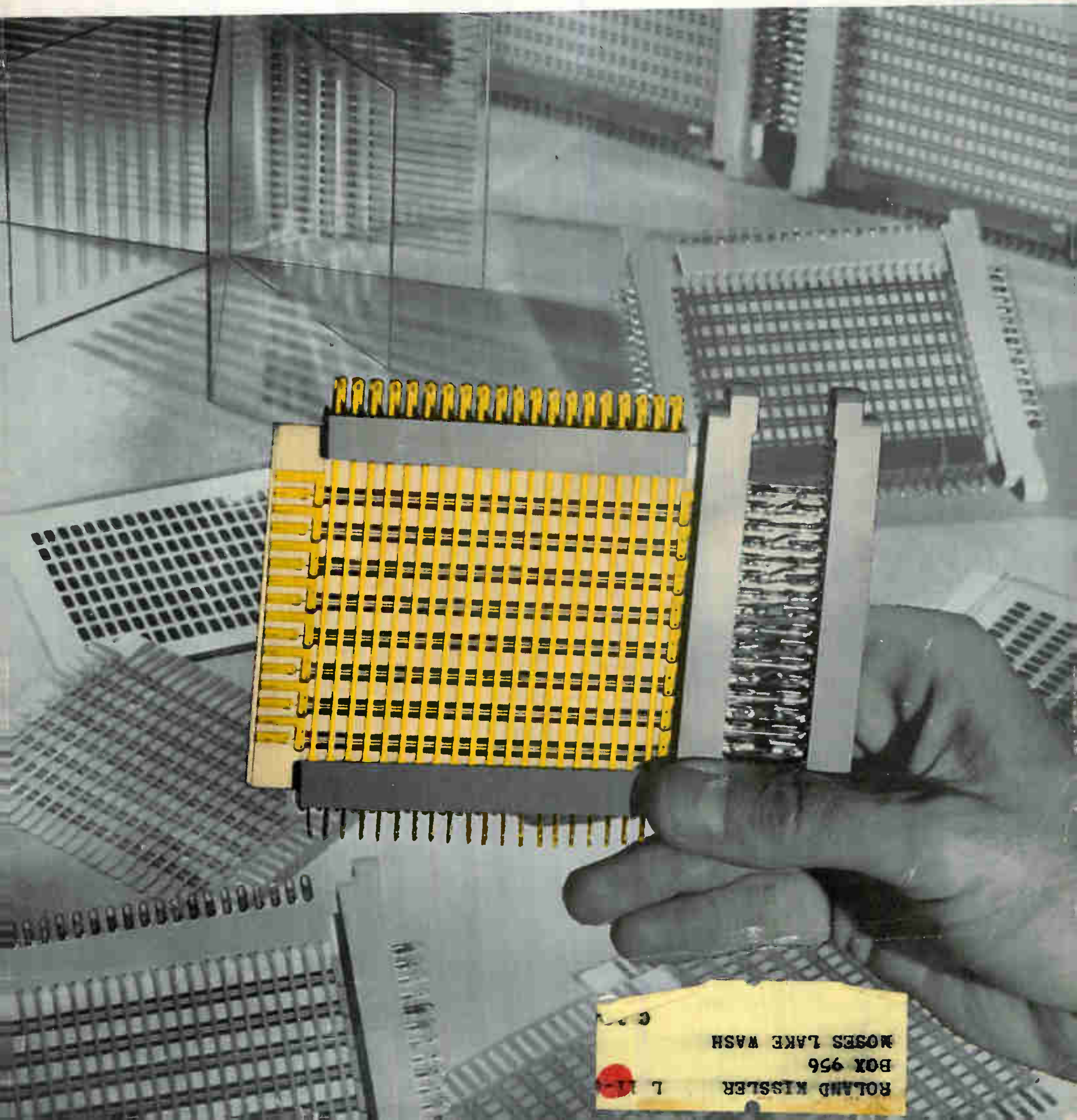
March 3, 1961

electronics

Compact computer memories with 0.2 microsec cycle times are made reproducibly by vacuum depositing 80-20 nickel-iron film 2,000 A thick on glass substrate under influence of a magnetic field, p 39

A McGraw-Hill Publication 75 Cents



NEW*

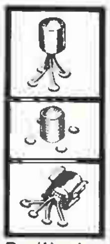
Revolutionary† DO-T and DI-T TRANSISTOR TRANSFORMERS

FROM STOCK—Hermetically Sealed to MIL-T-27A Specs.

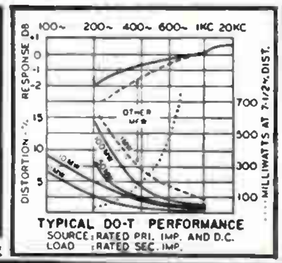
There is no transformer even twice the size of the DO-T and DI-T series which has as much as 1/10th the power handling ability . . . which can equal the efficiency . . . or equal the response range. And none to approach the reliability of the DO-T and DI-T units (proved to, but exceeding MIL-T-27A grade 4).

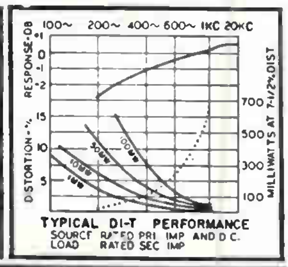
- **High Power Rating** .... up to 10 times greater.
- **Excellent Response** .... twice as good at low end.
- **Low Distortion** .... reduced 80%.
- **High Efficiency** .... up to 30% better . . . compare DCR.
- **Moisture Proof** .... hermetically sealed to MIL-T-27A.
- **Rugged** .... completely metal cased.
- **Anchored Leads** .... will withstand 10 pound pull test.
- **Printed Circuit Use** .... (solder melting) plastic insulated leads.
- **Suited to Clip Mounting** .... use Augat #6009-8A clip.

TRANSFORMERS PICTURED ACTUAL SIZE
DO-T: 5/16 Dia. x 13/32", 1/10 Oz.; DI-T: 5/16 Dia. x 1/4", 1/20 Oz.



Typical Printed Circuit Positioning





DO-T No.	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res. DO-T	Pri. Res. DI-T	Mw. Level	DI-T No.
DO-T1	20,000 30,000	.5 .5	800 1200	850	815	50	DI-T1
DO-T2	500 600	3 3	50 60	60	65	100	DI-T2
DO-T3	1000 1200	3 3	50. 60	115	110	100	DI-T3
DO-T4	600	3	3.2	60		100	
DO-T5	1200	2	3.2	115	110	100	DI-T5
DO-T6	10,000	1	3.2	790		100	
DO-T7	200,000 500	0 0	1000 100,000	8500 —		25	
	Reactor 2.5 Hys./2 Ma., .9 Hy./4 Ma				630		DI-T8
DO-T8	" 3.5 Hys./2 Ma., 1 Hy./5 Ma.			630			
DO-T9	10,000 12,000	1 1	500 CT 600 CT	800	870	100	DI-T9
DO-T10	10,000 12,500	1 1	1200 CT 1500 CT	800	870	100	DI-T10
DO-T11	10,000 12,500	1 1	2000 CT 2500 CT	800	870	100	DI-T11
DO-T12	150 CT 200 CT	10 10	12 16	11		500	
DO-T13	300 CT 400 CT	7 7	12 16	20		500	
DO-T14	600 CT 800 CT	5 5	12 16	43		500	
DO-T15	800 CT 1070 CT	4 4	12 16	51		500	
DO-T16	1000 CT 1330 CT	3.5 3.5	12 16	71		500	
DO-T17	1500 CT 2000 CT	3 3	12 16	108		500	
DO-T18	7500 CT 10,000 CT	1 1	12 16	505		500	
DO-T19	300 CT	7	600	19	20	500	DI-T19
DO-T20	500 CT	5.5	600	31	32	500	DI-T20
DO-T21	900 CT	4	600	53	53	500	DI-T21
DO-T22	1500 CT 600	3 5	600 1500 CT	86 —	87	500	DI-T22
DO-T23	20,000 CT 30,000 CT	.5 .5	800 CT 1200 CT	850	815	100	DI-T23
DO-T24	200,000 CT 500 CT	0 0	1000 CT 100,000 CT	8500 —		25	
DO-T25	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	800	870	100	DI-T25

DO-T No.	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res. DO-T	Pri. Res. DI-T	Mw. Level	DI-T No.
	Reactor 4.5 Hys./2 Ma., 1.2 Hys./4 Ma.				2300		DI-T26
DO-T26	" 6 Hys./2 Ma., 1.5 Hys./5 Ma.			2100			
	Reactor .9 Hy./2 Ma., .5 Hy./6 Ma.				105		DI-T27
DO-T27	" 1.25 Hys./2 Ma., .5 Hy./11 Ma.			100			
	Reactor .1 Hy./4 Ma., .08 Hy./10 Ma.				25		DI-T28
DO-T28	" .3 Hy./4 Ma., .15 Hys./20 Ma.			25			
DO-T29	120 CT 150 CT	10 10	3.2 4	10		500	
DO-T30	320 CT 400 CT	7 7	3.2 4	20		500	
DO-T31	640 CT 800 CT	5 5	3.2 4	43		500	
DO-T32	800 CT 1000 CT	4 4	3.2 4	51		500	
DO-T33	1060 CT 1330 CT	3.5 3.5	3.2 4	71		500	
DO-T34	1600 CT 2000 CT	3 3	3.2 4	109		500	
DO-T35	8000 CT 10,000 CT	1 1	3.2 4	505		100	
DO-T36	10,000 CT 12,000 CT	1 1	10,000 CT 12,000 CT	950	970	100	DI-T36
*DO-T37	2000 CT 2500 CT	3 3	8000 Split 10,000 Split	195		100	
*DO-T38	10,000 CT 12,000 CT	1 1	2000 Split 2400 Split	560		100	
*DO-T39	20,000 CT 30,000 CT	.5 .5	1000 Split 1500 Split	800		100	
*DO-T40	40,000 CT 50,000 CT	.25 .25	400 Split 500 Split	1700		50	
*DO-T41	400 CT 500 CT	8 6	400 Split 500 Split	46		500	
*DO-T42	400 CT 500 CT	8 6	120 Split 150 Split	46		500	
*DOT-43	400 CT 500 CT	8 6	40 Split 50 Split	46		500	
*DO-T44	80 CT 100 CT	12 10	32 Split 40 Split	9.8		500	
DO-TSH	Drawn Hipermalloy shield and cover 20/30 db						DI-TSH

‡ DCMA shown is for single ended useage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)

† DO-T & DI-T units designed for transistor application only. Pats. Pend.

* DO-T37 thru DO-T44 newly added to series.

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March 3, 1961

electronics

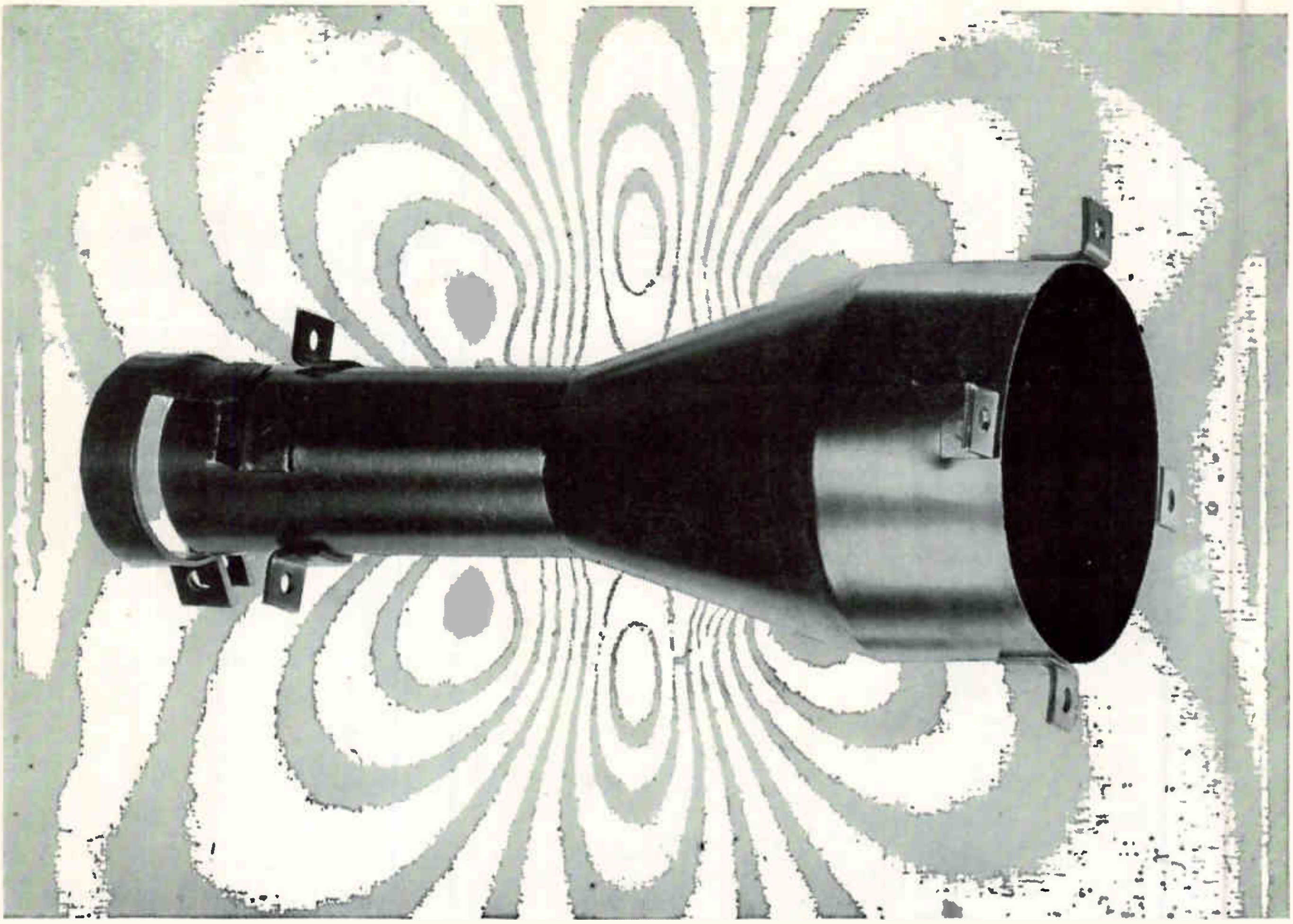
A McGraw-Hill Publication *75 Cents*

W. W. MacDONALD, Editor

BUSINESS

ENGINEERING

DEPARTMENTS



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These high-permeability shields are made from existing tools in a broad variety of single and multiple structures—cylinders, spheres, truncated cones—for applications ranging from dc into the audio range and higher. They can be used with almost all conventional transformer core and coil assemblies to provide any degree of magnetic, electrostatic or RF shielding against undesired signals of all classes. Reduction of field strengths to 100 db and beyond is common.

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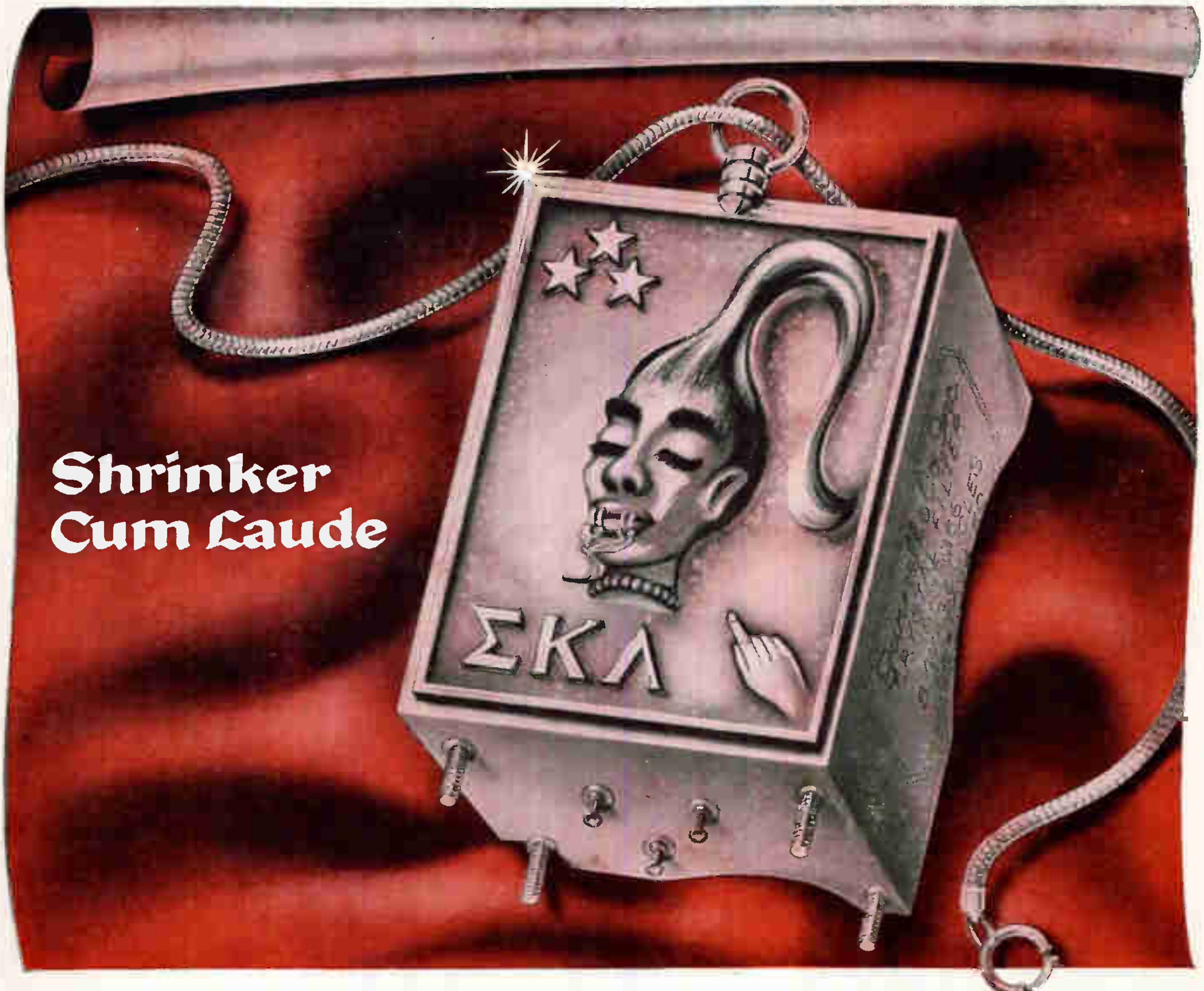
Shrinker Cum Laude



Know ye that we, the corporation of Burnell & Co., upon the recommendation of our customers in the electronics industry do hereby inaugurate the esteemed order of Shrinker Cum Laude.

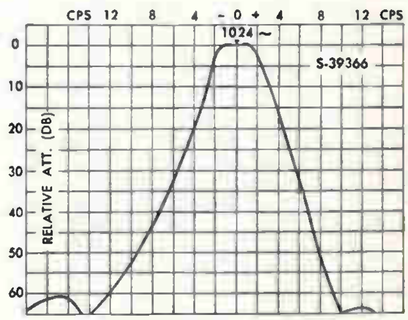
Be it further known that, (without undue modesty), the Shrinker Cum Laude award has been made to Burnell for displaying the highest degree of shrinkmanship in the design and utilization of microminiature, subminiature and miniature toroids, filters and related networks.

The Shrinker Cum Laude award has also been tendered for signal achievement in reducing developmental costs while increasing performance range–a feat accomplished by the designers of the new Burnell high selectivity, high attenuation, 1 kc crystal filter which possesses the following unique characteristics:

Attenuation — 3 db bandwidth — 3.8 cps
Shape Factor 60/6 — 4½:1
Input — 500 ohms
Output Impedance—500,000 ohms
Meets MIL-C 3908 B vibration standards

Other Burnell crystal filters available in frequencies up to 30mcs with considerable latitude in impedance range. Write for Bulletin XT 455.

See the complete line of Burnell components at Booths 2909-2910 IRE Exhibit, March 20-23.



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Mar. 3, 1961 Volume 34 Number 9

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CROSSTALK

DISCOVERER. Accompanying photo shows Agena satellite being hoisted into test stand for firing at Lockheed Missiles and Space division's Santa Cruz, Calif. test facility. These satellites are being used in the Discoverer series of launchings. In this program, reentry nose cone capsules are located by an azimuthal direction finder described in the article beginning on p 42. The author is A. T. Lloyd of Lockheed Aircraft Service, Inc. in Ontario, Calif.

TRACKING EQUIPMENT. Many observers in our industry feel the time is ripe to stop depending on the Russians to give us telemetered data from Soviet space probes, and on Jodrell Bank in England to tell us where our own space vehicles are and what data they're sending back.

Both the Defense Department and the National Aeronautics and Space Administration have a good start in ground facilities to take care of our defense needs and scientific experiments. But more and better equipment is needed.

There is a growing market in both R&D and hardware production of ground facilities to detect, track, identify, catalog, predict the orbital patterns of, instruct and listen to vehicles in space. U. S. space vehicles now being developed will acquire more data and penetrate deeper into space than before. Ground facilities must keep apace.

The article on p 20 describes the military's existing ground facilities and points out future needs. Last week, we covered NASA's networks and plans on p 20.

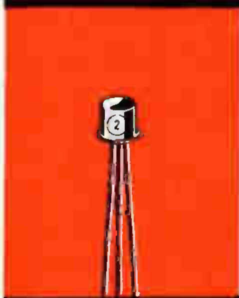
HIDDEN EAR. Electronic surveillance is hinted at but its existence is usually denied. Many states now invoke severe penalties against users of clandestine equipment. After talking to many people, but not receiving many quotable answers, ELECTRONICS gathered enough information to assemble the story on p 24. For obvious reasons, much of the information gathered cannot be published, but enough was learned to show this is an interesting area.

Coming In Our March 10 Issue

IRE HIGHLIGHTS. With approximately 300 papers to be presented at 54 sessions, this year's IRE show in New York looks like it will be just as hectic as in previous years. To help you direct your footsteps, ELECTRONICS editors have put together for our next issue a roundup of some of the new engineering developments slated for discussion. These include laser radar, log-periodic monopole antennas, tunable tunnel-diode amplifiers and semiconductor filters.

TYPE 2N768

- Micro-energy switch—designed for low current, low voltage, high speed applications
- 10 mc pulse rates, collector currents as low as 1 ma, collector supply voltages as low as 1 volt
- No reduction in switching speed, as with ordinary low current, low voltage devices. Permits higher density packaging
- Typical DC beta of 40 @ $V_{CE} = -0.20$ v, $I_C = -2$ ma



TYPE 2N769

- World's fastest switch—will operate reliably at speeds in excess of 100 mc
- Gain bandwidth product (f_T) typically 900 mc
- Low capacitance, low saturation voltage, high beta—ideal for low-level, high-frequency logic circuits
- Extremely low hole storage factor (K'_S) typically 18 nsec

TYPE 2N779

- Manufactured with tighter parameter control than any other transistor in the industry
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- Low saturation voltage—typically 0.12 volts
- Higher in performance, lower in price than mesa transistors with lesser specifications

3 new additions to the SPRAGUE MADT* transistor line!

High-speed switching transistors in TO-18 cases are now being mass-produced by Sprague. These hermetically-sealed germanium Micro-Alloy Diffused-base Transistors are made by a controlled-etch process to insure extreme uniformity. Maximum frequency capabilities have been improved by graded-base construction. Automated manufacturing techniques have brought about increased production efficiency, permitting favorable reductions in prices. This is why Sprague MADT Transistors can offer you greater performance per dollar than other high-speed devices in low-current switching circuits.

Other Sprague Micro-Alloy Diffused-Base Transistors

TYPE	APPLICATION
2N499	Amplifier, to 100 mc
2N501	Ultra High Speed Switch (Storage Temperature, 85 C)
2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
2N588	Oscillator, Amplifier, to 50 mc

For complete engineering information on the types in which you are interested, write Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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CIRCLE 5 ON READER SERVICE CARD

COMMENT

Medical Electronics

Your issue of Jan. 20 contained one of the best editorial summations of medical electronics I have had the pleasure of reading (on p 49). ELECTRONICS is to be complimented for publishing so thorough a treatment of what is becoming an increasingly important field of activity for the industry. We at Gulton look forward to the upcoming articles in the series.

Congratulations to you, author Bill Bushor, and everyone connected with this idea.

ANDREW J. LAZARUS
GULTON INDUSTRIES
METUCHEN, N. J.

The other articles in the series appeared on p 46, Feb. 3, and p 54, Feb. 24.

. . . Am a subscriber to ELECTRONICS. I read your treatment of medical electronics—and it's good . . .

HARRIS SKLAIRE, M. D.
PLATTSBURGH, N. Y.

Our thanks to you and Bill Bushor for the wonderful coverage in ELECTRONICS of medical electronics. Our thanks also for the cover of the Jan. 20 issue, together with the mentions in the article of AIL and our achievements. We think the article was grand . . .

HAROLD HECHTMAN
AIRBORNE INSTRUMENTS
LABORATORY
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Square Deal From Government

Reader A. E. Lander of Washington, D. C., was somewhat alarmed by the Navy's failure to contact the *Santa Maria* immediately (Comment, p 6, Feb. 10).

I wonder if the Navy played square with us. Seems to me they not only found the ship but found it within three or four hours of the initial alarm. I believe this controversy does not lie within the realm of adequate defenses, but rather some misguided sense of secrecy in Washington. We undoubtedly did not want the pirate captain to know we had located the vessel until a better insight into his plans for the passengers was gained. Considerable radio traffic would have been generated by persons outside the guarded government channels if every newspaper in the U. S. carried the story that the ship had been found and was being shadowed.

When it became apparent that no harm was to befall the passengers or that other steps would have to be taken, the Navy released a series of reports leading up to the actual interception. In other words, to keep the pirates from knowing we had intercepted their ship, the Navy took the rap that they had not found her.

A similar instance is unfolding right now about the large Soviet spaceship currently circling the globe. We did not release any information about this craft, yet when foreign observers pointed this out we immediately told the world we had been tracking the thing almost from the launch.

Our defenses are not what they should be, but I think these two cases were stupidly handled by the people in charge of telling the public.

WAYNE S. BECK
WHITNEY METAL TOOL CO.
ROCKFORD, ILL.

In our position close to these "people in charge of telling the public," we have become aware of an apparent trend in the last two months for government spokesmen to withhold information that might raise embarrassing questions. This tendency has been building up for some time. It has reached a point where the people who are really in charge of informing the public—the press, including the industrial press—are frequently denied access to the truth at the source. Many space-tracking people, for instance, have been gagged; all questions on the subject of the Soviet space ship are relayed to a government agency in Washington.

NEW FASTER WAY TO ANALYZE TRACES

The all-new Hughes High Frequency Memo-scope® Oscilloscope saves you time and money in transient analysis. With its 10 mc bandpass and one million inches per second writing speed, it can store fleeting phenomena for an indefinite period of time. It displays these non-recurring transients for thorough study until intentionally erased. In this way, you can eliminate expensive "hit or miss" methods of transient analysis.

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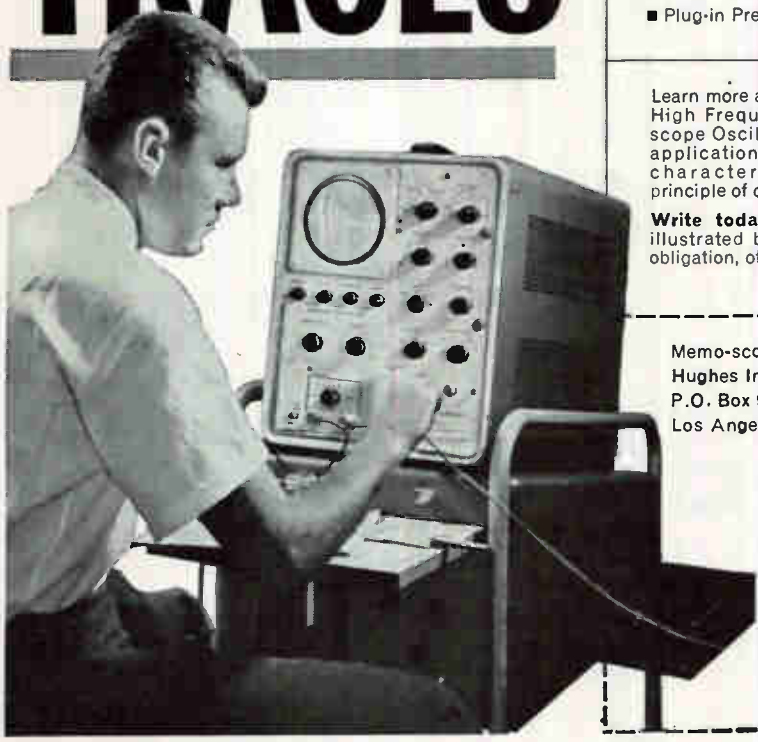

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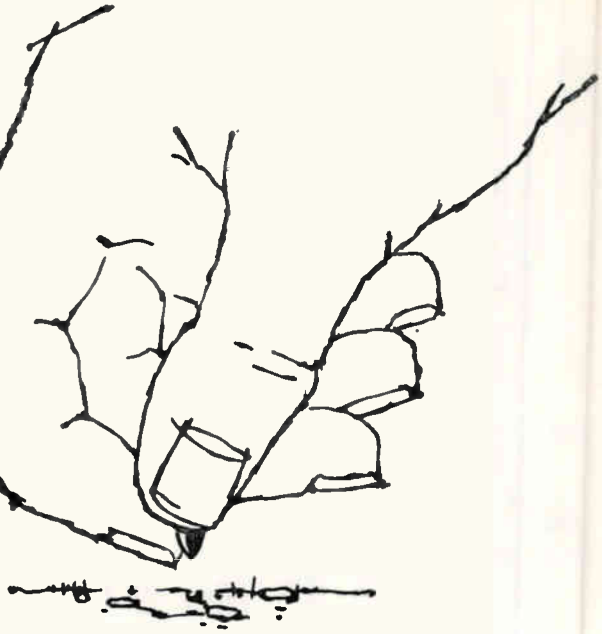

ELECTRONICS NEWSLETTER

Transistor Sales Increased 36 Percent in 1960

YEARLY GROWTH PATTERN in transistor sales was sustained in 1960 as U. S. producers rang up $301,-432,285 in factory sales. The figure represents an increase of 36 percent over the $222-million in sales recorded in 1959. Final 1960 figures were released last week by Electronic Industries Association's marketing data department.

A total of 127,928,586 transistors were sold in 1960; this is 55 percent above 1959's sales of some 82 million units. December was 1960's high month in numbers of transistors sold; over 13 million units were delivered for $27,915,649. March was high month in dollar volume; 12,021,506 transistors were sold that month for $28,700,129.

Japanese Electronics Still Going Strong

ELECTRONICS PRODUCTION in Japan for the first nine months of 1960 totaled $856 million, the Business & Defense Services Administration reported last week. Figure is 31 percent over the $655 million reported for the first nine months of 1959. Tv and radio made up about half the output, leveling off somewhat from 1959's upsurge. Tape recorders and phonographs continue a strong upward trend. Computers, control and measuring equipment, and special-purpose tubes are responding to government stimulus with production gains. Transistor production increased 34 percent and receiving-tube production increased 45 percent over the 1959 period.

Mitsubishi Electric announced last week that trial production is being undertaken on electronic instruments employing molecular electronic techniques. Instruments include notch filters, sawtooth generators, diode matrices, multivibrator units, multicontact electronic switches and audio preamps. Mitsubishi is affiliated with Westinghouse, imported the molecular electronic technology last May, revised it locally. Weight of molecular units is said to be a ten-thousandth that of a transistor.

In another development, Tokyo Shibaura last Monday announced that a silicon-controlled rectifier capable of putting out 200 amperes has been produced by a double-diffusion process.

Epitaxial Mesa Transistor Switches in 110 Nanoseconds

DEVELOPMENT of a germanium transistor with a maximum switching time of 110 nanoseconds was announced last Friday by Sylvania Electric. The new transistor, an epitaxial mesa unit designated 2N781, has a maximum turn-on time of 60 nsec, maximum turn-off time of 50 nsec. Storage time is reduced to 20 nsec, the company says.

Saturation voltage is −0.16 v max. Collector-emitter and collector-base voltages are rated at −15 v. Collector current at 25 C is 100 ma and power dissipation is 150 mw.

Echo II May Herald Passive Relay Chain

ECHO II, passive satellite one third bigger and 20 times more rigid than the still orbiting Echo I, is being developed by G. T. Schjeldahl Co. under $400,000 contract with National Aeronautics & Space Admintration. Satellite is scheduled for launch in 1962.

Second-generation Echo will be 135 ft in diameter, use stretchable aluminum laid over a Mylar base. It will be 0.00077 in. thick, will yield evenly under inflation pressure, forget packaging folds and wrinkles, stay smooth and spherical longer than its predecessor. Black inner surface will distribute heat uniformly to keep skin temperature steady around 122-140 F even in direct sunlight.

If successful, Echo II may be followed by a string of Echo satellites encircling the globe by 1963, possibly for radio-tv relay. Launching method now under consideration would kick balloons out at intervals—three from first rocket, six from another, and so forth—until the relay chain is complete.

Meanwhile, from Germany ELECTRONIC: editor W. W. MacDonald cables that European companies exhibit considerable interest in Bell System's proposed communications relay satellite. Several Telefunken executives, for example, will visit the U. S. in late March or early April to discuss mutual use of such a relay if and when it goes into orbit.

There is less interest in possible use of a satellite for radio-tv relay because of the time difference; feeling in Europe is that fast filming, kinescoping, video tape may do the job satisfactorily.

Tv Probe Observes Drilled Hole, Deep Lake

TELEVISION PROBE 25 inches in outer diameter has been developed by four engineers of Eastman International GmbH in Hanover, Germany, in cooperation with Grundig of Fuerth and the Austrian Engineering Bureau for Geology & Construction. Probe permits observation and photographic recording of geological conditions in drilled holes as deep as 1,312 ft, works faster and more accurately than coring procedures. Probe is 4.6 ft long, can withstand 735 psi.

Meanwhile, the Soviets announce that an underwater tv camera has been used to explore Lake Baikal in southeastern Siberia. The lake is one of the largest in Asia, is the deepest in the world.

Defense Contracts Stress Thermionics, Thermoelectrics

DIRECT CONVERSION of one energy medium to another is the research objective of a number of defense contracts disclosed last week.

General Electric in Lynn, Mass., has received two contracts from Army's Quartermaster Research & Engineering Command to study thermionic conversion systems and develop a self-contained heatingventilating system for combat clothing which can operate off a thermionic generator. Westinghouse has a parallel contract to develop a thermoelectric system for the same purpose. Meanwhile, Naval Research Laboratory has given itself a contract to explore fundamental heat-transfer processes in electromechanical, thermoelectric and magnetohydrodynamic devices.

In plasma research, Rome Air Development Center has asked Pratt & Whitney to investigate use of MHD principles for generating large quantities of electrical power. P&W is to evaluate both open- and closed-cycle systems, select one on the basis of feasibility studies, provide a conceptual design. Contract is due to be completed soon. Norair division of Northrop Corp. is winding up an RADC contract to study the generation of coherent electromagnetic radiation by a pulsating plasma. Norair was asked to analyze electron density at plasma interfaces and the modes of oscillation at such interfaces, study the behavior of pulsating plasmas, evolve the mathematics for the behavior, design experiments to demonstrate coherent radiation.

