FEBRUARY 6, 1959

electronics

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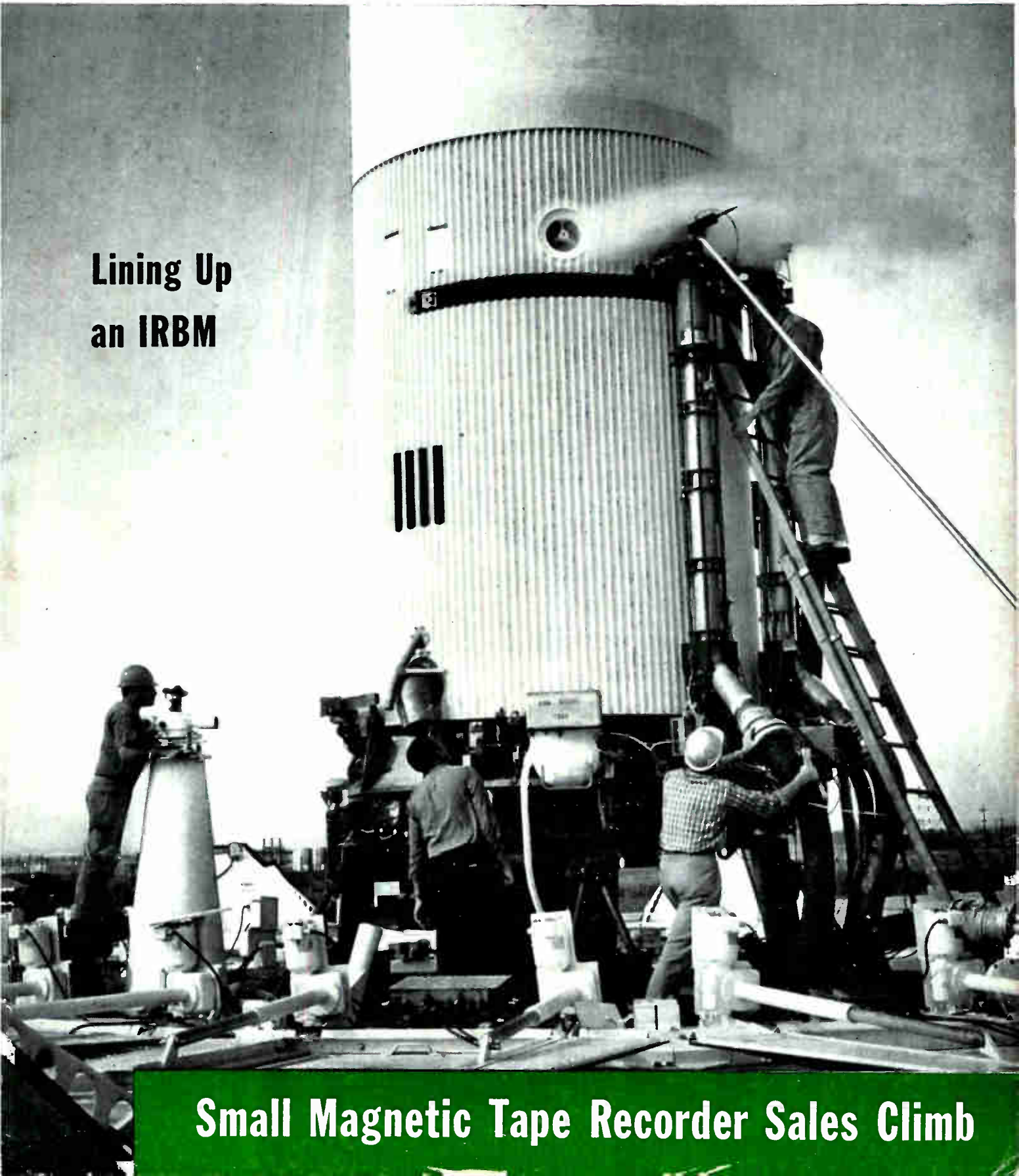

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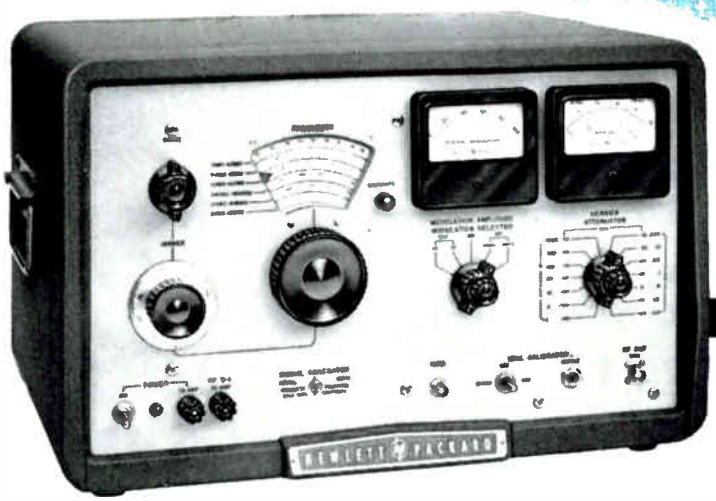

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SPECIFICATIONS

Frequency Range: 50 kc to 65 MC in 6 bands.
Frequency Accuracy: Within ±1%.
Frequency Calibrator: Crystal oscillator provides check points at 100 kc and 1 MC intervals accurate within 0.01% from 0° to 50° C.
RF Output Level: Continuously adjustable from 0.1 μv to 3 volts into a 50 ohm resistive load. Colibration is in volts and dbm (0 dbm is 1 milliwatt).
Output Accuracy: Within ±1 db into 50 ohm resistive load.
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Output Impedance: 50 ohms, SWR less than 1.1:1 at 0.3 v and below.
Spurious Harmonic Output: Less than 3%.
Leakage: Negligible; permits sensitivity measurements to 0.1 μv.
Amplitude Modulation: Continuously adjustable from 0 to 100%.
Internal Modulation: 0 to 100% sinusoidal modulation at 400 cps ±5% or 1000 cps ±5%.
Modulation Bandwidth: Dc to 20 kc maximum.
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Envelope Distortion: Less than 3% envelope distortion from 0 to 70% modulation at output levels of 1 volt or less.
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FEBRUARY 6, 1959

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Vol. 32 No. 6

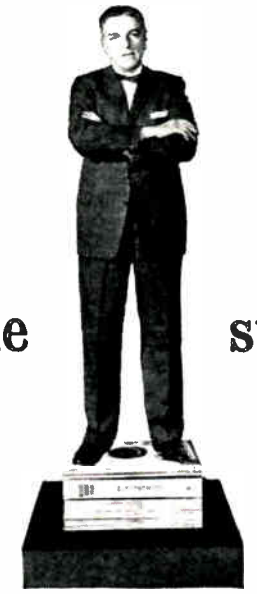
Issue at a Glance

BUSINESS

ENGINEERING

DEPARTMENTS

Art Harrison takes the stand for electronics



Arthur E. Harrison is an avionics systems engineer with Grumman Aircraft Engineering Corporation, a leading manufacturer of weapons systems including anti-submarine, airborne early warning, air-sea rescue, fighter and attack aircraft, etc.

Before coming to Grumman, Mr. Harrison was Director of Engineering with Fairchild's Guided Missiles Division. He is on the guided missile subcommittee of the American Ordnance Association.

Art Harrison has been reading **electronics** for more than 20 years. He maintains a complete library of bound volumes in his home.

Mr. Harrison has influence on purchasing electronic equipment through his design function, specifying the components and parts that go into systems.

It has been said that leading publications build a "personality" for themselves. This is a quality that cannot be measured with facts and statistics. Here's how Art Harrison characterizes the "personality" of **electronics** magazine.

"**electronics** *is a magazine that is edited for the work-a-day engineer, his jobs, and his problems. It offers broader coverage of the electronics industry than any other publication. I am thinking all the way from computers through instrumentation to communication and navigation.*"

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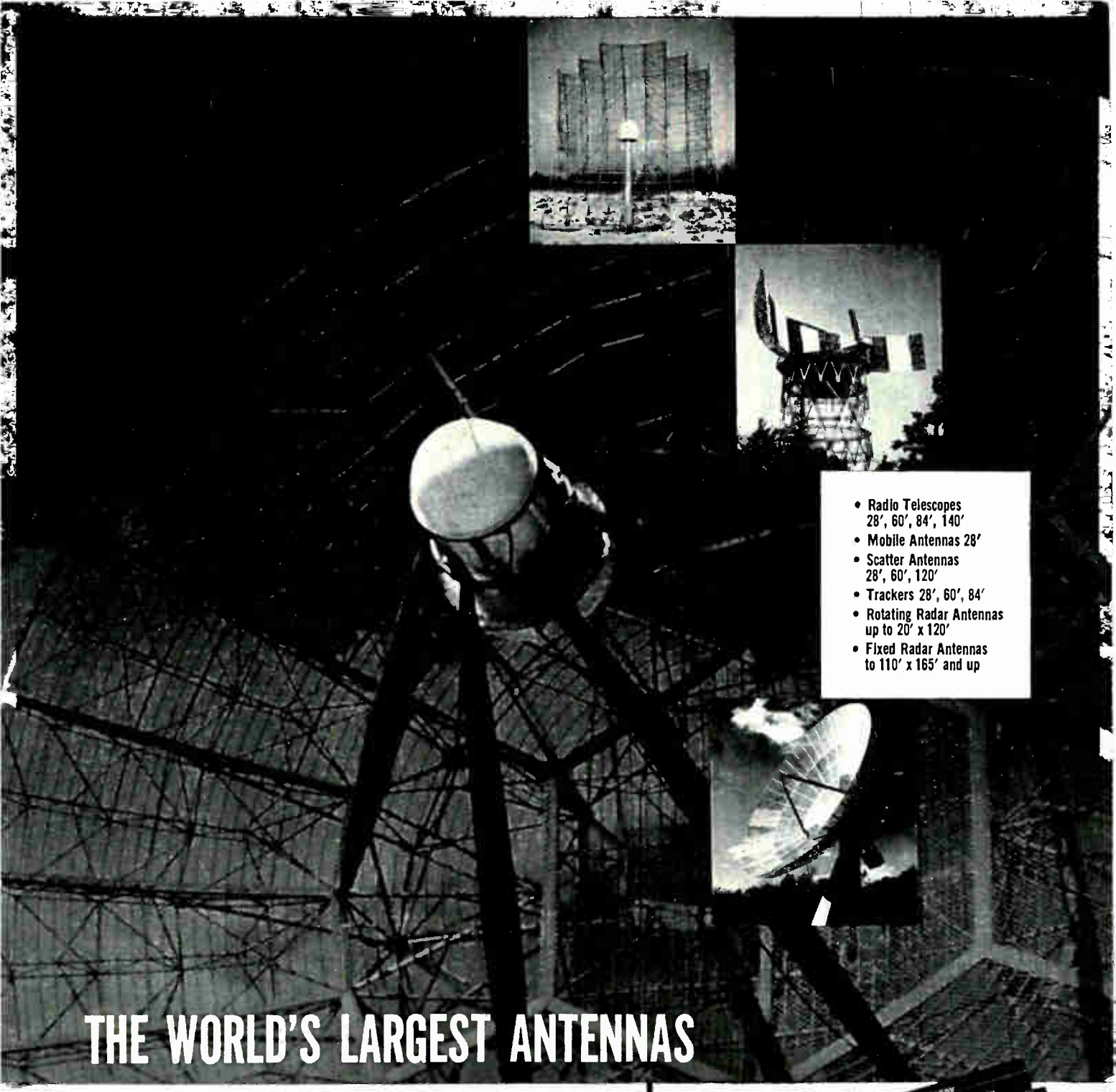

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Feb. 6, 1959 Vol. 32, No. 6

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SHOPTALK . . .

SOVIET ELECTRONICS. A little more than a year ago, the Soviet government put the full weight of a monolithic state behind its drive to build up the electronics industry in the Soviet Union. Since then noteworthy progress has been made, not only in the Soviet Union but also in Iron Curtain countries such as Red China, Hungary and Czechoslovakia.

Since late 1956, Associate Editor Janis, ably assisted by McGraw-Hill World News bureau chiefs overseas, has scanned every scrap of information available on Soviet electronics.

Last month, two developments put Soviet electronics even more in the news: launching of the Red moon rocket Lunik and the U.S. visit of Soviet First Deputy Premier Mikoyan.

First details on Lunik came from Moscow Bureau Chief Gibson, who relayed the Soviet government's 5,000-word communique on the rocket's "technical details" ("Soviets Give Data on Sun Satellite" p 66, Jan. 30).

A lot of questions remained unanswered. Then came a cabled query from Bonn Bureau Chief Herlitzer. Would ELECTRONICS be interested in the full technical story on Lunik's guidance, instrumentation and control? Of course we were interested and off went an okay to Herlitzer, plus our check for his confidential source. There are still some unanswered questions but you will know a lot more about Soviet missile guidance after reading our exclusive story "How Russia Guided Lunik" on p 22.

Out of First Deputy Premier Mikoyan's visit comes some idea of what electronic equipment and components the Soviet Union would like to ship to the U.S. and what they want in return.

Associate Editor Manoogian attended a reception for Mikoyan in Washington. There he had a very exclusive interview with the FDP—Manoogian and Mikoyan spoke to each other in Armenian.

Manoogian later got details by checking with other high Soviet officials. End product is the story "Soviets Reveal Trade Aims" on p 30.

Coming In Our February 13 Issue . . .

INDUCTION HEATING. Use of hydrogen thyratrons as rapid switching elements in induction heating equipment has many advantages, according to H. L. Van Der Horst of N. V. Philips of Eindhoven, Netherlands.

In thyratrons, heavy current can flow with low anode voltage; efficiency is high, so forced cooling is not required. Short ionization and deionization times permit oscillation at frequencies up to 10 kc. Van Der Horst describes a heating generator that develops 12 kw in the workpiece using this type of tube.

WAVEFORM DETECTOR. Automatic waveform detection applied to the high-speed testing of ferrite cores, transistors, transformers or other components not only eliminates inherent disadvantages of other methods, but also achieves greater sorting speed and accuracy.

IBM's B. Agusta describes an automatic waveform detection system in which the amplitude of a sampling trigger pulse is compared with combined amplitudes of trigger pulse and unknown waveform at sample time.

KLYSTRON CONTROL. Close frequency control in reflex klystrons is a common, yet frequently touchy problem. M. C. Harp of Lenkurt Electric in San Carlos, Calif., has devised a control method using magnetic amplifiers and transistors for a 6-mc microwave link handling up to 240 voice channels.

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because characteristics are so similar as to permit full and confident use

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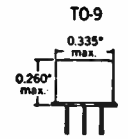
FOR LARGE SIGNAL APPLICATIONS

Temperature Range −65°C to +160°C

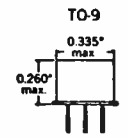


	Type	I_{EO} or I_{CO} at V_{CB} = 20 V_{dc} μA	V_{CE} max. volts	H_{FE}† ave.	r_b' f = 1Mc ohms	r_c kilohms	Noise Figure db (max.)	c_{ob} f = 100Kc ave. μμf	$f_{\alpha b}$ ave. Kc
PNP	2N327A	0.005	−40	15	1200	500	30	65	200
PNP	2N328A	0.005	−35	30	1400	500	30	65	300
PNP	2N329A	0.005	−30	60	1500	500	30	65	400
PNP	2N330A	0.005	−30	25	1300	500	15	65	250
NPN	2N619	0.005	50	15	2000	500	30	35	200
NPN	2N620	0.005	40	30	2500	500	30	35	350
NPN	2N621	0.005	30	60	2700	500	30	35	500
NPN	2N622	0.005	30	25	2400	500	15	35	300

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

FOR SMALL SIGNAL APPLICATIONS

Temperature Range −65°C to +160°C



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

*V_C = 5V; I_E = 3mA

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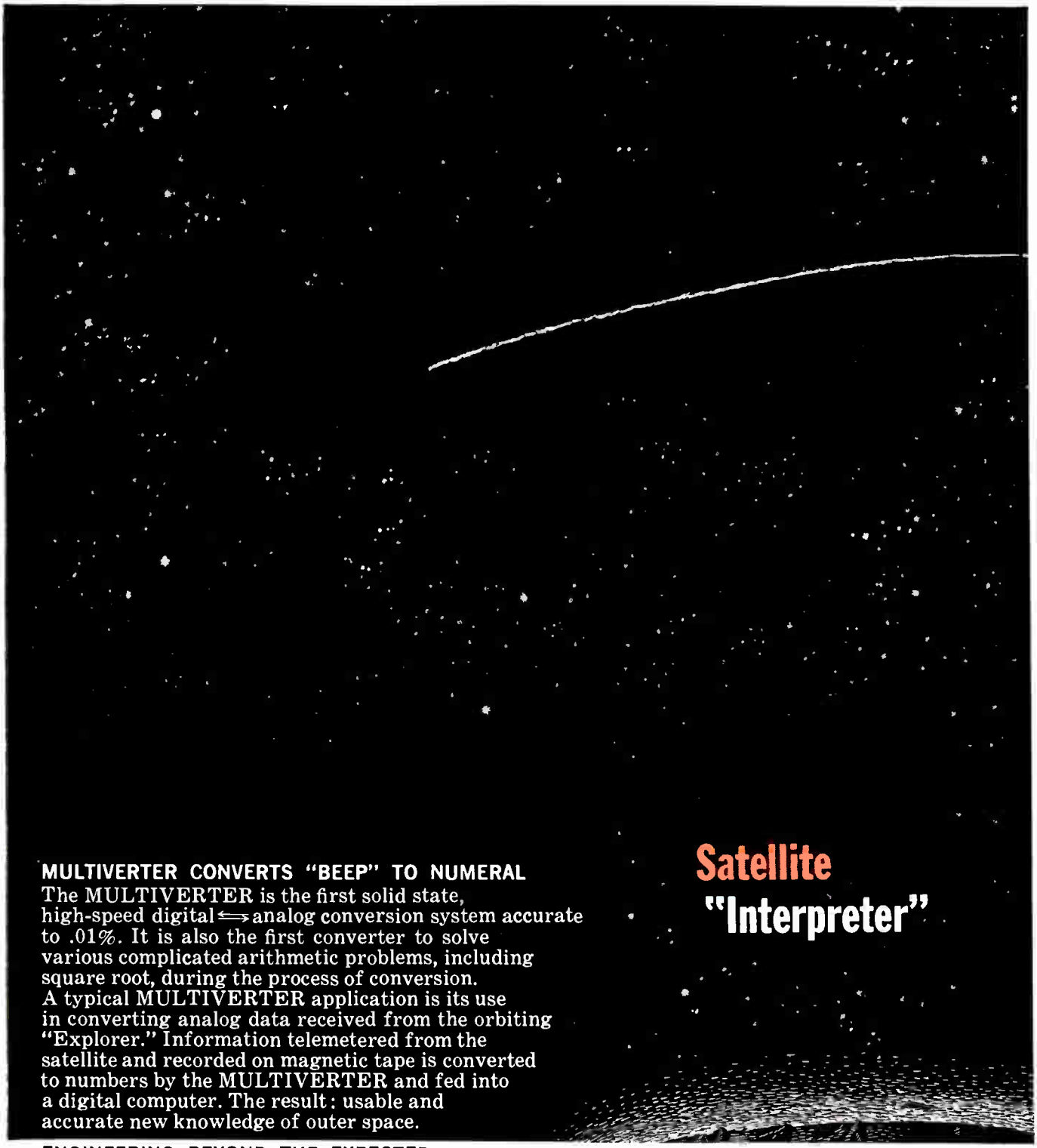
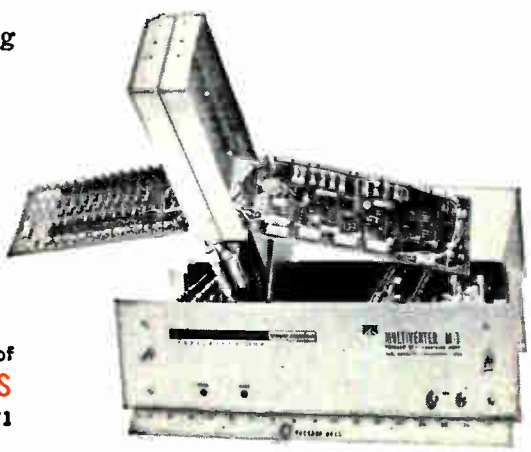


Satellite "Interpreter"

MULTIVERTER CONVERTS "BEEP" TO NUMERAL
The MULTIVERTER is the first solid state, high-speed digital ⟺ analog conversion system accurate to .01%. It is also the first converter to solve various complicated arithmetic problems, including square root, during the process of conversion. A typical MULTIVERTER application is its use in converting analog data received from the orbiting "Explorer." Information telemetered from the satellite and recorded on magnetic tape is converted to numbers by the MULTIVERTER and fed into a digital computer. The result: usable and accurate new knowledge of outer space.

ENGINEERING BEYOND THE EXPECTED
The need for highly accurate measurement in an accelerating technology called for a solid state converter with an accuracy of .01% and a speed of four microseconds per bit. The MULTIVERTER and related accessories resulted. One immediate application has been the interconnection of Packard Bell's TRICE, the first incremental differential analyzer to operate in real time, with various analog systems. Other applications include Missile Impact Prediction, Coordinate Conversion, Orbit Prediction and Solid State Automatic Checkout Systems.



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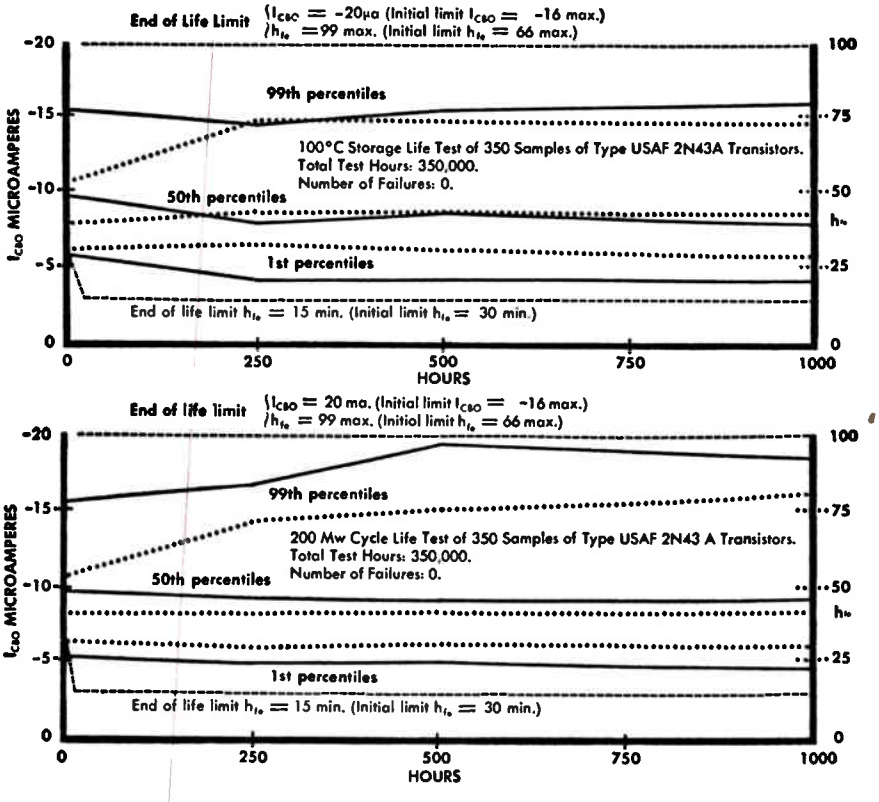
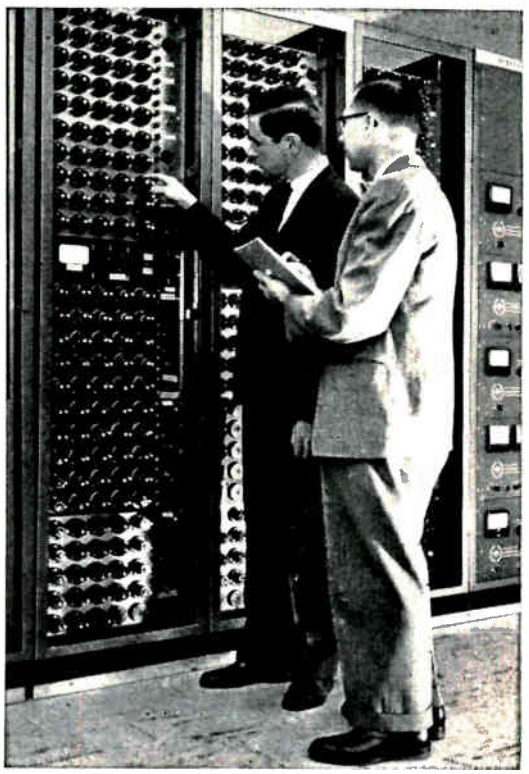


G-E 2N43A LIFE-TEST DATA OBTAINED AT 1000-HOUR POINTS. Upper chart shows results of 100°C storage test (25°C storage test not shown). Lower chart shows results of 200 mw operating test. Broken lines in each chart indicate h_{fe}. Solid lines indicate I_{CBO} in microamperes. After 1000 hours of testing, there were no failures. The 2N43A transistor's high standard of quality is inherent in all G-E germanium PNP audio and switching transistors.



Dick Welch (left), Transistor Evaluation Engineering, and Lee Leinweber, Transistor Production Engineering, take readings at cycled-life-test rack. In addition to electrical testing, G-E 2N43A transistors are subjected to all mechanical-test requirements specified in MIL-T-19500/18.

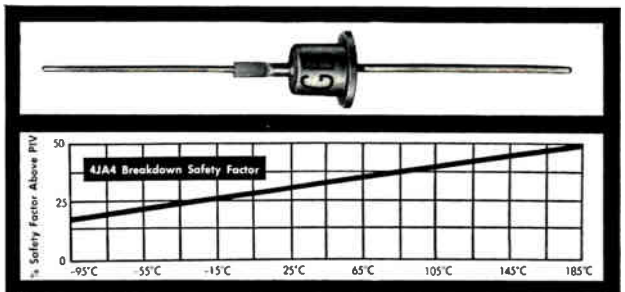
20% Safety Factor for silicon rectifiers aids designers

Designers who now apply their own safety factor to the published peak inverse voltage rating may avoid this step by using G-E low-current silicon rectifiers.

General Electric's PIV figures are set by allowing a 20% safety margin at −65°C. This margin is applied at the point of sharp breakdown voltage and increases with temperature until a maximum safety factor of 33% is reached at 150°C.

If you are derating published PIV figures to provide over-voltage protection, you may be buying costlier cells than you need, or, in series applications, more cells than necessary. Thus the built-in safety margin of G-E low-current silicon rectifiers could save you money. Note: This safety factor is provided for over-voltage protection only. Designs should, in all cases, be maintained within published maximum ratings.

This is only one reason why you should consider G-E low-current silicon rectifiers for all your power requirements. You'll find these devices more attractive to use than ever before—both in quality and price—with equally fine values in low-current silicon stacks. Stud-mounted units are also available. Ask your G-E semiconductor representative for the "big news" on low-current silicon rectifiers.



Maximum Ratings and Specifications

	PIV	RMS Voltage	Cont Reverse D-C Volt	D-C Output (150°C Amb.)	D-C Output (50°C Amb.)	Ambient Operating Temp
1N536-40, 1N1095-96 series	50-600	35-420	50-600	250	750	165
1N4408 series	100-600	70-420	100-600	300-500 (100°C)	300-750	150-165
1N1487-92 series	100-600	70-420	100-600	250 (125°C)	750 (25°C)	140
1N1692-95 series	100-400	70-280	100-400	250 (100°C)	600 (50°C)	115
	volts	volts	volts	ma	ma	°C

for General Electric audio transistors

General Electric's 1958 process and quality-control advances were reflected in recent life-test results exhibited by G.E.'s line of germanium PNP audio transistors. Random samples of Type-2N43A transistors were subjected to rigorous mechanical testing . . . drop-shock, detergent-bomb, lead-fatigue (i.e., all the MIL-T-19500/18 mechanical test requirements). Then a total of 1050 Type 2N43A transistors were put on Life Test, with the following results:

350 (10 lots, 35 units each) were given a 100°C storage test for 1000 hours. No failures.

350 (10 lots, 35 units each) were given a 25°C storage test for 1000 hours. No failures.

350 (10 lots, 35 units each) were given a 200 mw cycled-life test for 1000 hours. No failures.

Engineering test data indicate that, without exception, parameters remained stable (see curves at left).

The G-E 2N43A transistor is representative of the outstanding quality built into General Electric's entire line of germanium PNP audio and switching transistors.

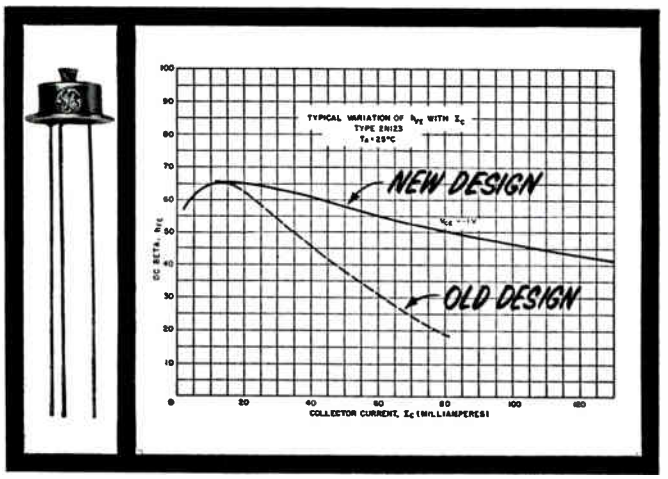
RATINGS: AUDIO AND LOW-FREQUENCY SWITCHING TRANSISTORS

		2N43	2N43A	2N44	2N44A	2N1056	2N1057	
Collector-to-base Voltage (25°C)	V_{CB}	−45	−45	−45	−45	−60	−45	volts
Collector-to-emitter V. (25°C)	V_{CE}	−30	−30	−30	−30	−75	−45	volts
Total Dissipation (25°C)	P_C	240	240	240	240	240	240	mw
Forward D-c Current Gain, Common Emitter I_C/I_B (V_{CE}= −1v; I_C= −20 ma)	h_{FE}	53	53	31	31	32	58	
(V_{CE}= −1v; I_C= −100 ma)	h_{FE}	48	48	25	25		52	
Collector Cutoff Current (V_{CBO}= −45v)	I_{CO}	−8	−8	−8	−8		−18	µa
(V_{CB}=75v; I_E=0)	I_{CO}	NOTE: All figures represent design-center ratings.				−18		µa

High frequency transistors modified for higher Beta

Recent design improvements in high frequency switching transistors (Types 2N123 and 2N450) have improved their d-c beta at higher collector currents. The result is higher gain and improved saturation characteristics at these high currents.

