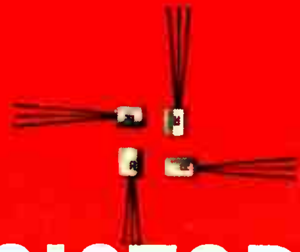

submin TRANSISTORS

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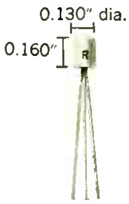

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COMPUTER TRANSISTORS
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SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	H_{FE_1} ave. I_B = 1 ma V_{CE} = −0.25V	H_{FE_2} ave. I_B = 10 ma V_{CE} = −0.35V	Rise Time* max. μsec
CK4	2N404	−24	12	30	—	—
CK25	2N425	−20	4	30	18	1.0
CK26	2N426	−18	6	40	24	0.55
CK27	2N427	−15	11	55	30	0.44
CK28	2N428	−12	17	80	40	0.33

*I_C — 50 ma; I_{B_1} = 5 ma; R_L = 200 Ω; I_{B_2} = 5 ma; Grounded Emitter Circuit

GENERAL PURPOSE **AUDIO** TRANSISTORS
Temperature Range −65°C to +85°C

SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	Beta ave. small signal	Power Gain Class A ave. db	I_{CO} ave. μa	Noise Factor ave. db
CK22	2N422	−20	90	40	6	6 max.
CK64	2N464	−40	22	40	6	12
CK65	2N465	−30	45	42	6	12
CK66	2N466	−20	90	44	6	12
CK67	2N467	−15	180	45	6	12

GENERAL PURPOSE **RADIO FREQUENCY** TRANSISTORS
Temperature Range −65°C to +85°C

SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	Beta ave.	C_{ob} ave. μμf	r_b'' ave. ohms
CK13	2N413	−18	2.5	25	12	70
CK14	2N414	−15	6	40	12	80
CK16	2N416	−12	10	60	12	90
CK17	2N417	−10	20	80	12	100

Dissipation Coefficients for all submin types: in air, 0.75°C/mW; infinite sink, 0.35°C/mW

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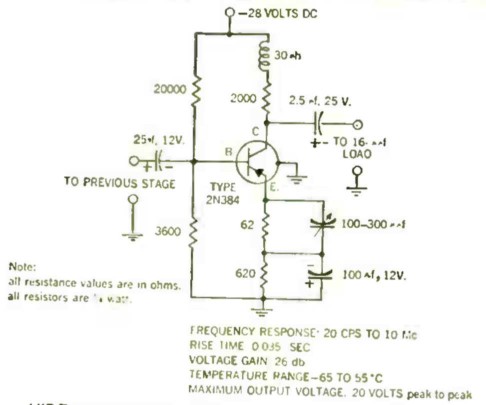
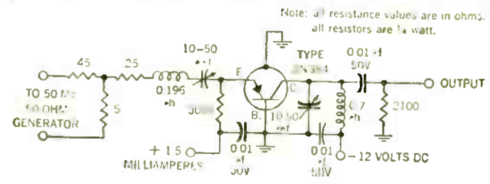
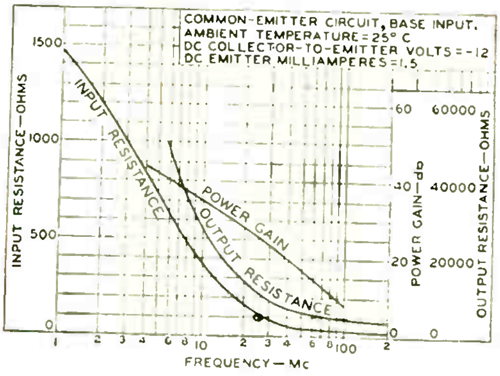


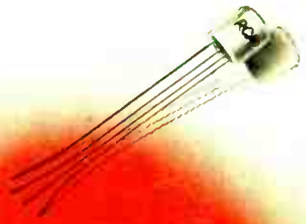
VIDEO AMPLIFIER CIRCUIT UTILIZING RCA-2N384



50-Mc-RF AMPLIFIER CIRCUIT UTILIZING RCA-2N384 AND PROVIDING A MINIMUM POWER GAIN OF 15 db.



RCA-2N384



VHF DRIFT TRANSISTOR

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- Efficient operation up to 100 Mc. in rf-amplifier service and up to 125 Mc. in oscillator service.
- Enables practical design of rf, oscillator, video, and if circuits of transistorized radio, radar, marker-beacon and navigation receivers, and other electronic equipment.

Designers of transistorized *high-frequency* electronic equipment now have the advantages of local sources of supply for RCA semiconductor devices. Of particular interest is the news that RCA-2N384 VHF DRIFT TRANSISTORS of the germanium p-n-p type are immediately available through your local RCA Semiconductor Distributor.

RCA-2N384 features high collector dissipation, high transconductance, low input and output capacitance, and excellent high-frequency response. RCA-2N384 is especially popular for service in either linear-type or pulse-type video-amplifiers featuring fast rise time. Typical circuits and technical data for this outstanding unit are shown here.

Maximum Ratings Absolute Maximum Values					Characteristics At Ambient Temperature = 25°C	
Collector-to-Base Volts	Collector Milliamperes	Transistor Dissipation Milliwatts At 25°C	At 55°C	At 71°C	Small-Signal Current Gain	Alpha-Cutoff Freq. Mc
−40	−10	120	70	35	60	100

For other information on RCA-2N384 DRIFT TRANSISTOR—or on any RCA TRANSISTORS or SILICON RECTIFIERS—contact your local RCA SEMICONDUCTOR DISTRIBUTOR.

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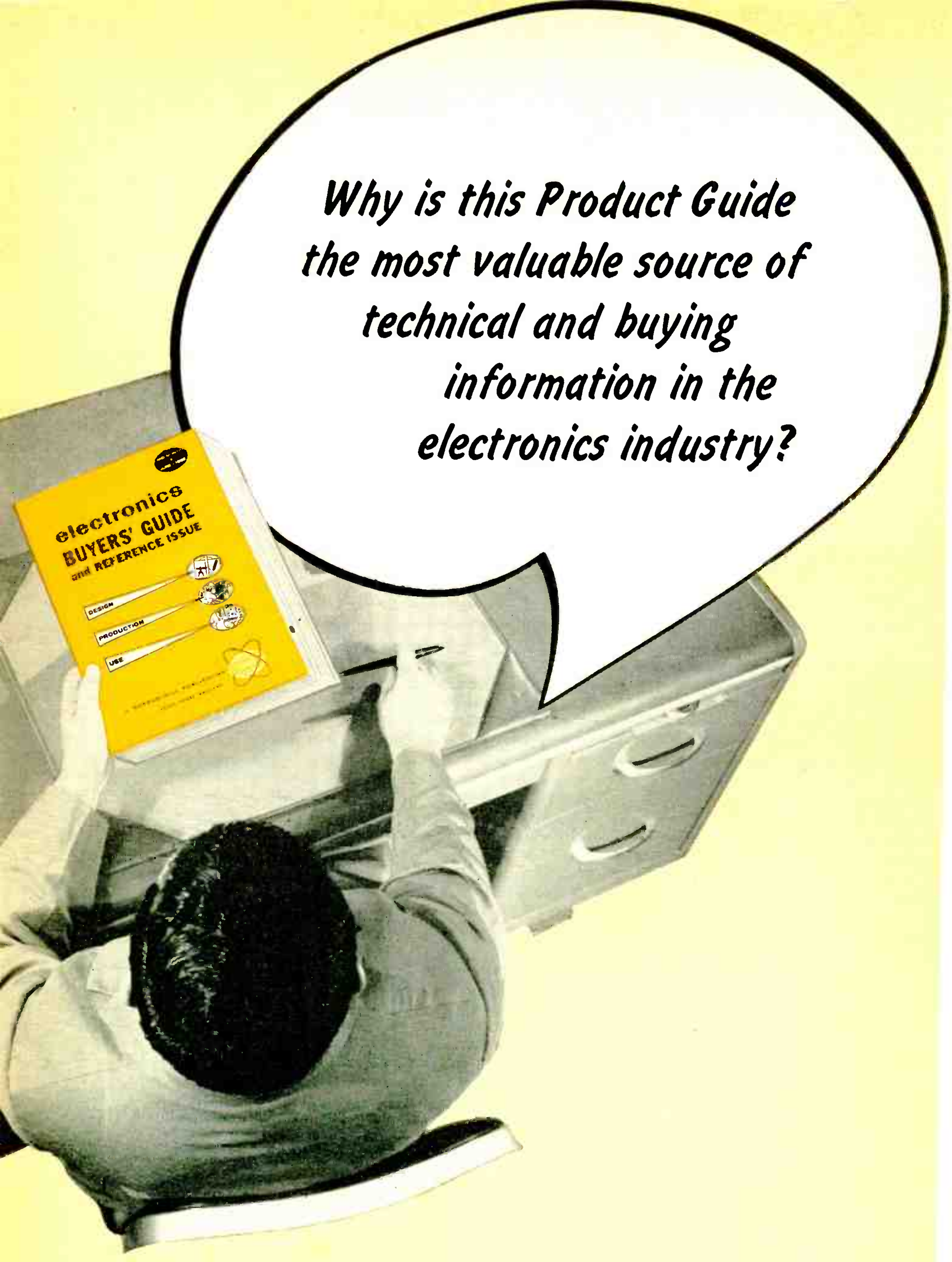
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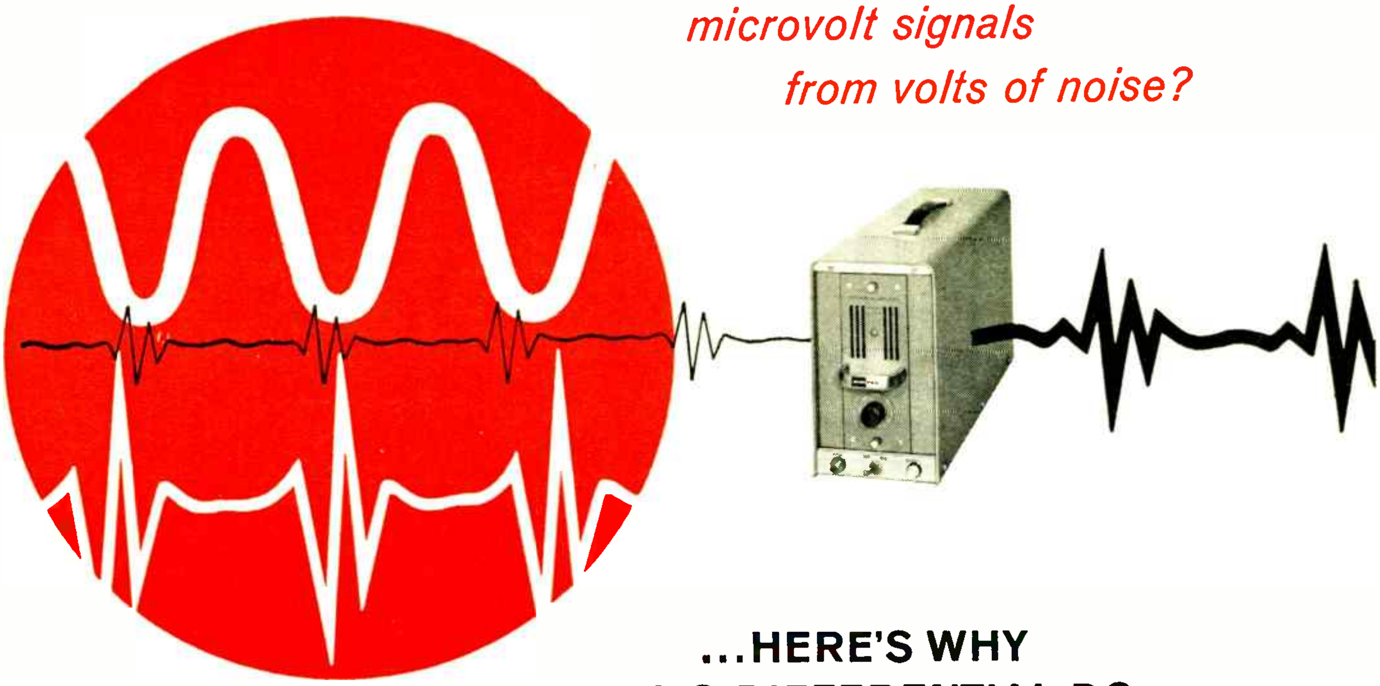
Puzzled by ground loop problems? How to rescue microvolt signals from volts of noise?



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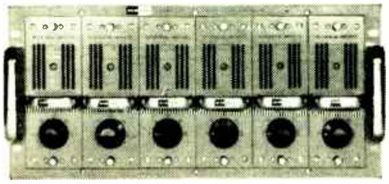
Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads; can be used inverting or non-inverting. Price $875.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL—the world's largest manufacturer of precision, chopper-stabilized DC instruments.

KIN TEL 114A differential DC amplifiers... convenient, interchangeable plug-in mounting in either 6-amplifier 19-inch rack mount modules or single-amplifier cabinets.



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ELECTRONICS NEWSLETTER

SOVIET COUNTERMEASURES experts claim to have developed a method for canceling the effect of noise jamming. Tass reports that a jam-cancel system operating on empiric statistical principles has been designed by M. Alexandrov of the Soviet Academy's Radio-Electronics Institute. Alexandrov's design ascertains frequency characteristics and power levels of the jamming signal, apparently with spectrum analyzers and computing circuits, and generates an "artificial counterflow of radio sounds" to selectively cancel the noise. Prototype of the new apparatus will shortly be placed on display at Moscow's Exhibit of Soviet Economic Accomplishments.

SELF-GUIDED BUSES may result from a series of tests now being undertaken by Chicago Transit Authority. CTA has outfitted a battery-powered industrial plant truck with electronic controls supplied by Barrett Electronics, Northbrook, Ill. Truck will be used for intraplant deliveries at CTA's South Shops. Truck scoots around at a top speed of nine mph, honks warning of its approach, halts automatically at programmed loading or unloading points, stops for closed doors or objects (or people) in its path. Truck-borne sensing gear picks up guidance signals from continuous closed loop of cable laid around the shops. Controls cost about $12,000. After trials in the shops, CTA will conduct field tests over a section of highway specially equipped with guide wires to carry the signals.

Radar echoes from deserts, forests, cultivated fields, swamps and other types of terrain are all different and tend to complicate airborne radar mapping. Goodyear Aircraft is now working on a Navy project to pinpoint the differences for future airborne mapmakers. Airborne strip-mapping radar and aerial cameras coupled with groundbased computers and analyzers will be used to gather and correlate terrain data.

VOICE OF AMERICA will build a $10-million radio relay station in Monrovia, the Liberian government says. The station in the Liberian capital will be the most powerful radio link in Africa.

NAVY'S EAGLE long-range air-to-air missile system moves nearer completion as more subcontractors fill out the industry group responsible for its design and development. Bendix is prime contractor for the missile, with the Bendix research labs subcontracting electronic guidance equipment and Bendix Pacific handling design and production of subsystems, missile assembly and testing. Grumman is subcontractor for airframe and propulsion system, launching system and some of the ground handling gear; Sanders Associates will design the "seeker" for homing on target; Litton Industries will develop a tactical computer; and Westinghouse's Air Arm division will build airborne intercept radar. Eagle – a long-range weapon meant to counter hostile planes or air-breathing missiles—will be launched from an aircraft dubbed Missileer, whose manufacturer has yet to be announced.

Japanese transistor radios will be marketed in this country under Bulova Watch Co. brand for the Christmas trade. Matsushita Electric will export 45,000 mercury-battery powered sets through its New York agent, Maco Electric Corp., between September and December, and another 15,000 sets early next year. Bulova will sell the radios.

SPACE TECHNOLOGY is "not as far advanced . . . as we had thought," NASA administrator T. K. Glennan told the USAF Symposium on Missiles and Space Technology last week. Ratio of successful launches to "successful failures" is not much improved over a year or so ago, and today in every shot "there is little or no margin for even a slight deviation from planned performance or parameters." His view: sober but not pessimistic. Meanwhile, NASA fired two Nike-Asp rockets from Wallops Island, Va., which ejected sodium vapor from 50 to 150 miles up to provide ground observers with basic data on wind activity; United Control Corp., Seattle, got a contract to build a thermal sensing system for Project Mercury so the man-in-space can know when his retro rockets fire; and Aerojet-General gave a $300,000 contract to MB Electronics, New Haven, Conn., to build an electronic and electromechanical test system for A-G's rocket engines. The MB system will duplicate in-flight vibration conditions, said to be direct or indirect cause of 40 percent of all service failures.

Basic research program of the Defense Department is expanding as the Washington climate for such spending improves. Herbert York, director of research and engineering, cited two priority areas in recent WESCON luncheon talk: materials, in which area basic research jumped 25 percent last year, more than doubled this year, and will go on rising; and oceanography, which relates to almost every aspect of the submarine defense program.

UNDERWATER RECONNAISSANCE is one of several areas in electronic countermeasures recently stimulated by Defense Department contracts. Hoffman Labs, Los Angeles, is now working on a $5.9-million contract from Navy Bureau of Ships for production of passive ecm (reconnaissance) gear for underwater and surface craft. Contract is for equipment developed by Hoffman under a previous R&D contract. RCA meanwhile is winding up a contract from Signal Corps for a communications jammer, Gilfillan Bros. is working on a dynamic target and countermeasures simulator for the same agency, and Polarad Electronics is pushing a "quick reaction" USAF contract for a specialized ecm receiving system.

WASHINGTON OUTLOOK

WASHINGTON—SEVERAL MAJOR ELECTRONICS projects may undergo stretchouts or cutbacks as a result of the administration's order to hold defense spending in fiscal 1961 at this year's $41-billion level. As development and production schedules stack up now, increased spending would be inevitable. Pentagon outlays would top the proposed $41-billion ceiling by well over $1 billion.

The first big cut so far has been the Air Force's decision to trim new orders for Convair B-58 bombers this year from 40 to 32.

Still in the works is a decision on the Air Force's Mace surface-to-surface missile. Mace's Atran guidance is built by Goodyear Aircraft, with inertial guidance from AC division of General Motors. Congress knocked out $127.5 million from the funds earmarked to buy the missile, but authorized the Pentagon to transfer an extra $150 million from other projects for any tactical or strategic missile program.

The Air Force wants to use funds saved by cutting B-58 production to buy more Maces. Gen. Lauris Norstad, NATO's commander, wants the all-weather tactical missile badly. But William M. Holaday, Defense Secretary McElroy's special assistant for guided missiles, has recommended against further production.

- **The Army** is fighting once more for money to produce Western Electric's Nike-Zeus anti-ICBM system, seeks at least $1 billion to start work. This is roughly three times the current project budget. Experimental production of a transistorized computer for Zeus is now underway. There's strong Pentagon opposition to Army's proposal to tool up for Zeus production.

  The Army also wants a whopping increase in funds to modernize its combat forces. Electronic communications and surveillance equipment are high on the shopping list.

  Included also are target locators which spot enemy targets and transmit data to automatic weapons; lightweight radios with improved range and reliability; reconnaissance drones; reconnaissance aircraft with advanced radar and infrared detectors; an improved walkie-talkie the size of a desk telephone.

- **Air Force** wants to continue output of B-52 and B-58 bombers for another year, and to push development of the B-70 and F-108, while bringing ICBM production into high gear. But there's considerable Pentagon sentiment in favor of halting production of manned aircraft and moving directly to a strategic missile force.

  Air Force's Titan ICBM (guidance by Bell Labs, ground control computer from Remington Rand Univac) is on the griddle. Its elder brother Atlas (command guidance by GE, inertial guidance by Arma, ground control computer by Burroughs) is now only "a few days" from being accepted as ready for combat use, according to a high Pentagon source. Development of the more advanced Minuteman (guidance by NAA's Autonetics division) is continuing successfully. With these rivals, Titan's value is minimized, and the budget pinch makes it extremely vulnerable.

  Each service is pushing for its own global communications network. The Air Force's 480L project (ITT) and the Army's Unicom system (Western Electric) are out on contract. There's a long-range Pentagon plan to make one military system serve all three services, but it's far enough in the future that the two existing projects are in no immediate jeopardy.

  Navy wants a big boost in funds for all-weather aircraft and anti-submarine forces. Its prospects for an increased budget are good.

Audio, telemetry and low frequency oscillators

Pictured here are six of the most widely used oscillators in electronics. All employ the highly stable, dependable, accurate resistance-capacity circuit. They require no zero setting. Output is constant, distortion is low and frequency range is wide. Scales are logarithmic for easy reading; all are compact, rugged and broadly useful basic instruments. Brief specifications are given below; call your hp rep for demonstration or write direct for complete data on any instrument.

Model	Frequency Range	Calibration Accuracy	Output to 600 Ohms	Recommended Load	Maximum Distortion	Max. Hum & Noise ¶	Input Power	Price
200AB	20 cps to 40 KC (4 bands)	±2%	1 watt (24.5 v)	600 ohms	1% 20 cps to 20 KC 2% 20 KC to 40 KC	0.05%	65 watts	$150.00
200CD	5 cps to 600 KC (5 bands)	±2%	160 mw 10 volts	600 ohms*	0.5% below 500 KC 1% 500 KC and above	0.1%	75 watts	$170.00
200J	6 cps to 6 KC (6 bands)	±1%†	160 mw 10 volts	600 ohms*	0.5%	0.1%	100 watts	$300.00
200T	250 cps to 100 KC (5 bands)	±1%†	160 mw 10 volts	600 ohms*	0.5%	0.03%	100 watts	$450.00
201C	20 cps to 20 KC (3 bands)	±1%†	3 watts (42.5 v)	600 ohms**	0.5%‡	0.03%	75 watts	$225.00
202C	1 cps to 100 KC (5 bands)	±2%	160 mw 10 volts	600 ohms*	0.5%§	0.1%	75 watts	$300.00

*Internal impedance is 600 ohms. Frequency and distortion unaffected by load resistance. Balanced output with amplitude control at 100. Use line matching transformer for other control settings. **Internal impedance approximately 600 ohms with output attenuator at 10 db or more. Approximately 75 ohms below 5000 cps with attenuator at zero. †Internal, non-operating controls permit precise calibration of each band. ‡0.5%, 50 cps to 20 KC at 1 watt output. 1.0% over full range at 3 watts output. §0.5%, 10 cps to 100 KC. 1.0%, 5 to 10 cps. 2.0% at 2 cps. 3.0% at 1 cps. ¶Measured with respect to full rated output.

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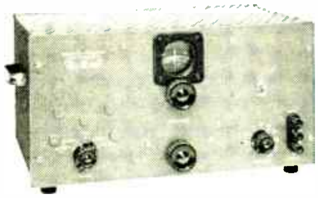
Field representatives in all principal areas

6036

hp 200AB Audio Oscillator

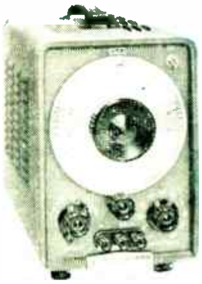
hp 200CD Wide Range Oscillator

hp 200J Interpolation Oscillator



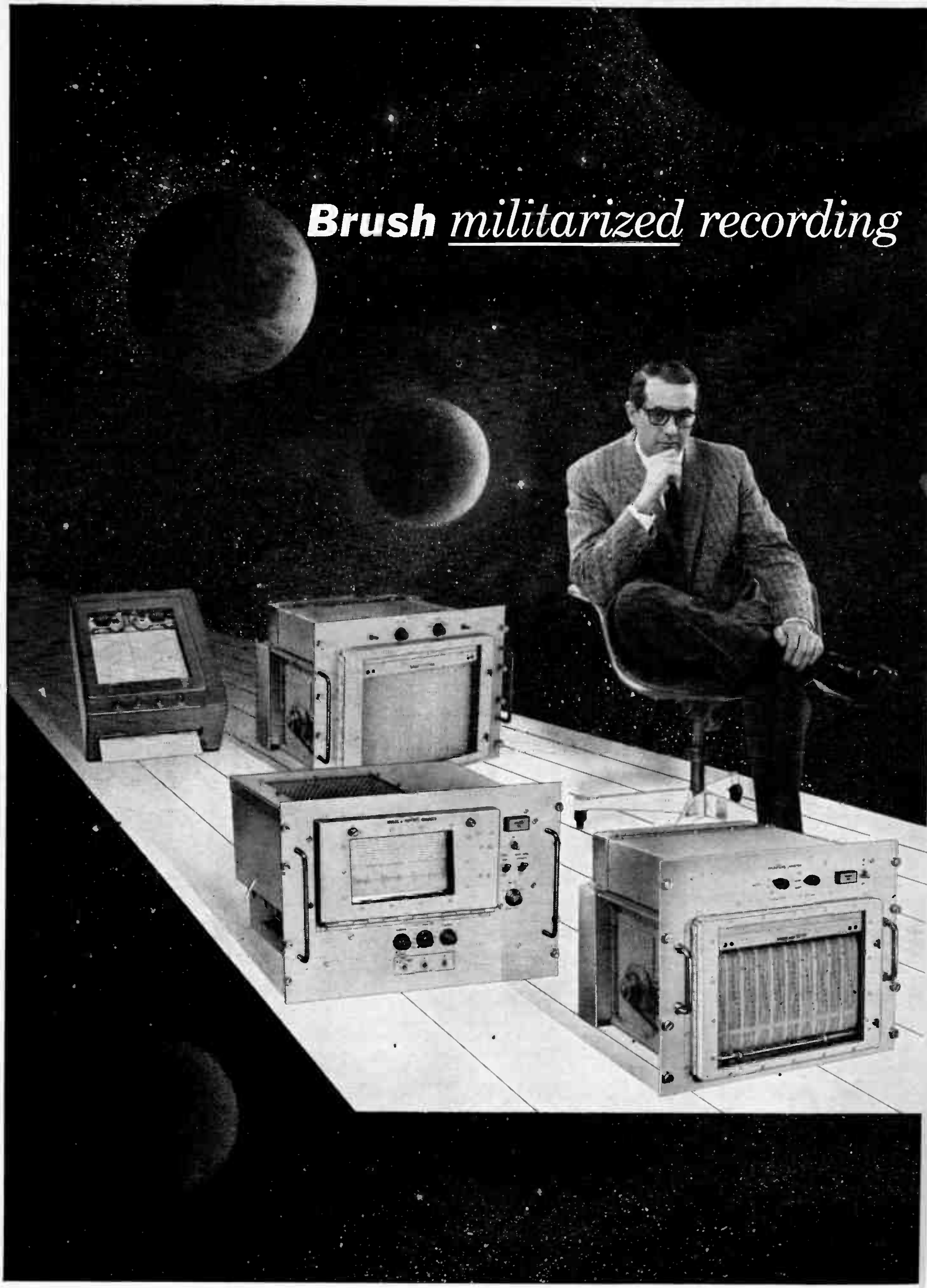
hp 200T Telemetry Oscillator

hp 201C Audio Oscillator



hp 202C Low Frequency Oscillator

hp pioneered the world-famous resistance-capacity oscillator circuit


Brush militarized recording

systems are....

READY NOW FOR "2nd GENERATION" SPACE VEHICLES!

When "second generation" space vehicles become operational, the readout of their performance will be monitored by Brush militarized equipment already in existence.

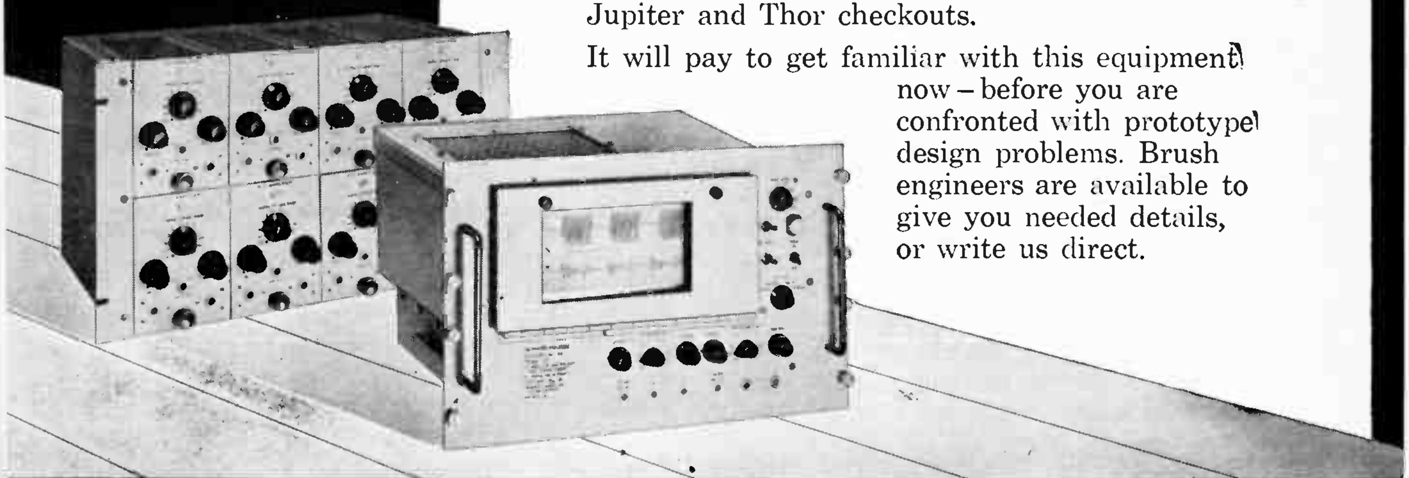
For instance, the 100-Channel Operations Monitor that will record 100 channels of data simultaneously – on a chart 12" wide! Complex checkouts are simplified.

Or 2- and 6-channel systems (including oscillograph and amplifier)... or the combination Analog and Sequential Recorder.

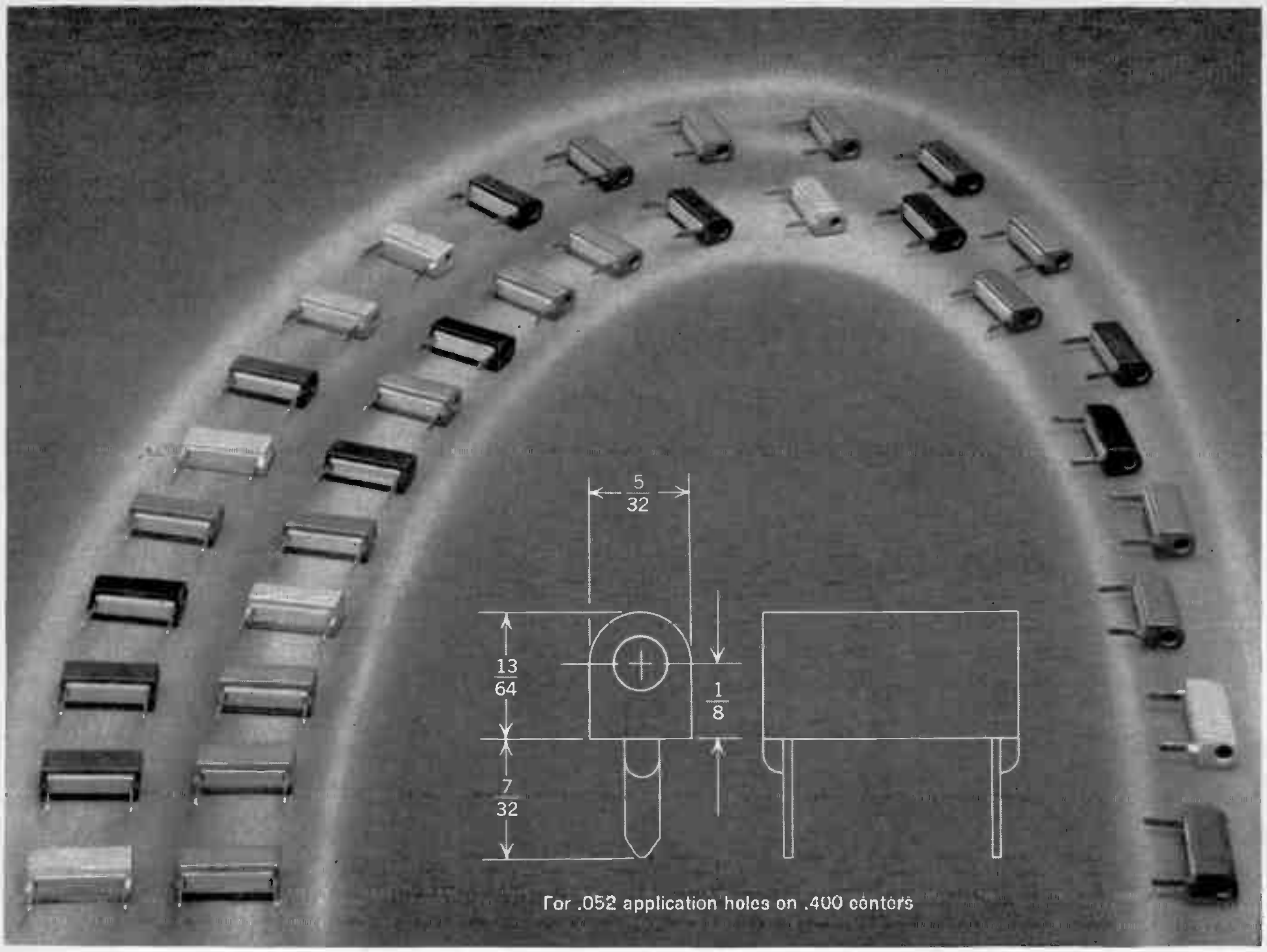
All equipment complies with Mil. E-16400, Mil. E-4158, Mil. E-4970 and other specifications as required.

For maximum reliability, equipment utilizes fast-response electric writing, proven on critical operational sites such as DEW Line, Jupiter and Thor checkouts.

It will pay to get familiar with this equipment now – before you are confronted with prototype design problems. Brush engineers are available to give you needed details, or write us direct.



brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO



Patents Pending

New

Test Jacks for Printed Circuits

Designed for permanent assembly to printed circuit boards, these new test jacks by Ucinite are easily accessible to standard .080 test probes and eliminate the need for individual adaptor boards.

Simple, economical construction ensures reliability and reasonable cost. Gold-over-silver-plated beryllium copper contacts provide dependable, low-resistance connections. Nylon bodies are available in eleven standard code colors specified as follows: Part number (119437) plus letter suffix . . . A-Opaque White, B-Red, C-Black, D-Brown, E-Green, F-Orange, G-Blue, H-Yellow, J-Gray, K-Violet, L-White translucent.

With an experienced staff of design engineers plus complete facilities for volume production of metal and plastic parts and assemblies, Ucinite is capable of supplying practically any requirement for fasteners, connectors, switches and other small metal and metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

ELECTRICAL ★ DOT ★ ASSEMBLIES

Manufactured by

The UCINITE COMPANY

Division of United-Carr Fastener Corporation, Newtonville, Mass.

New Dividends Keep Flowing

DIVIDEND ANNOUNCEMENTS from both commercial and military oriented electronics companies indicate a continued high level activity for many segments of our industry.

• **Magnavox Co.** board of directors will give consideration next month to a plan to increase dividend rates if stockholders approve a two-for-one stock split. The company plans to establish a $1.00 per share annual dividend rate payable quarterly.

• **Boeing Aircraft** stockholders will receive dividends of 25 cents a share as a regular third quarter issue next Thursday. This will be payable to shareholders of record on Aug. 20. Boeing reports sales of more than $667 million for the six months ended June 30 this year. Net earnings amounted to $3,551,688 for the period. Unfilled orders on June 30 totaled $2,387,000,000, of which $738,000,000 is for commercial jet transports.

• **Hoffman Electronics Corp.,** Los Angeles, will mail dividend checks on Sept. 30 to shareholders of record on Sept. 11. The amount will be 15 cents a share. The firm reports second-quarter earnings up 48 percent with sales totaling $10,912,712, as compared with $8,613,449 a year earlier. Company president H. L. Hoffman informs shareholders that semiconductor sales were about $5 million for the first six months of this year, as compared with $5,751,000 in all of 1958.

• **Garrett Corporation,** Los Angeles, will issue a three-percent stock dividend on Sept. 28 to shareholders of record on Sept. 2. Stockholders will receive one share for every 33⅓ shares held. The stock dividend is out of current earnings and is in addition to a cash dividend of 50 cents a share payable quarterly.

• **American Electronic Laboratories, Inc.,** Philadelphia, will ask shareholders to vote on a five-for-one stock split plan approved by company directors last month. Company spokesmen estimate that current contracts and the outlook for the balance of this year should put sales volume over the $2-million mark. Last year's volume was $1,185,045 with per-share earnings at $1.89. The company manufactures electronic and medical research equipment.

• **Television-Electronics Fund,** Chicago, issued a dividend last week of 8 cents a share from investment income, payable to shareholders of record on Aug. 3.

• **ACF Industries** will issue quarterly dividends at the rate of 62½ cents per share to stockholders of record on Aug. 28.

• **Columbia Broadcasting** plans to issue quarterly dividends of 22½ cents per share on Sept. 11 to stockholders of record on Aug. 28.