Westinghouse has completed its RADC contract for design and fabrication of a fossil-fueled convection-cooled thermoelectric generator of 100-w rating at 12 v. The generator, dubbed TAP-100, weighed 47 lb, exceeded its spec to produce 102.5 *w*, developed 19.7-v open-circuit potential, was tested to failure at RADC; initial failure came at 210 hrs. Texas Instruments continues its Office of Naval Research study of heat transfer and nuclear characteristics of thermoelectric direct-conversion nuclear reactors. Studies aim to find optimum design for a water-moderated uranium-dioxide reactor.

Electronics Still Attracts Venture-Capital Firms

DECISION of a major venture-capital firm to hire a hotel suite for the International Convention of the Institute of Radio Engineers indicates that financing of electronics ventures is still something of a buyers's market. The capital company is warming up for IRE week with a campaign of promotions. Previous IRE shows have seen many aisle-roamers looking for merger, acquisition or stock-issue possibilities.

Organizations with money to invest still look for managerial talent (all-scientific management is taboo), product or prospect with a predictable market, preferably a sturdy profit position. They shy away from fast-buck operators, dreamers, or the man with nothing but plans.

New Entry Is Coming In Color Set Production

AFTER MARKING TIME for a couple of years, color television is on the move again. Profits from set manufacture are stabilizing, and several setmakers are cautiously planning to enter—or reenter—the field.

Zenith Radio announced last week that it will begin producing color receivers in the fall. Details are presently limited. Among innovations, the sets will include a color-demodulation technique employing the Zenith-developed Adler switching tube. Three-gun shadow-mask picture tube of advanced design will be used. Console models will be priced above $600, the company says.

Self-Clocking Permits High-Density Recording

PACKING DENSITIES of 1,500 bits to the inch on standard digital recording tape are achieved in Potter Instrument's new tape units by means of self-clocked information pulses. A clock pulse is added to each information bit on each channel; the system helps account for tape skew, normally a severe hindrance to high packing densities. Skew causes an interchannel time displacement that makes it difficult to detect with adequate certainty which pulses in a parallel record go together.

In Potter's system, the clock pulses control the loading and unloading of a deskewing buffer; when a line is filled in the buffer, there is a clock pulse in each channel; the line is then read out and the buffer is refilled. Other compensating systems use a single clock pulse per line (across the width of the tape; that is, there is one clock channel on a multichannel head); tolerance requirements of such a system are high.

Potter system permits packing densities up to 1,500 bits to the inch and higher; tape handler made for Bendix's G-20 by Potter uses a density of 1,100 bits to the inch. Potter says maximum permanent error is one lost bit in 10^{10}, transient error is less than one in 10^{9}. Recent 40-hour test showed no permanent errors; one second was lost when a reread was necessary because of a transient error.

Germans, Russians Use Microwave "Blasting"

ELECTRONIC BLASTING is being used by the Soviets with some success and is also under study in Canada, ELECTRONICS editor W. W. MacDonald reports from Hamburg, Germany. In an interview with an executive of German tubemaker Valvo, MacDonald learned that that company, on the suggestion of German Mining Research Institute, is experimenting with microwave to heat up moisture in hard-coal seams.

In the coalmining application, 2 to 5 Kw of c-w power at 2.4 Gc is fed to an antenna in a drilled hole. R-f converts trapped moisture to steam, loosens coal deposits. Similar technique has previously been used to liquefy viscid oil deposits.

Three-Screen Tv Bows in Chicago

TELEVISION SET with three independent screens and separate, remotely controlled audio—record player and f-m, both stereo—was put on the market recently by De Forest of Chicago. Set permits the viewer to watch three shows at once, listen to one—or to something else, if he prefers. Separate earphones are provided to keep the audio ambient bearable.

Said one Chicago tv commentator: "the answer to the prayer of vidiots . . ."

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New TI 2N743 and 2N744 silicon epitaxial transistors are immediately available from distributor stocks or in mass production quantities at prices competitive with conventional silicon mesa and micro-alloy transistors.

Compare the 2N743 and 2N744 with conventional transistors!

Parameter	Approx. Test Conditions	TI 2N743	TI 2N744	2N834	2N706B	2N708
T_s(nsec)	$I_{B(1)} = -I_{B(2)} = I_C = 10$ ma	14	18	25	25	25
t_{on}(nsec)	$I_{B(1)}$ = 3 ma $I_{B(2)}$ = −1 ma I_C = 10 ma	11 (TYP)	10 (TYP)	35	40	35
t_{off}(nsec)		22 (TYP)	25 (TYP)	75	75	75
t_{on}(nsec)	$I_{B(1)}$ = 40 ma $I_{B(2)}$ = −20 ma I_C = 100 ma	12 6 (TYP)	12 6 (TYP)	NO SPEC	NO SPEC	NO SPEC
t_{off}(nsec)		40 18 (TYP)	45 23 (TYP)	NO SPEC	NO SPEC	NO SPEC
$V_{CE(sat)}$	I_B = 1 ma I_C = 10 ma T_A = + 170°C	0.35 v	0.35 v	No High Temp. Guarantee (0.19 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)
I_{CEX}	V_{CE} = 10 v V_{BE} = +0.35 v T_A = 100°C	30 μa	30 μa	No Guarantee	No Guarantee	10μa (MAX.) @V_{BE} = +0.25 V_{CE} = 20 v T_A =+125°C

NOTE: All limits are max. unless otherwise noted.

WASHINGTON OUTLOOK

THE KENNEDY administration has decided to place greater emphasis on readiness to fight limited wars. This is one of the key decisions resulting from the current intensive reappraisal of basic U. S. defense policy.

Another conclusion is to emphasize mobile, low-vulnerability missile systems such as Polaris and Minuteman in building up retaliatory nuclear strike forces.

Both decisions reflect the shift in fundamental deterrent strategy that was discernible in the last years under Eisenhower and which Kennedy will now accelerate.

The stress on limited-war capabilities should produce a spurt in new Army orders for communications and other electronic equipment. These will cover such items as a field army mobile air defense fire-direction system; division-corps forward area communications; a battlefield intelligence analyzer; combat surveillance drones; radar flight-control systems for drones and aircraft; electronic countermeasures for enemy artillery fuzes and f-m command radio for tactical vehicles.

Some details on these projects may be disclosed at EIA's Washington seminar on Planning for Limited War Requirements to be held March 14 prior to the Association's Spring conference.

DEFENSE SECRETARY McNamara has ordered an intensified drive to channel more military orders to small business. Organization of the Pentagon's Small Business Policy Office has been overhauled; the operation will be run by Civil Service experts in procurement rather than by political appointees as has been the case.

The services have been directed to limit the use of noncompetitive, sole-source contracting whenever possible to help give more orders to smaller firms. They have also been ordered to find greater opportunities for small business contract set-aside and to encourage prime contractors to increase competitive opportunities for small firms in subcontract work.

PROTECTIONIST groups are reportedly working against Senate ratification of U. S. membership in a new, 20-nation Atlantic economic alliance. They fear that the proposed Organization for Economic Cooperation and Development might eventually dictate U. S. trade and tariff policy. Representatives of several domestic industries expressed opposition to U. S. affiliation with OECD at recent Senate Foreign Relations Committee hearings.

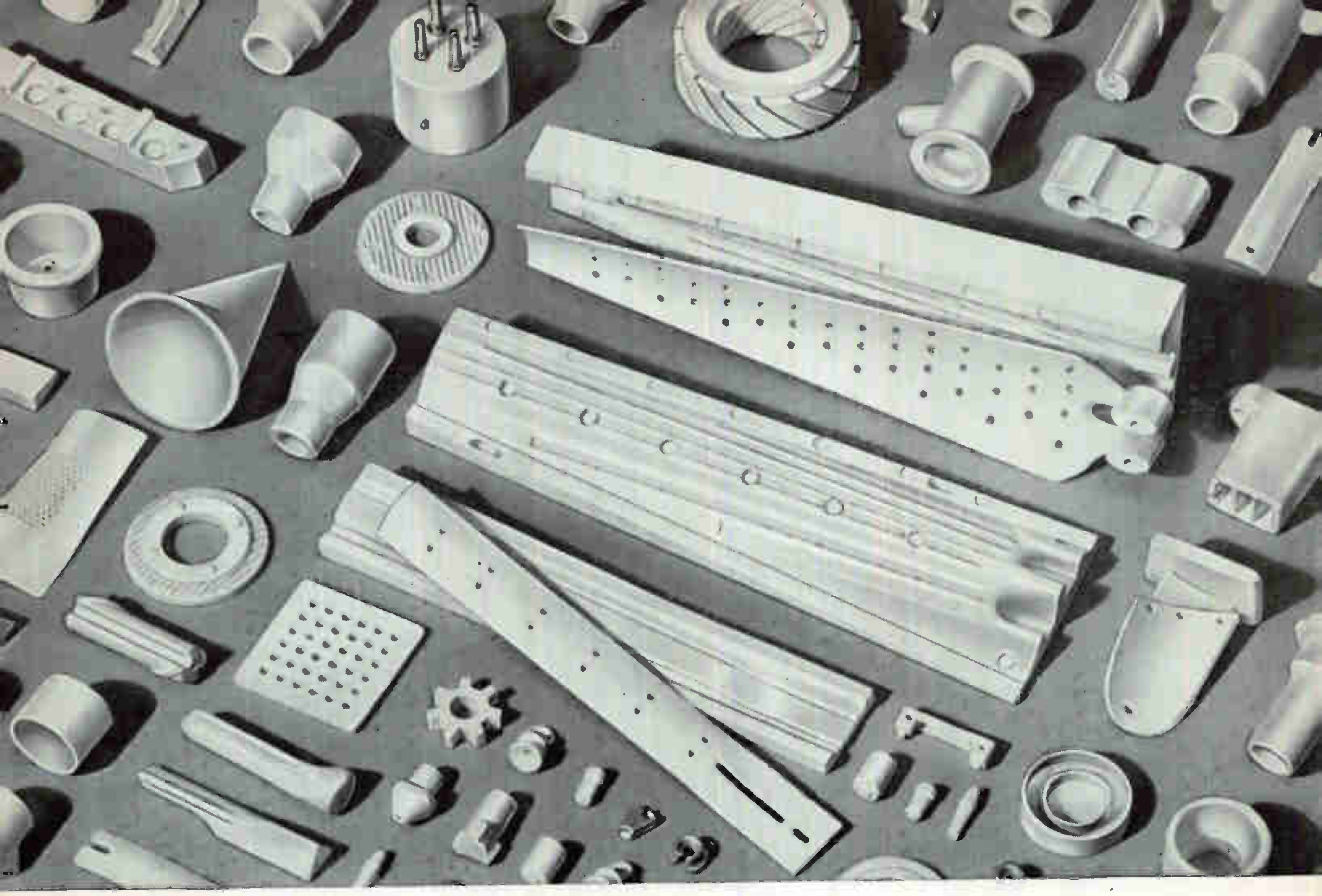
The Kennedy administration is pushing for U. S. membership in the Organization. Officials say one of OECD's prime goals is to expand world trade on a nondiscriminatory basis, but deny that the organization will have any tariff authority.

The administration views OECD as a forum for working out U. S. economic problems with Western European nations, particularly West Germany. One immediate U. S. aim is to find ways of stemming the balance of payments deficit.

But protectionist spokesmen here refuse to accept administration assurances and are trying to convince the Senate that OECD will infringe on Congress's own powers in formulating trade policy.

ELECTRONIC INSTRUMENTATION figures prominently in a drive now under way in Congress to expand government-financed oceanographic research. Sen. Warren G. Magnuson (D., Wash.) and others are pushing a 10-year program designed to match our reach into space for new scientific knowledge.

Cost of the program is estimated at $650 million, of which $59 million would be spent the first year. A bill to set up the program passed the Senate last year but never came to a vote in the House. Pres. Kennedy has singled out oceanography as an area which has been neglected in the past. This could be a tip-off to a more favorable outlook this year.



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Excellent electrical characteristics with extreme versatility! 7/8" coaxial line construction allows higher power operation with 7/8" connectors, up to 20 kw peak, 400 watts average. (Normally supplied with Type N, 3/8" connectors; 10 kw peak, 10 watts average.) Features 15 db isolation and 1 db max. insertion loss. VSWR is 1.25 max. based on 2:1 load mismatch; 1.15 max. into matched load. Model 1233: 2.0—4.0 kmc; model 1233-1: 3.0—5.5 kmc; $450. each.

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Provide maximum load isolation and minimum insertion loss over full standard waveguide frequency ranges. Extremely useful for maintaining signal source stability and eliminating long line and frequency pulling effects. Front-to-back ratios are the highest available on the market today: C Band—26:1, $250; XN Band—28:1, $225; XB Band—60:1, $235; X Band—30:1, $220.

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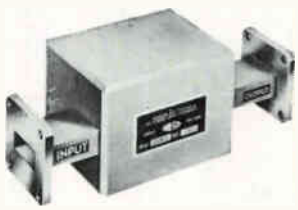

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ON DISPLAY AT THE IRE SHOW!

Military Needs NEW SPACE-TRACKING

By JOHN MASON,
Associate Editor

THE AIR FORCE may soon ask industry to come up with some fresh new ideas for designing a new radar that will detect and track silent earth satellites. This radar would be the initial piece of equipment for a new satellite detection and tracking network. It would be the first radar designed for both detecting—the big problem—and tracking vehicles in space.

The North American Air Defense Command (NORAD), which has the job of detecting, tracking and identifying non-radiating objects in space—and when technologically possible, intercepting those that are hostile—is now conducting studies to come up with requirements for a new system.

Spacetrack, the Air Research Development Command's National Space Surveillance Control Center, has already submitted to ARDC and to USAF its proposals for a new system. The proposal describes what is needed, leaving it to industry to come up with the answer.

As with NASA (see ELECTRONICS, p 20, Feb. 24), the DOD's existing tracking networks all require replacements and updating. Future networks represent R&D and new production business.

Spacetrack is an important part of NORAD's present operational network. The center analyses, catalogs and sends to NORAD and other agencies orbital data received from more than 100 sources all over the world. Sources include detection stations operated by government agencies, industry, universities, cooperating foreign observatories and the Ballistic Missile Early Warning System in Greenland, Alaska and, eventually, England.

Many facilities, both existing and being built, while designed for purposes other than tracking satellites, will be used for space tracking and communications. DOD operates FPS-17 radars in Canada, Texas, Aleutians, Puerto Rico and Turkey. The 600-ft maneuverable dish Navy is building in Sugar Grove, W. Va. and USAF's 1,000-ft bowl in Arecibo, P. R. will also be used.

Main DOD detecting net is the U. S. Naval Space Surveillance System (Spasur)—an east/west fence located on a great circle from San Diego, Calif. to Fort Stewart, Ga. Spasur reports directly to NORAD but also sends its data to Spacetrack and other government agencies. The fence, designed to detect non-radiating spacecraft, is divided into two complexes, one east, one west.

Each complex has two 108-Mc receivers about 500 mi apart and one 50-Kw transmitter equidistant between the receivers. To fill the gap between the two complexes, a new 560,000-watt transmitter will be built this year near Wichita Falls, Tex.

Each transmitter emits c-w radio energy creating vertical fan-shaped coplanar detection zones. The two interferometer receivers on either side of the transmitter measure the angle of reception of the reflected signals, determining the satellites position by triangulation.

The receiving stations transmit the measurement signals over a land-line to the Space Surveillance Operations Center, Dahlgren, Va. Here, signals are read visually and intrepreted and inserted into the Naval Ordnance Research Computer (NORC) for orbit determination. Eventually the data will be automatically collected and conveyed from the transmission lines to the newly installed 7090.

Another source that contributes to Spacetrack is Army's Astro-Observation Center, operated by the Army Signal Research and Development Laboratory, Fort Monmouth, N. J. Besides the center's operational tracking function, R&D is carried out for new spacetracking systems, ionospheric research and space communications. The center is located at two main sites, the Deal station and the Diana site at Evans, N. J. (ELECTRONICS, p 40, Sept. 11, 1959).

Facilities at the center include the 50-ft Diana antenna equipped with parametric amplifier, a 60-ft dish at Evans, one of the two 28-ft Courier communications antennas, one of the two main read-out stations for both of NASA's Tiros meteorological satellites, and six large conical-helix antennas.

The Deal station can presently make doppler measurements on random frequency up to 1,000 Mc and is equipped to extract telemetry on any one of 44 assigned missile frequencies in the 215 to 260-Mc band. There is immediate need for uhf precision tracking systems which could measure doppler up to 3,000 Mc—and eventually up to 10,000 Mc.

Each military service is responsible for specific satellite experiment programs.

Army built two 28-ft dish antenna tracking sites for its low-altitude delayed repeater communications satellite Courier (ELECTRONICS, p 38, July 22, 1960). One, mentioned above, is at Deal, N.J. and the other in Puerto Rico. Army's high-altitude active relay communications satellite Advent will use two 60-ft antennas (on the east and west coasts of the U.S.) and a smaller shipboard antenna. Sylvania is building the landbased antennas. Navy, responsible for the shipboard antenna system, has not yet awarded a contract.

Navy's navigational aid satellite, Transit, is tracked by small air transportable doppler stations located at five points in the U.S. and an undisclosed number overseas. Ultimately, stations may not be needed overseas although they will be maintained for byproducts of the satellite's data such as geodetic information. When the Navy puts up a series of operational Transit satellites, ground equipment will go from R & D to limited production.

USAF is responsible for three earth satellite systems.

The Discoverer series is designed to study problems of launching, communications, guidance, orbital performance and recovery. Ground

GEAR

station facilities are housed in vans or in permanent structures.

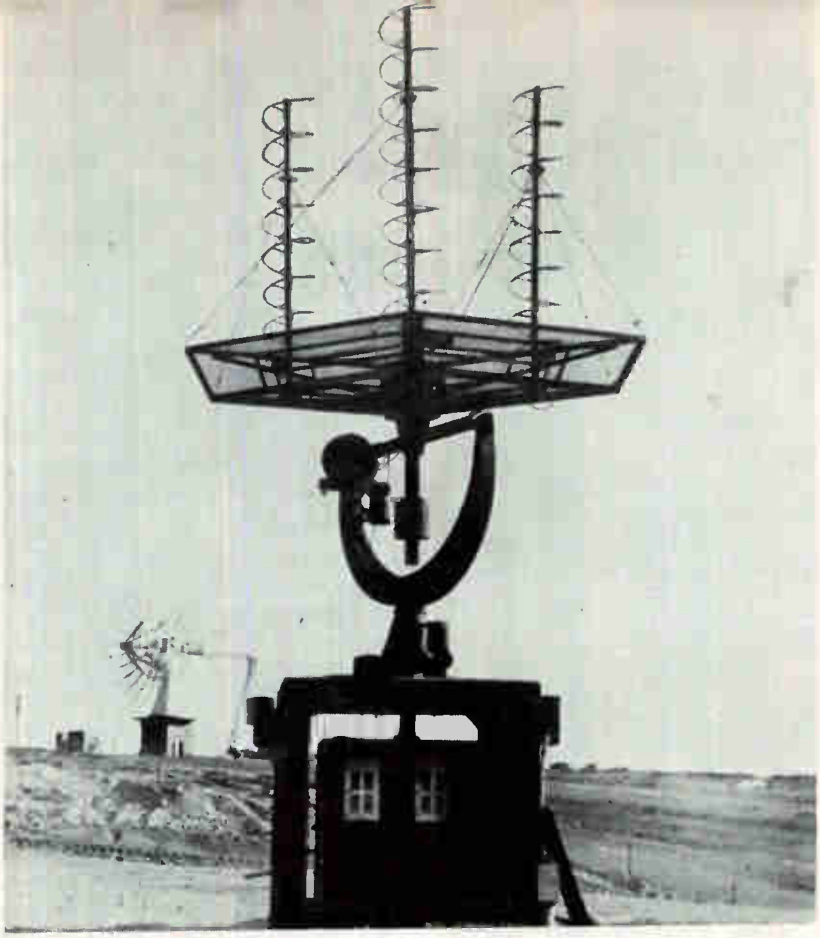
They include: administration and control van—master-control console, plotting board and communications; Verlort radar van—radar transmitter, receiver power supplies and orbital computer, outside antenna is 10-ft in diameter; instrumentation van for doppler tracking—phase-lock receiver, doppler-frequency measuring equipment, digital-to-teleprinter converter, master ground timing generators, tri-helix antenna; telemetry van—complete f-m/f-m telemetry facility composed of receivers, subcarrier discriminators, decommutators, tape recorders and an oscillograph recorder, a TLM-18 60-ft antenna; data transmission van—digital-to-teleprinter converter, digital-to-analog converters, polar-to-Cartesian connector, Cartesian-to-polar converter, acquisition programmer and checkout equipment.

Equipment is operating at Vandenberg AFB, Calif. where the satellites are launched; Point Mugu, Calif.; a tracking ship some 900 mi downrange; Kodiak, Alaska; Kaena Point, Hawaii; and New Boston, N.H. Tern Island in the Pacific uses only the TLM-18 and tri-helix antenna. Orbit projection is computed by the Air Force Satellite Test Center, Sunnyvale, Calif.

Samos, the photographic reconnaissance satellite, is using during its R&D phase the Discoverer tracking net with added special equipment plus Pt. Arguello (launch site) and St. Nicholas Is., Calif. Additional stations are planned in Iowa and Oregon.

Midas, the early warning satellites series to detect by infrared sensors enemy launchings of ballistic missiles, also uses both Discoverer and Samos tracking stations. Once operational, both Samos and Midas will undoubtedly need extensive permanent tracking and communications networks.

Another big market coming up is the worldwide ground tracking/data acquisition network for Dynasoar, the manned boost-glide vehicle. RCA has the contract, USAF and NASA the responsibility for the program (ELECTRONICS, p 26, Feb. 24). In its early phase, Dynasoar will be tested along the Atlantic Missile Range and will use existing Air Force and NASA's Mercury facilities—some on shipboard, some on islands. Super-high frequency tracking stations in the 13.5 gigacycle band will be used.



Manually controlled doppler-telemetry receiver antenna system for Discoverer may be replaced by automatic unit being developed

Analog Simulator Helps Control Flood Waters

ANALOG SIMULATOR designed and built by engineers at UCLA, Berkeley, will optimize use of a complex system of reservoirs within the Kansas River basin to combat flood conditions.

The reservoir system includes some 1,000 miles of river channel and ten reservoirs and is used during periods of heavy rainfall in a manner so various parts of the system are used to prevent overflow.

The analogue simulator will predict river stages and flow at all points on the basis of data from 70 rain gages, rainfall predictions, and reports of thunderstorm activity. This will enable opening of floodgates to control the effects of sudden flash floods.

Financial support of the simulator project was given by the Kansas City District of the U. S. Army Corps of Engineers.

Russia Announces I-R Hot Box Detector

MOSCOW—Soviet engineers here have announced development of an infrared hot box detector which is incorporated in a system to alert railway maintenance crews.

The device is installed several kilometers from the station and detects the overheated bearings on outgoing or incoming trains. A computer alerts an information desk in the train station and at the same time automatically switches on apparatus to spray the heated axle with white paint for identification.

Engineers Take 'Second Look' at Microcircuits

By JOHN M. CARROLL
Managing Editor

SAMUEL WEBER
Senior Associate Editor

A "SECOND LOOK" at microcircuits touched off the expected controversy at the 1961 International Solid-State Circuits Conference held recently in Philadelphia. Emphasis in the informal evening discussion session was on microsystems design to come to grips with problems of interconnection.

R. Alberts of Wright Field implied the day of microcircuit stunts is over and it is now time to do some real work.

W. Gaertner of CBS Labs posed the question of whether the component maker of the systems company will be the major factor when microcircuits come of age. R. Rice of IBM stated that some companies have the resources to cover both the components and systems aspects. A significant comment in that his firm is now energetically recruiting for a new components division.

R. G. Counihan of IBM said the concept of Boolean circuit blocks is wrong; what is needed is batch fabrication of devices at the systems level with interconnections engineered in. He concluded that "circuit designers must become systems oriented or find new jobs."

Talking about hardware, a Fairchild Semiconductors spokesman said that microcircuit computers made with several different techniques may be expected in 18 months. J. Nall of Fairchild said his company has worked with silicon circuit blocks using the planar technique. He predicted such a flip-flop in a 3 by 75-mil can selling at silicon-transistor prices.

R. E. Lee of Texas Instruments spoke of a $\frac{1}{4}$ by $\frac{1}{8}$ in. by 80 mil rectangular can containing 20 elements including bipolar, unipolar and field-effect transistors. He remarked that last year his firm sold 2,000 Solid Circuits of some 20 different varieties. Counihan announced that IBM has made 4 by 4 in. thin film circuit plates with 4,900 elements interconnected for a cryogenic system.

Questioned about new technical trends, T. Stanley of RCA mentioned use of ceramics such as barium titanate and ferrites for their magnetic, resistive and capacitive effects, use of electroluminescent-photoconductive (EL-PC) panels for neighborhood logic circuits of high reliability and cryogenic memories.

Gaertner mentioned use of electron beam machining. E. Fletcher of MIT, when questioned about sublimation decomposition, remarked that electron beams are being used for both machining and evaporation and that electron-beam decomposition for thin-film production looks promising. He also observed that ultraviolet optics are being used for demagnification.

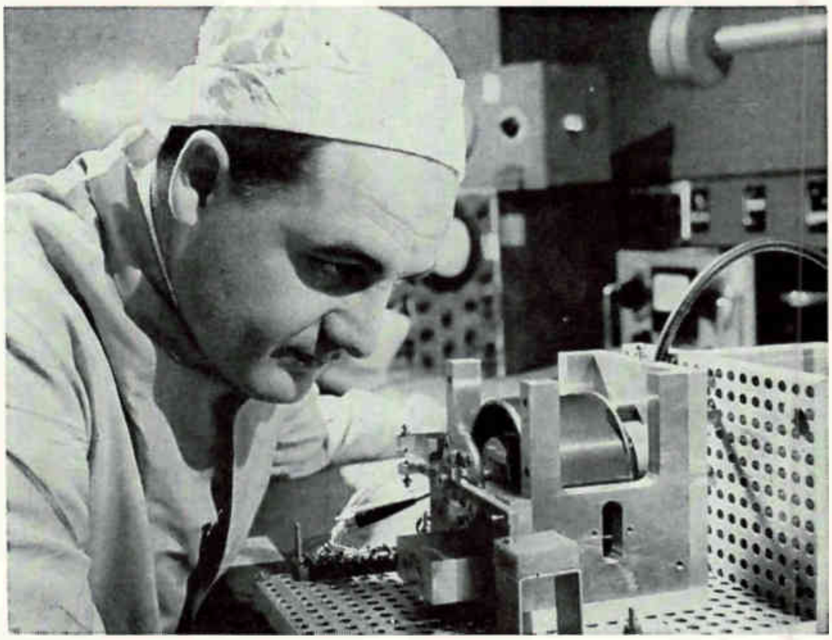
Some of the more immediate problems of microcircuits were explored in another informal session dealing with micropower circuits. Micropower implies performing logical operations at greatly reduced power levels and later amplifying up to operate output devices. Present level for computer circuit operation is about 12 v collector voltage, 100 ma collector current or 120 mw. Existing micropower techniques can reduce this to 5 or even 2 mw. Goal of micropower designers is 30 microwatt operation.

Micropower circuits could be used to do digital logic in space vehicles, satellites and compact computers, work in internally planted biomedical devices working off neuromuscular potentials, drive underwater hydrophones powered by high radiated r-f power and to reduce heat in microcircuits.

It was noted that low collector voltage permits low collector load resistance which decreases the collector R-C time constant and improves switching time, and that low collector current reduces self-induced transistor noise. However, collector capacitance increases at low voltages and emitter capacitance becomes an important factor at low currents.

Limit is set on collector voltage by the band gap of the material. Lowest collector voltage would seem to be 1 v for germanium, 2 v for silicon. Leakage current of the transistor sets a lower limit on current. Participants called for transsistors with 0.6 pf collector capaci-

Space Drum Stores 358,000 Bits



Miniature memory drum for Sperry navigation system has floating heads one ten-thousandths of an inch above the drum surface tance at 5 v collector potential and 10 pa leakage current.

Engineers suggested transistor-diode circuits for micropower, remarked that tunnel and backward diodes may be used as coupling devices. One man called for a thin-film pulse transformer.

In talking about present-day accomplishments, conferrees discussed a 6-mw 200 Mc amplifier with 15 db gain and a noise figure of 4 db; 3-mw logic circuits are also available for clock rates from 1 to 4 Mc.

At the informal session on microwave applications, B. C. DeLoach of Bell Telephone Laboratories brought whistles from the crowd with his report of a test on a new varactor diode which exhibited zero-bias cut-off at 360 Gc and reverse-bias cut-off at 500 Gc.

DeLoach told the group that the greatest limitation to use of diodes in parametric amplifiers was not the diode itself. but the lack of suitable pumping devices.

He called for more development activity in the area of higher power pumping devices in the 50 to 100-Gc region, without which it would be useless to develop varactor diodes with higher frequency capabilities.

Gallium arsenide diodes came under critical scrutiny at the microwave session and also at the session on tunnel diodes. Reports of deterioration of these devices after prolonged service was mentioned by one panel member of the microwave session. However, speaking from the floor, a Texas Instruments spokesman reported that 2,000-hr life tests at 100 C and reverse-bias of 5 v had yielded no change in characteristics.

At the tunnel diode discussion, the question of GaAs deterioration was again brought up. J. Tiemann of GE's Research Lab acknowledged that behavior of GaAs diodes under forward-bias conditions was not completely understood, and that work was being done to eliminate gaps in our knowledge.

He said there are apparently several independent mechanisms by which deterioration in tunneling characteristics take place. For example, in zinc-doped GaAs, the peak current decreases with age, while in cadmium doped material, the valley current goes up.

Electronic Surveillance: The Hidden Ear

By LESLIE SOLOMON,
Associate Editor

A CLANDESTINE but nonetheless growing area in electronics is the shadow world of surveillance. Surveillance encompasses all the techniques whereby electronics can be used to eavesdrop on another party to find out what is being said or done so advantage can be taken.

Severe legal penalties can be invoked for those involved in certain uses of electronic equipment for surveillance. Yet such uses exist and in many cases make use of excellent electronic engineering talent gone astray.

The main areas of surveillance are wire tapping and bugging. Wire tapping means gathering information from telephone lines. Bugging uses hidden microphones and radio equipment.

Other surveillance apparatus includes highly directional microphones, concealed tape recorders, infrared gear modeled after the sniperscopes of World War II, hidden photographic and television cameras making use of fiber optic lenses and remote controls.

The arrangement of any telephone line is recorded in a central office. When a tap is suspected, telephone company experts can make several different types of tests. For example: capacitance measurements are made between junction boxes. Knowing exactly what is attached to the line, the capacitance of the system is measured.

If the total capacitance is greater than normal, a physical search is then made of the section of line displaying the extra capacitance. Contrary to popular belief, taps do not cause noise on the telephone line.

A new development being used is pressurization of underground telephone cables. This system maintains air pressure within the cable and in case of a leak, the compressed air keeps out any moisture that may get in to damage the insulation. As the air pressure is monitored, any natural or manmade leak will be signalled.

One method of maintaining secrecy in sensitive areas is the use of tricoaxial line. The outside braid carries high-level white noise. This discourages induction tapping. Electrically disturbing the coaxial cable (such as with a direct metallic tap) is automatically signaled by a balanced bridge arrangement.

The use of speech scramblers is becoming popular as a countermeasure to wire tapping. These scramblers fit on the exterior of the telephone, making no direct wire connection. They are sold in matched sets and permit a reasonable degree of security.

One clandestine communications system exposed by the authorities is called the cheesebox. It was popular with bookmakers and operated as follows: One member of the gang rents a store and whitewashes the windows. Two telephones are interconnected by a circuit that contains an automatic timer.

One phone number is given out to regular customers and the other kept secret. Once the system is operating, the store is completely wired with burglar alarms so that if anyone forced the door or windows, the second phone connection is broken. When the gang opens for business, they are located many miles away from the store. One of them dials the second phone at the wired store and is interconnected to the first phone. When anyone calls the first phone, a signal is transmitted through the second phone. The automatic timer breaks the phone connection after a few minutes to throw off line tracing. Seven minutes is the time that some police departments say they need to trace a phone call. New techniques permit authorities to trace a call within moments if forewarned. It is also possible to "hold" a line even though both parties have hung up.

Radio bugs assume many different shapes. Most use transistors and miniature components. Operating at relatively quiet spots in the short-wave spectrum, these transmitters can have ranges up to several miles, using a-m or f-m.

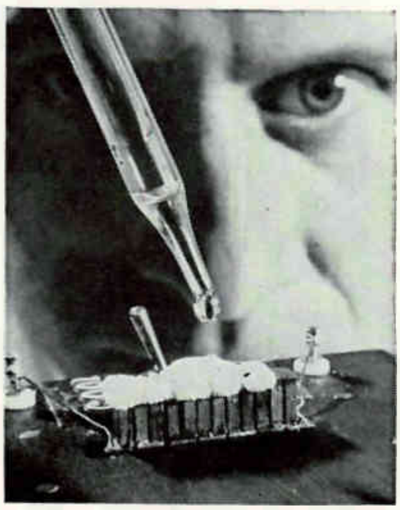
One of the drawbacks to the use of bugs used to be battery replacement. This usually means accomplices. Radio bugs now use free-power circuits. Thus a concealed bug can operate as long as the components hold out and the broadcast station stays on the air.

Locating radio bugs can be done with receivers or spectrum analyzers equipped with a small antenna fixed to the end of a coaxial cable. With the detection equipment operating, one person whistles loudly around the room while observing the receiving equipment. The other person probes the room walls, ceiling, floor and furniture.

Another system that can be used for electronic snooping is the concealed tape recorder. With the advent of miniature battery-powered tape recorders, concealment becomes relatively easy. Tape recorders can be supplied with shoulder holsters and concealed lapel or wrist watch microphones. They can also be built into an attache case.

In the latter case, the snooper pays a visit to his victim and forgets his attache case. The recorder is left running and will record conversations in the room for ½ hour or more. Then the snooper returns and reclaims the briefcase he "forgot".

Cool Device



Two flashlight batteries power three-stage cascaded Peltier device (Hughes) which brings temperatures down to —100 F

Santa Fe railway workers align a microwave antenna

Railroad Microwave Expands

MICROWAVE CONSTRUCTION projects now underway in the U. S. and Canada will see some 6,000 more rail miles covered by radio within the next year.

This prediction by Association of American Railroads points up the mushrooming growth of railroad microwave relay systems in the recent past.

Experimental work in this field was undertaken on the Rock Island Line in 1946, according to AAR, for point-to-point service. By 1950, the net was in full commercial use. The Long Island Rail Road had an experimental point-to-point system operating in 1948-49. The Santa Fe line began to work with microwave in 1952.

From these early beginnings, railroad microwave systems have expanded to a present figure of about 2,100 route miles of radio relay involving several hundred frequencies within the 6,000 Mc band.