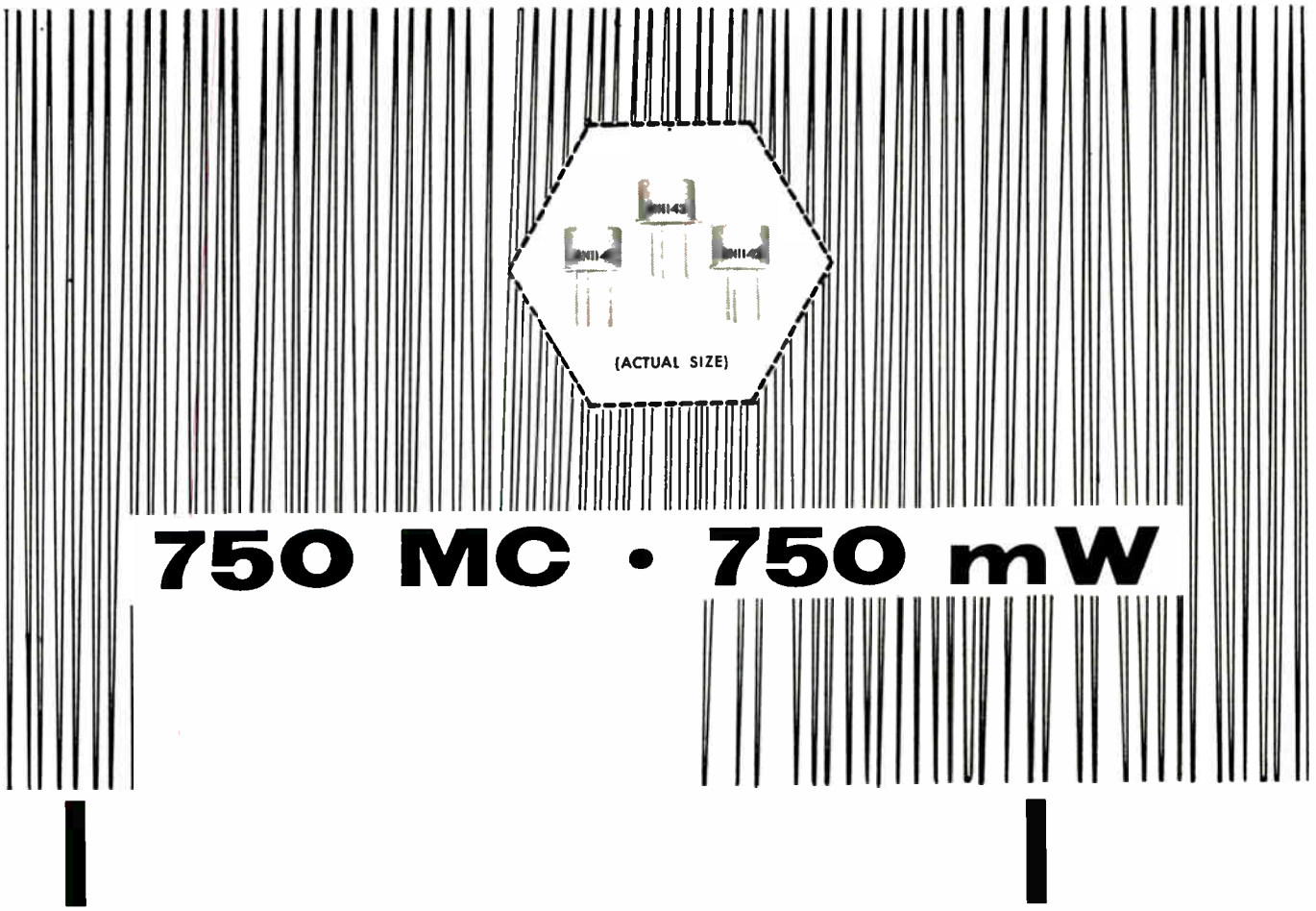
Refinements in quality control tests have also been put into practice on the production line. These units are affected: Types 2N123, 2N450 and the 2N396 series. Units are aged at 100°C for 96 hours to stabilize characteristics. All transistors are subjected to a high-pressure detergent test for hermetic sealing. D-C characteristics are warranted to be within the limits shown on specification sheets. As a result, these transistors are now widely accepted in missile computer work and other rigorous applications.



General Electric Company, Semiconductor Products Dept., Section S2529-6, Electronics Park, Syracuse, N. Y.

GENERAL ELECTRIC

NEW TI DIFFUSED-BASE

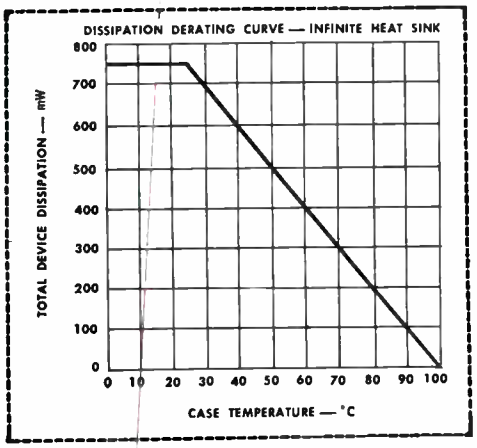


750 MC • 750 mW

Guaranteed current gains of 12, 10 and 8 db minimum at 100 mc with new TI 2N1141, 2N1142 and 2N1143 diffused-base "mesa" germanium transistors! Alpha cutoff ratings up to 750 mc coupled with 750 mW power dissipation at 25°C case temperature make these newest TI transistors ideal for military VHF power oscillators and amplifiers where assured reliability and performance are of primary importance.

All units are 100% production stabilized at temperatures well above their 100°C rated junction operating point ... far exceed MIL-T-19500A specifications ... and are *in stock now.*

Contact your nearest TI sales office or nearby TI distributor today ... *for immediate delivery.*



absolute maximum ratings @ 25°C case temperature

	2N1141	2N1142	2N1143	
Collector Voltage Referred to Base	−35	−30	−25	V
Emitter Voltage Referred to Base	−1	−0.7	−0.5	V
Collector Current	−100	−100	−100	mA
Emitter Current	100	100	100	mA
Device Dissipation (infinite heat sink)	750	750	750	mW
Collector Junction Temperature	+100	+100	+100	°C
Storage Temperature Range		−65 to +100		°C
Thermal Resistance Junction to Mounting Base	0.1	0.1	0.1	°C/mW

typical characteristics @ 25°C case temperature

Frequency Cutoff (Common Base)	750	600	480	MC
Collector Reverse Current, $V_{CB} = -15V$, $I_E = 0$	1	1	1	μA
Saturation Voltage, $I_C = -70mA$, $I_B = 17.5mA$	2	2	2	V
Small Signal Short Circuit Forward Current Transfer Ratio, $V_{CB} = -10V$, $I_C = -10mA$, f = 1000cps	0.97	0.97	0.97	

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ELECTRONICS NEWSLETTER

BEFORE LUNIK WAS LAUNCHED Jan. 2, the Soviets fired a number of test mockups consisting of operational first stage and dummy second and third stages. McGraw-Hill World News learned that this was to gain data on control and resistance built up as the vehicle passed through the earth's atmosphere. During tests an unknown number of liquid-fueled, 484,000-pound-thrust engines burned out on launching pad. With regard to possible unsuccessful Soviet lunar shots, observers cite two points: (1) 25-mile apogee of mockup trajectory for stage testing is believed too low to have been picked up by American radar picket fence in Turkey; (2) Hawaiian tracking stations, which picked up Lunik signals before Soviet announcement, would probably have picked up previous probes if they reached the same point, but then failed to orbit (see p 22).

Transistorized ignition system is being ordered by Detroit Arsenal from the Electric Auto-Lite Co., Toledo, Ohio. Orders cover prototype sets that meet particular military specifications.

NEW ATLAS GUIDANCE CONTRACTS totaling $110 million were received last week by GE, confirming earlier letter contracts. Three new contracts, for additional R&D as well as production of radio command guidance systems, bring GE's contract total for Atlas guidance to $193 million. The equipment will go to Vandenberg AFB, Calif., Warren AFB, Wyo., and Offutt AFB, Neb.

SALES of electronic products for business and industry are expected to rise by 27 percent this year over factory sales of $1.4 billion in 1958. So says RCA President John L. Burns. He adds that in data-processing systems alone a rise of more than 70 percent to about $600 million is anticipated. Meanwhile, says Burns, "industry sales of defense electronic products in 1959 can be expected to rise by at least 14 percent over last year's $3.6 billion."

FIVE NATO NATIONS may spend as much as $500 million in building the Army-Raytheon low-altitude Hawk air defense missile. European firms involved are: Ateliers de Construction Electrique de Charleroi, Belgium; Telefunken, West Germany; Finmeccanica, Italy; Philips, Holland; Thomson-Houston, France. T-H is expected to be chief coordinator, but each firm will be prime contractor in its own country. Holding company set up by the five firms will retain Hawk license rights.

AIRLINES of Europe and North America are studying means of speeding reservations messages automatically over linked teletypewriter systems. That, says International Air Transport Association, is one goal of an airlines committee. Second, long range phase of effort is integration of electronic data-processing systems into proposed interline reservations process. First step towards this is survey of data-processing equipment now in use or planned for the near future.

Missile measurement ship, the S. S. American Mariner, has been put into service tracking ballistic missiles and checking their performance on the Atlantic Missile Range. RCA was systems contractor for ship's electronic gear.

THERMO GENERATOR'S FUTURE lies in increasing efficiency of present power plants, not in replacing them, says Mark W. Cresap, Jr., Westinghouse president. Thermoelectricity has been getting "frantic attention" since semiconductor breakthrough, he reports. Also foreseen: appliances, such as bottle warmers and electric blankets, that will both heat and cool.

NEW AIRBORNE EARLY WARNING RADAR system is being produced for the Air Force by Hazeltine Corp. under contracts totaling about $15 million. Equipment is said to increase protection from surprise attack.

Soviet post-mortem conference on why Lunik failed to hit the moon reportedly gave greater weight to relative crudeness of third-stage cut-off mechanism than to influence of magnetic fields.

INTERNATIONAL CONVENTION on transistors and associated semiconductor devices, sponsored by Britain's Institution of Electrical Engineers, will be held May 21 to 27, a few days earlier than previously announced. Exhibition will be open during convention period.

JAPANESE ELECTRONICS industry reported production valued at $333 million for the first nine months of 1958, 24 percent above the comparable 1957 period. Information comes from a study prepared for the Commerce Department's electronics division by the U. S. embassy in Tokyo. Exports worth $26 million in the nine months ran about one-third more than for all of 1957.

BRITISH RADIO EQUIPMENT exports rose to $126 million last year, $4.5 million more than in 1957. Largest hikes were in sales of tubes and sound reproducing gear while components and capital goods exports fell slightly, reports Radio Industry Council of Britain. Council's breakdown of export customers for first nine months of '58 shows U. S. bought about $11.5 million worth of British radio goods.

WASHINGTON OUTLOOK

ODDS ARE AGAINST passage of Sen. Saltonstall's new bill to revamp military procurement policy. It faces stiff opposition from House Armed Services Committee Democrats and small business supporters.

The Saltonstall bill provides for:

(1) Increased use of negotiated, fixed-price contracts with special incentives for production cost reductions.

(2) Wider application of the weapon system management concept under which increased authority is granted to prime contractors.

(3) Other procurement short cuts.

The bill would allow the military greater latitude to award negotiated—as opposed to advertised—contracts. Under present laws, military award of negotiated contracts involves considerable red tape. Advertised procurement is considered the general rule; negotiated procurement is allowed only under specific exemptions to the law which the Pentagon must justify in detail before signing contracts.

For the most part, defense producer spokesmen are backing the bill. But small business advocates are suspicious of the measure's stress on weapon system management.

Under this system, control over weapon development is centralized in one prime contractor—with a minimum of government interference. The prime has responsibility for the design and production of an entire missile or plane and all its components.

He builds some of this himself, farms out the remainder to subcontractors, assembles the product, even directs crew training and supervises installation and maintenance. The scheme was devised as a means of simplifying and speeding development of complex new weapons.

- **A broader scope** on challenges to renewals of radio and television station licenses is shaping up.

  It appears, after a round of court actions, that the Federal Communications Commission must allow nonbroadcasters who compete with a broadcaster (or its parent) in another business to challenge renewals.

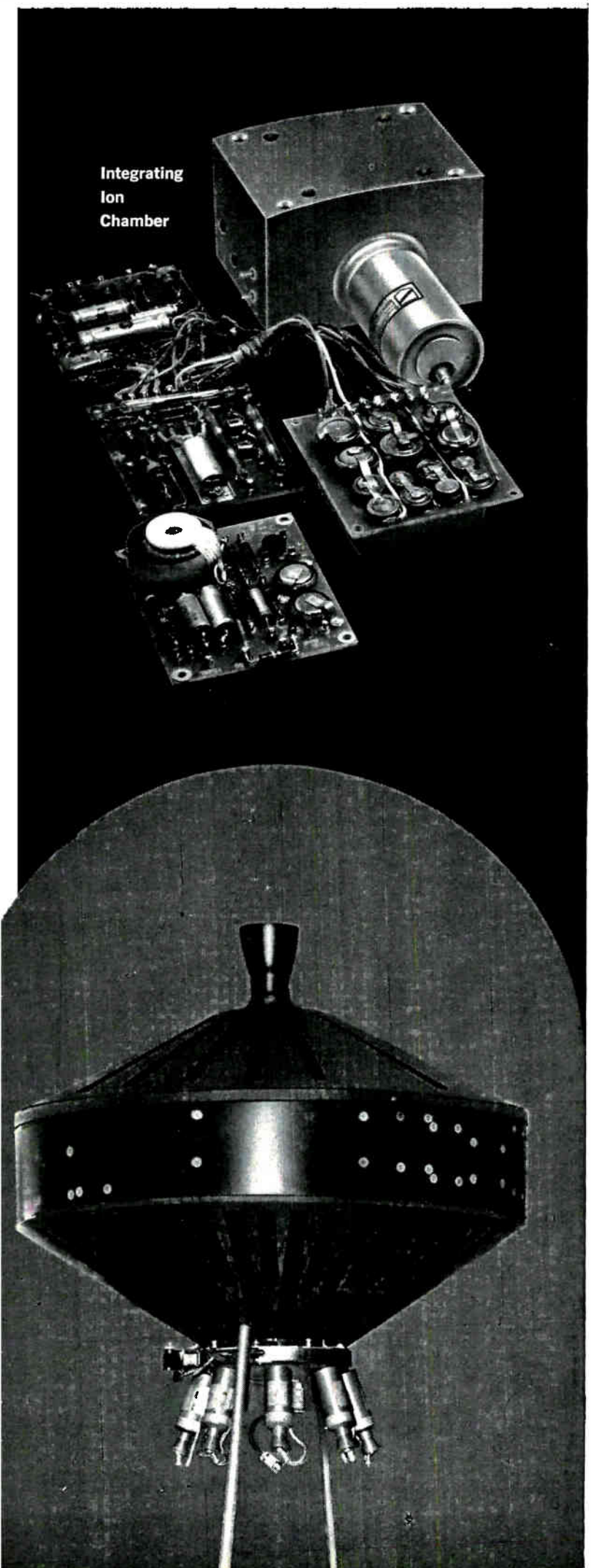
  Last June, the Court of Appeals in the District of Columbia reversed FCC's position that the Philco Corp.—as a nonbroadcaster—had no standing to challenge the renewals of NBC's Philadelphia radio and tv station licenses.

  Now, the U. S. Supreme Court has refused to review the Court of Appeals decision. FCC must now consider Philco's protest to the NBC renewals, specifically, that RCA-NBC antitrust troubles should disqualify NBC as a station operator.

- **New electronic developments** are expected to play a key part in the military's push for a global communcations network using space satellites.

  Dubbed Project Courier, three such communications experiment shoots are scheduled for 1960, with four more set for 1961. Early versions of the satellites are supposed to be able to receive and transmit messages at the rate of 2,000 words per minute.

  The Advanced Research Project Agency is in charge now but the new National Aeronautics and Space Administration will eventually take over.



Concerning Radiation Theories in Interplanetary Space

Aptly called **Pioneer**, the terminal stage of Able-One's space probe reached into the fringes of the universe to telemeter data that will help solve the problems of interplanetary travel. **Pioneer** successfully carried 39.6 pounds of Space Technology Laboratories' developed instrumentation for the gathering and transmission of data.

The ion chamber and associated equipment provided information concerning the radiation intensity in space. This experiment was carried on in connection with the Department of Physics, State University of Iowa.

In conjunction with the U. S. Air Force Ballistic Missile Division, and under the sponsorship of the National Aeronautics and Space Administration, **STL's** explorations and developments in seeking energy spectra of the radiation belt are continuing at an accelerated pace. Increased knowledge in the fields of interplanetary magnetism and the distribution of interplanetary matter are being sought. Related fields of astrophysics provide additional areas in which advanced experimentation may be expected to add substantially to man's knowledge of the universe.

These programs at **STL** open a whole new vista in analytical and experimental areas for the advanced technical person whose interests and experience qualify him for work in the following fields: electrodynamics, nuclear physics, communication theory, and the design and execution of physical experiments in interplanetary space. Inquiries are invited.

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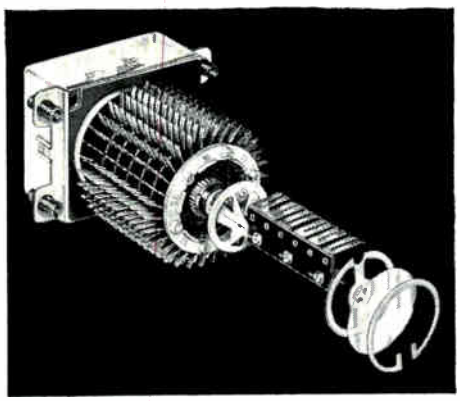
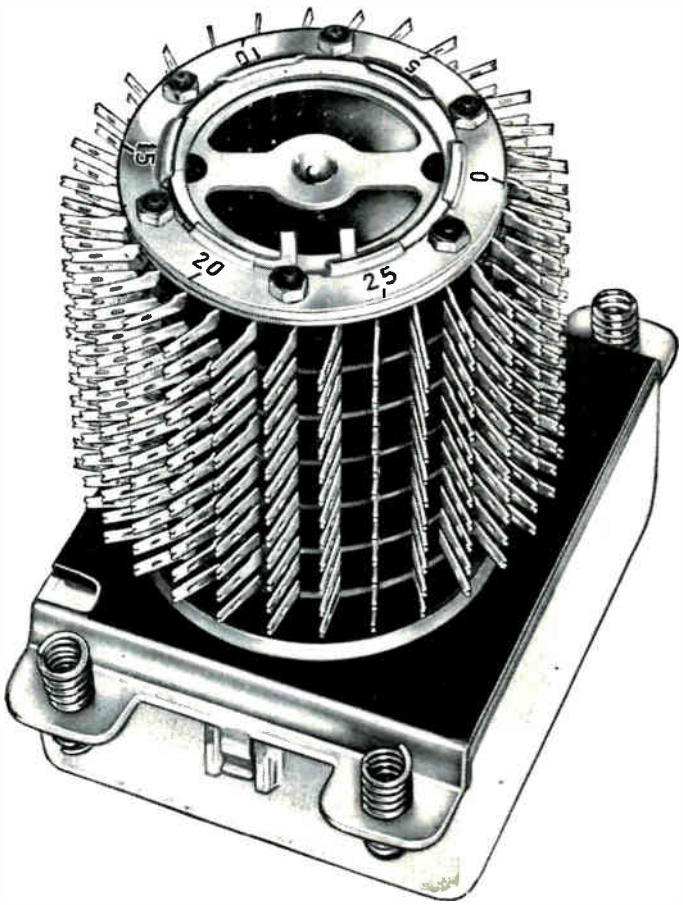


For circuit applications requiring up to 30 points per level, the switch is provided in 2, 4 or 6 levels with single rotor. For circuit applications requiring up to 12 levels with 15 points per level, the switch is furnished with a dual rotor. Bank contact ratings: 1 amp at rest; .2 amp. resistive when stepping. Off normal contact ratings .4 amp. resistive. Switch may be driven self-stepping or externally. Gold plated bank contacts and wipers are available for low level switching. Available with 12, 24, 48, 110 V. D.C. coils. Built-in spark suppression on 24 and 48 volt switches. Mounting dimensions: 1.968″x3.661″ O.C. Overall height: 4¾″ height above mounting, 3½″ (max. dimensions for 6 level switch). Weight: 1.32 lbs.



New Names Hit 'Big Boards'

LISTING of Ampex Corp. stock on the New York and Pacific Coast Stock Exchanges last week may point the way to increase in electronics firms on the "big boards" of U. S. securities markets.

An official of NYSE told ELECTRONICS that a check of records back to mid-1957 shows that the number of electronics listings has grown steadily.

During the past 19 months, the New York mart's rolls have been increased by eight firms which derive all or part of their income from electronics.

A spokesman for the American Stock Exchange told ELECTRONICS that seven electronics firms have obtained listings there in the same time period.

In order to qualify for listing on the New York exchange, a firm must meet the following requirements:

- It must be one in which there is nationwide interest.
- It must have issued at least 400,000 shares of stock which are owned by at least 1,500 investors.
- It must have demonstrated earning power of at least $1 million annually in its recent past.
- It must agree to publish quarterly financial statements publicly.
- Stock must have voting privilege.

Stocks listed on the major exchanges generally find a broader market than those sold over the counter. Some market observers say this is because many investors, such as institutions, mutual fund groups and endowment funds, do not buy securities not listed on the big boards. In some cases, such groups are prevented by law or policy from purchasing over-the-counter stocks. Also, listings are more widely published for main exchange stocks.

In addition to Ampex Corp., other newcomers mentioned by officials of the New York Stock Exchange for the period from July 1957 to the present are: Allied Products Corp., Detroit; Bausch & Lomb Optical Co., Rochester, N. Y.; Champion Sparkplug, Detroit; Glading McBean & Co., Los Angeles; Litton Industries, Beverly Hills, Calif.; Siegler Corp., New York; and Thiokol Chemical Corp., Trenton, N. J.

New electronics listings on the American Stock Exchange for the same period were reported as follows: General Transistor Corp., New York; Herold Radio & Electronics Corp., New York; Jetronic Industries Inc., Philadelphia; Philips Electronics, Inc., New York; Stratham Instruments Inc., Los Angeles; Teleprompter Corp., New York; and Victoreen Instrument Co., Cleveland.

OVER THE COUNTER

1958 BIDS LOW	HIGH	COMMON STOCKS	WEEK ENDING Jan. 16 BID	Jan. 23 BID	ASKED
3¾	20½	Acoustica Assocs	19	20	23
1⅝	3	Advance Industries	2⅞	3½	4¼
3⅛	6⅝	Aerovox	6½	6½	8⅞
20½	33	Amer Res & Dev	37¼	37½	39¾
16¾	24¼	AMP Inc	22	23¼	25⅞
5½	15	Appl'd Sci Princet	11	9¼	11⅝
1⅛	8⅞	Avien, A	9	10⅜	11⅜
6¾	24	Baird-Atomic	27½	26¾	30⅜
9¾	13⅜	Burndy	14⅜	14⅜	15½
6¾	9	Cohu Electronics	6⅞	6¾	7⅞
11	22½	Collins Radio, A	21⅝	25¼	27¾
10¼	22¼	Collins Radio, B	22¾	25¼	27½
4	7	Craig Systems	6⅜	6⅝	8¼
30	50½	Dictaphone	48½	48	52½
17⅝	25⅜	Eastern Industries	20	20½	22½
10½	21	Electro Instr	22½	26¼	29⅜
34	49	Electronic Assocs	52	51	56½
5	11	Electronic Res'rch	12	12¼	14⅛
8½	12¾	Electronic Spec Co	14	14½	15¾
15¼	49½	Epsco, Inc	43	41	48¼
5½	9⅜	Erie Resistor	8¾	10¾	12¼
10	17½	Fischer & Porter	16¾	16	18
36¾	50	Foxboro	48	49½	54½
5½	10½	G-L Electronics	10	11¼	13⅝
12	27	Giannini	29½	31	35⅛
30	39½	Hewlett-Packard	40½	42½	47⅝
23¼	48	High Voltage Eng	61	57	63½
1¾	3	Hycon Mfg	3½	3⅜	4
1⅛	5⅛	Industro Trans'tor	3	2¾	4
1½	4¾	Jerrold	4¼	4½	5⅛
21	30	D. S. Kennedy	28	33¾	37½
3¾	29	Lab For El'tronics	27¼	23¾	29⅜
19¼	28	Leeds & Northrup	28½	29½	32
2	3⅛	Leetronics	2	2	2⅜
5	18¾	Ling Electronics	19¾	18¾	21⅛
16	20½	Machlett Labs	22	21¾	24⅜
3¼	8¼	Magnetic Amplifiers	8	8	8¾
2⅞	4½	Magnetics, Inc	3⅝	3⅝	4⅛
4⅝	12	W. L. Maxson	12¾	13½	15¾
10⅝	29	Microwave Assocs	36⅞	34	42½
5¼	11¾	Midwestern Instr	11⅜	13¼	15
1⅛	7	Monogram Precis'n	9	8¼	9⅝
3½	7¼	Narda Microwave	6⅞	6½	7¼
9¾	16	National Company	16¾	18¼	20⅜
14¼	56	Nuclear Chicago	26	30½	38¾
14½	29¾	Orradio Industries	29¾	28¾	32
4½	7⅜	Pacific Mercury, A	9½	9¼	11½
10⅛	27½	Packard-Bell	28½	30½	33¼
4¼	9⅜	Panellit, Inc	7¼	6¾	8⅛
21	53¾	Perkin-Elmer	52	52¾	56½
11⅜	19½	Radiation, A	18	17¾	19½
2⅛	7⅜	Reeves Soundcraft	6¾	7⅞	9¼
13	32½	Sanders Associates	34	33	37¼
7	12	SoundScriber	14¼	15	20⅛
22¾	40	Sprague Electric	41½	41¾	45⅜
26	35	Taylor Instruments	34	34½	37¼
5½	15	Technical Operat'ns	15¼	16¼	18⅜
5½	15¾	Telechrome Mfg	15¼	16	21
3¼	7¾	Telecomputing	8½	8½	9⅛
1⅛	2¾	Tel-Instrument	2¾	2¾	3½
8¾	16¼	Topp Industries	12⅞	14⅝	16⅝
3¾	10¾	Tracerlab	12	12¼	13⅞
1⅛	3⅜	Universal Trans'tor	2⅝	2⅝	2⅞
14¼	40	Varian Associates	48½	50	56¼
12½	18½	Vitro Corp. Amer	15⅜	16¼	19⅝

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

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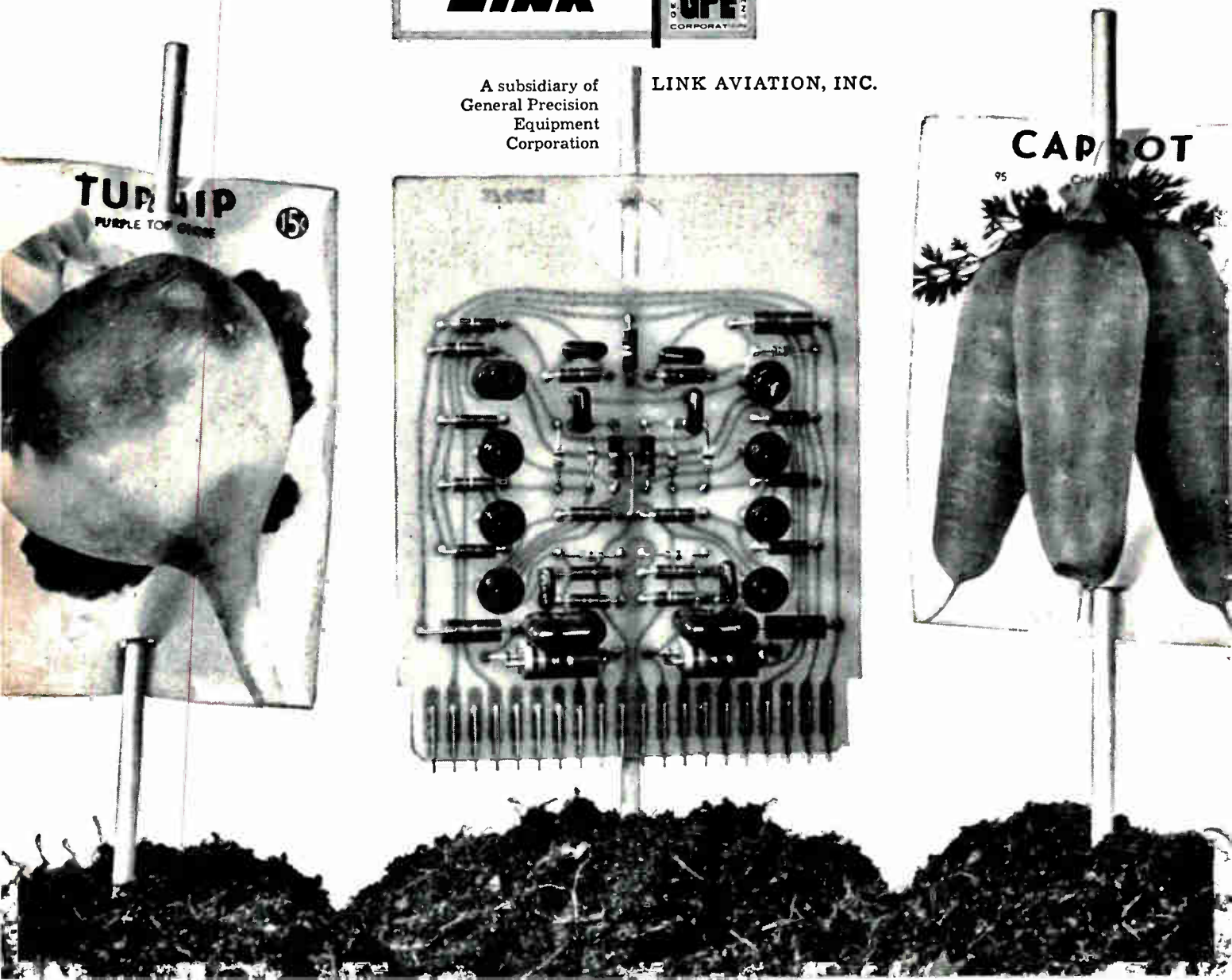

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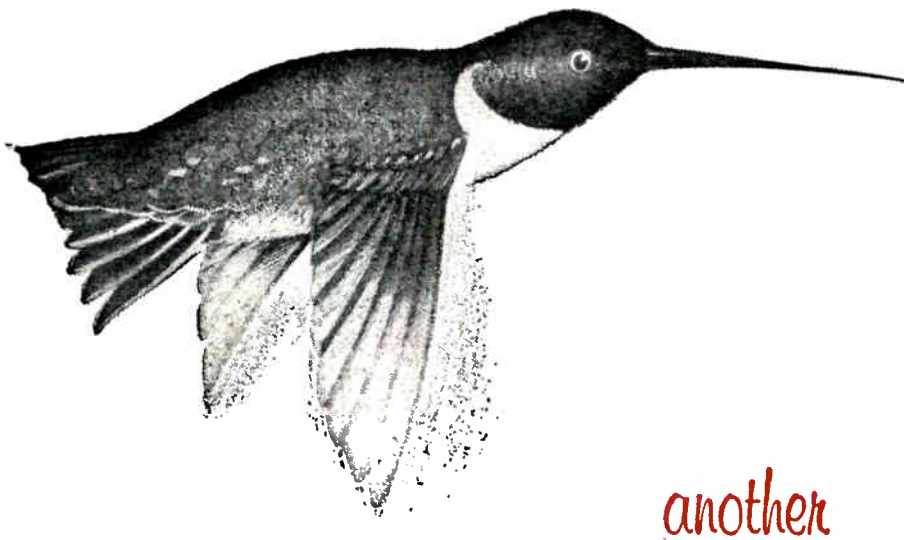

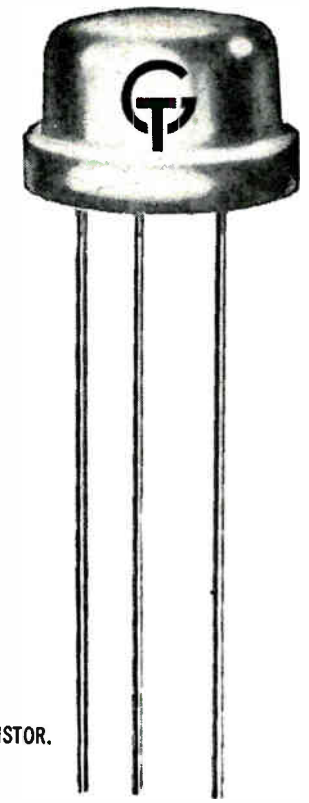

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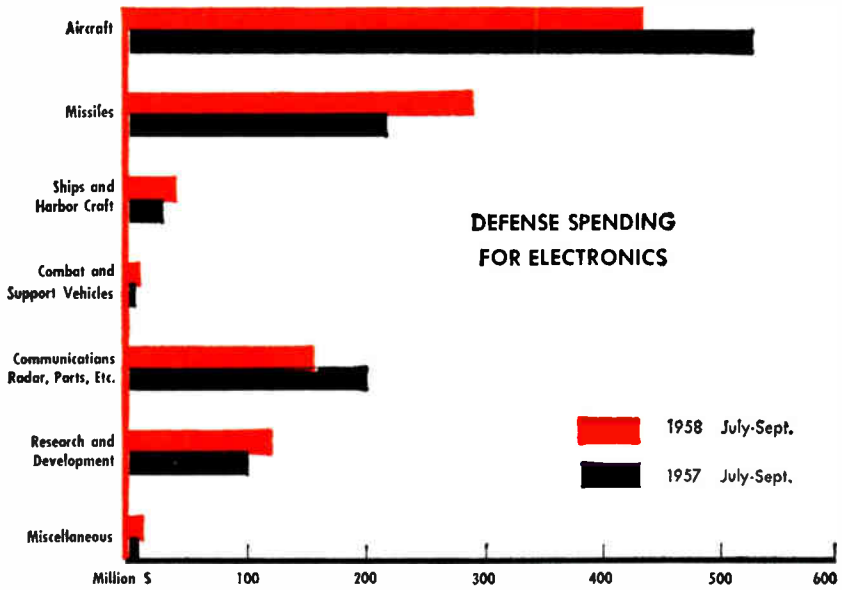


Missiles Rise in 3rd Quarter

DEFENSE DEPARTMENT spending for electronics during the months July to September, 1958, showed relatively little overall change from July to September, 1957. Of a total expenditure of $3.8 billion, electronics industry benefitted by some $1.06 billion in the third quarter of 1958, versus an outlay of about $1.09 billion in the third quarter of 1957. But gains were posted in five of seven categories.