25 MOST ACTIVE STOCKS

WEEK ENDING AUGUST 21

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Intl Tel & Tel	665	35⅜	33⅛	34⅛
Sperry Rand	657	24⅛	22⅝	23½
Avco Corp	613	14	13	13½
Gen Tel & Elec	587	76⅛	71	73¾
El-Tronics	572	1¾	1⅜	1⅜
Zenith	562	106	98	101
Burroughs	505	32¼	30¼	30⅞
Gen Electric	484	81¾	78⅛	80⅞
Gen Dynamics	444	51½	48¼	48⅜
Univ Control	443	18	16½	17¾
Raytheon	431	50	46⅜	46⅝
RCA	370	63⅞	60⅜	62⅜
Texas Instr	362	137	125¼	133¼
Westinghouse	335	91⅜	87⅜	89½
Beckman Instr	277	56½	50¼	54½
Philco	277	25⅞	23⅞	25¼
Reeves Soundcrft	254	9	8⅜	8⅝
Ampex	222	83⅜	77⅝	82⅛
Elec & Mus Ind	222	7⅛	6⅞	7
Standard Coil	220	17⅛	15⅝	16⅛
Dynamics Corp	196	10¼	9⅜	9⅞
Amer Bosch Arma	195	29⅞	27¼	28⅝
Litton Ind	181	111¾	103	110¼
Intl Bus Mach	162	431	412	426
Siegler Corp	162	29	26¾	28⅝

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

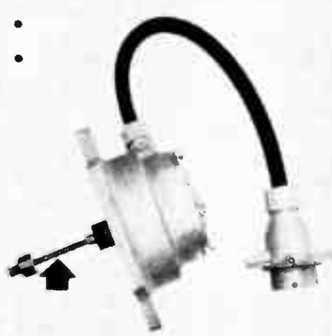
STOCK PRICE AVERAGES

(Standard & Poor's)	Aug. 19, 1959	July 22, 1959	Change From One Year Ago
Electronic mfrs.	88.89	100.77	+57.2%
Radio & tv mfrs.	107.44	118.20	+109.6%
Broadcasters	94.81	102.24	+43.5%

S.S.White

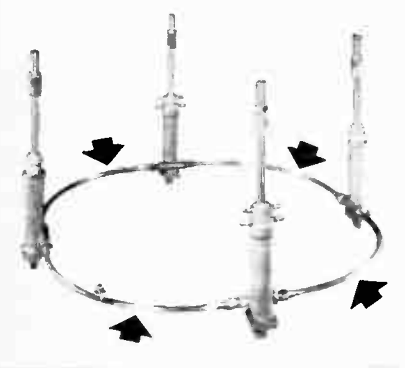
DRIVE AND CONTROL IDEAS FOR ENGINEERS

Tips on better designing with flexible shafts



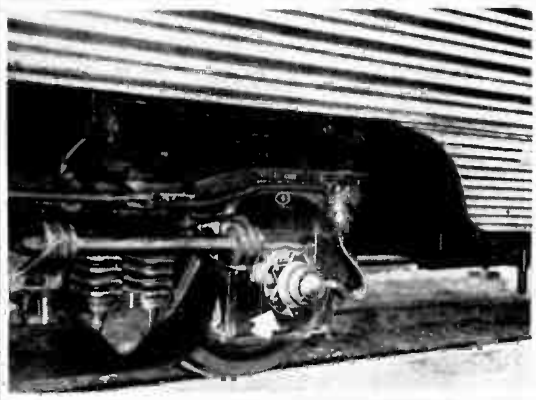
REMOTE CONTROL

Reliable synchronization at high temperature is made possible by S. S. White flexible shafts on this actuator system for jet afterburner nozzles. The job assigned the shafts was to synchronize the system to permit multipoint installation and smooth, even application of power . . . at ambient temperatures up to 650F! To see how flexible shafts simplify design, picture doing this with solid shafts, gearing, universals, and other paraphernalia, around a 360° bend . . . and then imagine installing it!



POWER DRIVE

Running cool at 45,000 rpm! The S. S. White flexible shaft on this grinder-miller permits the use of carbide and diamond tools at speeds that were previously unknown to hand tools. The flexible shaft drives the handpiece from a ¼-hp motor suspended over the table at speeds up 45,000 rpm, without overheating and without vibration. A good point for designers to note is that in many cases, the higher the speed of a flexible shaft, the better the performance.



COUPLING

Alignment and vibration problems are solved by an S. S. White flexible shaft on this railroad brake controller. The device detects wheel slippage during braking, by means of rotary switches on each axle that detect changes in relative movement between pairs of wheels on the truck. If damaging slip occurs, the device releases brake pressure until slippage stops. A flexible shaft is fitted to the axle and drives the rotor in the switch, eliminating alignment problems and preventing excessive axle vibration from reaching the sensitive device.

1056

S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION (Dept. E)
10 East 40th Street, New York 16, N. Y.

Standard S. S. White flexible shafts are available "off the shelf," making many savings possible.
Write for bulletin 5801.

USEFUL DATA ON SELECTION and APPLICATION!

S. S. White also offers engineering service and comprehensive selection of flexible shaft sizes and types to meet special requirements.
Write for bulletin 5601.

RADAR . . .

dishes and pedestals by Avco/Nashville

Today, radar takes many forms and handles many different tasks. Construction of a radar unit calls for several specialized design, engineering and production capabilities.

Such specialized capabilities are available at Avco's Nashville Division. At its large plant in Nashville, Tennessee, Avco/Nashville specializes in the design, engineering and construction of radar antennas or dishes. It also offers complete facilities for producing pedestals for large radars.

Recently the MPS-16 radar antennas and pedestals were manufactured by Avco/Nashville. Today, Avco/Nashville is at work on the antenna and pedestal of the FPS-26 radar, researched and developed by Avco's Crosley Division, that will stand three stories high and be housed in a radome about 50 feet in diameter. Also in production: very small radar antennas for use in the Mach 3 military aircraft that will be operating in the early 1960's. These use Avcomb, stainless-steel honeycomb.

Radar antennas of the conventional rod type, glass lay-up, and stainless-steel honeycomb are all within the proven capability of Avco/Nashville's engineering and production facilities.

Avco/Nashville has the capacity as well as the capability for more pedestal and antenna work, and invites inquiries from radar prime contractors. Write to: General Sales Manager, Nashville Division, Avco Corporation, Nashville, Tennessee.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO/NASHVILLE TODAY.

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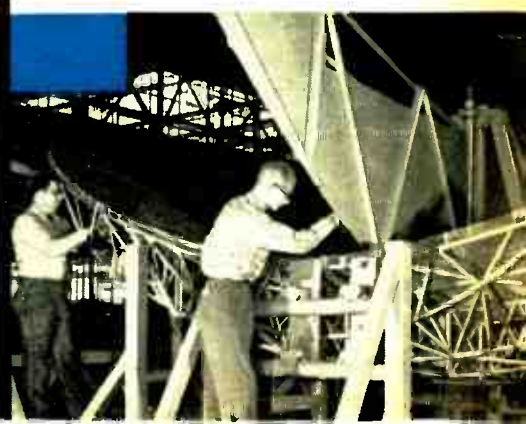
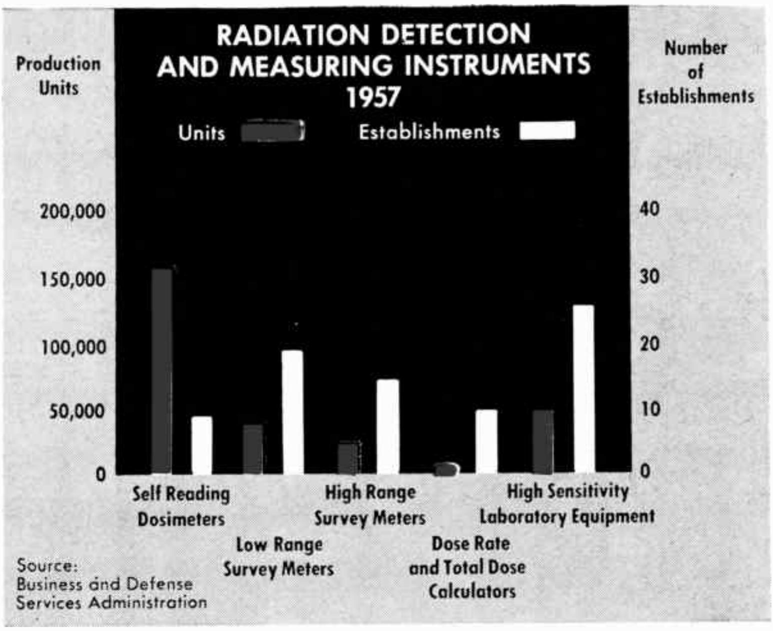




Atomic Gear: $40 Million

ATOMIC INSTRUMENTATION is one of the fastest-growing segments of the electronics industry with factory sales for last year roughly estimated at $40 million.

Business and Defense Services Administration has recently added to the limited facts available on this important market by issuing its report on radiation detection and measuring instrument production. Report data was collected in a survey conducted in 1958 among all known producers.

The BDSA report covers the 1957 production of five types of radiation instruments: Self-reading dosimeters, low-range survey meters, high-range survey meters, dose-rate and total-dose calculators and high-sensitivity laboratory equipment.

Self-reading dosimeters, with total production of 160,132 units in 1957, far exceeded unit production records of the other four instruments. Chart above shows the total unit production for each of the five instrument types and the number of producing establishments.

Analysis of survey details shows that the New England and Atlantic states account for most of the production of nucleonic instruments. For instance, over 90 percent of sensitive laboratory radiation measuring instruments are produced in Massachusetts, Connecticut, New York and New Jersey; 46,694 units were produced in this area, compared with 50,100 units for the whole nation.

However, the North Central and Pacific states are also actively participating in the manufacture of nuclear electronic equipment.

Of nine establishments producing self-reading dosimeters, five are situated in the North Central and Pacific regions. Slightly more than half of all low-range survey meter producers come from these two regions, a third of the high-range survey meter makers and about 70 percent of dose-rate calculator and sensitive radiation measuring instrument manufacturers.

Summaries of the radiation instrument survey are available from the Bureau of Census, as part of its Facts For Industry series. Questions on content should be addressed to the Scientific Motion Picture and Photographic Products Division of BDSA in Washington, D. C.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Aug. 14, 1959	July 17, 1959	Change From One Year Ago
Television sets	149,314	83,907	+19.9%
Radio sets, total	261,210	198,703	+15.0%
Auto sets	69,288	59,425	+52.1%

LFE DOPPLER NAVIGATORS.....

A model for every mission

LFE pioneered the development of fully automatic, self-contained, lightweight Doppler Radar Navigation Systems. A continuing research program has resulted in the design of systems for every type of aircraft . . . from helicopters to supersonic jets . . . with a model for every mission.

For example, LFE pioneered the Doppler system which provides hovering mode, vertical rate, and the low altitude performance required by helicopters in Anti-submarine Warfare. For Airborne Early Warning Aircraft LFE designed the system which employs ERDR (Earth Rate Directional Reference) . . . a North seeking compass system accurate to better than 0.25°. And at LFE, Doppler-Inertial, the navigation system of tomorrow, is a reality today . . . another pioneering achievement resulting from LFE *Leadership from Experience* in avionics.

L*eadership* ***f****rom* **E***xperience*

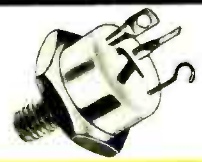
LABORATORY FOR ELECTRONICS, INC. 1079 COMMONWEALTH AVENUE • BOSTON

ENGINEERS — LFE offers outstanding opportunities for employment in Navigation — Radar & Surveillance — and Computer Systems, Instruments and Components.

5 EXCITING NEW SILICON TRANSISTOR

1. HI-POWER STUD-MOUNTED SILICON TRANSISTOR

A rugged package — easier to mount, with greater strength and lower thermal resistance. Has good beta linearity and switching characteristics good high frequency betas, low saturation voltage. Ratings up to 100 volts available.



Type	V_{cb} Max. Volts	I_c max. Amps	B Typical	R_{cs} Typical (Ohms)
2N1208	60	5	35	1.5
2N1209	45	5	40	1.5
2N1212	60	5	25	2.5

APPLICATIONS Regulated Power Supplies . . . High Current Switching . . . High Frequency Power Amplifiers

Send for Bulletin No. 1355M

2. CORE SWITCH

Improved switching speed and input characteristics. High-current capabilities with good power handling ability (5w @ 100°c). Rated and tested at 60v.

Type	V_{cb} Max. Volts	(β) Min.	Typ. Input Voltage (Volts)	Typ Saturation Resistance (Ohms)	Switching Characteristics (μsec)
ST4100	60	15	2.5	10	t_r .2
					t_s .2
					t_f .2

APPLICATIONS . . . magnetic core memory . . . high level multivibrators . . . buffer amplifiers . . . clock source

Send for bulletin 1355X

3. 150mc VERY HIGH FREQUENCY TRANSISTOR

New silicon logic transistor with speed surpassing the fastest silicon types, plus unusual power handling ability. Technical breakthrough now provides minimum and typical DC current gains of 20 and 40 respectively.

TYPE 2N1139

		Min.	Typical	Max.	Test Conditions
D.C. Current Gain	h_{FE}	20	40	—	I_C = 10ma, V_{CE} =10V
D.C. Collector Saturation Voltage	V_{CE}	—	.5	0.7V	I_C = 10ma, I_B = 1ma
Collector Cutoff Current	I_{co}	—	2	5 μa	V_{CB} = Rating
Output Capacitance	C_{ob}	—	8	12 μμf	V_{CB} =10V, I_E = 0 mA
High Frequency Current Gain	h_{fe}	5	7.5	—	F = 20mc, V_{CE} =10V I_E = 10 mA
Delay Time	t_d	—	6		mμsec.
Rise Time	t_r	—	12		mμsec.
Fall Time	t_f	—	10		mμsec.

Send for bulletin TE1355 B2

4. UNIVERSAL 50mc LOGIC TRANSISTOR

This transistor features universal application (replaces 2N337, 2N338, 2N1005, 2N1006) and high frequency response, with low saturation resistance, low input impedance, low capacitance.

Type	Typ. Alpha Cutoff (Mc)	Beta Typical	C_o (Typical) (μμf)	Max. (Volts)	Typ. Saturation Resistance (ohms)
ST3031	70	50	2	20	40

APPLICATIONS . . . flip-flops . . . IF and video amplifiers . . . transistor logic . . . pulse amplifiers

Send for bulletin 1353X

5. STABISTOR COUPLED LOGIC TRANSISTOR

Designed to provide minimum storage times under severe base overdrive conditions in transistor logic circuitry. Tightly controlled input characteristics provide interchangeability; low R_{cs} assures reliable operation at high temperature.

Type	Beta Typical	V_c max. (Volts)	Typical Saturation Resistance (ohms)	Typ. Alpha Cutoff (Mc)	Switching Characteristics (μsec)
ST3030	12	15	40	50	t_r .05
					t_s .20
					t_f .10

APPLICATIONS . . . designed specifically for SCTL and DCTL circuits (write for descriptive paper on SCTL)

Send for Bulletin 1353Y

DEVELOPMENTS FROM TRANSITRON *...added to* THE INDUSTRY'S MOST COMPLETE LINE

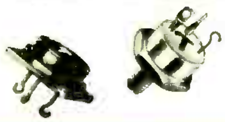
SILICON TRANSISTORS

JAN TRANSISTOR		Minimum Current Gain (β)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (Mc)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	JAN-2N118	10	30	10	1	• Only Jan Silicon Transistor

SMALL SIGNAL		Minimum Current Gain (β)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (Mc)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	2N333	18	45	7	50	• Low I_{co} • Operation to 175°C • 200 mw Power Dissipation
	2N335	37	45	10	50	
	2N480	40	45	11	.5	
	2N543	80	45	15	.5	
	ST905	36	30	10	10	

HIGH SPEED SWITCHING		Typical Cut-off Freq. (Mc)	Maximum Collector Voltage (Volts)	Maximum Collection Saturation Resistance (ohms)	Max. Power Dissipation @ 100°C ambient (mw)	FEATURES
	ST3030	50	15	60	50	• High Frequency Operation • Low Saturation Resistance • Low I_{co}
	ST3031	70	20	65	50	
	2N1139	150	15	70	500	
	2N337	20	45	150	50	
	2N338	30	45	150	50	

MEDIUM POWER		Max. Power Dissipation @ 25°C Case (Watts)	Maximum Collector Voltage (Volts)	Minimum DC Current Gain (β)	Typical Rise Time (μsec)	Typical Storage and Fall Time (μsec)	FEATURES
	ST4100	5	60	15	.2	.4	• Fast Switching • High V_c • Rugged Construction
	2N545	5	60	15	.3	.5	
	2N547	5	60	20			
	2N498	4	100	12			
	2N551	5	60	20			
	2N1140	1	40	20	.2	.2	

HIGH POWER		Maximum Power Dissipation .. 25°C Case (Watts)	Minimum DC Current Gain (β)	Typical Collector Saturation Resistance (Ohms)	Maximum Collector Voltage (Volts)	FEATURES
	ST400	85	15 @ 2 Amps	1.5	60	• High Current Handling Ability • Low Saturation Resistance • Rugged Construction
	2N389	85	12 @ 1 Amp.	3.5	60	
	2N424	85	12 @ 1 Amp.	6.0	80	
	2N1208	85	15 @ 2 Amps	1.5	60	
	2N1209	85	20 @ 2 Amps	1.5	45	
	2N1212	85	12 @ 1 Amp.	2.5	60	

Write for Bulletins: TE-1353 and TE-1355

Your local authorized TRANSITRON DISTRIBUTOR now carries in-stock inventories for immediate delivery.

Transitron electronic corporation • field, massachusetts

"Leadership in Semiconductors"

Table I — Chief Executives' Compensation

	% Changes over Previous Years			
	1958	1957	1956	1955
General industry	—1.8%	1.0%	5.1%	6.3%
Electrical equip.	—1.6	1.6	2.2	—2.2
Electronics	0.1	2.3	NA	NA

Table II — Sales, Profit Changes

	Sales		Profits	
	1958	1957	1958	1957
General industry	—3.1%	5.3%	—11.7%	—3.2%
Electrical equip.	—4.3	11.0	—34.5	1.1
Electronics	0.5	11.3	—23.5	12.6

Executive Pay Inches Up

Top men in electronics register slight gain while counterparts in other industries got less in '58. Survey points up pay comparisons

CHIEF EXECUTIVES in electronics in 1958 received a pay increase over 1957 despite the recession, while chief executives in general industry received less pay. The slump in profits, however, shaved the amount of the increase below that of the previous year.

These conclusions, just reported, come from the fifth annual survey of executive compensation carried out by McKinsey & Co., Inc., New York, international management consultants, covering 791 firms listed on major stock exchanges. Companies were grouped into 23 industries, with the electrical equipment industry embracing electronics.

In addition, a supplementary study was made of 41 companies heavily engaged in electronics with sales ranging from $10 million to $4 billion. Stress was on comparing year-to-year changes in pay of the electronics chief executive with other industry chiefs.

What's Compensation?

Survey defines compensation as salary, bonuses and deferred accruals awarded during the year, does not include fringe benefits.

Top electronics executives in 1958 gained 0.1 percent over 1957. Their general industry counterparts dropped 1.8 percent (see Table 1).

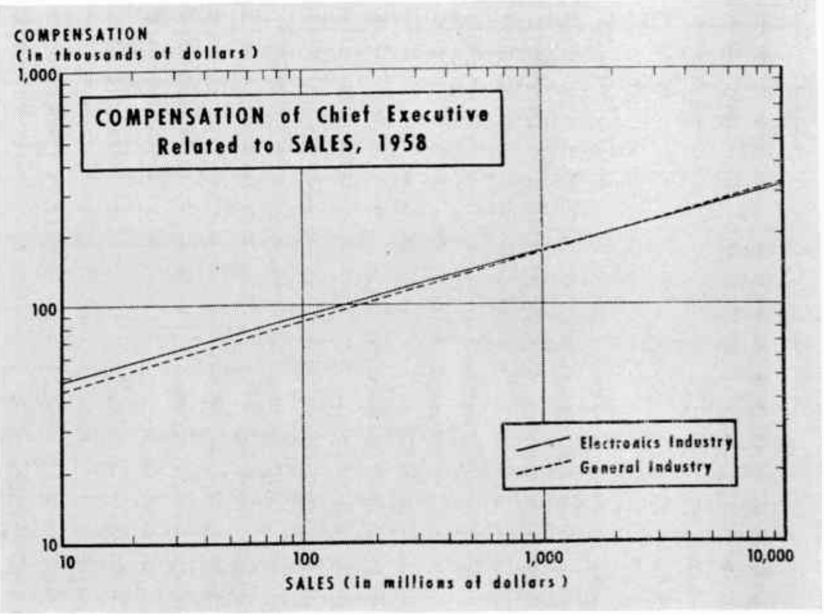
Despite the overall pay gain for electronics chiefs, the survey pointed up wide variations in the sample companies. Some 39 percent of the firms actually paid less, 27 percent paid the same and 34 percent paid more.

Thus, with 1958 profits down about 20 percent, almost one-third of the firms made no change in their chiefs' pay. Survey indicates that in 1957 about one-third of these executives received the same pay as in 1956, even though sales and profits were up more than 10 percent.

In 11 of the 41 electronics companies, the chairman of the board was the chief executive and the highest paid member of the management team. Seven chairmen were under 65.

Exact influence sales and profits have on the chief executive's pay is difficult to determine. However, this much seems clear:

Overall factory sales in electronics in 1958 were up 1.8 percent from the 1957 level of $7.8-billion. Breakdowns show that military and industrial electronic sales increased, and that consumer products and replacement items



dipped. Drop in consumer business is attributed to a 23-percent decline in retail television sales and a 10-percent slump in radio sales.

Broad Base Helps

Diversification of firms in all branches of our industry made the effects of the recession in consumer-durables sales less pronounced than in some other industries (see Table II). Average company profits, however, slumped almost twice the rate of general industry.

Relationship between sales and compensation in electronics companies follows very closely the pattern of the general industry group, as seen in chart, p 24. The electronics industry, however, pays its executives a little better than general industry in the small companies with low sales volume.

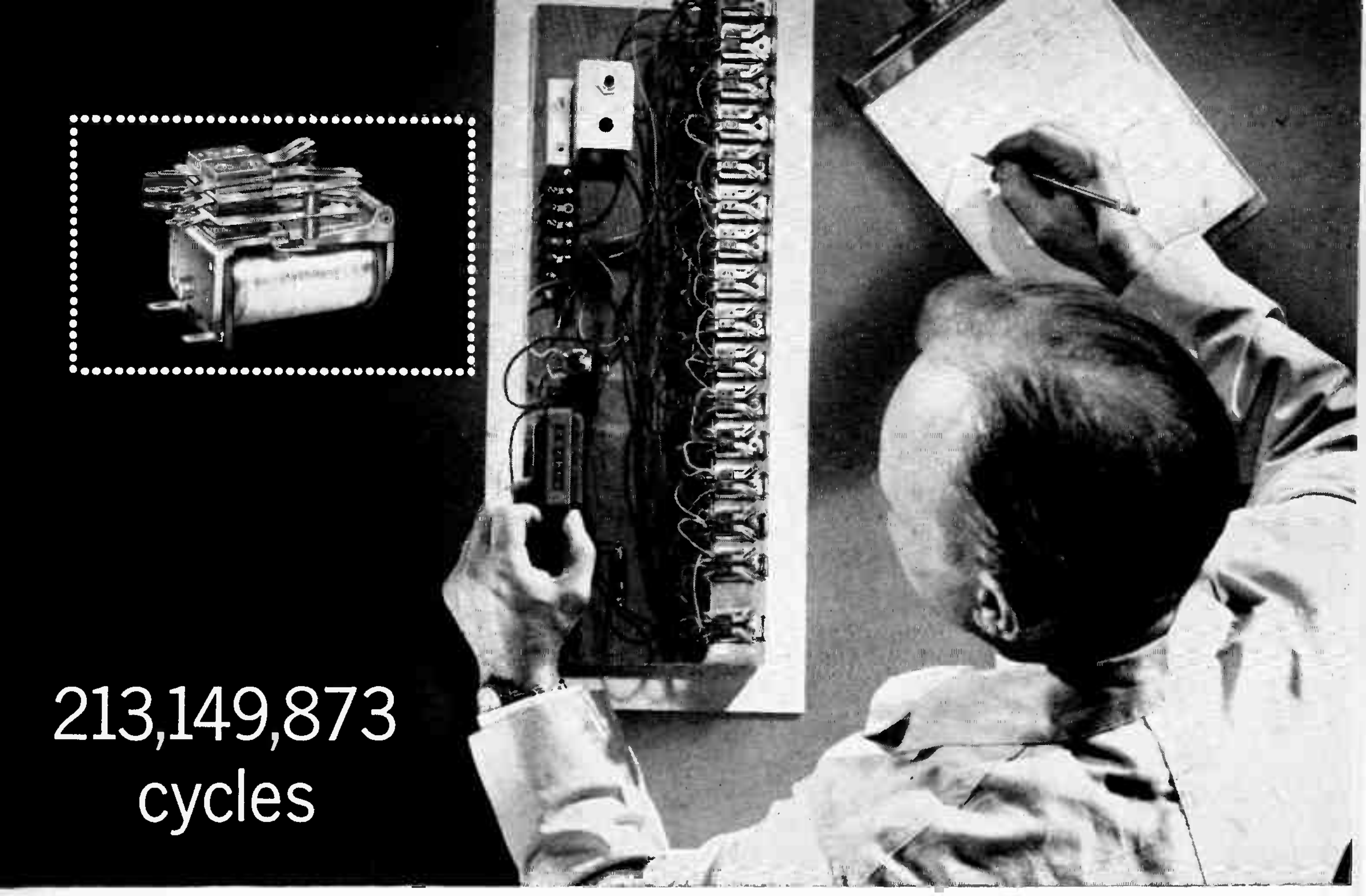
The chart indicates that the top executive who wants to increase his pay from $50,000 to $100,000 would have to increase his firm's sales from $12 million to $150 million.

For firms with sales of $50 million, pay of $74,000 for the chief executive of an electronics company compares with pay of $54,000 in air transport and $84,000 in business machines and tobacco. Comparable figures for companies with sales of $250 million are $72,000 in transport, $155,000 in personal and household supplies and $115,000 in electronics.

What Others Get

The survey reveals that executives other than the chief executive fared significantly better in electronics than in other industries. The Number Two men in electronics in 1958 received an average of 80 percent of the amount paid to the chief executive. Their counterparts in electrical equipment received 77 percent, and those in general industry, 73 percent.

For the Number Three man, the comparison was 66 percent of the chief's compensation in electronics, 63 percent in electrical equipment and 60 percent in general industry. Similar figures for the Number Four man are 58 percent in electronics, 59 percent in electrical equipment and 55 percent in general industry.



Test proves reliability of P&B's LS telephone type relay

These 16 LS relays, wired into a self-cycling chain, each operated 213,149,873 times before the test was discontinued. This test was made for a nationally prominent manufacturer and the certified results are available upon request.

Here is proof of the inherent reliability of P&B telephone type relays . . . and of the kind of performance you can expect when you specify them. LS relays are available with up to 20 springs (10 per stack) and are adaptable for printed circuit mounting.

Whenever multiple switching of loads up to 4 amperes is required, the LS can usually meet space, weight and—importantly—price considerations. Get full information today by calling or writing Zeke R. Smith, vice president, Engineering, or contact your nearest P&B representative.

TS RELAY
Short coil relay is available in AC and DC versions. Long life construction. Can be supplied (DC) with up to 20 springs (10 per stack).

GS RELAY
Excellent sensitivity: 50 mw per movable arm minimum (DC). For applications requiring many switching elements in small space.

BS RELAY
Long coil provides high sensitivity (25 mw per movable arm) and room for slugs for pull-in delays (150 milliseconds max.) or drop-out delays (600 milliseconds max.).

LS ENGINEERING DATA

GENERAL:

- **Breakdown Voltage:** 1,000 volts rms 60 cy. min. between all elements.
- **Ambient Temperature:** —55° to +85° C.
- **Weight:** 3 to 4 oz.
- **Dimensions:** 1$\frac{5}{32}$" W. x 2$\frac{3}{8}$" L. x 1½" H. (4 Form C)
- **Enclosures:** Sealed or dust cover (W can) Sealed or dust cover, up to 6 Form C, single contacts (D can)
- **Mountings:** Four #6-32 tapped holes ¾" x $\frac{5}{16}$" o.c. Other mountings available.

CONTACTS:

- **Arrangements:** 20 springs (10 per stack) max.
- **Material:** $\frac{1}{16}$" dia. twin palladium. Other materials available for specific applications.
- **Load:** 4 amps @ 115 volts 60 cy. resistive.

COIL:

- **Resistance:** 55,000 ohms max.
- **Power:** 65 mw DC per movable standard (50 mw possible); 3.5 watts max. at 25° C.
- **Voltage:** Up to 200 volts DC.

TERMINALS:

- **Contacts:** Three #18 AWG wires.
- **Coil:** Three #20 AWG wires.
- Available with octal plug, taper tabs or printed circuit pins.

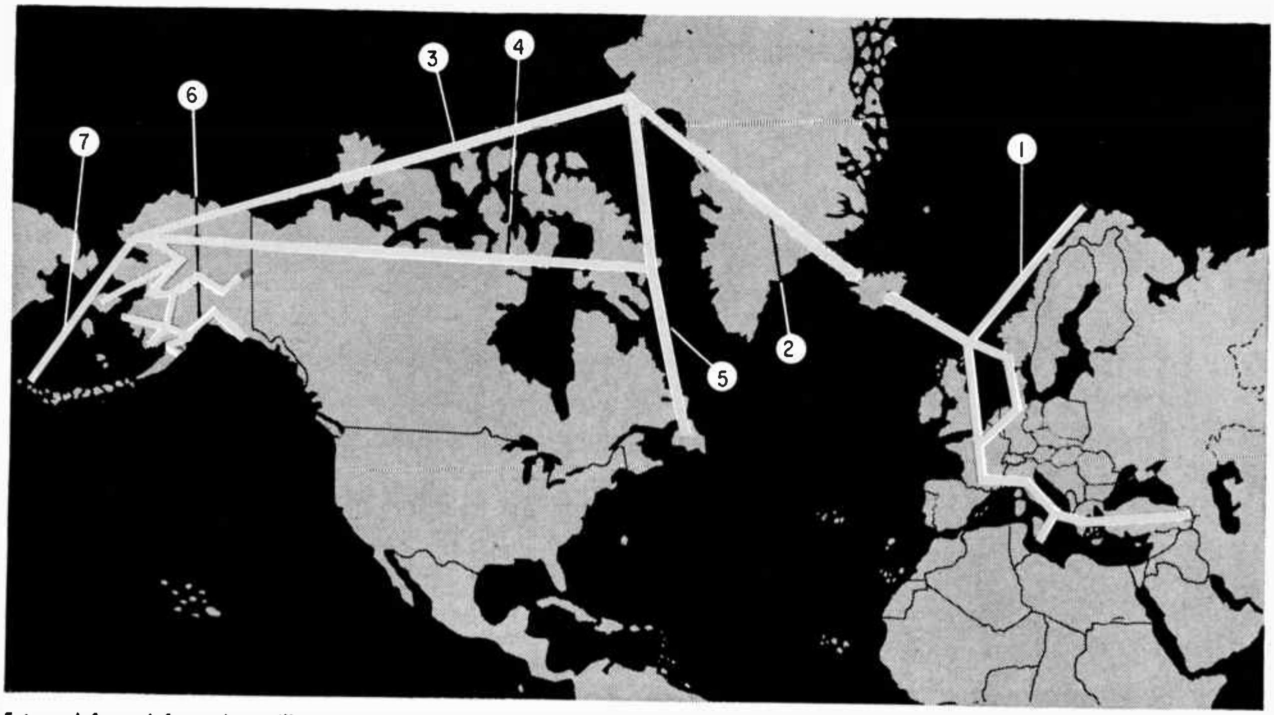
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

FREE
LS DETERMINATION DATA
Send today for booklet containing certified results of recent test described above. Data includes test circuit, interim and final measurements.

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

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



Future defense information will span two continents along these paths: (1) Ace-High (2) AN/FRC-39 (3) DEW-line (4) BMEWS (5) Pole Vault (6) White Alice (7) Stretchout

Tropo to Link Continents

Communications experts predict intercontinental defense messages will go direct from Turkey to Alaska within three years via new networks

DIRECT TROPOSCATTER communication between North America and Europe may become a reality within the next two or three years, according to information made available exclusively to ELECTRONICS this week.

Key to accomplishment of this goal is the completion of Ace-High, NATO's 6,500-mile tropospheric scatter system which will run from Turkey to Norway.

When completed, Ace-High will run from Turkey to Greece, Italy, France, West Germany, Belgium, Denmark, Norway, Sweden, and England, stopping eventually at Iceland. Also included will be a Mediterranean spur in the region of Malta (see map).

The system will include 41 troposcatter stations in addition to line-of-sight installations and some cables.

Present Washington plans tentatively call for extention of BMEWS into northern Scotland. BMEWS' communication system, or DEW-line's AN/FRC-39, which will run from Baffin Island to Iceland, would complete the two-continent circuit.

Completion Date Guarded

Target date for completion of Ace-High is being kept under wraps, although certain indicators exist. Radio Electronics Laboratory, a subsidiary of Dynamics Corp. of America, holds a $6-million contract to furnish troposcatter gear which includes 117 ten-kw amplifiers, 116 exciters and 81 receivers. R. F. Kelley, DCA president, says delivery is called for by midsummer of 1960.

Systems contractor for Ace-High is International Standard Engineering Inc., an IT&T company which, under an $11-million contract, is responsible for all systems engineering. Company officials tell ELECTRONICS that land acquisition and personnel recruitment will be handled directly by SHAPE (Supreme Headquarters, Allied Powers in Europe) rather than by the systems contractor for the project.

Among other U. S. firms involved in Ace-High is ITE Circuit Breaker Co., Philadelphia. This company's special products division is working under a $5,400,000 contract to supply antennas and waveguides for the project.

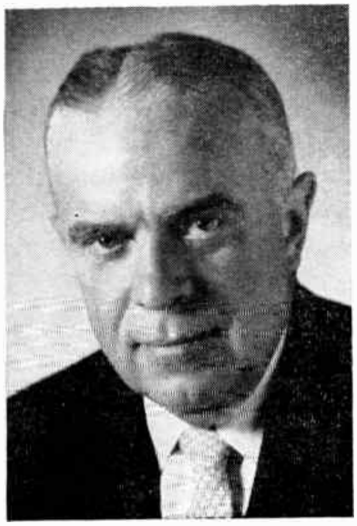
Some Shipments Slated

ITE will design and erect the antennas which will be manufactured in Germany by Krupp under subcontract to ITE. Initial delivery is slated for late this year. The host nations will provide foundations and riggers at each site.

Great Northern Telegraph Co. of Denmark will work in the area between Scotland and Iceland, where cable and microwave will both be used.

Telephone equipment will most likely be supplied by Pye, Ltd. of England and other European manufacturers. Coaxial cable and hardware items will come from German and Scandinavian factories.

How McGraw-Hill Circulation



Advertisers today are asking for more and more evidence on which to base their media decisions. This is a healthy attitude that we heartily encourage.

One subject on which we are often queried is circulation. From time to time, therefore, I believe it is helpful for us to restate and re-emphasize McGraw-Hill's basic circulation philosophy.

I am consequently using this method of frankly answering some questions that have been asked by agencies and advertisers.

Nelson L. Bond

PRESIDENT, PUBLICATIONS DIVISION

1.
Why does McGraw-Hill believe so strongly in paid circulation?

Fundamentally, because payment for a product represents the normal and natural way of doing business. Agencies sell their services, advertisers sell their products. The general magazines and newspapers of this country are sold, to subscribers or on newsstands. We're no different from these agencies, advertisers and other media. We simply share their belief in the cardinal rule, "If something has value it can be sold."

2.
Does paid circulation guarantee readership?

No. Payment for a subscription, however, certainly indicates an intent to read. The subscriber expresses this intent in the simplest and most universally recognized form—money. Having expressed it, he retains full freedom of choice. If he doesn't read the publication, he won't continue to pay for it.

Further evidence of readership of a publication by its paid subscribers is contained in a recent Laboratory of Advertising Performance study. (Laboratory of Advertising Performance Sheet 1195 will be sent on request.)

3.
Can paid circulation really provide "100% market coverage"?

No, especially if you interpret coverage as readership, not just receivership. We recognize that there are in every market a certain number of people who do not and will not read any publication; you can lead them to water but you can't make them drink. Nobody is going to get their attention as readers.

There is another group of people who can be reached only by McGraw-Hill's type of vigorous, persistent circulation selling activity. By direct mail, our own field salesmen, and by issue cards, we uncover many of the "hidden buying influences" who are important to market coverage, but who are not listed in directories or registration rosters.

McGraw-Hill publications provide representative, selective circulation in the markets they serve. Both the quantity and the quality of the subscribers are identified by actual audit of paid transactions. This provides the advertiser with documented answers to two basic questions about the audience he is buying: "Who are these people?" "How many of them?"

4.
Does paid circulation guarantee "editorial quality"?

In our view, "editorial quality" is measured directly by the publication's usefulness to the reader. If the editorial content does not match his job interests, serve his needs, help solve his problems and compel his continuing attention, it is not of real use.

If it isn't useful, he will neither buy the publication nor read it.