In addition to routine traffic uses, today's railroad microwave nets are transmitting signals that control switches, activate signals, govern electric power flow and even operate infrared hotbox detection systems. Also growing in importance is data transmission equipment giving a steady flow of traffic information, car movements and other data. The Denver and Rio Grande Western has recently installed facsimile equipment within its microwave complex. The facsimile is now being used to transmit waybills. A spokesman for AAR says other railroads will probably be installing facsimile equipment in the near future. The DRGW system occupies 120 voice channels.

The one early attraction to microwave by railroads was the relief it offered from wire-system failures due to heavy storms. Later, the advantages of bridging rugged terrain with more reliability and less expense became evident in many cases.

Because of the distances involved in railroad microwave systems, costs are often hard to determine in advance. Canada's Pacific Great Eastern Railway operates without wirelines. The microwave system to make this possible cost about $2 million. The route runs over the Canadian Rockies.

Southern Railway is now constructing a multichannel, transistorized microwave system between Washington, D. C. and Atlanta, Ga. The network will run 637 miles, have 54 relay stations, and will cost

$5.3 million. Southern Pacific operates a 120-mile system that cost $120,000. Rio Grande Western is building a 700-mile system integrating facsimile and voice channels. The system will serve 21 stations at a cost of $1,803,240.

Indications from AAR are that six more railroads are planning microwave systems at present.

A survey taken at midyear 1960 showed the following milage figures:

RAILROAD	MICROWAVE MILAGE
Alaska Railroad	50
Canadian National......	550
Canadian Pacific........	40
Pacific Great Eastern....	750
Pennsylvania	41
Rock Island	106
Santa Fe	396
Southern	158
Southern Pacific	23
	2,114

Systems now under construction are:

RAILROAD	MICROWAVE MILAGE
Denver & Rio Grand Western	700
New York Central	12
Santa Fe	1,988
Southern	637
Union Pacific	563
Total Miles	3,900

In addition, the Frisco Lines; Spokane, Portland and Seattle; Northern Pacific; Missouri-Kansas-Texas; Louisville & Nashville, and the Texas and New Orleans Railroad are reported to be studying possible use of microwave in their systems.

Studying Requirements Of Electronic Checkout Gear

BUREAU OF NAVAL WEAPONS has awarded a contract to PRD Electronics, Brooklyn, N. Y., to make basic engineering studies of electronic checkout equipment for aircraft weapons systems.

Contract covers work extending into 1964, aims to coordinate development of automatic checkout gear to enable Navy technicians without advanced training to detect and identify troubles in complex electronic systems with minimum wasted time and motion.

Japan Asks Curb On Okinawan Exports

JAPAN's Ministry of International Trade & Industry has asked the local government of Okinawa to curb the export of transistor radios to the United States.

Since last summer, when Japan's self-imposed quota system went into effect, three Okinawa shops have been turning out transistor radios using Japanese components, and shipping them to the U. S. under English-language brand names. Magnitude of the enterprise is unconfirmable; one shop reportedly ships 20,000 sets a month.

Japan feels Okinawan authorities should impose a quota similar to Japan's on their shipment of sets to Occidental markets, should seek wider markets elsewhere.

Yugoslavia to Produce Two-Stage Rocket

YUGOSLAV scientists expect to produce a two-stage sounding rocket dubbed Selenit within two years. The rocket will be used for scientific exploration of the atmosphere and ionosphere.

Rocket will have a solid-fuel first stage and liquid-fuel second stage, should have a range of about 65 miles. While Selenit is being built (plans are completed), the Yugoslav Aeronautical Federation will use Japan's Kappa-6 sounding rocket.

Russian Computer Translates Mayan

MOSCOW—Siberian scientists have disclosed progress in translating ancient Mayan manuscripts with the aid of an electronic computer. The Central American hieroglyphic language has been a mystery since the sixteenth century.

Researchers say the symbols, figures and dates were written in mathematical form along with drawings used by the Mayans, as a preliminary to the computer processing.

Two-thirds of the manuscripts were translated in some 20 computer hours. It is expected another 200 hours will be needed to clear up remaining text.

Study Local Geology Effect On Low-Frequency Noise

CAUSE OF NOISE at frequencies well below radio channels will be the subject of research directed by James R. Heirtzler of Columbia University's Lamont Geological Observatory.

Work is supported by a National Science Foundation grant of $25,000.

Natural noise generators other than lightning effects are operative below 1 cps. Propagation of the disturbances will be studied to determine the effect of local geology and other natural phenomenon and thus find the origin of these waves.

In 1958, Russian scientists detected at these low frequencies a U. S. high-altitude nuclear explosion above the South Atlantic, according to a recent article which appeared in the Russian newspaper Izvestia.

Displaying Navy Data

New battle display console (foreground) by Hughes Aircraft shows aspects of air, surface and submarine action for fleets. Rear: the grease-pencil method

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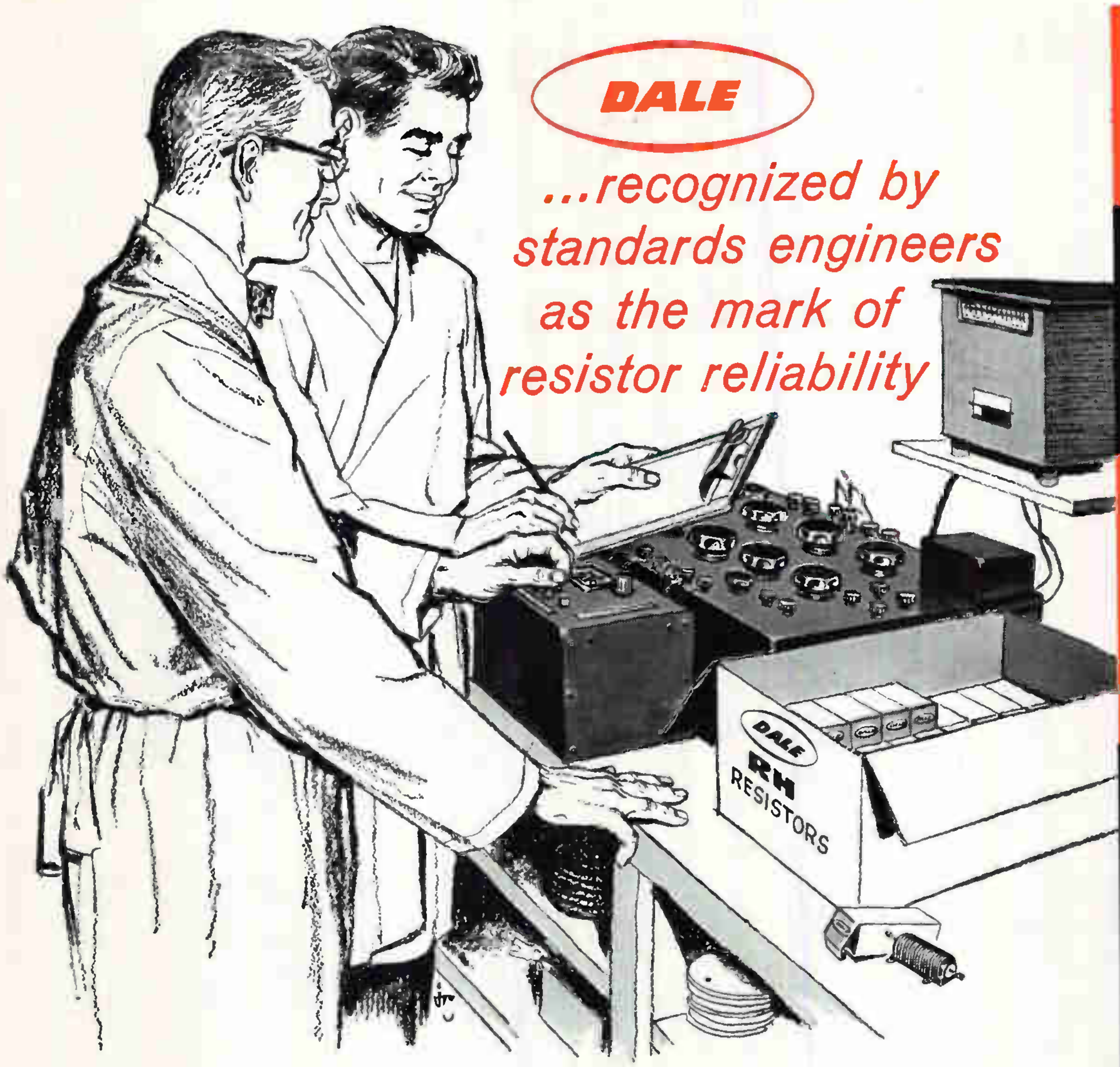

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MEETINGS AHEAD

Mar. 6-8: Data Processing Conf. & Exhibit, AMA; Statler-Hilton Hotel, Wash., D. C.

Mar. 9: National Federation of Science, Abstracting & Indexing Services; Manger Hotel, Cleveland.

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

Mar. 11: Quality Control, American Society for; Hart House, Univ. of Toronto, Ontario.

Mar. 14: Defense Planning Seminar, EIA; Statler-Hilton Hotel, Wash., D. C.

Mar. 15-19: High-Fidelity Show, Magnetic Recording Industry Assoc.; Cow Palace, San Francisco.

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

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

Mar. 27-31: Temperature, Its Measurement and Control, ISA, AIP, NBS; Veteran's Memorial Auditorium, Columbus, O.

Mar. 28: Rochester Soc. for Quality Control, ASQC; Univ. of Rochester, Rochester, N. Y.

Mar. 28-29: Nuclear Aspects of Atmospheric and Space Systems, ANS; Statler-Hilton Hotel, Dallas.

Apr. 4-6: Electromagnetics and Fluid Dynamics of Gaseous Plasma, IRE, IAS, U. S. Defense Research Agencies; Engineering Societies Bldg., New York City.

Apr. 4-7: Audio Engineering Society; Ambassador Hotel, Los Angeles.

Apr. 5-7: Global and Space Environments, Institute of Envir. Sciences; Sheraton Park Hotel, Wash., D. C.

Apr. 5-7: Materials and Electron Device Processing, ASTM Committee F-1; Benjamin Franklin Hotel, Phila.

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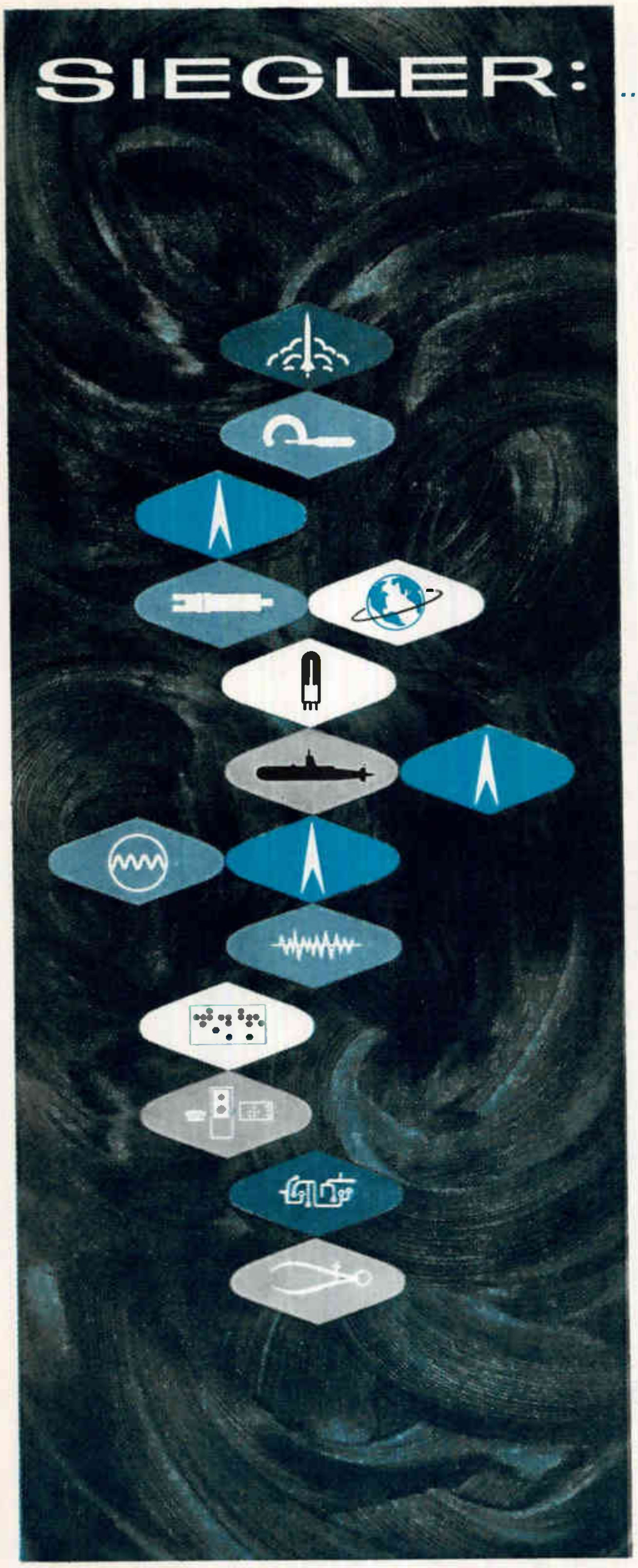

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Measurement Range
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Selectivity
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By our method of reporting unemployment...

We're Giving The United States A Black Eye That Is Not Deserved

The way in which our unemployment is reported is giving the United States an undeserved black eye around the world. The broad concept of unemployment we use exaggerates the amount of unemployment in the United States as compared to most other countries. Our reporting system also falls short of presenting a balanced picture by concentrating on people who are idle, while neglecting jobs that are idle because people cannot be found to fill them. This editorial explains these defects and suggests improvements.

The *Monthly Bulletin of Statistics*, issued by the Statistical Office of the United Nations, has become a standard reference for international comparisons of economic performance, including employment and unemployment. Here, from the November, 1960 issue, is part of a table giving comparative figures on the rate of unemployment for the United States and a group of European countries:

	UNEMPLOYMENT RATE	
	Annual Average 1959	Jan.-June Average 1960
West Germany	2.4%	1.0%
Netherlands	1.8	1.4
Sweden	2.0	1.8
United Kingdom	2.3	1.9
United States	5.5	6.1

A Distorted Picture

If taken at face value the table clearly says that the United States is doing far worse in providing jobs for its citizens than the other countries whose unemployment records are listed.

But the figures are deceptive. They are made so, in part, by our government's use of a much broader concept of what constitutes unemployment than is used by most other countries.

Sweden provides a clear case in point. The table indicates that during 1959 Sweden had an unemployment rate of 2.0%, while the rate in the

United States was 5.5%. But a report from Sweden, published in the U.S. Department of Labor's *Labor Developments Abroad,* indicates that if they had used the same methods of calculating unemployment as we, the reported jobless rate in Sweden would have almost doubled. Thus a large portion of the gap between the unemployment rate in the United States and the unemployment rate in Sweden would have been eliminated.

Graduation To Unemployment

In general, countries listed in the table use registrations at public employment agencies as the basis for calculating their unemployment. Our Department of Labor, in making its sampling of unemployment, includes unregistered young people who are waiting for jobs or training opportunities as well as housewives who are looking for jobs in a general sort of way but who have not registered anywhere in search of them.

It used to be that graduation from college was regarded as a day for great celebration and rejoicing. But, because of the way the Labor Department does its counting of unemployment, it is now a day of sorrow. For unless our young people immediately rush off to jobs, they graduate into unemployment and swell our jobless figures.

While our government very expansively counts all the unemployed, there is no offsetting report on the number of jobs that are unfilled because no one qualified can be found to fill them. Currently there are many jobs in this category, and it is to be expected that there will be more as the technological revolution picks up momentum.

A properly balanced report on unemployment would include a record both of people who are idle, as conceived on some standard international basis, and jobs that are idle. A combination of the two sets of data would provide a much better indication of the economic health of a nation than unemployment alone.

The United Kingdom regularly collects figures on unfilled jobs as well as the number of unemployed. Thus it is not an impossible task to collect information on idle jobs. **For a fast moving economy, such as ours, the collection of statistics on unfilled jobs presents special difficulties. But this information is so important that Congress should see that it is added to our employment and unemployment records.**

A National Disservice

There is not the slightest inclination here to minimize the amount of unemployment in the United States at any time, or the crucial importance of doing everything possible to keep it at rock bottom. If the reporting of unemployment were simply for domestic consumption, it would be possible to make an appealing case for using a very broad conception of it. This is one way of underlining the importance of the problem.

But when, as is the case, international comparisons of unemployment are treated as key gauges of the effectiveness of different economies, we do ourselves an important national disservice by using an exceptionally commodious concept of unemployment. American travelers abroad can testify that they are continuously being called upon to explain why the United States does such a relatively poor job in providing employment for its people. This is an unwise and unfair burden to impose upon the nation. **We make enough mistakes of economic commission and omission without issuing reports that distort our economic performance to our own discredit abroad.**

This message was prepared by my staff associates as part of our company-wide effort to report on major new developments in American business and industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

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✓Collector Current, I_C	−100 ma
Total Device Dissipation at 25°C	60 mw

ELECTRICAL CHARACTERISTICS (T = 25°C)

Static Characteristics	Min.	Typ.	Max.	
Collector Cutoff Current, I_{CBO} (V_{CB} = −5v)		1	3	μa
✓ Collector Cutoff Current, I_{CBO} (V_{CB} = −5v, T = 55°C)			18	μa
✓ Collector Breakdown Voltage, BV_{CBO} (I_C = −25 μa)	20			volts
✓ Collector Breakdown Voltage, BV_{CES} (I_{CES} = −25 μa)	20			volts
DC Current Amplification Factor, h_{FE} (V_{CE} = −0.5v, I_C = −40 ma)	20	50		
✓ DC Current Amplification Factor, h_{FE} (V_{CE} = −0.3v, I_C = −10 ma)	30	70		
Base Input Voltage, V_{BE} (I_C = −10 ma, I_B = −1 ma)	0.25	0.32	0.40	volt
Collector Saturation Voltage, V_{CE} (SAT) (I_C = −10 ma, I_B = −1 ma)		0.12	0.20	volt
Collector Saturation Voltage, V_{CE} (SAT) (I_C = −10 ma, I_B = −0.5 ma)		0.15	0.25	volt
✓ Base Input Voltage, V_{BE} (I_C = −10 ma, I_B = −0.5 ma)			0.34	volt
Dynamic Characteristics				
Output Capacitance, C_{ob} (V_{CB} = −6v)		1.5	3	pf
Rise Time, t_r (V_{CC} = −5v, I_C = −10 ma, I_{B1} = −2 ma)		25	60	nsec
Minority Carrier Storage Time Constant, τ_s (K'_s)I_B = −1 ma		100	120	pcb/ma
✓ Gain Bandwidth Product, f_T (V_{CE} = −3v, I_C = −5 ma)	100			mc

✓ *Checks indicate specification improvements*

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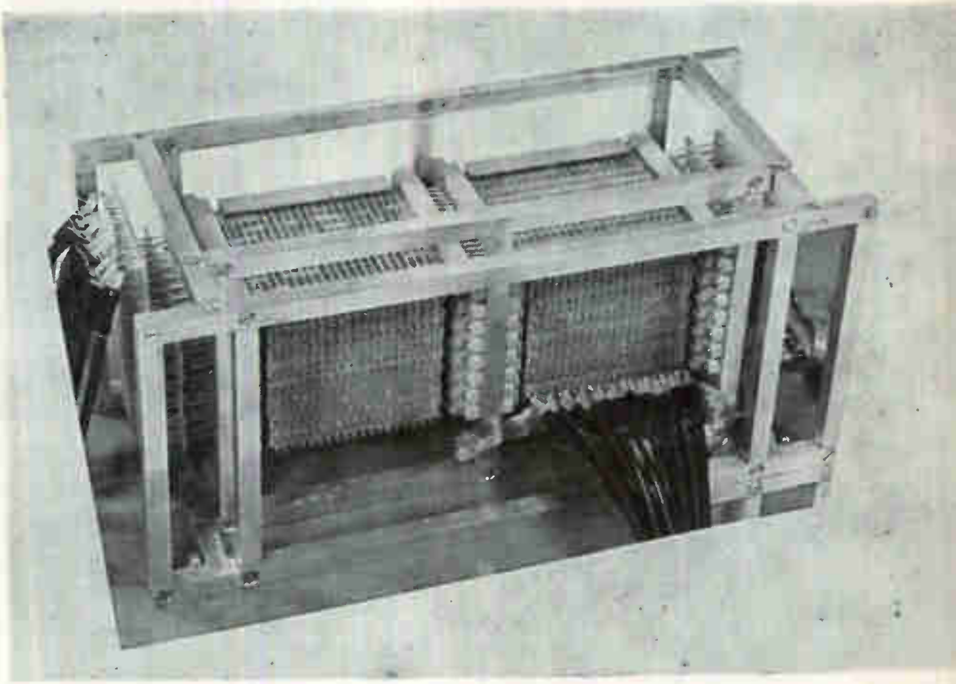
electronics

March 3, 1961

Memory planes using nickel-iron films 2,000 angstroms thick are made reproducibly by vacuum deposition on glass under influence of a magnetic field. Design of driving circuits is discussed



Assembled memory package with 16 memory planes capable of storing 2,560 bits, equivalent to 320 words of 8 bits each

DESIGNING

Thin Magnetic Film Memories For High-Speed Computers

By E. E. BITTMANN,
Burroughs Research Laboratories,
Paoli, Pa.

UNTIL RECENTLY, advances in high-speed computer memory systems were limited by the upper frequency characteristics of ferrite cores. Such devices, while capable of operation at speeds to 500 Kc, suffer from hysteresis losses due to internal heating when used at high frequencies. Attempts to overcome the problem and obtain greater speeds by using smaller cores have met with difficulties with regard to interwiring the resulting miniature elements.

One answer to these limitations has been known for some time to be deposited thin-film memory systems. Heretofore, problems of uniformity have made the commercial application of thin-film devices difficult; now, by using new techniques in vapor deposition, the problem of uniformity has been overcome and thin-film-memory building blocks are available.

The memory planes have cycle-time capabilities of 0.2 μsec and can be produced in large quantities at relatively low cost. They can accept greater drive tolerances than do ferrite cores; they yield bipolar outputs automatically, and can be driven by single polarity pulses for information entry and readout. Film planes are expected to find immediate use in scratch pad computer memories.

The storage elements in these thin-film memory planes are planar 80-20 Ni-Fe films approximately 2,000 angstroms thick, and are obtained by vacuum deposition onto a glass substrate under the influence of a magnetic field.

These thin films remagnetize predominantly by a spin-rotational mechanism rather than by a domain wall movement, as is usual in the more common material configurations. The spin-rotational switching is fast, having been measured in the nanoseconds (10-9 sec) range.

Thin-film memories with cycle times of 0.2 μsec or less are possible, owing to the films' fast operating speed, while fabrication simplicity of the wired film memory planes reduces memory cost. These two factors—high speed and low-cost—make thin films a desirable component in digital computer memories.

Films that are deposited on a substrate while under the influence of a magnetic field of 10 to 50 oersteds show a preferred or easy direction of magnetization, with all domains of an area of such a film lying parallel to the direction of this field. The magnetic characteristic of this deposited film in the preferred direction shows a square hysteresis loop, but perpendicular

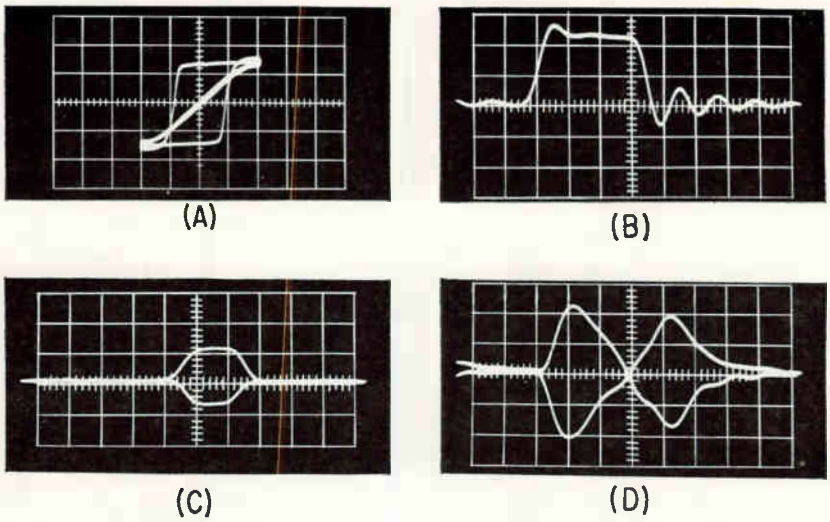


FIG. 1—Magnetic characteristics of film superimposed for both easy and hard directions of magnetization (A); word-drive current (B); information drive current (C); sense readout signals (D)

to the easy direction, called the hard direction, the film shows a linear loop, Fig. 1A.

If the sample is continually rotated from the easy to the hard direction, the characteristic changes from the square loop to the linear loop without interruptions. From these two characteristics, can be obtained: (1) the wall coercive force in the easy direction, H_c, and (2) the saturation magnetization force in the hard direction, H_K.

Any magnetic square-loop material can be used as a storage element in a random-access memory. The unique geometry, directional magnetic properties, and rotational remagnetization process must be considered in the design of thin-film memories. Their behavior can be compared with a magnetic dipole having two states, N and P, both of which are parallel to the preferred, or easy, direction. These two states represent the storage of a ONE or a ZERO in each thin-film element.

The principles of the memory operation are best explained by the discussion of a single bit. Three conductors are associated with such a bit, Fig. 2A with the word drive conductor parallel to the preferred direction and information and sense conductors parallel to the hard direction. The information conductor is split because: (1) it reduces the mutual capacitance between the information and the sense conductors and (2), it reduces eddy currents in the information conductor induced by the word drive current.

A current in the word drive conductor generates a transverse field H_T, which, if greater than the saturation force in the hard direction, H_K, rotates the magnetic moments or dipoles to the hard direction. This rotation induces a sense signal of positive polarity if the rotation originated from the ONE state and of opposite polarity if it originated from the ZERO state.

To magnetize an area of thin-film to the ONE or ZERO state, two magnetic fields, perpendicular to each other, are applied—the drive field lying in the hard direction and the information field in the easy direction. The resultant field lies between the hard and easy directions, oriented toward either ONE or ZERO, depending upon the direction of the information field. Removal of the drive field allows the dipoles to fall to the desired ONE or ZERO state, after which the information field can be terminated.

Waveforms of drive, information currents, and sense signal are shown in Fig. 1B through 1D.

The thin-film plane is sandwiched between two printed circuit boards. The boards are 10 mils thick and contain 20 word drive conductors and 8 sense and 8 information conductors. The wired plane measures 4 $\times$ 3¼ inches and is about 70 mils thick; it matches the nominal 0.063 inch wide printed circuit connectors having 0.156 inch contact spacings. The thin film rectangles are ⅛ inch wide, 3/16 inch high and their thickness is nominally 2,000 angstroms. Minimum sense output signal with a word drive current of 1 amp and 0.05 μsec rise time is 5 mv.

Minimum noise results if the sense and information line of pairs of planes are interconnected in a noise cancelling manner as shown in Fig. 2C. This wiring arrangement minimizes noise, but the sense readout signal for a stored ONE in one plate and from a stored ONE of the other plate will be of opposite polarity. The logic circuits in either the sense amplifier or in the information driver can be designed to compensate automatically for this polarity reversal.

Noise originating from ground currents can best be minimized by a common ground plane, such as a thin copper or aluminum plate.

Shielding against earth's magnetic field is recommended—a single layer of soft iron material helps considerably; signals can be observed without this shield, but memory storage units will need shielding. Magnets or Helmholtz coils also can eliminate the earth's field's influence.

A differential-type sense amplifier helps to reject the common mode noise signal while transformers are also used successfully. For example, a type F304 ferrite core (General Ceramics) T-1 type material with a 4-turn primary and 8-turn secondary gives good results. Sector windings or distributed windings are used too; sector wound cores have a slower response, but their fabrication is easier.

Signals from a memory plane can be observed if a fast-rise-time current generator is available. The current driver should deliver a 1 amp pulse into a terminated line. This current is applied to one of the word drive conductors. A d-c bias of 200 ma can be applied to one of the information conductors. A signal should appear on the corresponding sense winding. When reversing the polarity of the bias current a reversal of the sense signal should be noticeable. Oscilloscope sensitivity should be 5 mv per cm. Short cables and leads, and elimination of ground current loops will produce clean thin-film switching signals.

The typical 8 × 20 memory planes can be interconnected into a stack of 16 plates as shown in Fig. 1. This memory can store 320 words of 8 bits each.

Transmission line principles must be used when high-speed current pulses are to be transmitted through long conductors to prevent ringing in these lines that might obscure the output signal.

It is sometimes preferable to drive the films with short current pulses rather than longer rectangular ones, so that power dissipation in the transistor is reduced. Owing to the film's fast switching mechanism this can easily be done. The film is read out during the rise time of the word drive pulse and written into during the fall time, so that only two short pulses coinciding with the rise and fall times are necessary. This is shown in Fig. 3.

The information current also can be modified, by application of a d-c bias that returns the film automatically to the ZERO state, unless the write ONE current pulse is applied. This eliminates the need for a bipolar information driver. Sense readout signals thus obtained are not of the same amplitude when a ONE or ZERO is interrogated.

The word addressing drivers are of two types: one is the actual driver that furnished the current pulse, and the other a circuit that absorbs this current pulse.

The driver and switch in Fig. 4 handle current pulses of 1 amp with rise and fall times of 35 nanoseconds. When continuous operation of these circuits at a rate above 1 Mc is desired, precautions against overheating have to be taken.

The driver input is a 2-input AND gate. When both inputs are at +3 volts, the transistor, Q_1, is cut off; its collector tends to go negative but the diode holds it to about ground level. This drives the second transistor, Q_2 into saturation and its collector towards the +3 volt level in turn forward biasing the two npn output transistors (Q_3 and Q_4), each of which can handle up to ½ amp. A negative current pulse appears in the output. These drivers can drive a diode selection matrix, where the diodes are arranged in rows and columns. One such diode of a given row is indicated.

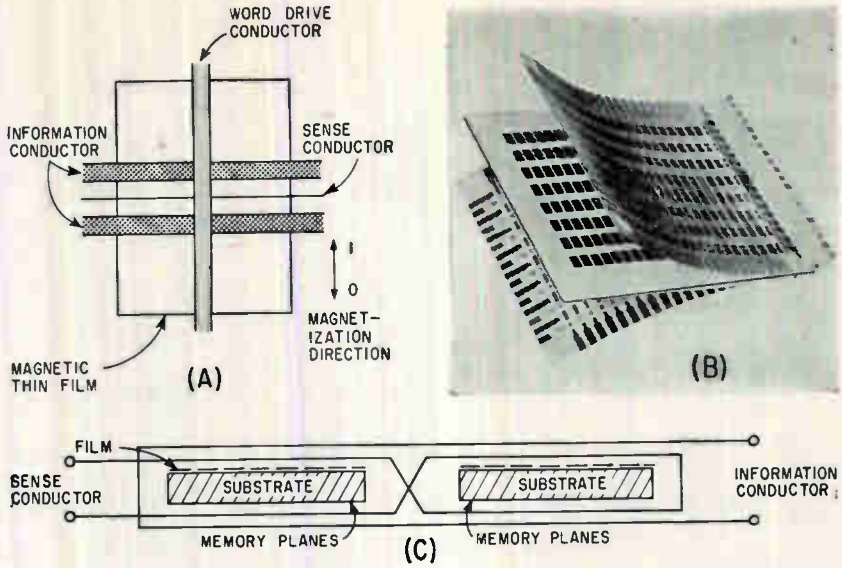


FIG. 2—Conductor orientation for control of one magnetic bit (A), and arrangement of conductors in a complete magnetic plane (B); interconnection of conductors to minimize noise signals (C)

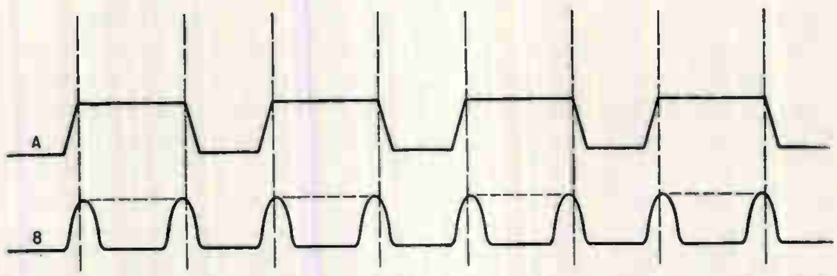


FIG. 3—Word-drive current pulses with (A) showing the conventional arrangement of rectangular pulses and (B) showing how transistor dissipation is reduced by using short pulses coincident in time with the edges of the conventional rectangular pulses

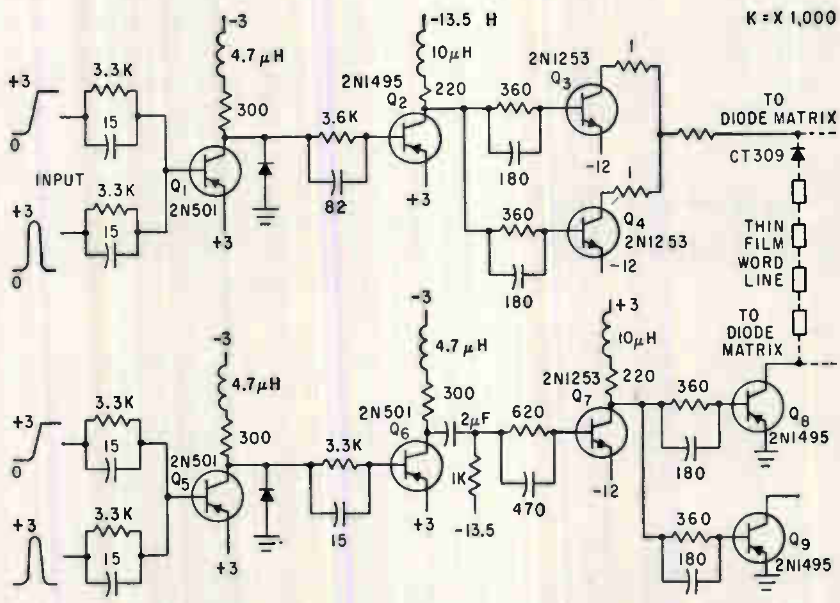


FIG. 4—Driver circuit generates 1 amp pulses with rise and fall times of 35 nanoseconds, and can operate continuously to nearly 1 Mc

Direction Finder Helps Recover Discoverer Capsule

Azimuthal direction finder locates reentry nose cone capsules within 70-degree sector from 50,000 ft to sea level. Outputs of two Yagi antennas appear side-by-side on an indicator to give visual indication of signal source direction

By A. T. LLOYD, Senior Project Engineer, Lockheed Aircraft Service, Inc., Ontario, California

THIS DIRECTION FINDING system is an extended-range, single-station azimuthal unit that provides continuous, positive and visual-display homing in the vhf spectrum on low-intensity a-m, f-m and c-w signals. The system consists of a special-purpose, high-gain receiver fed by high-gain antenna arrays, and a waveform analyzer to provide direction-correlated analysis of the receiver output.

The system was developed for reentry capsule recovery operations in the Hawaiian area and has demonstrated long-range target acquisition performance during numerous and extensive recovery operations.