Electronics expenditures for aircraft amount to $446 million during the third quarter of '58. About $531 million was spent for aircraft electronics in third quarter, '57.

Missile electronics accounted for $288 million in third quarter '58, $221 million in third quarter '57.

DOD budgets have lowered expenditures in the aircraft category. Missile electronics, on the other hand, has shown a steady increase —but not enough to compensate for the more severe cuts in aircraft electronics procurement.

Electronics spending in third quarter 1958: $34 million for ships and harbor craft; $6 million for combat and support vehicles; $161 million for communications, radar, parts, etc.; $120 million for research and development; and $7 million for miscellaneous electronics.

Electronics spending in third quarter 1957 totaled: $26 million for ships and harbor craft; $3.4 million for combat and support vehicles; $204 million for communications, radar, parts, etc.; $102 million for R&D; and $4 million for miscellaneous electronics.

The electronics portion of total spending for various budget categories is based on following percentages developed by ELECTRONICS research department: Aircraft electronics, 25 percent; missile electronics, 40 percent; ship and harbor craft electronics, 10 percent; combat and support-vehicle electronics, 6 percent; communications, radar, parts, etc., 100 percent; electronics research and development, 25 percent; miscellaneous electronics, 3 percent.

Most controversial of these categories is missiles. Percents for the electronics portion of missile systems have been estimated as low as 30. Other estimates have neared the 50-percent mark.

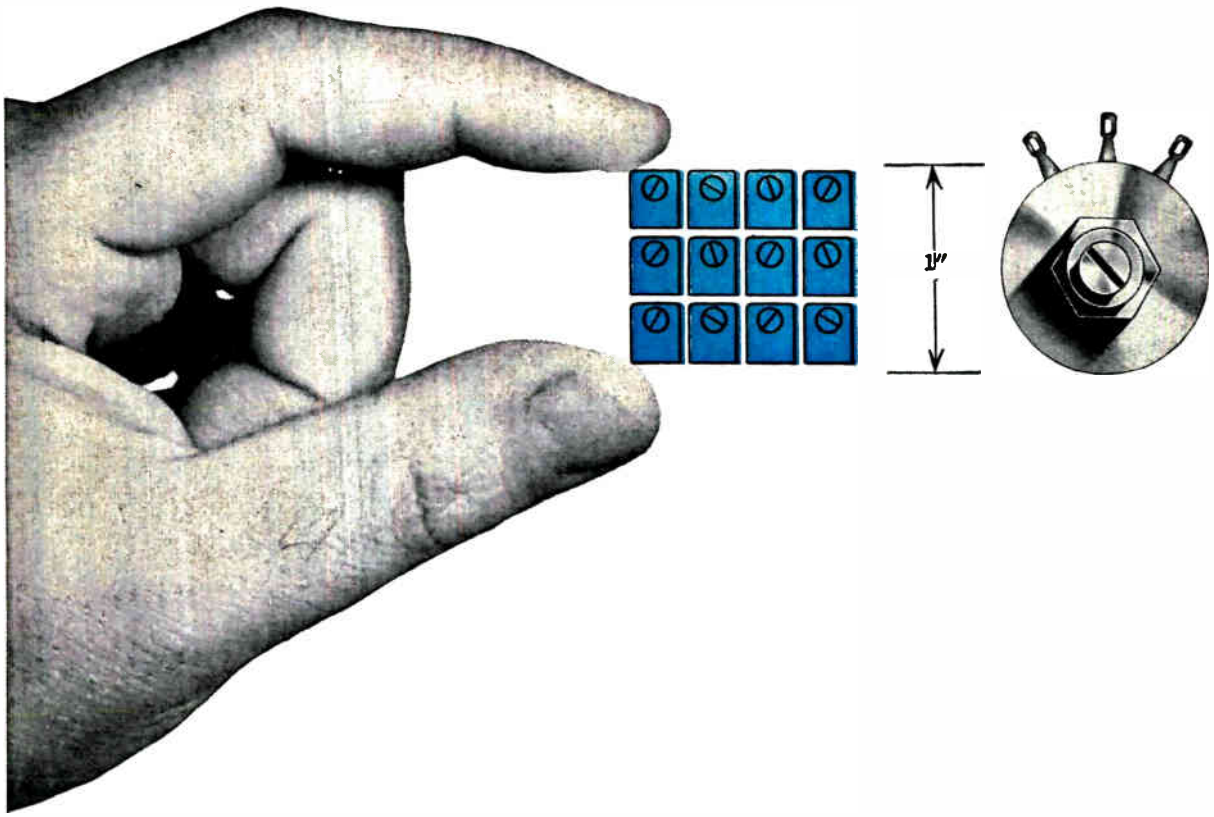
FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Jan. 16, 1959	Dec. 19, 1958	Change From One Year Ago
Television sets	103,696	110,021	— 4.7%
Radio sets (ex. auto)	279,954	319,478	+17.1%
Auto sets	109,765	124,976	+10.2%

STOCK PRICE AVERAGES

(Standard & Poor's)	Jan. 21, 1959	Dec. 23, 1958	Change From One Year Ago
Electronic mfrs.	74.56	72.24	+39.1%
Radio & tv mfrs.	82.36	76.19	+83.3%
Broadcasters	79.77	78.07	+36.9%



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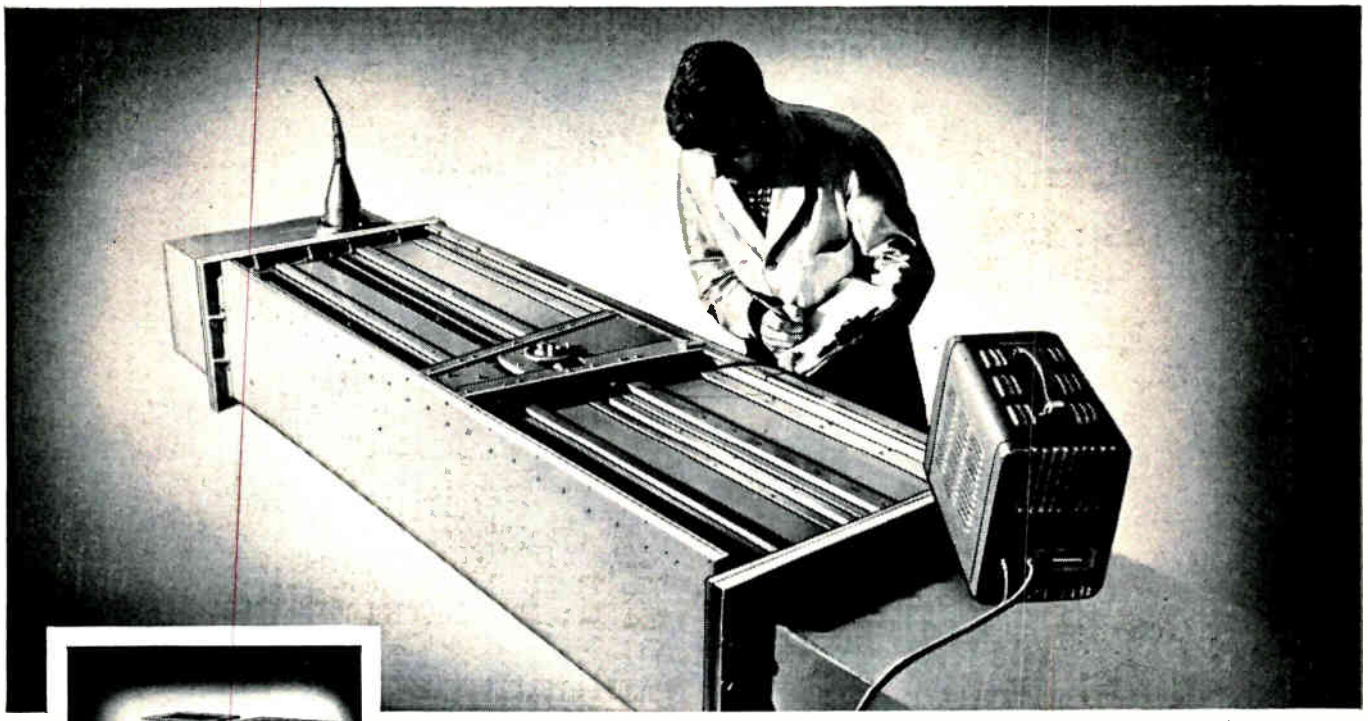

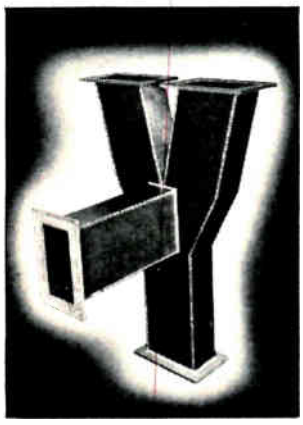

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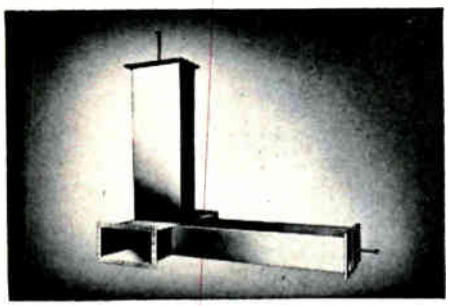
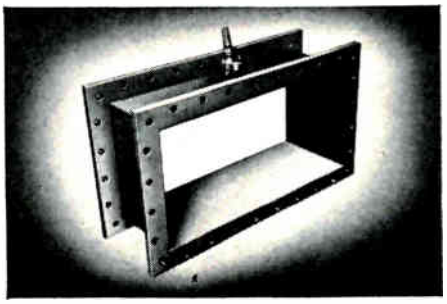
Here are a few examples of the waveguide test equipment and components currently available from I-T-E to meet the testing and operating requirements of multi-megawatt radar and scatter communications systems. This equipment reflects I-T-E's broad experience in all phases of large waveguide design and manufacture.

Take advantage of I-T-E's specialized knowledge of waveguide testing and the precision fabrication capabilities of a specially equipped waveguide shop. Facilities such as these assure you of the highest standards of quality, maximum economy, and excellent delivery—in single or production quantities.

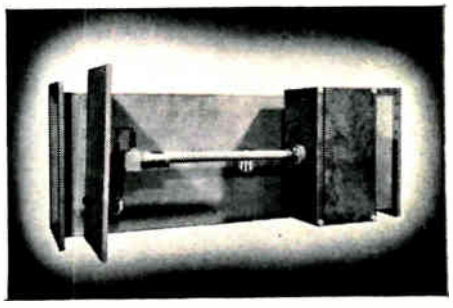
If you have a requirement or problem relating to waveguide test equipment, write I-T-E Special Products Division, 601 E. Erie Ave., Philadelphia 34, Pa. And ask for your copy of free-space wave length vs. guide wave length conversion tables for large waveguide.



E-H plane tuner



Close-loop directional coupler



Motorized short circuit section

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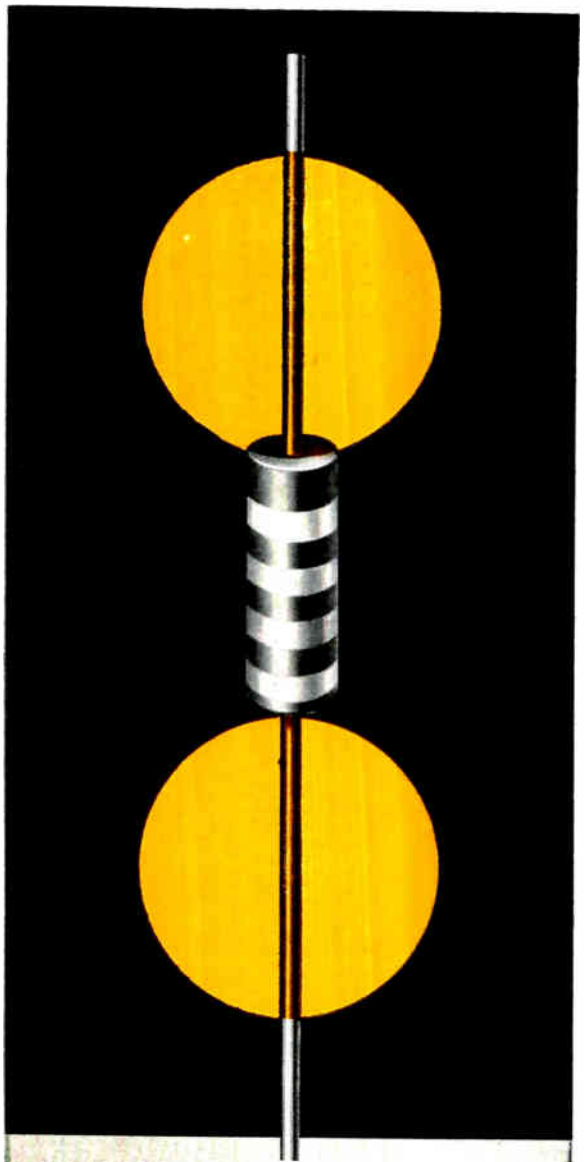


Get a head-start on production

with "solder-coated" resistors

You can pretty well take for granted that any one of several leading resistor brands will meet or exceed your performance requirements. But there's another factor to be considered too—ease of handling on your assembly lines. Mainly that means ease of soldering — and here Stackpole Coldite 70+ "solder-coated" fixed composition resistors stand head and shoulders above the field. Not only do these famous cold-molded resistors meet today's critical specifications, but they provide unmatched "solderability" on any hand or automatic, open wiring or printed circuit operation. That makes not only for a real saving in assembly work, but also stands to reduce subsequent service costs resulting from poor soldered connections.

Coldite 70+ Resistors Save You Money on Assembly Work!

Stackpole Coldite 70+ resistors solder easier and stay soldered more surely. Thanks to an extra solder coating applied AFTER the usual tin-lead coating, they solder perfectly by ANY method — dip or iron. Moreover, resistance variations from normal soldering heat are negligible.

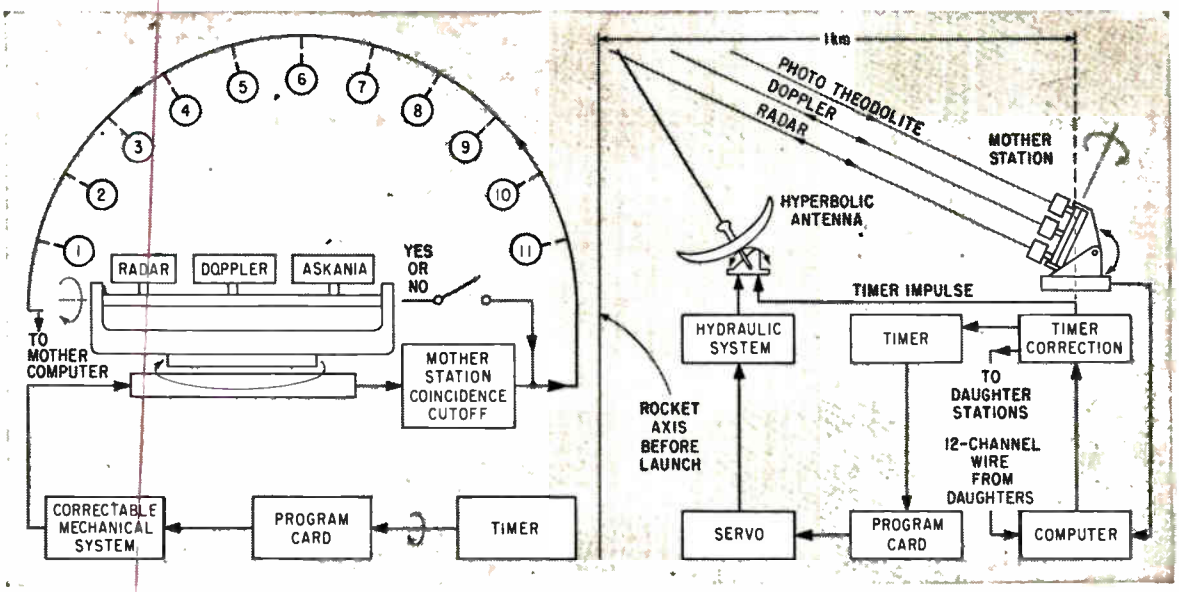
ELECTRONIC COMPONENTS DIVISION
STACKPOLE CARBON COMPANY, S.T. MARYS, PA.

STACKPOLE

Coldite 70+®

FIXED COMPOSITION RESISTORS

CERAMAG® FERROMAGNETIC CORES • SLIDE AND SNAP SWITCHES • VARIABLE COMPOSITION RESISTORS • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS • ELECTRICAL CONTACTS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • HUNDREDS OF RELATED CARBON, GRAPHITE, AND METAL POWDER PRODUCTS



Tracking station control system (left) and directional-beam missile guidance ground station

How USSR Guided Lunik

1. Documentation shows she aimed at moon's equator and missed
2. Red China supplied much high-purity germanium for the project
3. All-transistorized gear used two-dimensional printed circuits

BONN—DOCUMENTED information from the USSR makes it clear that the Soviet artificial planet launched Jan. 2 was, in fact, intended to strike near the moon's equator.

McGraw-Hill World News learned that the Russians dispensed with telemetering gear for providing rocket performance data, and made no provision for destruction in flight. Sodium cloud, released by preset timer, provided check data on rocket performance.

Lunik contained essentially the same instruments as Sputnik III to measure magnetic fields, cosmic radiation, radioactivity, interplanetary matter, corpuscular radiation, micrometeorites and temperatures; four intercoupled transmitters were provided to relay data on 19.993, 19.995, 19.997, and 183.6 mc, with a fifth transmitter included as a standby. Transmitters had 6-watt input and average output of 1 watt.

The transmitters, which started operating 10 minutes before firing time, were also interconnected with a magnetic trip system. In the event of transmitter failure prior to burnout of the last vehicle stage, the fuel system was to be cut off to stop the rocket's journey.

For the first time in a Soviet rocket, McGraw-Hill World News learned, all electronic gear was fully transistorized and two-dimensional printed circuits were used. Much of high-purity germanium came from Red China. Rocket was launched from a point northeast of the Aral Sea on the border of European Russia, and was slated to be tracked by 13 stations sweeping from Prague to Voroshilov, near the Pacific. Chemical batteries, exhausted after 62 hours, enabled continuous transmission of data while the vehicle passed through the earth's shadow.

The rocket used programmed guidance for coarse control and a directional beam for fine control. System is said to have permitted the Russians to come within three degrees of their target. Key to this success was third-stage cut-off with 0.1-second accuracy when Lunik had achieved the desired escape velocity on its planned path.

Guidance and control gear was located in both the third-stage and the ground control station. Though all controls were programmed, additional ground-to-missile fine control was obtained by riding the vehicle on a beam projected by a hyperbolic antenna.

The desired flight path was inscribed on a perforated aluminum card in the rocket. Readout of this data was programmed by a crystal-controlled oscillator. Meanwhile, on the ground, a perforated iridium card with identical commands inscribed on it programmed the movement of the directional-beam antenna. Oscillator in the rocket was pulse synchronized with an identical timer on the ground.

The guidance beam was provided by a 2,500-mc crystal-controlled transmitter feeding an 85.2-ft diameter hyperbolic antenna.

Three liquid-damped gyroscopes in each of Lunik's three stages acted on an inertia stable platform to control roll, pitch and yaw. Gravitational influences were compensated by gyro system; magnetic

influences causing roll or pitch were corrected by two induction coils. A third induction coil coupled directly to an integrating accelerometer governed the pressure of fuel injected into the thrust chamber.

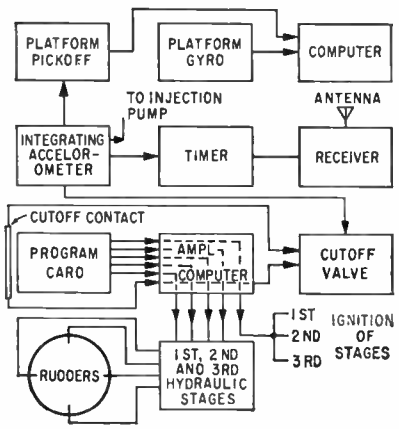
Guidance signals from the rocket's inertial system were sent through a computer to an amplifier, and compared in a second computer with signals from perforated-card program control. The resulting error signal was used to actuate a hydraulic system which positioned four graphite rudders at the end of the rocket nozzle.

The guidance beam was controlled by a ground station. There were 12 identical ground tracking stations, plus the main control station. Each station had a doppler radar, a conventional radar and a phototheodolite in a single turret.

The doppler used a parabolic reflector. The radar operated on 12-cm and used a 9.8-ft diameter reflector. The phototheodolite used an Askania system, some parts of which reportedly came from West Germany.

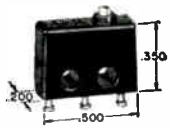
Correcting time pulses to the missile timer were sent as amplitude modulation on the guidance beam's 2,500-mc carrier frequency.

After launch, each subsidiary station, which was in phase, sent a signal to the main station indicating if it was zeroed in on rocket. Information from main tracker and all reporting subsidiaries was fed into master computer, which provided a correcting time pulse if necessary. Correcting time pulse went to the beam timer, the timer in missile, and the timers at subsidiary tracking stations.



Radio-inertial guidance equipment within missile

MICRO SWITCH Precision Switches



ACTUAL SIZE

More news about the "SX" miniaturized subminiature switch

The new "SX"—smallest precision snap-action switch—offers a new kind of answer to switching problems involving space, weight, and reliability. Here are some of the reasons:

SIZE (of case): .500" x .200" x .350" high—ten to the square inch.

WEIGHT: 1 gram . . . 28 switches to the ounce.

ELECTRICAL RATING: 28vdc: 7a. resistive, 4a. inductive-sea level; 2.5a inductive-50,000 ft.; 4a. motor load, 24a. max. inrush. 115/230 vac: 5a. resistive, 15a. max. inrush.

Other useful and newsworthy features of this remarkable switch include these:

Mechanical life is in the millions of operations.

The case of the "SX" has two through holes that will accept #2 screws. One hole is slightly elongated to facilitate mounting.

The "SX" operates dependably in temperatures from −65° F. to +250° F.

Operating force is controlled and predictable within 3 oz. to 5 oz. limits.

Terminals are integrally molded.

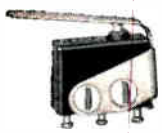
Special plating on terminals improves ease of soldering.

The normally-open and normally-closed terminal-contact inserts are solid silver and in one piece for maximum conductivity and heat dissipation.

For more information about this important switch, ask for Data Sheet 148.

New actuators add to versatility of "SX" Series

Two of the auxiliary actuators for the "SX" are shown below. Others, not shown, are pivoted lever and pivoted roller lever variations. All are made of stainless steel.


LEAF ACTUATOR


ROLLER LEAF ACTUATOR

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

Honeywell
MICRO SWITCH PRECISION SWITCHES

Twist It 'til It Snaps and It Still WON'T LEAK

The new improved Fusite V-24 Glass is so solidly fused to the stainless pins that 180° twisting won't break the bond between glass and metal.

Here is the line of hermetic terminals that is so resistant to both mechanical and thermal shock that terminals require no special nursing in application. Weld them, solder them, treat 'em rough—your assembly will remain hermetic, free of cracks under Statiflux testing.

Only V-24 Glass developed and smelted here in our own plant can produce terminals that give you such latitude in your production operation.

Wide variety of combinations of size, flange treatments, pin types and placement.

Write Dept. M-1 today stating your application and we'll send appropriate samples for your own testing.

INSULATE ELECTRICALLY
GLASS TO METAL
FUSITE
TERMINALS
PROTECT PRODUCT PERFORMANCE
SEAL HERMETICALLY

THE FUSITE CORPORATION

6000 FERNVIEW AVE., CINCINNATI 13, OHIO

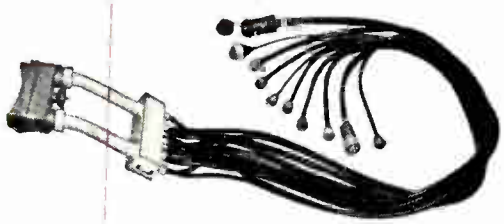
In Europe: FUSITE N. V. Königsweg 16, Almelo, Holland

Cable assemblies by BENDIX

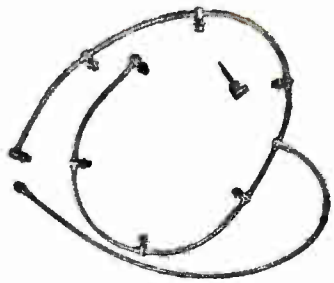
Specialized designs for the most exacting requirements

The versatility of design and reliability of performance offered by Bendix* Cable Assemblies result from over a quarter century of precision manufacturing in this field. Our outstanding research and design facilities are available for custom designing cable assemblies to meet your specialized requirements on each installation. Cable assemblies shown are typical Scintilla Division developments in cabling for aircraft, electronic and missile applications.

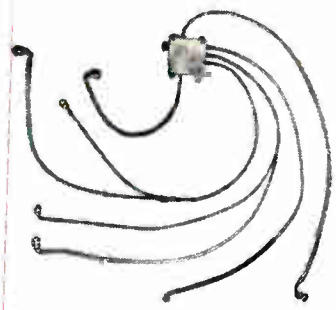
*REG. U. S. PAT. OFF.



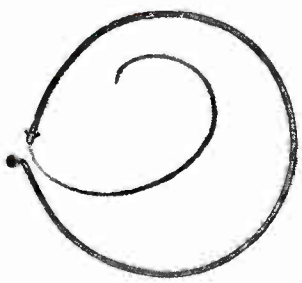
MISSILE CONTROL CABLE: This cable is fabricated using both Benseal® (a plastic molded covering) and Bendix electrical connectors. Protects vital circuitry controlling the firing of missiles.



THERMOCOUPLE HARNESS: Flexible, completely sealed and suitable for continuous operation in ambient temperatures of —65°F to 1500°F. Thermocouples are singly detachable and the sealed harness eliminates any chance of trouble from altitude, moisture or other contaminants.