Paid circulation means that we have accepted the challenge of placing our editorial services on the block. We have given every reader the option of deciding on the value of this editorial service to *him*. He casts his ballot, for or against, when he first subscribes and every time he comes up for renewal.

Editorial quality, or usefulness to the reader, thus is judged, not on a theoretical basis, but on the hard fact of a "sale" or "no-sale" decision by the publication's audience.

Policies Benefit Advertisers

5.

Doesn't it cost more to sell subscriptions than to give them away?

It is possible that, on some publications, selling costs may temporarily exceed subscription income. Usually this is because of circulation growth factors involved in the sale of new subscriptions. However, the economics of paid circulation are not based on selling new subscriptions only, but on the lower cost of renewals as well.

For example, over the last ten years, McGraw-Hill publications have collected more than $42,700,000 in subscription fees. The total of all expenses involved in the procurement (sales and collection) of these subscriptions amounted to just over $34,700,000. This gave us a subscription sales margin of about $8,000,000, plus the valuable privilege of mailing under second class postage rates. The subscriber, therefore, has shared in the costs of our publishing operation.

6.

Doesn't paid circulation mean that you have to accept all subscriptions, regardless of quality?

Not at all. Subscriptions are solicited and accepted only from people who meet the circulation *specifications* set by each publication. These standards are clearly defined, and can be examined by any interested advertiser or agency. These standards result in audiences of men who benefit from the publication's editorial contents and whose buying power benefits the advertiser.

We make clear in the masthead of each publication that we do not offer the publications to everyone who wants to subscribe. On the average, we decline about 20,000 subscriptions a year from people who, based on our specifications, would not benefit from receiving the publications. (Current listings of subscriptions recently declined are available on request.)

In addition, the nature of our publications' editorial contents, and the subscription payments screen out people who do not meet circulation specifications.

7.

Is it true that some people don't pay for their own subscriptions?

In some cases, yes. A study of our subscribers shows that 17.3% of subscriptions are ordered and paid for by the company. Another 32.7% are paid for by the company, but requested by the individual. The remaining 50.0% are paid for by the individual subscriber himself. So, 82.7%* of the subscriptions are delivered on the request and initiative of the individual. As to the remaining 17.3%, the company that buys for its key employes undoubtedly makes sure of the usefulness of the publication —particularly since it has to be renewed periodically by the payment of company funds.

8.

What does paid circulation mean to the advertiser?

Many things. But most directly and most importantly it means more evidence, and better evidence, as to publication values. Namely:

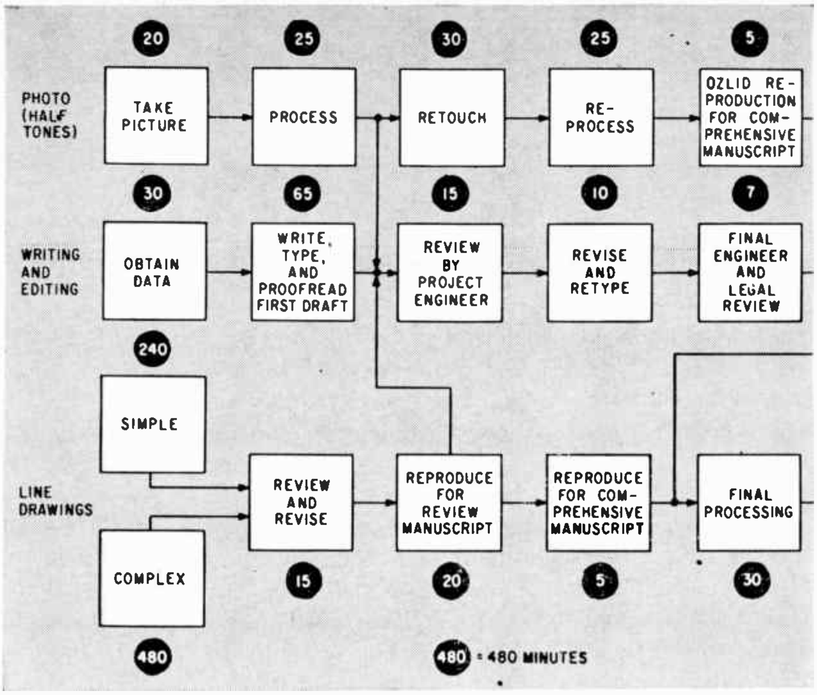
- Evidence of active interest in the publication, as represented by payment for a subscription.
- Evidence, in the same tangible form, of an *intent* to read the publication.
- Evidence of editorial quality, as represented by the interest and intent referred to above.
- Evidence of the reader's true evaluation of the usefulness of the publication, as represented by payment for renewal subscriptions.
- Evidence of active circulation, as represented by subscriber action in correcting and keeping up-to-date circulation lists.

**Figures from Laboratory of Advertising Performance, Sheet 1114, will be sent on request.*

This, of course, is not the complete story. Intangible benefits accrue from circulation policies based on the sound initial premise that the subscriber must be served first. Paid circulation, although an integral part, is certainly not the only ingredient of our publishing philosophy. We hope, however, that the foregoing answers have been of value in clarifying our position on this vital part. If you have further questions, won't you please contact your local McGraw-Hill representative? Or write directly to us.

McGraw-Hill
PUBLICATIONS

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42nd ST., NEW YORK 36, N. Y.



Evolution of a typical publication involves photography, writing and editing and drafting. Time in minutes for each phase is shown above each step in flow chart

Technical Reports: A

By **JOHN FALLON**, Sanders Associates, Inc., Nashua, N. H.

TODAY GOOD technical reports are a must for any successful engineering organization. Unfortunately, time and budgets often make report writing an engineer's nightmare. A well-planned program can readily overcome many of these problems.

The work-flow chart above shows how our firm successfully produces technical publications. Experience proves that the times allotted are realistic. Manuscripts are retyped before making masters. The first draft is reviewed and corrected. A clean second draft reduces typing errors on the masters.

The method blends four essentials of technical reports: information content, economy, presentability and speed of production.

To get an informative report, engineering and editorial responsibilities are separated. The engineer supplies facts and prescribes slant and emphasis. The editor insures clarity, readability and style.

Careful proofreading after retyping is a must. One person with a technical as well as editorial background must clearly indicate all necessary changes.

A comprehensive prototype of the finished report avoids errors in the master and enables the printer to position the illustrations properly.

Economy

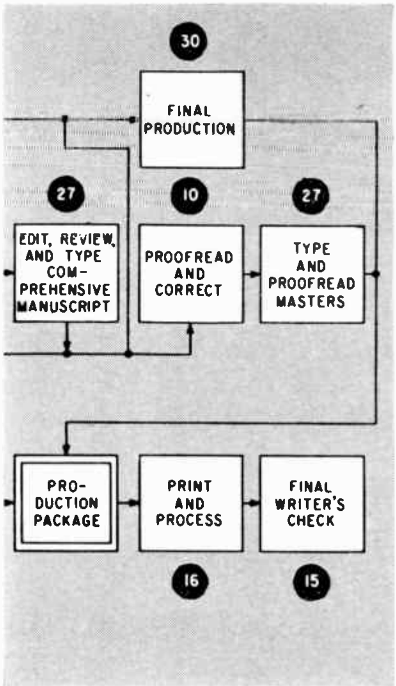
Personnel are required to charge their time accurately. Charge numbers should be subdivided to distinguish between each of the different services shown in the flow chart. A secretary should make a daily check of these time charges. A regular record of expenses, prepared by the accounting department, should be carefully compared with funds allotted.

Expenses should be broken down to cover each phase of report production. Key costs to review are the cost per page of text, equations and illustrations.

Publication costs should be included in overall contract bids. Specify exactly the number of text pages, halftones and line drawings in the finished report.

Presentability is not achieved by plushness. The report should be attractive but should not suggest that money is being spent for show.

Standardization of covers, page layouts, section headings and writing style is an economical way to improve appearance. The standards



New Look

should be distributed to all interested personnel.

Illustrations should appear immediately after their first text reference. Standardization of illustration size reduces production problems.

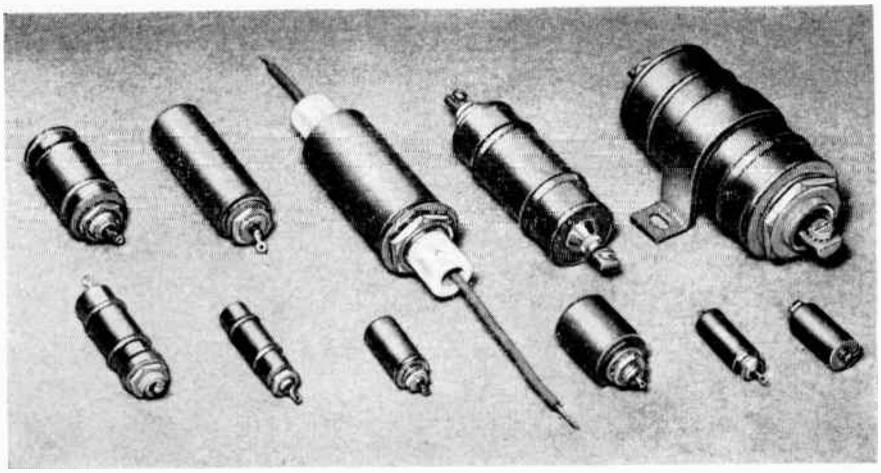
Delivery

All report deadline dates for the coming year should be reconciled to avoid bunching. In making a subsequent contract bid, specify a report delivery date that fits in with the long-range program.

Working backwards from the delivery date, starting time for each report can be accurately fixed. Knowing the approximate size and complexity of a report, it is possible to tell whether each phase is being completed on time.

A weekly status sheet describing progress and problems is helpful. The status sheet is distributed to management personnel. The sheet helps clear any jams that develop unexpectedly.

All phases of production should be flexible. By establishing a working relationship with outside vendors, it is often possible to get relief on crash programs.



New Series of Sprague Cylindrical-Style Radio Interference Filters: top row, l. to r.—4JX14, 5JX94, 1JX115, 20JX15, 50JX20 bottom row—5JX27, 1JX54, 1JX113, 1JX117, 2JX49, 1JX118.

New Series of Small, Light Radio Interference Filters

The new cylindrical-style radio interference filters recently announced by Sprague Electric Company are the smallest and lightest filters of their type available for military and industrial electronic and electrical equipment. Their basic design was pioneered by Sprague in order to achieve maximum miniaturization.

This new series of standard filters, believed to be the largest in the industry, ranges in current rating from 5 milliamperes to 50 amperes to cover the great majority of application needs.

The natural shape of the rolled capacitor section and of the toroidal inductors dictates the cylindrical form. All filters have threaded-neck mountings for use on panels or bulkheads. This assures both the proper isolation between input and output terminals as well as a firm peripheral mounting with minimum impedance to ground.

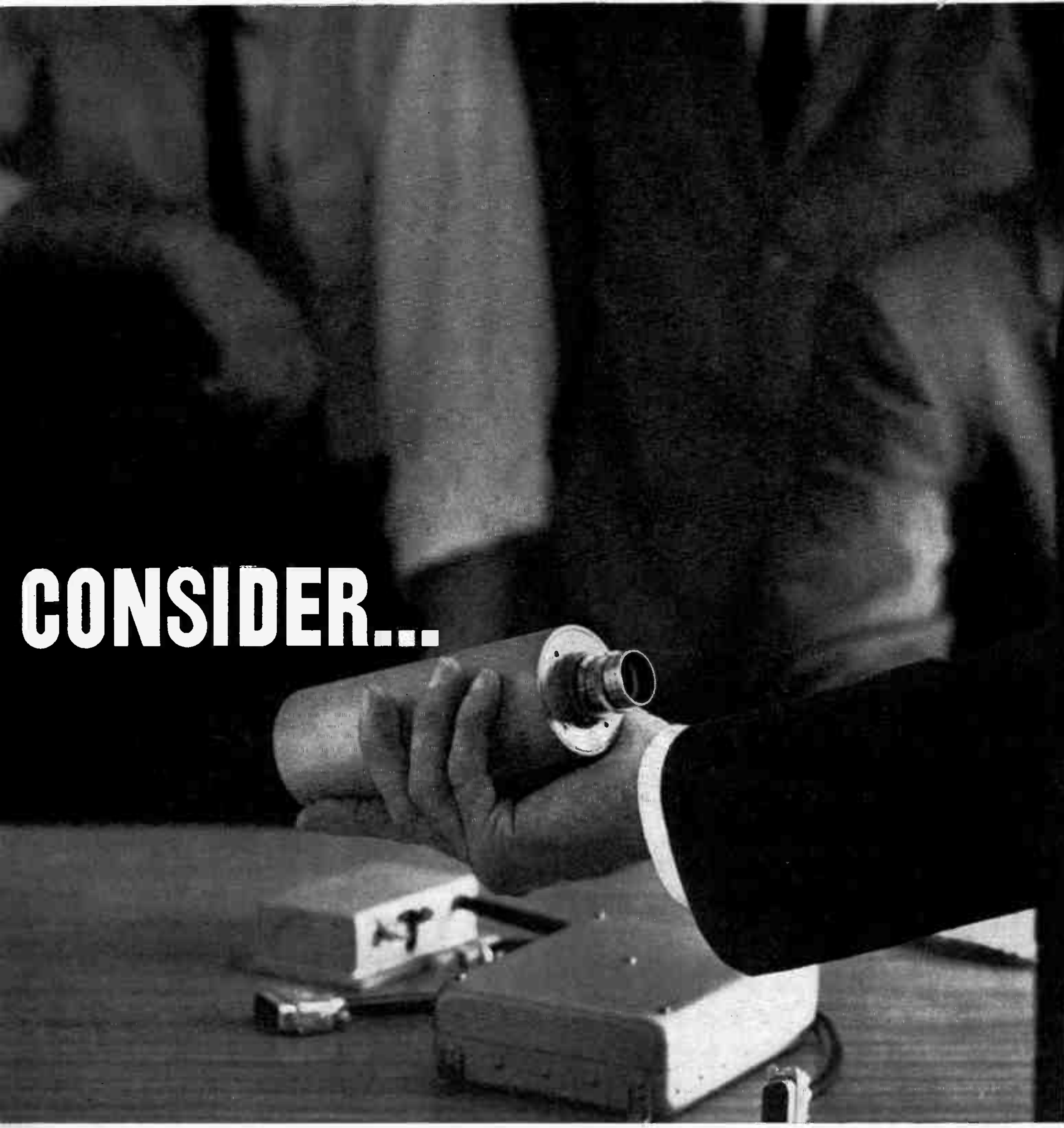
Listed in Sprague Engineering Bulletin 8100 (available upon request to the Technical Literature Department) are 68 of the more popular low-pass filter designs intended for use as three-terminal networks connected in series with the circuits to be filtered. The excellent interference attenuation characteristics reflect the use of Thrupass® capacitor sections.

Since maximum effectiveness of filtering involves elimination of mutual coupling between input or noise source and output terminals, filters should be mounted where the leads being filtered pass through a shielded chassis or bulkhead. The threaded neck mounting is designed to give a firm metallic contact with the mounting surface over a closed path encircling the filtered line and to eliminate unwanted contact resistance so that the theoretical effectiveness of these units is realized in practice.

Typical insertion loss is determined by measurements made in conformance with Military Standard MIL-STD-220. Minimum curves for specific filters are available upon request.

For assistance in solving unusual interference, rating, or space problems, contact Interference Control Field Service Manager, Sprague Electric Co., at 12870 Panama Street, Los Angeles 66, California; 224 Leo Street, Dayton 4, Ohio; or 35 Marshall Street, North Adams, Massachusetts.

CIRCLE NO. 31 READER SERVICE CARD



this rugged Video Telemetering System

THIS REMARKABLE NEW television system gives you the power of sight where human eyes cannot go. It can be directed outward for observation, or inward to "watch" internal operation from a range of 1,000 miles line-of-sight.

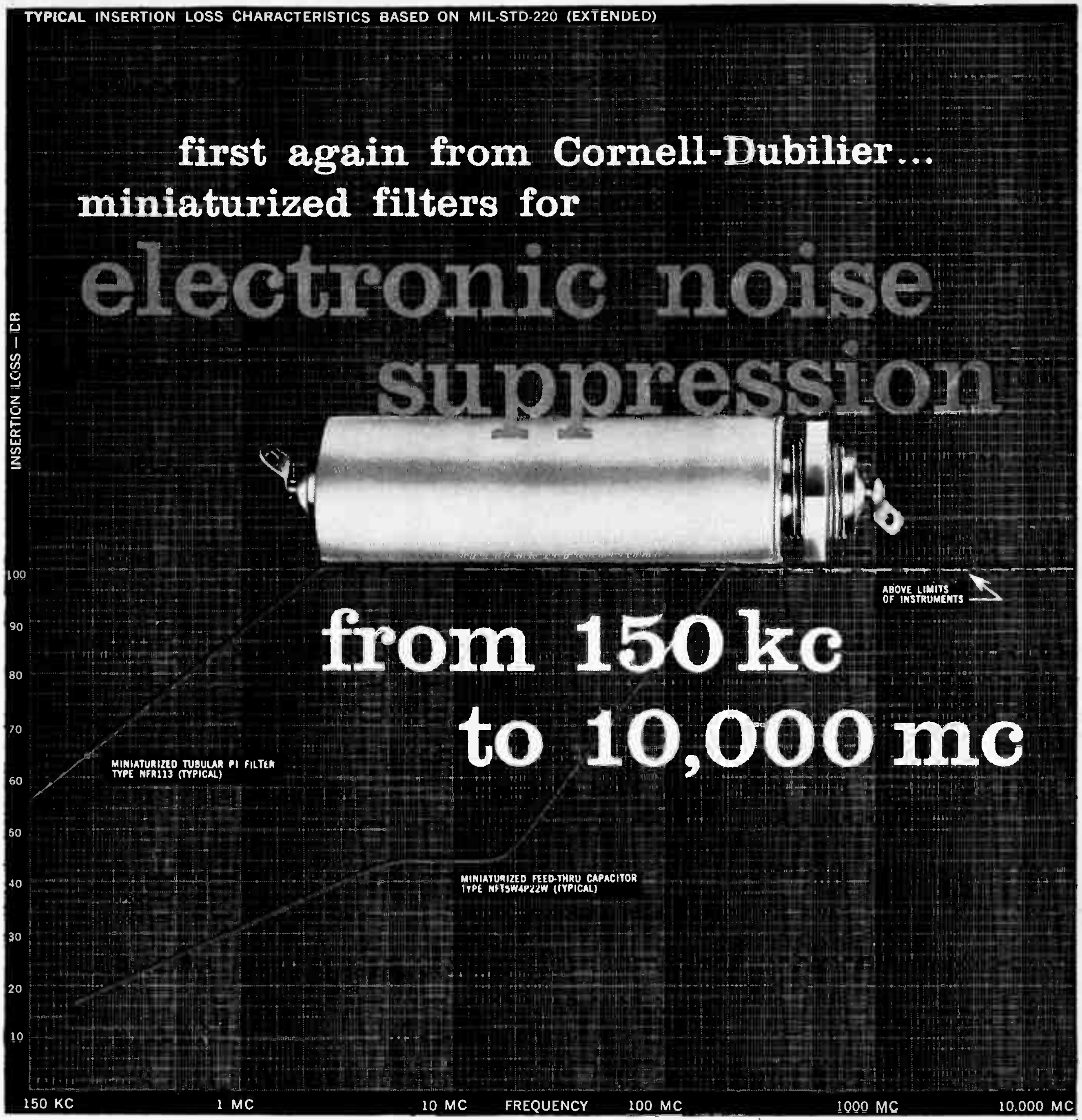
Capable of operation under extreme environmental conditions, and packaged for use under conditions requiring limited space, weight, and power, the Model 701 includes such features as: transistorized circuitry, 525 line, 30-frame fully interlaced picture, crystal controlled EIA synch, and high sensitivity.

Weight of the complete unit is under nine pounds. Total volume is less than 119 cubic inches. Its critical-design requirements are typical of all *LEAD* products. Each can be modified to meet many different requirements. Tell us what yours are. Contact our Marketing Branch, Lockheed Electronics & Avionics Division, 6201 E. Randolph St., Los Angeles 22...OVerbrook 5-7070.

Requirements exist for staff and supervisory engineers

LOCKHEED ELECTRONICS & AVIONICS DIVISION

Look to Lockheed for LEADership in Electronics



Another First From The Cornell-Dubilier Filter Laboratories. Now... MINIATURIZED pi filters and 3-terminal feed-thru capacitors for interference suppression at any frequency from 150 kc to 10,000 mc. No matter how unusual your design requirements, the C-D Filter Laboratories can deliver the precise suppression component you need. Tubular shapes, neck-mounting designs and smallest possible case sizes save space and weight, and provide easy installation. C-D's *miniaturized* tubular pi filters and feed-thru's also provide better insertion loss per unit volume, lighter unit weight and lower unit cost as compared to other types of suppression devices at identical ratings. To obtain complete specifications, write for Engineering Bulletins 171, 172 and 166 to Cornell-Dubilier Electric Corp., South Plainfield, N. J.

MINIATURIZED SUPPRESSION COMPONENTS

Typical Specifications

Tubular Pi Filter TYPE NFR113
Voltage: 120 VAC (60 cycles), 300 VDC
Current: 0.5 Amperes, Weight: 4.0 oz.
Dimensions: 1" x 2-11/16"

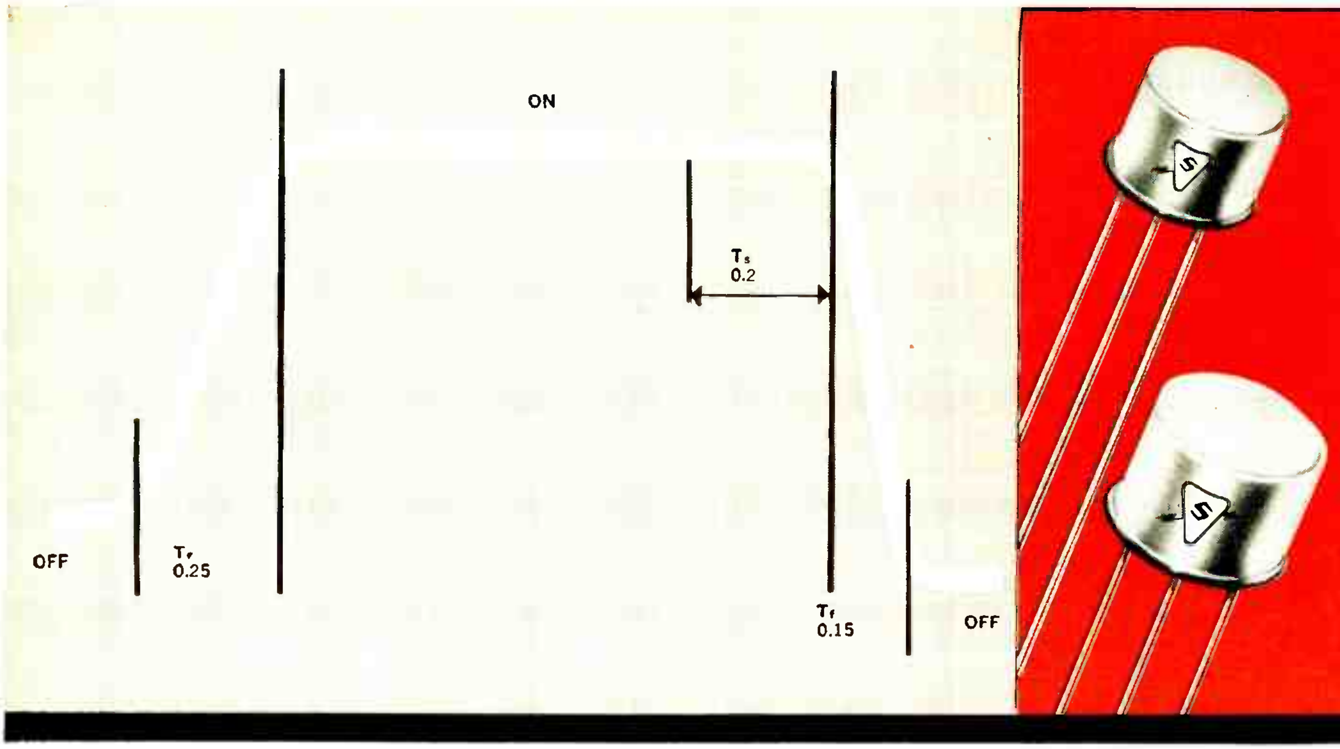
Feed-Through Capacitor TYPE NFT5W4P22W
Voltage: 125 VAC (60 cycles) 400 VDC
Current: 25.0 Amperes Capacitance: 0.22 mfd.
Dimensions: .562" x 1-29/32" Weight: 0.83 oz.

Consistently Dependable

CORNELL-DUBILIER

CAPACITORS

SYLVANIA MEDIUM AND *HIGH SPEED* SWITCHING TRANSISTORS



Both NPN and PNP types that switch in tenths of microseconds

Design engineers can get both NPN and PNP medium and high-speed switching transistors in quantity from Sylvania. Each type in the line is designed especially for computer and switching applications. They feature close control of current gain and frequency cut-off and are especially adaptable to high-temperature use.

These Sylvania medium and high-speed switching transistors are widely used in military equipment because of their outstanding reliability and stability. Each of the types is subjected to 100% leak tests and stabilizing tests that assure top performance under the toughest operating conditions.

Each type is encased in a JEDEC TO-5 package with the Sylvania welded hermetic seal for full protection against humidity and other severe environmental conditions.

Send for your free booklet on Sylvania computer transistors, or call your representative.

SYLVANIA MEDIUM AND HIGH-SPEED SWITCHING TRANSISTORS

Type	Collector to Base V	Emitter to Base V	Power Diss.	Freq. Cutoff, fab
		NPN		V_{CB} = 6 v. I_c = 1 ma min.
2N358	25 v	25 v	100 mw	5 mc
2N377	25 v	15 v	150 mw	2.5 mc
2N385	25 v	15 v	150 mw	4 mc
2N388	25 v	15 v	150 mw	5 mc
2N438	25 v	25 v	100 mw	2.5 mc
2N438A	25 v	25 v	150 mw	2.5 mc
2N439	25 v	25 v	100 mw	5 mc
2N439A	25 v	25 v	150 mw	5 mc
2N440	25 v	25 v	100 mw	10 mc
2N440A	25 v	25 v	150 mw	10 mc
2N679	25 v	15 v	150 mw	2 mc
		PNP		V_{CB} = 5 I_E = 1 ma min.
2N404	−25 v	−12 v	120 mw	4.0 mc
2N425	−30 v	−20 v	150 mw	2.5 mc
2N426	−30 v	−20 v	150 mw	3.0 mc
2N427	−30 v	−20 v	150 mw	5.0 mc
2N428	−30 v	−20 v	150 mw	10.0 mc

SYLVANIA
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

Sylvania Electric Products Inc.
Semiconductor Division
100 Sylvan Rd., Woburn, Mass.

Army's SD-5 surveillance drone, now under development by Fairchild Engine, will carry a wide variety of electronic sensing devices

Huachuca to Open Big Market

Army contract coming soon calls for volume buying of surveillance sensors, other gear

PRIME CONTRACT for Army's Electronic Environmental Test Facility in Arizona will be awarded around the first of the year. Though initial contract might not pass $5 million, follow-on contracts will multiply this amount several times. The number of subs and suppliers who will benefit from the project will be large.

Two programs will be carried out at the facility. One will test electronic emission devices used by Army tactical units, to determine compatibility of the Army systems with Air Force and Navy gear and simulated enemy equipment. The electromagnetic test range for this work will be situated near Gila Bend, Ariz.

The other program calls for testing surveillance drones, sensory devices, air-to-ground transmission of data, data processing, reduction and display.

Fly 250 Miles

The drone test range will extend from Fort Huachuca to Yuma, a distance of about 250 miles. The unmanned planes, carrying a wide variety of sensory devices, will be launched from Huachuca, fly along a 20-mile-wide corridor and end up in the drone race area which extends roughly from Yuma to Gila Bend and down to the Mexican border. The planes will go through special maneuvers. A new facility will be built at Colfred, Ariz.

Sensors will include tv equipment, infrared, radio-controlled cameras —still and movie—with automatic transmission back to the ground, magnetic mine detectors, radiation smellers and radar search units.

Ground equipment will include radio transmitters and receivers, data processing and reduction gear, magnetic recorders, display units, communications network, radar and theodolites.

The prime contractor's job will be largely managerial, like Pan Am's at Cape Canaveral. The contractor's initial work will be installation and operation of all monitoring devices and all equipment except that actually under test.

The project is planned in three stages: construction of the drone facility to be operational by late 1960; construction of the electromagnetic compatibility range at Gila Bend, which should take about two years; and completion of the entire program—five to ten years in all.

Signal Corps says the program will never really be completed due to changing equipment and concepts.

MEETINGS AHEAD

Sept. 7-12: Machine Searching and Translation, International Conf., Western Reserve Univ. and Rand Devel. Corp., Western Reserve Univ., Cleveland.

Sept. 14-16: Quantum Electronics Phenomena, Office of Naval Research, Shawanga Lodge, Bloomingburg, N. Y.

Sept. 15-17: Electronic Exposition, Twin Cities Electronic Wholesalers Assoc., Municipal Auditorium, Minneapolis.

Sept. 17-18: Engineering Writing & Speech, Dual Nationl Symposium, PGEWS of IRE, Sheraton-Plaza Hotel, Boston; Ambassador Hotel, Los Angeles.

Sept. 17-18: Nuclear Radiation Effects in Semiconductors, USASRDL, Western Union Auditorium, New York City.

Sept. 21-25: Instrument-Automation Conf. & Exhibit, ISA, International Amphitheater, Chicago.

Sept. 22-24: Industrial Nuclear Conf., Armour Research Foundation & NUCLEONICS (McGraw-Hill), Morrison Hotel, Chicago.

Sept. 23-25: Non-Linear Magnetics and Magnetic Amplifiers, AIEE, ISA, PGIE of IRE, Shoreham Hotel, Washington, D. C.

Sept. 23-25: Residual Gases in Electron Tubes and Related High-Vacuum Systems, International Symposium, Italian Society of Physics, Como, Italy.

Sept. 28-30: Telemetering, National Symposium, PGTRC of IRE, Civic Auditorium & Whitcomb Hotel, San Francisco.

Sept. 30-Oct. 1: Industrial Electronics Symposium, PGIE of IRE, AIEE, Mellon Inst., Pittsburgh, Pa.

Oct. 5-7: Communications Symposium, National Conf., PGCS of IRE, Hotel Utica, Utica, N. Y.

Oct. 12-15: National Electronics Conference, IRE, AIEE, EIA, SMPTE, Sherman Hotel, Chicago.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 76.

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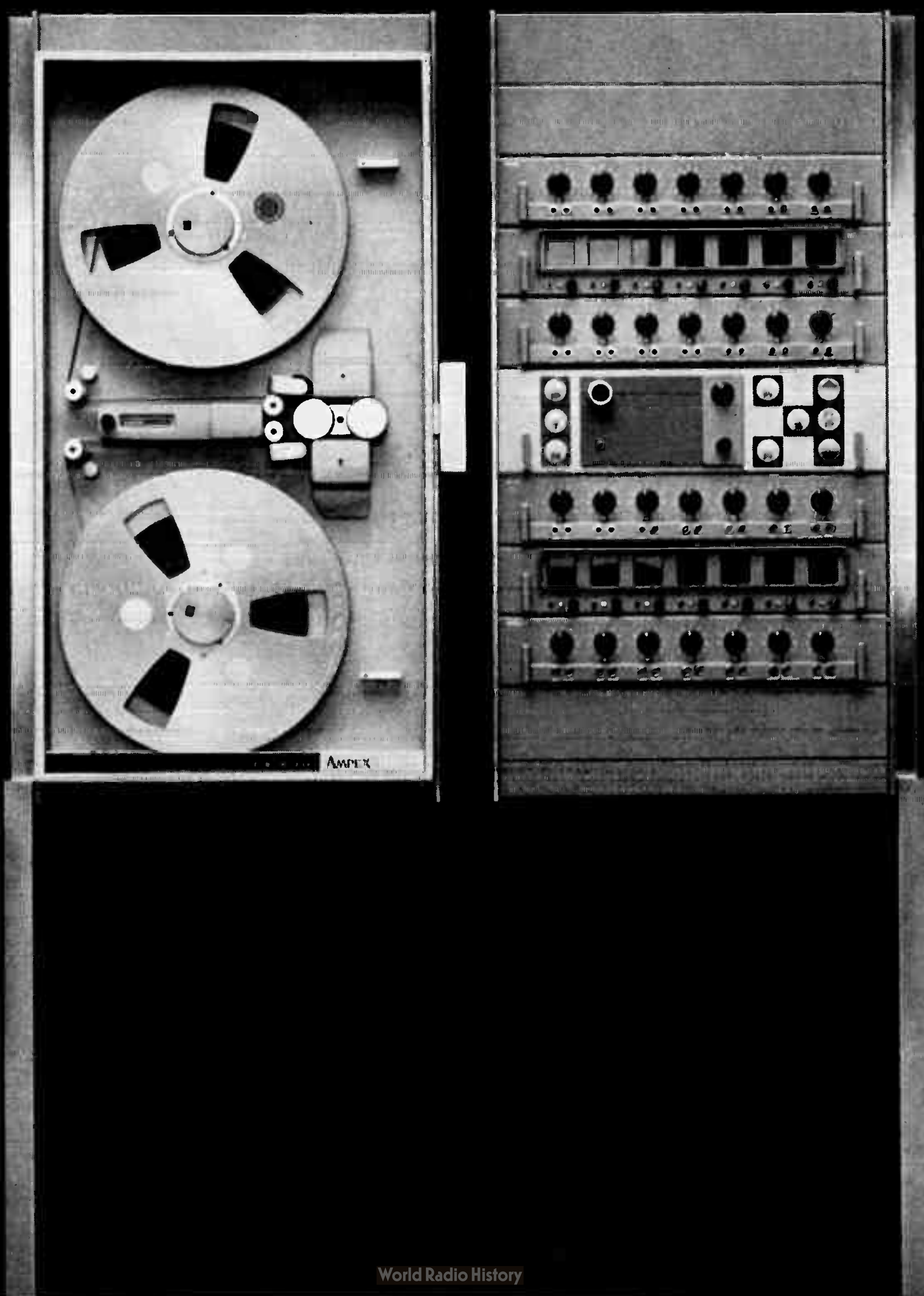

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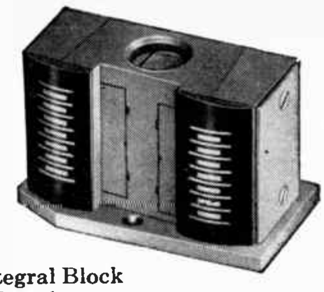
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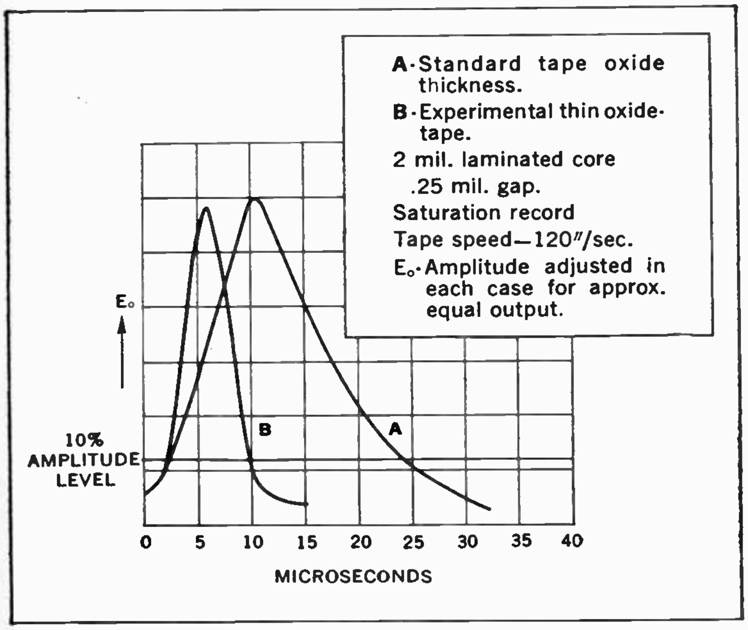

Pulse width comparison—standard and thin oxide tape.

CAPACITY—Five series of Clevite "Brush" multichannel heads give channel format variety for standard tape widths from ¼" to 2". A single block will handle up to 16 channels per inch of media width—an interlaced block up to 32 per inch. Clevite heads read pulse widths down to 1½ mils recorded to saturation on 0.3 mil coating instrumentation tape—approximately 600 pulses per inch with self-erasing saturation recording. More than 300 ppi packing is possible on 1 mil coated drums, operating 0.2 mils out of contact with a 3 mil pulse width on the drum.

ACCESS—Careful choice of material plus unique design and construction techniques enable Clevite "Brush" heads to provide uniform performance at very high processing rates. The heads themselves respond to wave lengths down to .15 mils (1.5 MC at 240 IPS) but standard instrumentation tapes and transports usually reduce the practical repetition rate of saturated recording to approximately 30 KC and 15 KC for RTZ and NRTZ respectively.