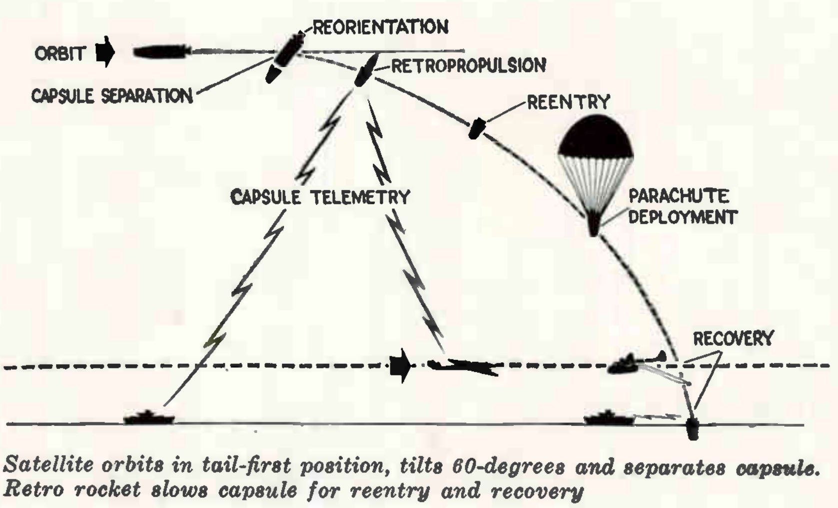
Many antenna types were investigated before the final selection was made. The antenna gain and radiation pattern design characteristics are based upon the operational requirement for a specified sector scan coverage consistent with long-range target acquisition.

A matched dual antenna configuration was developed to produce two 35-degree radiation patterns intersecting at approximately 2.5-db below the maximum 12-db gain point of the antenna and having an azimuth sector scan of 70-degrees forward of the aircraft heading.

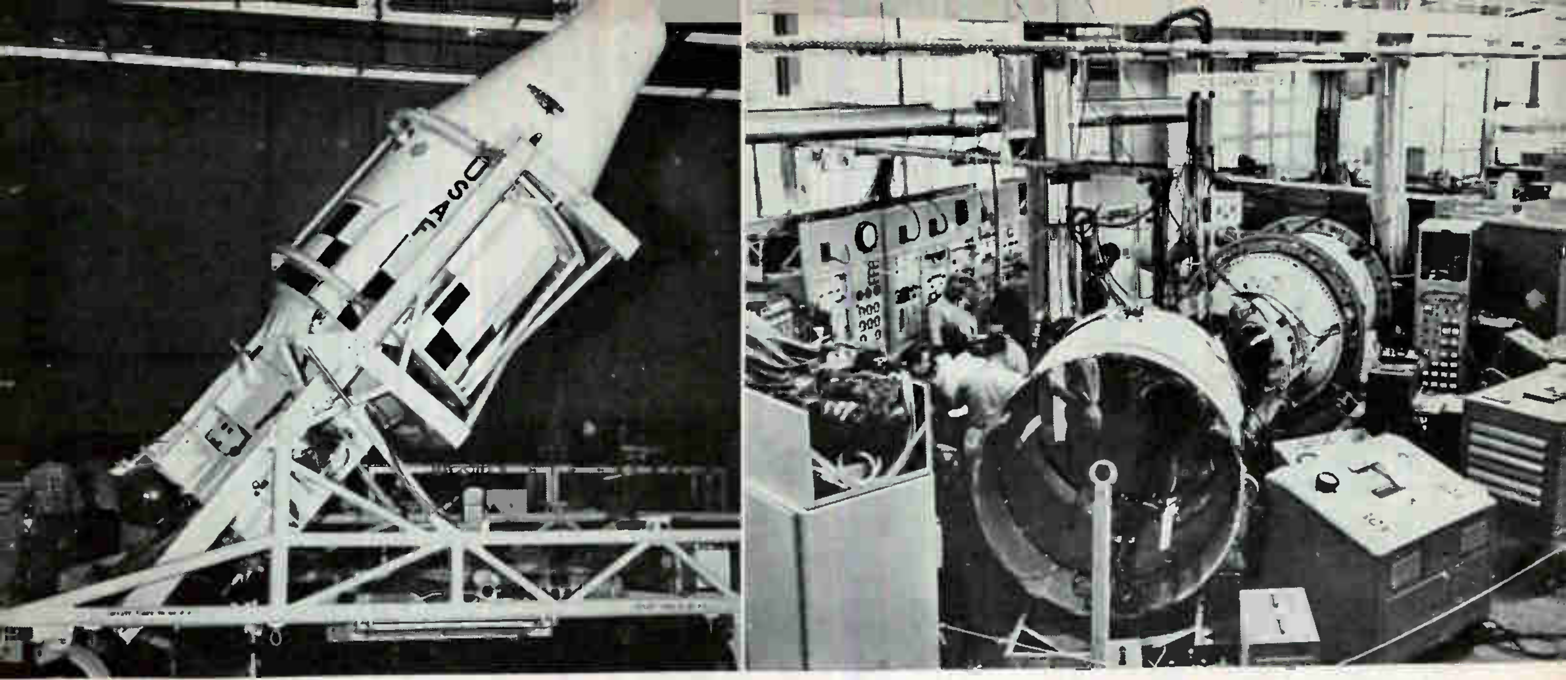
The direction finding system (called Retriever), is a lobe-switching direction finder as shown in Fig. 1A. Direction is determined by comparing the amplified outputs of two Yagi antennas whose main lobes are displaced from the center axis. The antenna outputs are fed into a delay cable that displaces the antenna beam from the horizontal axis. These outputs are alternately switched to the receiver input. At the same time, sweep circuits of the indicator unit connected to the receiver output are reversed in synchronism with the antenna switching so that the output of each antenna lobe appears side by side on an indicator to give the operator a positive visual indication of the direction of the signal source. The crystal-calibrate oscillator presets the receiver to the fine increment frequency setting required for direction finding.

The dual Yagi antenna sections are vertically polarized. In addition to the driven element, which is a trombone-tuned, tee-matched folded dipole, each section has two parasitic director elements and one parasitic reflector element. The folded dipoles of each section are connected through a phase loop to the lobe-switching network. Each Yagi array is balanced and matched for optimum gain and lobe pattern displacement. A sensitive balun is part of the antenna matching network.

In operation, the directors and reflector are excited by the received signal. The re-radiation from these elements induces voltages in the driven element. The voltage phases, determined by the lengths and spacing of the elements, result in an essentially uni-



Satellite orbits in tail-first position, tilts 60-degrees and separates capsule. Retro rocket slows capsule for reentry and recovery



Agena satellite, used in Discoverer program, weighs 8,500 lb at launch and requires a maze of checkout equipment

directional radiation pattern. The balun is incorporated to transform the balance voltage at the center of the driven element to the unbalanced coaxial cable. The design and construction of the balun is very critical so as to maintain symmetry in the radiation patterns of the antennas as the operating frequencies are changed.

Outputs of the antenna arrays are combined through a phase-delay cable as shown in Fig. 1B, to horizontally displace the maximum of the antenna radiation pattern. Simultaneously, the indicator unit sweep is synchronously switched so that the sweep, starting approximately at the center of the cathode ray tube, is deflected in the same direction as the maximum of the antenna radiation pattern.

Amplified and detected signals from two radiation patterns are compared in amplitude on the indicator. Receiver output is connected to the left-hand sweep when the lobe switch displaces the antenna radiation pattern to the left of the centerline and to the right-hand sweep when the lobe switch is in the opposite position. In Fig. 1C, the signal source is to the left of the centerline and the received signal strength is substantially greater on the left side of the indicator than on the right. In Fig. 1D, the opposite is true. In Fig. 1E, the received amplitudes of the two antenna lobes are equal. The indicator presentation shows this by the height of the display on both sides being equal. This is the condition of the signal source being on centerline of antenna array.

The calibration test oscillator shown in Fig. 4, is transistorized and crystal-controlled. It provides an accurate, fixed frequency c-w signal used to tune the receiver. The receiver dial is quickly and accurately set to the precise frequency involved in the operation of this system.

A tetrode transistor is used in a Pierce oscillator circuit tuned to the third overtone of the fundamental crystal frequency. The fifth harmonic of the oscillator is the calibration frequency. Excellent results have been realized with this arrangement.

A block diagram of the indicator is shown in Fig. 5. The indicator is driven by the receiver, whose video output is amplified by the vertical amplifier and applied through pulse stretchers to the vertical deflection plates of the cathode-ray tube. A signal taken from the vertical amplifier triggers the sweep generator; the sweep voltage is then amplified by the horizontal amplifier and applied to the horizontal deflection plates of the cathode-ray tube through the sweep-reversing relay. The sweep-reversing relay and the lobe-switching relay are driven in synchronism by the switching amplifier, which receives a square-wave input signal from the lobing rate multivibrator.

The airborne direction finding system uses a special-purpose receiver having exceptionally high sensitivity with circuit function switching to select 300 Kc, a-m or f-m signals through a single superheterodyne channel having an i-f of 21.4 Mc. The receiver also is equipped with a function switch which has a 10 Kc position and a dual conversion circuit having a 21.4 Mc first i-f followed by a 1 Mc second i-f.

The r-f tuner produces the lowest possible noise figure and has a practical tuning structure capable of tuning with reasonably uniform performance over the uhf band.

The installation requirements for a direction finding system in aircraft created problems involving the effect of the aircraft configuration on the target signal. The optimum position on the aircraft for the location of the direction finding antenna is determined by scale model studies on an antenna pattern range.

Radiation patterns were measured at eleven locations to establish the optimum operating location. Tests were made on a corner reflector, log-periodic, and Yagi-type antennas. The Yagi-type antenna best fulfilled the direction finding requirements. The gain and lobe pattern proved exceptionally well

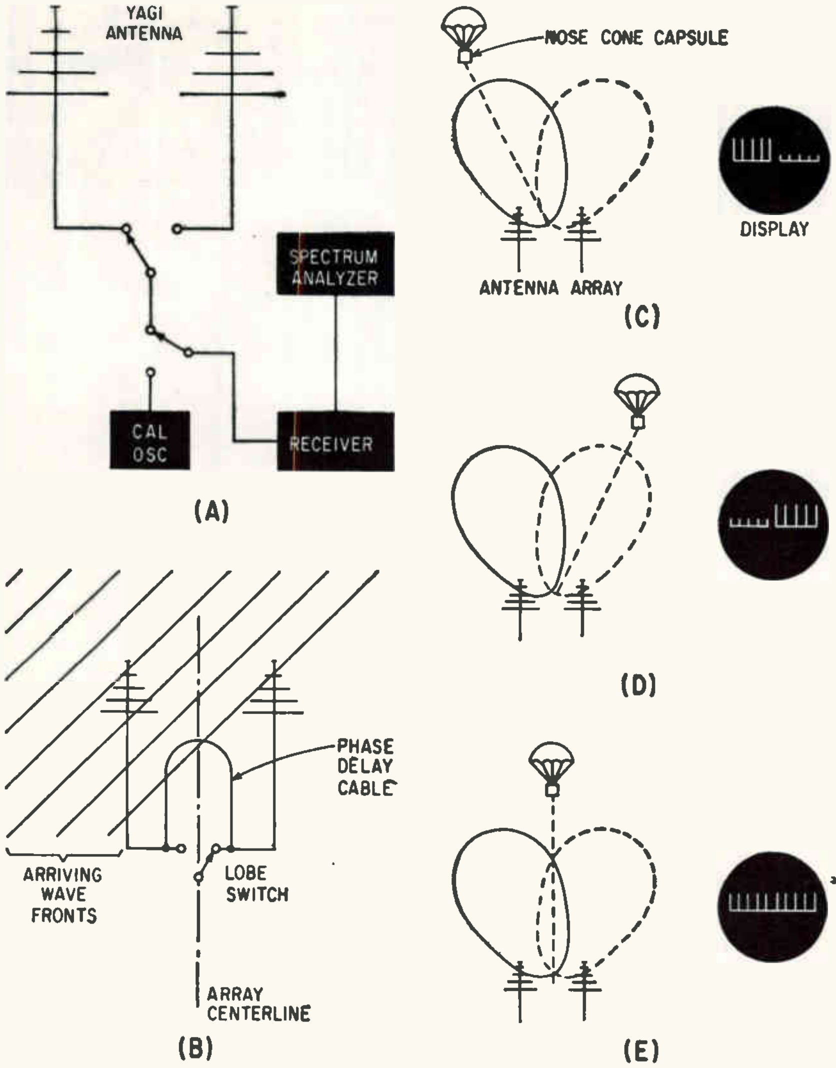


FIG. 1—Functional block diagram (A) and principle of operation (B) showing phase delay cable. Azimuth determination in the airborne system shown in (C), (D) and (E)

adjusted for lobe switching target acquisition. The beam crossover point was adjusted to 2.5 db below maximum signal level.

A 1/14 scale-model aircraft was used for the final test measurements. Some preliminary patterns were measured using a 1/20 scale-model C-130-B Aircraft. The airplane was mounted on a 21-foot polyester glass fiber honeycomb tower and spaced a distance exceeding 25 λ from the transmitting horn.

The scale-model antennas were tuned and matched for agreement with the full scale Yagis. Normal procedure has been to adjust the full scale antennas on frequency A and use them on frequency B. The 1/14 scale-model antennas used in the test were adjusted to have the same pattern on scaled frequency B as the full-scale antenna had on frequency A.

Preliminary patterns were measured in sets of principal planes and 30-degree cone angle patterns for eleven mounting configurations to determine the optimum location of a scaled Yagi antenna. When the optimum location was determined, complete sets of cone angle patterns were measured, using a scaled Yagi, a 60-degree corner reflector and an 8-element log-periodic array. The cone angle sets were then integrated and further calculations determined the radius of each pattern group.

Preliminary patterns on the Yagi antennas indicated that only small pattern variations resulted from moving the antenna along a C-130 aircraft longitudinal axis between certain stations. Moving the antenna between other stations changed the maximum lobe of the pitch plane pattern from in-line with the longitudinal axis of the airplane to 15-degrees above the horizon. Spacings from λ/4 through λ/2 between the driven element on the Yagi and the aircraft skin were tested. Using a spacing of 5λ/16, excellent crossovers of between −2 and −3 db were obtained with no detrimental lobing or pattern variations in the area of the crossover point. The rear lobe was virtually unaffected by changes in Yagi location, and was 25 db below the main lobe maximum as shown in Fig. 4.

The patterns on the corner reflector were measured using a 60-degree corner reflector. The skin of the aircraft was used as one side of the corner and the other side was constructed of a 0.9-λ boom with 8 equally spaced, 0.6-λ vertical elements. An antenna corner-to-exciting-dipole spacing of 0.45 λ was used. The side of the corner that used the aircraft skin apparently caused unbalance of the antenna pattern, resulting in radiation perpendicular to the line of flight. Although this is not desirable from a directional ambiguity standpoint, the broad pattern reduced the forward gain of the antenna to a level below the desired requirement.

The radiation patterns of the 4-element Yagi indicated excellent operation of the homing system when using two such antennas. Antenna gain calculations showed the maximum lobe to have a gain of 12.6 db above an isotropic source, and the crossover point approximately 2.5 db below maximum signal level. Variation in placement was not considered serious if the antenna on a particular airplane had to be relocated as much as several inches for structural reasons.

A series of performance tests were conducted at the Pacific Missile Range to evaluate the airborne and shipboard direction finding systems. The tests were conducted with one simulated airborne reentry capsule and one test nose cone capsule floating in the water. Two C-119 aircraft and one destroyer equipped with a prototype direction finding system performed

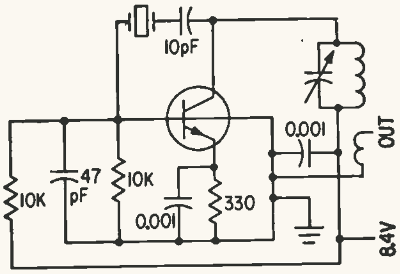


FIG. 2—Calibration oscillator uses tetrode transistor in Pierce oscillator circuit

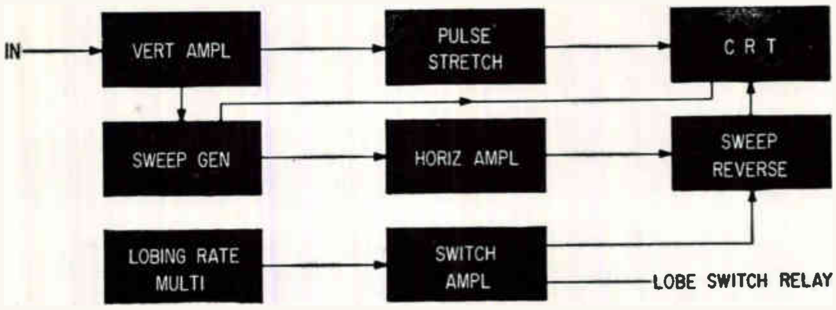


FIG. 3—Sweep reverse circuit and lobe switching relay are driven in synchronism to produce directional information

simulated recovery operations of the capsule from the water. Dual Yagi antennas were installed on the mainmast of a destroyer, 80 feet above the water line. The test nose cone used an antenna constructed of $\lambda/4$ flexible steel ribbon mounted in a vertical position approximately 18 inches above the water line. Shipboard reception in excess of 59 miles was realized on the Retriever direction finding system. Day and night signal reception was observed to be of uniform intensity.

The ship's original direction finding equipment intended for backup and comparison purposes received the nose cone capsule signals for approximately 12 miles before signal fadeout occurred.

To test the effect of antenna gain on the long-range signal reception exhibited by the direction finding system, the Yagi antenna on the left-hand side was attenuated below the half-power gain of the right-hand antenna. On repeated test operations moving toward and away from the floating nose cone capsule target, the low-gain left-hand antenna caused the receiver to lose the signal for approximately 2 to 5 miles between 15 and 20 mile ranges. The high-gain right-hand antenna received the signal through the low-intensity signal region. Once past the 20-mile range, the signal level increased in amplitude on both left- and right-hand antennas. The second low-intensity signal area started at 50 miles with the left-hand low-gain antenna losing the signal. The right-hand antenna continued to receive the signal with the background noise level increasing, until the noise exceeded the target signal at a 60 mile range from the target.

Homing and recovery operations were conducted at Edwards Air Force Base using dummy capsules. Capsules dropped at an altitude of 47,000 ft were successfully identified and recovered using prototype direction-finding equipment. Homing accuracies of ±1-degree were realized. At distances of 40 and 50 miles, target detection was achieved before radar acquisition and sector information were furnished to the C-119 navigator. Airborne target acquisition in excess of 200 miles was achieved during the prototype field tests conducted during this period; 400 mile air-to-air target acquisition was observed with the direction finding aircraft flying at 35,000 feet during preliminary evaluation testing of the C-130 prototype installation.

A squadron of C-119 aircraft equipped with the direction finding system are on daily operational duty in the Hawaiian area. Training flights with this direction finding equipment are conducted between Hilo, Hawaii and the island of Oahu, a distance of 190 miles. C-119 aircraft flying at 15,000 ft receive strong signals from the ground target 190 miles away. Line-of-sight distance is less than 150 miles and quasi-optical distance is approximately 172 miles. Actual reentry nose cone capsule acquisition and recovery have resulted from the long-range direction-finding performance of the Retriever system.

FIG. 4—Antenna pattern of the dual Yagi array mounted on a C-130A aircraft

The development and field tests covered in this article are only a representative sample of numerous investigations and experimental data acquired during this overall program. The data obtained indicate the need for even better direction-finding systems capable of locating the reentry vehicle as quickly as possible.

Direction finding systems for reentry vehicles, consistent with the present state of the art, would include a long-range 360-degree target acquisition antenna and a narrow-beam homing provision for tracking and target recovery after the initial locating contact

The direction finding system functions and characteristics dictate and prove the need for an exceptionally high receiver sensitivity with a noise figure (inherent receiver noise) reduced to the best figure obtainable. Eventually there will be the elimination of all mechanical and/or electromechanical switching devices by the use of electronic or solid state switches.

Increasing antenna gain to the maximum level attainable will improve reception and overall system performance when operating under conditions of low-intensity signals, resulting in target acquisition at even greater distances.

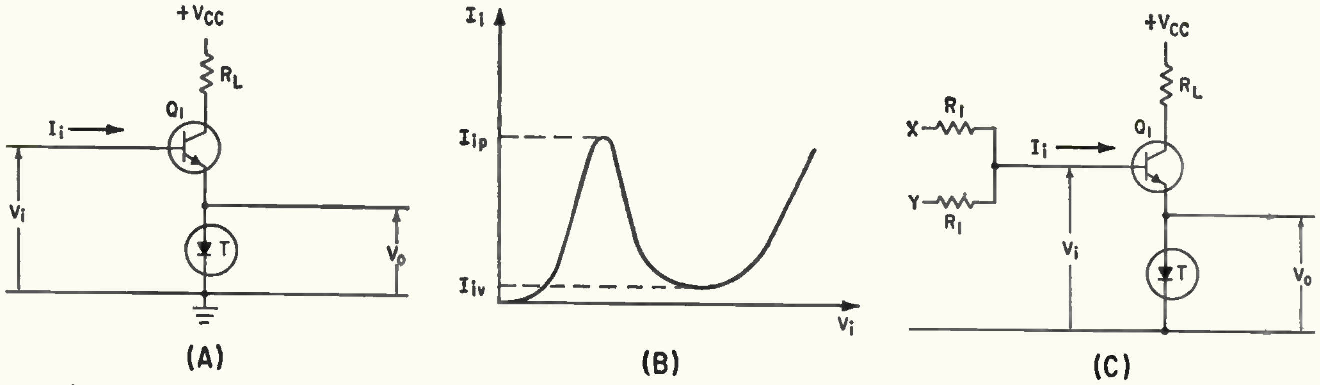


FIG. 1—Basic TDTL circuit (A) has input characteristics of (B). Two-input AND *gate (C) action is shown in*

Logic Combines Tunnel Diodes

Switching speed of tunnel diodes and isolation capabilities of transistors are combined to obtain logic having switching times of 0.7 nanosecond

By R. W. LADE, Marquette University, Milwaukee, Wisconsin

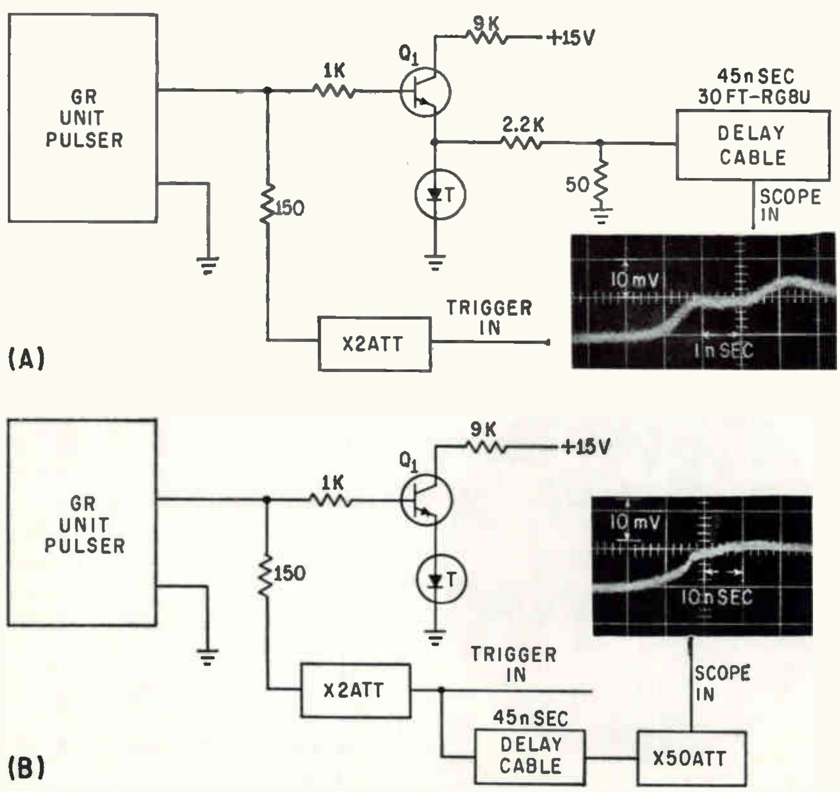


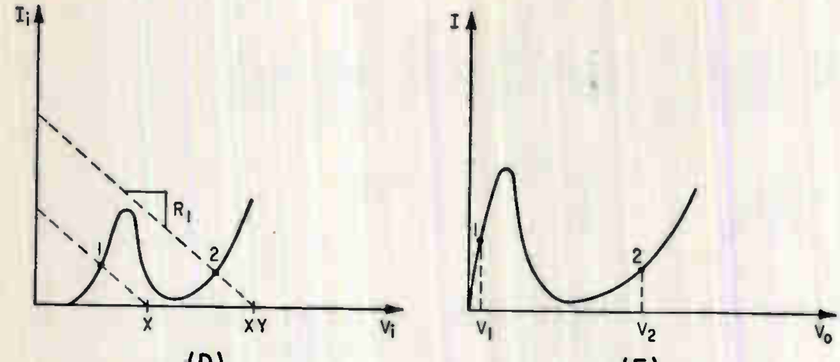
FIG. 2—Output of TDTL gate in (A) has rise time of 0.7 nsec. Waveform in (B) shows input to gate

CIRCUIT ENGINEERS have used tunnel diodes in high-speed logic switching circuits with some success. There remains, however, the basic drawback of isolation, a problem partly solved with coupling diodes and resistance decoupling. A logical building block termed tunnel diode-transistor logic (TDTL), that combines the high switching speed of the tunnel diode with the isolation properties of conventional transistor circuits, will be described

The basic circuit is in Fig. 1A with the input voltage-current characteristic shown in Fig. 1B. This circuit was reported earlier in connection with controlling the effective peak and valley currents at the input terminals of the circuit.[1] The input characteristic consists of the series connection of a forward biased *p-n* junction (the emitter-base junction Q_1) and the normal tunnel diode v-a characteristic.

Observed input peak and valley currents are found to be less than the actual peak and valley values of the tunnel diode. This is true because the base current is always $(1-\alpha)$ times the emitter current. Thus when the emitter current is at the peak current level of the tunnel diode, I_p; the peak input (I_{ip}) current is $I_{ip} = (1-\alpha)\ I_p$ and the input valley current is $I_{iv} = (1-\alpha)\ I_v$ where I_v is the actual tunnel diode valley current.

Operations involved in TDTL gating can be explained by considering the two-input AND gate of



(D) and output across tunnel diode in (E)

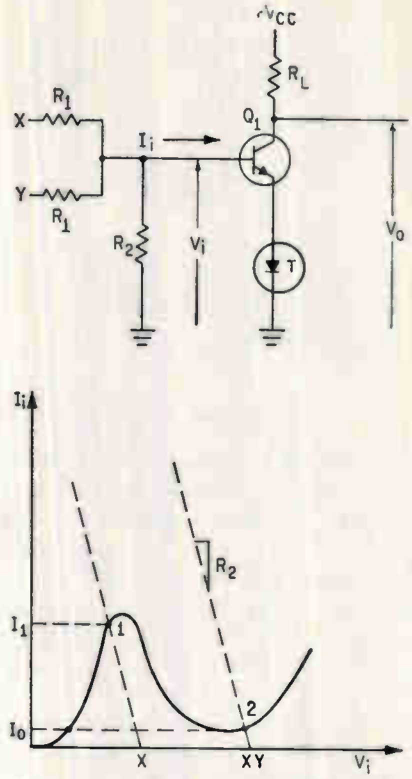


FIG. 3—Exclusive OR *gate has computer applications*

With Transistors

Fig. 1C. With inputs X and Y absent, $v_i = i_i = 0$ and the operating point is at the origin in Fig. 1D. With X present and Y not present, the operating point is at position 1, and correspondingly, the output across the tunnel diode is V_1 as shown in Fig. 1E. With both X and Y present, the operating point shifts to position 2 and the output voltage becomes V_2.

Voltage across the tunnel diode changes fast in the transition between the peak and valley points. When the circuit is driven by a constant current source, the speed is independent of transistor performance since a constant current is maintained throughout. Unfortunately, near ideal current drive requires high signal voltages and would not permit logic buildup without interstage amplification. Thus a compromise must be reached wherein the transistor cutoff frequencies play a minor role in circuit performance.

Asynchronous operation for the AND gate (Fig. 1C) requires that with either X or Y present (but not both) the load line must intersect only the low-voltage region of the input characteristic. This insures that the circuit will be self-resetting. For OR gating either the driving signal or the series resistance is adjusted to permit triggering of the gate with one signal.

Switching time of a typical TDTL gate is shown in Fig. 2A. In the OR circuit shown, the transistor was an experimental germanium *npn* mesa device and the tunnel diode, a GaAs unit. The output was attenuated and matched to a 50-ohm line to get a 45-nsec delay of the signal with respect to trigger. A Tektronix 545A oscilloscope with the type N sampling attachment was used to observe the waveform. Risetime of the gate is seen from the scope trace to be approximately 0.7 nsec. Computer circuits using TDTL logic can be operated at a clock rate of at least 500 Mc.

The test circuit for the driving signal is shown in Fig. 2B. The observed wave form has a risetime of approximately 14 nsec. Risetime of the output signal is essentially independent of the trigger risetime. However, circuit propagation time is certainly influenced by the leading edge of the trigger and amount of overdrive present. For small turnoff times, V_{cc}, R_L and the tunnel diode peak current value must be selected so that the transistor does not saturate with base currents of I_{ip} (Fig. 1A and B). For non-ideal current drive in which a significant collector current change occurs, the negated signal may be developed between collector and ground. There is a d-c offset to consider in this arrangement and it is generally not preferred.

A negated exclusive OR logic can be achieved with a slight modification (Fig. 3) of the basic TDTL circuit. Here the external circuit impedance as viewed between the base of Q_1 and ground must be less than the magnitude of the tunnel diode negative resistance. Output is taken between collector and ground. The logical function of the negated exclusive OR circuit in the Boolean form is $\overline{0} = X\overline{Y} + \overline{X}Y$. Or, an output is not present if X and not Y, or, not X and Y are present, but exists for all other cases.

In Fig. 3 with X and Y not present, operation is at the origin and the collector of Q_1 is at $+V_{cc}$ which, by definition, gives an output. If X and not Y, or, not X and Y are present, operation moves to point 1. This causes Q_1 to conduct and the collector voltage to fall, corresponding to no output. With X and Y present, the load line moves to position 2 and the collector current falls to near zero, moving the collector voltage to near V_{cc} and an output is again present. Care is taken to insure that a base current of I_1 will not saturate Q_1.

The author acknowledges the suggestions made by James D. Horgan during the writing of this paper.

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Designing Chopper-Stabilized Operational Amplifiers

By R. B. FRADELLA,

United ElectroDynamics, Inc., Pasadena, California

TRANSISTOR operational amplifiers are small, reliable, and have low drift. These features are particularly attractive for airborne control systems and mobile analog computers. This article deals with drift stabilization techniques, with emphasis on practical design application.

Figure 1A shows a block diagram of a drift-stabilized amplifier. The differential amplifier $G_d(s)$ has drift D referred to its input. The chopper amplifier section $G_c(s)$ has negligible drift. $Y_{fb}(s)$ is the feedback admittance $1/Z_{fb}$. Time constants τ_1, τ_2 and τ_3 are necessary.

For low frequencies, that is drift frequencies, the time-dependent terms can be neglected. Without the stabilizing amplifier ($K_c = 0$), the drift component at the output is

$$E_{oD} = DK_d/(1 + Y_{fb}K_d) \simeq D/Y_{fb} \quad (1)$$

With the stabilizing amplifier,

$$E_{oD}' = D\,K_d/[1+(1+K_c)\,Y_{fb}\,K_d] \approx D/Y_{fb}K_c \quad (2)$$

The approximations are dependent upon $Y_{fb}\,K_d \gg 1$ and $K_c \gg 1$. Comparing E_{oD} and E_{oD}' in Eqs. 1 and 2, the drift component at the output is seen to be reduced by the factor K_c. When Y_{fb} has a series capacitor, it is convenient to refer the drift D to the E_i input. Thus, $D' = R_i\,D/(1 + K_c)$ is the equivalent drift voltage referred to the input, and is integrated the same as the input signal E_i.

The closed loop transfer function of the operational amplifier is

$$\frac{E_o}{E_i}(s) = \frac{\dfrac{K_d/R_i}{(\tau_3 s+1)}\left[1+\dfrac{K_c}{(\tau_1 s+1)(\tau_2 s+1)}\right]}{1+\dfrac{Y_{fb}K_d}{(\tau_3 s+1)}\left[1+\dfrac{K_c}{(\tau_1 s+1)(\tau_2 s+1)}\right]} \quad (3)$$

Within the passband frequency $1/\tau_3$, $E_o/E_i = Z_{fb}/R_i$.

Note from Eq. 3 that a transmission zero will result if the bracketed term goes to zero. This will happen if the gain of the chopper amplifier $G_c\,(j\omega)$ is unity at 180 deg phase lag (at ω_o). This dictates $1/\tau_1 > \omega_o$. To make the sampling frequency ω_s at least double $1/\tau_1$ with K_c large, τ_2 must be large. These considerations lead to the frequency response in Fig. 1B.

The feed-forward gain and phase of $[1 + G_c\,(j\omega)]\,[G_d\,(j\omega)]$ are plotted on Fig. 1C. The differential amplifier roll-off at $1/\tau_3$ is necessary to prevent high frequency oscillations. It allows a drop in gain at 90 deg phase lag so that the transistor frequency cut-off characteristics appear only at loop gains less than one. Transistors for the differential amplifiers must have a high cut-off frequency if a high K_d and system bandwidth are required.

Three typical operational amplifiers include a simple d-c amplifier, integrator and integrator plus proportional.

Simple d-c amplifier:

$$E_o/E_i\,(s) = -R_{fb}/R_i = K_1; \quad Y_{fb} = 1/R_{fb} \quad (4)$$

Integrator:

$$E_o/E_i\,(s) = -1/R_i\,C_{fb}\,s = K_2/s; \quad Y_{fb} = C_{fb}\,s \quad (5)$$

Integral plus proportional:

$$E_o/E_i\,(s) = -(R_{fb}/R_i + 1/R_i\,C_{fb}\,s) = K_1 + K_2/s; \quad Y_{fb} = C_{fb}\,s/(R_{fb}\,C_{fb}\,s + 1) \quad (6)$$

Figure 1C and Eqs. 3, 4, 5 and 6 show that arg $[(1 + G_c)\,G_d\,Y_{fb}] \lesseqgtr$ 90 deg and no instabilities will occur for the conditions assumed. Loop gain is high at all frequencies below $1/\tau_3$.

A practical circuit with a spdt chopper is shown in Fig. 2. The positive and negative supplies are 100 v. Assume all transistors have $\beta = 30$.

First consider d-c bias conditions. So that transistors Q_1 and Q_2 have the same stability factor, their bases should see the same resistance to ground. Therefore, $R_5 \parallel (2R_2 + R_4) = R_{15}$. Considering relative values,

$$R_5 \simeq R_{15} \quad (7)$$

An important observation is that node g is a virtual ground. This is due to the high loop gain. Thus

$$I_i = E_i/R_i \quad (8)$$

$$I_{fb} = E_o\,Y_{fb} \quad (9)$$

Therefore, the currents feeding node g can be represented as current generators.