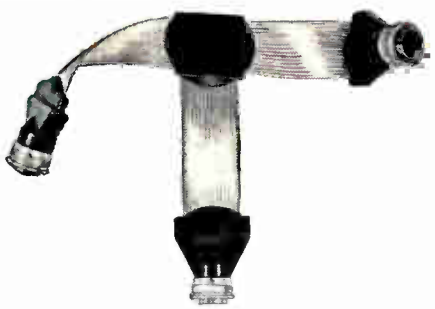


CONTROL HARNESS: This configuration, encased and sealed in metal braid and complete with junction box, can safely withstand the adverse effects of engine environment such as heat, vibration, and oils.



FUEL CELL CABLE: Safely conducts electricity to fuel control valves, pumps, switches and gaging devices immersed within fuel cells. Features: unbroken stainless steel bellows type conduit, double layer protection between current carrying conductors, stainless steel integral connector shells.

HEAVY DUTY CABLE: Ground support cable assembly built and designed for hard usage at missile launching sites. Heavy duty moldings and a tough neoprene tubing combine to resist wear.



RIBBON CABLE: Ribbon type cable terminated to both standard MS or Bendix Pygmy® connectors. Advantages offered by this type of wiring include durability, performance, lightness, plus minimum space requirements.

Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N.Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec

SCINTILLA DIVISION
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Small Recorder Sales Climb

Rising sales rate in battery-operated recorders holds promise of brisk component sales, say manufacturers, as consumer interest grows

INDUSTRY EMPHASIS on small size and portability of electronic gear is becoming increasingly evident in the manufacture of tape recorders.

Estimate by one audio manufacturers' group is that slightly more than thirteen percent of all models now on the market are battery operated. About one-third of the battery-operated models are transistorized.

Tape recorders in general are now enjoying what one firm describes as the "steepest sales climb" in tape-recorder history. Predictions by a major tape manufacturer are that yearly sales of tape recorders, amounting to some 600,000 this year, will total 865,000 units by 1960. Dollar volume is expected to hit $151 million in the next two years, an increase of almost one-half over present figures.

Performance

Although many battery-operated tape recorders have audio characteristics that leave much to be desired from the hi-fi enthusiast's point of view, a large number of them are capable of response curves extending from 50 to 15,000 cps.

A number of manufacturers are using spring motors to reduce power drain on recorder batteries. The spring motors are used to activate the transit mechanism, while the batteries supply power to the electronic portion of the unit. Some spring motors are designed to allow rewinding while the unit is in use, while others must be switched off to rewind.

Almost without exception, the battery operated models are available with more than one transit speed. A number of models feature speeds of 3¾, 7½, and 15 inches per second. There are several models that move tape at 1⅞ ips.

Sizes vary from units as big as briefcases weighing close to 20 pounds, to 9½-in. models weighing closer to six pounds.

While following the trend to miniaturization, some tape recorder manufacturers have not forgotten the great interest in stereo now prevalent. A substantial portion of the battery operated models are dual track units equipped for stereo playback.

Some models are available with four-track heads.

Pricing

Current prices for portable recorders hover at about the $400 mark although there are exceptions both above and below this price. The beginnings of European competition are being felt in this field.

A number of factors have caused the rise of the battery operated recorder. Some spokesmen for the recorder business say the increase is due to growing demands on broadcasters and record companies for records of events taking place away from conventional power sources.

Many manufacturers are banking on the belief that the tape recorder has, in many cases, become the businessman's working tool.

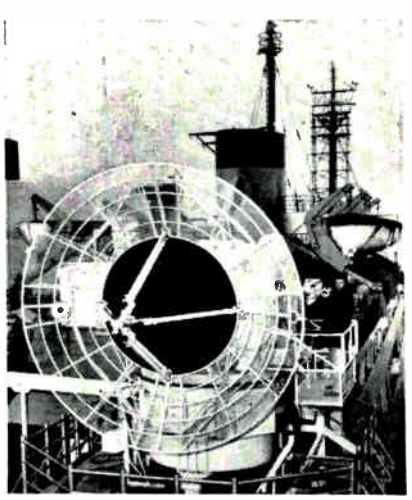
Business Uses

One example of the way portable sound is used is being demonstrated to good advantage by a manufacturer of retail consumer goods. A major part of the firm's sales campaign hinges on radio and tv commercials.

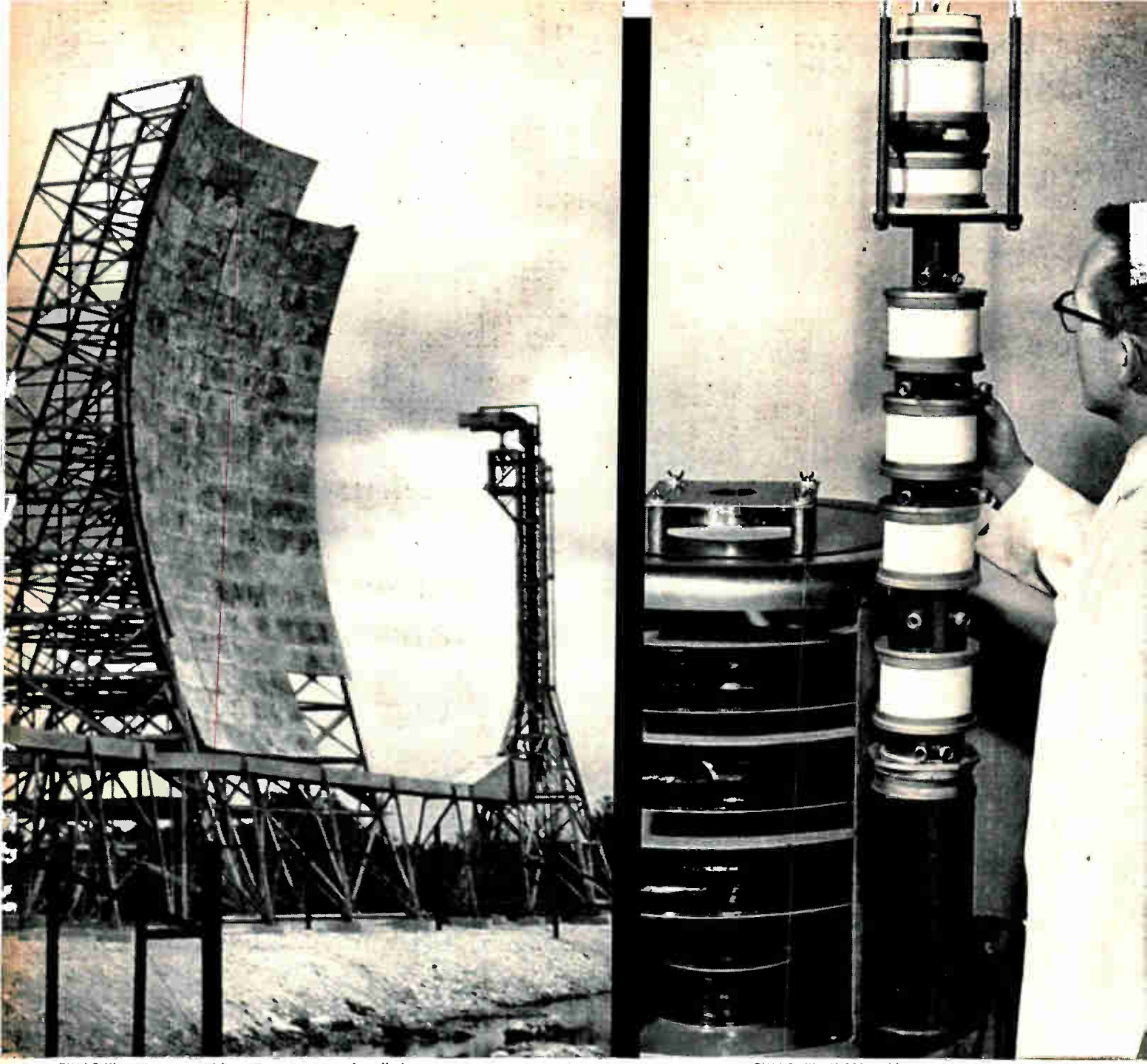
Company salesmen are provided with tapes of the radio-tv message so that they can give the retailer an accurate rundown of what the firm is doing to help him sell the product. In addition to sales demonstration, the salesmen also use the recorders to keep notes and data while on sales trips, and to record consumer comment on the products they are selling.

Another firm is contemplating the use of portable tape recorders for its time-and-motion study personnel. The group would go through the plant equipped with recorders to make verbal notes of changes in procedure, employee comment, and other information.

Electronic Laboratory Goes to Sea



Plotting and recording gear (left) is among equipment RCA installed and will operate on *S. S. American Mariner*, new "missile measurement ship" now active on the Atlantic Missile Range. Huge dish is described as largest tracking radar antenna afloat



EIMAC Klystrons are used in most tropo-scatter installations

EIMAC 4KM50,000LQ klystron

NOW, 400 TO 985 MEGACYCLES SPANNED WITH JUST TWO EIMAC 10KW KLYSTRONS

Exceptionally wide frequency coverage, 400 to 985 megacycles, is now available with just two interchangeable klystron amplifiers using the Eimac 4KM50,000LA and LQ 10 KW klystrons. This important tropo-scatter and UHF-TV range can now be covered with a single transmitter. In addition, both tube types offer exclusive design advantages that have made Eimac klystrons the most widely used power tubes in tropo-scatter networks.

Field-Proved External Cavity Design

Extra wide tuning range with single set of tuning cavities. Lower original cost.

Tube replacement cost much lower since external tuning circuitry need not be replaced.

Uniform bandwidth through inductive tuning plus greater broadbanding by external cavity loading.

Wide Range Load Coupler

One coupler covers entire frequency range.

Modulating Anode

Provides simplified overload protection.

Protects cathode from internal arc damage.

EMA Cathode

Combines ruggedness and long life of a pure metal emitter with the high efficiency of an oxide cathode.

Extra large area cathode conservatively rated for exceptional reliability.

Eliminates need for high voltage bombarder power supply, reducing system cost and total power consumption.

Series Connected Body Magnet Coils

Permits use of single power supply and control for body magnets.

Performance Proved Reliability

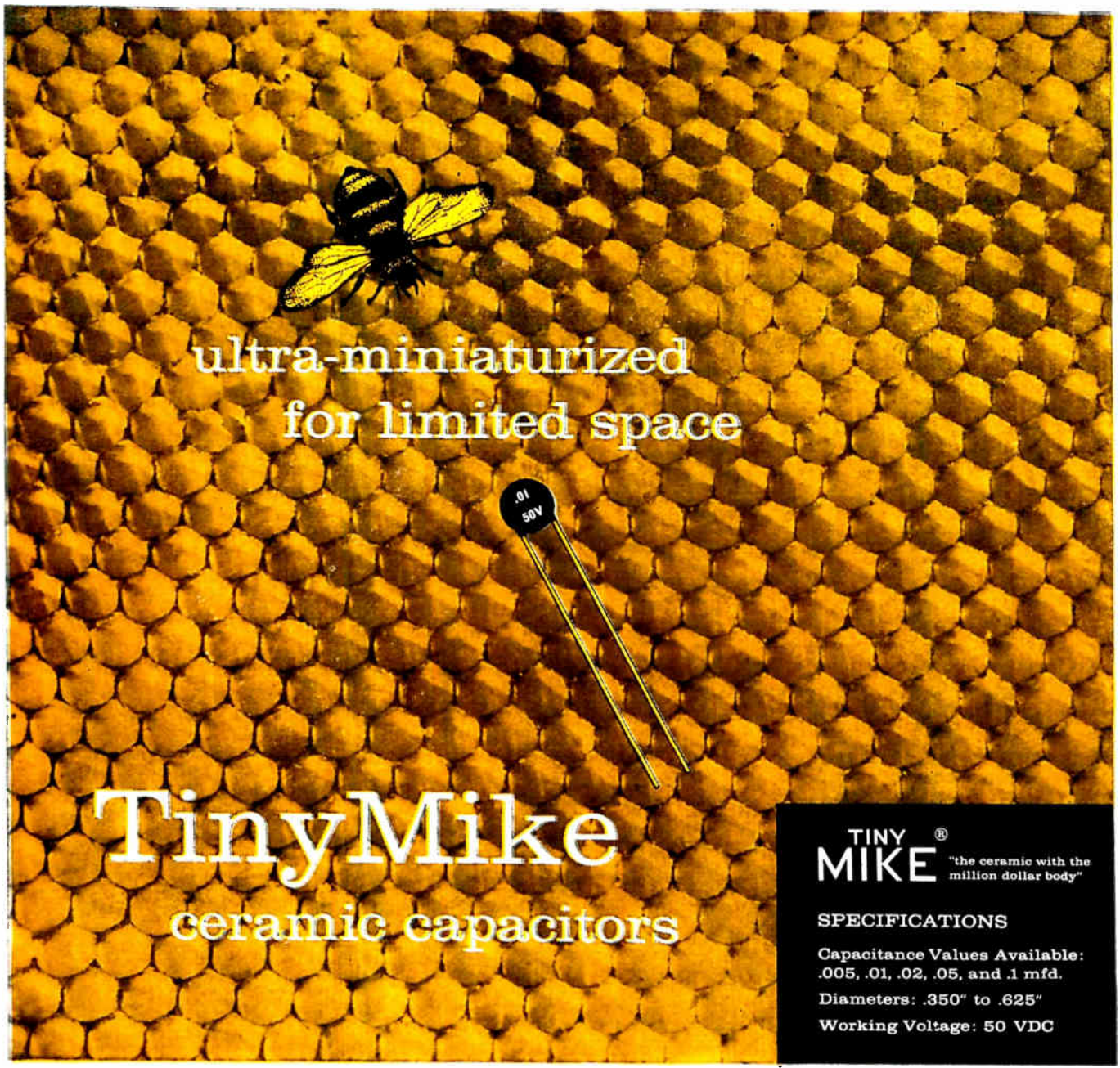
In tropo-scatter service, individual Eimac klystrons have logged more than 25,000 hours air time.

EITEL-McCULLOUGH, INC.

Eimac

San Carlos, California

CIRCLE 19 READERS SERVICE CARD



TINY MIKE® "the ceramic with the million dollar body"

SPECIFICATIONS

Capacitance Values Available: .005, .01, .02, .05, and .1 mfd.

Diameters: .350" to .625"

Working Voltage: 50 VDC

Crimped and Straight-Cut Leads for Automation. These units are available in 600 and 1000 VDCW units on types C, JA, JB, JC, BYA and other General Purpose capacitors. Leads are accurately spaced on these units for easy insertion into printed wiring boards. Crimped-lead units prevent bottoming on the printed wiring board assuring positive contact for soldering. Straight-cut leads save height off the board and may be inserted to circumference of disc.

Controlled phenolic dip avoids "rundown" of the phenolic on straight-cut leads. Assures always-uniform soldered connections.

Immediately available in production quantities!

Ideal for limited space and low-voltage requirements of portable radios and a variety of other miniature battery-powered and line-powered equipment. Excellent for bypass and coupling. Tough phenolic coating affords excellent insulation while protecting against severe humidity and vibration. For further information, write for Bulletin SEB-2 to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

Consistently Dependable

CORNELL-DUBILIER

CAPACITORS

Soviets Reveal Trade

In an exclusive interview, Associate Editor Manoogian (left) chats in Armenian with Soviet First Deputy Premier Anastas J. Mikoyan and an embassy secretary

Transistorized computers, machine tool controls and other electronic gear are among items Russia wants to sell United States

NEW YORK—Soviet Union is offering as part of a new trade campaign to sell small, transistorized computers and electronic instrumentation to the U. S. and wants to buy other electronic equipment, some of which is now denied to it as strategic material, ELECTRONICS learned exclusively.

Following a private conversation with Soviet Deputy Premier Mikoyan at the Soviet embassy in Washington, our staffer was introduced to N. N. Smeliakov, new chairman of the board and president of Amtorg Trading Corp., USSR's export-import agency in U. S.

In an exclusive interview, Smeliakov said the Soviets believe they have products in "many areas of electronic instrumentation in which the U. S. does not have commercial equivalents."

He explained that he could not give specific technical product details, but said that Amtorg was planning to publish a quarterly magazine in English that would contain information about products the USSR wants to sell here.

Items for Sale

Smeliakov arrived unobtrusively in this country as part of Soviet Deputy Premier Mikoyan's party and quietly remained behind to assume his new duties. He said he was formerly chairman of the economic council of the Gorky district.

According to Smeliakov, the "areas" of instrumentation in which the Soviets have products that would interest American firms in-

Aims

clude: machine tool controls, spectrographic analyzers, and rotational and linear speed indicating devices. The Soviets also want to sell new transistorized computers and cameras with electronic accessories.

The USSR, he said, wants to buy from the U. S. complete chemical factory equipment including all of its electronic instrumentation, equipment for manufacturing synthetic fibers and plastic tubing.

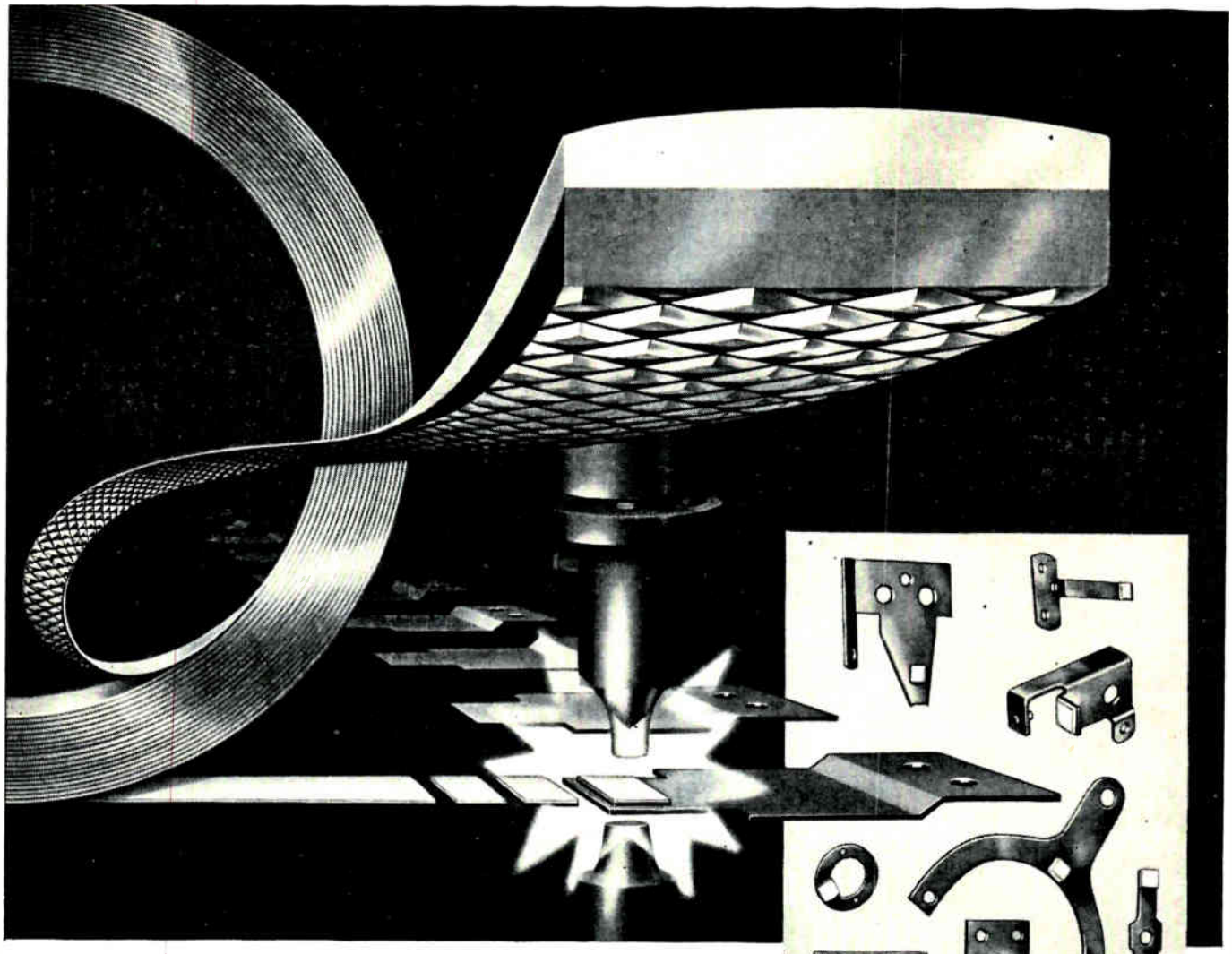
In addition, Smeliakov said the USSR is interested in promoting patent licensing agreements. He said the Soviets are now considering requests from U. S. firms who want Russian licenses covering equipment manufacture. The Soviets, he added, would like to obtain U. S. licenses in electronics, chemistry and metal-working.

An aide to Smeliakov cited radiosondes used during the International Geophysicial Year as an example of electronic items already purchased in the U. S. He said an application to buy replacement radio, tv tubes is pending.

With regard to the proposed sale here of Russian electronic products, Smeliakov stressed that the Soviets want to sell only equipment, not components. Among other items that fit in this category is food processing equipment, some of it apparently controlled electronically. One example is equipment that automatically separates crabs from their shells and packs them.

X-Ray Sampler

Automatic x-ray fluorescent spectrograph made by North American Phillips is used by Haynes Stellite Co. to test composition of metal alloy batches. Machine compares batch sample with known sample and prints results on tape



Now with General Plate Electrical Contact Tape... You Can

SAVE UP TO 40%

On Contact Cost

In addition . . .
Contact Tape permits:

- **Broader latitude in contact assembly design**
- **Smaller contacts for same electrical loads**
- **Weight-saving**
- **Simpler material handling**

General Plate Electrical Contact Tape can be applied to any large-volume contact design, permitting the automatic assembly of two or more parts in a single operation.

Tape contacts are easily attached by spot welding methods. They are self-aligning . . . allow broader assembly tolerances. Because of this, tape contacts reduce assembly costs and eliminate or reduce adjustment time.

Tape contact material is supplied in long continuous lengths which simplify material handling.

In addition to supplying clad electrical contact tape material, General Plate is equipped to weld contact tape sub-assemblies for you.

Design engineers are invited to make use of General Plate contact engineering services . . . for material selection . . . parts design . . . samples.

Let us make an electrical contact cost analysis on products you want to automate. Find out how General Plate electrical contact tapes, as well as other clad contacts, can be put to work for you.

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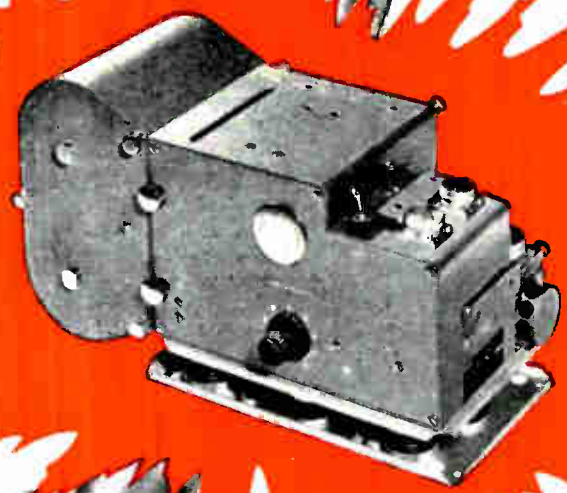
TOTAL DESTRUCTION EXPECTED!

YET RECORDS REMAIN INTACT



Century Oscillograph

LET US TELL YOU THE DRAMATIC 409 STORY

Century can tell you of dramatic incidents where little has remained of either the vehicle or its instrumentation but complete accurate — permanent — reproducible test records have been salvaged from even totally mutilated 409 Century Oscillographs!

Today's 409 Series of Century Oscillographs Have Features Usually Only Found In Large Laboratory Units.

- 13 - lbs. weight — Size 12" x 6 - 15/16" x 5"
- 12 Recording Channels
- Easy Trace Identification
- Permanent - Reproducible High Contrast Record
- Up to 40 hours continuous recording
- Provision for remote operation

Century OF TULSA

CENTURY ELECTRONICS & INSTRUMENTS, INC.

1353 N. UTICA • TULSA, OKLAHOMA

Announcing BEN-HAR "1258"

the most flexible Silicone Rubber Insulating Tubing ever developed . . . and the toughest

Never before has there been an insulating tubing with the remarkable flexibility of Ben-Har "1258" Extruded Silicone Rubber Tubing . . . and it's actually less expensive than conventional Class H tubings and sleevings, with higher rated temperature performance.

300% more flexible than silicone varnished glass.

700% more flexible than Teflon.

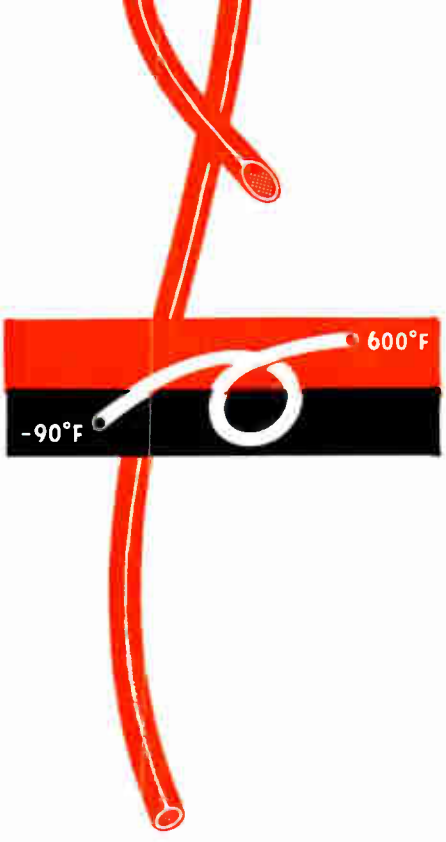
Ben-Har "1258" retains its flexibility after continuous service at 250°C. Equally serviceable at —85°C temperatures encountered in high altitude operation.

Ben-Har "1258" uses a new silicone rubber formula. It is highly resistant to abrasion and cut-through. It is especially designed for resistance to corona attack and harmful radiation effects.

Ben-Har "1258" conforms to wires and connections being covered. Its expandability assures snug fit and minimizes vibration.

Ben-Har "1258" is made by a new (patent pending) extrusion process which permits substantially more accurate dimensional control than required by ASTM — D — 922.

Available in standard wall thicknesses of .015" and .035" and in a complete range of colors. Special dimensions can be custom-engineered. Write for samples and data or ask to see a Bentley, Harris representative.



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200 BARCLAY STREET
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Receivers mounted on both fenders of tank during maneuvers amplify electromagnetic signals from mines. Cable carries signals to stopping mechanism in engine compartment, simulating a tank being destroyed during combat

Electronic 'Mine' Halts Tank

War games device now undergoing tests employs a completely transistorized circuit

ELECTRONICALLY-OPERATED antitank mine simulator system developed by Army's Combat Operations Research Group is slated for extensive use in tests, training and maneuvers.

When a tank runs over a practice mine during maneuvers, the system puts the tank out of action temporarily, simulating a tank being destroyed by a real mine during combat.

System was developed and tested at Fort Monroe, Va., by civilian scientists of Technical Operations, Inc., Burlington, Mass., and officers of Continental Army Command.

When tank runs over mine pressure plate, mine emits electromagnetic signal which is picked up by one of two receiver coils mounted on tank's belly. Signal is carried to receiver on tank fender, where it is amplified and carried by cable to stopping mechanism in engine compartment. Mechanical linkage actuated by receiver signal shifts tank transmission into neutral. Army says entire circuit is transistorized.

Environmental Testing Expands

A NEW torture chamber for electronic equipment and components went to work at the U. S. Army's Environmental Test Division, Frankford Arsenal, Philadelphia.

The giant rain and sunshine chamber, duplicates practically every extreme and characteristic of rain and sunshine found in nature. Size of raindrops, their velocity, rainfall per square inch along with accompanying air temperature and wind velocity can be controlled. Sunshine can be varied from sunrise at the pole to high noon on the equator.

Another new environmental chamber at the arsenal is a humidity and ozone test room which for the first time simulates the corrosive effect of ozone.

These units and other new environmental equipment recently installed at the arsenal add up to $1½ million in value. The arsenal's test division has blossomed under growing military recognition of the importance of environmental testing. It now has $5 million worth of testing equipment.

A giant step has been taken in the U.S. military development program with contracts for the creation of an unprecedented primary strategic weapon system. It is the Air Force DYNA-SOAR, now in Phase-I design stage by a six-company project team under Martin direction.

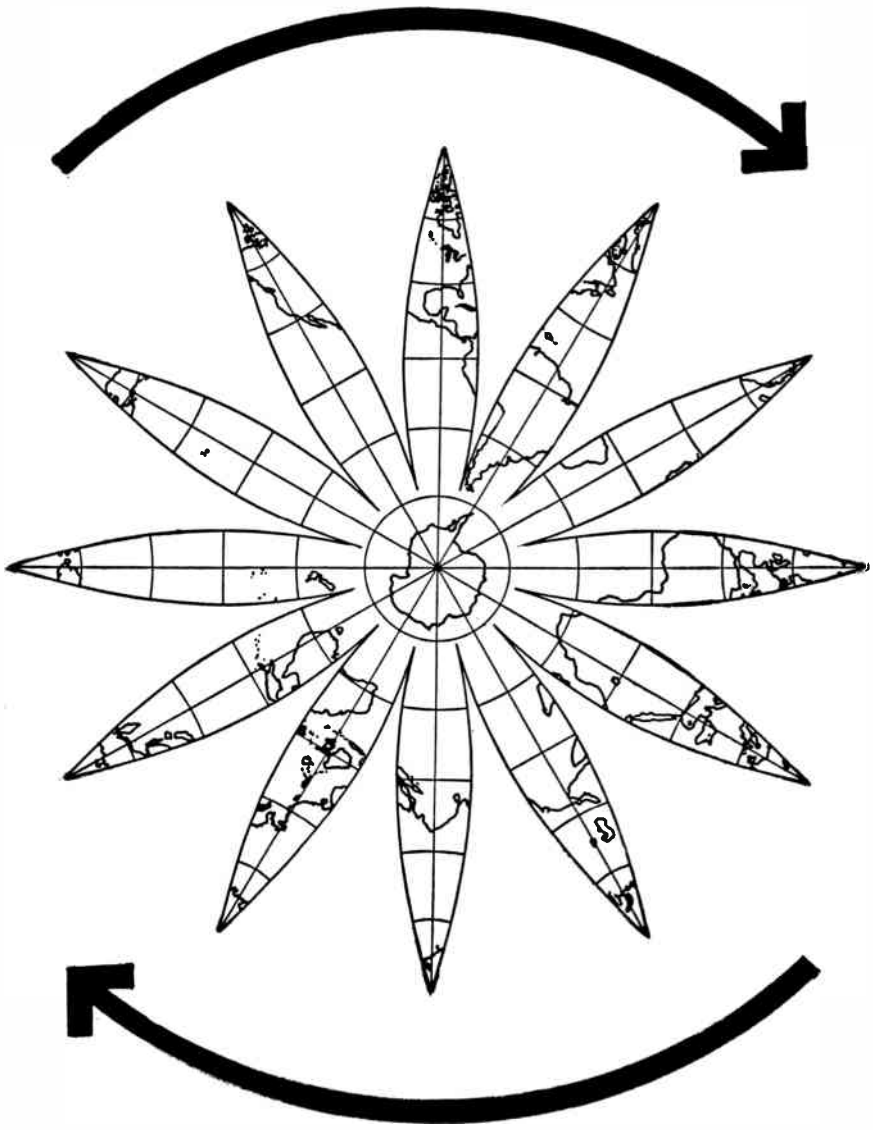
DYNA-SOAR—the most advanced military weapon system now in development—is a pilot-controlled bomber-reconnaissance space vehicle, its mission being to circle the earth at orbital velocity, with controlled aircraft landing capabilities. It will be propelled by several stages of rocket boosters, enabling it to operate from ground level to the ionosphere at hypersonic speeds.