RELIABILITY— Clevite "Brush" tape and drum heads hold track width and location to ± 0.001-inch tolerance. Azimuth, contact angle and gap perpendicularity are true ± 0 deg., 5 min. and can be held even closer when required. "Gap-mounted" head (see photo) has lapped bracket and cartridge surfaces for fast replacement without critical adjustment. Redundant and interlaced (see photo) designs provide immediate checking of recorded data and higher output per channel respectively. All multichannel heads available in epoxy or full metal face (to reduce oxide pickup) at no extra charge.

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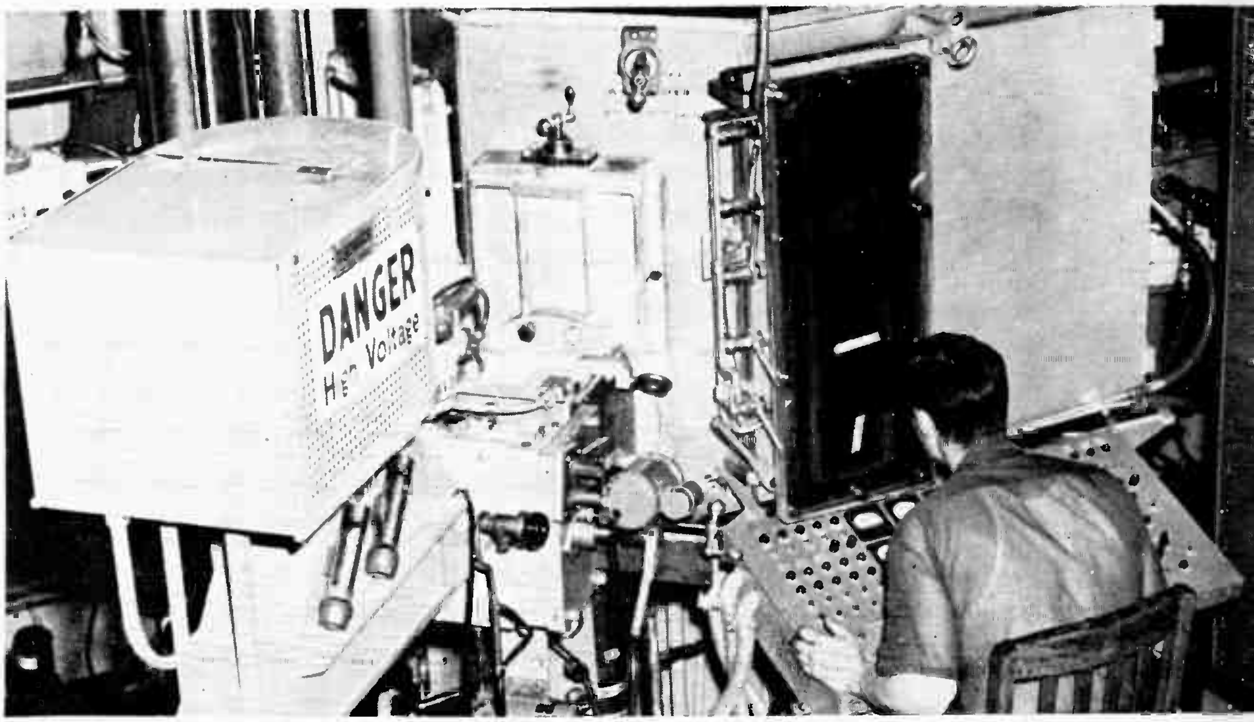

Operator looks into a Stauffer-Temescal 225-hw furnace and watches electron bombardment of tantalum

Processing Materials With Electron Bombardment

New techniques use electron beams to give metals and insulating materials qualities heretofore unattainable. Some improved qualities are purity, high-temperature stability and strength

By ALAN LAWLEY, Research Associate, University of Pennsylvania, Phila., Pa.

UNTIL THREE YEARS ago[1] the heat necessary to melt the high-melting-point refractory materials was almost always produced by high-frequency induction or by radiation. Since then, the technique of electron bombardment has been advanced and modified to include beam zone leveling and refining, beam melting and beam welding.

ELECTRON-BOMBARDMENT UNIT—A beam-bombardment unit works like a normal x-ray tube. The rod specimen takes the place of the x-ray tube target but is not water cooled. Accelerating voltages are also usually lower than for x-ray work. The specimen is the anode and is surrounded by an annular cathode which is the electron source. The usual type of electron-beam unit is shown schematically in Fig. 1. Tungsten or tantalum wire serves as a cathode filament while the focusing plates may be of tantalum or molybdenum. The focusing plates limit the vertical spread of electrons from the cathode to produce high heat concentration at a specific cross section of the specimen.

In earlier designs it was usual to move the specimen and its holding frame and to have the cathode assembly fixed. However, by moving the cathode and keeping the specimen stationary, there is greater length of travel for a given height of bombardment chamber. Furthermore, vibrations produced in a moving specimen lead to instability within the molten-zone region.

For successful beam bombardment, it is essential to have a vacuum better than 10^{-4} mm mercury. This is usually obtained in a dynamic pumping system using oil or mercury diffusion pumps backed by a rotary pump. It is necessary to have a cold trap, usually liquid-nitrogen cooled, between the working chamber and the diffusion pump. The trap avoids carbon contamination brought about by cracking of the diffusion-pump oil vapor on the hot specimen.

On melting, copious quantities of gas are evolved from the specimen in addition to the vapor from the material itself. Thus, a high pumping speed must be maintained throughout the system. A 4-in diam pumping line for a 20-liter working volume gives a pumping speed of around 200 liters/sec.

Power requirements are low compared to h-f heating. Typical figures are 400w for 0.180-in diam tungsten, 300w for 0.150-in diam tantalum, 180w for 0.150-in diam molybdenum, 130w for 0.250-in diam iron, and 125w for 0.240-in diam vanadium.

When considering the necessary electrical equipment for electron bombardment, is must be realized that instability may be produced from the outgassing of the heated charge. This produces ions which bombard the filament, raising its temperature and increasing electron emission. Because of this emission, it is essential to automatically control power input.

CONTROL—Two methods of control are available. One is emission control, where the bombardment current is kept constant by automatically adjusting the cathode temperature. The other uses high voltage fed in from a constant current source. Bombardment current is kept at a constant level by automatic adjustment of the bombardment voltage.

In almost all the units in operation, an emission temperature-control method is used. With this method, cathode temperature is automatically adjusted.

Whichever method of filament power control is used, emission current is measured by passing it through a resistor and comparing the voltage developed with a reference voltage. The out-of-balance error signal is amplified and fed to a controller which varies the filament-heating power. Control techniques may incorporate servo-controlled variable transformers, electronic impedance, time modulation switching and magnetic amplifiers. The essential requirement is speed of response to a change in bombardment conditions.

ZONE LEVELING AND REFINING—Many materials may be purified by the use of zone-melting in which the repeated traversal of a specimen by a molten zone brings specimen impurities to one end of the specimen. The specimen impurities which are segregated are those which are preferentially soluble in the liquid. By using a floating molten zone, crucible contamination is eliminated. This method is particularly attractive in that traversal by the molten zone often results in the growth of one large single crystal, no seed crystal being required. Simultaneous removal of gas and volatile impurities leads to a high degree of purification.

A wide range of specimen diameters may be handled although there is a maximum diameter for zoning which depends on the surface tension and density of the material[2,3,4]. Thus, for tungsten, this diameter is about 0.5 cm. Heat flow considerations demand that the minimum height of a completely molten zone cannot be much less than the outside diameter. There is no theoretical lower limit to specimen diameter, although a limit is set by practical difficulties. The maximum zone length which can be supported by surface tension is of the order of the diameter. Above this length, the zone becomes unstable and collapses.

Crystals of metals, alloys, insulators and semiconductors have been grown by electron-beam zone leveling and refining. Molybdenum rod having had nine zone-refining passes gave a ductile fracture under tensile conditions down to −196 C.[5] No trace of oxygen, nitrogen and carbon was detected in the material. Similar work on tungsten[6] showed that after eight passes, the carbon content was reduced from 70 ppm down to 20 ppm and the oxygen content from 3 ppm to 1 ppm. After three passes, the ultimate tensile strength dropped from 37,000 psi to 17,000 psi.

Vanadium, niobium and tantalum have been successfully zone refined by this method and Vickers-diamond-hardness figures as low as 80, 51 and 76 respectively have been quoted[5]. In the case of vanadium, a high-percent evaporation occurs (about 30 percent).

In general, the lower the melting point of the material the more difficult is beam bombardment. Copper has a low surface tension and there is much loss of heat due to conduction. Of the platinum group of metals, platinum, iridium and ruthenium evolve little gas so that a stable molten zone may be established during the first traverse. With rhodium, many outgassing passes are required before stable conditions are attained.[7] As an example of the purification of ruthenium[8], a traverse at 1½ in/hr reduced the oxygen content to below 7 ppm and the hydrogen and

What Electron Bombardment Means to Us

Here is a brand-new industrial application for electronic equipment. The equipment used also presents some unique problems.

Then, too, the electronics industry is one of the best customers for metals and insulators processed by electron bombardment. More versatile materials are on the way.

nitrogen contents to values below those amenable to quantitative analysis.

Single crystal specimens of Mo-Re[9,10], Ta-Nb may be grown with little segregation of the alloy components. In the case of Ta-V, tantalum-rich specimens were always produced due to evaporation of the more volatile vanadium. Experiments in England on Ti-C, Wo, W_2C, TaC all gave inhomogenous specimens due to preferential volatilization of one of the components. If the partition coefficient of a particular binary-alloy system is low (less than 5) the passage of a zone will lead to a nonuniform composition along the specimen. To promote homogeneity in the single crystals, the technique of reversing the direction of zone travel after each pass may be applied. This method has the disadvantage that impurities in the binary alloy will not be separated out at the end of the specimen.

Homogenous alloys may be produced from rod specimens of the pure components, if the melting-point values of the components are not too dissimilar. Belk[11] has produced molybdenum-tungsten alloys by wrapping tungsten wire around a molybdenum rod, melting the whole assembly, and then using the reversing technique and remelting.

With insulating materials, alumina, sapphire and ruby, as the sample become transparent at or near the melting point there is much loss of heat by radiation. In addition, the cathode becomes coated. To prevent coating the cathode must be shielded from the specimen and the electron beam focused by electrostatic or magnetic means. It is proposed to use beam-bombardment techniques for the production of magnesium oxide of a purity higher than that previously attained. This method may produce a more ductile material.

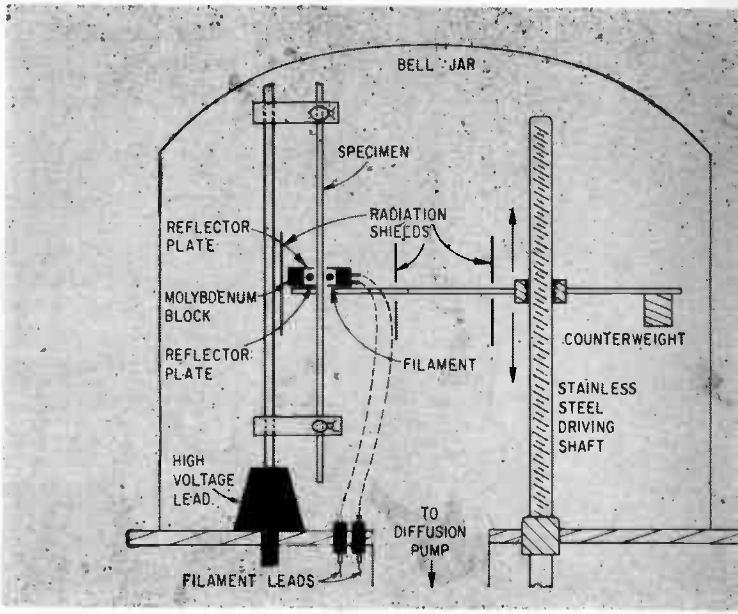

FIG. 1—In this typical bombardment unit the filament moves up and down. Thus electrons bombard only a small section of the specimen at a time

ELECTRON-BEAM MELTING—Melting and refining of metals under high vacuum by electron bombardment is now a commercial operation; one company has cast 200-lb ingots of refractory metals by this technique.[13] The initial metal charge may be powder, sponge, sintered bar stock or premelted ingot. Generally, two electron guns are necessary, the upper gun fusing the charge with the lower gun concentric with the water-cooled ingot mold maintaining a molten pool into which the feed stock drips. For previously melted ingot being remelted for homogenization and purification, it is possible to use only one gun with suitable focusing, and to melt the feed ingot and maintain a lower molten pool simultaneously. By retracting the solidified ingot at a selected rate, ingots up to 4-in diam by 4-ft length have been produced. With Cb, a melting rate of 250 lb/hr requires 120 kw.

On a laboratory scale, and using a similar electron bombardment arrangement, molybdenum ingots have been cast from $\frac{1}{2}$-in diam bar[11]. By zone refining the molybdenum prior to melting, it is possible to achieve a high degree of purity in the final ingot.

Thus, beam melting offers many advantages. The melt surface is under a high vacuum and there is no contamination from the water-cooled mold. It is possible to exercise a high degree of control over the melt with regard to time of holding, temperature, and possible alloying.

ELECTRON-BEAM WELDING—By design of the electron gun, ideal welding conditions for many types of joining may be met. An upper limit for size of components to be welded is set by the need to work at high vacuum. A prototype beam welder has been[14] used to join 3/16-in thick stainless-steel plate, the components being 12-in long by 6-in. wide. The gun is situated approximately 8 in. from the surface joint. Welds are extremely sound, clean and gas free. A welding area from below $\frac{1}{64}$-in diam up to $\frac{1}{8}$-in diam is possible with another unit.[15]

In France[16], electron-welding guns have been designed for the welding of fuel elements on a commercial scale. Small welding areas in thin metal sheet are possible.

Details of the electron bombardment unit were abstracted from work supported by the office of Naval Research. The author is grateful to R. Maddin for helpful discussions.

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Solid-State Generator

Here is a tubeless microwave generator which produces 10 mw at 2,000 mc. Applications are in fields where light weight and high efficiency are musts

By **M. M. FORTINI,** Research Div., Philco Corp., Phila., Pa.

J. VILMS, Drexel Inst. of Technology and Philco Corp., Phila., Pa.

CONVERSION OF D-C POWER to a-c power can be accomplished in one step by an oscillator; it can be done in two or more steps by letting an oscillator operate at a frequency lower than the desired one and then converting the low frequency to the desired frequency with one or more harmonic-frequency converters. The two-step method to be described produces microwave power from a semiconductor source. This source uses a transistorized oscillator and amplifier which run at frequencies in the low-hundreds of mc and a diode harmonic multiplier.

Diode Harmonic Generator

Harmonic frequency conversion depends on the fact that a nonlinear element driven with a sinusoidal voltage or current gives a nonsinusoidal response. A semiconductor diode exhibits resistive, hole-storage and capacitive types of nonlinearity. The resistive mode suffers appreciable power loss in the nonlinear resistance due to average conduction current.[1] The hole-storage mode is based on the recovery time of a diode, the time required to remove the stored minority carriers when attempting to turn off the diode. For some diodes this recovery time appears as a narrow spike of reverse current which is rich in harmonic content. The two major limitations in using this method are high average-conduction-current losses and the requirement that the period of the applied signal be more than twice the recovery time of the diode.

The capacitive mode is far more suitable for harmonic generation because conduction current causes no power loss, and the frequency of operation is solely limited by the Q of the diode. Therefore this mode was chosen for the all-semiconductor system.

An equivalent circuit for a diode used as a nonlinear capacitor is shown in Fig. 1A. Diode dissipation factor $1/Q = \omega C_d r_s + 1/\omega C_d r_d + r_s/\omega C_d (r_d)^2$ and diode capacitance $C_d = K(V + \phi)^{-\frac{1}{2}}$. For good harmonic-generator performance, diode requirements are low spreading resistance (r_s), low dissipation factor and high reverse-breakdown voltage. Figures 1B and 1C show the nonlinearity characteristics of a good microwave harmonic-generator diode. The r_s and C_d were measured at 3.5 kmc. Diode Q was measured at 3 kmc, with Q ranging from 10 to 15 at a reverse voltage of 0.5 v to 20 v, respectively. The I-V characteristic indicates the voltage range of the capacitive-nonlinearity mode. Variation in r_s at low voltages may be explained by space-charge widening due to the reverse voltage. In a thin diode this widening is an appreciable portion of the diode thickness.

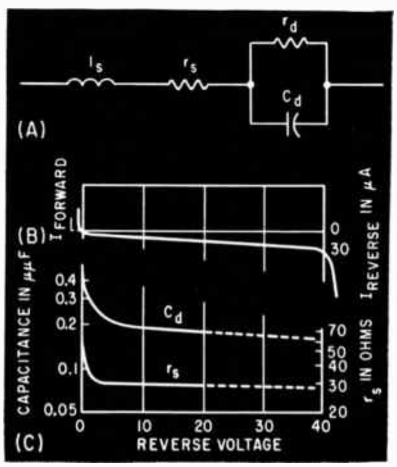

FIG. 1—Diode equivalent circuit (A); I-V characteristic (B); diode capacitance versus reverse voltage (C)

To achieve minimum conversion loss, the harmonic-generator circuit must provide the proper impedance transformation between source and diode and between diode and load. The circuit must also prevent power dissipation at other harmonic frequencies of the fundamental. Eliminating power dissipation at unwanted harmonics raises efficiency. Either short or open circuits for the unwanted harmonics eliminate this dissipation. To minimize losses in the nonlinear diode, which are primarily in its r_s, the matching sections must provide high source and load impedances looking in either direction from the diode.

Shown in Fig. 2A and B are two circuits suitable for harmonic generation in the nonlinear-capacitance mode. Circuit 2A short-circuits and circuit 2B open-circuits the undesired harmonics. Inductance L_f and capacitance C_f are resonant at the input frequency, L_h and C_h are resonant at the desired harmonic frequency, and C_1, C_2, L_1 and L_2 are for impedance matching.

The open-circuit arrangement appears to be more desirable because it eliminates device dissipation caused by the unwanted harmonic currents. However, analysis shows

for Microwave Power

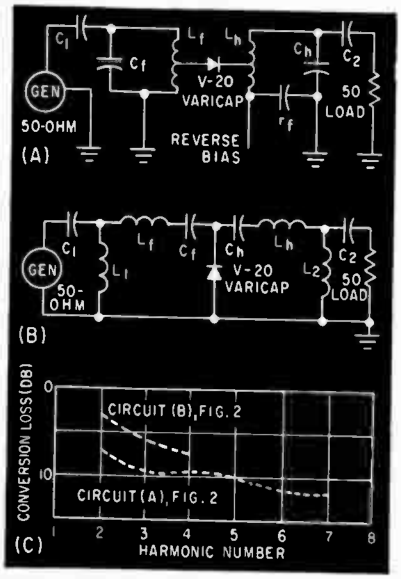

FIG. 2—Short-circuiting harmonic generator (A) and open-circuiting harmonic generator (B); their frequency response (C)

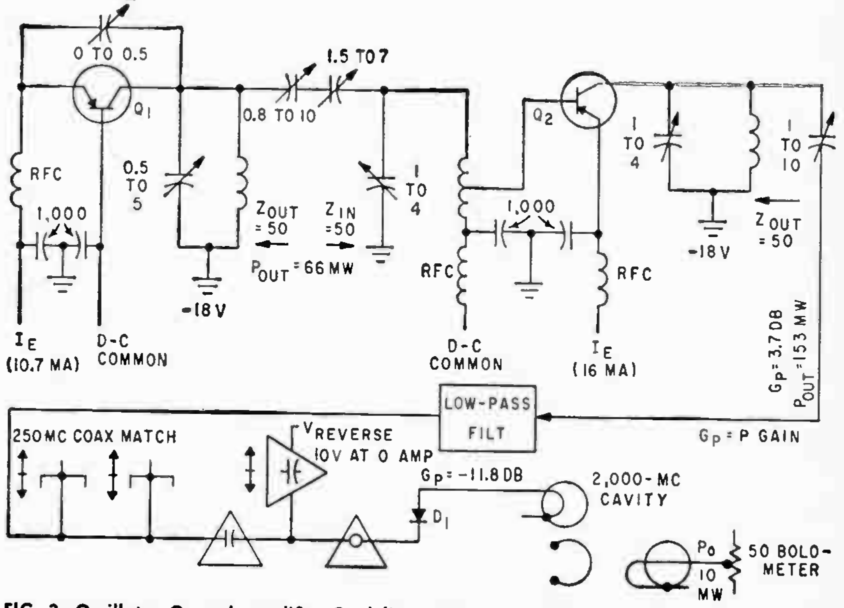

FIG. 3—Oscillator Q_1 and amplifier Q_2 deliver 153 mw at 250 mc to the coaxial matching section. Despite a conversion loss of 11.8 db in diode D_1, a 10-mw output at 2,000 mc appears across the 50-ohm bolometer

that one can open-circuit all undesired harmonics only for second-harmonic generation, due to the form of the diode C-V characteristic.

Another difficulty encountered with the circuit of Fig. 2B is the practicability of obtaining high Q's in the series-resonant branches. In general, the short-circuit arrangement is more suitable for high-order harmonic generation at high frequencies. Here the load and the source are coupled to the diode by parallel-resonant tanks, which short-circuit the undesired harmonics.

Figure 2C compares frequency-conversion loss versus harmonic number obtained, using a Varicap diode type V-20 as a nonlinear capacitor for the circuits of Fig. 2A and B. This diode has a capacitance of 10 to 60 $\mu\mu$f, an r_s of 15 ohms, and reverse breakdown of 45 v. Input frequency and power were held constant at 20 mc and 100 mw respectively, with impedance matching (and diode bias for Fig. 2A) optimized for each harmonic.

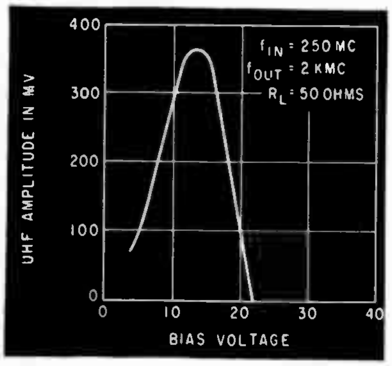

FIG. 4—Variation of uhf amplitude with diode bias

All-Semiconductor Source

Since the efficiency of a transistor is inversely proportional to the frequency of operation, it is wise to operate the transistorized section of a 2-kmc power source in the low-hundred-mc frequency range. Thus, at 250 mc the diode harmonic multiplier operates as an eighth-harmonic generator. Figure 3 shows the all-semiconductor 2-kmc power source. Two Philco high-frequency power transistors[2] are used as oscillator and power amplifier at 250 mc and a Transitron S-555G diode (D_1) operates in the capacitive mode as an eighth-harmonic generator. This system provides 10 mw at 2 kmc for a d-c power input of 423 mw; thus overall efficiency is 2.3 percent.

More recent data obtained using Philco experimental diodes as harmonic generators in place of the S-555G indicate the possibility of obtaining 10 mw at 2 kmc from only 300 mw of d-c power input to the entire system. Efficiency is then 3.3 percent. This increase is due mainly to the better efficiency of the Philco experimental diode and to the higher gain that the transistor buffer amplifier has when it provides less output. As efficiencies of diodes and transistors improve, further increases in efficiency will be feasible.

A simple way to modulate a variable-capacitance harmonic generator was devised. Since it is possible to vary the harmonic-generation efficiency, for a given r-f drive and for best matching and tuning conditions, by varying the back-bias voltage on the diode, this variation can be used for modulation purpose.

Figure 4 shows the change in output voltage at 2 kmc as the biasing voltage is changed. Since the diode impedance at audio frequencies is high, little modulating power is required.

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Network Design of

Distributed resistance and capacitance give networks with new characteristics. The technique simplifies some circuits and makes others possible.

By **CHARLES K. HAGER,** Director, Microcircuitry Applications Research, Varo Manufacturing Co., Inc., Garland, Texas

THE MICROCIRCUITRY program is concerned with the development of a circuit fabrication technique based on the combination of elementary materials rather than on the assembly of individual components. At the present stage, circuits are made by the vacuum-deposition of thin films of conductive, resistive and dielectric materials on supporting substrates.

The technique results in types of passive networks where the resistance and capacitance are distributed throughout the films rather than lumped within individual components. The distributed parameters literally introduce new dimensions into passive circuit design and make available circuit functions not heretofore available with a finite number of lumped elements. With these new possibilities there is an attendant increase in the complexity of the mathematics.

Shown in Fig. 1 are examples of the morphologies of some simple distributed-parameter R-C networks as they are fabricated in microcircuitry. Each consists of a resistive film deposited on a high dielectric substrate with either another resistive film or a conducting film on the opposite side and in alignment. The conducting films *A*, *B*, *F* and *G* form the input and output connections.

For uniform resistance per square and uniform capacitance per unit area, networks *A* and *B* in Fig. 1 are the simplest distributed-parameter circuits used. They are equivalent to constant impedance transmission lines with no series inductance and no shunt capacitance. Their analyses are comparatively simple. Networks *C* and *D* are analogous to tapered transmission lines but are not mathematically equivalent.

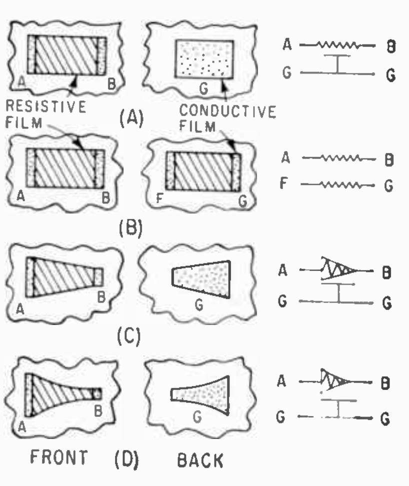


FIG. 1—Distributed-parameter networks. Simple *RC* (A); Simple *RR* (B); Linearly tapered *RC* (C); Exponentially tapered *RC* (D)

Network Characteristics

The characteristics of networks made this way are unlike those made by combinations of lumped resistors, capacitors and inductors. Even with the simplest distributed-parameter network, the characteristics can be controlled by the shapes of the resistive and conductive films, the resistance per square of the resistive film which need not be uniform, the capacitance per unit area of the resistive film relative to the conducting film, which need not be uniform and the locations of conducting tabs on the resistive film.

Resistance per square of the resistive film is controlled directly by the thickness of the film. Capacitance per unit area is controlled either by the thickness of the high dielectric substrate or by the relative shape and location of the opposing conducting film.

The concept of distributed parameter networks may obviously be extended to include more complex morphologies such as multiple layers of resistive and conductive films separated by dielectric materials, solid or three-dimensional R-C networks rather than thin films, combinations of lumped-parameter impedances with distributed-parameter networks and combinations of linear active elements with distributed-parameter networks.

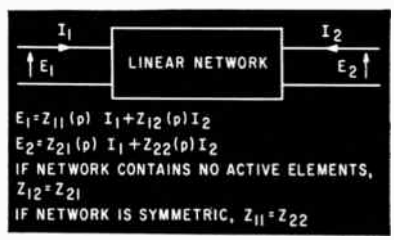
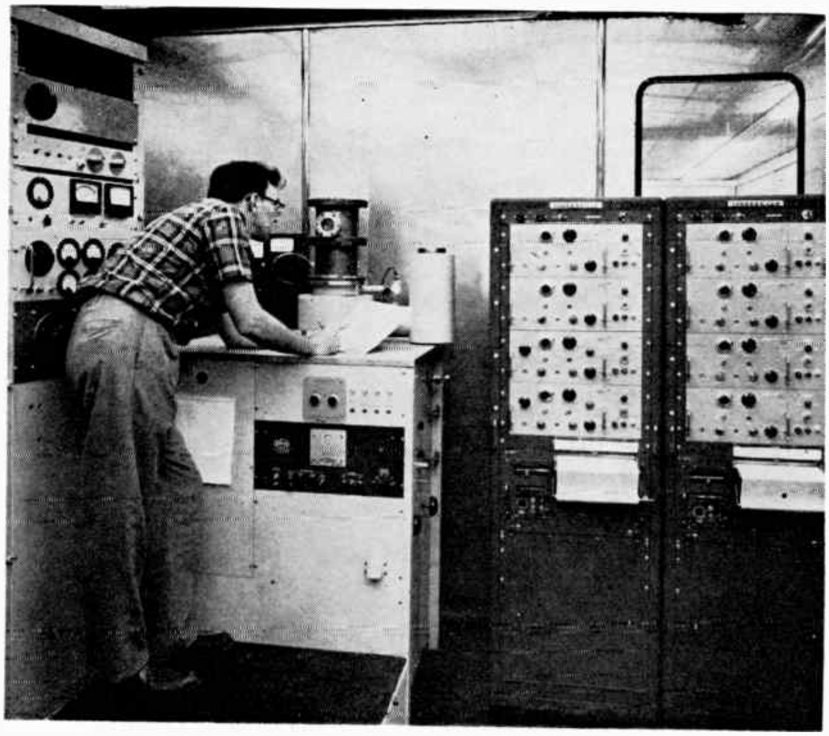
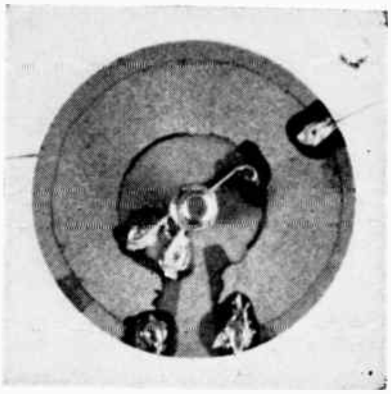


FIG. 2—Operational characteristics of a linear network

Up to the present time only the simplest networks have been analyzed. The considerations listed above show the general directions in which future work on distributed parameter networks will probably proceed. The analytical methods associated with these more complex concepts likewise become more complex and in most cases these networks must be evaluated either from the basic electromagnetic equations, as tapered transmission lines, or empirically. However, since only the external behaviors of the networks are of interest, these may always be expressed in the

Microcircuits





A working model of the oscillator of Fig. 15A. A T-37 transistor is soldered to conducting tabs

The vacuum-deposition system. The fireplug on the bench is the chamber in which the materials are vapor-deposited. The vacuum system with mechanical and diffusion pumps is located behind the lower panels. At the left are power supplies, temperature indicator, and an automatic pulser and timer. At right are recorders for critical variables

familiar z or h parameters commonly used by circuit designers[1].

The use of inductance in networks has not yet been investigated to any great extent because of technical difficulties in fabricating inductance from thin films. However, this problem is not insurmountable. It has already been established that lumped inductance may be simulated in circuit functions by the appropriate combinations of capacitance, active elements and feedback. Also, it is technically possible to deposit conducting and magnetic films to generate at least relatively small inductances.

Evaluation Techniques

Up to the present the evaluations of distributed-parameter networks have been limited to the determinations of the steady-state characteristics. Future studies will cover transient analyses, pole-zero techniques and synthesis procedures.

The evaluation method being used is the specification of the z parameters of the networks in operational form[2]. By means of the z parameters, the external behavior of a 3- or 4-terminal network can be completely specified with a minimum number of independent parameters. The corresponding relations are shown in Fig. 2. The symbol p is defined as the differential operator d/dt so the $z(p)$ parameters are merely shorthand methods for writing the differential or difference equations which relate the terminal voltages and currents. For a network composed of a finite number of lumped components, $z(p)$ is always a rational function[2]; for distributed parameter networks, $z(p)$ contains infinite-order polynominals which are sometimes expressible in closed form, as will be

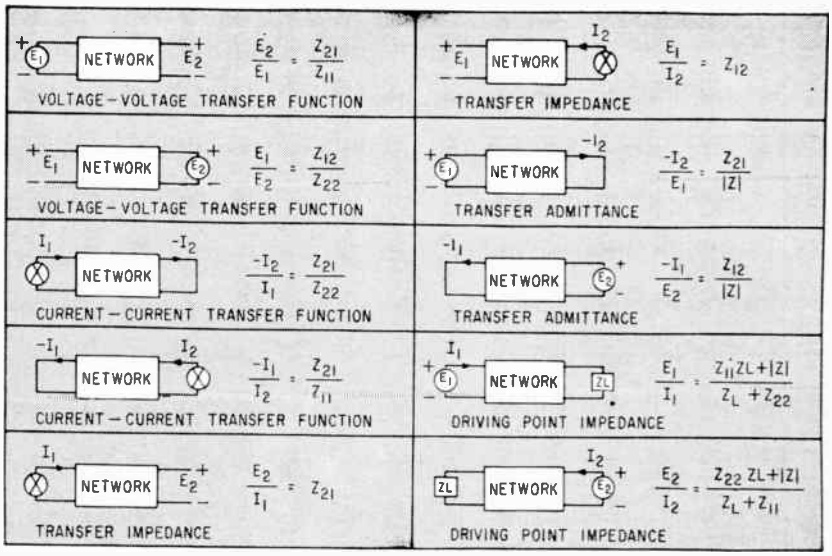


FIG. 3—Transfer functions of linear networks from z parameters

shown. Substitution of $j\omega$ for p yields the steady-state response of the network. Substitution of s for p yields the transfer function in the complex frequency domain.

All the transfer functions of a linear network with which the circuit designer must cope are expressible as simple functions of the $z(p)$ parameters, $|z(p)|$, and the corresponding operational impedances of loading networks. Examples of these are shown in Fig. 3. By use of the z parameter concept, the evaluation of any series, parallel or cascade arrangement of either lumped and/or distributed parameter networks is readily accomplished by appropriate matrix manipulations.

Analytical Methods

The simplest distributed parameter R-C networks may be analyzed as untapered transmission lines. The analysis in this case consists of solving the partial differential equations by the same technique applied to constant impedance transmission lines. Networks A and B in Fig. 1 were analyzed in this way with the following assumptions: the resistance per square of the resistive film is constant over the film, the capacitance per unit area relative to the opposing conducting surface is constant over the film, conducting tabs on the resistive films are narrow so end capacitance effects are negligible, and the high dielectric substrate is thin so edge effects around the films may be neglected.

The $z(p)$ parameters of variations of networks A and B of Fig. 1 are shown in Tables I and II. Note that the z parameters depend on the selection of input and output terminals. The time constant T is defined as an R-C product in every case, where R is the total series resistance of each network and C is the total shunt capacitance. Table I shows the networks connected as 3- and 4-terminal devices and Table II shows them connected as 2-terminal devices. These are only part of the variations possible and are indicative of the complexities of the z parameters of the simpler networks.

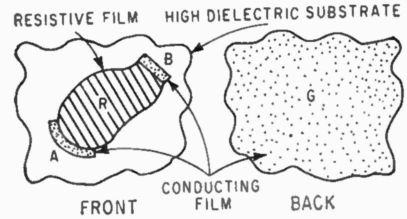
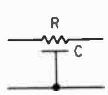
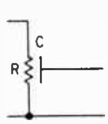
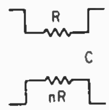
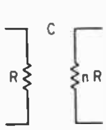
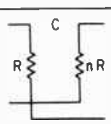
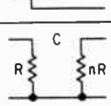


FIG. 4—General distributed parameter RC network

TABLE I—THREE— AND FOUR—TERMINAL DISTRIBUTED PARAMETER NETWORKS AND Z PARAMETERS

NO.	NETWORK	Z PARAMETERS	
1		$Z_{11}=Z_{22}=\frac{R\coth\sqrt{T_p}}{\sqrt{T_p}}$ $Z_{12}=Z_{21}=\frac{R\,\mathrm{csch}\sqrt{T_p}}{\sqrt{T_p}}$	T=RC
2		$Z_{11}=\frac{2R}{\sqrt{T_p}}\tanh\frac{\sqrt{T_p}}{2}$ $Z_{12}=Z_{21}=\frac{R}{\sqrt{T_p}}\tanh\frac{\sqrt{T_p}}{2}$ $Z_{22}=\frac{R}{\sqrt{T_p}}\coth\sqrt{T_p}$	T=RC
3		$Z_{11}=Z_{22}=\frac{(1+n)R\coth\sqrt{T_p}}{\sqrt{T_p}}$ $Z_{12}=Z_{21}=\frac{(1+n)R\,\mathrm{csch}\sqrt{T_p}}{\sqrt{T_p}}$	T=RC
4		$Z_{11}=\frac{2nR}{(1+n)\sqrt{T_p}}\left[\frac{\sqrt{T_p}}{2}+\frac{1}{n}\tanh\frac{\sqrt{T_p}}{2}\right]$ $Z_{12}=Z_{21}=\frac{2nR}{(1+n)\sqrt{T_p}}\left[\frac{\sqrt{T_p}}{2}-\tanh\frac{\sqrt{T_p}}{2}\right]$ $Z_{22}=\frac{2nR}{(1+n)\sqrt{T_p}}\left[\frac{\sqrt{T_p}}{2}+n\tanh\frac{\sqrt{T_p}}{2}\right]$	T=RC
5		$Z_{11}=Z_{22}=\frac{R}{(1+n)\sqrt{T_p}}\left[n\sqrt{T_p}+2n\,\mathrm{csch}\sqrt{T_p}+(1+n^2)\coth\sqrt{T_p}\right]$ $Z_{12}=Z_{21}=\frac{R}{(1+n)\sqrt{T_p}}\left[n\sqrt{T_p}-2n\coth\sqrt{T_p}-(1+n^2)\mathrm{csch}\sqrt{T_p}\right]$	T=RC
6		SAME AS NO.4 EXCEPT	T=4(1+n) RC

For the more complex networks, the most general analytical method which is applicable is that of determining and solving the basic electromagnetic equations. This method can be quite involved for arbitrary film shapes and arbitrary resistance and capacitance distributions. For very complex circuits the results must be expressed as approximations or infinite series.