For the differential amplifier section, define K_d as E_o/I_i with the chopper amplifier killed and the feedback open. This leads to the approximate partial equivalent circuit of Fig. 3A. This is a good approximation because K_d is important primarily at frequencies between ω_o and $1/\tau_3$, where C_1 and C_b are essentially short circuits and $R_1 \ll R_3$ (Fig. 2).

The output of the chopper amplifier section has been represented by its equivalent source impedance (approximately R_5).

Since R_{e1} is much larger than the other resistances in the $Q_1 - Q_2$ emitter circuit, the resistance looking into the base of Q_1 is

$$R_{b1A} \cong \beta\left[R_p + \frac{1}{\beta}R_b\right]$$

$$R_{b1A} \cong \beta\,R_p + R_b \quad (10)$$

The transistor internal collector resistances will be assumed to be much greater than R_{c1}, R_{c2}, and R_{c4}. Thus the differential mode collector currents of Q_1 and Q_2 are

$$I_{c1} = I_{c1A} = I_{c1B} = \frac{R_1 \parallel R_{15}}{(R_1 \parallel R_{15}) + R_{b1A}}\,I_i\beta \quad (11)$$

Neglecting the common mode component, and replacing the current generators I_{c1} in parallel with R_{c1} by the Thevenin equivalent, Fig. 3B results.

From this circuit the differential mode collector currents of Q_3 and

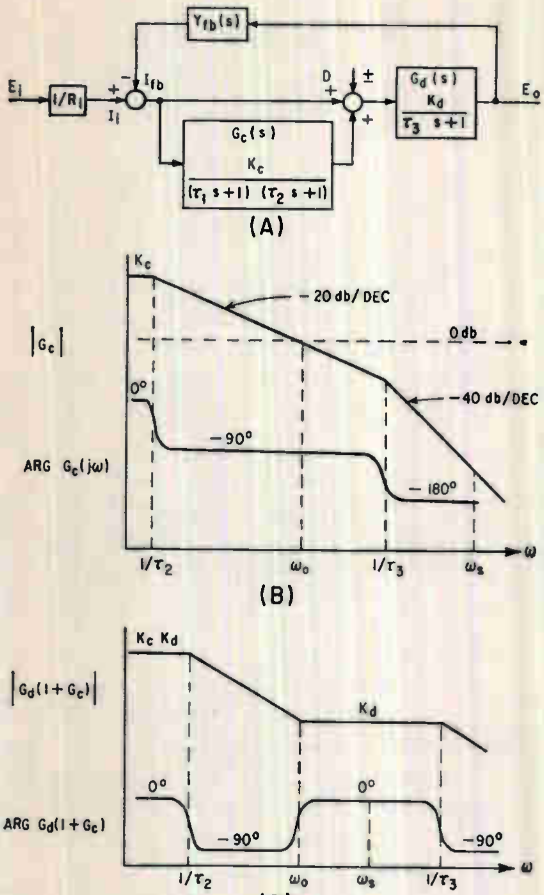

FIG. 1—*Schematic block diagram of drift-stabilized amplifier (A) ; plot of gain and phase against frequency for chopper amplifier (B); and plot of feed-forward gain and phase against frequency (C)*

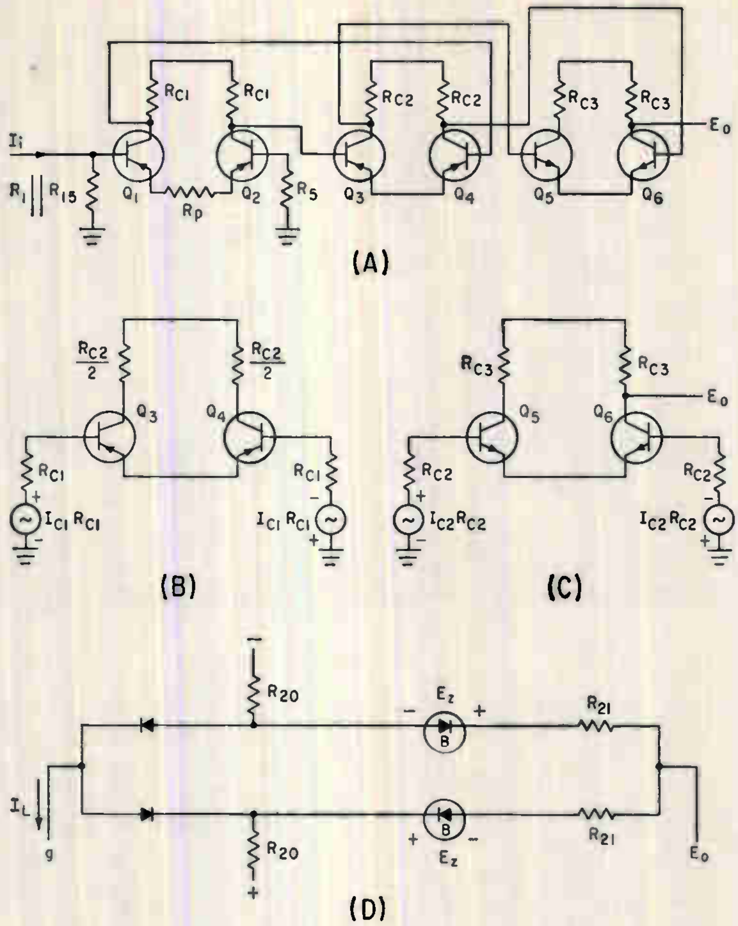

FIG. 3—*Approximate partial equivalent circuit for differential amplifier section (A); after replacing current generators I_{ci} with R_{ci} by Thevenin equivalent (B); circuit equivalent of last differential stage (C); and a limiter circuit (D)*

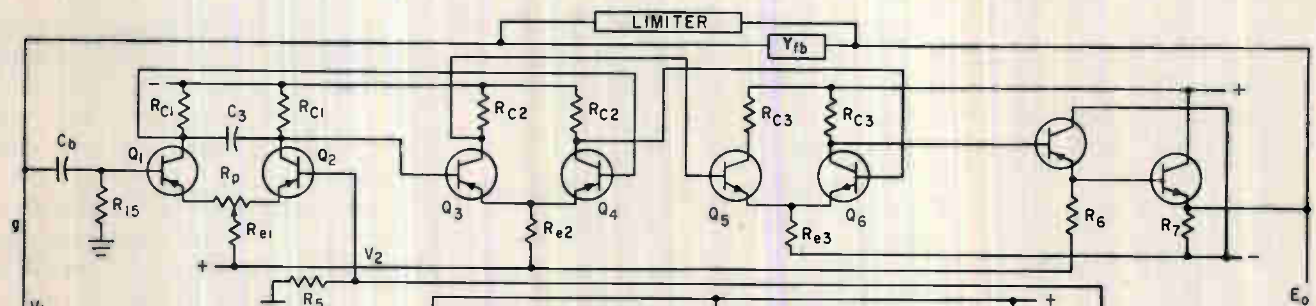

FIG. 2—*Practical circuit diagram with a spdt chopper*

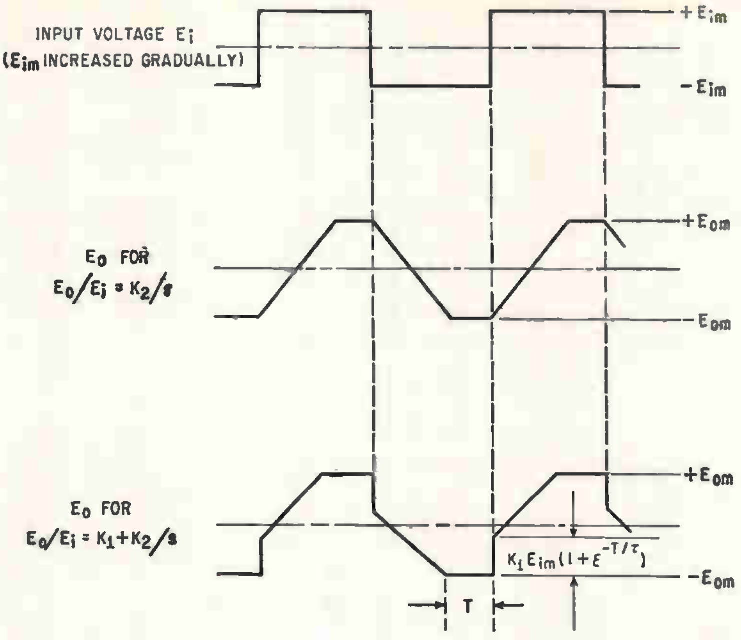

FIG. 4—Response of operational amplifiers to square-wave input

Q_4 are therefore seen to be

$$I_{c2} = I_{c2A} = I_{c2B} = \beta I_{c1}. \quad (12)$$

Finally, the circuit equivalent of the last differential stage, Fig. 3C results. Note that $R_{c2} = R'_{c3} \parallel \beta (R_6 \parallel \beta R_7)$. See also Fig. 2. The single-ended differential amplifier output is essentially E_o.

From Fig. 3C

$$E_o = R_{c3} \beta I_{c2} \quad (13)$$

Combining Eq. 7, 10, 11, 12 and 13

$$K_d = E_o/I_i = \frac{(R_1 \parallel R_{15}) R_{c3} \beta^3}{(R_1 \parallel R_{15}) + R_i + \beta R_p} \quad (14)$$

Gain K_d is essentially independent of R_{c1} and R_{c2}.

Typically, the quiescent collector currents might be 0.5 ma, 1 ma, 1.5 ma, 2 ma and 4 ma for the 3 differential and 2 common emitter stages respectively. This determines $R_{c1} \cong 100{,}000$ ohms, R_{c1} . . . etc. Experimentally it was found that R_p should be about 2,500 ohms for effective balancing.

For Eq. 4, 5 and 6 to be valid within 1 percent in the passband and to realize proportional gains K_1 on the order of 5, determine what value of K_d will suffice and if it can be accomplished with 3 differential stages. Choose $R_4 = R_5 = R_{13} = 250{,}000$ ohms. Then Y_{fb} is $(5 \times 250 \times 10^3)^{-1} = 8 \times 10^{-7}$. From Eq. 3

$$Y_{fb} K_d > 100$$

and

$$K_d > 12 \times 10^7 \text{ volts/amp} \quad (15)$$

Nominally, $R_1 \approx 50{,}000$ ohms and $R_{c3} \approx 60{,}000$ ohms. Substituting these values in Eq. 14 gives $K_d \approx 30 \times 10^7$ volts/amp.

Amplifier gain A_c of the chopper amplifier section and approximate component values to realize K_c must be determined.

The base impedance of Q_2 at low frequency is

$$R_{b1B} \approx \beta R_p + R_{15} \quad (16)$$

The chopper amplifier section gain can be defined as

$$K_c = V_2 R_{b1A} / V_1 R_{b1B} \quad (17)$$

$$V_2 = \frac{R_{b1B} \parallel R_5}{R_2 + R_4 + (R_{b1B} \parallel R_5)} (1/2) A_c V_1$$

$$V_2 \approx \frac{(R_{b1B} \parallel R_5) A_c V_1}{2 (R_2 + R_4)} \quad (18)$$

Combining Eq. 10, 16, 17 and 18

$$A_c \approx 2 K_c (R_2 + R_4)/(R_{b1B} \parallel R_5) \quad (19)$$

For maximum K_c with minimum amplifier gain A_c and maximum τ_2 with minimum C_2,

$$R_2 \approx R_4 \quad (20)$$

A comparison of relative component values shows that, roughly

$$\tau_1 \approx R_1 C_1 \quad (21)$$

$$\tau_2 \approx (R_2 \parallel R_4) C_2 \quad (22)$$

Choose $K_c = 1{,}000$. Then $\tau_2 \approx 3$, $1/\tau_2 \approx 0.3 \approx 0.05$ cps, and $1/\tau_1$ can be 100 cps. For $R_1 = 50.000$ ohms, $C_1 \approx 0.03$ microfarad. For $R_2 = R_4 = 1$ megohm, $C_2 \approx 6$ microfarad. A_c must be 32,000. Four amplifiers should be used. Since the gain of the first, $A_1 = 1$, the other three should have gains $A_2 = A_3 = A_4 \approx 32$ volts per volt.

It can be shown that for these amplifiers

$$A_2 \approx \frac{R_8 + (R_9 \parallel R_{10})}{R_9 \parallel R_{10}} \quad (23)$$

All capacitors in this circuit except C_1, C_2, and C_3 are for a-c bypass. Selection of resistor values for a given circuit is straightforward.

When the input impedances to the base of Q_3 and Q_4 are considered, $(R_{b2A} = R_{b2B} \approx R_{c1})$ and

$$\tau_3 \approx R_{c1} C_3 \quad (24)$$

A limiter circuit is shown in Fig. 3D. During linear operation, current circulates from plus to negative through the zener diodes. The silicon or vacuum diodes are blocked (reverse biased). The only effect of the limiter on the circuit for this mode is to load the output with the equivalent resistor $(R_{20} + R_{21})/2$.

When E_o exceeds the small drop across R_{21} plus the zener and forward conduction voltages of the diodes, I_{fb} will be augmented by current I_L through the limiter. E_o is held at the maximum value E_{om} and

$$(I_L + I_{fb}) R_i = E_i \quad (25)$$

The input-output relation can be characterized by observing the response to a square-wave that is gradually increased in amplitude to $\pm E_{im}$. This gradual increase does not unbalance the output.

It is helpful to remember that before limiting $I_{fb} = I_i$ and the output voltage is merely $E_o = I_{fb} Z_{fb}$ plus initial condition Q/C_{fb} (where Q is the initial charge on the feedback capacitor C_{fb}).

The transition from the limited mode to the linear mode for the integral plus proportional amplifier is not as simple as the other two types. For this amplifier, after limiting $I_{fb} = I_o \epsilon^{-t/\tau}$ where $\tau = R_{fb} C_{fb}$ and I_o is I_{fb} just before limiting. This results in the waveforms shown on Fig. 4.

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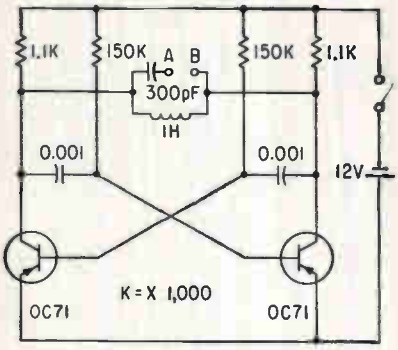
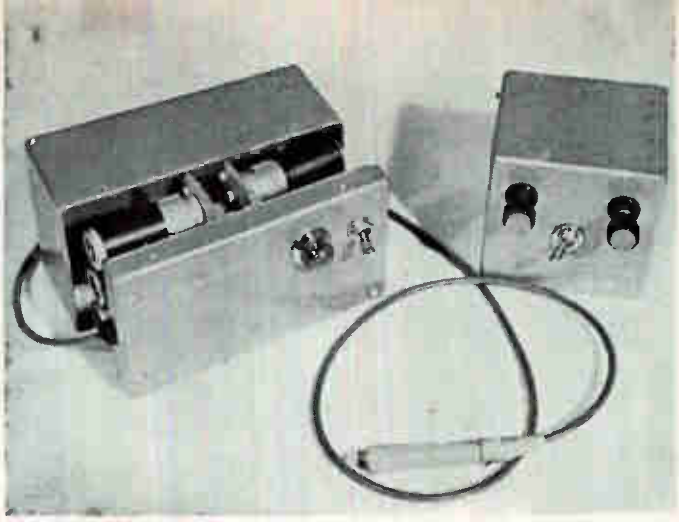


FIG. 1—Multivibrator provides the wire-tracing signal



Wire identifier assembly consists of two units

Probe Identifies Cable Wiring

Transistor circuits and a magnetic probe are used to locate individual wires in cables having a large number of wires

By J. S. RUSHTON,
Electronics Dept.,
English Electric Aviation Ltd.,
Warton, England

THE PROBLEM of identifying a particular wire in a multiwire cabling run often arises. In the aircraft industry, for example, it may be necessary to splice into a cable run to connect experimental apparatus. In simple circuits, color coding can be used, but if the cable run contains a large number of wires this is not practical and a wire identifier is necessary.

An earlier type of wire identifier used a capacitance pickup, but proved inconvenient because of the need to ground all wires in the cable except the desired wire, which carried a 1-Kc alternating current.

The identifier described here uses a magnetic pickup to sense an alternating current in the wanted wire. This pickup simplifies application of the identifier, since it is only necessary to ground one end of the wanted wire and to connect the a-c source between the other end of the wire and ground.

The 20-Kc frequency of the source was determined experimentally. This frequency gave a satisfactory signal in the pick-off and was not too high to cause losses in the transistor amplifier when using cheap readily available transistors.

The signal source (Fig. 1) consists of a parallel-tuned circuit driven by an astable multivibrator. Connecting the tuned circuit to the output terminals (A, B) puts the wire being identified in the path of the circulating current, thus making use of the Q of the tuned circuit.

The amplifier pickup probe is made of about 600 turns of 40-gage enamelled wire wound on two lamina of 3/4 × 3/16 in. transformer steel, the steel forming a U-shaped probe end; the cable wires fit into the U-shaped end, sometimes several at a time, depending upon the core size. This shape has the advantage of speeding up the search since small bunches of the wires can first be checked to reveal the bunch containing the wanted wire and then the individual wires in the bunch can be checked. The pickup is connected to a length of coaxial cable, the cable end having been potted in Araldite to a length of about 3 in. to give a pencil grip.

The coaxial cable goes to the amplifier (Fig. 2). Output of the two-stage a-c amplifier (Q_1, Q_2) is rectified and then amplified by Q_3, whose output energizes relay K_1. The relay's contacts light a lamp mounted on the cover of the amplifier package.

The battery power supplies of each unit provide about 200 hours of continuous operation.

The permission of English Electric Aviation Ltd. to publish this article is acknowledged.

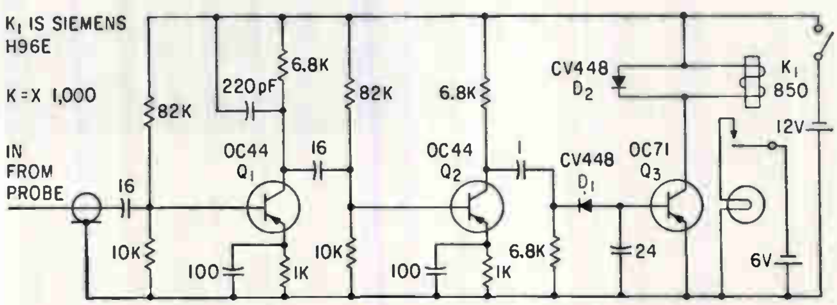
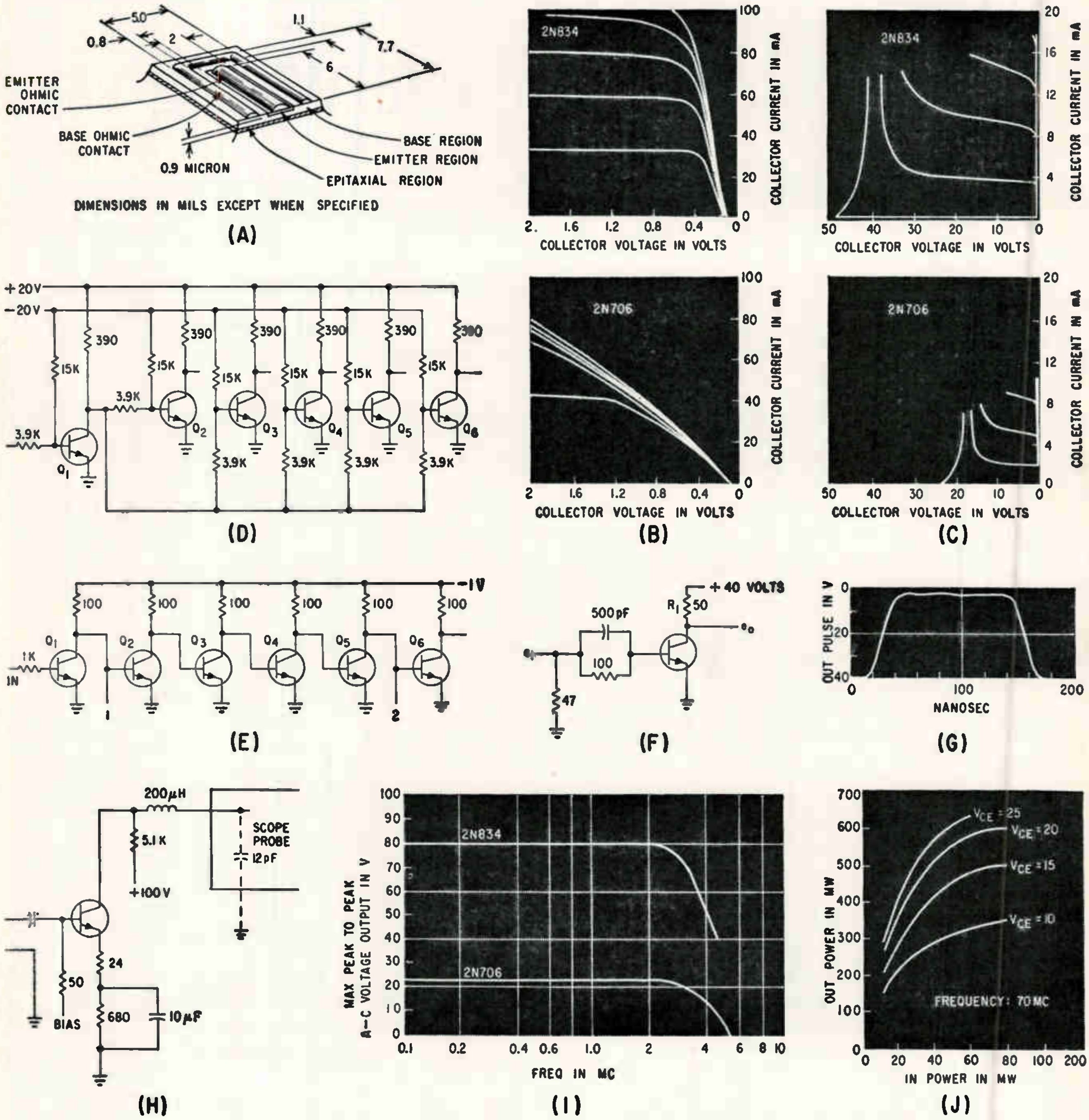


FIG. 2—Amplifier energizes relay when wire is located

Epitaxial Process Improves Transistor

Comparison of epitaxial and conventional mesa transistors shows advantages of incorporating the epitaxial growth process in manufacturing the mesa



Using epitaxial mesa structure (A) results in improved collector characteristics in saturation (B) and breakdown (C) regions; NOR circuit (D) is for transient tests while (E) is used to determine propagation time. Pulse circuit (F) has output of (G) and video output amplifier (H) has frequency response of (I). Performance of 2N834 as r-f power amplifier is shown in (J)

Characteristics

By W. D. ROEHR,
Applications Engineer, Motorola, Inc., Phoenix, Arizona

EPITAXIALLY GROWN MESA transistors combine the mesa transistor advantages of high-frequency cutoff and rugged physical structure with the alloy transistor advantage of low saturation resistance. Figure A shows why this is so.

Normal mesa transistors have a high saturation resistance (R_s) because the mesa wafer must be relatively thick for physical rigidity. Lower resistivity collector material permits a lower R_s, but at the expense of a lower breakdown rating. With epitaxial transistors this compromise is not necessary. Most of the wafer thickness is of low resistivity, hence R_s is negligible. The thin epitaxial layer is of high-resistivity material, giving a high voltage rating, but adding little to R_s.

The 2N834 and its nonepitaxial cousin, the 2N706, are compared in B and C. At high currents, saturation voltage of 2N834 is improved by a factor of four and breakdown voltage by a factor of two.

The higher resistivity material also reduces collector capacitance and thus increases the frequency limits. Furthermore, the physical area of the emitter may be reduced, since smaller area devices now yield acceptable saturation resistance. This results in still higher frequency transistors.

The NOR circuit in D allows a direct comparison of the epitaxial 2N834 and the 2N706. Here, circuit design was a compromise between 2N834 and 2N706 specifications. Collector saturation voltage of the 2N834 at 50 ma is only 0.25 v while for the 2N706 it is 1 v. Minimum h_{fe} of the 2N834 is 25, compared to 20 for the 2N706. No attempt was made to speed up this circuit as it is used primarily to compare transient response of the transistors.

A positive pulse of 20 volts is applied to Q_1, which drives the five load transistors. Typical results for a random sample of transistors are shown in the table. In this table, t_{d1} is the delay between the leading edge of the input pulse and the leading edge of the output pulse. Similarly, t_{d2} refers to the trailing edges of the same pulses. The 2N834 has a 50 percent shorter turn-on time and a 60 percent shorter turn-off time than the 2N706. Transient response is improved in all respects using the 2N834, and the output voltage levels show its low collector saturation voltage.

This low collector saturation voltage gives the epitaxial transistor an advantage in DCTL (direct-coupled transistor logic) circuits. Figure E illustrates the fast propagation time of the 2N834 operated in a chain of inverters. If the voltage on the base of the transistor is low enough, the transistor will remain cut off. The low collector saturation voltage of the 2N834 makes this possible, yielding an output signal of 0.65 volt.

An input signal of 10 volts was applied to driver Q_1 and waveforms were observed at the collector of each stage. The average propagation time for one stage is found by averaging the turn-on and turn-off delay times. The average propagation time per stage $\bar{t}_{pd} = (t_{d1} + t_{d2})/2m$, where t_{d1} is the time delay between the 50-percent points of the leading edge of the pulse, t_{d2} is the delay between the same points on the trailing edge, and m is the number of stages between measurement points.

To find the propagation time per stage, the outputs at points 1 and 2 were compared. The delay between the two pulses was then due to a four-stage shift. Typical propagation time using 2N834's was slightly over 4 nsec per stage.

Figure F illustrates the high power capabilities of the 2N834. A 15-v pulse, e_i, is applied at the input. The 40-v pulse across R_1, the 50-ohm load, is shown in G. The rise and fall times are approximately 20 nsec each. The input network of F yields a storage time of 10 nsec. Average saturation voltage drop is 1.1 volts at the peak collector current of 800 ma. Although current gain is low at this high current, performance is good.

Because of its high collector voltage breakdown, a 2N834 can serve as a video output amplifier in a commercial tv receiver as shown in H. The results of using a 2N834 and 2N706 in this circuit are shown in I. The bandwidth is nearly the same for both units, but the 2N834 develops sufficient voltage to drive a crt.

The 2N834 also makes a useful r-f power amplifier. Power of 600 mw can be obtained at 70 Mc with power gain over 10 db. Figure J shows c-w output power at 70 Mc under various conditions.

The 2N834 is useful as an a-m collector-modulated power amplifier operating from a 12-v supply where peak voltage during upward modulation would be 48 volts. Generally, h-f transistors have low voltage ratings, necessitating a low secondary voltage supply derived from a resistor divider or a zener diode regulator. The 2N834 transistor eliminates the need for these components and improves circuit efficiency.

The results presented in these varied applications are evidence of the great improvement in transistors made possible by the epitaxial process. Of prime importance is the fact that no trading off is necessary; most characteristics are significantly improved.

TIME DELAY COMPARISON

Transistor	2N834	2N706
Turn On		
t_{d1}	80 nsec	111 nsec
t_r	40 nsec	72 nsec
Turn Off		
t_{d2}	90 nsec	140 nsec
t_f	60 nsec	100 nsec
Output Level		
ZERO	0.25 v	1 v
ONE	20 v	20 v

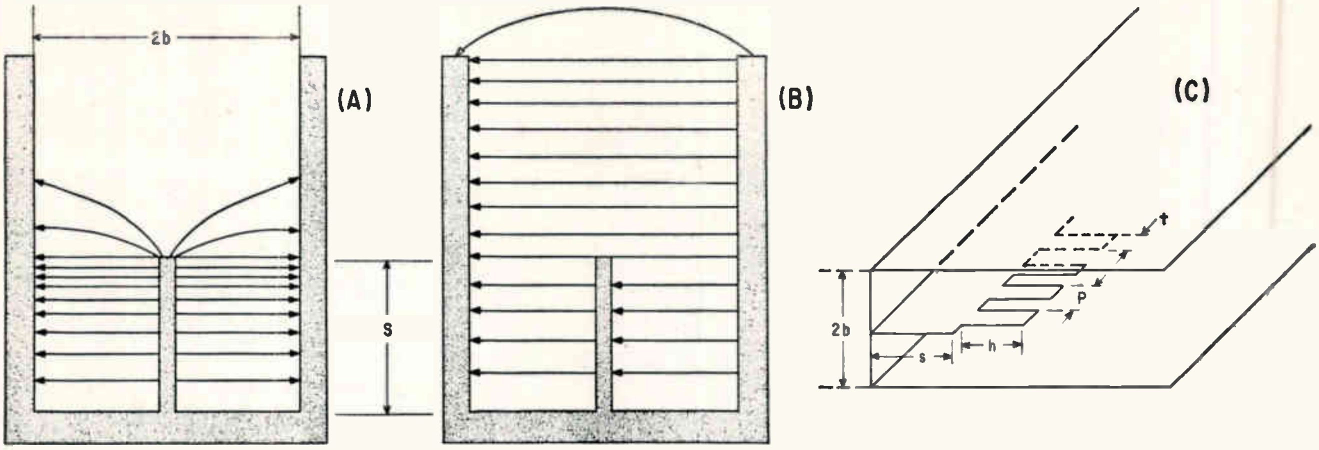


FIG. 1—Dimensions of trough waveguide showing nonradiating TE mode (A), radiating TEM mode (B), and the method of periodic loading (C)

Electromechanically Scanned Trough Waveguide Array

Obstacles deliberately introduced into trough waveguide change its transmission from a nonradiating to a radiating mode. Motor driven obstacles produce a continuously varying radiation pattern giving a 50-degree scan of radiated energy

By W. ROTMAN and A. MAESTRI, Melpar Inc., Falls Church, Va.

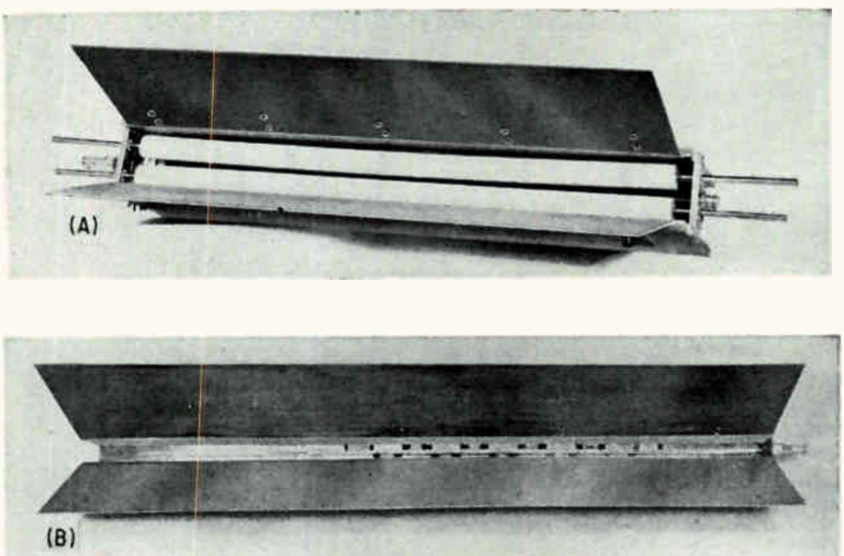
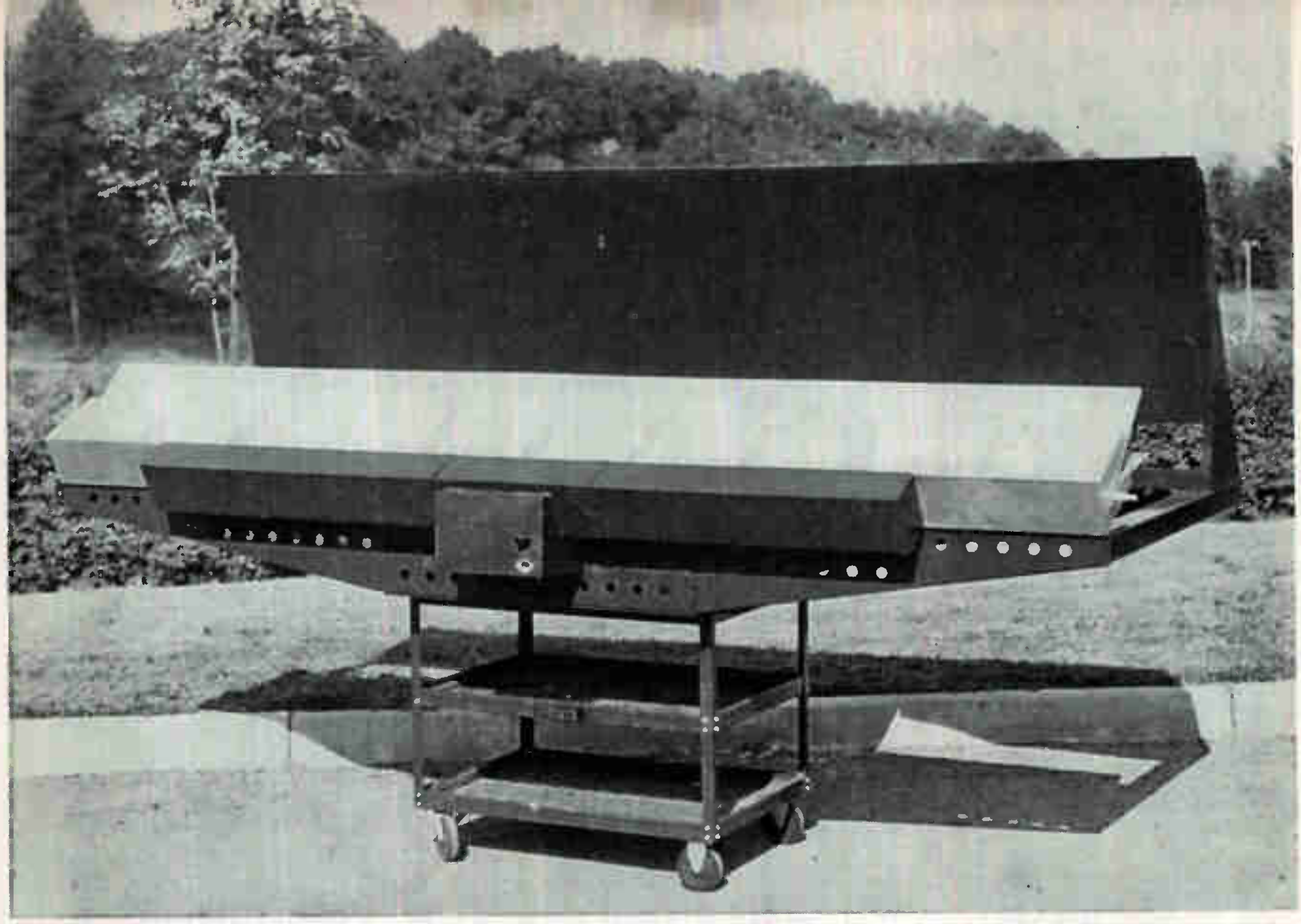


FIG. 2—Trough waveguide with anisotropic artificial-dielectric structures (A) and an array that was developed from this trough waveguide (B)

TROUGH WAVEGUIDES — relatively unexploited for antenna use—have several desirable features as r-f energy radiators, including strip transmission line simplicity, waveguide propagation, wide-band response, and radiation that is easily controlled. These characteristics, coupled with electromechanical scanning, make the trough waveguide an interesting feed for microwave antennas.