In an entirely new and advanced concept of integrated industry coordination, the six companies teamed in this No. 1 military program constitute top capabilities in the basic areas of airframe, propulsion and radar guidance system development.

Bell, a pioneer in the boost-glide field, will design and build the airframe of the vehicle ...Bendix will develop communication, telemetry, hydraulic and electrical power conversion systems...Goodyear will produce the crew-escape capsule and the radar systems ...Minneapolis-Honeywell will be responsible for guidance and navigation to keep DYNA-SOAR on course and supply position and velocity information to the crew. American Machine & Foundry's responsibility is an advanced system of ground handling and launching equipment...And Martin will establish the configuration and design of the rocket boosters, carry out an experimental aerodynamic program for the complete vehicle, and assemble a full-scale mockup of the system.

Because of the challenging technical problems involved, the presidents of the six companies — aggregating assets of over $2 billion — comprise an active advisory panel, with their top engineering teams participating.

Never before in military history has so formidable a task force of specialized industrial capabilities been applied against such an advanced concept.



MEETINGS AHEAD

Feb. 1-6: American Institute of Electrical Engineers, Winter General Meeting, Statler Hotel, N. Y. C.

Feb. 12-13: Transistor & Solid-State Circuit Conf., AIEE, PGCT of IRE, Univ. of Penn., Philadelphia.

Feb. 12-13: Electronics Conference, AIEE, IRE, ISA, CPS, Eng. Soc. Bldg., Cleveland.

Feb. 16-20: Western Audio Convention, Audio Eng. Soc., Biltmore Hotel, Los Angeles.

Mar. 3-5: Western Joint Computer Conf., AIEE, ACM, IRE, Fairmont Hotel, Los Angeles.

Mar. 5-7: Western Space Age Conf. and Exhibit, L. A. Chamber of Commerce, Great Western Exhibit Center, Los Angeles.

Mar. 15-18: National Assoc. of Broadcasters, Annual Convention, Conrad Hilton Hotel, Chicago.

Mar. 23-25: Flight Testing Conf., ARS, Daytona Beach, Fla.

Mar. 23-26: Institute of Radio Engineers, IRE National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Mar. 31-Apr. 2: Millimeter Waves Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg., N. Y. C.

Apr. 5-10: Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.

Apr. 6-9: British Radio and Electronic Components Show, Great Hall, Grosvenor House, Park Lane, London, W.I.

Apr. 13-15: Protective Relay Conf., A & M College of Texas, College Station, Tex.

Apr. 14-15: Industrial Instrumentation & Control Conf., PGIE of IRE, Armour Research Foundation, Illinois Inst. of Tech., Chicago.

Apr. 16-18: Southwestern IRE Conf. and Electronics Show, SWIRECO, Dallas Memorial Auditorium & Baker Hotel, Dallas.

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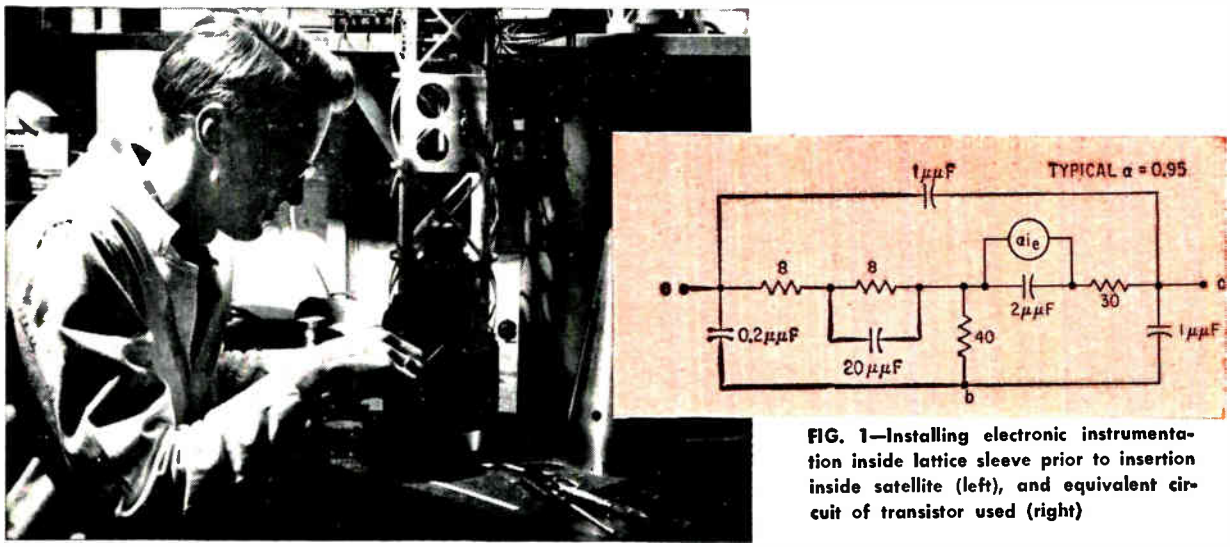


FIG. 1—Installing electronic instrumentation inside lattice sleeve prior to insertion inside satellite (left), and equivalent circuit of transistor used (right)

Instrumenting the Explorer I Satellite

Design philosophy employed prior to successful launching of the Explorer I satellite was to achieve maximum reliability within the predicted environment. Here are the results of design decisions based on estimated effects

By HENRY L. RICHTER, Jr., WILLIAM PILKINGTON, JOHN P. EYRAUD, WILLIAM S. SHIPLEY and LEE W. RANDOLPH,

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Cal.

RESEARCH LEADING to the instrumenting of the Explorer I satellite (1958 Alpha) ranged from consideration of the basic physics which determines the environment of a satellite to the final environmental testing of the entire satellite itself. A philosophy of instrumentation of minimal-weight satellites was evolved and will be set forth in the materiél that follows.

Several of the characteristics of the payload were determined by the characteristics of the launching vehicle. The allowable weight of the payload section (including all structure forward of the fourth-stage motor case) was set at under 20 lb. The physical dimensions of this section were indicated by the vehicle configuration; the spin stabilizing of the high-speed stages imposed an additional restraint on the design of the payload.

The desire to provide a maximum operating life of the payload along with the transmission of sufficient data to insure the success of the experiment led to the development of the Microlock[1] communications system.

OBJECTIVES—Concisely stated, the objectives met in equipment design were high reliability, sufficient receiver sensitivity consistent with minimum power levels to insure continuous tracking, development of telemetry techniques to insure wide geographical coverage and maximum lifetime, and the application of methods to keep the information bandwidth to a minimum.

Two completely independent radio transmitters

are used in the Explorer, each with its own power supply and antenna. This arrangement provides reliability in the form of redundancy. One transmitter operated at 108.03 mc with an output of 60 mw. The low-power unit operated at 108 mc at 10 mw.

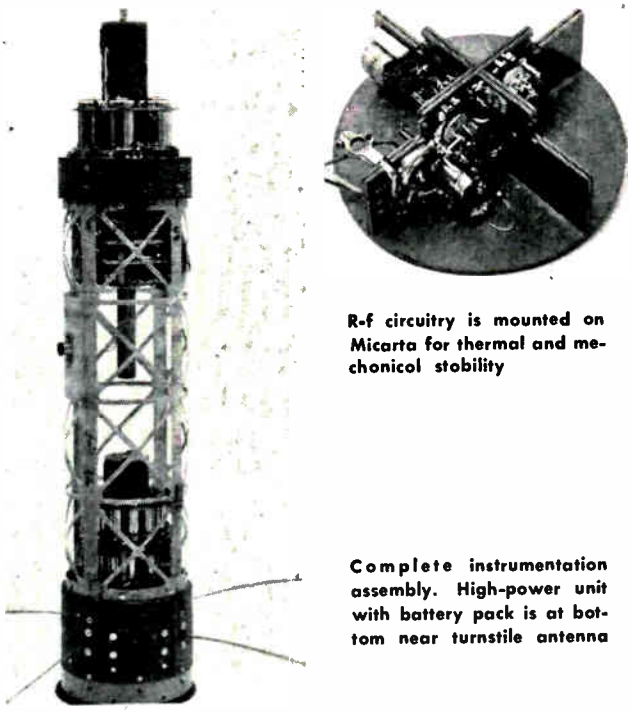
The high-power unit, using amplitude modulation, insured the recording of telemetry signals by nonprofessional equipment all over the earth. Because of the higher power, this transmitter operated for only a 2-week period. The 10-mw transmitter provided tracking data for two months, which was the calculated operating lifetime of this unit. Small-deviation phase modulation, which is compatible with the low power level, was used as the telemetry system.

TRANSMITTERS—In Explorer I there were two similar transmitters, each one separate and self-sufficient. They were not interconnected in any way except through radiative couplings between two separate antennas and through the sharing of an input to one telemetering channel.

The 10-mw unit was heard continuously for as long as 35 min during a pass (near apogee). This probably established a distance record for such a low-power transmitter, as the satellite traveled approximately 10,000 miles in 35 min and was a minimum of 5,000 miles from the receiver at the most distant point.

Transistors used in these units are a selected version of the WE 53194 which itself is a version of the original BTL 2039 transistor. The 2039 is a germanium diffused-base transistor with excellent characteristics for high-frequency operation. The use of these transistors in the r-f circuitry of the Explorer satellite made it possible to have an overall efficiency of better than 25 percent including power used by the oscillator, doubler buffer, and modulator. This does not include the power used by the cosmic-ray package.

An equivalent circuit for the 2039-type transistor is shown in Fig. 1. It can be seen that the output impedance of this transistor is low at frequencies



R-f circuitry is mounted on Micarta for thermal and mechonicol stobility

Complete instrumentation assembly. High-power unit with battery pack is at bottom near turnstile antenna

of the order of 100 mc and that at these frequencies the input impedance is also low in the grounded-base configuration. Both qualities are advantageous for low-voltage, low-power oscillators and amplifiers. It is difficult to obtain reasonable efficiencies at the low powers desired in beacons of this sort using vacuum tubes.

BLOCK DIAGRAM—Figure 2 shows a block diagram of both transmitters. Figure 2A shows the low-power transmitter which consists of a 54-mc crystal-controlled oscillator with a modulator producing phase modulation at 54 mc. A second r-f stage acts as a doubler and buffer amplifier with a total output of approximately 10 mw. This output is phase-modulated with four channels of telemetry to approximately 14-deg phase deviation per channel. The output from this transmitter is radiated

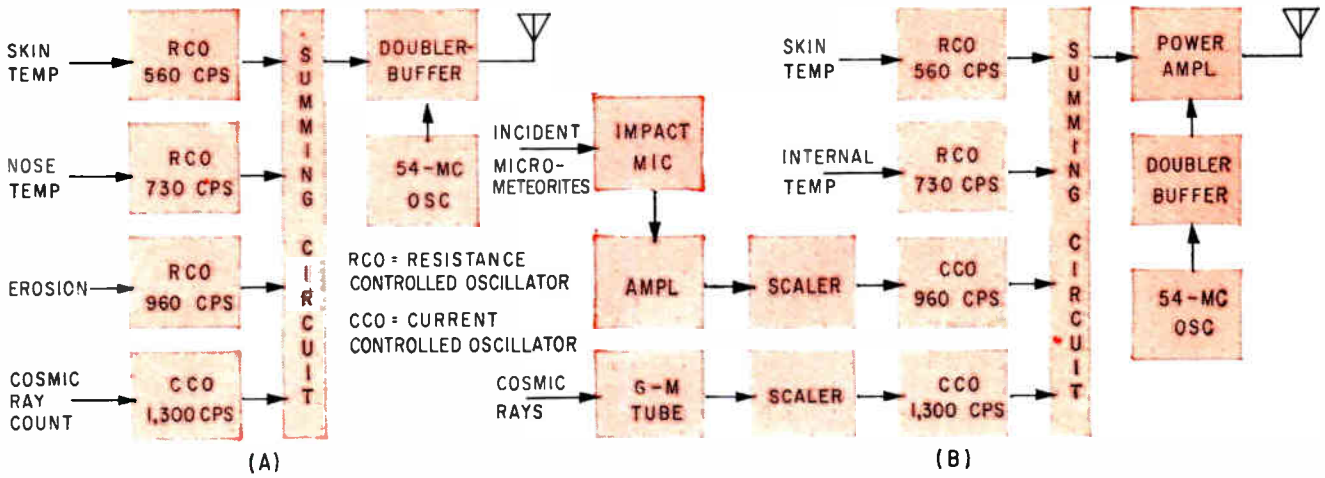


FIG. 2—Block diagram of the telemetry transmitters. The phase modulated low-power unit (A) operates at 108 mc. Amplitude-modulated high-power unit has output of 60 mw at 108.03 mc

by an unsymmetrical dipole antenna produced by electrically separating the nose cone of the vehicle from the shell and driving the nose cone against the shell as a dipole. The pattern of such an antenna is similar to that of a dipole, but with the main lobes bent slightly to the rear of the vehicle.

The high-power transmitter of Fig. 2B is similar. The battery pack supplies a slightly higher voltage; the oscillator generates 54.015 mc and is not modulated as is the low-power transmitter. The second transistor acts as a doubler and buffer. Amplitude modulation is produced by varying the voltage applied to the collector of the doubler-buffer transistor. The r-f power output with modulation applied is approximately linear from 20 to approximately 5 v.

ANTENNA—Output of this transmitter goes through an antenna phasing and matching network into a turnstile antenna which is made up of four whip antennas. These antennas are perpendicular to and spaced at 90-deg intervals about the body of the missile, forming a circularly polarized antenna pattern.

Figure 3A shows a schematic diagram of the low-power transmitter. The transmitter is powered by a series of six mercury batteries from which it draws approximately 5 ma current at about 8 v d-c. Crystal-controlled oscillator Q_1 uses a WE 53194 transistor and oscillates at 54 mc. The oscillator is a grounded-base type with feedback from a small turn on the tank coil through capacitor C_1 to the fifth-harmonic 54-mc crystal. Inductor L_1 is wound on resistor R_1 and placed in parallel with the crystal. The inductor resonates the capacitance of the crystal.

PHASE MODULATION—In Fig. 3A resistor R_3 stabilizes the feedback loop by reducing the effect of transistor input impedance changes. Capacitor C_3 is used as a d-c blocking capacitor in the feedback circuit.

Phase modulation is produced by varying the voltage applied to the collector of oscillator Q_1. One side of the tank is bypassed through capacitor C_3 which effectively grounds that side to r-f but allows the a-f sum voltage from the telemetry oscillators to be applied in series with the d-c supply. The collector of a transistor of this type is equivalent to a back-biased diode and has a capacitance which is voltage-dependent; thus, the voltage applied to the tank circuit produces a proportional variation in the tank tuning. This produces in the stable crystal-controlled oscillator a small-angle phase modulation.

A tap on the battery supply brought to the base of the transistor with resistor R_3 in the emitter circuit provides fixed bias. There is some loss of efficiency with this type of bias but it has a high degree of stability.

CONVERSION—Output from the oscillator is coupled by a small turn around the tank coil at fairly low impedance to the emitter of doubler-buffer Q_2. The output desired is a 108-mc signal. It is also desirable to have the conversion as efficient as possible, which calls for approximately class-C operation.

For maximum efficiency, the angle of conduction in the emitter of Q_2 must be fairly small producing short pulses at a 54-mc rate. The amplified pulses appear as 108-mc energy in the resonant tank circuit. Bias for the doubler-amplifier is provided by r-f from the oscillator across resistor R_4.

An antenna-matching network is used between the 50-ohm output connector and the nonsymmetrical dipole from which the power is radiated into space.

HIGH-POWER TRANSMITTER—R-f circuitry of the 60-mw transmitter is shown in Fig. 3B. Oscillator Q_3 is almost identical to the low-power version. This unit does not have phase modulation applied in the manner described for the low-power beacon, but power from the oscillator Q_3 is coupled into an amplifier-doubler stage Q_4 and the modulation applied at the collector of the doubler in a manner similar to plate modulation of a vacuum tube.

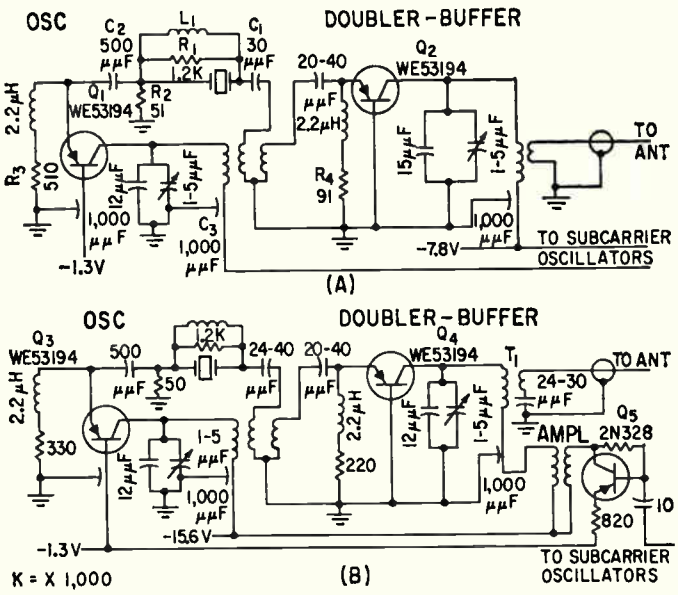


FIG. 3—In (A), phase modulation of the r-f unit is achieved by utilizing voltage-dependent capacitance of Q collector. In (B) amplitude modulation is accomplished conventionally

Because of the resistance of the transformer T_1, the 15-v battery voltage is dropped to approximately 14 v at the collector of buffer Q_4. To this is added an audio voltage of approximately 8-v peak which produces about 50 percent amplitude modulation of the carrier.

Output of this transmitter is coupled through a matching system consisting of lengths of miniature 50-ohm cable, cut to produce approximately 90-deg phase rotation from each antenna to the next. Actually, the circular pattern was designed to have

some elasticity so that spin could easily be measured from the r-f signal-strength records of the ground receivers.

AMPLITUDE MODULATION—Amplitude modulation of the high-power beacon is accompanied by some phase modulation which is convenient for telemetry when using phase-locked receivers.

The basic structural material used to support the electronic components was micarta because it is a good thermal insulator with excellent mechanical properties.

A thermal time constant of several hours was desired for the internal electronics so that external temperature extremes would not cause malfunctions. All the electronics including batteries were thermally connected to produce the longest reasonable time constant.

The telemetering subcarrier oscillators incorporated in the Explorer I satellite are of two basic design configurations. One type is a resistance-controlled oscillator (rco) wherein the subcarrier frequency varies as a function of the change in input resistance. The second type is a current-controlled oscillator (cco) whose frequency is varied by a change in input current.

The telemetry channels used are 2, 3, 4, and 5, whose frequency ranges are 518-602, 675-785, 888-1,032, and 1,202-1,398 cps, respectively.

The two telemetering systems are completely self-contained in that each system has its own power supply consisting of 4 mercury-cell batteries. The total power consumption for each system is approximately 2.5 mw. The telemetry systems for the two transmitters are arranged as indicated in Table I.

For phase modulation of the low-power transmitter the low-impedance winding on each subcarrier-oscillator transformer is connected in series to form the modulation transformer.

The amplitude-modulated high-power transmitter requires only the addition of a class-A amplifier-modulator stage in the transmitter section. The telemetering system utilizes the same low-impedance output windings as in the low-power transmitter but is capacitively coupled to the class-A amplifier.

At left, engineer prepares part of instrument package for shake table test. During power phase of launching period, payload was exposed to a force of approximately 100 gravities. At right, assembled payload is lowered onto fourth-stage rocket motor, the culmination of 80 days of intensive effort

RESISTANCE-CONTROL—The type of resistance-controlled oscillator used in Explorer I is shown in Fig. 4A. The simplicity of the circuit and operation made this oscillator configuration most advantageous.

The frequency limit of this circuit is related directly to the tuning capacitance ratio of C_1 and C_2. For the case of a high C_1/C_2 ratio, the frequency deviation obtainable is limited to less than the ±7.5 percent necessary in telemetering subcarrier channels. In the case of a low C_1/C_2 ratio, the Q of the tuned circuit drops to an impractical value. Actual limits are approximately $1 \geqq C_1/C_2 \leqq 3$. When used with telemetering subcarrier oscillators, a C_1/C_2 ratio of 1.5 is about optimum.

CURRENT-CONTROL—The typical current-controlled oscillator shown in Fig. 4B uses a relatively new method[2] for controlling oscillator frequency: time-controlled reactance modulation.

This method is made possible by the characteristics of the transistor. The operating frequency of a conventional L-C oscillator can be altered by introducing an alternating current that is of the same frequency but is 90 deg out of phase with the oscillator voltage. The frequency shift thus produced is proportional to the amount of additional current introduced into the tuned circuit.

Oscillator frequency shift can be obtained using a transistor employed as a time-controlled reactance modulator. The portion of the cycle during which this reactive current is introduced can be

WHAT EXPLORER I REVEALED

Temperatures on various parts of the satellite shell ranged between −25 and 75C; temperatures inside the cylindrical section ranged from 0 to 35 C; nose cone temperature varied from 5 to 40 C.

Data from the high-power transmitter indicated 38 impacts from micrometeorites were detected. The average influx of particles 4 microns or larger in diameter was therefore approximately 0.02 particles/sq m/sec averaged over the time period of January 31 to February 12. The low-power unit indicated that no more than one and possibly none of the wire gauges was broken on the grid-type micrometeorite detector. This information permits an upper limit to be established for the influx of particles 10 microns or more in diameter. This limit is 0.001 particles/sq m/sec from January 31 to April 14.

At altitudes below 1,000 km the radiation detection gear indicated a cosmic-ray intensity in general agreement with results from balloons and high-altitude rockets. However above this altitude a suddenly anomalous behaviour of the circuitry was encountered.

It is believed that at altitudes above 1,000 km, for regions between 30 deg N and 30 deg S latitude, there is an intense field of low energy electrons. On impact with the satellite shell, these electrons with energies ranging from about 50 to 90 kev produce x-radiation, resulting in an indicated count 1,000 times greater than that expected from primary cosmic radiation alone.

Table I—Explorer Telemetry System

Channel	Measurement	Subcarrier Type	
		10 mw	60 mw
2	Skin Temp.	rco	rco
3	Nose Cone Temp.	rco	rco
4	Meteorite Impact	rco	—
4	Meteorite Count	—	cco
5	Cosmic Ray Count	cco	cco

controlled by d-c current introduced into the control transistor. By this new method, frequency modulation is achieved with minimum dependence upon temperature-sensitive parameters.

TESTING AND CALIBRATION — Environmental test specifications for the Explorer satellite prescribed two complete testing procedures: flight-acceptance and type-approval tests. Flight-acceptance tests, applied to all units prepared for flight, including spares, were designed to subject the units to an environment simulating that encountered in flight. The type-approval tests, applied to a sample payload, were designed to verify that the payload design was capable of surviving an environment more severe than that expected, as well as surviving the flight-acceptance test and then the flight.

The use of 100-percent flight-acceptance testing in the Explorer program, in preference to any sampling or test-to-failure plan, was dictated by the complete lack of statistical information concerning the reliability of the units and by the high reliability desired. Furthermore, flight-acceptance testing was the only conceivable technique which would provide assurance that custom-made r-f transmitters, such as the Microlock beacons, would provide satisfactory signals for low-power reception while subjected to the severe environmental conditions expected in the launch and orbiting phases of the Explorer's operating life.

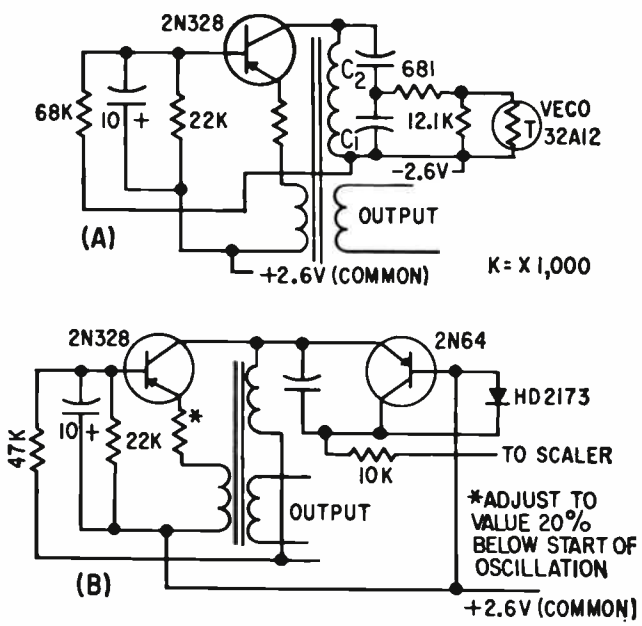


FIG. 4—Schematics of typical subcarrier oscillators. (A) is resistance-controlled type; (B) is current-controlled

Basically the program was broken into two parts: thorough and accurate calibration of the telemetering equipment; and testing to assure that the equipment not only performed satisfactorily over the expected temperature environment but also during the initial launch-phase environment.

MICROMETEORITES—Two types of micrometeorite detectors are used in Explorer I: a parallel combination of twelve wire-grid detectors; and an impact microphone and its associated amplifier.

In the grid type, a severed wire in one of the grid structures caused by a micrometeorite of sufficient size and velocity produces a small step increase in resistance. This change of resistance, when sensed by the rco, results in a step increase in subcarrier frequency. To assure accuracy, a flight erosion gauge with a multiple-switching network is used for calibration.

Frequency against temperature data for the impact microphone is obtained by subjecting both the beacon and the microphone equipment to the applied temperature. Thus, if the scaler output voltage varied with temperature, it is automatically included in the frequency calibration.

PARTICLE MASS—Determination of microphone sensitivity is made by dropping glass beads of known size and density on the satellite shell from various heights. Knowing the height necessary to actuate the scaler and the size of the glass bead, the required momentum averaged over the entire shell was found to be 0.012 gm-cm/sec. Therefore, if a velocity of 40 km/sec is assumed for a micrometeorite, the minimum detectable particle mass is found to be 3×10^{-9} gm.

The second phase of the testing program consisted of subjecting the payload to an environment similar to that expected during flight. The remainder of the environmental testing was carried out in the following order: noise vibration to simulate the firing of the fourth-stage motor; centrifuge test to simulate the linear acceleration due to the firing of the fourth-stage motor; spin test at 750 rpm; and altitude test to check out the high-voltage circuitry.

PERFORMANCE—The performance of the payload during environmental testing proved to be extremely satisfactory. The only major problem encountered was in the altitude test. It was found necessary to provide more adequate high-voltage breakdown protection.

REFERENCES

(1) H. L. Richter, Jr., W. F. Sampson, and R. Stevens, Microlock: A Minimum-Weight Radio Instrumentation System for a Satellite, to be published in *Jet Propulsion*.

(2) F. M. Riddle, Patent No. 2,728,049, assigned to California Institute of Technology.

Magnetic Drum Provides

Drum recording system developed to make analog simulations in designing continuous-processing system provides time delay. Precision of 0.1 percent between recorded and played-back low-frequency analog voltages is exceeded in highly stable system applicable also to tape

By **H. L. DANIELS** and **D. K. SAMPSON,** Remington Rand Univac, Division of Sperry Rand Corp., St. Paul, Minn.

PRECISION of 0.1 percent in a magnetic-recording system was required for analog simulation of transport delays in designing a continuous-processing system. A relatively uncomplicated recording technique is described that achieves such precision with a high degree of stability.

A typical transport delay is the temperature-time function of a fluid flowing at a variable rate through a long insulated pipe. The delay is the time displacement of the temperature function between points of intake and discharge.

Continuously variable delay was required over a wide range without interruption or degradation of the function. This requirement made conventional electrical delay lines unfeasible.

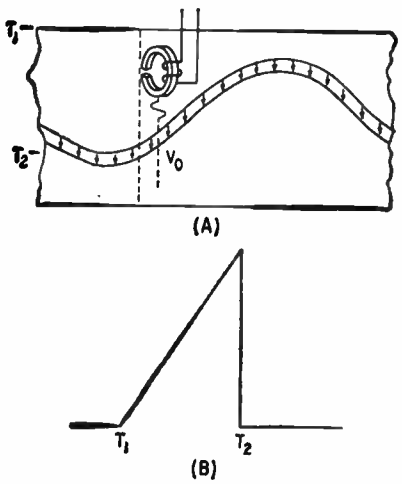


FIG. 1—Magnetized line at (A) is plot of analog voltage. Sawtooth at (B) is initiated when head crosses reference line and ended when head crosses analog

The application required delays of 5 to 20 sec for analog signals ranging between −50 and +50 volts. Accuracy within 0.1 percent was specified for frequency components from zero to one cps. Gradual degradation of accuracy was allowable above one cps, with response signal not down more than 3 db at 30 cps.

Noncontact magnetic recording on the surface of a rotating drum was selected as the basic delay mechanism because of its freedom from considerations of head and surface wear. Control of delay could be provided by adjustment of rotational speed or of angular displacement between recording and playback stations.

The magnetic record form in Fig. 1A is a plot of the analog signal using a transversely magnetized line on the surface of a strip-form recording medium. The time axis is represented by coordinates along the length, and instantaneous values are represented by coordinates across the strip.

Playback Principle

The playback method in Fig. 1A uses a conventional but thin ring-form playback head that crosses the record at constant velocity. Its gap remains parallel to the direction of motion of the medium and perpendicular to the direction of magnetization of the recorded line.

Time between T_1 of crossing a fixed reference line and T_2 of crossing the recorded function line is translated into a proportional voltage, as shown in Fig. 1B. A linearly rising voltage is initiated at T_1 and abruptly returned to zero at T_2.