General Case

The general case of a distributed parameter R-C network is shown in Fig. 4. The resistive film R on the high dielectric substrate is of arbitrary shape with arbitrarily located conducting terminals A and B. Let the resistance per square, which is controlled by the thickness of the film, be $R(x_1, x_2)$, where x_1 and x_2 are arbitrary coordinates chosen to accommodate the shape of the film. The reverse side of the substrate is coated with a conducting film of infinite expanse, G. Let $C(x_1, x_2)$, which is controlled by the thickness of the dielectric, be the capacitance per unit area of the resistive film relative to the conducting film. The equations of the R-C film combinations are:

$$\nabla V(x_1, x_2, t) = -R(x_1, x_2)J(x_1, x_2, t) \quad (1)$$

$$\nabla \cdot J(x_1, x_2, t) = C(x_1, x_2)\partial V(x_1, x_2, t)/\partial t \quad (2)$$

where V is the potential of the resistive film relative to the conduct ing film and J is the vector current density of the resistive film.

Since the system is linear and a steady-state solution is desired, the variables may be separated as follows:

$$V = E\,(x_1, x_2)\, e^{j\omega t} \quad (3)$$
$$J = I\,(x_1, x_2)\, e^{j\omega t} \quad (4)$$

where E and I are complex quantities representing the relative amplitudes and phases of the voltage and current density within the resistive film.

Substitution into Eq. 1 and 2 yields

$$\nabla \cdot [\nabla E/R] = -j\omega C E \quad (5)$$
$$\nabla[\nabla \cdot I/j\omega C] = -RI \quad (6)$$

Thus the analysis of the steady-state characteristics of an arbitrary R-C film combination becomes a boundary value problem where Eq. 5 and 6 must be solved and boundary conditions imposed according to the shape of the film and the locations of the terminals. Such a technique may be laborious even for simple film shapes and constant R and C over the films, and solutions in closed form are probably obtainable only for very special configurations.

It appears at first glance that any arbitrary R-C film combination might lend itself to analysis as a one dimensional tapered transmission line if the coordinate system were chosen so that the single displacement coordinate is normal to the isopotential lines in the resistive film. The fallacy here is that isopotential in this case means equal amplitude and equal phase. Isopotential lines in this sense probably exist only for a limited number of film configurations, the rectangular films of Fig. 1A and 1B being two examples.

Typical Networks

The analytical and empirical evaluations of the networks analyzed so far have revealed some very interesting and useful properties. In all the examples discussed below the resistance per square and capacitance per unit area of the films are considered constant.

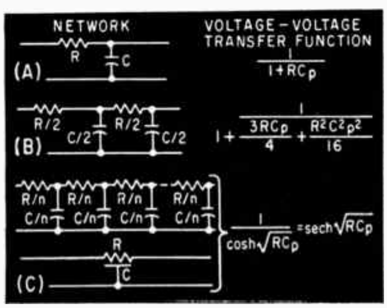


FIG. 5—Evolution of simple distributed parameter RC network

Consider first the use of the simple R-C network of Fig. 1A as a low pass filter. An intuitive approach to this network is shown in Fig. 5 starting with the two element lumped parameter R-C integrating circuit. If the number of series resistors and shunt capacitors is increased without limit in this ladder network so that the total series resistance and shunt capacitance remain invariant, the open circuit

is understood that the actual differential equation relating the output voltage to the input voltage is

$$z_{21}(p)E_1 = z_{11}(p)E_2 \quad (8)$$

where z_{21} and z_{11} are operators. The steady-state response is always obtained by writing the relationship in the form of Eq. 7, substituting $j\omega$ for p and evaluating the resulting complex function. From the z parameters for network 1, Table I

$$E_2/E_1 = (R\,csch\sqrt{Tp}/\sqrt{Tp})/ R\,coth\sqrt{Tp}/\sqrt{Tp} = sech\sqrt{RCp} \quad (9)$$

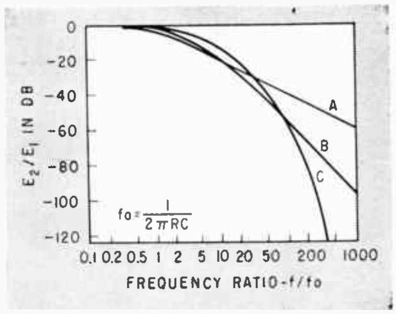


FIG. 6—Normalized amplitude responses of circuits of Fig. 5

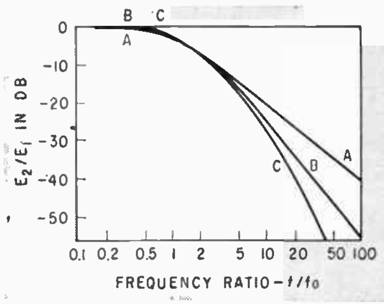


FIG. 8—Amplitude responses of networks at —3 db points for circuits of Fig. 5

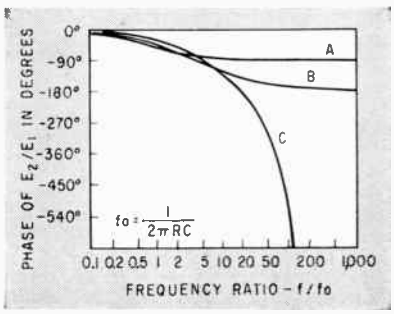


FIG. 7—Normalized phase responses of lumped parameter and distributed parameter RC networks. Curves are per Fig. 5

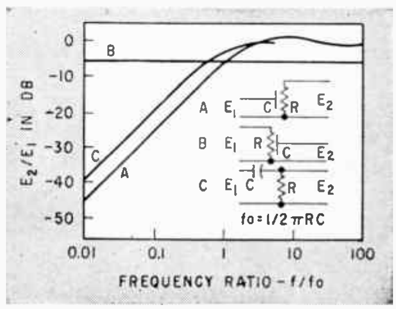


FIG. 9—Normalized amplitude responses of lumped parameter and distributed parameter networks

voltage-voltage transfer function becomes a correspondingly higher order polynomial in p until in the limiting case it approaches *sech* $\sqrt{RCp}$.

By applying the techniques discussed previously, the low pass filter characteristics of this network may be obtained readily from the z parameters. From Fig. 3 it is seen that the open circuit voltage-voltage transfer function of a linear network is given by the operational relation

$$E_2/E_1 = z_{21}(p)/z_{11}(p) \quad (7)$$

where E_1 is the input voltage and E_2 the output voltage. In Eq. 7 it

Substituting $j\omega$ for p, the resulting complex function is

$$sech\sqrt{j\omega RC} = \left[e^{-j\tan^{-1}(\tanh\sqrt{\omega T/2}\,\tan\sqrt{\omega T/2})}\right] \left[\sqrt{2/(\cosh\sqrt{2\omega T}+\cos\sqrt{2\omega T})}\right] \quad (10)$$

where $T = RC$ and ω = angular frequency. Thus, the amplitude and phase response of this network are:

$$A(\omega) = \sqrt{2/(\cosh\sqrt{2\omega T}+\cos\sqrt{2\omega T})} \quad (11)$$

$$\phi(\omega) = -\tan^{-1}(\tanh\sqrt{\omega T/2}\,\tan\sqrt{\omega T/2}) \quad (12)$$

For high and low frequencies, these expressions may be approximated by

$$A(\omega) \cong 1 \; (\omega \ll 1/T)$$

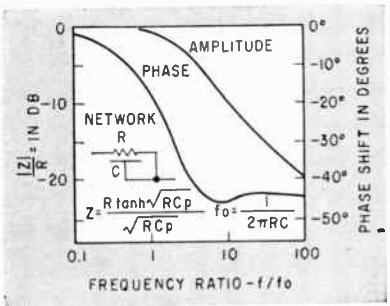


FIG. 10—Normalized impedance curves for distributed parameter *RC* network

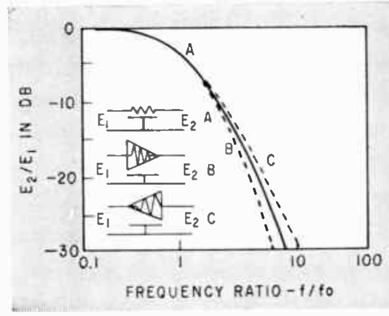


FIG. 11—Amplitude responses are matched at—3 db points

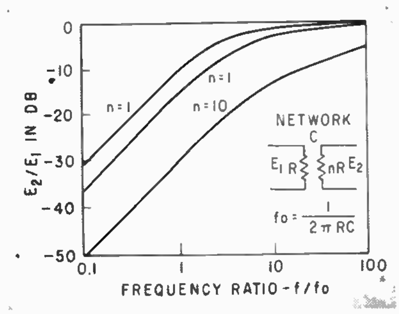


FIG. 12—Amplitude response of *RR* dis-·-ibuted parameter network

$$\simeq (2\ sech\ \sqrt{2\omega T})^{1/2} \qquad (\omega \gg 1/T) \qquad (13)$$

$$\phi(\omega) \simeq \tanh\sqrt{\omega T/2}\ \tan\sqrt{\omega T/2} \qquad (\omega \ll 1/T)$$

$$\simeq \sqrt{\omega T/2} \qquad (\omega \gg 1/T) \qquad (14)$$

Figures 6 and 7 show the normalized amplitude and phase responses of the first and second order lumped parameter networks of Fig. 5 as compared with those of the limiting distributed parameter network. With a finite number of components, the R-C network always approaches an asymptotic cutoff rate with respect to log frequency and the phase response approaches a final finite value. For the distributed parameter network both the amplitude and phase response drop off at an ever increasing rate as shown by Eq. 13 and 14.

If the distributed parameter R-C network is to be used as a low pass filter, Fig. 8 shows that it offers, at least in one sense, a better cutoff characteristic than either of the other two networks. Here the responses are matched at the −3 db points, showing that the distributed parameter network exhibits sharper cutoff characteristics.

Other Networks

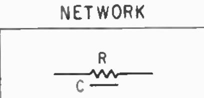
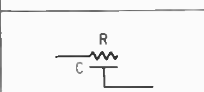
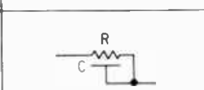
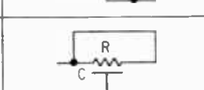
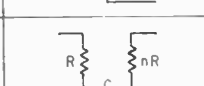
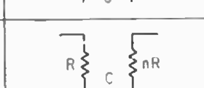
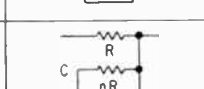
Shown in Fig. 9 are the response characteristics of the same distributed parameter network connected as a high pass filter and as a frequency independent attenuator. These are compared with those of the single order R-C differentiator. Note that for configuration *A*, a voltage gain greater than unity is realized over a finite bandwidth. Actually, the response constitutes a damped oscillation about the zero db axis with increasing frequency. The $z(p)$ parameters for these network configurations are given in Table I.

Also of interest is the 2-terminal impedance of the same distributed parameter R-C network with the output short circuited. This is shown in Fig. 10, normalized with respect to the *RC* product. Note that at high frequencies the network has characteristics half way between those of a resistor and a capacitor. The asymptotic cutoff rate is 10 db per decade and the phase response approaches −45 degrees. This network is number 3 in Table II.

Fig. 11 demonstrates how the tapering of distributed parameter R-C networks might modify and improve certain desired characteristics. Shown are the measured low-pass filter characteristics of the linearly tapered network of Fig. 1C compared to the response of the untapered network of Fig 1A. These curves are all matched at the −3 db points. In all cases the responses at frequencies below the −3 db point are nearly the same. Above this point, however, the tapered network exhibits sharper cutoff characteristics when driven from the wide end and less sharp characteristics when driven from the narrow end. This would be expected intuitively since in the former case the loading effects per incremental stage are reduced and in the latter case they are increased.

This tapered R-C network points out the interesting variations that are possible in synthesizing transfer functions by the thin film technology. An interesting problem that immediately arises is to find the shape or taper of an R-C film

TABLE II—TWO—TERMINAL DISTRIBUTED PARAMETER NETWORKS AND IMPEDANCES

NO.	NETWORK	IMPEDANCE
1		$\frac{2R}{\sqrt{T_p}}\tanh\frac{\sqrt{T_p}}{2}$, $T=RC$
2		$\frac{R\coth\sqrt{T_p}}{\sqrt{T_p}}$, $T=RC$
3		$\frac{R\tanh\sqrt{T_p}}{\sqrt{T_p}}$, $T=RC$
4		$\frac{R\coth\frac{\sqrt{T_p}}{2}}{2\sqrt{T_p}}$, $T=RC$
5		$\frac{(1+n)R\coth\sqrt{T_p}}{\sqrt{T_p}}$, $T=(1+n)RC$
6		$\frac{(1+n)R\tanh\sqrt{T_p}}{\sqrt{T_p}}$, $T=(1+n)RC$
7		$\frac{(1+n)R}{n+\sqrt{T_p}\coth\sqrt{T_p}}$, $T=(1+n)RC$

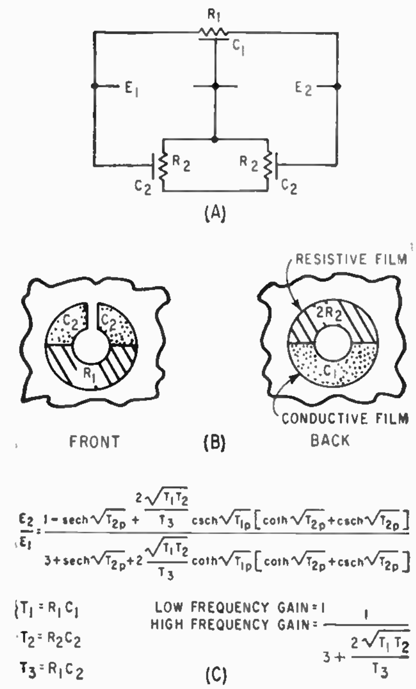


FIG. 13—Distributed parameter notch filter

combination that will yield certain prescribed cutoff characteristics.

These networks also offer interesting possibilities for use with operational amplifiers for generating prescribed transfer functions in the analogue computer field. It appears that the field of distributed parameter networks is virgin territory awaiting the explorations of engineers and circuit designers. It will enforce new concepts and demand new techniques for analysis and synthesis.

Fig. 12 shows the frequency response of circuit number 6 of Table I. This circuit is useful as a coupling network between transistor amplifier stages where R is the collector load resistance and nR is the bias resistance for the following stage. Functionally, it serves no better than lumped components. But in building a circuit from thin films, it does eliminate a specific coupling capacitor.

Another interesting network is the notch filter of Fig. 13. Three untapered R-C networks are arranged as shown in Fig. 13A. The morphology is shown in Fig. 13B and the response equation in 13C. Precise evaluation of the transfer function for optimization of the response is obviously a computer operation, but a notch obtains for the condition $C_1 \cong 2C_2$, $R_1 \cong R_2$.

The response of a typical distributed parameter notch filter is shown in Fig. 14 where it is compared to that of a twin-T network. Unlike the twin-T network, the distributed parameter analogy exhibits a high frequency attenuation of about 13 db.

Applications

Examples of the application of microcircuitry technology to working circuits are shown in Fig. 15[5]. The R-C oscillator which is shown in the upper-three sketches, of Fig. 15 makes use of the phase characteristic of network number 1 of Table I to achieve oscillation by negative feedback around a single transistor stage. The three resistors are first deposited as a single film and then over-deposited with appropriate conducting tabs for the transistor leads. A single grounded conducting film behind R_2 provides the phase shift necessary for oscillation while the resistance films R_2 and R_3 together establish the proper bias point. A conventional transistor is soldered to the films to provide amplification.

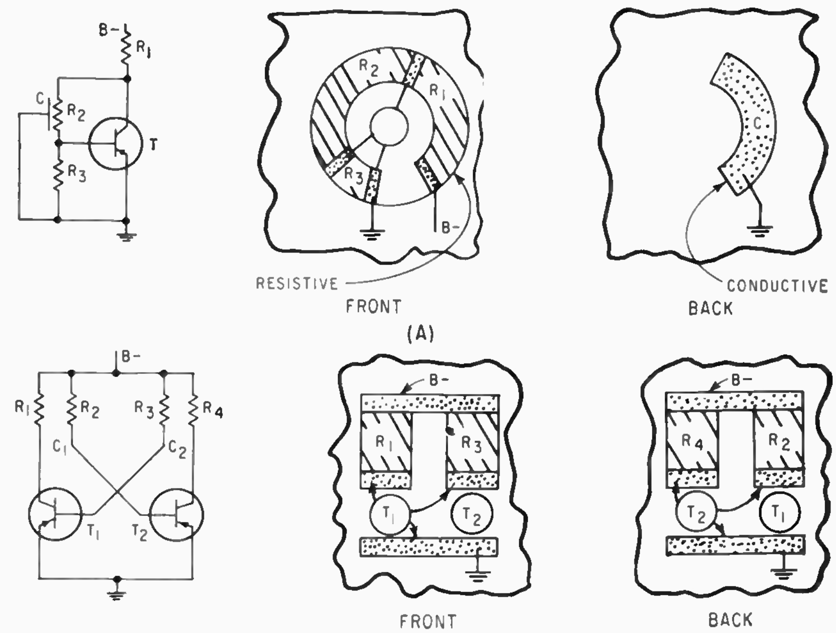


FIG. 15—Typical circuits using distributed parameter networks, RC oscillator is shown in upper sketches and a stable multivibrator in lower sketches

The astable multivibrator of Fig. 15 makes use of network number 4 of Table I. The resistance films R_1 and R_4 are the transistor loads and R_2 and R_3 control the bias current. Interstage coupling is obtained from capacitance C_1 between R_1 and R_2 and capacitance C_2 between R_3 and R_4. The capacitance exists because of the close physical placement of the resistive films on the front and back of the dielectric substrate.

As in the case with the oscillator of Fig. 15, conventional transistors are soldered to the conducting tabs to provide amplification.

The oscillator and multivibrator are only two of the many possible circuits which can be developed with the technique.

Conclusion

With the development of new circuit fabrication techniques such as are used in microcircuits, distributed parameter networks will make available to the circuit design engineer new types of linear transfer functions not heretofore realizable with a finite number of lumped components. Not only will the thin film technology ultimately result in new degrees of miniaturization, producibility and reliability, but distributed parameter networks will help reduce the number of distinct elements used. Further progress in analyzing and synthesizing distributed parameter networks will enhance the fabrication of circuits and circuit functions by the combinations of elementary materials rather than by the assemblies of standard lumped components[4].

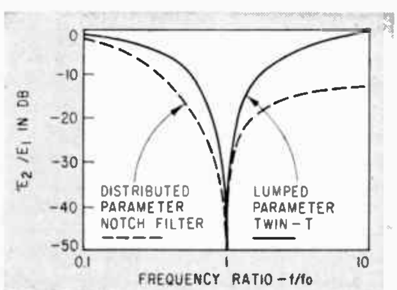


FIG. 14—Comparative responses of Twin-T and distributed parameter notch filters

References

(1) E. A. Guilleman, "Communication Networks", Vol II, John Wiley and Sons, Inc., New York, 1935.
(2) J. E. Storer, "Passive Network Synthesis", McGraw-Hill Book Co., Inc., New York, 1957.
(3) F. E. Terman, "Radio Engineering", McGraw-Hill Book Co., Inc., New York, 1947.
(4) A. Smith and G. Cooper, Distributed Components in Printed Circuits, *Proc Electronics Component Symposium*, 1956.

Solders for Nuclear

Standard 60-40 and 50-50 solders often fail in critical environments. Here are some of the soft and silver solders which take heat, cold and radiation

By ALVIN B. KAUFMAN,
Research Engineer, Head, Research and Analysis Dept., Litton Industries, Los Angeles, Calif.

NUCLEAR AND SPACE age requirements of electronic equipment require a reevaluation of soldering materials and techniques. A review of the state of the art is advisable for engineers concerned with solders used in these new environments.[1,2,3,4,5]

Solder joint reliability is a prime factor in the overall reliability and serviceability of systems exposed to a wide range of temperatures or nuclear environments. This is clearly shown in a computer with 60,000 to 70,000 connections. If there is one failure

Table I—Characteristics of Soft and Silver Solders for Electronic Equipment

Trade Name & Spec	Composition	Conductivity (%)[b]	Short Term Tensile Strength (in psi × 1,000) −320F	80F	200F	300F	Plastic[c] (deg F)	Liquidus (deg F)	Remarks and Applications
SOFT SOLDERS[a]									
Sn-60 QQ-S-571b	60Sn-40Pb	11	17	6.3	—	—	361	370	rosin flux; not satisfactory for extended use below 0 F; poor ductility at cold temperatures (Sn-60 and Sn-50)
Sn-50 QQ-S-571b	50Sn-50Pb	11	18	6.28	3.09	1.15	361	414	
Ag 1.5 QQ-S-571b	97.5Pb-1.5Ag-1Sn	7.5	9	3.6	2.5	1.7	580	588	rosin flux; excellent for low to high temp; good cold ductility; withstands nuclear, humidity, salt spray environment
Sb-5 QQ-S-571b	95Sn-5Sb	13	12.6	5.9	4	2.4	450	468	rosin flux; poor cold temp ductility; p-c boards, good solder filets
Indalloy 3	90In-10Ag	22	5.1	2.05	1.25	0.7	—	446	good where high conductivity or fluxless use is required[d]
———	95Sn-5Ag	14	—	15	—	5	415	430	same as Sn-60
———	95Cd-5Ag	—	—	24	(6 at 500 F)		640	750	highly corrosive flux requires extensive flux removal; solder's corrosion resistance is questionable
SILVER SOLDERS			−424F	−320F	80F	1,000F			
AWS-ASTM BAg5	45Ag-30Cu-25Zn		75	74	61	14	1,250	1,370	high temperature joining of components and circuits; corrosion resistance questionable; fluxes should be removed after joining (BAg5 and BAg10)
AWS-ASTM BAg10	70Ag-20Cu-10Zn		57	54	34	5.5	1,335	1,390	

(a) Soft solders are defined by American Welding Society as alloys melting below 800 F; materials melting above 800 F are specified as brazing materials (b) Conductivity, as percent of copper conductivity, based on IACS volume resistivity (c) plastic temperature approximates zero psi (d) Flux is generally detrimental and is rarely required

and Space Environments

Table II—Typical Solder Parameters

Tensile strength and ductility vs temperature range required.

Compatibility with temperature, nuclear, liquid oxygen[a], humidity and salt-spray requirements

Quality: adherence to various metals and 'wetting' ability of solder

Electrical characteristics: conductivity vs copper

(a) This requirement differs from temperature, as noted in the text

per 20,000 connections during 1,000 hours of operation, the system's mean time to failure is approximately 25 hours.[6]

Today, an environmental specification for temperature may call for an extreme low of −300 F to −400 F and a high of 500 F. Induced artificial radioactivity is another current problem. These parameters are good cause for materials and techniques review.

The standard 60-40 and 50-50 tin-lead solders, used in such industrial or commercial electronics fields as radio and tv, are not suited to such extreme environments.

Various standard solder alloys and those containing or consisting of exotic metals, have been evaluated in an attempt to secure an all-purpose solder. But one solder generally does not meet the majority of both temperature and nuclear requirements.

Table I lists the characteristics of some standard solders, exotic solders and improved common alloy solders. They are capable of meeting some or all of the environments specified. Table II presents major solder parameters useful for solder evaluation. Solder radioactivities after exposure to nuclear environments are reported in Table III.

Silver solders are included although they are not commonly used for electronic equipment. They are of interest for thermocouples or other wires requiring special solder materials and also for components, such as heaterless tubes, which operate at extreme temperatures.

Tin-based solders without additives are not satisfactory for long-term cold environments. Phase transformation in the tin destroys the connection. Ductility is lost at low temperatures and the solder becomes brittle.

Antimony and other select elements inhibit such phase transformation.[7] The 95Sn-5Sb solder is useful for low temperatures. It has been evaluated for printed circuit board use and found excellent, within the environmental limits given in Tables I and III.

Lead-based solders exhibit increasing tensile strength, combined with excellent ductility, down to −400 F and colder. High lead base-silver alloy solders, however, have low corrosion resistance and poor solderability. This is corrected by the addition of tin (Ag 1.5 solder), producing an excellent solder[8] meeting requirements of all current space and nuclear environments.

Solder used in direct contact with liquid oxygen must be inert. Most solders are not inert under the igniting action of shock. High ductility should offer an improvement, by increasing the force required to detonate.[9]

Low electrical resistivity and ability to tin or wet some metals may require the use of exotic solder alloys like pure indium or Indalloy 3 (Indium Corp. of America).

The author gratefully acknowledges the assistance of Leonard B. Gardner in reviewing certain nuclear parameters and preparing Table III.

Table III—Radioactivity of Solders

Solder	mr/hr @ 1 ft[a]	Solder	mr/hr @ 1 ft[a]
Sn-50	10^{-3}	Ag 1.5	0.8×10^{-3}
Sn-60	10^{-3}	BAg5	2×10^{-2}
Sb-5	1.8×10^{-3}	BAg10	4×10^{-2}

(a) Approximate gama radiation (milliroentgen) from "point source" of 10 grams of solder, 2-5 days after irradiation. At one cm the dosage rate would increase approximately 1,000-fold.[5] Based on irradiation for 60 days with thermal neutrons at 10^7 n/cm²/sec. Alpha, Beta and other radiations were not considered but can be hazardous without adequate personnel safety measures.

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Analyzing Multipath Delay

Although multipath delay causes troublesome phase distortion in communications systems, this phenomenon can be useful in analyzing ionospheric conditions. This article describes an automatic analyzer that triggers at appreciable changes in signal amplitude due to multipath delays, and prints out the delay times between triggerings

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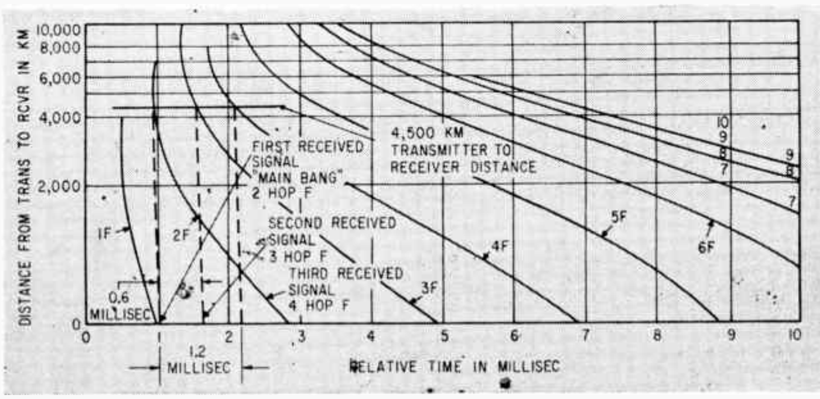


FIG. 1—Chart illustrates multipath signal propagation time delays for a transmitter-to-receiver distance of 4,500 km. Assumed layer heights are F=300 km and E=100 km

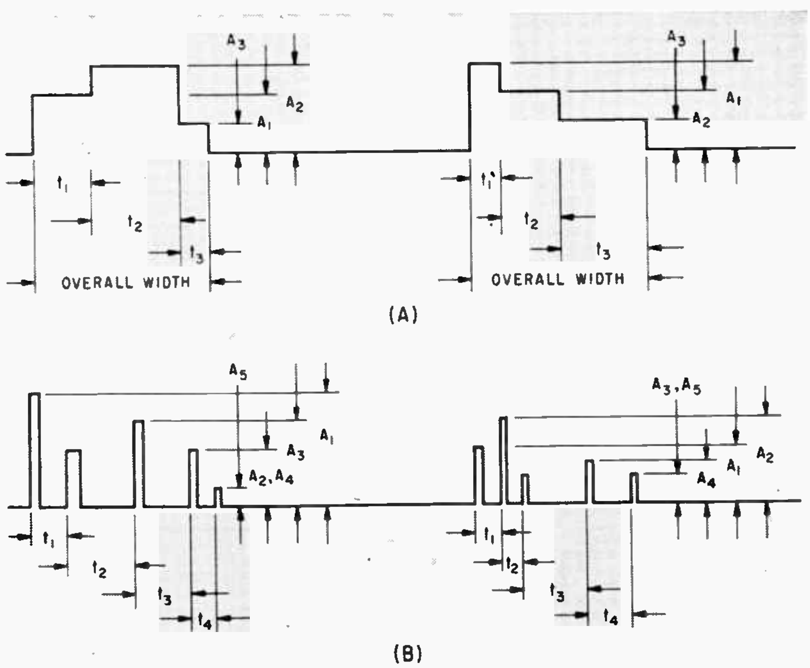


FIG. 2—Composite waveforms (A) occur when transmitted pulse is much longer than multipath delay time. Discrete waveforms (B) result when path delay is relatively short

Propagation of r-f signals by reflection from the ionosphere exhibits unique characteristics which are dependent upon the type of signal transmitted, the path length and the geographical location. In the h-f range, propagation is usually of the skywave type, the distinguishing characteristics of which are the simultaneous existence of several propagation paths (see Fig. 1). Each propagation path for a particular communications link is termed a multipath, and is physically described by identifying the ionospheric layer from which the signal reflections occur and also by the number of reflections which are occurring. Typical propagation paths are two-hop F_2 and three-hop E. The electrical parameters of a communications link relating the individual multipath signals at any instant of time are relative phase and amplitude.

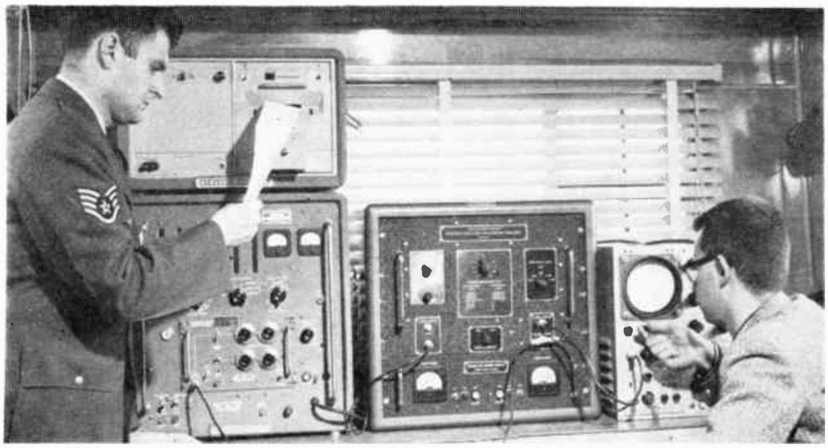
Measurements

The individual multipath signals of a communications link add at the receiver input. The measurement of the relative phase and relative amplitude of a transmitted c-w signal at the receiver input is extremely difficult. However, pulse transmission provides a means of measuring the individual multipath electrical characteristics by converting relative phase information to measurable time intervals.

The received signal that results

in Communications Studies

from pulse transmission is one of two general types. The first results when the transmitted pulse is appreciably longer than the relative multipath time delay. Received signals of this type are the composite signals shown in Fig. 2A. The second general type results when the transmitted pulse is appreciably shorter than the relative multipath time delay. This is the system of discrete signals shown in Fig. 2B. Thus, the use of pulse transmission reduces the difficult determination of relative multipath characteristics to the more easily managed measurement of pulse widths and pulse amplitudes.



Multipath delay analyzer in use at the Air Force Cambridge Research Center yields data on reflecting layer heights, transmitting distances and other features of the ionosphere

Equipment to be described is designed to sample the received signals periodically and provide high-speed printed digital output data relating individual multipath signal characteristics to one another. The equipment is completely automatic and may operate unattended. When operating with received signals of either the composite or discrete type, the equipment provides relative amplitude and time interval information as indicated in Fig. 2.

A block diagram of the system utilizing the multipath analyzer is shown in Fig. 3.

A general communications receiver provides inputs to the multipath analyzer. The diode-detector output immediately following the last intermediate-frequency amplifier stage of the receiver is fed directly to the multipath analyzer. The receiver is operated at maximum r-f bandwidth and without automatic gain control. The maximum r-f bandwidth provides the best pulse response, and in the absence of age, the receiver functions as a linear detector.

The noise-clipper circuits of the multipath analyzer clip the input signal above the receiver noise level. Receiver noise clipping may be accomplished in either the manual or automatic modes. The threshold-level circuit is bypassed during composite-pulse operation. For discrete-pulse operation, the threshold-level circuit provides an indirect measurement of the relative amplitude of individual multipath signals.

The following considerations refer particularly to composite-signal operation, although discrete signal operation necessitates only slight changes in procedure.

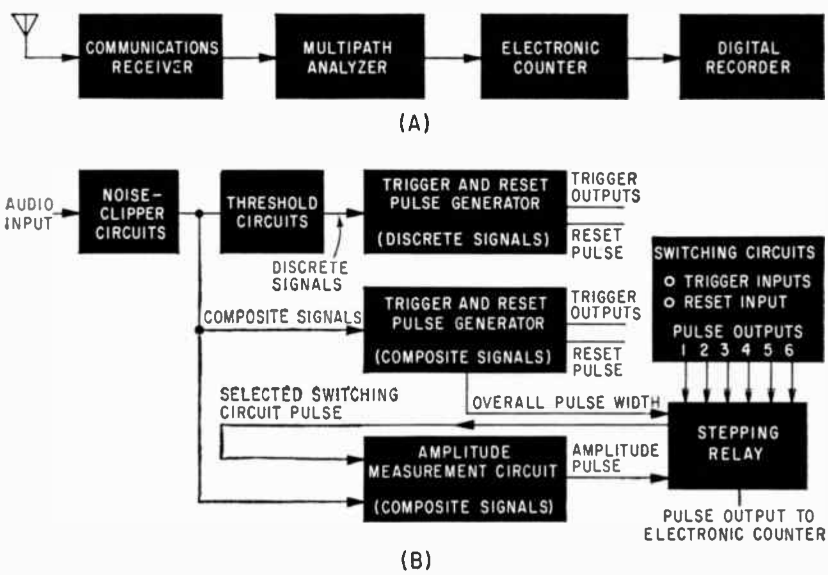


FIG. 3—Block diagrams of overall system (A) and details of multipath analyzer (B)

Switching Circuit

The trigger and reset pulse generator provide inputs to the switching circuits for each input signal amplitude discontinuity. These in turn also provide a delayed pulse using a monostable multivibrator, to reset the switching circuits to their initial positions in the time interval between successive pulse trains. The time sequence of these switching circuit inputs is shown in Fig. 4.

The switching circuits generate pulses corresponding to the time intervals between successive input triggers. These circuits are capable of generating nine individual output pulses corresponding to nine distinct time intervals of the type shown in Fig. 2A. The analyzer capability, however, is limited to four time intervals by the sampling technique. Fig. 4 illustrates the correspondence between the switching circuit output pulses and the composite pulse time intervals. They are of identical width and there is absolute time coincidence between them. The latter property is of importance in the measurement of relative amplitude.

The switching circuit output pulses are sampled by a stepping relay, Fig. 3, whose output feeds an electronic counter and a digital recorder. The digital-recorder printing mechanism limits the sampling rate to five pulses per second.

The amplitude measurement circuit converts signal amplitude information to pulse width information. Inputs are the received composite signal, and the switching-circuit output pulse corresponding in time to the input signal amplitude portion to be measured. The output is a pulse whose width is linearly related to the input signal amplitude.

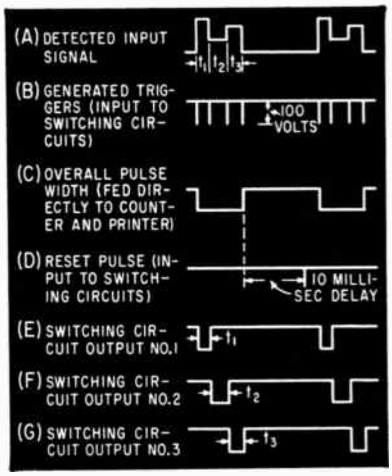


FIG. 4—Waveforms at various portions of the multipath analyzer

Noise Clippers

The noise-clipper circuits accept the communications receiver output and provide automatic or manual clipping above the receiver noise level. The input signal is amplified, clamped to ground and then clipped. Clipping bias is from a diode detector (automatic) or a bleeder across the supply voltage (manual). The bias voltage is fed from a cathode follower to provide a low-impedance source.

The threshold circuit is similar to the noise clipper. Bias voltage for clipping is an adjustable percentage of the noise clipping voltage. Threshold level is calibrated in db with respect to the receiver noise level.

A typical input signal to the trigger and reset pulse generator is shown in Fig. 4A; Fig. 5 is the schematic diagram of this circuit. A differentiating circuit provides triggers for each input signal amplitude discontinuity. The resultant positive and negative polarity triggers are converted to a uniform negative polarity in paraphase amplifier V_{21A}. These uniform polarity triggers are shown in Fig. 4B after amplification in V_{23} and V_{24}.

A second channel, composed of overdriven amplifiers V_{25} and V_{26} and cathode follower V_{21B}, provides an output pulse whose width corresponds to that of the overall input signal, as in Fig. 4C. The lagging edge of the overall pulse triggers a one-shot multivibrator V_{28} to generate a suitably delayed reset pulse for the subsequent switching circuits. The time sequence of this reset pulse is illustrated in Fig. 4D.