Possibly the most suitable line source (primary feed) for a cylindrical reflector or lens, the trough waveguide consists essentially of a channel with a center fin parallel to the outer walls, as shown in Fig. 1. Although physically open on one side, the structure acts as a non-radiating transmission line un-



Complete array with motor driven obstacles in the trough waveguide that change transmission mode from a nonradiating one to a radiating one

til some obstacle introduces an asymmetry into the guide. The trough waveguide combines the mechanical simplicity of a strip transmission line with the propagation characteristics of a waveguide. Its bandwidth for single-mode propagation exceeds that for a rectangular waveguide by a factor of 3 to 2.

Two methods can be used to continuously vary the guide wavelength at a suitable rate: rotation of symmetrical structures along a longitudinal axis within the trough waveguide and mechanical variation of the height of periodic structures located on the top of the center fin of the trough. A combination of both methods in short arrays was studied but emphasis was placed on the latter method to effect scanning of a 10-foot linear array.

Properties of the trough waveguide were discovered by the antenna laboratory of the Air Force Cambridge Research Center. The waveguide configuration can be derived from either a symmetric bisection of a strip transmission line carrying the first higher-order transverse electric (TE) mode, or from folding a rectangular waveguide carrying the $TE_{1,0}$ mode. The latter derivation also allows two different modes of propagation to coexist when the width of the trough waveguide is less than a half wavelength. The first, or TE mode propagates energy along the axis of the guide, with field intensity decreasing exponentially as a function of the distance from the center fin. This TE mode is bound to the center fin, and being nonradiating, satisfies the waveguide equation—a definite cutoff wavelength plus a phase velocity greater in the guide than in free space. The second and coexisting mode is the transverse electromagnetic (TEM) which can propagate. Its field configuration is antisymmetric with respect to the center fin and produces radiation whenever energy strikes the open side, or aperture, of the trough waveguide.

Placing an asymmetrical obstacle in the trough waveguide converts some energy from the nonradiating TE mode into the TEM mode. The energy in this TEM mode then radiates into space. The size and orientation of these obstacles controls the radiation along the length of the trough waveguide. Symmetrical obstacles, by contrast, have no mode-coupling effect, thus may be used as tuning elements.

A traveling-wave linear array can be obtained in the trough waveguide. If a continuous asymmetry exists in the guide, the nonradiating mode gradually converts to the radiating mode as it progresses along the trough.

Radiation from the continuously asymmetric trough waveguide is restricted in the range of angles

Design Parameters for Trough Waveguide Antenna

Design Frequency	$f_0 = 3.0$ Gc
Guide Wavelength Ratio	$\lambda_0/\lambda_g = 0.7$
Angle of Beam Maximum	$\theta = -22$ degrees
Proportion of Input Radiated	90 percent
Length of Array	78 in.
Length of Individual Blocks	1.75 in.
Trough Waveguide Width	$2d = 1.22$ in.
Amplitude Distribution	$A = 2.2 + 0.8 \cos \pi/2\ (Z/L)$

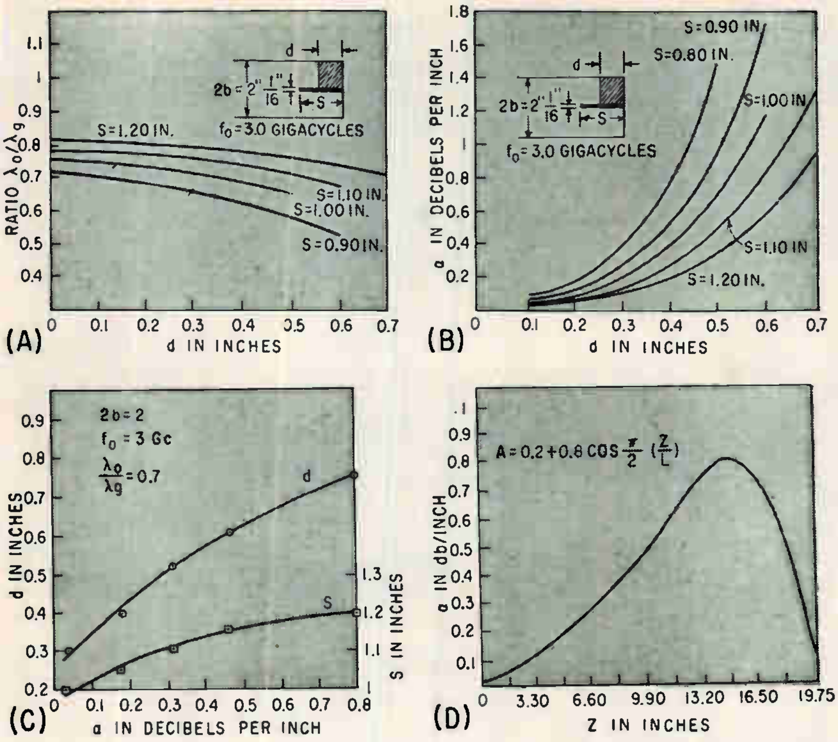


FIG. 3—Wavelength in asymmetrical trough waveguide (A), attenuation constant in asymmetrical trough waveguide (B), dimensions of periodically asymmetrical trough waveguide against a (C), and attenuation-constant against discrete points Z along the array (D)

over which it can scan. The relation between the guide wavelength and the direction of the beam maximum is given by

$$\sin \theta = \lambda_0/\lambda_g \quad (1)$$

where θ is the angle of the emerging beam with respect to the normal to the array, λ_0 is the free space wavelength and λ_g is the guide wavelength. This equation limits the practical scan to a range of angles near endfire.

Broadside and near-broadside beams can be produced, however, if the traveling wave undergoes a 180-degree phase reversal in the guide. This phase reversal can be accomplished by periodically varying the asymmetry about the center fin, or by placing blocks of uniform length along the base of the guide, alternating them from side to side.

The angle of the beam maximum in the periodically asymmetric trough waveguide is given by

$$\sin \theta = \lambda_0/\lambda_g - \lambda_0/2a \quad (2)$$

where a is the length of one base block. From this equation the beam maximum will occur at broadside ($\theta = 0$ deg) when a is made equal to one-half wavelength. In general, no other principal maxima appear if the beam is restricted to broadside and near-broadside conditions and the guide wavelength is less than twice the free-space wavelength. The beam can be scanned from the near-broadside direction through the normal direction, thus so radiators of this type have an advantage over the conventional linear array of discrete resonant elements.

A linear trough waveguide with a periodically asymmetric base can be viewed and designed as a lossy transmission line. The designer can specify phase constants and attenuation constants (radiated energy) for each section of line, even though the line itself is not continuous. Because the asymmetrical base blocks represent periodic, nonresonant impediments, the trough waveguide approximates a traveling wave array of nonresonant elements.

For scanning purposes the principal maximum of the radiated beam is at an angle expressed by Eq. (2). Rewriting the equation in terms of a and λ

$$\lambda_g = \frac{(2a)\,(\lambda_0)}{(2a \sin \theta) + \lambda_0} \quad (3)$$

reveals that the maximum value of a occurs when trough waveguide dimensions make λ_g as snort as possible.

A trough waveguide can achieve effective scanning if a suitable longitudinal distribution of radiating elements is used, and if the guide wavelength is continuously varied while maintaining a constant input frequency.

Wavelength can be varied by rotating a conducting, anisotropic structure about its longitudinal axis within and parallel to the trough waveguide. Such anisotropic structure—artificial dielectrics—embody a number of discrete, conducting objects that alter the speed of the traveling wave.

Two artificial dielectrics (24-inch long cylinders) were placed side by side in a trough waveguide. These anisotropic structures presented a soldier-like formation of beryllium-copper pins in cylindrical castings of low-loss isocyanate foam. Because wave velocity generally increases with element (pin) length, for electrically short elements an artificial dielectric of rectangular cross section will give the longest element and the greatest variation in element length. To provide the longest average element length plus a consistently and continuously variable dielectric constant, a circular cross-section was selected. Structures of this type located along the axis of a slotted line (Fig. 2A) were found to yield smooth standing-wave patterns at all angles of rotation and to provide a practical amount of variation in the guide wavelength.

Scanning can also be accomplished by mechanically varying a critical dimension within the guide, for example the height s of the center fin. Such a variation will change the wavelength within the guide and shift the phase relations in an array of radiating elements, thereby causing the beam to scan.

Since the variation of the trough waveguide propagation characteristics with frequency is similar to that of an ordinary waveguide, the existing fast wave can be accelerated by periodic loading introduced into it. This periodic loading can be accomplished by modification of the center fin only; that is, by a series of teeth in the top of the fin. Parameters affecting variation in wavelength (Fig. 1C) are the height, s, of the center fin, the height, h, and the periodicity, t/p, of the teeth.

Antenna models were constructed as shown in Fig. 2B using periodic asymmetry to produce radiation from the trough waveguide. Short arrays successfully incorporated both methods of scanning. A final antenna of aluminum was designed and fabricated with an overall length of 10 feet, the array of radiating elements being approximately 6.5 feet. These dimensions gave a three-degree beamwidth in the plane of scan. Array width (Fig. 1B) was determined from the required amplitude distribution to be 1.22 in.

To secure proper amplitude distribution, the attenuation constant in nepers per unit length is computed using the following equation

$$2\alpha(Z) = A^2 \Big/ \left[\left(\int_Z^L A^2\, dz \right) + \left(\frac{P(L)}{P(o) - P(L)} \int_0^L A^2\, dz \right) \right]$$

when $P(L)/P(o) = 1/10$.

Theoretical values of attenuation constant α and ratio λ_o/λ_g obtained from previous derivations are plotted in Fig. 3A and 3B as functions of asymmetry d and fin height s for the continuously asymmetrical case. Using these data as design parameters, the relation λ_o/λ_g was chosen for the final trough waveguide. Dimensions of the periodically asymmetrical trough waveguide (Fig. 3C) are a function of attenuation constant for a constant phase velocity ratio, $\lambda_o/\lambda_g = 0.7$. These dimensions can not be easily computed, but are readily measured.

For a given cross section the guide wavelength is almost identical for both continuous and periodic asymmetry; however, the attenuation for the periodic case is less than for the continuous structure. Near each interface the periodic type behaves as a symmetrical structure and radiates less, thus reducing the average attenuation rate.

Attenuation data for the periodic asymmetry was obtained by measuring the insertion loss of a uniform section of trough waveguide with and without the periodic asymmetry. Amplitude distribution across the aperture of the array appears in Fig. 3D as a plot of attenuation constant α at discrete points Z along the array. The equation for amplitude distribution A includes total length L of the array.

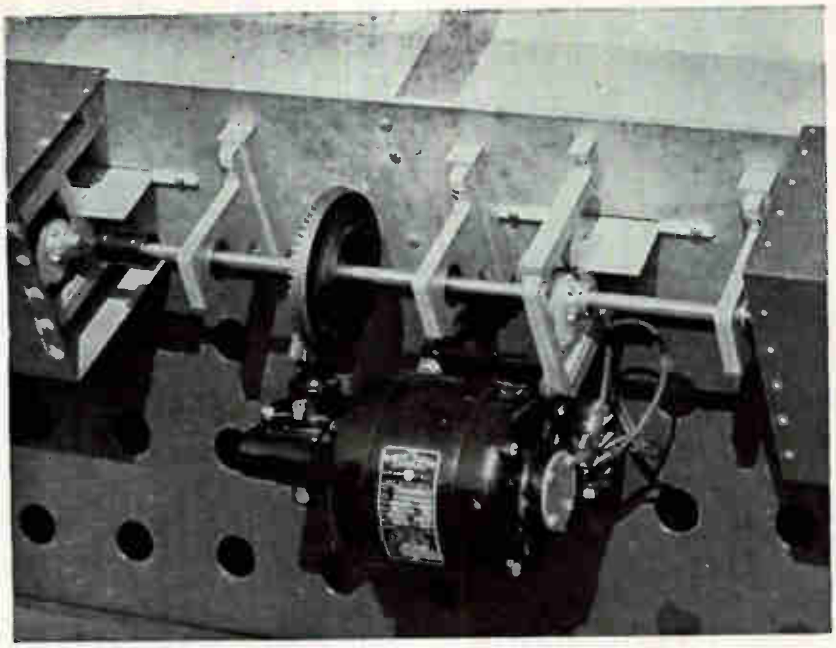


FIG. 4—Motorized cams drive obstacles into the trough waveguide to change its transmission characteristics according to a predetermined pattern

The final array was scanned during periodic loading of the center fin, this loading being done by serrating the top of the center fin (Fig. 3). Continuous variation in the height of the serrations (a necessity for varying the guide wavelength) was permitted by constructing the center fin in three sections—two stationary side pieces and a movable serrated center piece. Capacitive coupling linked both movable and fixed pieces.

Augmenting the scan capability of the waveguide, a parabolic cylinder restricted the issuing beamwidth to ten degrees in the nonscan (elevation) plane. Thus the final antenna consisted of a trough waveguide array feeding a parabolic reflector, with scanning action accomplished by mechanically changing the height of periodic structures on the center fin of the waveguide.

Variation of center fin periodic loading was accomplished smoothly and continuously by a cam-link arrangement which transformed rotary motion of a drive shaft into reciprocating motion of the serrated portion of the center fin. Positive-action cams eliminate the use of springs or gravity to maintain contact between the cam and follower. The mechanism and drive motor are shown in Fig. 4. Speed of the scanning mechanism can be varied from zero to 120 rpm, a speed of 60 rpm yielding a scan rate of 90 degrees a second. The design of the final antenna includes the parameters listed in the table.

Radiation patterns of this antenna were measured over the frequency range: 2.8 Gc to 3.2 Gc, for both scan plane (azimuth) and elevation. Scanning can be done either by rotating an anisotropic dielectric structure within the guide, or by periodic loading of the center fin.

The trough waveguide offers a new geometry in the designing of arrays, and also offers additional possibilities for rapid, wide-angle scanning. This type antenna should prove useful since the geometry of the trough waveguide provides a scanner operating within a minimum volume.

The research discussed in this article was sponsored by the Electronic Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command, under contract AF19(604)-4056.

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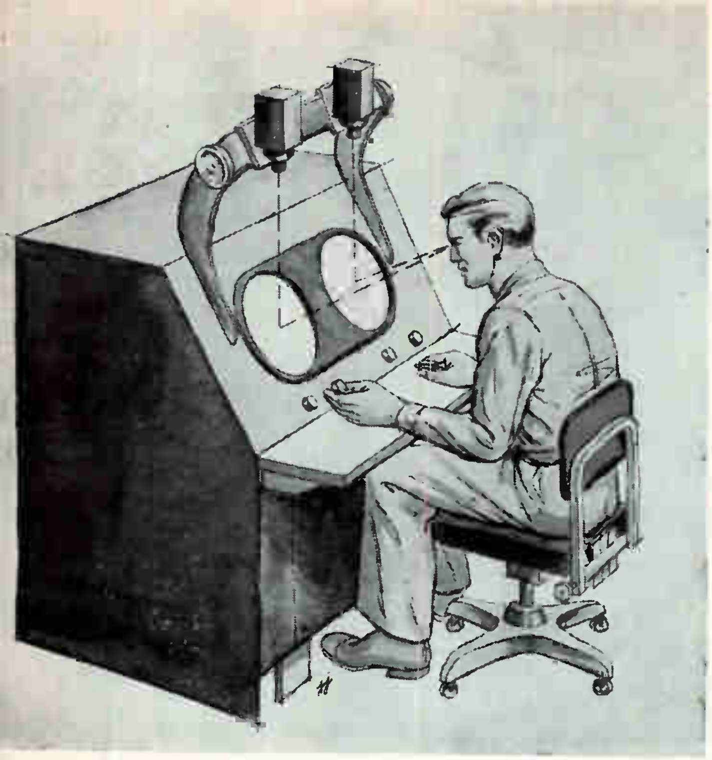

FIG. 1—Projector is positioned above console to avoid interference with observer, and to prevent reflections visible in normal operating position

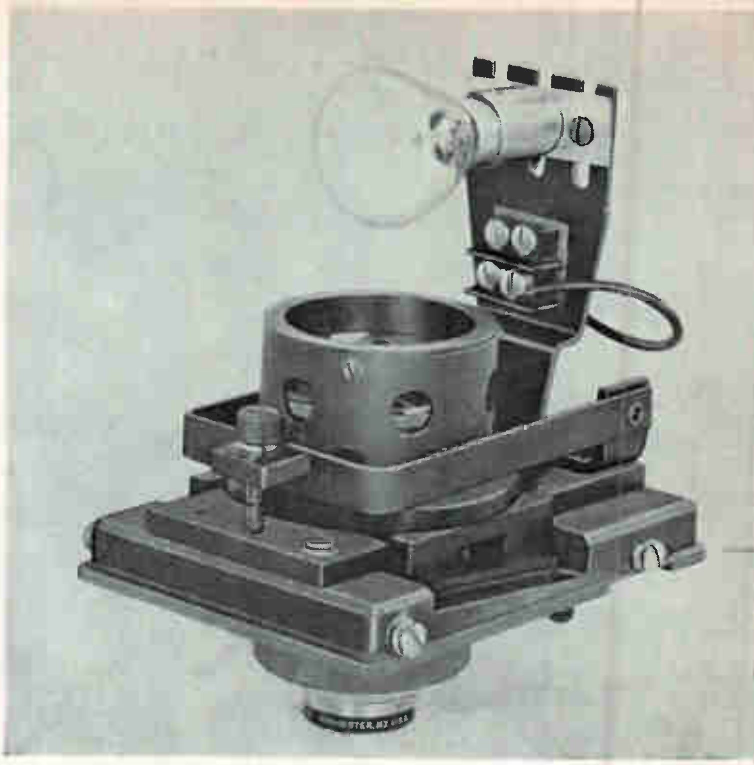

FIG. 2—Projector/camera unit with cover removed. Note the inclined film plane for focusing on the standard screen

Optically Projecting Data On a Cathode-Ray Tube Face

Avoids parallax in superimposing maps and grids on radar display

By HERBERT H. NAIDICH,*
ITT Laboratories, Nutley, N. J.

RADAR AND NAVIGATION CONSOLES and other devices using cathode-ray tube displays often require maps or grids superimposed over the cathode-ray image. Ideally, such overlay should appear in the same plane as the phosphor image, and its brilliance should be adjustable independently of the crt image intensity. For clarity, the overlay should also have a contrasting color or colors.

Mechanical methods of overlay range from the edge-lighted Plexiglass graticule on service oscilloscopes to complex optical devices that give the illusion that the map is superimposed on the electronic display. However, mechanical methods always encounter the parallax problem; and because of the crt face curvature the solution is often a compromise. A limited viewing angle often restricts the number or position of observers.

Video mapping is another method used for map superposition. By flying-spot scanner techniques, the map is converted into electrical signals and mixed with the target video. In this way, the map presentation resembles normal video. Although video mapping eliminates the parallax problem, it involves complex electronic equipment and this often makes it prohibitive.

A new approach to solving these problems is the map projection technique. Using a conventional incandescent light source, the map or grid is projected directly on the crt, whose phosphor face makes a reflecting screen. To avoid interfering with observer, the projector is placed at top of the display console; its optical axis forms a sharp angle with screen (See Fig. 1).

Oblique projection, of course, implies an optical distortion of the map. To compensate for this, a severe predistortion must be introduced into the map slide. The following problems must be considered:

(1) Lens magnification is a function of lens-to-image length, that is, portions of the map at the bottom of the crt receive greater magnification than portions at the top.

(2) Projected light must pass

* Formerly with Radio Division, Bendix Corporation

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through the Plexiglass overlay (normally amber for a P7 phosphor) and through the glass faceplate of the crt. Both these factors may bring in objectionable reflections.

(3) Light intensity falls off as the square of the projected distance, therefore the projected map has nonuniform brightness.

(4) As the light rays pass through the overlay and the glass faceplate at varying angles of incidence, refraction will displace portions of the map by different amounts. The lower portions of the map would be shifted downward more than the upper portions, since the light rays forming the bottom portion enter the refracting surfaces at greater angles of incidence than the rays forming the upper portions of the map.

(5) The curved surface of the screen would cause pincushion distortion even if projection were normal to the crt face. Oblique projection complicates this distortion still further.

(6) The entire projected image must be sharp, but large depth of field in the lens system would make for uncritical focusing. The focusing adjustment would cause changes in magnification, thus producing distortion.

(7) Sharp focusing and a large depth of field are indicated, but these are conflicting requirements. Large depth of field would make for uncritical focusing. The focusing adjustment, however, would cause changes in magnification, and this would cause distortion on the curved screen surface.

To take care of the distortion problems, the map slide must be predistorted. However, it would be impractical to calculate the magnitude of each error introduced by projection and to try to compensate for all errors when preparing the slide.

With the new system, predistortion is introduced into the slide by reversing the projection process and using the projector as a camera. The map or grid, full size and undistorted, is placed on the inside surface of a glass faceplate cut from a crt of the proper size. This dummy tube is then placed in the crt mount, and the Plexiglass overlay is put in place. The projector then photographs the map and the slide is suitable for distortionless projection.

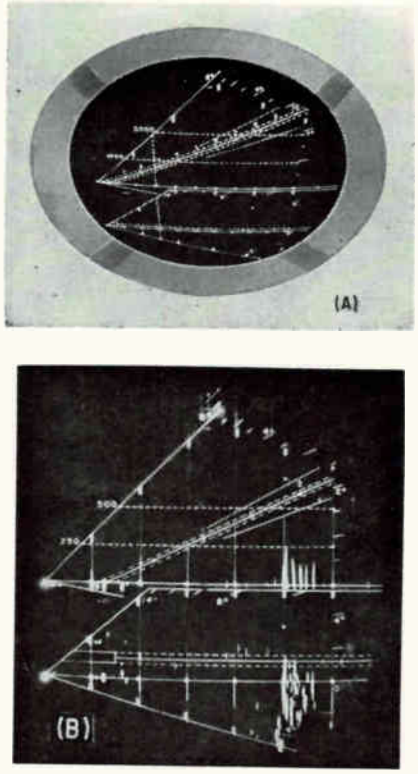

FIG. 3—A predistorted slide, slightly enlarged, is seen in (A). Projected map as seen on crt is shown in (B). The map is for a precision approach (GCA) radar display

The projector/camera unit (see Fig. 2) has a film plane tilted with respect to the optical axis. The tilt is in agreement with the lens equation, $1/f = 1/u + 1/d$, where f is the focal length of the lens, u is the subject distance and d the image distance. The tilt produces critical focusing across the entire face of the crt, and the depth-of-field problem becomes negligible. However, the tilt is in a direction to increase the magnification distortion on the negative. A 6-volt automobile lamp serves as projection lamp, and the condensing lens system is conventional. A locking bracket secures the slide in place after accurate positioning.

To prepare the map for photographing, the lines and numbers of the map are pasted on the inside of the dummy crt surface. Then the entire surface is covered with a white cloth as a contrasting background. A test slide helps for focusing, centering and adjusting the projector. It is necessary to have the optical axis of the projector intersect the axis of the crt, and to keep the film plane and map plane positioned with respect to each other.

Once the projector is in position, its outer cover, condensing lens and lamp are removed. The map blank is illuminated by two photoflood lamps, and the film is exposed by turning on the floods. Kodalith film has proved to be satisfactory: it gives high contrast and fine detail. A red safelight may be used, but otherwise the photography process takes place in a darkened room. Figure 3 is a sample of the predistorted slide that results.

When the dummy tube is removed and the crt installed, the projector is again centered and focused by a test slide. Five small dots on the crt face—one at the center and four on the X and Y axes—correspond to similar dots on the slide. Once centered, the slide is locked in place.

The projected map appears in the same plane as the cathode-ray information on the curved phosphor surface. The map presentation is pleasing and can be improved by a colored filter; a red filter gives especially good results. Reflections from the surfaces of the Plexiglass and the crt outer surface are not apparent to the observer in his normal viewing position, unless the reflecting surfaces become dirty. The reflections become visible if the viewing angle equals the angle of incidence of the projected light, but this does not include the normal viewing angle and so reflections are not a problem.

This method of map presentation is highly accurate. Quantitative errors are difficult to measure here for the map appears on the inside of the crt glass faceplate that is behind the Plexiglass overlay. Map specifications are usually in terms of flat surfaces, and one of the compromises that must be made is in the method of preparing the original map on the inside of a curved surface.

The author wishes to acknowledge the encouragement of W. Hicks, W. O'Hara and J. Nolen on this project.

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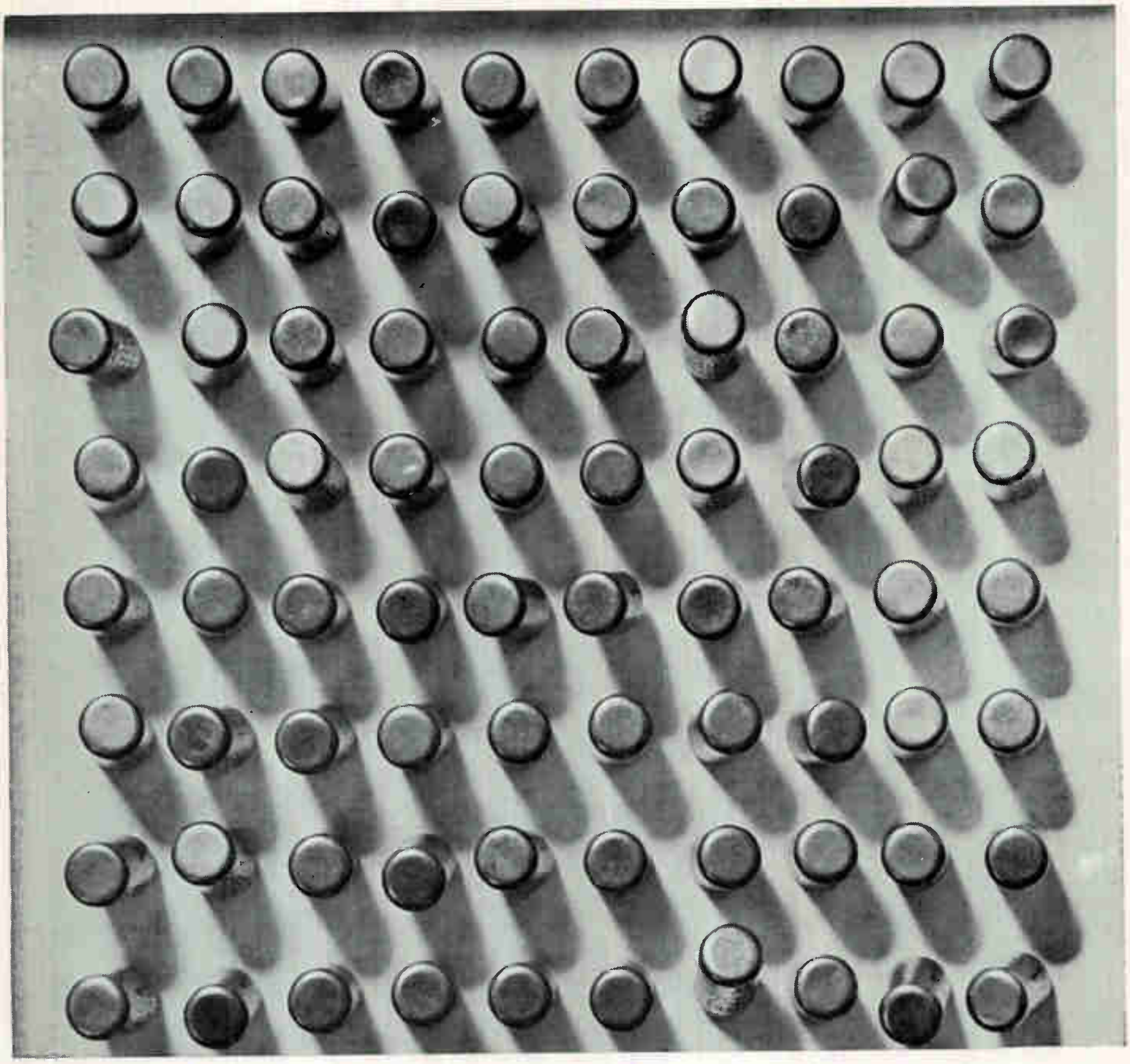

Microwave Figure of Merit for Tunnel Diodes

By HATSUAKI FUKUI,
Sony Corp., Tokyo, Japan

FIGURE of merit for tunnel diodes at microwave frequencies can be determined from an equivalent circuit. Comparisons of actual and calculated values demonstrate accuracy of the circuit from low to microwave frequencies. By permitting separation of characteristics, the circuit provides a means of evaluating tunnel diode performance at high frequencies.

Tunnel diode admittance was measured at frequencies from 0.3 to 4.6 Gc using the standing-wave method. The tunnel diode was terminated in a purely resistive load to avoid oscillations when the diode operated in the negative conductance region.

A solid brass block having the same dimensions as the tunnel diode was used. It was mounted in place of the diode to determine the point of minimum standing wave voltage, which was used as a reference to indicate infinite admittance. The diode was then inserted in place of the block and its admittance was measured with input level limited to 1 microwatt. The measurements demonstrated that within this level, tunnel diode admittance was independent of input. From measured swr and the minimum voltage point, admittance at the reference was calculated. This value of admittance is equivalent to tunnel diode admittance.

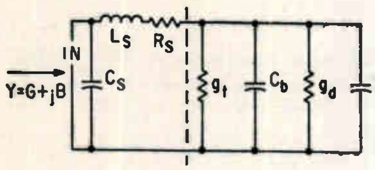

FIG. 1—Small signal equivalent circuit represents tunnel diode characteristics

In the negative conductance region, swr can be expressed by negative values. The presence of negative conductance was apparent from amplitude of the standing wave, which exceeded that of total reflection. For a Sony 1T1103 tunnel diode, negative conductance was observed at the input terminals at 4.6 Gc.

The equivalent circuit for a tunnel diode is shown in Fig. 1. Values that are dependent on bias voltage are tunnel conductance g_t, barrier capacitance C_b, diffusion conductance g_d and diffusion capacitance C_d. The negative region for g_t is in the direction of easy flow. In regions of small bias voltage, g_d and C_d can be neglected for either direction of flow because of their insignificance compared with tunnel current.

To determine capsule capacitance C_s, measurements were made on a number of burned out tunnel diodes. The most probable value of C_s was estimated to be 0.85 pf. Bulk resistance R_s and capsule inductance L_s were determined by increasing bias to produce a large value of g_t. The value of R_s was found to be $2.5 + 0.5\ (f)^{1/2}$ ohms, where f is frequency in Gc, and L_s was 0.21 ph.

Junction admittances $(g_t + g_d$ and $C_b + C_d)$ are essentially independent of frequency. For capacitances C_b and C_d the relationship between bias voltage and $1/(C_b + C_d)^2$ was plotted as shown in Fig. 2A. Capacitance in the linear region resulted from C_b, which satisfies the barrier capacitance equation in the case of a step junction. In the diffusion current region, the relationship deviates from a straight line because of added capacitance C_d. The values obtained from the plot agree well with the calculated values for a comparable germanium *pn* junction. The values of C_d shown in Fig. 2B also agree closely with the calculated value for diffusion capacitance in the high bias region.

Because of the close agreement between calculated and observed results, the equivalent circuit can be used to represent tunnel diode characteristics with sufficient accuracy to be used from low to microwave frequencies.

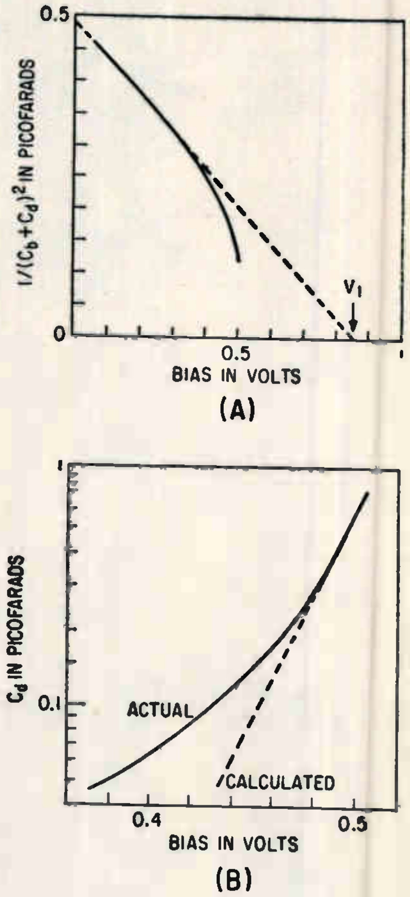

FIG. 2—Plot at (A) shows agreement with capacitance of comparable germanium pn junction with plot at (B) also agreeing with calculated C_d at high bias region

The tunneling that is responsible for negative conductance requires little time. Because of junction capacitance, however, time constant C_b/g_t limits response time. Therefore, a minimum value of C_b/g_t is of primary interest as a figure of merit for a tunnel diode at microwave frequencies. The minimum value of C_b/g_t was found to be about 1.1×10^{-10} sec. Approximate calculation indicates that this value corresponds to that of the germanium *pn* junction.

Time constant C_b/g_t accounts for only the junction, but total time constant for the tunnel diode must include bulk resistance R_s and capsule inductance L_s. Using the

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SYNCHROS

	VOLTAGE (400 cps)	CURRENT (amps)	IMPEDANCE INPUT	IMPEDANCE OUTPUT	T.R.	NULL (mv)	ERROR (min)
Transmitter CJO 0565 100	26	.045	576 /74.7	94.2 /71.4	.454	34	10
Control Transformer Low Z-CJO 0555 100	11.8	.0408	250 /73	1085 /72	1.765	34	10
High Z-CJO 055 900	11.8	.0202	550 /74	2390 /73	1.765	34	10
Differential CJO 0595 100	11.8	.0408	250 /72	313 /69.8	1.154	34	10
Resolver Low Z-CJO 0585 100	26	.0485	537 /64.7	677 /74	1.0	34	10
High Z-CJO 0589 100	26	.0145	1795 /68.1	2210 /76	1.0	34	10

Weight: 0.90 oz; Length: 1.250 in.

SERVO MOTORS

	J126-06	J126-02
No-Load Speed	9800 rpm	9800 rpm
Stall Torque	0.10 in. oz	0.10 in. oz
Rotor Moment of Inertia	0.175 gm cm^2	0.175 gm cm^2
Voltage $\phi 1 / \phi 2$ (400 cps)	26 /36-CT	26 /26
Power Input /Phase	1.7 w	1.7 w
Duty	continuous at stall	

SYNCHRONOUS MOTOR

	CJO 0172 200
Pull-In Torque	0.06 in. oz
Pull-Out Torque	0.10 in. oz
Pull-Out Power	4 w
Length	1.24 in.

MOTOR GENERATORS

MOTOR	CJ4 0812 001	CJO 0812 650	CJO 0813 200
Voltage $\phi 1 / \phi 2$ (400 cps)	26 /36-CT	26 /36-CT	26 /26
Power / ϕ	1.5 w	1.5 w	1.5 w
No-Load Speed	8000 rpm	8000 rpm	8000 rpm
Stall Torque	0.10 in. oz	0.10 in. oz	0.10 in. oz
GENERATOR			
Voltage (400 cps)	26 v	26 v	26 v
Power	1.5 w	1.5 w	2.0 w
Volts /1000 RPM	0.1 v	0.1 v	0.5 v
Null	1.3 mv	10 mv	6.7 mv

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equivalent circuit, resistive cutoff frequency and self-resonant frequency are 5.6 Gc and 8.7 Gc, respectively.