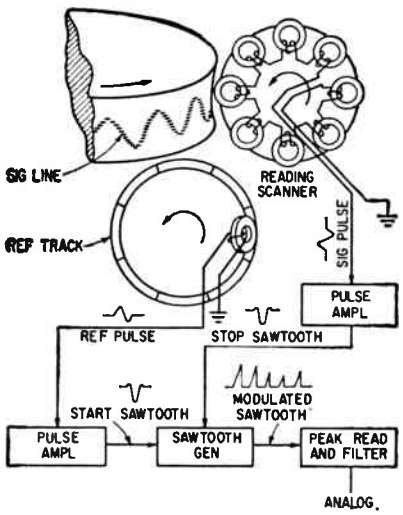


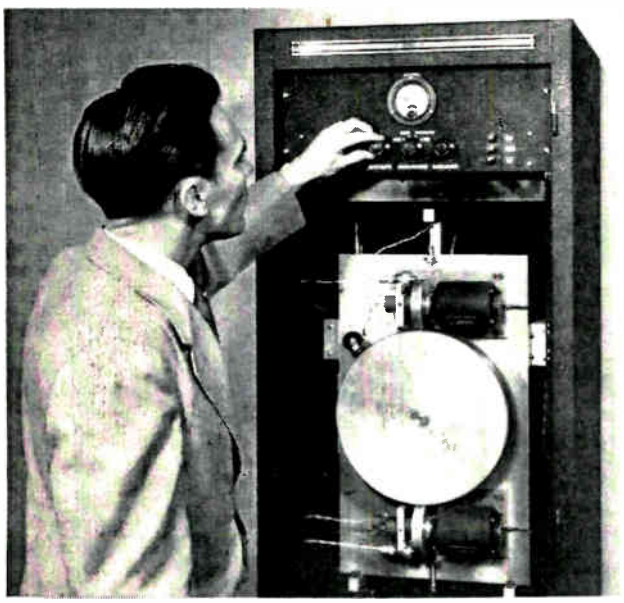
FIG. 2—Black diagram shows how reference and signal pulses initiate and stop sawtooth generator

If the record is scanned at a rate sufficiently high relative to the velocity of the medium, the composite of the peaks of the resulting modulated sawtooth becomes the desired electrical playback.

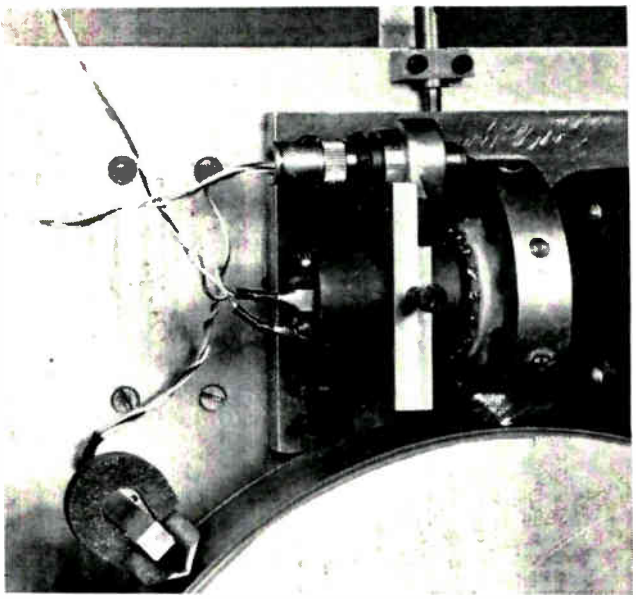
The playback head, shown in Fig. 2, comprises a rotating structure carrying eight ring-form heads with their gaps uniformly spaced around a cylindrical surface. The series-connected coils are connected to the electronic circuits through slip rings.

The peripheral spacing between gaps is made at least equal to the active width of the recording medium to avoid ambiguity. The surface of the recording medium is

Analog Time Delay



Adjustment of two potentiometers is required to zero system. Becouse there is little interaction between the two settings, system can be adjusted with one repetition of the two steps



Permanent magnet at left erases drum before it rotates to recording scanner. Curvature of drum assures that recording gaps are at constant distance from drum

curved to maintain constant spacing to the gaps.

A rotating reference track of magnetic oxide has a permanent recorded pulse for each active gap. A fixed playback head reads this track to supply reference pulses, which are generated just before each rotating head enters the active area of the medium.

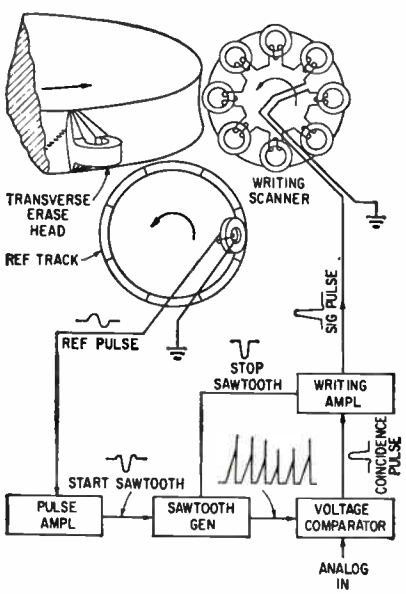


FIG. 3—Recording system is similar to ploybock system. When sowtooth reaches analog value, o write pulse is delivered to writing scanner

Recording Principle

The recording arrangement shown in Fig. 3 is substantially a reversal of the playback method. The analog voltage and the sawtooth are fed to a voltage comparator. At the instant they are equal, the comparator generates a write signal that initiates a pulse of current in the head and records a mark on the medium. A series of these marks represent, by their composite pattern, the wave form of the input voltage.

The powdered-iron transfers shown in Fig. 4 were made from several actual recordings. They were obtained by dusting the surface of the medium with finely divided iron powder and transferring the powder adhering to the magnetic discontinuities of the medium to pressure-sensitive cellophane tape.

In the prototype equipment, the medium was erased by a longitudinally saturating d-c wipe prior to recording. The resulting magnetic discontinuity formed between the uniformly saturated area and the transversely magnetized line is readily readable with adequate resolution.

Inherent Errors

One source of error inherent in the system involves the relative velocities of the medium and the transverse scanning gaps. If the medium velocity is v_m and the gap velocity is v_g, the crossing line of the gap is inclined at an angle $\tan^{-1}(v_g/v_m)$ to the longitudinal axis of the medium. This source of difficulty is eliminated by making the ratio v_g/v_m in playback equal to that in recording.

Another source of distortion stems from the effective dimension of the gap across the head and normal to the direction of scan. Even if gap width were reduced to zero, the gap would have an effective dimension along the length of the medium of perhaps 15 to 20 mils under noncontact conditions.

The result of this type distortion is shown in Fig. 5. It vanishes when the recorded line is parallel to the axis of the medium and becomes increasingly serious with increasing inclination of the line.

Two types of deterioration may

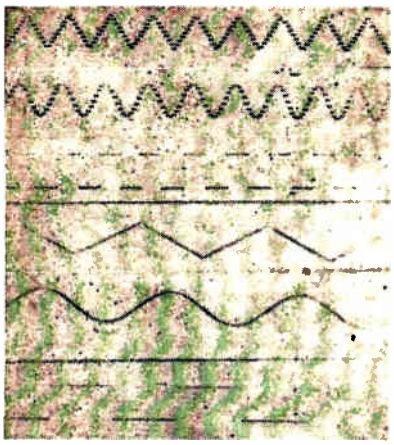


FIG. 4—Powdered-iron transfers were made from actual recordings. Composite of individual marks is analogous to input

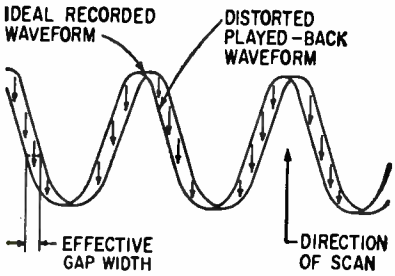


FIG. 5—Distortion resulting from limitations in resolving ability of head are aggravated with increased inclination of recorded mark

be caused by the continuous-line recording of a series of discrete marks. One involves a relationship between medium velocity, scanning rate and effective width of recording and playback gaps such that successive marks overlap along the axis of the medium, as in Fig. 4. The other involves having the marks physically separated longitudinally.

Longitudinal overlap yields nonharmonic distortion in a manner similar to that shown in Fig. 5. Longitudinal separation, on the other hand, is entirely free from such distortion provided playback scanning is so synchronized that the scanning gaps are properly centered on the recorded marks.

Prototype Construction

The reading and recording scanners are mounted so that the gaps of the two units are separated by 180 degrees of arc around the aluminum drum. The drum can be driven either synchronously or with controlled variable speed. Drum and scanners are mounted on a normalized cast-aluminum base. The scanners are adjusted so that spacing between gaps of the read-record heads and the medium are between 0.0015 and 0.002 in.

The scanner disk is mounted directly on the shaft of a 3,600-rpm hysteresis synchronous motor. The heads were roughly positioned radially in fabrication with setscrews. They are held in place permanently after wiring by embedment in a resin whose thermal expansion coefficient approximates that of the aluminum disk.

Longitudinal erase is achieved with a permanent magnet with properly shaped pole pieces.

Generation of Reference Pulses

A single line of pulses is written on the drum by rotating the drum with the scanner stationary, as shown in Fig. 6. One read-record head is energized and its gap positioned near the edge of the drum. The drum is then stopped and each scanner is rotated.

The played-back and amplified pulse from each scanner is used to trigger a writing circuit connected to its reference head. Thus pulses are permanently written on the reference track at the exact spacing of the read-record heads.

Two sawtooth-control flip-flops such as shown in Fig. 7 are used, one for the recording and the other for the reading sawtooth generator. When flip-flop output is negative with respect to the reference voltage shown as zero set in Fig. 7B, sawtooth output is dropped through the diode gate to the reference voltage. A start-sawtooth pulse

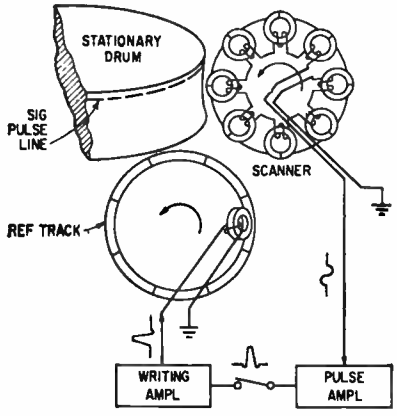


FIG. 6—Using this arrangement, reference pulses are recorded so that sawtooth is initiated just as gaps reach active area of drum

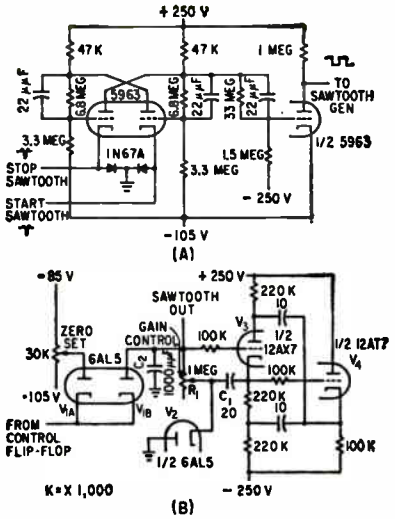


FIG. 7—Negative output from flip-flop at (A) returns sawtooth output at (B) to reference level established by zero-set potentiometer. Positive flip-flop output permits sawtooth voltage to rise

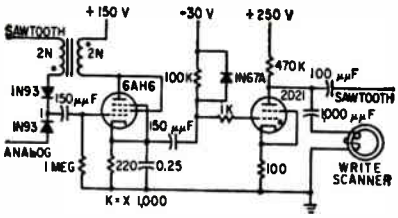


FIG. 8—When sawtooth amplitude reaches analog level, blocking oscillator causes thyratron to fire

makes flip-flop output positive. Voltage at the sawtooth output in Fig. 7B begins to rise toward ground potential.

Sawtooth Output

Sawtooth output is returned to reference level by switching the flip-flop back with a writing or a played-back signal pulse.

Extreme linearity of the sawtooth circuit is obtained by the reflexing arrangement shown in Fig. 7B. When sawtooth output is clamped to the reference voltage because of negative output from the flip-flop, voltage at the left of C_1 is returned to ground through the 6AL5 clamp.

At the right of C_1, voltage is essentially that appearing at the cathode of V_3. When output voltage is allowed to rise, the cathode voltage of V_3 follows closely. Because C_1 is large, the drop across R_1 is maintained nearly constant. This ensures a linearly rising voltage at the sawtooth output.

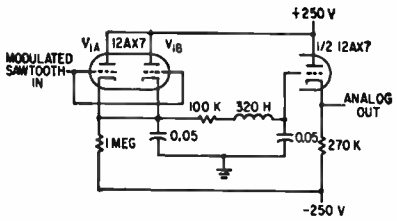


FIG. 9—Peak-reading circuit recovers analog voltage from modulated sawtooth

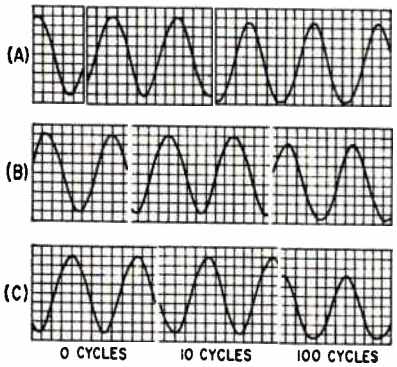


FIG. 10—Oscillograms show effects when sine wave is recorded and played back 0, 10 and 100 times. Plot at (A) was made immediately after zeroing, and plots at (B) and (C) were made at succeeding one-hour intervals without further adjustment

Measured linearities of such a circuit have been within 0.05 percent.

Adjustment

Gain control is achieved with a slope control on one sawtooth generator. Zero set is obtained by variation of the reference voltage of one sawtooth generator.

Zeroing the system and adjusting for unity gain requires adjusting two potentiometers. First, a −50-v signal is recorded and the zero-set potentiometer turned until a zero-center microammeter connected directly between input and output indicates balance. Then a +50-v signal is recorded and the gain-control potentiometer turned until the meter is again centered. Because there is little interaction between the two settings, the system can be adjusted by one repetition of the two steps.

The voltage comparator shown in Fig. 8 is similar to the multiar circuit. When amplitude of the sawtooth exceeds analog voltage, the positive feedback loop of a blocking oscillator is completed through a conducting diode. The blocking oscillator conducts, triggering a thyratron writing circuit.

Peak-Reading Circuit

The peak-reading and filter circuit used to recover the analog waveform from a modulated sawtooth is shown in Fig. 9. Charging current for the 0.05-μf capacitor in the cathode circuit of V_{1B} exists when instantaneous voltage of the modulated sawtooth appearing at the grid exceeds cutoff, as referenced to the instantaneous voltage of the recovered analog appearing at the cathode. When cutoff does exist, the capacitor discharges through the one-megohm resistor. Discharge rate is equal to the maximum rate of change of voltage for the highest possible analog frequency.

A conventional RLC filter follows the peak-reading circuit.

Desired performance of the recorder is a condition in which overall gain is exactly unity, a-c signal variations of the input are exactly reproduced at the output and there is no d-c voltage shift between input and output.

Because departures from ideal performance under continuous record-playback operation were too small to measure, a recirculation technique was adopted. Output was connected directly to input after a function had been initially recorded on the drum. Recirculating the function through the recorder progressively exaggerated systematic errors. Output was then recorded with a direct-writing pen recorder.

Performance

A played-back, 40-v peak-to-peak, 0.75-cps sine wave is shown in Fig. 10 after zero, 10 and 100 cycles of recirculation. Peak-to-peak amplitude is virtually unchanged after 100 cycles, but the signal has drifted 3 v in the negative direction.

Assuming constant drift rate, a d-c shift of 0.03 v/cycle of record and playback is indicated. Since peak-to-peak recording and playback amplitude is 100 v, precision is 0.03 percent of full scale immediately after zeroing.

The oscillograms in Fig. 10B and 10C were taken at one-hour intervals after those of Fig. 10A with no further adjustments. In Fig. 10B, after 100 cycles of recirculation, d-c level has drifted 3 v and amplitude has diminished about one v. In Fig. 10C, after 100 cycles, d-c level has drifted 5.6 v and amplitude has diminished 7.25 v.

After 100 cycles of recirculation, positive peaks of the sinusoid are narrowed in the time direction and negative peaks are broadened. Also progressive attenuation of peak-to-peak amplitude results because higher frequency components are generated in the positive peaks than the low-pass output filter will accommodate.

Inherent distortion and the resultant filtering action is even more evident with square and triangular waves, as is shown in Fig. 11 and 12.

A one-cps sine wave of 0.3 v peak-to-peak was recorded, read back and reproduced on a direct-writing recorder. Input voltage was then reduced to zero and noise level recorded. Noise did not exceed 0.1 peak-to-peak. Since the linear range of the recorder exceeds 100 v peak-to-peak, dynamic range is in excess of 60 db.

Frequency response is essentially flat from zero to 20 cps, with 3-db attenuation at about 30 cps.

There appears to be no serious obstacle to adapting the principle used here to tape to provide extended records for permanent storage.

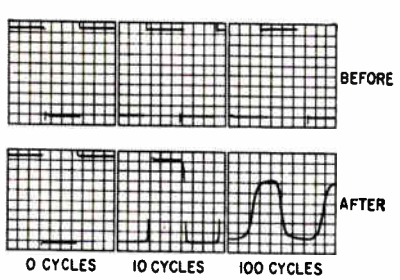


FIG. 11—Oscillograms show square waves before and after recirculation

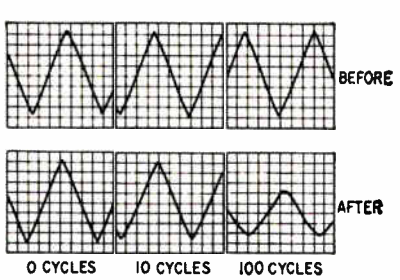


FIG. 12—Oscillograms show triangular waves before and after recirculation

Wideband Amplifier Design Data

Circuits, relationships and equations are presented to help the circuit designer confronted with the problem of securing both high gain and wide bandwidth

By RICHARD H. ENGELMANN,

Associate Professor of Electrical Engineering, Univ. of Cincinnati

TABLE I—Formulas and Parameter

Voltage Gain Per Stage

$$G_S = \frac{\frac{g_m}{C} K F_N}{B_T} = g_m R_{EQ} \quad (1)$$

Overall Gain

$$G_T = G_S{}^N = \left[\frac{\frac{g_m}{C} K F_N}{B_T}\right]^N \quad (2)$$

B_S = bandwidth of one stage
B_T = overall bandwidth in rad/sec
= $B_S F_N$
C = total cap, plate to ground
= $C_{in} + C_{out} + C_{stray}$
F_N = bandwidth narrowing factor for N stages
g_m = tube transconductance
G_S = voltage gain per stage
G_T** = overall gain of ampl
K*** = advantage factor
= ratio of gain bandwidth product of any stage to the gain-bandwidth product of a single stage ampl with a resistance load only, using the same tube
R_{EQ} = an equiv load resist

**solve for G_T for enough values of N until G_T is sufficiently large
***effect of K should be kept in mind when comparisons are made

TWO BASIC VARIABLES of wideband-amplifier circuits are the tube and the type of configuration used. The tube determines transconductance and, in part, total capacity from plate to ground. The type of circuit determines the advantage factor and the bandwidth narrowing function for each stage.

Three basic maximally flat wideband-amplifier circuits and their equivalents are given in Fig. 1. These circuits may be compared readily with data in Table I.

The maximum voltage gain per stage and the overall gain of these and other amplifiers are calculated from Eq. 1 and 2.

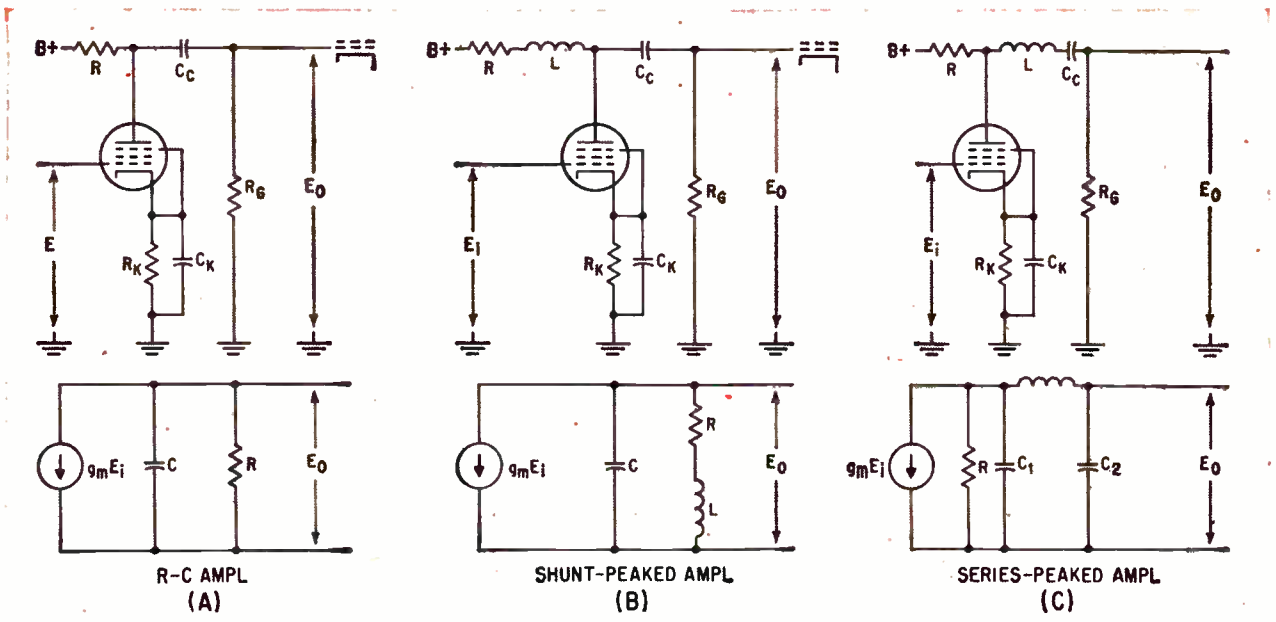


FIG. 1—Basic wideband-amplifier circuits and their equivalents

Relations Used in Amplifier Design

Screen grid supplies have been ignored. Equiv circuits in Fig. 1 are based on assumptions that C_c, R_G, R_K and C_K will have effects only at low frequencies and that R_G and r_p are much larger than other impedances encountered in the circuits.
Capacitor C_1 is output capacitance of the tube plus stray capacitance in parallel with it: $C_1 = C_{out} + C_{stray}$.
C_2 is input capacitance of next stage plus its parallel stray capacitance: $C_2 = C_{in} + C_{stray2}$. All these capacitors may be augmented artificially, and must be in some cases.

Ampl Circuit	K	Bandwidth Narrowing Factor, F_N	Parameter Relations	Values of F_N for N stages									
				1	2	3	4	5	6	7	8	9	10
(A) R-C Ampl	1	$\sqrt{2^{1/N}-1}$	$R = R_{EQ}$	1	0.643	0.51	0.435	0.386	0.35	0.323	0.301	0.283	0.268
(B) Shunt Peaked	1.722	$\sqrt{(2^{1/N}-1)\left(1+\sqrt{1+\frac{23.3}{2^{1/N}-1}}\right)}\Big/2.435$	$R = R_{EQ}$ $L = 0.414\ R^2C$	1	0.773	0.679	0.622	0.583	0.554	0.53	0.511	0.494	0.48
(C) Shunt Peaked Plus R-C	1.1	$\sqrt{2^{2/N}-1}$ N even only	$R = \sqrt{2}\ R_{EQ}$ $L = 0.500\ R^2C$	—	1	—	0.802	—	0.714	—	0.66	—	0.621
(D) Feedback Pair	1.1	$\sqrt{2^{2/N}-1}$ N even only	$R = \sqrt{2}\ R_{EQ}$ $R_1 = g_m R^2 >> R$	—	1	—	0.802	—	0.714	—	0.66	—	0.621
(E) Series-Peaked	$C^*/2C_1$ or $3C/2C_2$	$\sqrt{2^{1/N}-1}$	$R = R_{EQ}$ $C_2 = 3\ C_1$ $L = 2.67\ R^2C_1$	1	0.863	0.799	0.758	0.728	0.705	0.686	0.67	0.657	0.645

* $C = C_1 + C_2$. Advantage factor is = to or < 2. Use the form which yields the value less than 2 using the original values of C_1 and C_2. Note from relationship between C_1 and C_2 that one element in general must be augmented. The augmented value is used in the parameter-relationship equations.

In the following examples, a 12BV7 tube is used throughout. For this tube, g_m is 13,000 μmhos; C_{out} is 3 μμf; C_{in} is 11 μμf. Stray capacitances C_{stray1} and C_{stray2} are assumed equal, each having a value of 5 μμf. Therefore, C_1 is 8 μμf; C_2 is 16 μμf; and C is 24 μμf. Radical g_m/C is 542 × 10^6 rad/sec, which is the gain-bandwidth product for a single R-C stage.

DESIGNING THE CIRCUIT—As an example, assume that the circuit calls for an overall bandwidth of 10 mc and overall gain of 5,000. How many stages are required and what are the circuit parameters using (A) resistance-capacity stages, (B) shunt-peaked stages, (C) series-peaked stages?

To solve (A), convert 10 mc to rad/sec and obtain 62.8 × 10^6 rad/sec for B_T. For the R-C amplifier, K equals 1. The maximum value of G_s possible is calculated from equation (1), taking $F_N = 1$. This yields 8.63.

To avoid extra work, calculate the minimum number of stages required under this ideal condition of no bandwidth narrowing from 8.63^N equal to 5,000. In this case find the G_s and G_T values beginning with N equal to 4. For each value of N above 4, G_s is calculated using Eq. 1; and G_T is calculated using Eq. 2.

For this problem 10 stages yield insufficient gain. Using the equation $\sqrt{2^{1/N}-1}$ for the R-C amplifier, in Table I find that N equal to 11 yields a gain of 5,900, which is adequate. Under this condition, G_s equals 2.2 and consequently R equals G_s/g_m equals 169 ohms from Eq. 1.

To solve part (B): If shunt-peaked stages are used, K equals 1.722, and the maximum value of G_s is equal to 14.9. Using the ideal case of no bandwidth narrowing, calculate N greater than 3 from 14.9^N equal to 5,000. Again G_s and G_T are calculated for each value of N. For N equal to 4, G_s equals 9.25 and G_T equals 9.25^4 or 7,200.

We now calculate components from the parameter relationship equation and Eq. 1 in Table I: R equals 712 ohms; and L equals 5.03 μH.

To solve part (C): If series-peaked stages are used, first calculate the advantage factor. This will be the smaller of the two forms K equals $C/2C_1$ equals 1.5 and K equals $3C/2C_2$ or 2.25.

Use the 1.5 for K, and C_2 must be augmented by 8 μμf to satisfy the required relationship between C_1 and C_2. Note that the use of the augmented value of C_2 in the second form for K yields K equals 1.5 again. Because C_2 must equal $3C_1$, the advantage factor in many cases is reduced below the ideal of 2.

From Eq. 1, the maximum value of G_s is 12.95 and the minimum number of stages possible is $N > 3$ from $12.95^N = 5{,}000$. Beginning calculations with N equal to 4, find G_s equal to 12.95 × F_N equal to 12.95 × 0.758 equal to 9.8; and G_T equal to 9.8^4 or 9,100.

The parameters are calculated as before: R equals 754 ohms; L equals 12.1 μH. Capacitance C_2 is increased by 8 μμf.

Solutions can be obtained for combinations of these circuits using the data in Table 1.

Compact one-mc transistorized oscillator yields a frequency stability of one part in 10^9 per day at normal room temperature. Total weight of oven and oscillator is 2.5 lb. A 12-lb, 45-v battery can furnish both oven and circuit power for 72 hours at room temperature

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Stable, Low-Cost

MODERN communication and radar systems place stringent requirements on stability of oscillators. The oscillator to be described exhibits a stability of one part in 10^9 per day at a frequency of one mc for operation at 25 C ± 10 C. A normal slow variation of ambient temperature from 25 to 50 C yields a frequency change of two parts in 10^9.

Figure 1 illustrates the effect of varying the oven temperature at the rate of 8 C per hour from 0 to 50 C. Figure 2 shows the transient response of the oven and oscillator to a temperature change of 5 deg per minute from 27.5 to 50 C. Major factors related to the stability are the crystal, the oven, the circuit configuration and selection of components.