Figure 6 is a schematic diagram of the switching circuits, the heart of which is a magnetron beam switching tube.

Tube V_{11} is the switching tube. Each target circuit is identical, as is each spade circuit, with the exception of the zero spade. A time constant network in series with the zero spade insures formation of the beam in the zero position after the tube has been cleared by a reset pulse. Reset pulses are injected into the circuit at the grid of tube V_{12B}. This stage acts as the cathode resistor of the switching tube; driving V_{12B} to cut-off interrupts the beam current and clears V_{11}. Tube V_{12A} and the time-constant network in the zero spade circuit assure the re-formation of the beam in the zero position.

Beam Current Switching

With beam current at a given target, the current is switched to the leading target by temporarily releasing the beam. Lowering the grid voltage of the position to be switched frees the beam, and allows the magnet constructed around the tube to rotate the beam current to the leading position. Alternating grids are connected together into two sets, even and odd. The alternating trigger source is flip-flop V_{13}. The input triggers from the trigger and reset pulse generator are applied symmetrically to both halves, but are effective for only the off-tube. The reset pulse is used to trigger one-half of the flip-flop circuit to insure that it is in the proper initial state.

Consider operation of the switching circuits with triggers as shown in Fig. 4B. The first trigger switches the beam to the first position, the second to the second posi-

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PHENOMENON OF MULTIPATH DELAY

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Multipath delay is a troublesome form of phase distortion occurring often on high-frequency layer-refracted or reflected signals, and also on vhf scattered signals.

Basically it is caused by the existence of more than one signal path between transmitter and receiver with signal components reaching the receiver at slightly different times. If these components arrive in phase, they add, lengthening the signal by the addition of echo tails, which, if long enough, may cause garbled transmissions. If they arrive out of phase, they cause cancellation, eliminating parts of the signal, and again cause distorted and garbled signals.

Fortunately this multipath phenomenon, harmful to communications, can be used profitably in communications studies. If the reflecting layer height or heights are known, the distance of a transmitting station can be determined; if the distance to the transmitter is known, information on the heights, variations and other features of the ionospheric reflecting points can be deduced. This can be particularly useful in studying the occurrence of ionospheric storms, particularly around polar blackout periods.

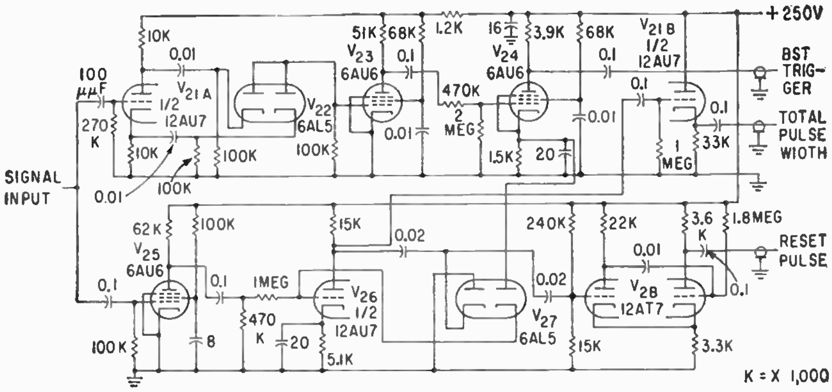

FIG. 5—Trigger and reset pulse generator. This circuit provides triggers for each input signal discontinuity as well as a reset pulse for the switching circuits

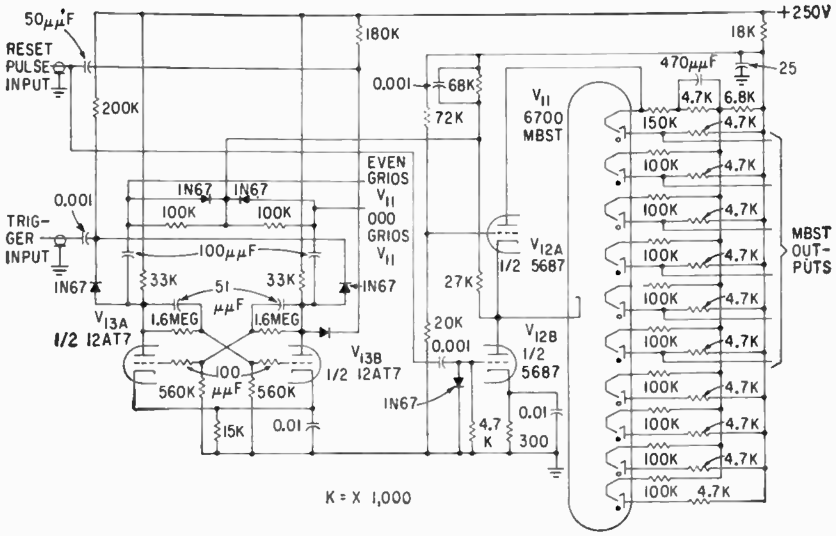

FIG. 6—Heart of the switching circuit is the magnetron beam switching tube V_{11} which produces outputs in coincidence with input signal amplitude variations

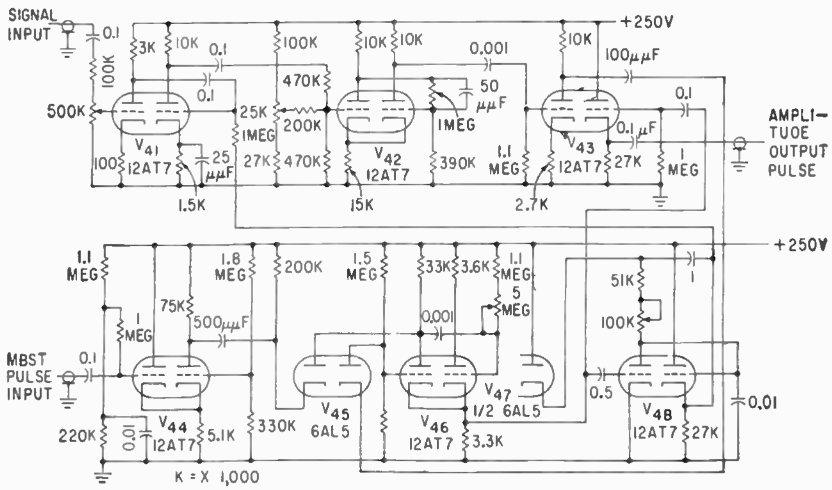

FIG. 7—Amplitude measuring circuit produces pulse whose width is linearly related to selected portion of the input signal. Pulse width is measured by a counter

tion, etc. This process continues until a reset pulse re-zeroes V_{11} and the switching sequence repeats. The waveforms in Figs. 4E, 4F and 4G are present on targets 1, 2 and 3, respectively. Thus, the succeeding switch-circuit output pulses are time-coincident with succeeding amplitude portions of the input signal. This property is of importance in the amplitude measurement technique.

Figure 7 is a schematic diagram of the amplitude measurement circuit. The circuit operation is best illustrated by an example. Suppose the amplitude of the t_2 portion of the input signal of Fig. 4A is to be measured. The input signal is amplified and applied to the grid of Schmitt trigger V_{42}. The switching-tube output corresponding to t_2 (Fig. 4F) is amplified in cathode-coupled clipper circuit V_{44}. One-shot multivibrator V_{46} (actually operated as a flip-flop) is triggered by the leading edge of this output pulse. A positive linear sweep voltage is generated in a bootstrap sweep generator V_{48} and added to the negative input signal at the Schmitt trigger grid. When the sum is one volt positive, the Schmitt trigger circuit changes state and returns multivibrator V_{46} to its initial state. Then, in turn, the sweep voltage ends and the Schmitt trigger circuit changes state. The pulse-width of the cathode waveform of V_{46} is thus linearly related to the t_2 amplitude portion of the input signal. This pulse-width is sampled and measured by an electronic counter.

Possible Refinements

The equipment described is a prototype unit developed on limited funds. Consequently, several refinements could greatly increase its operation value. A special receiver having wider bandwidth, lower noise figure and better selectivity would provide input signals superior to those now obtained. The equipment should also be modified to operate with i-f signals, rather than the detected i-f now used. This would eliminate phase distortion originating in the communications-receiver detector. Perhaps the greatest improvement is to be gained by incorporating a faster read-out system into the multipath analyzer. A faster read-out would extend the utility of the equipment manyfold. The present stepping relay permits a readout rate exceeding sixty lines per second.

This work was sponsored by Air Force Cambridge Research Center under USAF Contract AF 19(604)-3047. Assistance of H. Laskin and D. Neuf is acknowledged.

Design of Transistor

Design criteria for transistorized power converters are covered in this article, Examples cover silicon type delivering 15 w and a germanium type deliv ering over 100 w both from a 24-v source

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ALTHOUGH TRANSISTORS are attractive for mobile equipment operated from low voltages, thermionic tubes may often be either indispensable or established in designs which it would be uneconomic to scrap. In these circumstances, the change to transistors must be gradual, and the need for a power unit to provide plate supplies from low voltage batteries remains.

If this power unit involves vibrators, fractured reeds and fused contacts must be expected. Rotary converter brushes and bearings will eventually wear out and sparking at contacts and brushes may cause serious interference. In many cases a transistor power converter will provide a more efficient and far more reliable replacement which can be readily incorporated into an existing system.

Additional applications of these versatile circuits include fluorescent lighting, electronic photoflash and servo system power supplies. Transistors now available allow output powers from a few milliwatts to several hundreds of watts. Efficiencies of 70-90 percent can be achieved, and input voltages may range from 1½ to 50 v. Series or parallel connection of transistors permits still higher output powers and input voltages.

Transistor Requirements

The maximum collector current of a transistor is decided on considerations of instantaneous dissipation and of linearity (fall of β at high collector currents).

During the half cycle when a converter transistor is cut-off, it will experience a collector voltage equal to twice that of the supply, and a small base voltage tending to cut it off still further. From this it would appear that a safe supply voltage would be half the open-circuit emitter breakdown voltage.

Unfortunately, at the end of the conduction cycle hole storage may allow current to continue when the transistor voltage has risen to the supply voltage or even higher. Under these conditions the transistor open-circuit base breakdown voltage is relevant, and should preferably also equal twice the supply voltage if avalanche breakdown is to be avoided.

Transistor dissipation is likely to limit power output only at high ambient temperatures. For example: the 2N389 silicon transistor has a maximum rated dissipation of 45 w at 100 C. With the maximum value of R_{cs} of 5 ohms and a total supply current of 1 ampere the mean dissipation will be only 2½ w in each transistor.

The corresponding figure for the 2N457 germanium transistor is 50 w at 25 C. For a typical R_{cs} of 0.05 ohm, 5 amperes will give a mean dissipation of less than 1 w.

These figures ignore leakage current, transient and input dissipations, as these will normally be small. They show that heat-sink requirements are usually modest.

It is important that the peak collector currents of the two transistors should be practically the same, otherwise the lower current will limit the output prematurely. The fall of β at high currents tends to equalize these peaks but transistors with widely differing β should not be used.

Since the feedback winding pro-

Transistor Converter Design Equations

Maximum Load Power Output

$$P_{Lmax} = \frac{V_s^2}{4\,R_{cs}}$$

Current for Output Power P_L

$$I_c = \frac{V_s - \sqrt{V_s^2 - 4\,P_L\,R_{cs}}}{2\,R_{cs}}$$

Oscillation Frequency

$$f = \frac{V_s}{4\,B_{max}\,n_p\,a} \times 10^8 \text{ cps}$$

Minimum Emitter Current for Oscillation

$$I_e = \frac{25}{\dfrac{R_L}{N} - \dfrac{r_b}{\beta}} \text{ ma}$$

P_{Lmax} = max load power output in watts
V_s = supply voltage
R_{cs} = transistor saturation resistance
I_c = current for output power P_L
f = oscillation frequency
n_p = number of primary turns
B_{max} = saturation flux density of core in gauss
a = core cross section area in cm^2
r_b = transistor internal base resistance
N = primary to feedback windings turns ratio
R_L = secondary load reflected across primary
I_e = minimum emitter current to insure oscillation
β = transistor beta

Power Converters

vides an almost constant voltage, variations of transistor input impedance will affect base (and hence collector) currents. The addition of a small base series resistor, of the same order as the input impedance, will tend to give constant-current drive. The minimum resistance possible must be used otherwise drive power will be lost and carrier extraction efficiency on switch-off impaired (although this may be restored with a bypass capacitor). The base resistor can be common to the transistors and in series with the starting diode.

As transistor and transformer parameters make exact behavior hard to predict, voltage and current waveforms of a converter design should be observed on an oscilloscope.

Transformer Design

The transformer core material must have low hysteresis loss when taken to complete saturation and, preferably, a high saturation flux density. A high permeability should be maintained until saturation, in order that the inductive current shall be small compared with the load current. All this suggests square-hysteresis-loop materials such as ferrites. However, ferrites show a comparatively high hysteresis loss when taken to complete saturation and have a low saturating flux density (about 3,000 gauss) and are therefore suitable only for low output powers. Certain nickel-iron materials also show this square-loop characteristic, and have a high saturating flux density (typically 15,000 gauss) with a low saturation hysteresis loss (around 750 ergs/cycle/cm^3).

The choice of core material and of operating frequency (unless this is decided by other considerations, such as ripple frequency) will depend on the power output required.

At power levels of less than a watt, the maximum nickel-iron core volume for reasonable efficiency will become very small. A ferrite core may then be preferable, and high-frequency operation (at several kilocycles) will counteract the low saturation flux density and give reasonable copper losses.

For higher powers a nickel-iron core is essential, and a comparatively low operating frequency will be necessary. Core hysteresis losses are directly proportional to frequency and eddy-current and residual losses increase according to a square law. The optimum frequency will generally be from 200-800 cps.

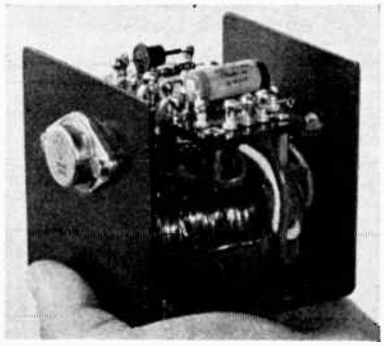
A possible core is chosen for the power to be handled. As a starting point, about 1 cm^3 of core volume should be allowed for each watt of output power required. On this basis a material having a loss of 700 ergs/cm^3/cycle would give a core loss of 3 percent at the typical frequency of 400 cps. An operating frequency is chosen, and the number of primary turns is calculated. By allocating roughly half the winding space to the primary, the primary resistance, and that of the secondary reflected in the primary, may be estimated. The copper loss can then be compared with the core loss obtained from the core volume and the operating frequency. A high proportion of copper loss will suggest raising the frequency or increasing the core volume (and vice versa). The effect on the total loss of these alternative measures can then be compared.

The number of feedback turns are chosen to give the full load collector current, allowing for the starting diode and added base resistance voltage drop.

The secondary winding is chosen to give the required output voltage, bearing in mind that the primary voltage is less than the supply as a result of R_{cs}. Slight readjustment of the secondary turns may be necessary to cover the resistive drop in the winding.

Typical Designs

The silicon transistor converter shown in Fig. 1 was designed to give 15 w output from a 24-v supply. It uses two 2N389 silicon power transistors and can operate in ambient temperatures up to about 130 C.



Placement of components in 120-watt power inverter

The 2N389 has a maximum collector-to-emitter voltage of 60 v, so that operation will be safe with supply voltages up to 30 v.

The maximum R_{cs} for transistors currently available is 5 ohms. Taking the worst possible case, if other losses are ignored, the maximum output is $V_s^2/4\ R_{cs}$ = 28 w for 50 percent efficiency. For 70 percent actual efficiency, which might be the minimum tolerable, the maximum output will be at least 15 watts.

In this case a square stack of laminations was chosen having a volume of 19.8 cm^3 and a core area a of 1.61 cm^2.

The hysteresis loss of the material to the saturation flux density of 15,000 gauss was stated by the makers as 650 ergs/cm^3/cycle. For a typical operating frequency of 400 cps, loss = 650 × 400 × 19.8 ergs/second = 0.515 joule/second or 515 mw. For an output of 15 w this corresponds to a loss of 3½ percent, and is therefore acceptable.

The collector current for P_L = 15 w is 0.76 ampere. If all losses apart from R_{cs} are assessed at 3 w, the actual I_c will be 0.88 ampere, and the voltage appearing across the primary will be 24 − (0.88 × 5) = 19.6 v. The primary will have 50.5 turns.

The area of the winding space

is approximately 0.4 sq in. Allowing 0.1 sq in. for each primary and a suitable space factor, 20-gauge wire is indicated. Two layers will give 45 turns, involving a change of frequency to 450 cps.

For a full load output voltage of 200 (rising to about 240 v on no load), allowing for secondary and rectifier voltage drop, the secondary $= 204/19.6 \times 45 = 470$ turns. This should be of 28 gauge in order to fill the remainder of the bobbin. The copper losses in primary and secondary are roughly the same as the core hysteresis loss and both are small compared with R_{cs} loss. The lamination pattern and operating frequency are therefore suitable.

The feedback turns can be calculated from the V_{be}/I_c characteristic shown in the 2N389 data; 3.8 v will be required for an I_c of 0.9 ampere. Allowing 1 v drop across the starting diode and 0.7 v across the base resistor, 5.5 v will be required, giving 13 turns for each base winding. Wire of 28 gauge is suitable.

To give low leakage inductance it is preferable to sandwich the feedback windings between the primaries, which in turn should be placed in the middle of the secondary, wound in two equal sections.

The input resistance of the 2N389 at high current is about 30 ohms. Series base resistors of 10 ohms will drop just less than the 0.7 v allowed and give sufficient current equalization throughout the cycle.

The emitter current required for starting may now be calculated. Here, $R_L = 24/0.9 = 26.6$ ohms and $N = 45/13 = 3.5$. For low currents, r_b will be higher than usual, about 40 ohms, and the effective value will be increased by the added base resistors, giving a total of 50 ohms; β will also be lower, approximately 10. The minimum emitter current to insure oscillation will be 10 ma.

The total I_b required will be 2.0 ma so that $R = 12{,}000$ ohms. In fact, 5,600 ohms were found to be necessary. This difference can be explained by the rather arbitrary choice of r_b and β, both of which affect the result considerably, and the fact that the transistors oppose each other until a higher collector current is established.

At the full load of 15 w, 70 percent efficiency was obtained with a dissipation of less than 4 w per transistor. At temperatures up to 100 C, a copper or aluminum heat sink of about 3 square inches will be sufficient; at higher temperatures a larger one (preferably of copper) may be necessary.

Germanium Transistor Converter

The circuit of this converter is exactly the same as that of the silicon version. The component values are also in Fig. 1. Two 2N457 germanium power transistors are used, and over 100 w may be obtained from a 24-v supply at about 90 percent efficiency.

The R_{cs} of the 2N457 is typically 0.05 ohm, with a maximum of 0.2 ohm. The maximum current of 5 amperes will give a maximum saturation voltage of 1 v. In this case, I_{cmax} and not R_{cs} limits the output; the arguments above concerning R_{cs} may be ignored, although an allowance must be made for the saturation voltage when considering the actual transformer primary voltage. A laminated core with a volume of about 40 cm³ was used and to reduce hysteresis losses, a frequency of 300 cps chosen.

By a similar process to that used for the silicon converter, the windings are calculated as follows: primaries, each 54 turns 18 gage; secondary, 588 turns 26 gage (for 250 v); and feedback windings, 10 turns each, 26 gage.

The input resistance of the 2N457 is about 10 ohms, and base resistors of 3.3 ohms give adequate current sharing.

The total effective r_b is now 13.3 ohms, $N = 5.4$, $R_L = 4.8$ ohms and β at least 30. This requires I_c of 55.5 ma, and $R = 6{,}500$ ohms. The experimental converter actually started with 8,200 ohms, showing that the β of one transistor was higher than supposed.

The mean R_{cs} dissipation at full load will be less than 2½ w per transistor, and a small heat sink about 4 or 5 square inches will allow operation in ambient temperatures up to about 65 C assuming a junction temperature of 80 C.

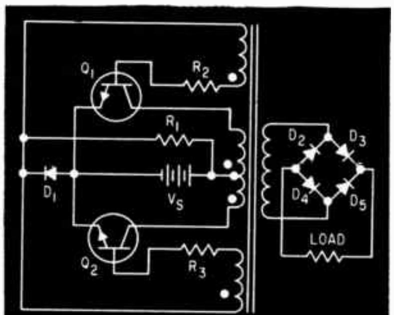
In neither design is smoothing shown, as ripple specifications may vary widely. As a rough guide, however, a single capacitor of 2 μf gave 4 v peak ripple (2 percent) on full load with the silicon converter, and necessitated changing the starting resistor to 3,300 ohms in order to start on full load. For the same percentage ripple, the germanium converter required 4 μf.

Although considerably higher power and efficiency can be obtained with germanium transistors than with silicon transistors at present available (at much lower ambient temperatures), it is anticipated that silicon transistors will soon be available with lower R_{cs}. The silicon transistor will then rival the germanium type.

Using selected 2N389 transistors having an R_{cs} of 2½ ohms, the circuit of Fig. 1 has given 30 w at 75 percent efficiency when operated from a 24-v supply.

Two 2N514B germanium transistors (25 amps, 80 v) have given 630 w at 90 percent efficiency. Thus the d-c converter can now meet any specification that previously required a vibrator power unit or rotary transformer.

Acknowledgement is made to the editor of Electronic and Radio Engineer, Iliffe and Sons, Ltd., London, England, for permission to reproduce some material.



	SILICON	GERMANIUM
Q_1 Q_2	2N389	2N457
D_1	IN645	IN538
R_1	5,600	8,200
R_2, R_3	10	3.3
D_2, D_3, D_4, D_5	IN647	IN540

FIG. 1—Practical converter circuit with full-wave rectifiers. In the germanium unit, diode D_1 and the supply voltage must be reversed

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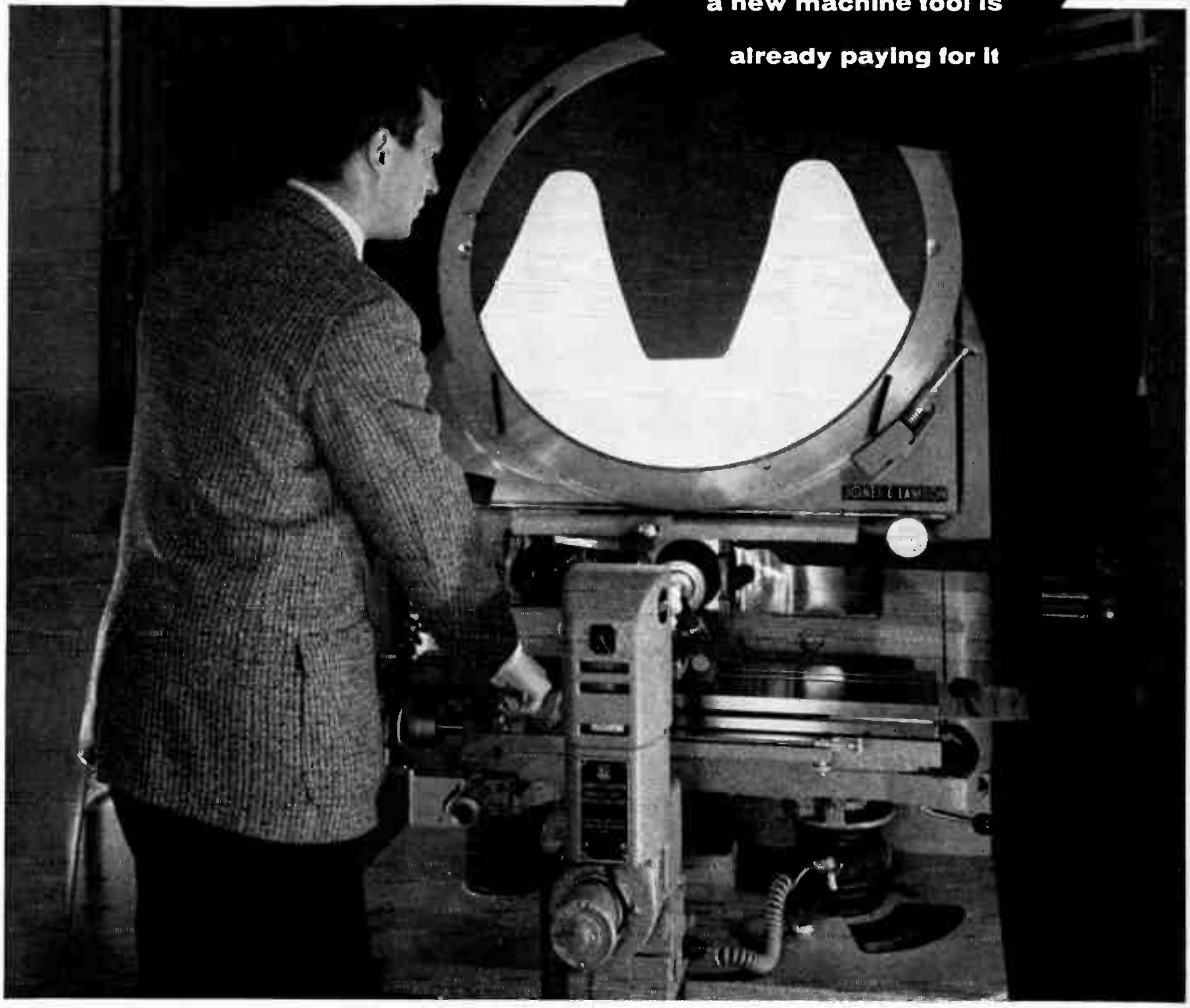
the man who needs a new machine tool is already paying for it



This revolutionary new light source makes optical inspection more efficient than ever

Jones & Lamson now offers the J & L Mercury Arc Lamp, an entirely new light source unit that gives *more than 5 times the intensity of the best filament light source available today.*

This new unit, designed for use with any J & L 14-inch or 30-inch screen Comparator, actually gives a *new* kind of light . . . an extremely bright, *steady* arc, with *no* flickering. Its high intensity produces an incomparably bright screen with razor-sharp black shadow, even at highest magnifications.

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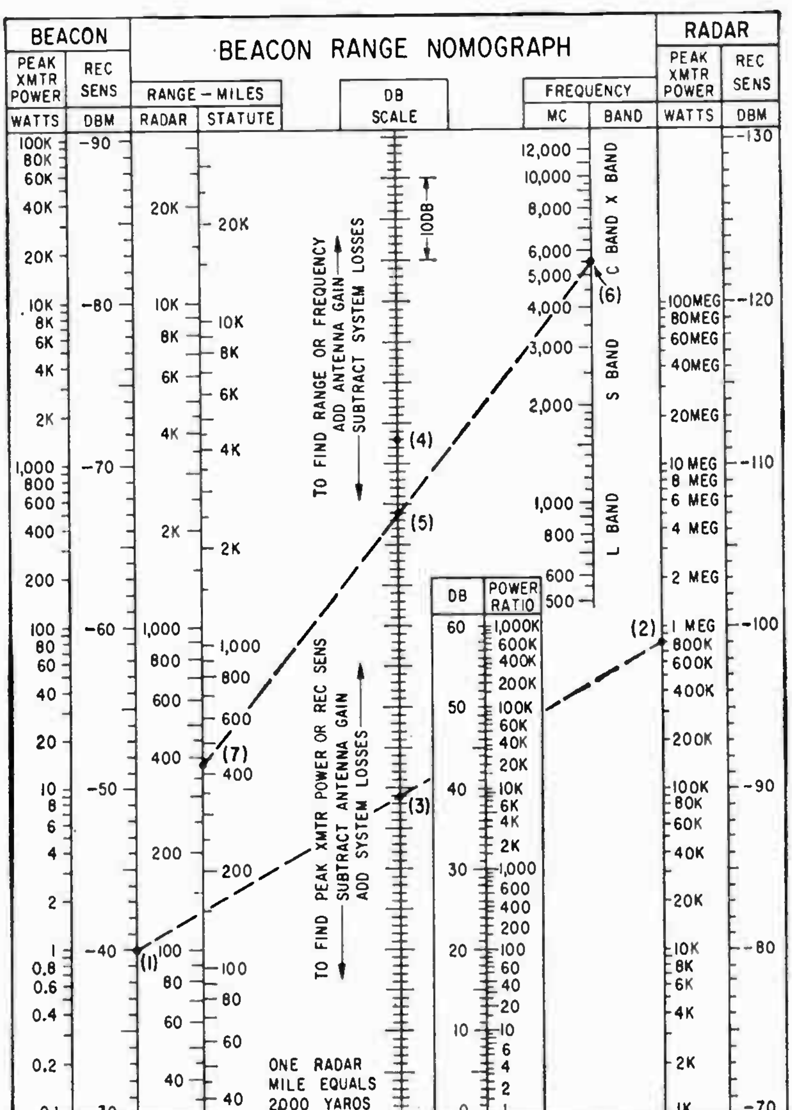
Determining Range of Radar Beacons

Method for easily solving range equation and accounting for system losses is presented. Chart also provides power-ratio-to-db conversion

By NORMAN S. GREENBERG,
Research Consultant, Avion Div., ACF Industries Inc., Paramus, New Jersey



THIS NOMOGRAPH quickly solves for the range, R, in the beacon range equation $R = (\lambda/4\pi)\ (P_T\ G_T\ G_R/P_R)^{1/2}$ where P_T and P_R are the transmitter and receiver power, G_T and G_R are transmitting and receiving antenna gains and λ is the wavelength of radiation used. The interrogation link (radar to beacon) and the response link (beacon to radar) are solved individually.

Range Example

Find the range when given an interrogation link with

Radar peak xmtr power	800 kw
Radar antenna gain	+44 db
Radar r-f losses	−3 db
Beacon rec sensitivity	−40 dbm
Beacon antenna gain	0 db
Beacon r-f losses	−6 db
Frequency	5,500 mc

Draw a straight line between −40 dbm on BEACON REC SENS (1) and 800 kw on RADAR PEAK XMTR POWER (2). From the point where this line intersects the DB SCALE (3), add on this scale the radar and beacon antenna gains totaling 44 db (4) less the radar and beacon r-f losses of −9 db (5). Extend a straight line from 5,500 mc on FREQUENCY (6) through (5) on DB SCALE to RANGE and read 430 statute miles or 380 radar miles (7).

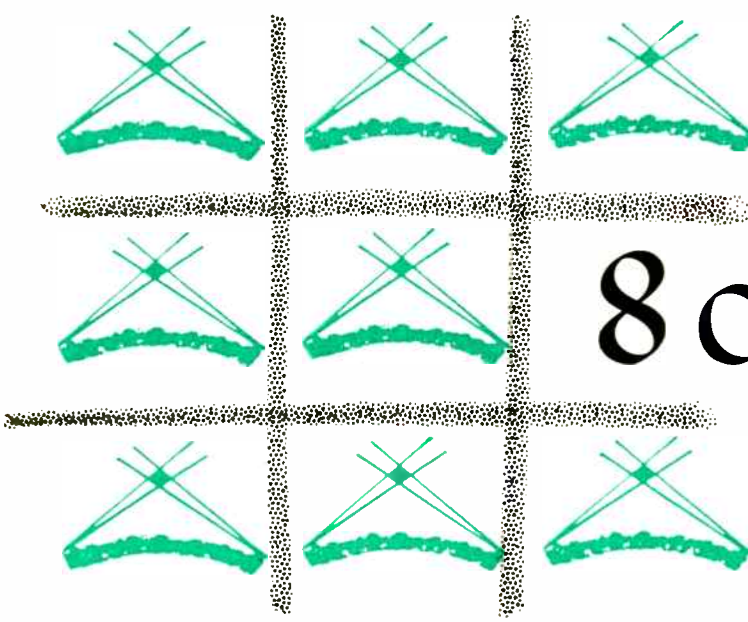
To determine the peak transmitter power or receiving sensitivity when one of these factors and the range are given, reverse the procedure. In this case, the antenna gains are subtracted and the system losses are added.

A whole new world of communications has emerged from the utilization of tropospheric scatter. For the first time, voice and teletype messages can be clearly received far beyond the horizon at all times, regardless of atmospheric or electromagnetic disturbances.

Long-range communication between radar outposts and Free World defense headquarters is no longer subject to disruption by weather conditions, and the same reliability is assured for civil telephone systems using tropo scatter.

It was radio equipment by REL which first proved the practicability of tropo communication in the Far North, and of transmission across large bodies of open water. Today, tropo apparatus designed and built by REL may be found halfway around the world.

Eight of the nine major networks in operation or on order utilize equipment designed and manufactured by REL. More kilowatt miles of tropo equipment by REL are in use or in production than those of all other companies combined—significant proof of REL's world leadership in tropo scatter.



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REL

Time-Constant Detectors Control Tv Sets

By K. R. CROSS and R. O. WHITAKER, Rowco Engineering, Indianapolis, Indiana

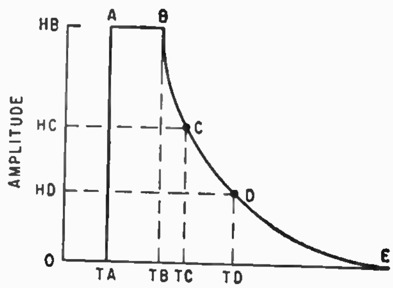

FIG. 1—Time required for signal to decay between *HC* and *HD* is proportional to time constant of exponential curve

COMMERCIAL success of wireless remote control systems for tv receivers spurred development of a time-constant detector circuit. The detector produces an output pulse the width of which is proportional to the time constant of an exponentially damped ultrasonic signal.

Developed primarily for remote control of tv receivers, it may be used in other measurement applications, such as measurement of reverberation constants of auditoriums, determination of damping in tuned circuits and measurement of resonant characteristics of vibrating mechanical members.

Other Systems

We also developed other basic remote control systems for tv receivers. A pulse train in which the number of pulses conveys intelligence from the remote position to the tv receiver is simple and reliable. A system in which information is carried by the width of a single pulse may be more reliable, but circuitry in the receiver is more complex.

In the past, other tv remote control systems have used cables, light beams, ultrasonic signals and r-f signals. The cable systems have not been accepted by the public. R-f systems affect other receivers and are subject to interference from noise sources. However, walls are virtually impenetrable using ultrasonic signals, and interference sources are seldom encountered.

In the present tv remote control system, an ultrasonic signal is used to convey intelligence from the remote position to the tv receiver. The circuit delivers a pulse of width proportional to the time constant of the damped wavetrain.

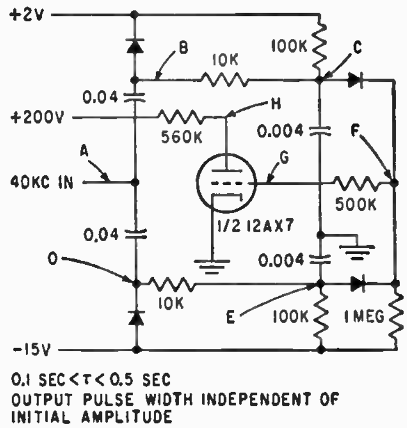

FIG. 2—Time detector delivers output pulse between 0.1 and 0.5 sec that is independent of input amplitude

The transmitter consists of a shock-excited resonator in which the time constant is varied in accordance with the function (channel selection, volume or contrast control). At the receiver, a highly resonant microphone receives the ultrasonic signal and feeds it to an amplifier. Amplifier output is rectified and filtered.

Gain of the system is such that the amplifier generally overloads, giving a detector output as shown in Fig. 1. Between points *A* and *B*, the amplifier is overloaded. Between *B* and *E*, the signal is decaying along the exponential. It is a characteristic of such curves that

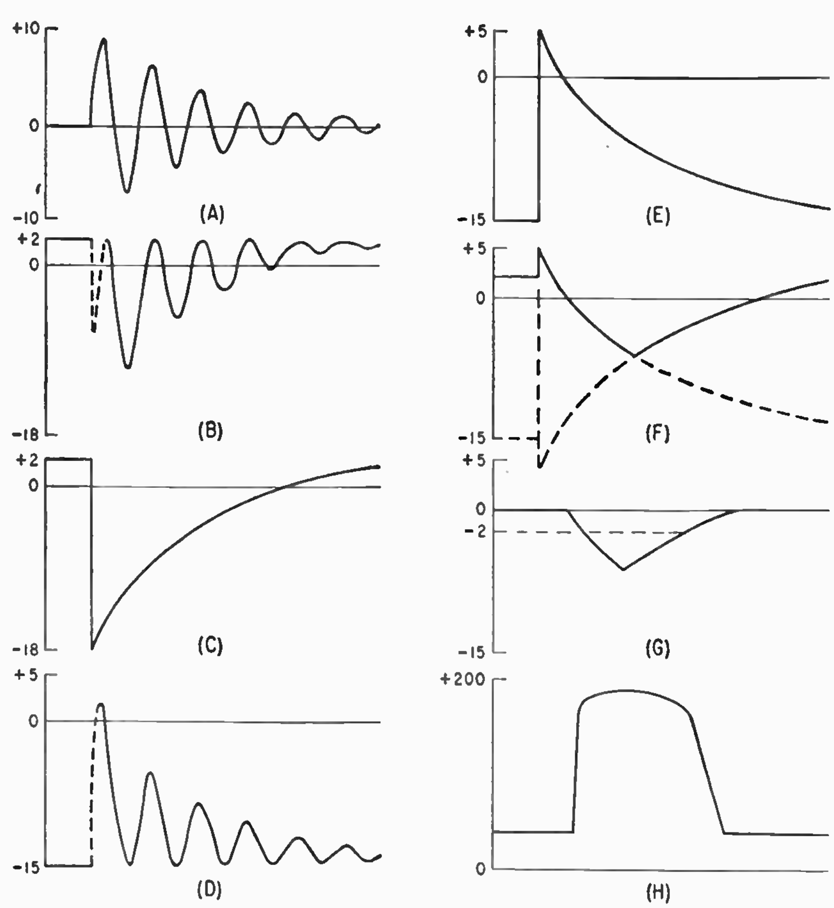

FIG. 3—Waveforms at points indicated in circuit schematic show how final pulse of duration proportional to exponential decay is produced

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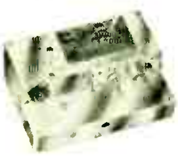

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$5\frac{19}{32}$" x $3\frac{13}{16}$" x 4"
15 to 30 Watts

Model 1462

6" x $4\frac{1}{4}$" x $3\frac{3}{4}$"
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Model 1466A

6.5" x 4" x 3.25" RF Amplifier
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the time required for the signal to decay between two fixed levels (such as *HC* and *HD*) is proportional to the time constant. Thus, $HC = HB\,\epsilon^{-(TC - TB)/\tau}$ and $HD = HB\,\epsilon^{-(TD - TB)/\tau}$.