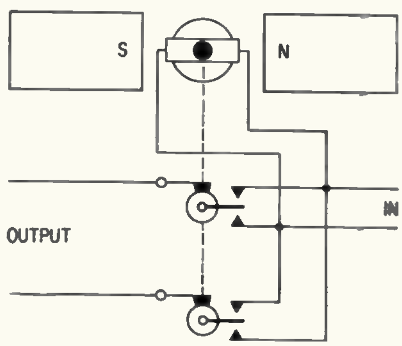
Polarity Protection for Transistor Circuits

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

PROTECTION of polarity-sensitive equipment is provided by a simply constructed relay. It functions reliably over a wide range of power loads and can be easily miniaturized. Heavy-duty applications only require that current through the relay coil be limited.

Primary need for the polarity-seeking relay was for use with battery-operated transistor receivers and test equipment. However, it is expected to be useful in many applications where incorrect polarity can damage equipment or interfere with its operation, particularly when the result of incorrect polarity may not be readily apparent.

Voltage to the equipment is applied across the armature coil in the figure. The field produced by current through the coil reacts with the field of the permanent magnets imparting torque to the armature. Direction of rotation of the armature is dependent on polarity of the input voltage.



Polarity of output is always the same regardless of input polarity

Two slip rings are mounted on the armature, and a brush wiping each ring is connected to the output terminals of the polarity-sensing relay. Two switching arms are also mounted on the armature, and each arm is electrically connected to a slip ring. Rotation of the armature in either direction completes circuits between the input and output terminals. However, polarity at the output terminals is always the same because direction of rotation of the armature will be reversed if input polarity is reversed.

Two helical springs keep the armature at a neutral position in which no contacts are completed by the switching arms when no input is applied. When voltage is applied to the input, armature torque overcomes the slight force of the springs rotating the armature in the appropriate direction for correct input polarity.

Phase-Lock Receivers For Ionosphere Study

PROPAGATION of radio frequencies through the ionosphere will be investigated using a six-receiver system. Each receiving station will operate at 20, 40, 41, 108, 360 and 960 Mc.

The high-sensitivity receivers were designed by the Electronics and Ordnance division of Avco for the National Aeronautics and Space Administration. Two large cabinets each house three of the receivers, power supplies, tuning controls and frequency synthesizers.

The equipment will be used in conjunction with a NASA satellite that will transmit on all six frequencies. It is hoped that much more information can be obtained about affects of the ionosphere on radio transmissions at different frequencies and times. The satellite will be launched in an elliptical orbit having an average altitude from the earth of 500 miles.

Each receiver can be locked in phase on a signal of the particular frequency transmitted from the satellite. Phase comparators will detect and measure the relative phase shift or delay between any two of the six received signals.

Plans for the project are to gather data over the next year. The receiving systems will be installed at Cape Canaveral, Huntsville, Stanford University, Boulder Laboratories, University of Illinois and Pennsylvania State University.

Removing Oxidation from Conductive Paths

A SIMPLE PROCESS for depositing a pure tin coating onto copper, copper-based alloy and lead-tin electroplate is eliminating production bottlenecks in printed cricuit manufacturing operations where oxidation, and its resulting effects on solderability, are a problem.

In another application, the same process eliminates soldering problems with lead wires on resistors and capacitors caused by nonuniformity of hot tin dipping. Simple treatment makes the wires solderable.

One manufacturer of soldering irons uses this process to deposit tin onto soldering iron tips, thus eliminating the necessity of tinning the iron to make the tip wet more easily.

Another company uses the process to restore or impart brightness to electronic parts and assemblies, especially where appearance is an important consideration.

Solving these wide spread solder problems is the work of CUPOSIT LT-26, made by Shipley Company, Inc., of Wellesley, Mass. The new process is so simple that parts can be treated in bulk by inexperienced operators, with great advantages in production rates and savings in labor costs for the user. Immersion in the solution cleans lead-tin electroplate, even after it has been etched by ammonium persulphate, and makes the printed circuits solderable.

In most circuit manufacturing or assembly, cleaning is done in three-stages beginning with dipping the part for 5 to 10 minutes in a cleaning solution. Then each part gets a vigorous wire brushing by hand, followed by a hot water rinse. Holes, in through-hole circuits, are inadequately cleaned by this method. At a normal production rate of 25 to 30 average boards per man-hour, a number of cleaning stations are required to provide the cleaned parts for the assembly lines.

By contrast, the Shipley process is fast and simple. A solution, made up of water, hydrochloric acid and LT-26 concentrate, is heated to 160F. Copper parts need to be precleaned before immersion, but lead-tin plated parts do not. Dry parts are placed on a rack, immersed in the solution for 30 seconds to 5 minutes depending on the thickness of the tin coating required, then removed and agitated for one to two minutes in a warm water rinse. The oxidized areas have been cleaned and a uniform coating of pure tin covers all the metal surfaces including the copper edges of the conductive paths as well as the plated surfaces on the sides of the holes in through-hole circuits. The number of parts which can be processed at one time is limited only by the capacity of the bath.

Since tin is not deposited over non-conductive surfaces, the solution does not affect dielectric materials. Printed circuit panels of glass-cloth epoxy, paper-based epoxy and paper-based phenolic materials showed no adverse effect on insulation resistance when tested according to A.S.T.M. E. 104-51.

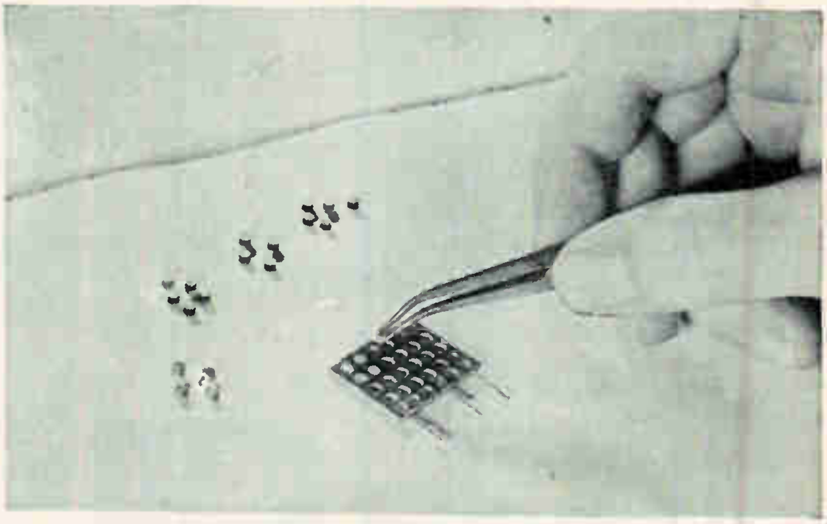
The tin deposited coatings are sufficiently dense to withstand immersion in hot chromic sulphuric acid, but they will be attacked by ammonium persulphate, ferric chloride and proprietary chromic acid etching solutions. Thickness of the deposits increase with the length of immersion time:

0.000010 in.	thickness	in	1 min.
0.000015 in.	"	in	2 "
0.000030 in.	"	in	5 "
0.000050 in.	"	in	10 "
0.000100 in.	"	in	60 "

In addition to cleaning oxidized surfaces of lead-tin electroplate, the solution provides excellent resistance to oxidation on copper and lead-tin electroplate. In accelerated life tests in a 95 percent humidity chamber in the presence of an oxidizing agent, copper and lead-tin electroplate treated with LT-26 showed no adverse effects, but untreated lead-tin electroplate became badly oxidized and unsolderable. This last part was later treated and restored to solderable condition.

With such protection against oxidation, printed circuit users either

Microcomponent Packaging Concept



This unitized component assembly, in which all components are of uniform size and shape regardless of function, illustrates the Mallory Company's packaging concept.

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How to get accurate data on a small recorder

Ampex's new CP-100 nicely balances four desirable qualities

Compact. Definitely, and a great advantage in trailers, in airplanes, in submarines, or even in regular laboratory use. There's complete front access to everything. All-transistor amplifiers and power supplies cut power needs and keep down the heat – an advantage in tight equipment layouts.

Portable. We'll frankly admit it takes two men to carry it – not just one and a half. But by calling in an occasional fractional man (or by using an accessory dolly) you gain exactly the needed performance that portables have lacked until now. In laboratory use, the CP-100 is "bench-top equipment."

Precise. Let the numbers talk. Though compact, the CP-100 is a full-fledged, uncompromised laboratory recorder: 200 kc response at 60 ips tape speed (and proportional at others); flutter well within telemetered-data requirements; intermodulation distortion so low it never adds spurious data of its own.

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The essential data
Model: CP-100 Compact Recorder/Reproducer. *Reel size and tape width:* 10½-inch reels with ½- or 1-inch tape (as specified). *Types of recording:* direct or FM carrier by plug-in interchangeable amplifiers. *Tape speeds:* 60, 30, 15, 7½, 3¾ and 1⅞ ips. *Frequency response:* direct, 300 to 200,000 cps ± 3 db at 60 ips; FM carrier, 0 to 20,000 cps at 60 ips; response at other speeds proportionate. *Tape compatibility:* yes, with Ampex FR-600, AR-200 or interchangeable with FR-100, FR-1100, 300 and 800 series.

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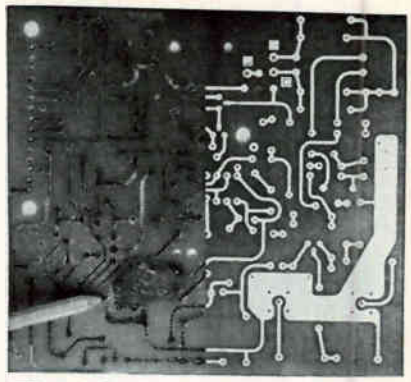


The right half of this badly oxidized printed circuit was cleaned by immersion in a solution which removed oxidation from the conductive paths, covered them with a coating of pure tin and made the part solderable. The dielectric materials are not affected. All metal surfaces are coated and protected against oxidation

purchase or manufacture circuits for inventory, knowing that these parts will be useable without further treatment when they are needed.

The solution is easily mixed in containers of pyrex, ceramic, high-temperature plastic or plastic-lined steel. It does not contain cyanides. In mixing a 10-gallon solution, a half-gallon of 22 deg. Baumé hydrochloric acid is added to 8½ gallons of water and heated to 180 F. Then 12½ lbs. of concentrate is stirred in until dissolved. The solution is highly stable. It may be cooled to room temperature when not in use, then reheated for reuse.

In addition to use with printed circuits, LT-26 has many other applications. Typical uses are for preventing oxidation and improving solderability of terminal lugs, eyelets, electronic hardware and fabricated parts made of copper, copper-based alloys or lead-tin plate.

Silicon Threads Grown For Strain-Gage Uses

A GROUP OF SCIENTISTS at Picatinny Arsenal is finding silicon whiskers useful in their research work.

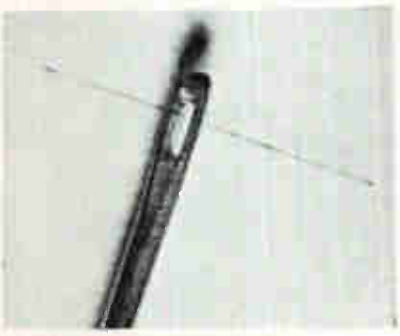
Made from silicon crystals, the whiskers are used as strain gages for detecting weaknesses in mechanical parts. Short lengths of the whiskers are attached at various points on airplane landing gear and wired into electrical circuits containing indicating meters.

As the part bends imperceptibly

under normal use, the whiskers are stretched and compressed. Subsequently, the resistance of the whisker is either increased or reduced, registering the amount of strain of the landing gear. If, because of the design or shape of the part, it becomes weakened or breaks, the part is redesigned to eliminate the weakness.

The whiskers are grown by placing crystals of silicon mineral in one end of a sealed quartz tube and heating it until it vaporizes. The vapor condenses at the cool end of the tube, forming whiskers about one-half inch long and one thousandth of an inch in diameter, small enough to be threaded through the eye of a needle.

Similar whisker-like growths sometimes form on telephone relays, causing malfunctions. The growths possess remarkable tensile strength, as much as one million pounds per square inch. Investigation led to present application.



In view magnified 10 times, mineral thread easily slips through eye of needle for size comparison

Silicon was selected as the best material for manufacturing the whiskers because when it is compressed or stretched, its electrical resistance changes, causing more or less current to flow in its electrical circuit. Other materials have this property, but to a lesser degree. Gages of silicon whiskers are 50 to 60 times more sensitive than those using conventional materials.

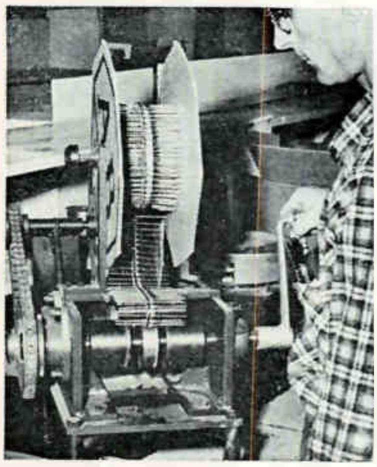
The development of Picatinny's use of silicon was directed by Edward D. Padgett.

Picatinny Arsenal is the U. S. Army Ordnance Corps' principal research and engineering center for ammunition and special weapons and has developed warheads for the country's most formidable nuclear and non-nuclear missiles.

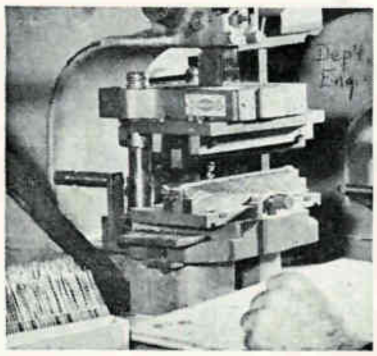
Cutters, Benders Prepare Parts Leads Quickly

ROLLERS, PRESSES, BARS and cams can all be used as well as the more familiar knives and shears to repidly cut and form component leads. All are being used at Erie Resistor Corporation's Elgin Laboratories, Waterford, Pennsylvania, in addition to commercially-available component preparation devices.

The first devices described below are loaded in bulk from the packages in which the components are supplied. The others handle loose components. Although most of the strip packages and printed wiring assemblies made in quantity by the firm are hand assembled, component preparation helps maintain uniformity and speed assembly.



Hand crank operates roller-cutter



Arbor press set up for lead shearing

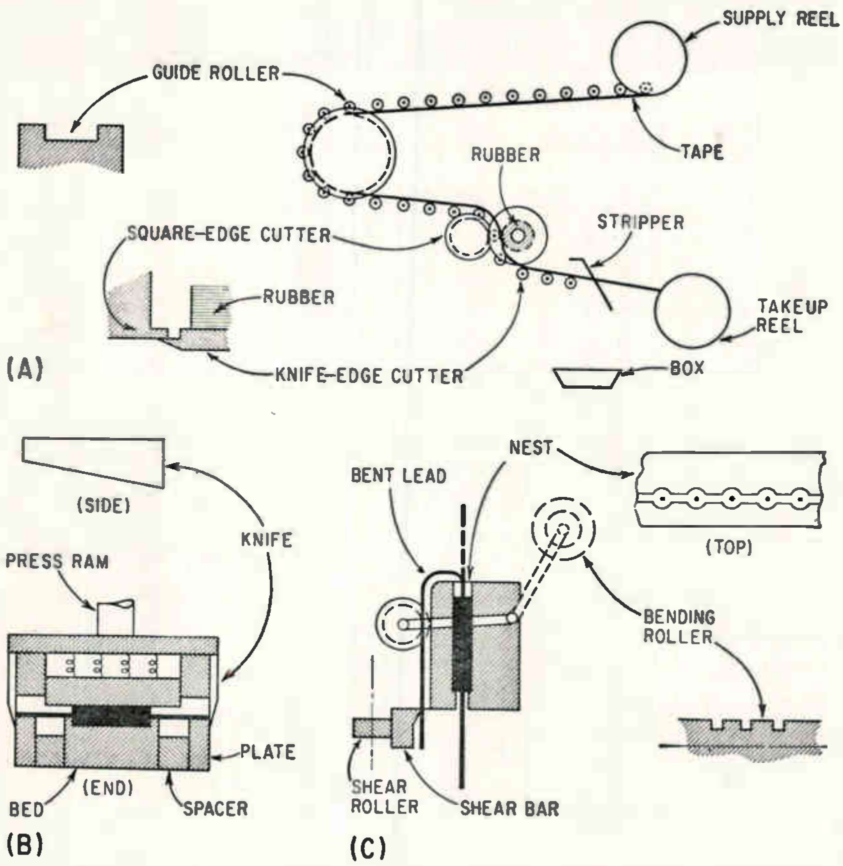


FIG. 1—Sketches illustrate the operation of the roller-cutter for tape-packaged components (A), cutter (B) and cutter-bender (C) for strip-packaged components

A roller-cutter for components supplied on adhesive tape belts will trim leads at a maximum rate of 150,000 components an hour. The cutter is operated by a hand crank.

Its roller arrangement is shown in Fig. 1A. The crank turns the axle of the square-edged cutter, which is geared to drive the other cutter. A belt from the axle drives the takeup reel, which pulls the tape through. The leads are sheared as they reach the contacting edges of the cutters. As the components pass between the cutters, they compress a corded rubber drum in the knife-edged cutter. The friction of the rubber keeps the components moving with the tape. Springback frees the components from the cutters as they emerge. Components can be re-reeled on the same tape. To drop them loose into a box a fork-shaped stripper plate is mounted with a tine on either side of the tape to push off the components.

Arbor presses provide shearing force when relatively small amounts of components packed in cardboard strips are to be trimmed. The strips are placed in the recessed bed of the lower die Fig. 1B. Leads extend over the outer plates, which are positioned by spacers to the desired lead length. The knives are set at an angle (side view) so they shear the leads one at a time as the press ram is lowered. Springs above the upper plate prevent the component bodies from being crushed.

Another arbor press is used to bend the leads of strip-packaged components. The setup is the same, except that plates with dull, parallel edges are used instead of the knives. If the lower, outer plates and all the spacers are removed, leads can be accurately bent next to the component bodies.

The leads of strip-packaged com-

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Radio Specialties Co., 12775 Lyndon

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Lafayette Radio Corp. of N. J.
24 Central Avenue

New York, New York
Harrison Radio Corporation
225 Greenwich Street
Terminal-Hudson Corporation
236 West 17th Street

Paterson, New Jersey
Pop's Tool Shop, 76 River Street

Philadelphia, Pennsylvania
Almo Radio Co., 913 Arch Street
Philadelphia Electronics, Inc.
1211 Vine Street

Pittsburgh, Pennsylvania
Radio Parts Co., 6401 Penn Ave.

IN THE MIDWEST

Chicago, Illinois
Allied Radio Corporation
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Newark Electronics Corporation
223 West Madison Street

Cincinnati, Ohio
United Radio, Inc., 1314 Vine St.

Dayton, Ohio
Srepco, Inc., 314 Leo Street

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Radio Specialties Co., 209 Penn Ave.

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Radio Specialties Company, Inc.

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Busacker Electronic Equipment Co.
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Model TC602 - 60 watts **$10.00** list
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(prices shown are for irons with tip and 2-wire cord)

Send for NEW Magnastat Soldering Iron literature

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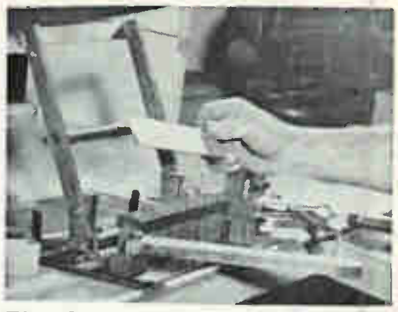
CIRCLE 71 ON READER SERVICE CARD



This device bends and shears leads

ponents are bent and sheared for standup mounting (body at right angles to circuit board) with the device illustrated in Fig. 1C. The card is held in both hands and all the leads on one side of the card started in the row of nests. The card is shaken so the components drop into the nests.

The bending roller is pulled forward so each of the circular grooves engages one of the top leads. Continuing the pull bends each of the top leads down across the face of the nest block. The shear bar is swung in place against the leads and the shear roller placed against the bar. The roller is mounted on a lever arm. As the lever is pulled, the roller travels from right to left along the bar, so force is applied to each lead in turn. The bar is provided with overtravel so it will shear the straight leads after the bent leads. To remove the components, the operator puts a thin metal strip under all the leads and lifts the strip. When the components are clear of the nests, the components are slid from the strip into a box.

Fig. 2 shows how Elgin loops the ends of leads to prepare components for cage-type assemblies. The loops fit over the cage's riser wires. There are several variations of this device, each forming the loops by rolling the ends of the leads around pins.

Leads are placed against the center pins. The operator holds the component body with his thumb

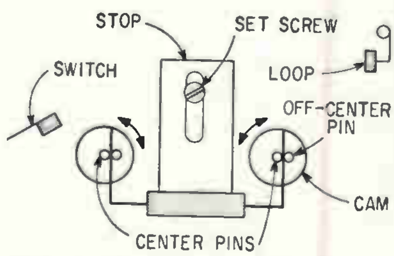
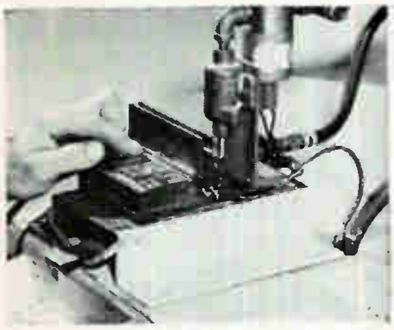


FIG. 2—Component lead looper

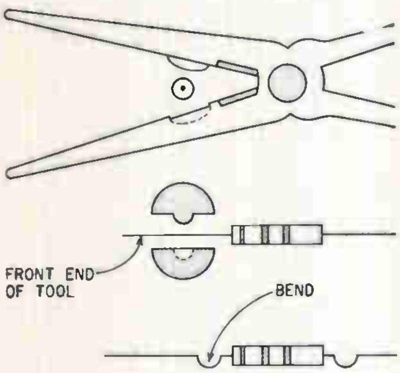
while tripping the air cylinder cam drive with a finger switch. The cam revolves the off-center pin around the center pin, looping the lead. The cam returns the off-center pin to loading position. The center pins are retracted, freeing the loop. The machine is sloped so that the component slides off it and into a box while the operator is picking up another component.



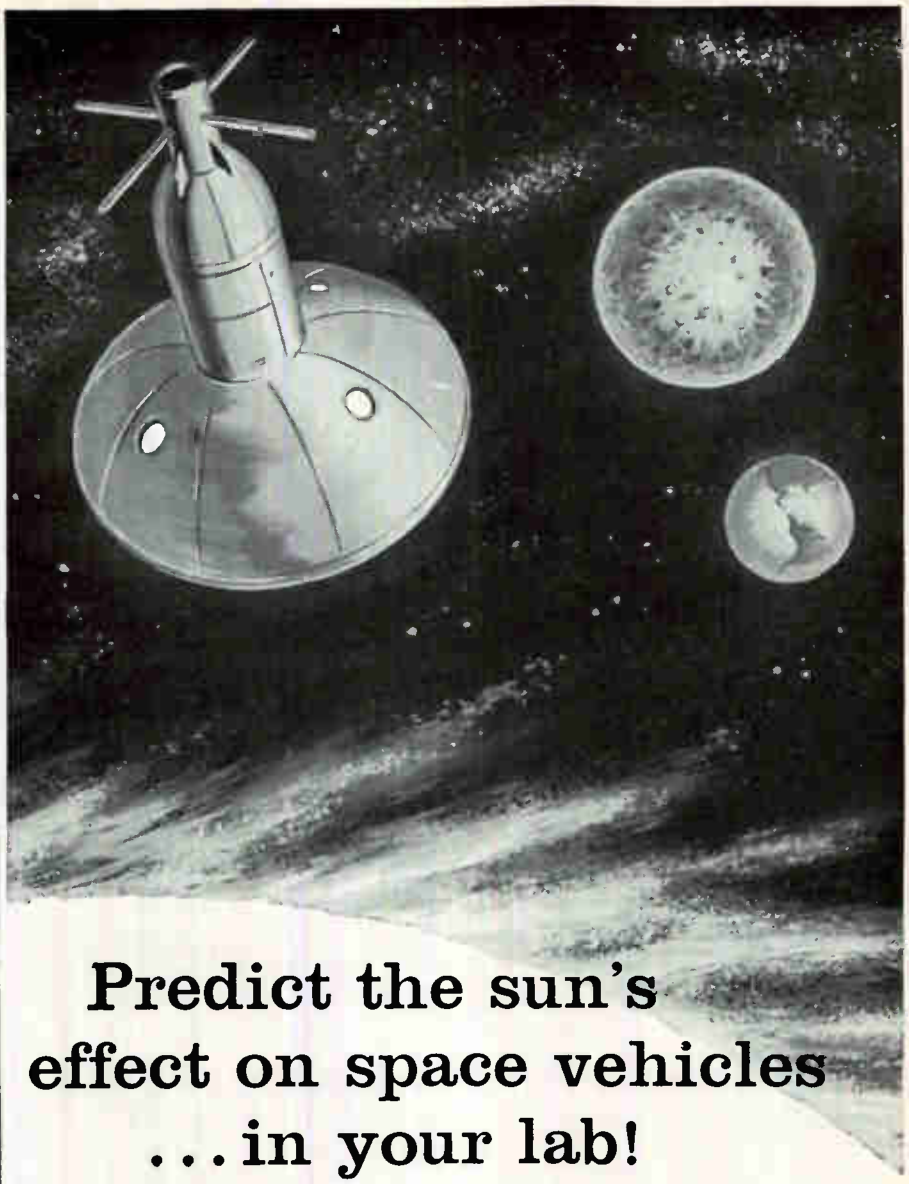
Looper with knife to precut leads

Another version also cuts leads to length before looping. The cuts are made by small guillotine knives near the cams. When the operator touches the switch, the knives are actuated first. After a time delay, the cams revolve.

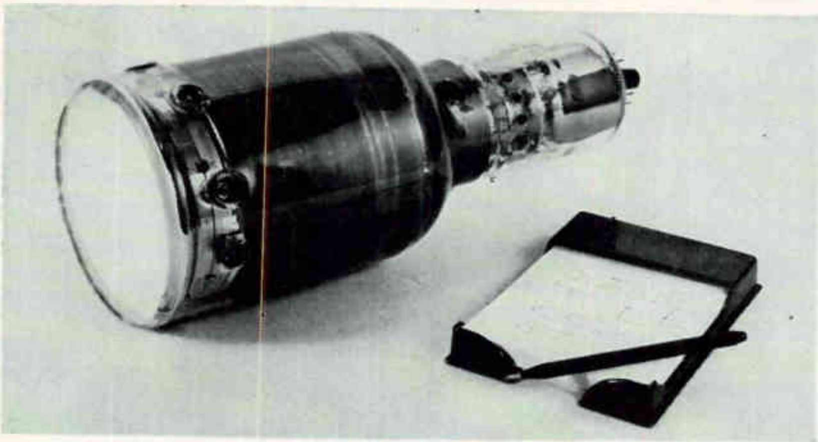
Pliers Put Relief Bend in Part Leads



SPECIFICATIONS frequently require that component leads be provided with relief bends to minimize strain and allow for thermal contraction and expansion. A long nose plier can be adapted to perform this operation. With the same tool, the technician can cut component leads to length, form the relief bend and wrap the component lead to the terminal. The sketch shows preparation of a resistor. This technique was submitted by Ralph Rinaldi, Theta Instrument Corp., Saddle Brook, N. J.



New On The Market



Selective Erasure Tube
HAS HIGH RESOLUTION

A DISPLAY STORAGE tube capable of high-speed selective erasure, simultaneous display of stored and nonstored information and high resolution light or dark trace displays has been announced by Hughes Aircraft Company, 2020 Short St., Oceanside, Calif.

The tube, (Multi-Mode Tonotron storage tube) incorporates a special dual effects target employing bombardment induced conductivity effects in addition to secondary electron emission effects.

Information may be written stored or nonstored or rapidly and selectively erased depending on the energy level of electrons striking the target. High-energy electrons erase the display, low-energy electrons write stored information, and intermediate energy electrons write nonstored information. The tube has resolving power up to three times better than tubes now in use while maintaining the brightness and halftone capabilities of conventional tubes, the company claims.

As a display in radar systems the tube will enable a second, or nonstored trace, to be superimposed over the scan. Programming makes it possible to erase or change any undesired parts of the display.

In slow-scan tv systems the tube allows all data to be present on the tube at all times. Erasing takes place while the new scan is being written.

CIRCLE 301 ON READER SERVICE CARD

L & S Band Amplifiers
MINIATURIZED

A SERIES of four miniature continuous wave L&S band cavity amplifiers have been developed by Resdel Engineering Corp., 330 South Fair Oaks Ave., Pasadena, Calif. The firm claims these are the smallest and lightest vhf-uhf cavity amplifiers available. They operate in the frequency range of 215 Mc through 2,325 Mc. For space applications and ground support equipment, the units are precision fabricated from light metal alloys and are gold-plated for optimum surface conductivity and corrosion protection. Filtering and shielding of power

supply leads is provided in each model. All units are designed for heat sink type mounting and components are derated to provide extended trouble-free operation. Mechanical tuning adjustments are stable and have negligible backlash.

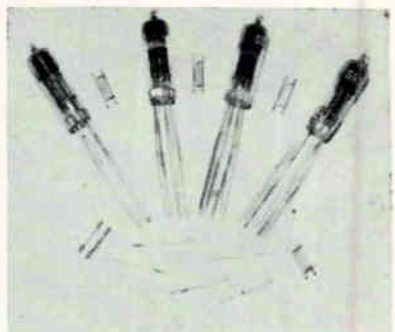
Model numbers are P-30 X2-30, X3-30 and P31. Model P-30 and P-31 are power amplifiers; model X2-30 is a frequency doubler; model X3-30 is a frequency tripler.

CIRCLE 302 ON READER SERVICE CARD

Subminiature Tubes
HAVE STRAP FRAME GRIDS

FOUR high-gain, low-noise, subminiature receiving tubes using a strap frame-grid construction have been developed by Sylvania Electric Products Inc., 730 Third Ave., New York 17, N. Y. The four tubes have Sarong cathodes.

Two medium-mu uhf double triodes and two high-mu uhf triodes have been introduced. Features of the medium-mu triodes, compared



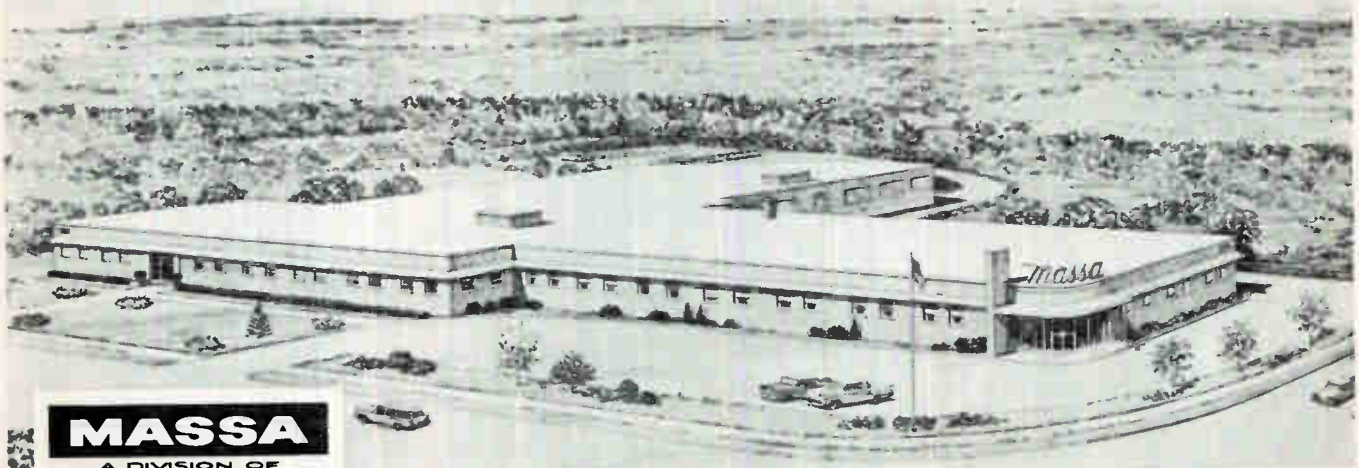
with their prototypes, are: one exhibits a 100 percent increase in g_m and g_m per milliampere of I_b, the other has 80 percent higher g_m at 40 percent lower plate voltage and 20 percent lower heater power. Features of the high-mu triodes are: one has a 1,300:1 ratio of g_m to I_b, while the other employs one-third the heater power with a 3 db improvement in noise figure.

CIRCLE 303 ON READER SERVICE CARD

Time Quantizer
TO NANOSECONDS

A COMPLETELY solid-state automatic high-speed system that measures or quantizes time intervals to a resolution of 10 nanoseconds has been announced by Computer Equipment Corp., 11612 Olympic Blvd., Los Angeles 64, Calif. The system, designated LFQ-10, is expected to find wide application in nuclear physics, calibration of radar navigation systems, high density pcm

THIRD EXPANSION IN 15 YEARS



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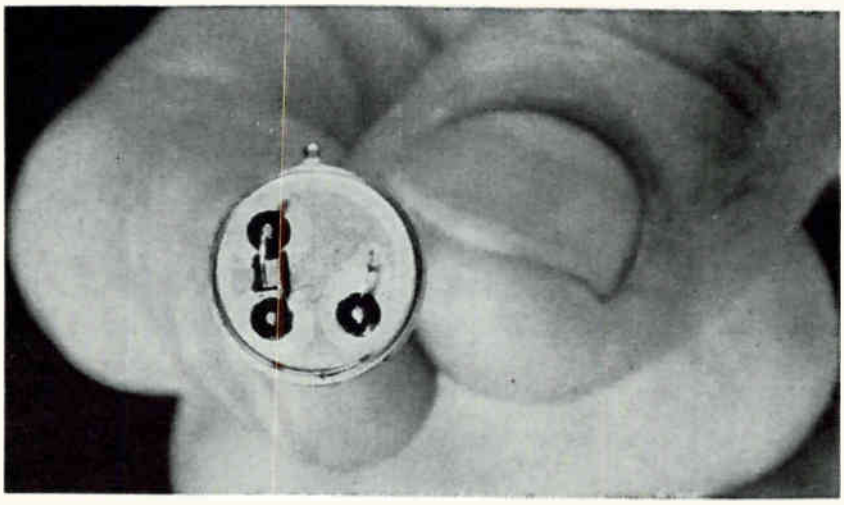
telemetry, semiconductor switching time evaluation, etc.

One version of the quantizer, developed for three dimensional missile tracking systems, permits high altitude measurements to a resolution of plus or minus 2½ feet.

The system may be used with high-speed digital computers for real-time analysis of the physical phenomena being measured. Output may be binary, BCD or decimal. Time intervals of interest may be transient, repetitive, or varying in their duration.