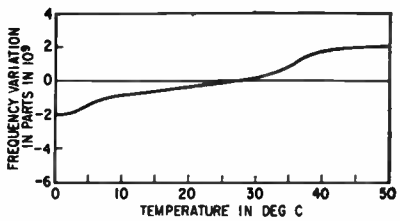


FIG. 1—Frequency characteristics of the one-mc oscillator when ambient temperature is varied at a rate of 8 C per hour

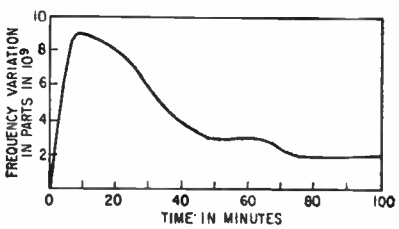


FIG. 2—Frequency characteristic when ambient changes rapidly from 27.5 to 50 C

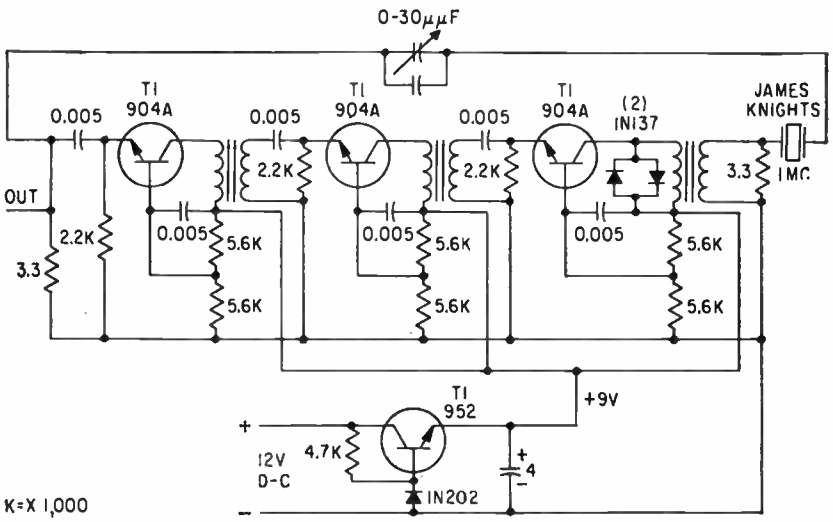


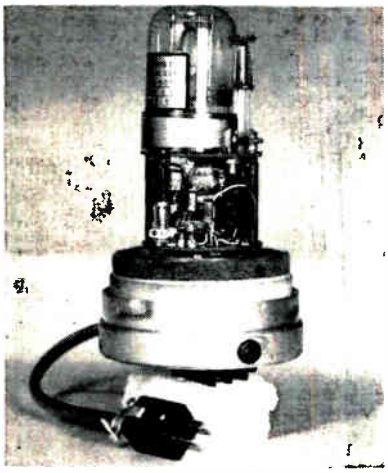
FIG. 3—Schematic diagram of the crystal oscillator

Crystal Units

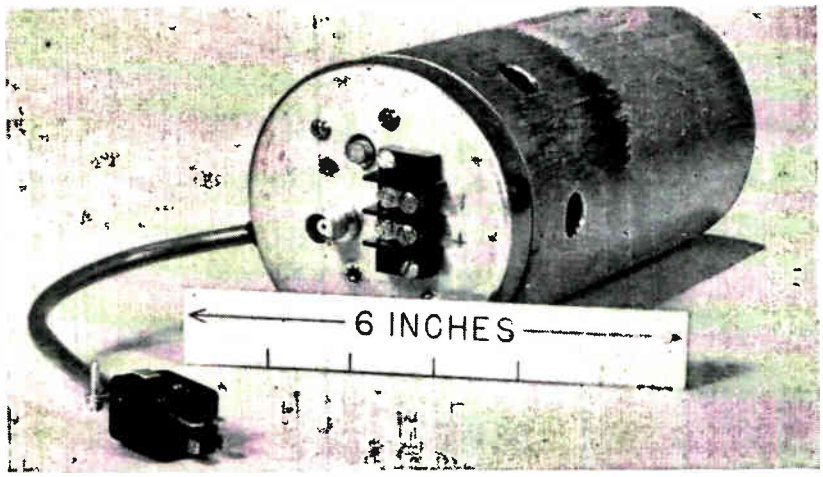
The one-mc crystal is an AT-cut crystal with a Q of 1.6 million. It is designed for operation at 60 C. In the operating range, the temperature coefficient of the crystal is 0.146 cycle per deg C. Series impedance at resonance is about six ohms. A 20-g shock for eight millisec results in a frequency change of 15 parts in 10^9. A new design of crystal mounting is said to reduce the effect of shock considerably. The James Knights crystal is mounted in the horizontal plane and is supported by a spring structure.

Insulating medium for the General Radio oven is a vacuum flask. At a room temperature of 25 C, an average power of two watts maintains the oven at a temperature of 60 C. Oven temperature remains constant within a few hundredths of one deg with normal slow changes in ambient temperature. A heavy-duty 45-v battery can act as a power source for the oven for a 72-hour period. A transistor serves as a switching device to deliver power to the heating element.

If a-c power is available, the



Front view of the oscillator



Complete oven and oscillator assembly

One-Mc Oscillator

heating element can be controlled by a thyratron through the same power connector used with the battery. In both methods of oven control, the control circuit is not troubled by contact resistance of the thermostat. Since the oven was made for use in a tv transmitter monitor, it was necessary to modify it considerably to package the oscillator. However, the thermal time constant was not changed appreciably. A roughing oven enclosing the oven described would improve the instability caused by thermal shock.

Circuit Description

Basic aim of the circuit is to reduce undesirable phase shift in the amplifier portion of the oscillator and to maximize the phase-angle change across the feedback network as a function of frequency. Variations in temperature and supply voltage can introduce a change in phase angle of the amplifier.

To alleviate temperature and voltage effects, the entire oscillator circuit and a transistor voltage regulator were placed in the oven. Since tuned amplifiers could introduce phase problems, the amplifier was designed to be of broad bandwidth. Because crystal impedance is six ohms, the crystal must be terminated in a low impedance to provide a high-Q feedback network.

Figure 3 shows the oscillator and voltage-regulator circuits. A three-stage grounded-base transistor amplifier delivers the necessary power gain. The output transformer requires a 23 to 1 turns ratio to drive the three-ohm termination of the crystal from a grounded-base stage. A turns ratio of 3 to 1 is used for the interstage transformers. Amplitude limiting in the final amplifier is accomplished with two diodes placed in opposite polarity across the output transformer. Since the circuit operates at 60 C, silicon transistors are used. It is possible to change frequency of the oscillator slightly by adjusting the trimmer capacitor in parallel with the feedback capacitor. A change of 30 $\mu\mu$f varies the frequency by 0.4 cycle. The rms voltage output of the oscillator is 3 mv.

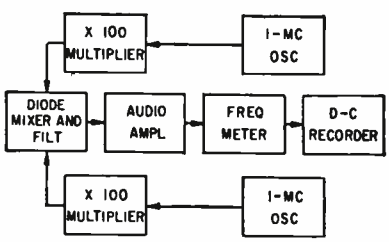


FIG. 4—Block diagram of the measuring equipment

Stability of the oscillator was measured by multiplying the one-mc output to 100 mc. Tests were made to determine effects of the multiplier chain. No variations within the resolving power of the measuring equipment (parts in 10^9) were introduced.

The 100-mc signal produced by the multiplier was mixed with a 100-mc signal from a National Radio Atomichron. This latter unit has a five-mc source stable to one part in 10^{11}. By offsetting the frequency of the one-mc transistor oscillator so that it was 3.9 cps below one mc, a beat note of 390 cps appeared at the mixer output. This audio frequency was delivered to a 400-cps frequency meter having a direct output voltage proportional to frequency. A recorder displayed variations in the d-c output of the frequency meter.

Figure 4 is a block diagram of the measuring equipment. Maximum deviation over a 24-hour period was one part in 10^9. Similar results were obtained by using the same technique to measure drift between two of the transistor oscillators. Another method of measurement involved the Lissajous pattern produced by two of the transistor oscillators. By introducing distortion in one of the oscilloscope inputs to distort the Lissajous pattern, one can measure the number of minutes required for the phase difference between the two oscillators to shift by 360 deg. Research on this project was supported by the Army, Navy and Air Force under contract with MIT.

F-M Tuner Adapter for

Four-tube unit separates subcarrier signal from output of standard f-m tuners and, after demodulation, matrixes it with main signal to provide two stereophonic channels. Though designed for Crosby system of multiplex transmission, provision is made for use with other systems

By **LEONARD FELDMAN,** President, Madison Fielding Corporation, Brooklyn, N. Y.

STEREOPHONIC BROADCASTS attempted to date have had various shortcomings.

Simultaneous a-m/f-m stereo broadcasts, using one of the two media for each channel, result in one good channel and one relatively inferior channel; also, the listener equipped with only one type of receiver hears a highly unbalanced program which favors the left or the right. Twin f-m stations pooling their efforts for stereo eliminate the first of these shortcomings, but they retain the second and also reduce the number of programs that can be transmitted on the f-m band in any given area.

Development of the Crosby f-m multiplex stereophonic system affords two channels which together are as good as the single channel used in conventional f-m transmissions. In addition, the listener to a stereo transmission with a conventional f-m receiver hears a complete and balanced monophonic signal.

This article describes an inexpensive converter that, when used in conjunction with a conventional f-m tuner or receiver, will separate the two stereo channels. The unit requires no tuning or other periodic adjustments and its circuits are effective only during periods of stereo transmission.

Transmission System

Figure 1 shows the transmission setup for the Crosby system. A two-channel signal is supplied from a stereo tape or disk, or two properly positioned microphones. The two channels, A and B, are added in-phase in a mixing network to obtain an output signal that is the sum of $A + B$. This sum signal is used to modulate the f-m transmitter in the usual way. It is therefore this total-program signal that the listener equipped with only a conventional f-m receiver will hear.

The B-channel signal is also passed through a phase inverter; the $-B$ output signal is added to the A signal in another mixing network to obtain an output signal which is A-B, the difference between the two channels. This signal may be thought of as the stereo-content signal.

The A-B signal is used to modulate a 50-kc generator to a maximum deviation of ±25 kc. Thus, the frequency limits of this subsidiary generator are 25 kc and 75 kc. This f-m is used to further modulate the f-m transmitter.

Since the total permissible deviation per f-m channel is ±75 kc, equal deviation is assigned to the main carrier and the 50-kc subcarrier, or a 37½ kc maximum deviation for each. Subcarrier modulation will always be constant at 37½ kc whereas the main $A + B$ modulation will vary in accordance with audio content as always. In any case, the total bandwidth requirement will never exceed the allowed 75 kc on each side of the r-f carrier.

For the monophonic listener, the reduced primary audio modulation (to 37½ kc) will result in a 6-db reduction of audio amplitude. Advances in f-m tuner signal-to-noise and quieting sensitivity design are such that this slight decrease in sound level can be deemed unimportant.

In the case of stereo listening, no reduction in sound level results. Both the $A + B$ and $A - B$ signals are preemphasized in accordance with standard practice.

Reception System

Figure 2 is a block diagram of the system needed to receive the

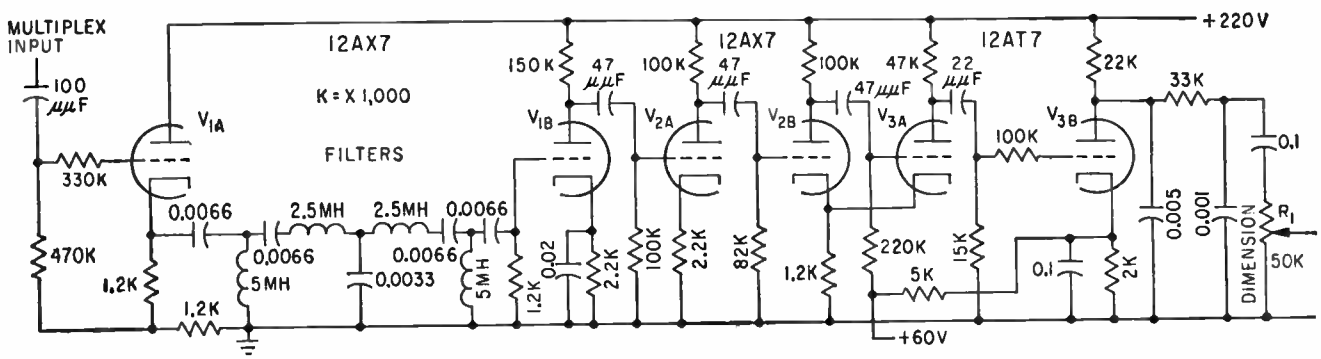


FIG. 3—Complete circuit for separation of sum-and-difference signals of Crosby system into original two-channel signals, S1 permits unit to be

Multiplexed Stereo

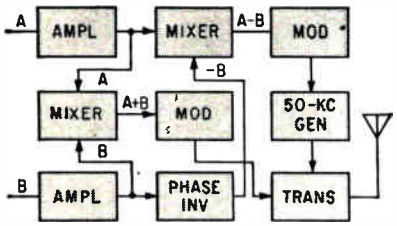


FIG. 1—Basic Crosby multiplex transmission system for two stereophonic channels

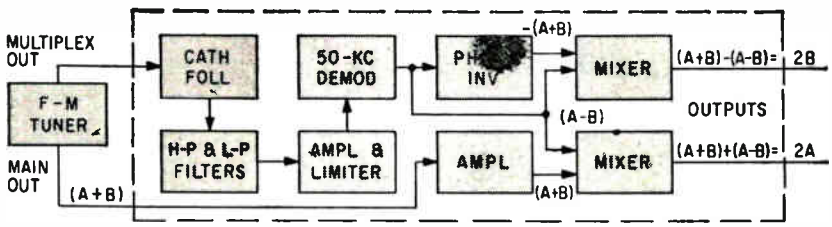


FIG. 2—System necessary to receive stereophonic transmissions; encircled blocks comprise converter circuits

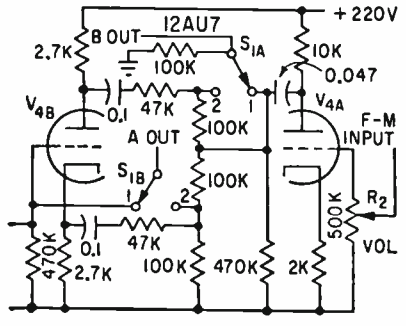
stereophonic broadcasts. The blocks enclosed in the dashed line comprise the converter circuits. This is the only additional piece of equipment needed, assuming that the listener is already equipped for other stereo media.

The main output of an f-m tuner is connected to one of the inputs of the converter. A second connection is made from the multiplex output of the tuner.

Multiplex Output

The multiplex output is taken ahead of the deemphasis network, at the output of the discriminator or ratio detector. As the pertinent signal at this output is the 50-kc subcarrier, the length of cable must be kept minimal, usually no more than 3 ft.

The multiplex signal is stripped of primary audio content by sharp high-pass filters having a cut-off point of 20 kc. The subcarrier is then amplified, limited and demodulated. After demodulation, the $A - B$ signal is recovered and mixed, in phase, with the $A + B$ signal from the main output of the tuner. The resultant output is $(A + B) + (A - B)$ or $2A$,



used with other multiplex transmission systems

The $A - B$ signal also undergoes phase inversion to produce a $-(A - B)$ signal that is added to the main $A + B$ signal to produce $(A + B) - (A - B)$ or $2B$.

Noise Figure

The factor of two in each case is relative, depending upon the amplification in the particular circuits; it substantiates the earlier hypothesis that no signal-to-noise deterioration results when listening to stereo.

The subcarrier noise figure is somewhat better than the main-carrier noise figure, so when the two are remixed, the noise figure of each channel (A and B) is actually better than that of an equivalent monophonic transmission.

The complete circuit diagram of the converter unit is shown in Fig. 3.

Amplifier V_{1A} equates the level of the primary ($A + B$) audio with subsequently demodulated $(A - B)$ components.

The signal from the multiplex output of the f-m tuner is passed through cathode follower V_{1A} to provide isolation and a proper source impedance for the filters to follow. While the circuit parameters used suggest nonlinear operation of this stage, sinusoidal reproduction at this point is not necessary as only frequency variations of the subcarrier contribute to the final demodulated output. Maximum gain (minimum loss) was the governing factor, rather than minimum distortion.

As both the main audio and the subcarrier are available at the multiplex output of any standard f-m tuner, it would have been possible to provide only one input on the converter, with subsequent separation taking place in the converter itself. This was avoided for two reasons: (1) the main audio signal derived at the discriminator or ratio detector of an f-m tuner lacks the necessary high-frequency deemphasis characteristic. While a deemphasis network could have been built into the converter this would have duplicated parts already present in the tuner and increased cost. (2) Many jacks of present-day tuners have an isolating capacitor that is adequate for passing the subcarrier but hardly adequate for coupling audio to the high-impedance input of the converter.

Filters

The filters that follow V_{1A} are necessary to completely eliminate all audible frequencies thus far accompanying the subcarrier. Since these frequencies extend to 15 kc, the cut-off point of both high-pass sections is 20-kc.

The single low-pass section has a cut-off frequency of 75 kc, to restrict demodulated noise of the bandwidth necessary for proper functioning of the rest of the circuit and no more. Terminating and source impedances are 1,200 ohms.

It was found that 10-percent resistors and 5-percent capacitors and inductors were satisfactory.

For the high-pass sections, a leeway of ±3 kc for the 3-db attenuation point will not deteriorate performance, as the highest audio frequency transmitted is 15 kc, fully 5 kc removed from the beginning of the nominal passband.

In a positive direction, 25 kc is the first frequency of interest in

the subcarrier. This frequency is attained only under conditions of 100-percent (25 kc) modulation of the subcarrier; with the amplitude available from most tuners, an attenuation of as great as 6 db at 25 kc will not affect limiting, demodulation or noise figure.

The low and high-pass characteristics of the filter sections are shown in Fig. 4.

The f-m subcarrier is amplified by V_{1B} and V_{2A}; the latter also affords partial saturation limiting because of the large voltage swings in its plate circuit.

Detection

At this point in the circuit, the classic approach would have been to provide further limiting and subsequent f-m detection by any one of the several techniques available. Anticipated variations in sub-carrier level because of different tuners used, cable lengths and other factors discouraged this approach, as full limiting could not be relied on unless more stages were incorporated. Also, as it has been decided to employ pulse or counter detection, waveshapes had to be consistent and fixed for proper pulse differentiation and minimum distortion in the recovered audio signal.

For these reasons, the actual subcarrier is abandoned at this point and is used merely to generate or trigger a series of square waves utilizing the monostable multivibrator consisting of V_{2B} and V_{2A}. The time constants were chosen to produce consistently shaped wave trains at any frequency from 25 kc to 75 kc. Thus, any amplitude of subcarrier of about 0.1 or more at the multiplex input jack will produce a steep, high-amplitude square-wave train suitable for differentiation in the network in the grid circuit of counter detector V_{3B}.

Parameter Choice

The choice of the parameters in the differentiation network involved a classic compromise, that of gain versus distortion. A time constant of 1μsec or three times that of 0.33 μsec, as finally chosen, would have yielded an audio output in the plate circuit more than twice as great. Unfortunately, the lowest frequencies of pulse trains would also undergo severe amplitude and shape distortion, which would in turn manifest itself as high-order second-harmonic distortion in the recovered $(A - B)$ audio.

Properly designed, the counter detector is extremely linear and highly suitable at the frequencies under consideration. The r-c networks in the plate circuit of V_{3B} remove residual subcarrier components and the necessary 75-μsec deemphasis.

Matrixing

The recovered $(A-B)$ signal is fed to V_{1B} and derived in phase at its cathode and out of phase, $-(A-B)$, in its plate circuit. The two signals are then mixed in proper proportion with the $A+B$ signals to complete the electrical algebra necessary for the ultimate recovery of the individual A and B channels.

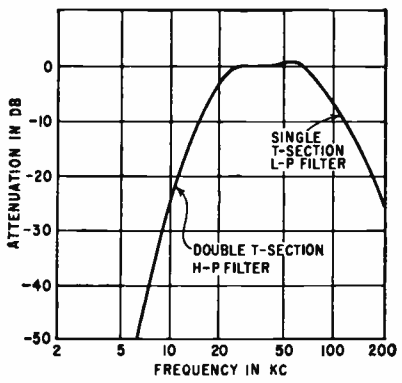


FIG. 4—Characteristics of filter networks used in circuit of FIG. 3

Fixed proportions of mixing could have been preset at a considerable reduction in cost. However, potentiometer R_1 that governs the percentage or proportion of $A-B$ signal provides an excellent customer feature. With this control set at minimum, conventional monophonic f-m is received, even when stereo is being broadcast since only $A+B$ is supplied at the outputs of the converter.

When stereo is desired, the user adjusts this dimension control to introduce as much or as little stereo effect as he pleases. This flexibility enables too closely spaced speakers to create the illusion of being further apart and visa versa.

Volume control R_2 provides a means for adjusting the level of the monophonic $A+B$ signal from tuners of different manufacturers.

Switch S_1 is shown in the position required for Crosby-system stereo transmissions. If this system gains universal approval, S_1 will probably be eliminated. Until that time, it is conceivable that some stations may wish to transmit other types of f-m stereo signals, in which channel A may be broadcast through regular f-m and channel B through the f-m subcarrier. In that event, S_1 will enable the user to extract subcarrier audio from one output jack and main audio from the other.

In either case, connection is made from the two output jacks to high-level high-impedance inputs of two single-channel amplifiers or a dual-channel stereophonic amplifier. In the absence of stereo broadcasting, the dimension control may be adjusted for normal f-m reception from both speaker systems. Under these conditions, amplifier volumes would be adjusted to provide equal volume from each of the speaker systems. Then, when the dimension control is used on the occasion of stereo broadcasting, perfect spatial balance will be automatically achieved.

Performance

For the main channel, the gain is -3 db with a frequency response of 20 to 18,000 cps $\pm$ 1 db. Harmonic distortion is less than 0.3 percent for the 0.4-v output obtained with 37.5-kc maximum deviation when fed from a ratio-detector type tuner.

The subchannel has a response of -11 db at 8 kc and is flat from 20 to 15,000 cps $\pm$ 1 db when fed with a signal having standard 75-μsec preemphasis. Full limiting of the subcarrier channel is obtained with as little as 60 mv input; up to several volts input can be handled without overload.

Output of the adapter is 0.4 v for 25-kc (maximum) deviation of the subcarrier and the harmonic distortion is less than 1 percent over-all for full deviation of the sub and main carriers.

Up to 6,000-cps, phase error between the $A+B$ and $A-B$ channels is less than 15 deg.

Soft Magnets for Amplifiers

Choice of magnetic amplifier core materials broadens as new square-loop and high-permeability alloys are added to the old standbys

By GEORGE SIDERIS, Associate Editor

TABLE I—Properties of Representative Magnetic Amplifier Core Materials

Typical Trade Names	Composition (balance Fe)	Initial Permeability ($\times 10^3$)	Maximum Permeability ($\times 10^3$)	Saturation Induction (kilogauss)	Saturation Hysteresis (erg/cm³/~)	Residual Flux Density (kilogauss)	Coercive Force (oersted)	Electrical Resistivity (μohm-cm)	Curie Temp (°C)
Deltamax, Hipernik V, Orthonol, Orthonik, Permeron, etc.	45–50 Ni grain-oriented	0.4–1.7	30–150	13 5–20	200–700	8.3–15	0.15–0.5	40–50	475
High Perm 49	49 Ni	5	50	16	.....	6.5	0.075	43	475
Hipernik, H_2 ann.	50 Ni	4	70	16	220	.....	0.05	45	500
45 Permalloy	45 Ni	2.5–2.7	23–25	16	1,200	8	0.3	45	400
45 Permalloy, H_2 ann.	45 Ni	4	50	16	.....	.....	0.07	45	...
65 Permalloy	65–68 Ni	1.5	250–600	13	.....	13	0.03	20	600
4750 Allegheny	47–50 Ni	3–9	50	16	.....	6–6.2	0.07–0.08	52	430
4–79 Permalloy	79 Ni, 4 Mo	20–22	72–100	8–8.7	200	5–5.5	0.05	55–60	460
Supermalloy	79 Ni, 5 Mo	55–150	500–1,000	6.8–8	8	.....	0.002–0.05	60–65	400
Hy Mu 80	80 Ni, bal Mo-Fe	10–20	90–100	7–9	.....	2.5	0.05–0.07	55–58	460
Dynamax	65 Ni, 2 Mo	.....	1,750	12.5	.....	12	0.0053	.....	...
Mumetal	77 Ni, 5 Cu, 2 Cr	20	100	6.5–8	200	6	0.05	60–62	400
1040 Alloy	72 Ni, 14 Cu, 3 Mo	40	100	6	200	2.5	0.014–0.02	55	290
Supermendur	49 Co, 2 V	.....	92.5	24	2,000	21.5	0.2	26	980
Hipersil, Silectron, Magnesil, Alphasil, Tran-Cor 3X, etc.	3–3.5 Si grain-oriented	a	17.5–55	18–20	700	8.3–14	0.1–3.3	45–50	735
Ferramic H	Ni-Zn+Cu ferrites	0.850[b]	4.3	3.4[c]	.....	1.17[c]	0.18	10^{10}	150
Ferramic H-1		0.550[b]	3.8	2.8[c]	.....	1.5[c]	0.35	2×10^{10}	125

[a] Uncertain; value at 100 gauss induction reported as 7,500 [b] At 1 mc [c] Induction at field strength of 25 oersteds

TABLE II—D-C Magnetic Properties of Cube-oriented and Grain-oriented 3% Silicon Steels[a]

Direction of Measurement	Maximum Permeability	Residual Induction	Energy Loss[b]	Coercive Force
Measured Parallel to Rolling Direction				
Cube-oriented	116,000	12,200	0.56	0.07
Grain-oriented	55,000	9,500	0.60	0.08
Measured Perpendicular to Rolling Direction				
Cube- oriented	65,000	11,500	0.65	0.08
Grain-oriented	8,000	1,750	1.6	0.27

[a] Source: report in *Jour App Phys*, March, 1958
[b] Watts/pound at 15,000 gauss induction and 60 cps

PERMEABILITY (B/H) of an ideal magnetic amplifier core material is infinite to the saturation point on its hysteresis loop. A rectangular loop material is generally preferred in the output stages of the amplifier, but an alloy with high permeability may do the job in an input stage. Choice of materials is wide.

High resistivity reduces core losses. Losses can also be minimized by using thin laminations or, at high frequencies, by using ferrites. Silicon steels perform well at high power. Permalloy types give high sensitivity. Supermalloy features low magnetizing currents and Mumetal, low saturation induction.

Properties of typical materials are given in Table I. Properties of the alloys will vary widely according to production methods and post-annealing care.

NEW MATERIALS—New materials include Supermendur, Dynamax and cube-oriented steel, table II, which is being tried in transformers.

Tape Recording System

Pulse duration recording technique and 31-channel block format give large information content, minimum dead space and effect from tape skew plus ability to selectively rerecord on individual blocks. Unique electronically controlled pneumatic tape transport permits high rate of information transfer

By **WAY DONG WOO,** DATAmatic Div., Minneapolis-Honeywell Regulator Co., Newton Highlands, Mass.

NOVEL RECORDING TECHNIQUES are enabling a data processing system to handle information at a rate of 60,000 digits or 40,000 alpha-numeric characters a second. This article describes the information format, read and write circuits, and tape transport mechanism which give the system the required speed and capacity.

Information Format

Magnetic tape is the common medium of information transferal throughout the system. A 3-inch wide tape capable of accommodating 36 magnetic channels is used. Three channels control and position the tape, 31 contain recorded information, and two are spares.

Information is recorded in blocks of 62 words, 2 words in each of the 31 information channels. Start and finish of each block is indicated by marks on the control and position channels. An interlace recording technique minimizes the dead spaces between blocks required to accelerate the tape and eliminates the need for rewinding.

Interlacing is done by recording on every other block while the tape is moving in the forward direction, then recording in reverse to fill in unused blocks as shown in Fig. 1A. A full reel of tape contains 50,000 blocks: blocks numbered 1 through 25,000 are used during the forward cycle and 25,001 through 50,000 during the reverse cycle.

Magnetization of the block mark channels and the signal as it appears when the tape is played back are shown in Fig. 1B, 1C and 1D. To assure that recording begins at the proper point, the positive pulse appearing in the forward or reverse mark channels must occur with the check pulse in the check mark channel. Positive and negative pulses in the forward or reverse mark channels indicate the respective beginning and end of reading.

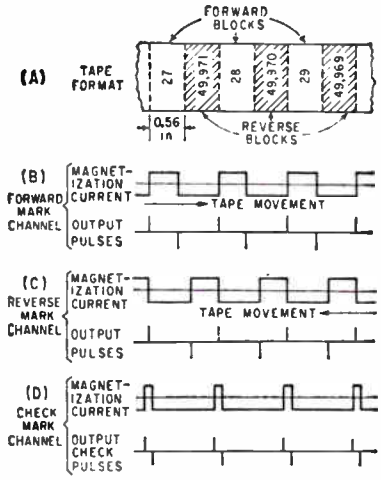


FIG. 1—Tape format (A) and corresponding block mark waveforms (B C and D)

Recording Technique

A pulse-width-modulation technique is used for magnetically recording binary digits on the tape information channels. Binary digits are represented by the interval of time between two successive reversals of magnetization of the tape. An example magnetic pattern is shown in Fig. 2.

During playback, peak output voltages are obtained when the head passes through a reversal of magnetization. Alternate peak voltages are generated every 31 or 62 μsec. Information is conveyed by frequency deviation of the carrier and not by variation of amplitude. Since noise causes fluctuation of amplitude, a lower signal-to-noise ratio can be tolerated than in conventional recording systems.

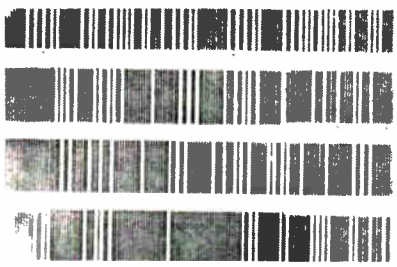


FIG. 2—Magnetic flux pattern of four information channels

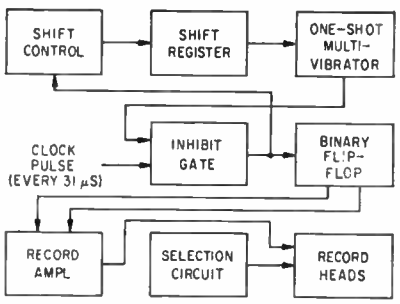
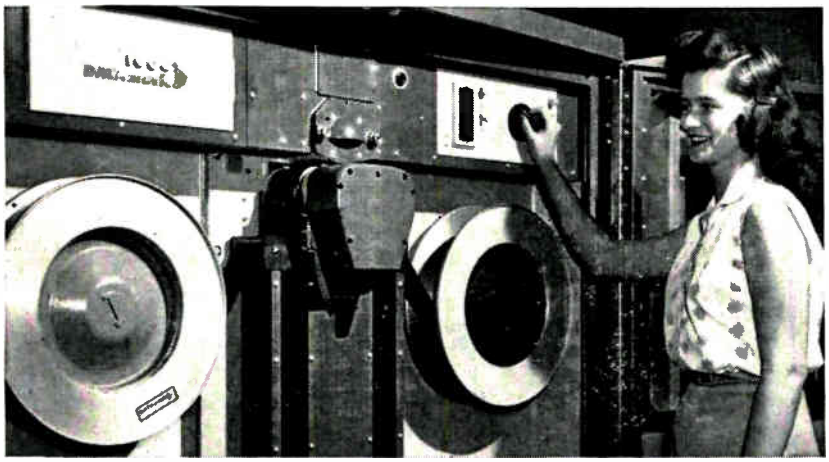


FIG. 3—Writing circuits convert 62-word information block in shift register to magnetization pulses in recording head

Erasing of previous recording is not necessary when new words are recorded. Since the magnetic medium is subjected to saturation of one polarity or the other, the resultant magnetization of the tape is completely independent of its history. This feature allows information blocks to be selectively altered without disturbing adjacent blocks. Also, need for synchronization of pulses in different channels

Speeds Data Processing



Operator starts DATAmatic 1000 magnetic file unit. Reel holds 2,700 feet of 3-in. wide tape containing over 37 million decimal digits

is eliminated thereby removing skew as the limiting factor in obtaining maximum pulse density.

Writing Circuits

A block diagram of the magnetic tape writing circuits is shown in Fig. 3. The 106 bits of the two words to be written in each channel are stored in the shift register and are read out serially during recording. A ZERO output permits clock pulses to be applied to the binary flip-flop every 31 μsec. A ONE output, however, energizes a one-shot multivibrator which actuates the inhibit gate for 44 μsec. This action permits only the second, or 62-μsec, clock pulse to be fed to the binary flip-flop. After being amplified, the flip-flop output is applied to the head selected by the selection circuit. Writing current is reversed in the selected head in 31 μsec for a ZERO and in 62 μsec for a ONE.