To solve for decay time from *HC* to *HD*, the logarithms become $\ln HC = \ln HB - (TC - TB)/\tau$ and $\ln HD = \ln HB - (TD - TB)/\tau$. Subtracting and rearranging these equations, $TD - TC = \tau\,(\ln HC - \ln HD)$. If *HC* and *HD* are two fixed levels, time interval $TD - TC$ becomes a function of the time constant only.

Circuit

Circuitry for fixing two levels, such as *HC* and *HD*, and measuring the time required for the signal to decay between them is shown in Fig. 2 and a phase diagram showing the action that takes place at the correspondingly lettered points is shown in Fig. 3. The *HC* level is set by the −15-volt bias; the *HD* level is set by the −2-volt bias. The

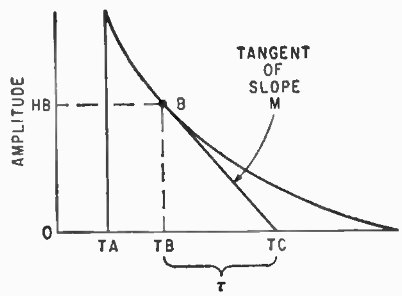


FIG. 4—In alternate arrangement, advantage is taken of the fact that if *HB* is fixed, time constant is function of *M* only

circuit is such that the output tube plate goes to a high positive value during the time when the input signal is between the two voltage levels.

The circuit has operated very satisfactorily. Such trouble as has been encountered has been traced to failure of the time constant of the ultrasonic resonator to be constant. This problem in turn has been traced to nonlinear effects and undesired modes of vibration in the shock-excited resonator.

In other applications where the input signal more nearly approaches an exponentially damped wavetrain, operation should be much improved. An additional stage of amplification in the output section should provide clipping action and a much better output square wave.

An alternate system using another characteristic of the time-constant curve was also developed. Referring to Fig. 4, it can be shown that $\tau = HB/M$. If HB is fixed, then the time-constant becomes a function of M only.

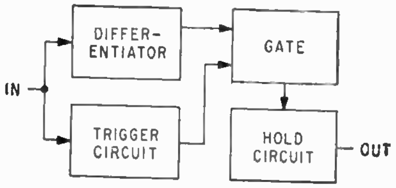


FIG. 5—Differentiator monitors slope and gate is opened when signal drops to *HB* level. Hold circuit maintains d-c level inversely proportional to time constant

A block diagram of the circuit is shown in Fig. 5. The differentiator monitors the slope of the curve. The trigger circuit turns on the gate when the signal drops to the *HB* level. The hold circuit holds the highest amplitude fed to it. Thus the output of the measuring circuit is a d-c signal of amplitude inversely proportional to the time constant. The circuit operated quite well, but trouble from noise was greater than for the time-interval system.

New SAGE Antenna

New air-to-ground communications antenna for SAGE early warning system is housed in capsule made from Bakelite epoxy and glass fibers. Entire 110-ft structure can be lowered and antenna changed in 20 minutes by untrained crew. Forty-five structures weighing 925 lb each have been ordered by Air Force

Electromagnetic Relay Design Trends

By EDWARD C. HOELL, Design Engineer, Allied Control Co., New York City.

JET AIRCRAFT, missiles and rockets have brought about rapid and significant changes in the design of electromagnetic relays in recent years. New high-speed aircraft and space-aimed rockets crammed with electronic equipment created a sudden demand for smaller relays that would perform better under new and more rigorous environmental conditions.

Table I shows relay design trends at Allied Control since 1945. Although miniaturization produced the most strikingly apparent effect on relay design by reducing volume by about 15 to one in less than fifteen years, efforts to curb vibration have resulted in a similar sharp trend. In the past ten years, vibration resistance of relays has increased from 10 g's in a frequency range from 10 to 55 cycles per second up to 30 g's in ranges up to 2,000 cycles.

Table I—Electromagnetic Relay Design Data

Dates, aircraft type, MIL specs	Contact Rating (amps)	Vol (cu in.)	Weight (oz)	Vibra (cps)	Shock (G's)	Accel (G's)	Alt (1,000 ft)	Temp Range (C)
1945–53 Advanced propelled AN-R-20 & MIL-R-5757	10	6.4	6.5	10^{a} to 55	50	10	30	−55 to 71
1954–56 Jet propelled MIL-R-5757 rev. MIL-R-25018	2 2 2 10 0.5	1.5 1.1 0.5 1.5 0.25	4 2.5 1 4 0.33	10^{b} to 500	50	15 to 30	50 to 70	−55 to 85
1956–59 Guided missiles Advanced jets MIL-R-25018 rev. MIL-R-5757C MIL-R-6106	5 5 10 2	1.5 1.1 2.2 0.3	4 2.5 5 0.5	5^{c} to 3,000	100	30 to 60	80 to 100	−65 to 200
1960	2 to 5	0.1	0.15	5^{d} to 3,000	100 to 125	100	potted relays 100 up	−65 up to 500

a—at 0.6 in. double amplitude; b—at 0.06 in. double amplitude; c—at 0.5 in. double amplitude; d—at 40 and 50 g

Vibration

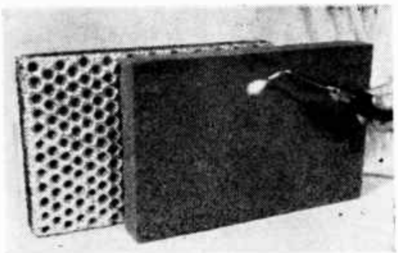
Vibration frequencies of aircraft rose sharply from the natural vibration range, 10 to 55 cycles, of the prop propelled aircraft with the advent of the jets. Jet compressor vibration and vibration caused by air flow at the higher speeds attained increased the range of vibration sharply. Acoustic vibration induced by noise, air flutter and variations in thrust from rocket engines also helped push the frequency range up to 3,000 cycles. Concurrently, the new relays have been designed to withstand vibration amplitudes that have increased from 10 to 30 gravity units.

Environmental specifications for relays, which were virtually nonexistent up to the end of World War II, mounted swiftly in the postwar era of jets and missiles. Requirements for resistance to shock in recent years have jumped from 50 to 100 gravity units, for acceleration from 10 to 60 g's. Relays, expected to perform at altitudes of 30,000 feet only a few years ago, now must operate at 100,000-foot levels. The required temperature range has expanded in both directions: from a low of −55 deg C to —65 C and from a high of 71 to 200 deg C.

New conditions for radiation resistance can be expected to influence relay design in the immediate future. Future design trend will also follow the line already established with further, but less sharp, decreases in size and weight, possibly higher and more stringent requirements for performance under more rigorous environmental conditions, such as resistance to temperature up to 500 deg C. The ability to withstand a specified degree of intensity of radiation will probably be included under the new environmental conditions.

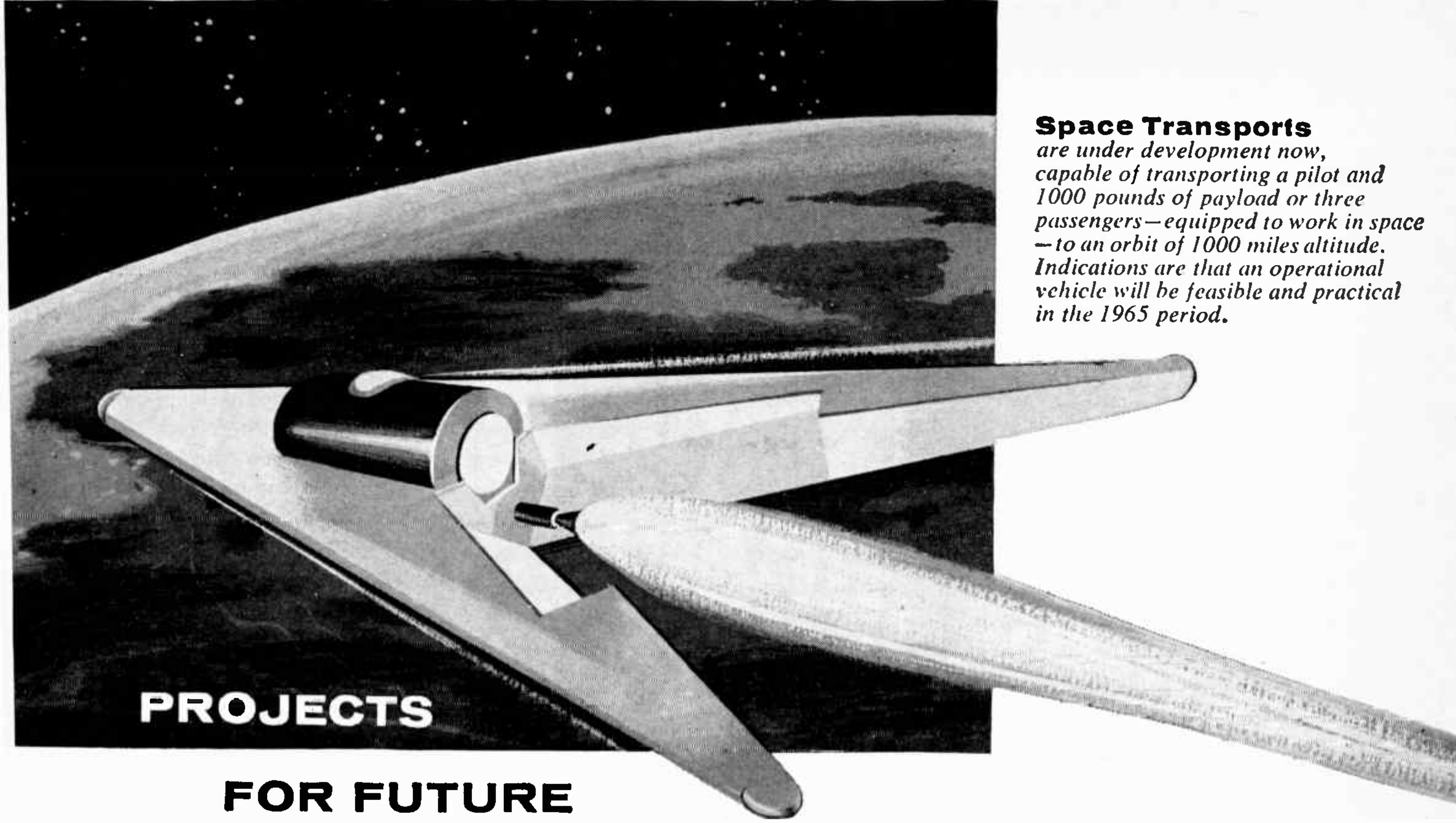
Silica Absorber

FOAMING of pure silica yields a material for absorption of microwave energy at ultra-high temperatures. Electrical and structural qualities make it suitable for variety of microwave applications, including radome interiors, windows for antennas, as support pieces in construction of microwave devices, and as cavity fill in missile antennas.



Matrix material for an ultrahigh temperature absorber. Energy to be absorbed impinges on the surface to which torch is being applied

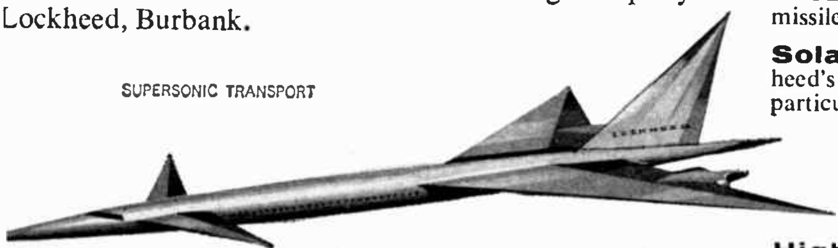
Developed by Emerson & Cuming in cooperation with Pittsburg Corning, Eccofoam Q is capabe of 3,000 F operation. As an absorber, however, it is limited to about 1,200 F. Material offers a series of dielectric



Space Transports *are under development now, capable of transporting a pilot and 1000 pounds of payload or three passengers—equipped to work in space—to an orbit of 1000 miles altitude. Indications are that an operational vehicle will be feasible and practical in the 1965 period.*

FOR FUTURE DECADES IN SPACE... *another Lockheed Progress Report to Engineers*

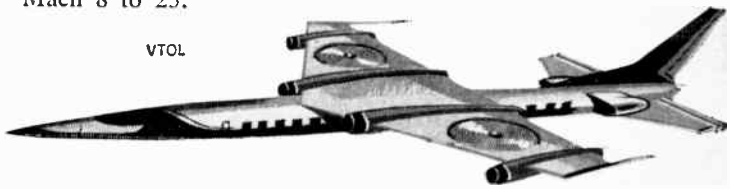
Plotting the nation's future space exploration projects requires the capabilities of a forward-looking company; one with vision, superiority in technical skills and advanced facilities. Lockheed, Burbank, long a leader in extending the science of flight, is placing its vast resources and accumulated knowledge into programs designed to provide major breakthroughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Shown here are artists' renderings of a few of these important projects. Such project diversification calls for high-level technical skill, offers genuine challenge to experienced engineers. At Lockheed these varied projects require engineers in many fields. Take advantage of this need. Go forward with a forward-looking company: Lockheed, Burbank.


SUPERSONIC TRANSPORT

Supersonic Transports—have held an important place n our thinking for the past several years. Extensive wind tunnel ests have been conducted on many design concepts, supplemented y exhaustive laboratory and structure studies. Lockheed is pre-ared to build an airliner that will travel at speeds in excess of Mach 3 at an altitude of 75,000 feet.

Infrared Systems studies are being conducted using an advanced method of detecting fast-moving missiles and high-speed aircraft.

High Altitude Flight Vehicle programs have recently been awarded to Lockheed for supersonic vehicles of improved aerodynamic design configurations with speed ranges between Mach 8 to 25.


VTOL

Vertical Take-off and Landing Projects—Lockheed, Burbank, is engaged in exploring the potential of VTOL projects on a very broad scale. Different VTOL features are embodied in each proposal. Considerable emphasis is being placed on VTOL "air recovery" vehicles, designed for air rescue and reentry missiles recovery missions.

Solar Radiation Studies—are being conducted at Lockheed's flight test radio station at Briar Summit, California, placing particular emphasis on solar flares.

Manned Vehicle studies are being conducted concerning fundamental problems associated with landing manned vehicles capable of hypersonic glide or orbit above the earth.

High caliber scientists and engineers are invited to take advantage of Lockheed's outstanding career opportunities. Openings now exist in: *Aero-Thermodynamics; propulsion; armament; electronics—research and systems; instrumentation—wind tunnel; servomechanisms—flight controls; dynamic analysis methods; operations research; electrical instrumentation; physics; antenna; underwater sound propagation; and manufacturing research.* Write today to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1509, 2400 North Hollywood Way, Burbank, Calif.

LOCKHEED / CALIFORNIA DIVISION • BURBANK, CALIFORNIA constants from 1.1 to 5.0. It has a low dissipation factor, is light in weight, with a density of from 10 pounds to 50 pounds per cubic foot.

Carbon or metallic particles can be incorporated in the basic material to convert it for high-loss applications.

Eccofoam Q, now in development, will be marketed in production quantities before the end of '59. An inorganic cement has been developed for bonding.

Basic foam material made by Pittsburgh Corning is modified by E & C for various electrical characteristics. E & C will market a series of silica foam products with adjusted electrical qualities.

Flight Safety Lights

Designer-pilot H. W. Atkins points out features of wing-tip lights, as Minneapolis-Honeywell's Jim Michaud looks on

EVALUATION of an airplane wing-tip light system, following more than 750 hours of flight testing on a DC6B, is nearing completion. The test installation has operated without failure through the entire evaluation period over most of Northwest Orient Airlines route.

The system consists of high-intensity flashing strobe lights mounted on each wing tip. Three to five blue-white lights flash at different frequencies to give flight information. The intensity of the lights is fifteen times that required by the Federal Aviation Agency. The lights have been observed in flight over 100 miles away.

The light was designed by H. W. Atkins, a Northwest Airlines pilot. Further development was done in cooperation with the Aeronautical Division of Minneapolis-Honeywell, currently designing flush wing tip installations for all major aircraft.

The system will incorporate advanced transistor circuitry, and modular construction will insure adaptability as an integral part of the airframe of any aircraft.

Tungsten Deposit

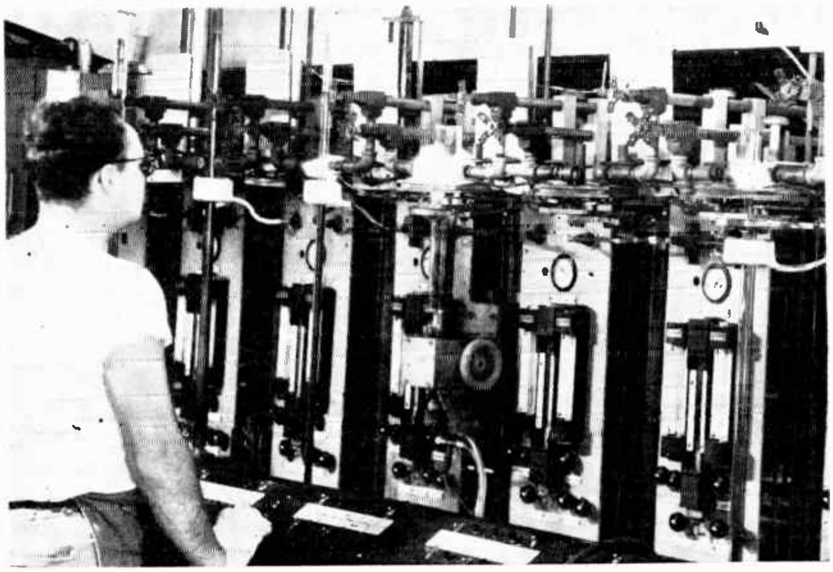
IMPROVEMENT of a long-known process for vapor phase deposition of chromium, molybdenum and tungsten to produce adherent coatings of the metals on various substrate materials has been announced by Alloyd Research of Watertown, Mass.

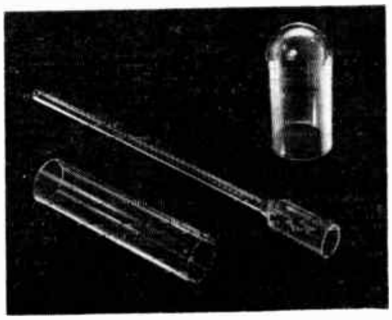
Promising electronic applications include coating of certain components with high-purity high-density tungsten to prevent contaminants in the base materials from adversely affecting the electronic emission characteristics.

According to the company, by producing thicker coatings, the possibility exists for fabricating thin electronic parts of refractory metals in this manner. The company emphasizes that the process is in the developmental pilot plant stage.

Radar Antenna Cover

Inflatable radome made of dacron, coated with a synthetic rubber (chlorosulphonated polyethylene) to make it weatherproof, is used to protect radar antenna built by Convair. The 13-feet in diameter balloons are manufactured to specifications by Muehleisen Manufacturing Co. of San Diego, California. Looking like a huge ping-pong ball that has rolled in a hole, the radome keeps out ice, sand, snow and dust and withstands winds of more than 100 miles an hour





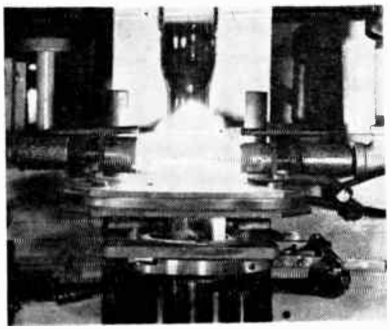
Vidicon tube envelope, twt envelope and thyratron spacer (top)

Battery of precision tube-forming machines. The motorized fixture which revolves mandrel and tubing and lifts them through heat can be seen in center machine

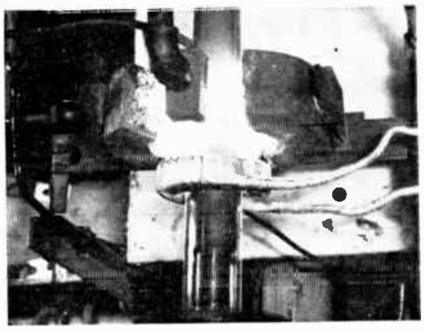
Shrinking Forms Glass Parts Precisely

PRECISION GLASS TUBING for electronic tube envelopes and other parts is prepared by shrinking stock tubing onto a mandrel. Among the production benefits are more rapid assembly because glass parts are interchangeable and the preservation of critical dimensions.

The method described is used by Fischer & Porter Co., Hatboro, Pa., to produce traveling wave tube (Fig. 1) and vidicon tube envelopes and internal spacers of thyratron tubes. It is also used to produce other precision glass components and industrial equipment.



Drop of tubing onto mandrel can be seen above flame



R-f coil is used here to preheat large mandrel

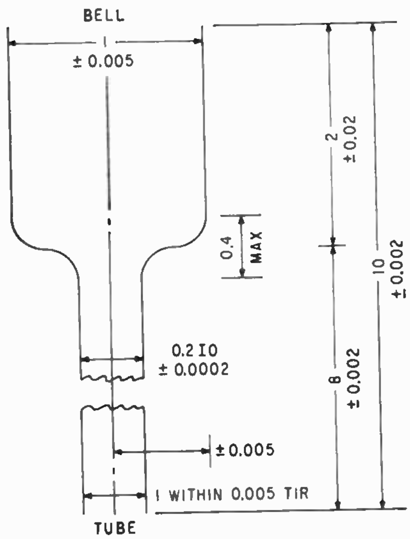


FIG. 1—Typical twt dimensions, and tolerances, in inches

The twt part is made by forming a bell and sealing it to the tube. Precision tubing is required for the twt and thyratron because of critical internal spacing. The vidicon tube requires a barrier to prevent entrapped particles from reaching the tube face. Gaps between the barrier and envelope, caused by variations between diameter and roundness of barrier and envelope, would permit particles to pass.

Stock tubing generally has a diameter tolerance of about 0.03 inch. After shrinking, tolerances can be as close as 0.0002 inch, depending on diameter. The accuracy of the mandrel determines tolerances of inside dimensions. Variations in tube wall thickness will be duplicated in the reformed part, but can be eliminated by grinding the outer surface. Tolerances obtained by this method in a typical twt envelope are indicated in Fig. 1.

Small, round, straight tubing with a narrow bore is reformed by floating a mandrel inside the tubing on a horizontal glass lathe. The gas flame inches along a horizontal worm gear while the tubing rotates. The tubing is supported on an anvil machined to accept the tubing. The anvil moves with the flame.

Large tubing and tubing which is not straight and round is shrunk on vertical mandrels. This type of mandrel can have a horizontal cross section that is circular, square, hexagonal or various combinations of curves and straight lines. Vertical cross sections can be a taper, rectangle, or a bulge or depression

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	2N1168	2N392	2N1011	2N1159	2N1160
V_{cb} max.	50	60	80	80	80 volts
I_c max.	5	5	5	5	7 amp.
I_{co} (V_{ec} 2 volts) Typical 25°C.	65	65	65	65	65 μa.
HFE (3 amp.)	–	60-150	30-75	30-75	–
HFE (5 amp.)	–	–	–	–	20-50
AC Power Gain (I_c=0.6 amp.)	37 DB	–	–	–	–
V_{ceo} (I_c = 1 amp.)	40 typical	50 typical	60 min.	60 min.	60 volts min.
Thermal Gradient max.	1.5	1.5	1.2	1.2	1.2° c/w

Delco Radio rounds out its power transistor line with this new 5-ampere germanium PNP series. Types 2N1168 and 2N392 are specially designed for low-distortion linear applications, while 2N1159 and 2N1160 are outstanding in reliable switching mode operations.

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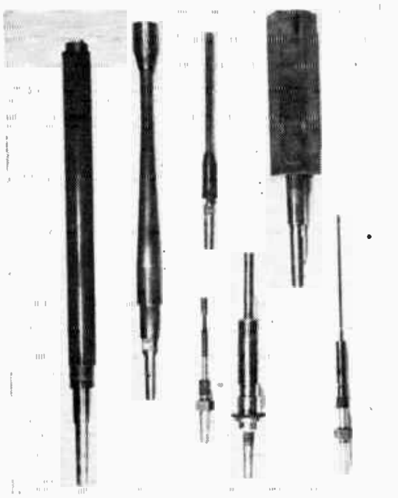


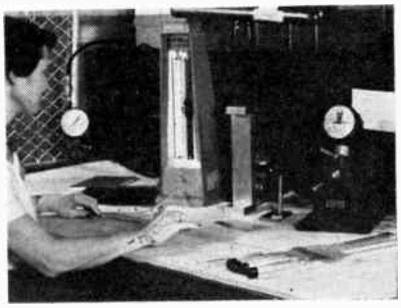
Mandrels. Vacuum ports are visible on some of the adapters

at one end. If a bulge or depression at both ends or in the center is required, a take-apart mandrel is needed.

The glass is slipped off the mandrel after it is reformed, as described below, and cooled. Since the heat used expands both the glass and the mandrel, mandrel material must be chosen to satisfy several requirements: it must expand more than the glass, it must have sufficient heat capacity and it must remain rigid at the working temperature. Refractory metals are sometimes required although stainless steel is a commonly used material.

Thin mandrels can be heated by the gas flame which softens the glass. Bulky mandrels are preheated by r-f coils placed below the flame. Very large mandrels are hollowed and preheated, to avoid excess capture of the gas flames' heat.

Nominal mandrel dimensions can be calculated from known heat expansion rates. Outside dimensions of mandrel and inside dimension of the tubing match at the working temperature of the glass. As both cool, the tubing shrinks to the specified dimension. The mandrel must shrink sufficiently more to permit



Critical internal dimensions of twt envelopes are checked with air gage

removal of the tubing. Precision tolerances generally require that the mandrel be made slightly oversize and reduced after trial runs.

The mandrel is fitted to a Morse adapter (Fig. 2) with a neoprene collar. A vacuum port is drilled in the mandrel and is connected to a vacuum pump through the adapter and the holding fixture.

The fixture is motorized so that it rotates the glass and mandrel at a steady rate. It also rises steadily along a vertical worm gear. Gas flames are positioned so that they are at the top of the mandrel when the fixture is at the bottom, or loading position. Two flames, facing each other, are used. An r-f heating coil is positioned several inches below the flames. The machine is instrumented to indicate or control rotation and amount of rise, gas pressure, r-f energy and vacuum.

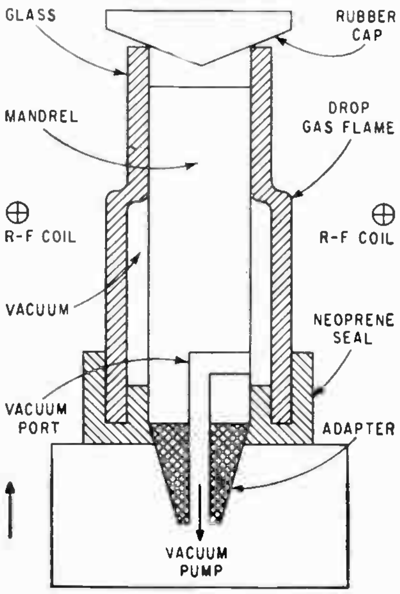
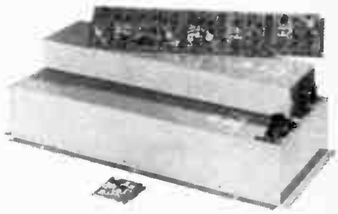
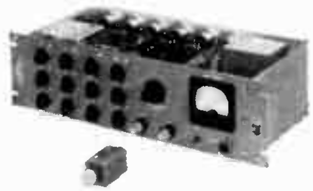


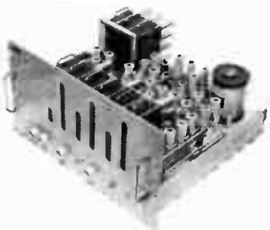
FIG. 2—Method of mounting mandrel and maintaining vacuum between mandrel and tube

The operation of the machine is adjusted for each type of workpiece. Optimum settings result in the glass "dropping" smoothly onto the mandrel without flow or sag. As the glass softens, it is sucked to the mandrel by the vacuum. The operator loads the machine by slipping tubing over the mandrel, into the neoprene collar. The open end is closed with a rubber cone and the glass heat-sealed to the mandrel at the top. Top and bottom are later trimmed off. Dimensions of the finished tubing are air-gaged.

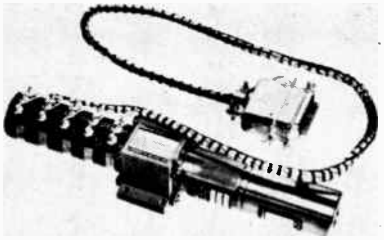
CIRCLE NO. 75 READER SERVICE CARD →







On The Market



Servo Package
in-line units

HELIPOT DIVISION of Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif., has available in-line servo packages. These compact modules free the designer from positioning, testing, matching and aligning individual components. The size 11 system module consists of a 115-v, 400-cycle servomotor-rate generator; gearhead; mounting pad; five ganged model 5203 single-turn pots; and AN connector. Entire unit measures only 7 3/4 in. by 1 3/4 in. by 1 1/2 in.

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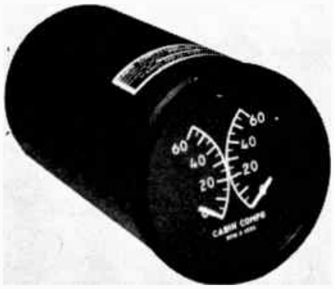
Tachometer
all electronic



VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas. A new electronic tachometer houses two complete indicators with overspeed sensing and protective circuits in a single compact package. Unit measures rpm of a rotating shaft, gear or rotor from 0 to 60,000 rpm with full scale accuracy of ±3 percent. It is designed for operation from a 28-v a-c source and withstands a temperature range of −55 C to +50 C and vibration of 2g's to 500 cps. Package is only 3.23 in. in diameter and 6 1/2 in. long and weighs less than 2 lb.

CIRCLE NO. 201 READER SERVICE CARD

Coax Cable
Teflon-insulated

TIMES WIRE AND CABLE CO., INC., Wallingford, Conn. For high-power, high-temperature r-f transmission requirements such as radar installations, a large Teflon-insulated coaxial cable, Type RG-117U, is offered. Center conductor is a solid copper rod surrounded by extruded Teflon on which is woven the braided copper shield and wrapped with Teflon tape which serves as a moisture seal. The tough outer jacket is of fluorocarbon-impregnated fibreglass for high temperature resistance as well as to prevent fraying of the jacket.

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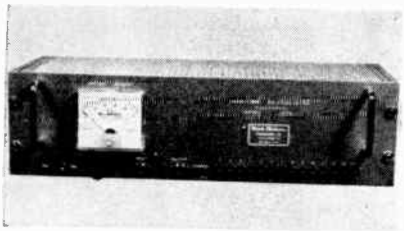
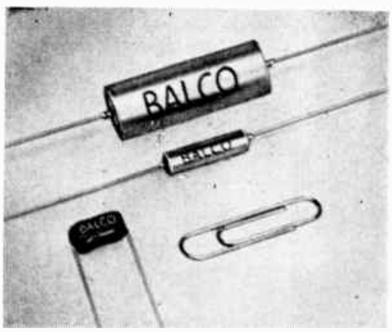


Decommutator
pam/pdm

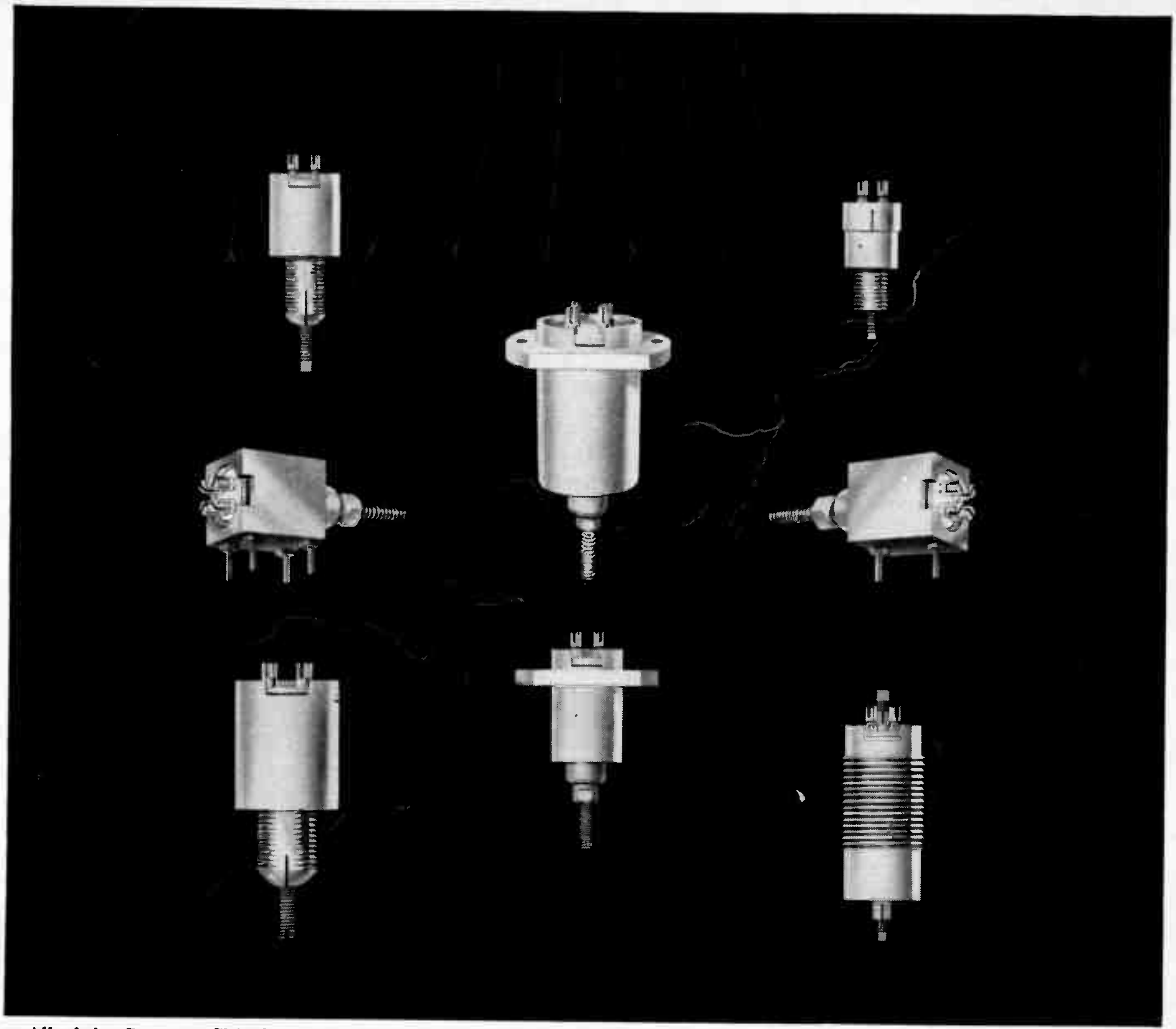
MISSILE ELECTRONICS ENGINEERING CO., 14644 Keswick St., Van Nuys, Calif., announces a solid state telemetry pam/pdm decommutator. System will accept all standard IRIG data trains and has an overall system accuracy of better than ±1 percent. Modular constructed throughout, the entire package weighs less than 35 lb for a 28 channel system and consumes less than 10 w.

CIRCLE NO. 203 READER SERVICE CARD

Miniature Capacitors
low voltage



BALCO RESEARCH LABORATORIES, 49-53 Edison Place, Newark 2, N. J., has developed a new series of low voltage, space saving capacitors for high temperature environments, transistor circuits and high performance applications. The LV and LZ series are normally designed for continuous operation from −70 C to 175 C without derating. Extended temperature types T_1 and T_2 are available to 200 C and 250 C respectively without derating. They are available hermetically sealed or epoxy dipped and with axial, radial or dual leads. Standard capacity range is 0.0005 μf to 0.25 μf. Voltage ratings are 15 and 30 wvdc



All of the CAMBION Shielded Coil Forms shown above are available unwound, or wound precisely to your specifications.