The LFQ-10 fits in a cabinet measuring 35 in. high, 24 in. wide and 24 in. deep. Another version, model LFQ-80, which yields a resolution of 80 nanoseconds, fits in a cabinet measuring 24½ in. high, 24 in. wide and 24 in. deep. Prices of these systems being at $5,000.

CIRCLE 304 ON READER SERVICE CARD



200 Mc Transistor

WITH 3 WATT OUTPUT

A TRIPLE DIFFUSED silicon mesa *npin* transistor designed specifically for very high frequency applications has been developed by RCA, Somerville, N. J. Designed as a large signal power amplifier capable of operation up to 200 Mc, the device (TA-2084) is intended for use in Class A, B or C power amplifier and power oscillator applications for both military and industrial electronic equipment.

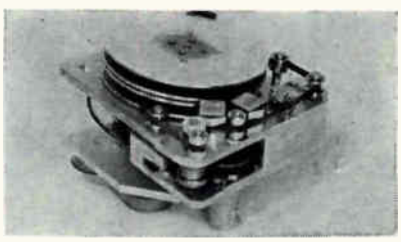
Maximum ratings announced include a collector-to-base voltage (emitter open) of 140 v, a collector-to-emitter voltage (base open) of 140 v and emitter-to-base voltage (collector open) of 1 v. Peak collector current is 1 ampere and transistor dissipation (100 C case temp) is 5 watts. R-f power output (measured in a class C, common-emitter unneutralized power-amplifier circuit) is 3 watts at a frequency of 200 Mc, making possible complete transistorization of many communication systems operating at up to 200 Mc.

CIRCLE 305 ON READER SERVICE CARD

Satellite Recorder

WITH LOW-POWER DRAIN

A MINIATURE MAGNETIC tape recorder/reproducer for satellite and missile application has been developed by the Datalab Division of Consolidated Electrodynamics Corp.. 360 Sierra Madre Villa, Pasadena, Calif. Power consumption of the device is considerably less than 1 watt. Size is about 40



percent smaller than the 10-watt recorder/reproducer unit used in the Courier communication satellite program.

The unit will record for approximately 2½ hours at one inch per second and playback in about eight minutes. The system has a reproduce frequency range of 1 Kc to 25 Kc.

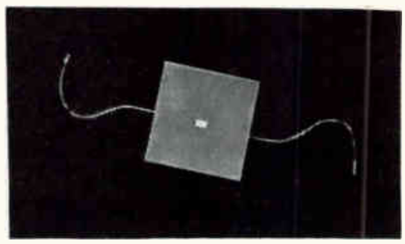
One of the principal means of improving power economy has been to use a new d-c motor for primary drive. Rolling rather than sliding brushes are used in the motor. The brush design reduces friction and increases brush life. An electronic speed control system which consumes less than 40 mw controls motor speed to better than ¼ percent.

CIRCLE 306 ON READER SERVICE CARD

Infrared Detectors

PEAK AT 6.8 MICRONS

ROOM TEMPERATURE photoconductive InSb infrared detectors which peak at 6.8 microns are now available from Block Associates, Inc., 385 Putnam Ave., Cambridge 39, Mass. With a time constant of less than 1 microsecond, these inexpensive InSb detectors are claimed to be the longest wavelength room



temperature semiconductor ir detectors presently manufactured. Custom built, InSb ir detectors will be supplied in any configuration, including arrays, to suit customer requirements. Specifications for a typical cell 1.5 mm × 6 mm are: black body response, D* (500 deg K, 1,000, 1) 3 × 10^7 cm-$cps^{1/2}$/watt; NEP (500 deg K, 1,000, 1). 10^{-8} watts/$cps^{1/2}$; resistance, 20 ohms; time constant ≦ 1 microsecond; and peak response, 6.8 microns.

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Rated: 50V amp
up to 250 volts

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magnetic reed switches

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- Long, dependable life

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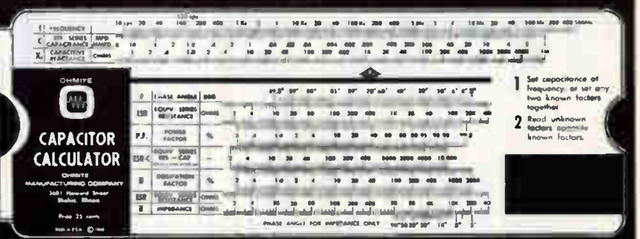
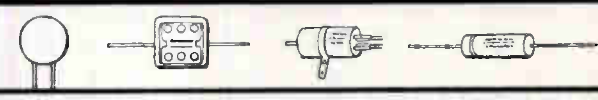
OHMITE CAPACITOR Calculator



Pocket Size 2⅝" x 7"



One setting of the slide solves problems in capacitance, frequency, capacitative reactance, power factor, dissipation factor, impedance and phase angle. Use it for all types of capacitors from 1 mmfd to 1000 mfd. Also includes slide rule scales A, B, C, D; capacitance formulas; comparison table on different types of capacitors. Constructed of heavy, varnished cardboard . . . . **25¢**

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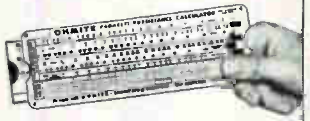

Solves Ohm's Law and parallel resistance problems. Includes A, B, C, D slide rule scales . . . **25¢**
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CIRCLE 77 ON READER SERVICE CARD

electronics and aircraft industries by the Precision Meter Division of Minneapolis-Honeywell Regulator Company, Grenier Field, Manchester, N. H. Designated MM-1 (Medalist) and MCE-1 (edgewise),

both meters employ core magnet, self-shielded mechanisms in structures providing high sensitivity at the null point and sharp square-law attenuation as the pointers deflect from centers.

The meters, which can indicate large amounts of unbalance in bridge or other detection circuits without damage, are available with sensitivities of one-half, one and two microamperes at the null point, with end scale values of 100, 200 and 500 microamperes. Other sensitivities can be supplied to meet specific circuit requirements. The instruments will be available within 60 days.

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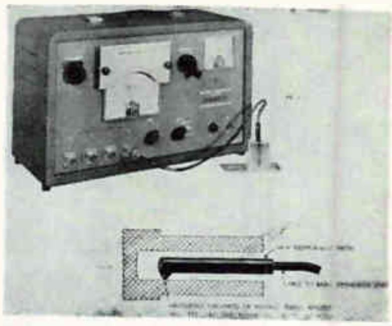


Thickness Tester
FOR COATINGS

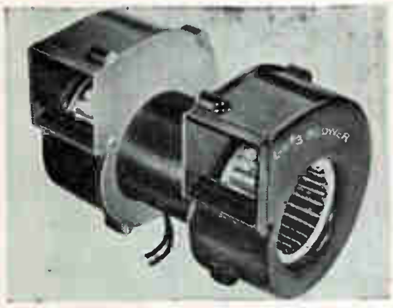
UNIT PROCESS ASSEMBLIES, INC., 61 E. 4th St., New York, N.Y. The Dermitron model D-2 nondestructive coating thickness tester is a portable instrument for both lab and production use. It gives fast, accurate and direct readings of virtually any coating on any base. The unit comes with four measuring probes for extra wide thickness ranges from thin to thick deposits, and requires only a ⅛ in., circle-area for measurement.

CIRCLE 309 ON READER SERVICE CARD

Pressure Transducers
LIGHTWEIGHT

DAYSTROM-WIANCKO ENGINEERING CO., 255 N. Halstead St., Pasadena, Calif. The small size and low power requirement of the P2-3000 series variable-reluctance d-c pressure transducers are suited to applications with critical weight limitations. Type P2-3076, for pressure ranges up to 5,000 psig, weighs 5 oz and requires only 3 ma at 28 v d-c for 0 to 5 v d-c output.

CIRCLE 310 ON READER SERVICE CARD



Dual-Outlet Blower
FOR HEAT DISPERSION

RIPLEY CO., INC., Middletown, Conn., announces the model 8481 dual-outlet blower for heat dispersion. The one-piece, impact resistant phenolic plastic housing with aluminum motor-plate is 6⅜ in. from top to bottom. Total width of motor and blowers assembly is 7⅞ in. Motor is 150 v, 60 cps. Incorporates sealed ball bearings requiring no maintenance. Total free air delivery is 150 cfm.

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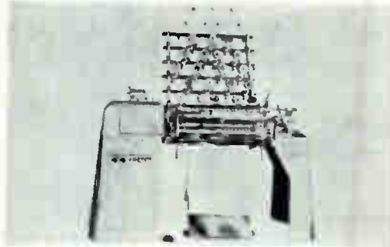
Latch Relay
MICROMINIATURE

HI-G, INC., Bradley Field, Windsor Locks, Conn. Relay features a magnetic latch system that maintains an actuated condition without continuous power drain; uses rotary balanced armature construction, allowing relay to meet extremes of vibration and shock. Microminiature sensitive d-c magnetic latch relay, spdt, sensitivity at pull-in at 25C, 25 mw or better; 40 mw or better for dpdt.

CIRCLE 312 ON READER SERVICE CARD



Transformer Winder
COMPACT UNIT

GEO. STEVENS MFG. CO., INC., Pulaski Road at Peterson, Chicago 46, Ill., offers a compact multiple transformer winding machine suitable for long production runs. Model 407-AM multiple winds paper section power, audio, fluorescent ballast and similar types of transformer coils at speeds up to 2,000 rpm using 18 through 44 Awg wire. Maximum coil o-d is 9 in. if round and 4½ in. if rectangular.

CIRCLE 313 ON READER SERVICE CARD

Resolvers
HIGH ACCURACY

KEARFOTT DIVISION, General Precision, Inc., 1150 McBride Ave., Little Falls, N. J., introduces the Z5153-004, Z5163-001, and Z5193-001 size 28 high accuracy resolvers whose maximum error from electrical zero does not exceed 20 sec. They also feature high versatility since the same basic design permits their function as four-wire control transmitters, control differential transmitters, and control transformers.

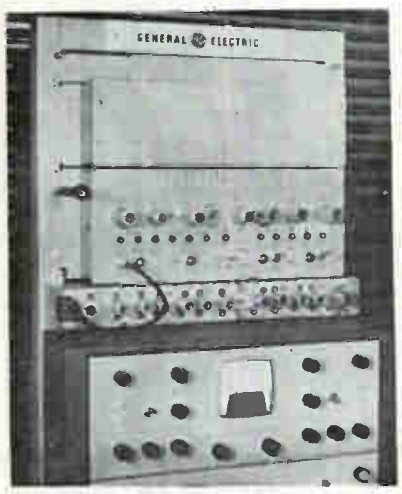
CIRCLE 314 ON READER SERVICE CARD

Power Diode

RUGGED UNIT

CENTRAL ELECTRONIC MANUFACTURERS DIVISION, Nuclear Corp. of America, Denville, N. J., announces the 7030 high-vacuum diode. Rugged construction is free of internal insulators, spring tensioning devices and fragile elements, and features a cathode that is a thoriated tungsten bifilar helix.

CIRCLE 315 ON READER SERVICE CARD



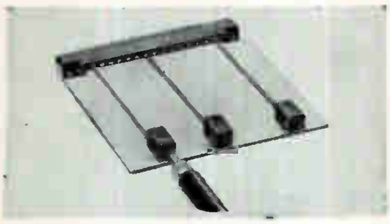
Microwave System

FOR 5,925-7,450 MC

GENERAL ELECTRIC COMMUNICATION PRODUCTS DEPT., P. O. Box 4197, Lynchburg, Va., announces a new microwave system, type UA-6B, accommodating up to 240 voice channels, for point-to-point com-

munication. Basically a duplex radio transmission set, the new equipment operates over the range of 5,925-7,450 Mc.

CIRCLE 316 ON READER SERVICE CARD



Test Point Connectors

FOR P-C USES

DEJUR-AMSCO., 45-01 Northern Blvd., Long Island City 1, N.Y. These test point connectors can be located at convenient positions on a printed circuit board, or in critical p-c applications for easy test takeoff points. Single contact and multiple contact types with 4, 6, 8, 28 and 42 test points are available for right angle dip soldering to p-c boards.

CIRCLE 317 ON READER SERVICE CARD

V-R Tubes

GLOW DISCHARGE TYPE

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio. Types VX62 and VX64 glow discharge type voltage regulator tubes are enclosed in standard T-3 glass envelopes. They provide a miniature and inexpensive means of regulating at 95 and 150 v respectively with current ranges from 100 μa to 50 ma.

CIRCLE 318 ON READER SERVICE CARD

Trimming Pots

TWO MODELS

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa.,

Rexolite® and Brand-Rex Technical Service Answer Most Microwave Insulation Problems

Across the microwave spectrum, from anode toppers to timing blocks; from antennas to duplexer pins, to filament cores, to light pipes, phaser assemblies and probe insulators; from slot arrays to slip ring disks and sweep arms, to transformer locks and cores, to timers and tubes . . . Rexolite plastic dielectrics and Brand-Rex technical service have teamed to stamp "solved" on a long list of complex microwave insulation problems.

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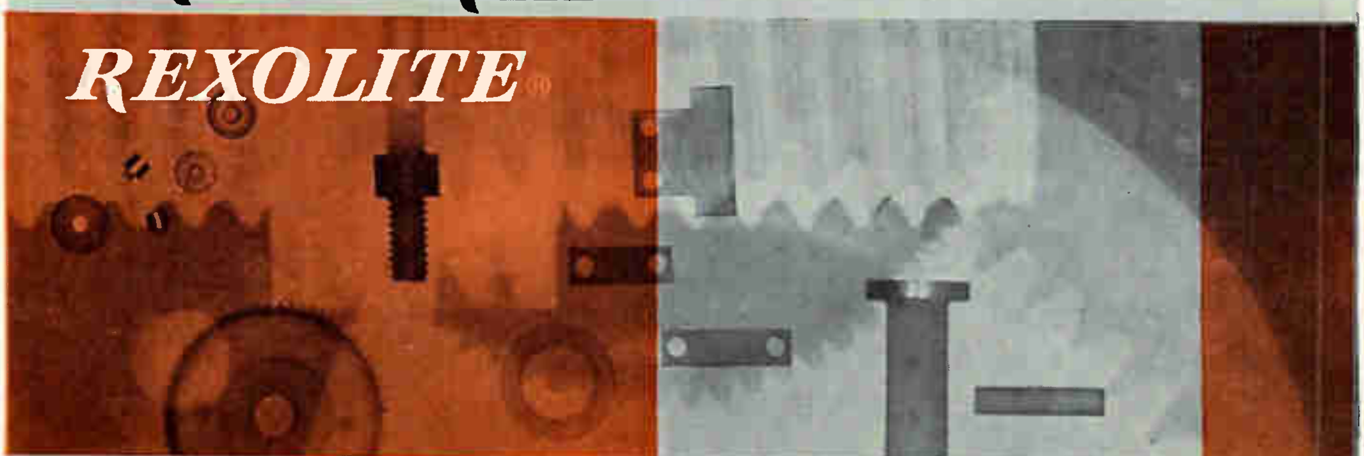

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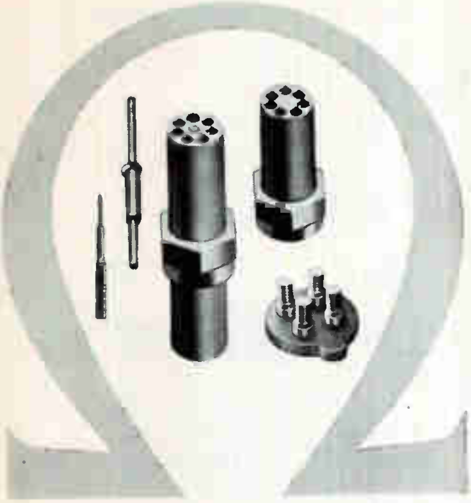


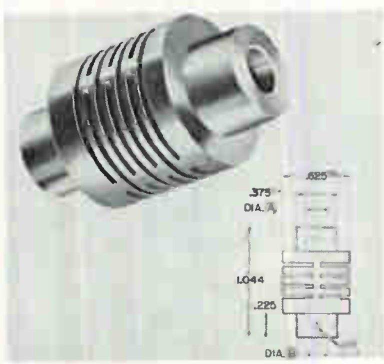
announces two new types of precision trimming potentiometers. The CT-100's tap adjust feature eliminates the need for expensive mechanical components with no sacrifice of electrical characteristics. Electrical and mechanical rotation are 320 deg ±5 deg. Type CT-200 is a ½ by ½ in. square unit and is available with p-c terminals or Teflon-coated wire leads.

CIRCLE 319 ON READER SERVICE CARD

Tape Recorder
AND PLAYBACK UNIT

ELECTRO-TECHNICAL LABS, P. O. Box 13243, Houston 19, Texas. Model DS-7 flatbed recorder and playback unit is a self-contained lightweight, direct-recording, magnetic-tape device. Static and/or dynamic time correction can be introduced on playback. Reliable operation under field and office conditions is provided by the simplified plane-surface head carriage system.

CIRCLE 320 ON READER SERVICE CARD



Instrument Coupling
SUPERPRECISION UNIT

SANTA FE INSTRUMENTS, INC., 2343 Jerome Ave., New York 68, N. Y., introduces a superprecision flexible instrument coupling for missile systems. It answers the need of designers and engineers of servo gear trains, computer mechanisms and other rotating precision devices, for an efficient, precise, all speed, flexible coupling. There are no moving and wearing parts.

CIRCLE 321 ON READER SERVICE CARD

D-C Voltmeter

HIGHLY ACCURATE

CALIBRATION STANDARDS CORP., 1025 Westminster Ave., Alhambra, Calif. Model DC200AR is an all-transistorized d-c voltmeter with accuracy to ±0.01 percent +5 μv. Other features include self-calibration and complete warm-up in less than 30 minutes. Range is 0 to 1,000 v d-c; potentiometer accuracy, ±0.002 percent; temperature stability, 2 ppm/deg C from 10 to 40 C; and regulation, ±0.001 percent for a 10 percent line change.

CIRCLE 322 ON READER SERVICE CARD

Logic Module

VARIABLE DELAY

HARVEY-WELLS ELECTRONICS, INC., 14 Huron Drive, Natick, Mass., announces a dual-output variable delay logic module for use in digital systems where adjustable and/or long delays are required. Model 1321 Delay C is variable from 0.1 μsec to 0.7 sec in five incremental steps, by means of a front-panel selector, and continuously variable between steps, by means of a front-panel vernier control. Price, $205.

CIRCLE 323 ON READER SERVICE CARD

Literature of

SOLDER PREFORM ALLOY Accurate Specialties Co., Inc., 345 Lodi St., Hackensack, N. J. Technical data bulletin Z-105 describes Alloy D-800, a high-strength low-temperature solder alloy.

CIRCLE 324 ON READER SERVICE CARD

RELAYS Brook Electronics Co., 1005 Brook Ave., New York 51, N. Y., has published a four page folder fully describing its compact heavy-duty industrial relays.

CIRCLE 325 ON READER SERVICE CARD

PATCH PANELS Trompeter Electronics, 7713 Oakdale, Canoga Park, Calif., has available a bulletin illustrating and describing a line of r-f and video patch panels. Prices are included.

CIRCLE 326 ON READER SERVICE CARD

KLYSTRON POWER SUPPLY Microwave Associates, Inc., Burlington, Mass. A four-page folder covers the MA-2-S klystron pump power supply designed for use with parametric amplifiers and other high-stability applications.

CIRCLE 327 ON READER SERVICE CARD

SILICONE RUBBER General Electric Co., Silicone Products Department, Waterford, N. Y. Four-color silicone rubber selector chart contains data on applications, typical properties, primary classes and standard industry and military specifications.

CIRCLE 328 ON READER SERVICE CARD

PLASTICS Synthane Corp., Oaks, Pa. Technical data sheet gives information on Synthane Grade FR-2, a flame-retardant industrial thermosetting laminated plastic.

CIRCLE 329 ON READER SERVICE CARD

SWITCHES Micro Switch, a division of Minneapolis-Honeywell, Freeport, Ill. Bulletin displays precision switches for machine tools and other industrial equipment.

CIRCLE 330 ON READER SERVICE CARD

ACCELEROMETER — AMPLIFIER Columbia Research Laboratories, MacDade Blvd. and Bullens Lane, Woodlyn, Pa. Data sheet describes the model 50X2 accelerometer-amplifier system and lists all physical, electrical and environmental specifications of the system.

CIRCLE 331 ON READER SERVICE CARD

ALARM UNIT San Diego Scientific Corp., 3434 Midway Drive, San Diego 10, Calif., has available a brochure describing a solid state alarm unit, Magne-Alarm, designed to provide engineers with a solution to temperature monitoring problems.

CIRCLE 332 ON READER SERVICE CARD

TRANSDUCERS Clark Electronic Laboratories, CELAB Research Division, Palm Springs, Calif. "Micro-ducer News", a condensed catalog of components and materials, covers a full line of transducers including CELAB pressure-sensitive paints.

CIRCLE 333 ON READER SERVICE CARD

CHART RECORDERS Curtiss Wright Corp., P. O. Box 110, Princeton, N. J. Features of rectilinear strip chart recorders are listed in a single sheet.

CIRCLE 334 ON READER SERVICE CARD

THYRATRONS CBS Electronics, Danvers, Mass., has released two bulletins in the "Tech Tips" series, entitled "Thyratrons Are Different" and "The Care and Control of Thyratrons".

CIRCLE 335 ON READER SERVICE CARD

ATTENUATORS PRD Electronics, Inc., 202 Tillary Street, Brooklyn 1, N. Y. A 4-page bulletin describes fixed and variable microwave waveguide and coaxial attenuators, including mil spec, precision dial, precision gage; level set, and variable cutoff types.

CIRCLE 336 ON READER SERVICE CARD

CHECK-OUT SYSTEMS Audiotronics Co., Box 2187, Dayton 29, Ohio, has published a bulletin on the Speed-Tronik automatic checkout system, an all-parameter testing system capable of checking any characteristic convertible to an electrical equivalent.

CIRCLE 337 ON READER SERVICE CARD

CIRCLE 91 ON READER SERVICE CARD→

Collins: advocate, not a referee

NEW PRESIDENT of the National Association of Broadcasters is a quiet, soft-spoken man with a talent for making those around him feel at ease. This characteristic alone would well qualify LeRoy Collins to head the key organization of today's broadcast industry, but he also brings many other traits to the job.

The former governor of Florida talks of technical innovations, of legislation that may help or hinder station operations and seems as eager to learn the technical environment as well as he knows the political. An NAB staff member, hearing Collins deplore his lack of technical knowledge, chuckled and shook his head: "In a couple of months he'll probably know more than all of us" he said.

Collins is no stranger to broadcasting. As governor he made monthly reports on statewide tv hookups and amazed studio personnel with his sense of timing. Although scorning the use of a script, he managed to cover a variety of subjects and always wind up broadcasts exactly on time.

"I'm really just a patron of broadcasting," he says with a smile, "I like to listen to the radio and watch tv. On some matters I feel that, right now, I'm a patient addressing the surgeons, but I am learning."

Despite this modesty, Collins shows a dedication to the future of broadcasting that bodes well for the industry. He is a firm believer in freedom from censorship and excessive government regulation of broadcasting, but infers what he expects from broadcasters in a comment he once made on states' rights: "If more people would be concerned with responsibilities instead of rights, there would be little loss of those rights."

Known as "Roy" to thousands of Floridians, Collins is the son of a grocer and grandson of a circuit-riding Methodist minister. One of six children, he was born in Tallahassee in 1909.

He graduated from high school in 1927 and took up his father's offer to match whatever he could save towards his education. In 18 months he saved $500 as a grocery clerk and delivery boy, went to New York to study at the Eastman Business School in Poughkeepsie. Another two years as a bank teller yielded $500 more and bought a one-year law course at Cumberland University in Tennessee. That same year he passed the Florida bar examinations with the second highest grade scored up to that time. Describing his next step Collins grins, "I boldly hung out my shingle . . . then proceeded to starve."

In 1932 he married and two years later entered politics by being elected to the Florida House of Representatives. For almost 25 years he has served his home state, the last six as governor.

Collins recently told an annual assembly of the FCC Bar Association: "I believe in broadcasting—not just as a business or as a great industry. It is far more than that. Broadcasting, like America, has not "arrived". It too has only begun, and ahead it also faces goals which demand resourcefulness and loyalty and hard effort, better to serve mankind's needs. He added that "No segment of American life has a greater responsibility towards helping American life succeed than American broadcasting" and said "Nothing touches with such intimacy and effectiveness the lives of so many Americans as does electronic mass communications."

Concerning future policies in his new position Collins considers himself an advocate, not a referee. "Broadcasting," he says, "no less than an individual, has legitimate interests. I shall, to the best of my abilities articulate and advance these legitimate interests with reason, clarity and vigor."

In speaking of his move to Washington, the former governor says he admits to some jitters but sees them dissipating. Except for family get-togethers, Collins and his wife Mary lead quiet social lives. His son, LeRoy Jr., 26, is a Lt. (JG) in the submarine service. Three daughters, Jane, 22, Mary Call, 18, (freshman at Florida State) and Darby, 10, complete the family.

For relaxation, the 6-ft, 197-lb NAB president enjoys hunting and fishing.

Monitor Systems, Inc. Names Project Manager

G. ROBERT JACOB has joined Monitor Systems, Inc., Fort Washington, Pa., designer and manufacturer of

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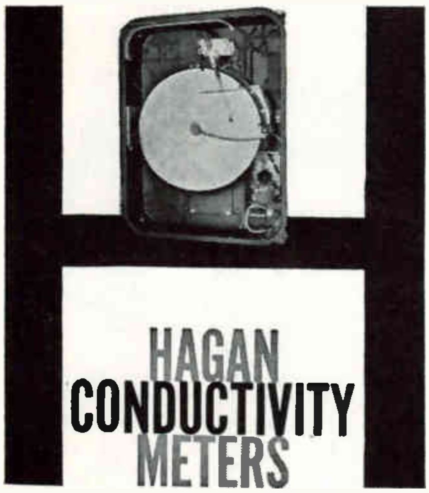

advanced high-speed electronic data systems for defense and industry, as project manager.

Prior to joining MSI, a subsidiary of Epsco, Inc., he was chief engineer for Measurements Research Co., where he proposed new designs and was responsible for the development of all designs of a contractual nature.

Ling-Temco Sets Up New Division

LING-TEMCO ELECTRONICS, INC., has announced the establishment of a new micromodular components division in Anaheim, Calif. This division will specialize in the manufacture of subminiaturized high and low-voltage rectifiers, semiconductor logic circuits and custom miniaturized modular packaging.

Design counseling, relative to circuit configuration, choice of component, subminiaturization and reliability problems, will be provided at no additional cost.

Motorola Promotes John Gray

JOHN L. GRAY has been named vice president and eastern area sales manager for Motorola Semiconductor Products Inc., Phoenix, Ariz. He was formerly central area sales manager for the firm.

General Electric Reassigns Erlandsen

CHARLES F. ERLANDSEN has been appointed manager of quality control at GE's semiconductor products department plant in Buffalo, N. Y.

With GE for the past 21 years, Erlandsen's last position prior to his present assignment was manager of quality control at the selenium and copper oxide rectifier plant in Lynchburg, Va.

Audio Devices, Inc. Erecting New Plant

AUDIO DEVICES, INC., manufacturer of magnetic tapes, recently broke ground for a two-story, 20,000 sq ft building in Stamford, Conn. The structure when completed will house the company's expanding research and development, and engineering departments.

The new building will provide added laboratory and pilot production facilities for video, seismic, computer, and other specialized tapes to meet the critical demands of the magnetic tape market.

PEOPLE IN BRIEF

Myron C. Pogue, formerly with Eitel-McCullough, joins Philco Corp. as manager of planning for the Western Development Labs. **Robert J. Erickson,** ex-Centronix and Bell Aircraft, chosen associate director of production by Astronautics, Inc. **Everett Babbe** leaves Marquardt Corp. to become chief engineer for Temptron, Inc. **F. Beringer Fank** advances at General Electric to manager of the company's low power traveling wave tube engineering. **Jim Hinsdale,** from Motorola, appointed director of engineering at Dynamic System Electronics Corp. **H. Raymond Jacobus** leaves Tung Sol Electric to become manager of the negative grid tube division at Eitel-McCullough, Inc. **Charles K. Krill** promoted by General Precision to plant manager of the Librascope Division's Burbank Branch. **Louis Friedman,** previously with Polarad Electronics and CBS-Columbia, takes the post of plant manager at Transdyne Corp. **Phillip N. Buford,** ex-Westinghouse Electric, joins Page Communications Engineers as senior staff engineer in their research and development directorate. **Ludwig P. Reiche,** formerly of Stanford Research Inst. named manager of the microwave communications branch at Melabs.

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to
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Electronics technician, U.S. citizen, desires overseas employment in Middle East (preferably Israel). Background includes radar, communications, industrial controls and digital computers. Also, teaching and technical writing experience. PW-6220, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

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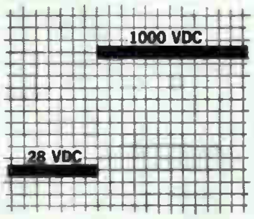

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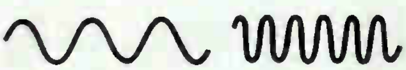

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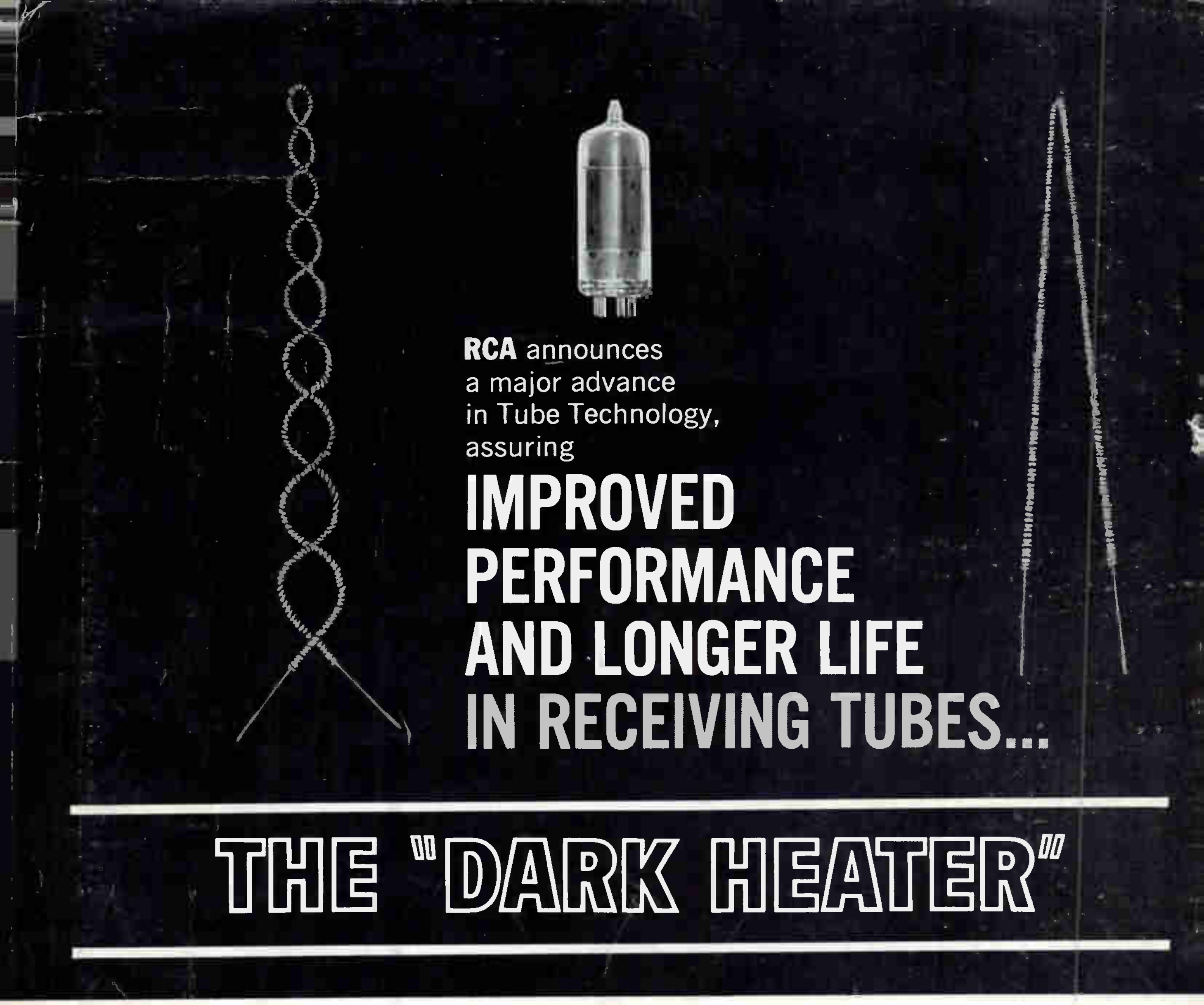
THE DAVEN CO. LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN Ⓓ STANDS FOR DEPENDABILITY



From RCA—which in recent months has brought you the revolutionary nuvistor tube, the dramatic Novar receiving tube, new super-strength metallized ceramics, the vacuum-melted cathode, and S-311 high-dissipation plate material—now comes the latest in a proud list of contributions to tube making: "DARK HEATER".

The "DARK HEATER" is a key to greatly extended life and improved performance of receiving tubes.

The "DARK HEATER" operates at greatly reduced temperatures—as much as 350°K below the 1500 to 1700°K of the "White" heater. The unique dark surface radiates heat more efficiently and improves the transfer of heat to the cathode. Thus the required cathode temperature is attained with the heater operating temperature lowered to approximately 1350°K.

For more information on what this dramatic advance in heater design can mean to you in your equipment, see your RCA Field Representative.

SPECIFIC ADVANTAGES TO YOU INCLUDE:

EXTENDED HEATER LIFE—Heater wire strength is much greater at lower operating temperatures. For example, a reduction of 350°K in operating temperature results in a 50% increase in ultimate tensile strength of the wire, and a reduction of as much as 25% in internal stresses which may occur during heater cycling.

REDUCED LIKELIHOOD OF HEATER FAILURE—The smaller thermal change during heater cycling, and the greatly reduced operating temperatures minimize the tendency toward recrystallization and burnout.

CONSTANT HEATER CURRENT—The "DARK HEATER" exhibits an exceptionally stable current characteristic throughout its life. This feature is especially desirable in maintaining a constant cathode temperature.

REDUCED HEATER-CATHODE LEAKAGE AND HUM—AC leakage and hum are significantly reduced through the use of the "DARK HEATER". This improvement is most startling because it eliminates "spike" or pulse leakage currents sometimes present in other heaters. In addition, the reduction of heater temperature serves to reduce both AC and DC leakage from heater to cathode, and heater emission to other tube electrodes.

IMPROVED MECHANICAL STABILITY—The cooler operation of the "DARK HEATER" minimizes changes in heater shape during life, reducing the possibility of heater damage and heater shorts.

GREATER SAFETY IN VOLTAGE RATINGS—Cooler heater operation provides a greater margin of safety in present H-K voltage ratings.

RCA

The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

RCA FIELD OFFICES: East: 744 Broad St., Newark 2, New Jersey, HUmboldt 5-3900
Midwest: Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill., WHitehall 4-2900
West: 6801 East Washington Boulevard, Los Angeles 22, Calif., RAymond 3-8361