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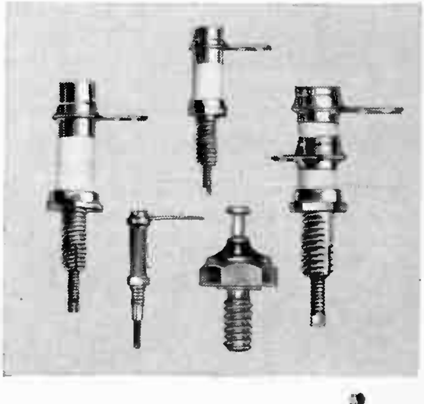
For further details, contact your local CAMBION Distributor or write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. On the West Coast: E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles, California. In Canada: Cambridge Thermionic of Canada, Limited, Montreal, P. Q.



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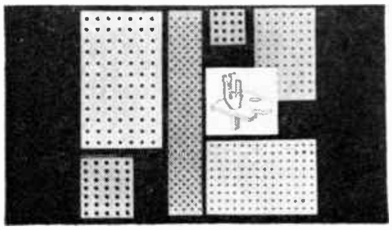

Terminal Boards prepunched

VECTOR ELECTRONIC CO., 1100 Flower St., Glendale 1, Calif., announces a complete series of prepunched terminal boards for use in the fast, easy mounting of circuitry in breadboarding and permanent installations. Component wires and push-in terminals are quickly inserted where desired. The terminal boards, known as Vectorbord, are available in six different patterns with 0.062 and 0.093 holes, in XXXP phenolic, G-7 glass silicone, G-10 glass epoxy and paper epoxy.
CIRCLE NO. 205 READER SERVICE CARD

D-C Motors brushless

CROSBY RESEARCH INSTITUTE, 9028 Sunset Blvd., Hollywood 46, Calif., has available a brushless d-c motor. Applications would be for (1) low pressure environments (where brush wear is rapid and excessive); (2) explosive atmospheres (where brush sparking presents a fire hazard); (3) in applications requiring minimum radiated interference. The motors may be used in positioning and control systems in the same manner as multiphase induction motors or servo motors.
CIRCLE NO. 206 READER SERVICE CARD

Delay Networks 3 by 4 by 2 in.

RATIGAN ELECTRONICS INC., 425 W. Cypress St., Glendale 4, Calif. LD-30-1006 fast rising delay network meets MIL-E-5272 and MIL-STD-202A. Time delay is 12 μsec $\pm$0.1 μsec; taps at 4 μsec $\pm$0.1 μsec, 8 μsec $\pm$0.1 μsec, and 10 μsec $\pm$0.1 μsec; impedance, 1,000 ohms $\pm$10 percent; input rise time, 0.075 μsec; output rise time, 0.25 μsec, attenuation, 2.3 db maximum with a 5 percent maximum distortion.
CIRCLE NO. 207 READER SERVICE CARD

Test Chamber minimum floor space

CONRAD, INC., Conrad Square, Holland, Mich. The Temp. Rac 19 is a portable self-contained environmental test chamber of minimum floor space. It fits into a standard 19 in. wide relay rack. Chamber is 1½ cu ft. Unit is completely packaged as an assembly to slide into a customer's standard relay rack or can be furnished with the relay rack housing enclosure. It is supplied with indicating controller, forced air circulator, electric heating and direct refrigeration.
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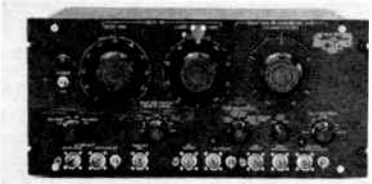
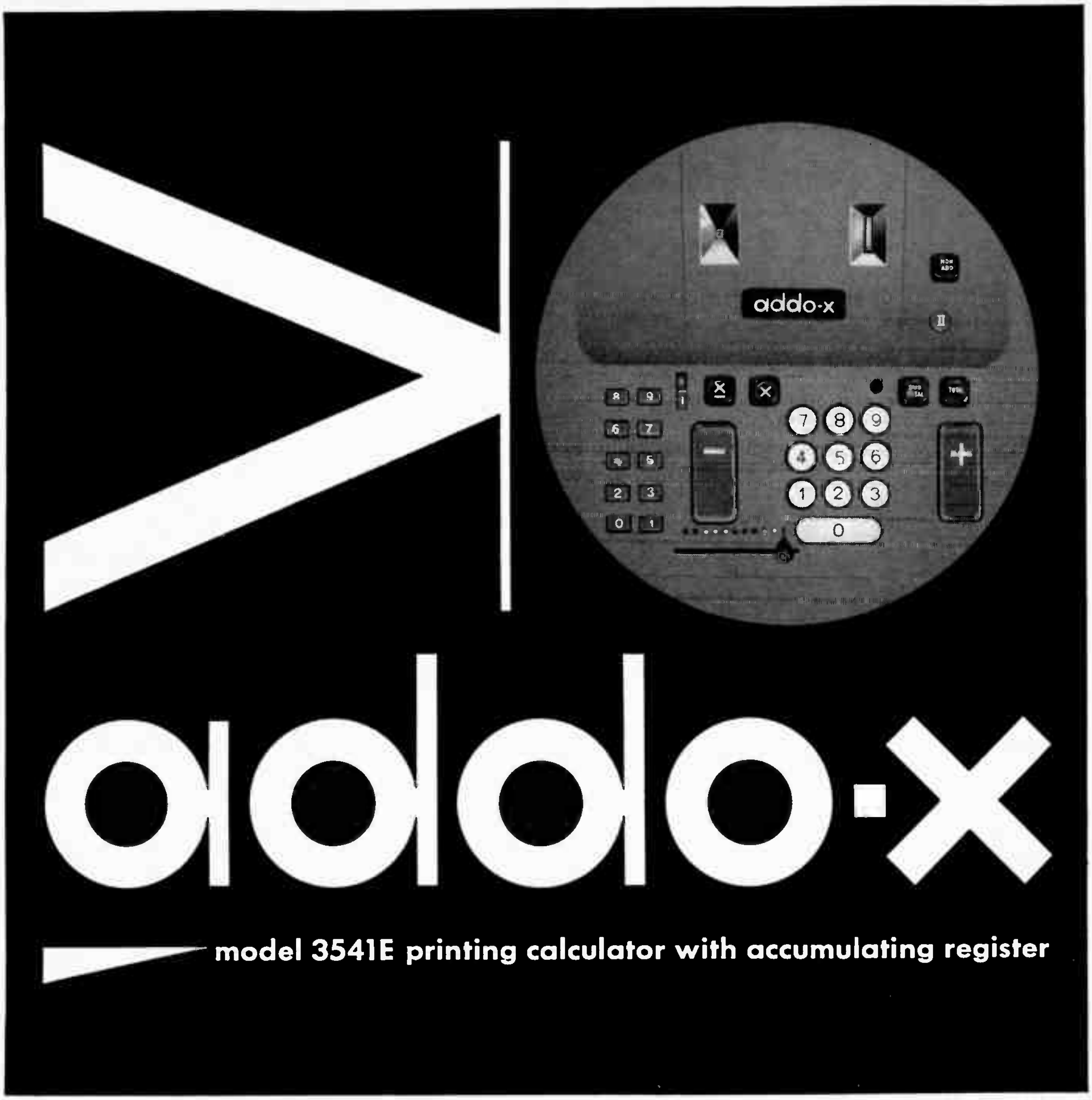


Time Delay Generator analog type

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1392-A is an analog genera-



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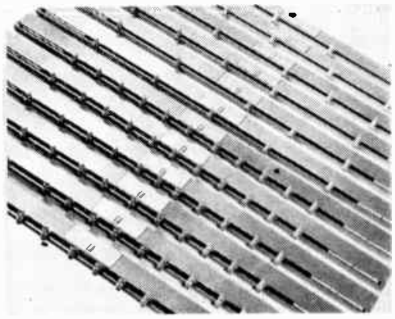

Delay Line magnetostriction

FERRANTI ELECTRIC INC., 95 Madison Ave., Hempstead, L. I., N. Y. Type 5810 is a longitudinal mode delay line for delays up to 100 μsec and digit rates up to 1 mc. Any required number of continuously variable taps can be provided subject, in this instance, to a minimum tap spacing of 2 μsec. Input and output impedances can be made to suit circuit requirements. A group of 12 lines of this type is illustrated.

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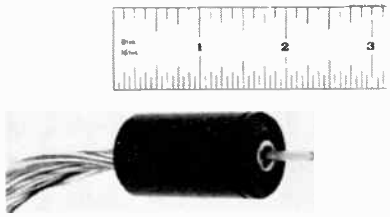

Shaft Encoder miniature size

LITTON INDUSTRIES, INC., 336 N. Foothill Road, Beverly Hills, Calif., announces a digital shaft encoder with a diameter of only 1.062 in. The analog-digital converter is par-

Jack Carroll

Managing Editor, **electronics**
Holds Partial Staff Meeting

Resumé:

Carroll, John M., (seated in photo) Lehigh University, BS, Hofstra College, MA in Physics, member several I.R.E. committees. Naval electronics, World War II. Electronics engineering officer during Korean war. Background in engineering derives from experience with the National Bureau of Standards, Naval Research Laboratories, Liberty Aircraft, American Instrument Co. Author of technical books for McGraw-Hill Book Company.

Present Occupation:

Jack Carroll is responsible for "getting-out-the-book" each week within the framework of editorial policy formed by W. W. MacDonald, Editor of **electronics.** Jack is occupied with editorial makeup, with the accuracy of editorial content, with scheduling the workload of a 26-editor staff to provide maximum coverage of technical developments and business information.

References:

Jack is a dedicated man—dedicated to the interests of the readers of **electronics** magazine. His prime goal is to help edit a publication which will be required reading for the important people in the electronics industry — a publication that will fill the needs of design-research, production, management. If you are not receiving the publication that is edited to keep you best informed, if you are not a subscriber, or if your subscription is expiring, fill in the box on the Reader Service Card. Easy to use. Postage is free.

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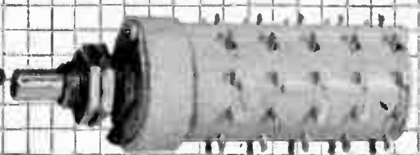

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ticularly desirable for airborne equipment where size, weight, and torque requirements must be kept low. Analog input to the shaft is converted to binary numbers through coded disks scanned by double pickoff brushes. Ambiguous outputs are eliminated by arrangement of the pickoff brushes in a V-scan, and internal isolation diodes allow time-sharing with minimum circuitry.

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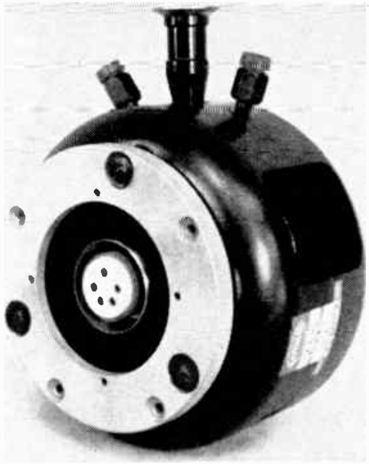

B-W Oscillator voltage tunable

RAYTHEON MFG. CO., Waltham 54, Mass. The QK625 is a voltage tunable wide band (2,500-3,300 mc) c-w backward-wave oscillator providing a minimum power output of 180 w and a nominal power output of 250-350 w over the band. Tuning sensitivity is approximately 0.35 mc per v. Tube is designed with an integral permanent magnet and weighs approximately 25 lb. The r-f output is standard $\frac{7}{8}$ in. coaxial. The QK 625 is liquid cooled and may be mounted in any position.

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Demagnetizer for tape heads

ARGONNE ELECTRONICS MFG. CORP., 165-11 South Road, Jamaica 33, N. Y. Model AR-294 tape head demagnetizer is designed for use with any tape recorder. Three sets of interchangeable pole pieces are supplied (straight, 45 deg and 90 deg) providing access to any tape head;

complete head demagnetization is accomplished without removing tape heads from the recorder.

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Solid-State Relay for teletypewriters

TREPAC CORP. OF AMERICA, 30 W. Hamilton Ave., Englewood, N. J. Model 530-C solid-state relay is designed to eliminate the conventional polar relays in all teletypewriters. Circuit design utilizes silicon diodes and transistors to perform the switching functions. Incoming signals are accurately reproduced under wide variations in line-circuit current and conditions. Unit introduces no distortion and, having a purely resistive input, generates no inductive "kicks" to disturb the loop and cause interaction with other printers on the line. It uses no moving parts, no vacuum tubes, and requires no periodic adjustment or recalibration.

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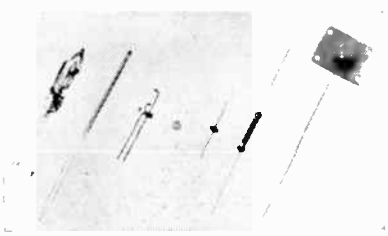

Matched Thermistors varied sizes

VICTORY ENGINEERING CORP., 524 Springfield Road, Union, N. J., offers matched thermistors of varied sizes and resistance values. The close-tolerance thermistors are especially designed for stable, self-heated applications such as gas chromatography analysis, temperature measuring bridges, temperature control circuits, remote temperature controls, interchangeable calibrated units for thermometry and many others. They also provide an economical means of obtaining close tolerance interchangeability, with matching available to better than 1 percent.

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ACCURATE SPECIALTIES CO., INC., 37-11 57th St., Woodside 77, N. Y. High purity precision preforms, including disks, spheres, washers, and pellets used in making alloy junctions in silicon and germanium semiconductor devices are now available in a wide variety of alloys in either small lots or million piece production runs.

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Test-Point Jack takes longer probes

SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y. Type SKT-27 test-point jack will accept a probe 0.450 in. long by 0.093 in. in diameter. Because of its longer leakage path—0.187 in. or more—this jack has particular value in applications requiring h-v ratings. It features a machined beryllium-copper contact member with gold flash over silver-plate finish. It may be used over a temperature range of −55 C to +200 C.

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RESUME:

Charest, Roland J., Boston University, BS in Journalism. Formerly New England editor for **electronics**. Navy sonarman. Writer, reporter, editor for Lynn Item, Boston Globe, Boston Traveler. Won a New England Associated Press (AP) award in 1955 for writing feature articles in the major city newspaper class.

PRESENT OCCUPATION:

Rolly Charest supports Managing Editor Jack Carroll for editorial content accuracy and expediting putting each weekly issue to bed. Rolly reworks headlines for greater readability, is involved in makeup, and helps polish editorial content. Rolly's across-the-board background assures you accuracy in the face of journalistic pressures; articles in this week's issue that could be held over to the next deadline, but are not. The readers' interests come first!

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MATERIALS

Dielectric Materials. Emerson & Cuming, Inc., Canton, Mass., has available a condensed listing of its complete line of dielectric materials, including casting resins, foams, absorbers, adhesives, impregnants, coatings, ceramics and reflectors.

CIRCLE NO. 250 READER SERVICE CARD

COMPONENTS

D-C Returns. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md. Bulletin 178 gives complete specifications for low vswr d-c returns, which are available in four models, covering the range of 1 to 11 kmc.

CIRCLE NO. 251 READER SERVICE CARD

UHF Oscillator. Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, Calif. Technical bulletin W-J208 covers the Helitron, a uhf and microwave oscillator that is continuously voltage-tuned and is electrostatically focused.

CIRCLE NO. 252 READER SERVICE CARD

Transformer. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif. Two-color data sheet describes a small, 50-w transformer that withstands military environment.

CIRCLE NO. 253 READER SERVICE CARD

EQUIPMENT

Swinging Head Counter. American Electronics, Inc., 75 Front St., Brooklyn 1, N. Y. A product sheet describes a swinging head counter which prints direct read-out data ranging from +9999 to −9999 and makes the smooth transfer from plus to minus (and vice versa) without losing a digit.

CIRCLE NO. 254 READER SERVICE CARD

Microwave Test Equipment. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. Bulletin 200 de-

the Week

scribes a variety of microwave test equipment with illustrations and specifications on more than 50 different models of coaxial and waveguide frequency meters.
CIRCLE NO. 255 READER SERVICE CARD

Hall Generators. GRH Halltest Co., 157 S. Morgan Blvd., Valparaiso, Ind. A 28-page booklet contains information on constructional design, definitions and applications of Siemens Hall generators.
CIRCLE NO. 256 READER SERVICE CARD

Frequency Counters. Northeastern Engineering Inc., 25 S. Bedford St., Manchester, N. H., has available a short form catalog on frequency counters for the ranges of 120 kc, 1.2 mc and 10 mc. Plug-ins and accessories are also covered.
CIRCLE NO. 257 READER SERVICE CARD

Shift Register. Magnetics Research Co., Inc., 255 Grove St., White Plains, N. Y. A 10-bit transistor driven shift register which operates at 125 kc is discussed in technical bulletin 159.
CIRCLE NO. 258 READER SERVICE CARD

FACILITIES

Transistor Digital Subsystems. Tempo Instrument Inc., Commercial St., Hicksville, N. Y. Facilities for the design, development and production of transistor digital subsystems are described in a recent folder.
CIRCLE NO. 259 READER SERVICE CARD

Electronic Circuitry. Beck's, Inc., 300 E. Fifth St., St. Paul 1, Minn. A series of bulletins discuss the Beck process for imbedded, flush, formed, switch and double sided circuitry.
CIRCLE NO. 260 READER SERVICE CARD

Antenna Field Service. D. S. Kennedy & Co., Cohasset, Mass., has released a 4-page bulletin describing field service facilities for the antenna industry.
CIRCLE NO. 261 READER SERVICE CARD

CTS Forms New Subsidiary

CHICAGO TELEPHONE SUPPLY CORP., Elkhart, Ind., announces formation of a new subsidiary, CTS, Inc., and the opening of a 10,000 sq ft plant (picture) in Berne, Ind.

New plant manufactures wirewound variable resistors, buzz and balance rheostats and special electronic components. This is CTS' fifth plant, bringing total plant area to 436,000 sq ft.

The parent organization is situated in Elkhart, Ind. Subsidiaries besides the one in Berne, are CTS of Asheville, Inc., Skyland, N. C.; Chicago Telephone of California, Inc., South Pasadena, Calif.; and C. C. Meredith & Co., Ltd., Streetsville, Ontario, Canada.

Products manufactured in the various plants include composition and wirewound variable resistors, tube savers, switches and other components for radio, tv, commercial and military electronic equipment.

Bailey Becomes INTEC Staffer

INTERCONTINENTAL ELECTRONICS CORP., Mineola, N. Y., announced that Llewellyn H. Bailey has joined the staff as contract coordinator. In this capacity, he will be responsible for all areas connected with company operations.

Formerly with Rocke International, Bailey's background includes technical and technical sales experience in the systems field. During his 20-year career, he has served in important positions in the communications, television, components and government contracts business.

INTEC, a systems manufacturer for the aircraft, power instrumentation and telecommunications industries, is jointly owned by Airborne Instruments Laboratory, a division of Cutler Hammer, Compagnie de Telegraphie Sans Fils (CSF), American Research and Development Corp., the Morgan Guaranty Trust Co., and the Banque de Paris.

Bulova Appoints Project Engineer

BARNETT POMERANTZ has been appointed project engineer at Bulova Research and Development Laboratories, Inc., Woodside, L. I., N. Y., for the firm's aircraft altimeter development and production programs.

Pomerantz has had 40 years' experience in the precision instruments and automatic controls fields. Before coming to Bulova last year, he had been chief engineer at Swivelier, Inc., Nanuet, N. Y.

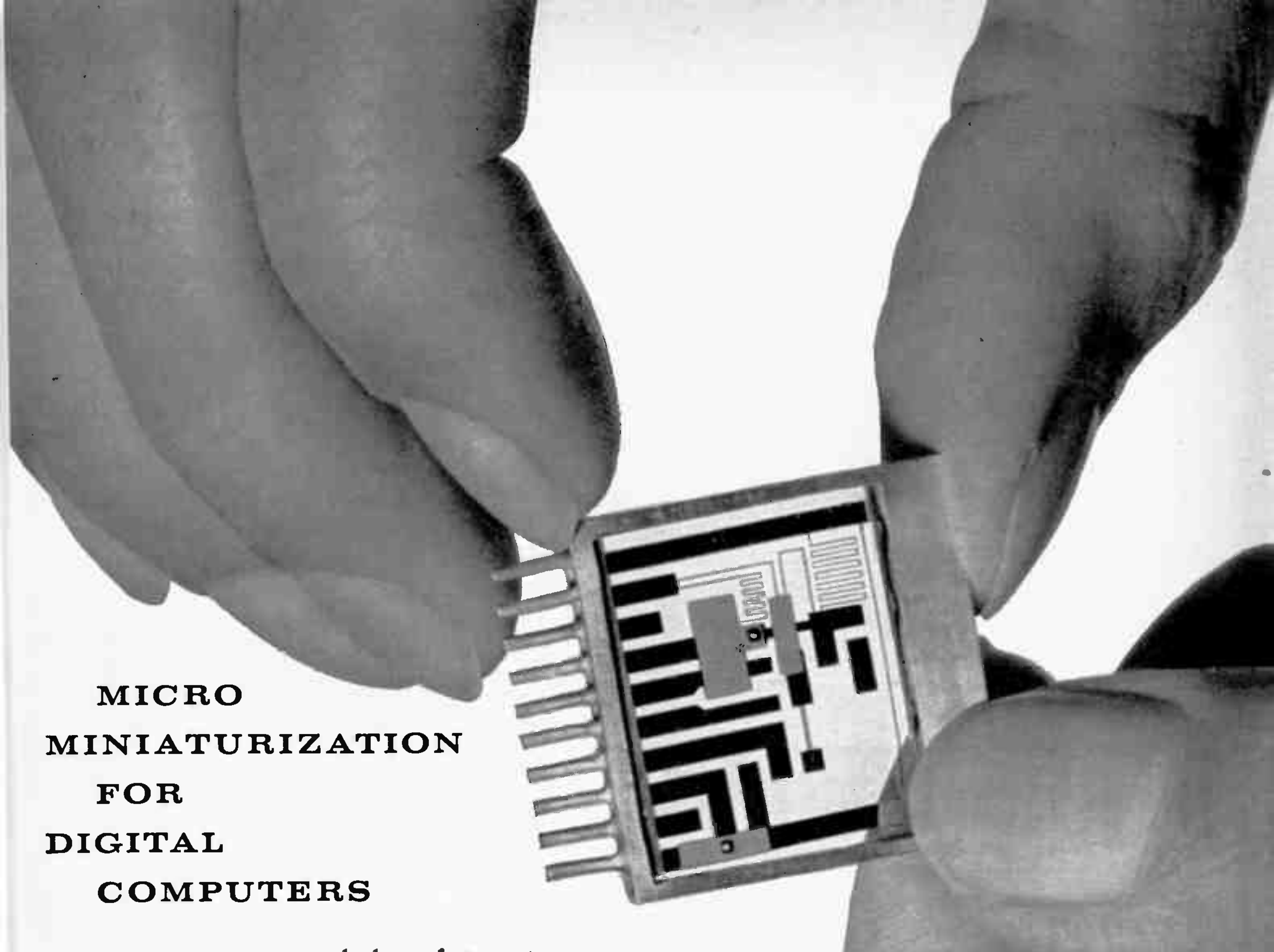
Honeywell Names V-P of Research

FINN J. LARSEN has been named to the newly-created post of vice-president in charge of research for Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. He has been Honeywell's director of research since 1953.

As corporate vice-president, he will continue to direct activities of the company's central research laboratory in Hopkins. In addition, he will work closely with Honeywell management and the firm's various divisions in providing research program guidance and in evaluating new product developments.

Nothelfer Moves To Larger Plant

NOTHELFER WINDING LABORATORIES, pioneers and specialists in custom building of transformers, recently



MICRO MINIATURIZATION FOR DIGITAL COMPUTERS

12 resistors, 4 capacitors, 4 diodes and 4 transistors...
all are contained in the complete flip-flop circuit illustrated above.

At the Hughes Research & Development Laboratories, dramatic reduction in component size is symbolic of the advances in the digital computer art...advances which are preparing the digital computer for its role as a system control in space.

In addition to developing new digital circuits and components, Hughes engineers are delving into other digital computer space mission tasks such as navigation guidance and control, communications processing and display, vehicle control, mission programming.

An intensive Hughes program in digital computer systems has created openings for creative engineers and physicists with degrees from accredited engineering universities in the following fields:

CIRCUIT and COMPONENT DEVELOPMENT: Digital Computer Analysis, Microcircuitry and Cryogenics, Solid State Physics, Magnetic Storage Devices.

SYSTEMS ENGINEERING: Closed-loop Digital Control, Digital Sensing and Conversion, Radar and Communications Information Processing, Inertial Navigation.

The salary structure for these personnel reflect the exceptional backgrounds required and the unusual challenge of the projects.

Inquire by writing directly to:
Dr. Allen Puckett, Director
Systems Development Laboratories

HUGHES

Hughes Aircraft Co.,
Culver City 65, California

moved its plant and offices to larger quarters in Trenton, N. J. The new plant, encompassing 18,000 sq ft, is located on a 26-acre tract.

Promote Archer At Budd Company

GEORGE RICHARD ARCHER was recently named chief engineer, electronic controls section of The Budd Company, Philadelphia, Pa. He was first associated with the company in 1952 as a stress analyst working with the weapons division. In 1955 he was appointed a project engineer.

Appoint Linsley To AIL Key Post

JOHN F. LINSLEY has been appointed manager of industrial sales for the Airborne Instruments Laboratory division of Cutler-Hammer, Inc., Mineola, N. Y.

In his new capacity, he will be responsible for all AIL products sold through the Cutler-Hammer national sales organization. These will include Inchworm and Microtrol, AIL's standard industrial products, as well as the industrial control systems that will be built jointly by Cutler-Hammer and AIL.

Linsley was an application and sales engineer with Cutler-Hammer, Inc., for 19 years. When C-H acquired AIL last year, he was appointed AIL's manager of industrial control systems sales.

News of Reps

Charles Walsh Associates of Deerfield, Ill., is named Midwest sales rep for the Sodeco impulse counters manufactured by Landis & Gyr, Inc. Rep firm will cover Minnesota, Iowa, Missouri, Kentucky, Michigan, Wisconsin, Illinois and Indiana.

R. E. Weber Co., South River, N. J., now represents Allegany Instrument Co., Inc., Cumberland, Md.; Exact Electronics, Inc., Portland, Ore.; Greibach Instruments Corp., New Rochelle, N. Y.; Industrial Test Equipment Co., New York, N. Y.; and Mid-Eastern Electronics, Inc., Springfield, N. J., in the following territory:

Eastern Pennsylvania, New Jersey, Delaware, metropolitan New York, Long Island and part of Connecticut.

The Amerelay Corp., New Hyde Park, N. Y., names **Habco Electronic Sales Co.** of Towson, Md., as rep for the territory of Delaware, Maryland, Virginia and Washington, D. C.; and **Fred R. Lesser** of Manchester, N. H., for the states of Maine, Vermont, New Hampshire, Massachusetts, Connecticut and Rhode Island.

Long & Associates of Redwood City, Calif., have been appointed reps for Tape Cable Corp., Rochester, N. Y., in northern California and western Nevada.

COMMENT

Doppler Radar Navigation

In your May 8 ELECTRONICS (p 62) is a tabular presentation of some of the airborne automatic navigation systems using doppler techniques. I also notice at the top the name of F. B. Berger, who is a very good friend of mine and an outstanding authority on doppler navigation.

I was most concerned with the characteristics noted for our APN-105 system. Some of the characteristics—input power, antenna system, transmission frequency and basic outputs—were in error . . .

JOHN E. STACY
LABORATORY FOR ELECTRONICS
BOSTON

Author Berger sends this amplifying information along:

. . . A number of errors appear in Table I, "Characteristics of Airborne Automatic Navigation Systems." A few of the items were not known to us at the time of submission of the original article. However, they are now available and we feel it is desirable to include them with the corrected information so that the Table is complete.

APN-66: *Input power* should read *4,650 w a-c and 350 w d-c. Accuracy* should read *ground speed 0.2 percent; drift angle 0.2 deg; present position 0.5 percent.*

APN-67: *Temperature range* should read *−55 to +71. Accuracy* should read *present position 1 percent with 0.5 deg heading reference.*

APN-78: *Weight* should read *190. Volume* should read *6.7. Input power* should read *805 v-a a-c, 224 w d-c. Temperature range* should read *−55 to +55. Altitude limits* should read *0 to 25,000 ft. Speed* should read *±3,000 fpm vertical. Accuracy* should read *ground speed 0.2 percent; drift angle 1.0 deg indicated.*

APN-79: *Temperature range* should read *−55 to +71. Antennas* should read *two lenses and reflector. Transmission frequency* should read *13,500. Coherence* should read *co-*

herent. Accuracy should read *velocity components 0.23 percent; present position 0.67 percent.*

APN-81: *Accuracy* should read *wind speed 2 percent ±3 knots.*

APN-82: *Accuracy* should read *ground speed 0.2 percent; drift angle 0.2 deg; wind speed 2 percent ±3 knots; wind direction ±0.2 deg; present position 1.5 percent (actual measured).*

APN-89: *Accuracy* should read *ground speed 0.2 percent; drift angle 0.2 deg.*

APN-96: *Volume* should read *5.2. Input power* should read *70 w d-c. Altitude limits* should read *200 to above 70,000. Speed* should read *100 to 1,000; 200 to 2,000.*

APN-102, RADAN 212: *Accuracy* should read *better than 0.5 deg of drift angle.*

APN-105: *Weight* should read *220. Volume* should read *6.8. Input power* should read *805 v-a 3-phase 224 w d-c. Temperature range* should read *−55 to +71. Antennas* should read *one lens. Transmission frequency* should read *9,800. Altitude limits* should read *0 to 80,000. Speed* should read *−50 to 1,500. Basic outputs* should read *ground speed, drift angle, present position (lat. and long.), course to destination, distance to destination, and ground track. Accuracy* should read *present position 0.6 percent or ±0.2 nautical miles, ground speed ±0.25 knots or 0.5 percent, drift angle ±0.3 deg.*

It should be noted that two definitions of Janus doppler systems appear in existing literature on the subject. Fried (in "Principles and Performance Analysis of Doppler Navigation Systems," *Trans. IRE*, Vol. ANE-4, Dec. '57, p 167) defined a Janus system as one employing both fore and aft directed beams; the author (*ibidem*, p 157) used a more restrictive definition calling for mixing of the echoes before final detection. The former definition is applicable where used in the published table.

F. B. BERGER
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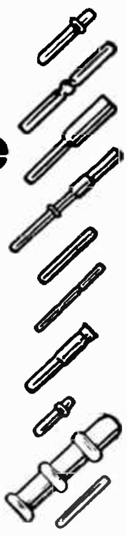

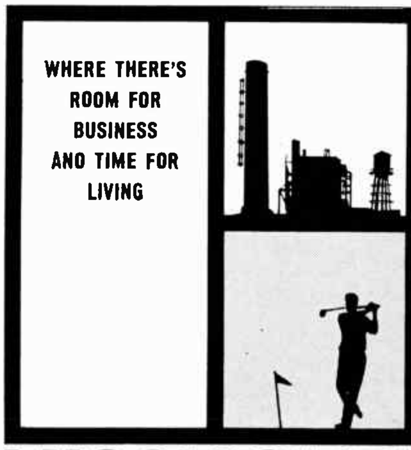

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- Display and storage devices

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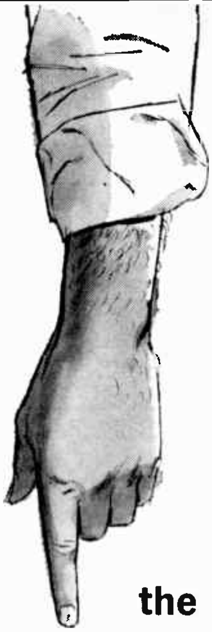
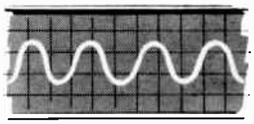
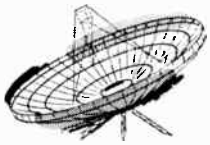


the satellite reports scientific data back to earth.  At the ground station, special communications equipments receive and demodulate space telemetry signals.  A data processing system analyzes findings which are fed in turn to the satellite control network and the computer memory banks, increasing man's knowledge of his newest frontier. 

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This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

The Landing of the Puritans

On the banks of Gitchie Goomie,
Lake the white men call Atlantic
Heap big redskins going frantic,
Radar got no Bomac tubes! *

See the Pilgrims land on rock there!
See them cross the sky blue water!
Redskins know they hadn't oughter,
But radar got no Bomac tubes!

Beat the drum, call heap big powow,
Call the braves from heap big teepee,
Get um chief to put on toupee —
Radar got no Bomac tubes!

Fixum Cavity, Bald Eagle!
Get um faulty Klystron going!
Heap big white men come a-rowin
And radar got no Bomac tubes!

Storm Cloud, get those fingers flying!
Mend with rawhide, patch with sticks
Too late now to get um "fix" . . .
Radar got no Bomac tubes!

Redskin radar rests in ashes,
White men use um wood for fire, now.
Price of real estate is higher now . . .
Radar had no Bomac tubes!

On the banks of Gitchie Goomie
Different people now are living,
Every year they give Thanksgiving
Radar had no Bomac tubes!

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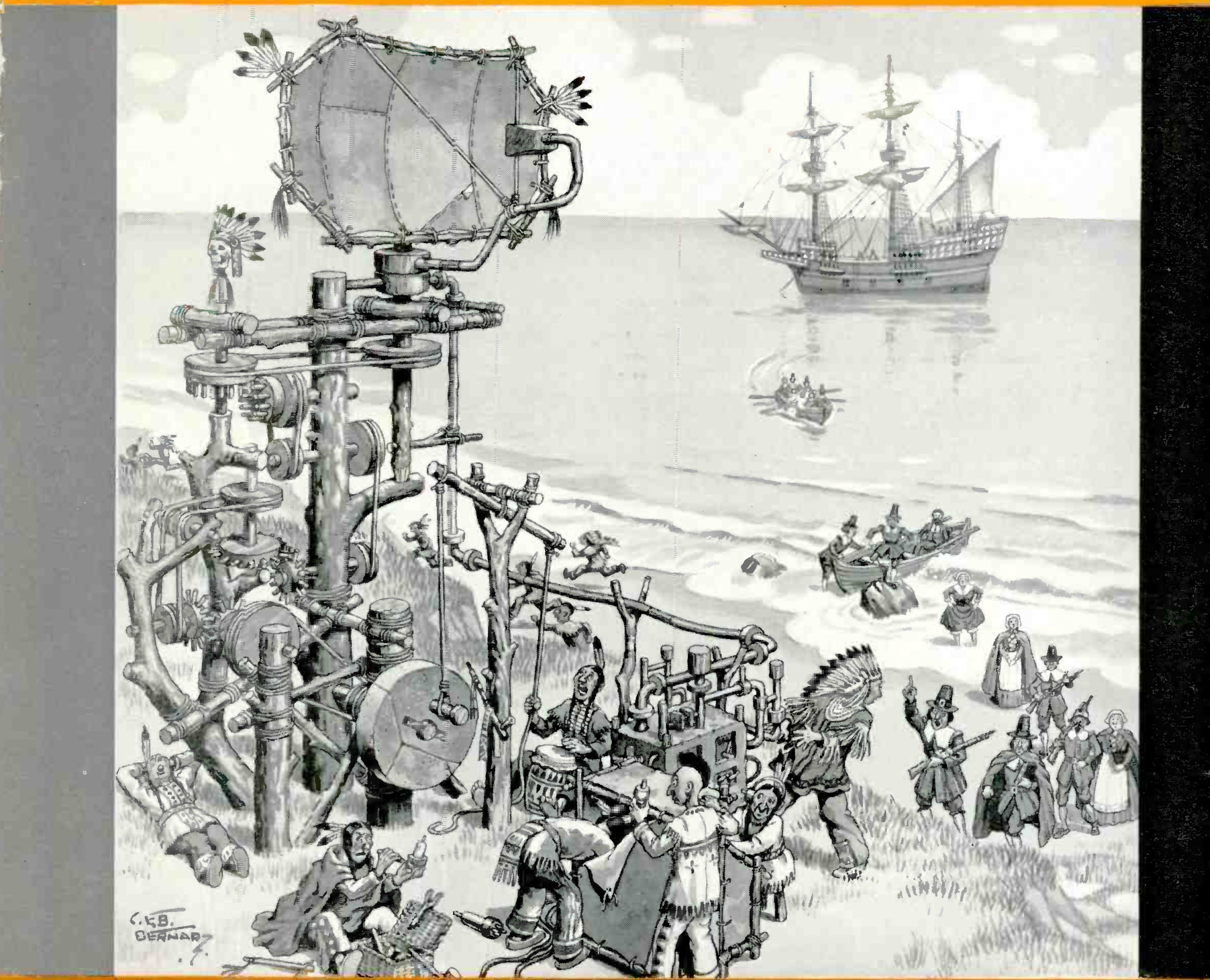

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