The circuit used to apply the output of the binary flip-flop to a selected head in the remotely located magnetic file unit is shown in Fig. 4. Magnetic recording transformers T_1 and T_2 associated with the selected head are connected to +190 v; transformers of all unselected heads are connected to +160 v. Since the voltage applied to the selected head transformers exceeds the amplifier B + voltage, plate currents from tubes V_1 and V_2 flow in the transformer primary generating +60 ma of magnetization current in the head winding.

Diodes D_1 and D_2 clamp the amplifier end of all head transformer primaries at the plate supply voltage, while voltage E_1 on the other end of unselected head transformer primaries is held at +160 v. Since the back resistance of series diodes D_2 and D_4 is high, current cannot flow in unselected heads.

Pulse-width modulation results in different length words in different channels thus, signals are necessary to indicate where information begins and ends. Writing starts when the beginning mark from the block mark channel is detected. A few ZEROES followed by a ONE, which are not information bits, are then written. After the 106 information bits are recorded, another ONE and a few ZEROES are written.

The noninformation ONE bits, called sentinals, serve to signal the start and finish of the information bit recording. The ZERO bits preceding and following the sentinal bits are used to make certain that at least one ZERO is read in spite of tape skew, delays and the like.

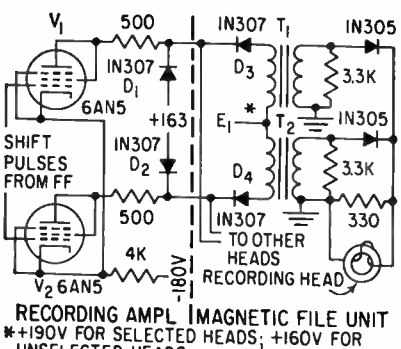


FIG. 4—Recording amplifier and record head circuits

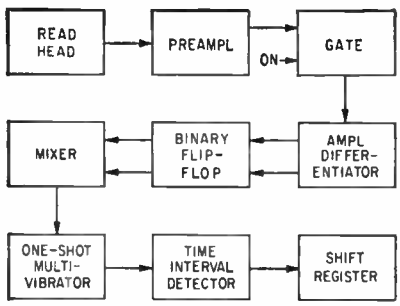


FIG. 5—Reading circuits convert signals from read head to digital information in shift register

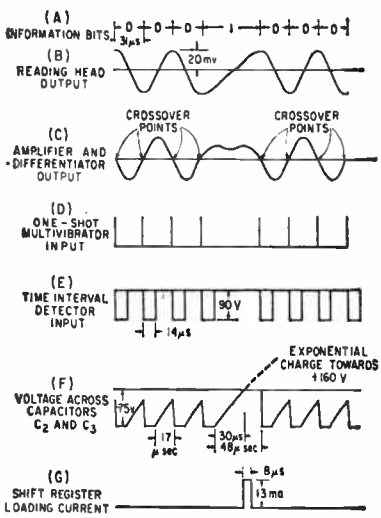


FIG. 6—Waveforms at various points in reading circuit

Reading Circuits

A block diagram of the tape reading circuits is shown in Fig. 5. Information bit content and corresponding read head output waveform are shown in Fig. 6A and 6B.

Signals from a head are amplified and gated on when the associated channel is read. The gated signal is again amplified, differentiated and phase split to give the

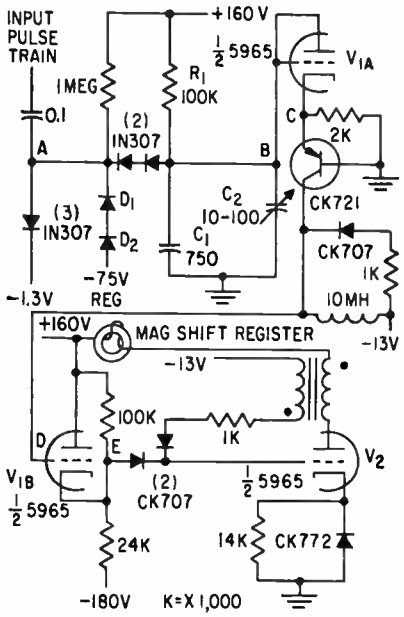


FIG. 7—Time interval detector in writing circuit

waveform shown in Fig. 6C. Since the signal is differentiated, crossover points occur through the base lines at the positive and negative peaks of the original head signal.

The outputs of the amplifier and differentiator are fed into the opposite inputs of the binary flip-flop. The two flip-flop outputs are then differentiated, mixed and fed to a one-shot multivibrator. The multivibrator output signal, shown in Fig. 6D, contains a 14 μsec negative pulse for every change in polarity of tape magnetization.

The train of pulses is now applied to the time interval detector circuit shown in Fig. 7. In the quiescent state, point A is at +1.3 v while B and C are at ground potential. If a large negative pulse arrives, the potential of points A and B is driven down to −75v and clamped there by diodes D_1 and D_2. When the input pulse disappears, the potential at points A and B rises exponentially towards +160 v with a time constant R_1 $(C_1 + C_2)$. As soon as point B rises to ground potential, V_{1A} conducts driving the potential of point D from −13 v to ground. Tube V_{1B} then conducts raising the potential of point E to ground triggering blocking oscillator V_2 which delivers a 13-ma pulse to the core winding in the magnetic shift register.

Time constant R_1 $(C_1 + C_2)$ is set to raise points B and C from −75 v to ground in 30 μsec. If a ZERO bit is read, time delay between successive pulses is only 17 μsec; therefore, no magnetization pulse is generated. However, if a ONE bit is read, time delay between successive pulses is 48 μsec and a pulse is delivered to the shift register.

Tape Transport Mechanism

Two continuously counter rotating capstans driven by a synchronous motor and traveling at circumferential speeds of 100 ips move the tape. Capstan surfaces contain a number of small holes which are connected to a pneumatic suction system through electrically operated valves. To stop the tape, the suction is removed from the capstan and applied to brake surfaces located under the chosen head.

A schematic diagram of the driving circuits is shown in Fig. 8. The two capstans and brakes are connected to the vacuum and the low pressure compressed air reservoirs through a valve system containing three control vanes; one for the brake surfaces, and one each for the counter rotating capstans[1]. Each vane together with its air passage forms a bistable pneumatic flip-flop. In one state the capstan or brake surface is connected to the vacuum, in the other to the pressure reservoir.

The vanes are set at one of the two positions when pulses are applied to the two actuators. When a GO FORWARD pulse is received, it is amplified by V_{1A} and used to energize the one-shot delay tube V_2 which delivers a 3.5 millisec positive pulse. Through cathode follower V_{1B}, the vacuum actuator is energized with a current of 1.5 amp through the plate circuit of V_3, thereby conecting the forward capstan to the vacuum. The output of V_{1B} also energizes the low pressure actuator which removes the brake. Similarly when a STOP FORWARD pulse is received, the one-shot-delay tube V_6 becomes operative delivering a pulse of 2.5 millisec to the low-pressure actuator which disconnects the forward moving capstan from the vacuum and connects it to the low pressure air line. Output of V_{5B} also energizes the vacuum actuator which brakes the tape to a stop.

In cases where a GO FORWARD command is received before 2.5 millisec has elapsed from the last STOP FORWARD command, the effect of the stop command is immediately overridden by a cancel circuit consisting of coupling capacitor C_1. The negative pulse on V_{2A} cuts off V_{6A} under all circumstances, thereby causing the output of V_7 to immediately return to a negative value. This action cuts off tubes V_7 and V_8 with the result that low pressure and vacuum actuators immediately energize moving the tape forward. A similar circuit is used for the reverse drive.

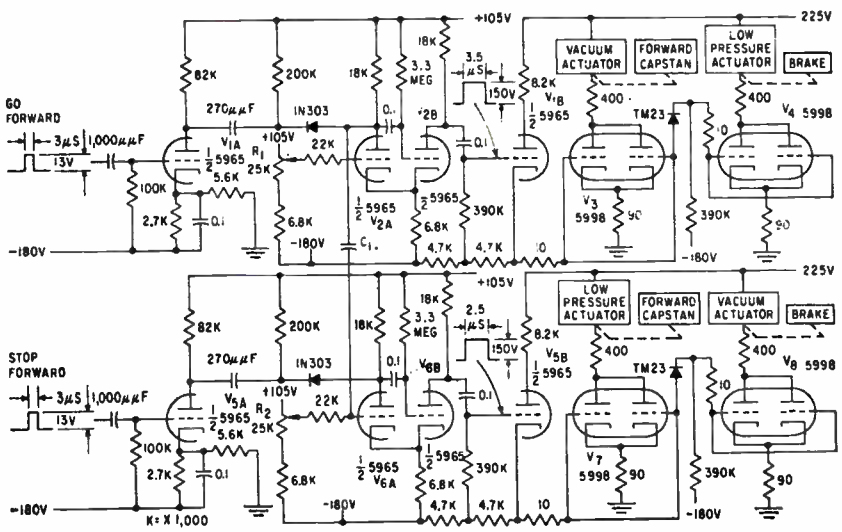
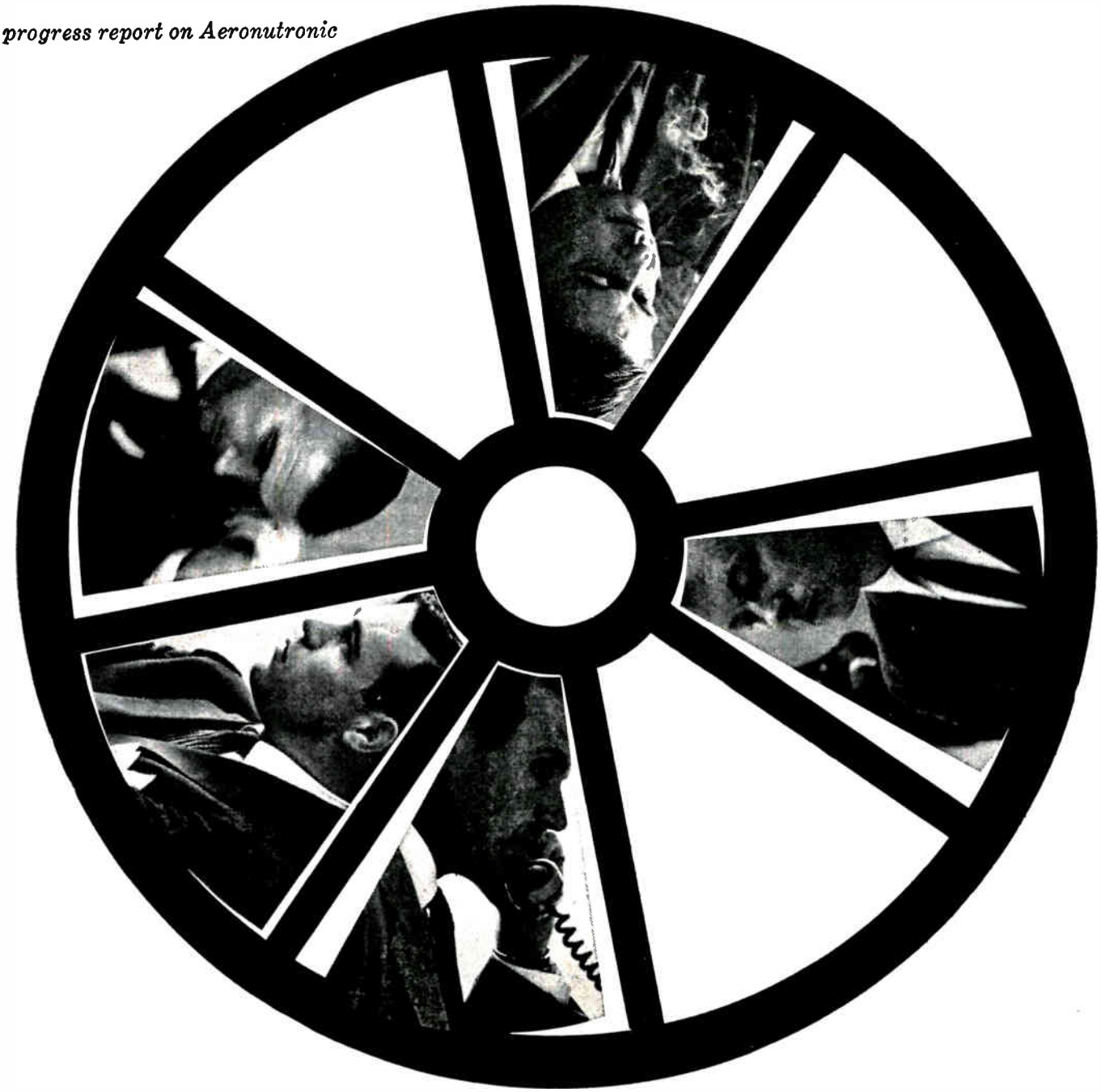


FIG. 8—Electronic control circuit enables tape transport mechanism to start, stop and reverse in a few milliseconds

REFERENCE

(1) R. B. Lawrence, R. E. Wilkins and R. A. Pendleton, Apparatus for Magnetic Storage on Three-Inch Wide Tapes, Proc EJCC, 1957.

progress report on Aeronutronic



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Waveguide Data Charts

Double and triple-post susceptance data charts permit design of X-band waveguide filters with high precision

By ELIO SION*, Airborne Instruments Lab., Div. of Cutler-Hammer, Inc., Mineola, N. Y.

INDUCTIVE POSTS offer one of the simplest and most economical ways of designing multiple-cavity X-band waveguide filters.

These charts can be used to design filters with a bandwidth as narrow as 0.8 percent. Constructed ten-cavity one-percent bandwidth filters had insertion losses of less than 0.75 db at midband. The low susceptance sections of the filter employed two-post structures, while the high-susceptance cavities used the three-post structure.

In actual filter design, the cavity sections are made slightly shorter than calculated. The filter sections are tuned by capacitive screws or capacitive dimpling.

For triple posts, cavity Q's in the order of 6,300 were obtained, and Q's of 5,000 were obtained for double posts. Cavity designs consisted of silver posts in silver-lined X-band waveguide. A silver plated hemispherically tipped tuning screw was used for tuning.

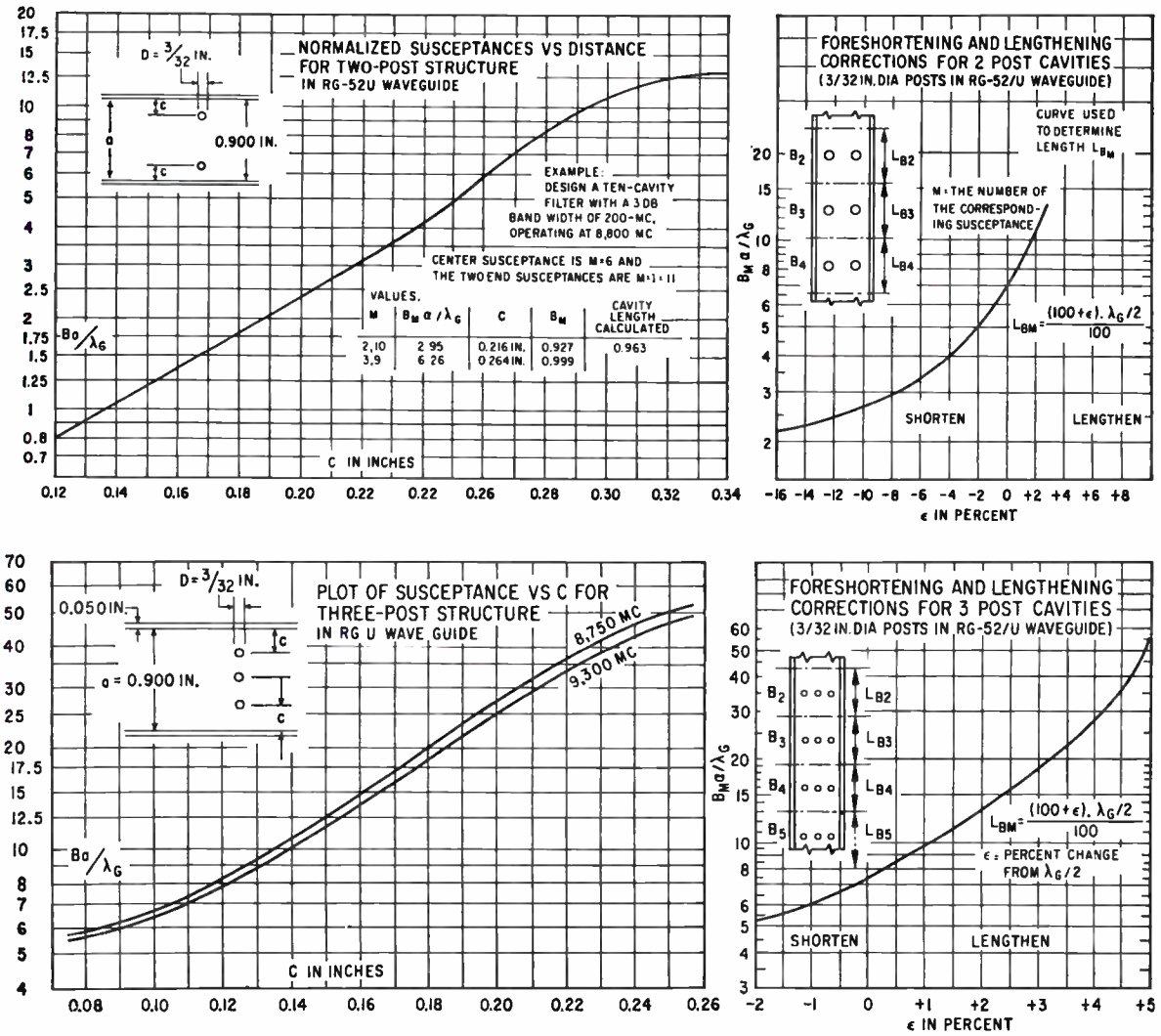
Length L_{Bm} is determined using the correction curves.

In the example given on the chart, the calculated length of the second cavity, namely the distance between B_2 and B_3 is,

$$\tfrac{1}{2}L_{B2} + \tfrac{1}{2}L_{B3},$$

hence this is equal to 0.963 inch.

* Now with Hughes Systems Development Labs.



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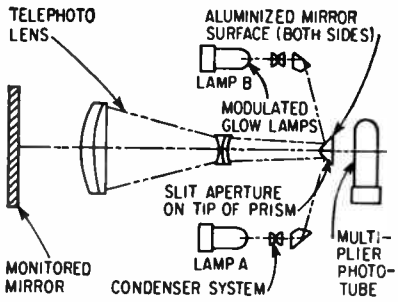

FIG. 1—If monitored mirror is not perpendicular to line of sight, modulated light reaches multiplier phototube

THE FRONT COVER—Tie-in to geographical reference is achieved with a survey theodolite incorporating an accurate azimuth circle and sighting telescope. Perkin-Elmer system provides reference for Ford Instrument inertial guidance in Jupiter

Theodolite References Jupiter Guidance

AZIMUTH orientation of inertially guided missiles before launch establishes a frame of reference without which the missile could not navigate to its target. The irrevocable nature of inertial guidance after blast off spurred development of a highly accurate azimuth theodolite by Perkin-Elmer. The prototype and operational requirements have been supplied for the Redstone Arsenal for use with the Jupiter missile.

Optical and electronic techniques are combined in the theodolite to form a closed servo loop. Accuray is characterized by the systems ability to detect deviations within the angle subtended by a dime placed a mile away.

Operation

The theodolite detects discrepancies in alignment of basic monitored equipment by continuous observation of reflections from a mirror mounted on the stable platform of the guidance package. Rotational discrepancies cause error signals that are applied as corrective signals to drive elements of the monitored equipment via a closed loop between theodolite and missile.

The monitoring optical system consists of two modulated light sources, a telephoto lens as the objective, a beam dividing vee prism and a multiplier phototube. The system is shown in Fig. 1.

Light from the sources is reflected from a mirror or prism mounted on the stable platform. Two glow discharge lamps used as sources are modulated at 400 cps in phase opposition. The two lamps are each imaged at the focal plane of the telephoto objective by separate condenser systems.

A prism-shaped mirror reflects the beams along the optical axis of the objective lens. The resultant signal produced by the multiplier phototube is a function of the angular displacement of the monitored mirror from the squared-on position. This 400-cps signal is in phase or 180 degrees out of phase with the reference voltage, depending on the direction of deviation.

If the monitored mirror is squared on with the optical axis, reflected light will re-enter the objective, fall on the opposite side of the prism and be lost in the source. Thus by being perpendicular to the line of sight, a null results.

Tie-in to the geographical reference is achieved with a survey theodolite incorporating an accurate azimuth circle and sighting telescope. Desired angle between reference and monitoring line of sight is set off using the azimuth circle. The zero setting is determined by autocollimating both systems from a common test mirror.

Error Signal

If the monitored mirror is rotated in azimuth even slightly, returning beams will not be centered on the optical axis and will pass through a slit (which is ground and polished on the apex of the prism) and strike the multiplier phototube, shown in Fig. 2. An error signal is produced which, by its phase, represents direction of azimuth deviation and, by its magnitude, the amount of error.

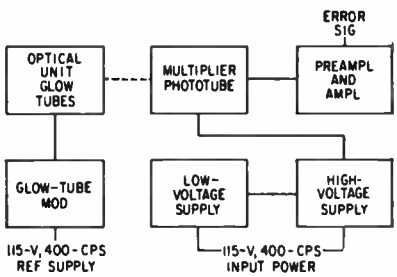

FIG. 2—Modulation of glow lamps is 180 degrees out of phase, so that light reaching multiplier produces signal indicating direction of error

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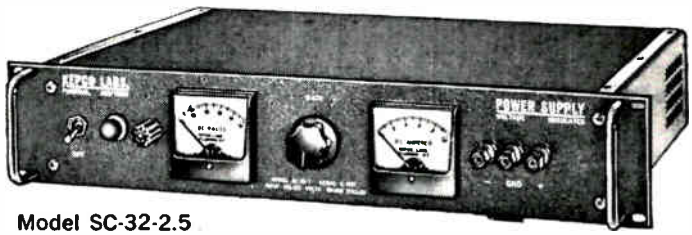

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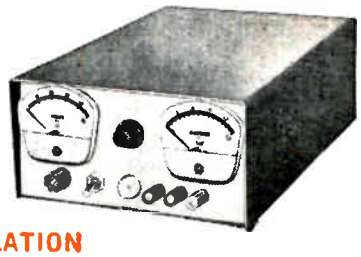
SC-32-1	0-32	0-1
SC-32-1.5	0-32	0-1.5
2SC-32-1.5	0-32	0-1.5
DUAL OUTPUT	0-32	0-1.5
SC-32-2.5	0-32	0-2.5
SC-32-5	0-32	0-5
SC-32-10	0-32	0-10
SC-32-15	0-32	0-15
SC-60-2	0-60	0-2
SC-60-5	0-60	0-5
2SC-100-0.2	0-100	0-0.2
DUAL OUTPUT	0-100	0-0.2
SC-150-1	0-150	0-1
SC-300-1	0-300	0-1



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SC-18-2	0-18	0-2
SC-18-4	0-18	0-4
SC-36-0.5	0-36	0-0.5
SC-36-1	0-36	0-1
SC-36-2	0-36	0-2
SC-3672-0.5	36-72	0-0.5
SC-3672-1	36-72	0-1

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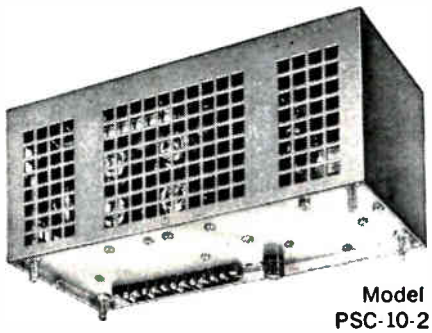
PSC-15-2	12.5-17.5	2
PSC-20-2	17.5-22.5	2
PSC-28-1	22.5-32.5	1
PSC-38-1	32.5-42.5	1



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platform back to correct azimuth heading. Error signals generated by the theodolite may also be recorded to obtain longterm data for making corrective adjustments.

Alignment using long-range theodolites is generally performed with the missile upright. In this position, its nose section is susceptible to sway of greater magnitude than the monitored prism width. Thus the long-range model incorporates a sway compensating system.

Short-Range Model

Two theodolites are used with the Jupiter. The model described is supplimented by a short-range model. The short-range unit is stationed 3 to 4 feet from the foot of the missile and sends beams to an auxiliary prism monitoring unit (with same heading as top prism) in the Jupiter base.

This monitoring unit is directly connected to the launching ring on which the missile is positioned. A second auxiliary monitoring prism is also attached to the launching ring at an angle representing a second target point.

The short-range theodolite takes over alignment in the event of poor weather conditions that might distort the beam path to the nose section.

Thyratron Used for Bistable Circuit

DEVELOPMENT of a tester for checking out repaired dial telephones led to an experimental bistable circuit. It uses a triode, a thyratron and only three other components.

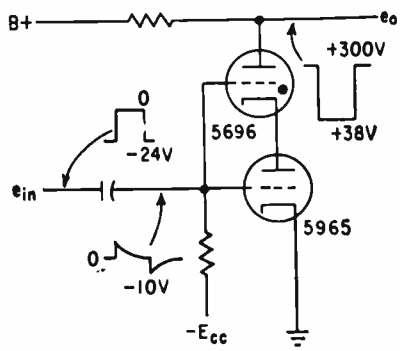


FIG. 1—Triode-thyratron bistable circuit delivers large pulses without being sensitive to changes in load

Conventional flip-flops were unsuitable for the particular application because they are sensitive to changes in load characteristics when handling large pulses. A thyratron was used because its plate-to-cathode voltage does not change with changes in current.

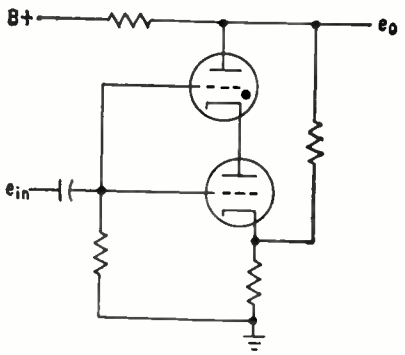


FIG. 2—Normal condition of monostable circuit is the ON state

The load can be entirely in the plate or cathode circuit of the flip-flop shown in Fig. 1, and an external load may be directly coupled. Triggering is unaffected by changes in plate current. Since the circuit does not have regenerative feedback, somewhat larger triggering pulses are required.

Time required for transition from OFF to ON state depends on breakdown time of the thyratron (about 5 μsec). Transition from ON to OFF state is about equal to the rise time of the trigger waveform.

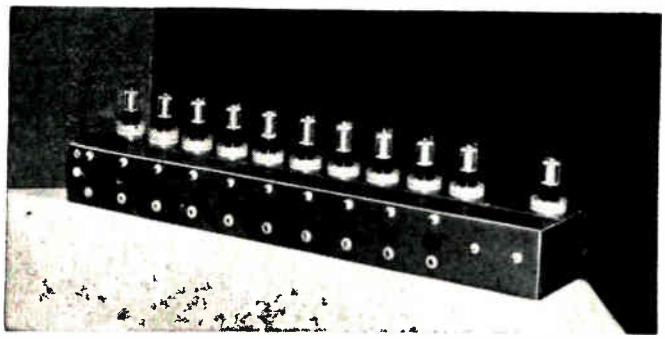
Operation

In the OFF state, both tubes are cutoff. An external positive pulse fires the thyratron and causes the triode to conduct. Because the triode grid is positive with respect to its cathode, it draws grid current. However, the thyratron grid is at a lower potential than its cathode so it delivers current. The circuit therefore locks in a stable condition.

An external negative pulse cuts off the triode, opening the thyratron cathode circuit and returning the circuit to its OFF state.

Other vacuum tube-thyratron circuits can be derived from the basic circuit. A monostable circuit is shown in Fig. 2.

This material was abstracted from The Western Electric Engineer, Oct. 1958, p 21-24.



One conventional tube uses as much power as 10 cold-cathode tubes

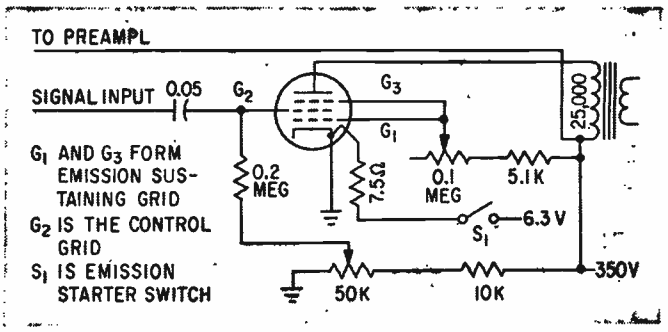


FIG. 1—Audio output amplifier using cold-cathode tube

New Self-Sustained Emission Tube

MAGNESIUM OXIDE cold cathodes are a new electron source discovered at the Signal Corps Research and Development Laboratory, in the course of a study of the self-sustained secondary emission. Use of this cathode in a pre-production model of an audio output tube was recently demonstrated jointly by Tung-Sol Electric and the Army.

The cathodes were first discovered when thin MgO layers were deposited on a nickel base and bombarded with electrons possessing sufficient energy to produce secondary electron emission from the MgO. When the bombarding beam was turned off, the MgO layer continued to emit electrons without external stimulus. Neither heat, nor external light was necessary to keep alive the emission current. By varying the voltage at the collector electrode, this self-sustained current could be easily controlled for many hours from a few microamps to several tens of milliamperes.

A simple technique was finally developed which was suitable for large scale production of efficient and reproducible MgO cathodes. The resulting cathodes were successfully employed in electron tubes under a Signal Corps contract with Tung-Sol Electric Inc.

Mechanism Of SSE

When emission starts from MgO a positive charge is developed at the surface of the MgO layer. Since the cathode coatings are thin, a high electrical field is created across the coatings. It is assumed that under the influence of this field, electrons multiply by an avalanche process, and gain sufficient energy to enter the vacuum. The avalanche of electrons is assumed to be the result of a photoelectric effect in which photons are ejected during the recombination of positive ions with electrons. This concept can be considered only as a first approximation at present.

The Tube

The first pre-production tube developed was an audio output amplifier (see Fig. 1). It develops 900 mw of power to drive a loudspeaker. Outwardly it looks exactly like a hot cathode tube since it is made of similar parts.

The power required to run one hot cathode of the conventional type is sufficient to run ten magnesium oxide cold cathodes. The cold cathodes require only three quarters of a watt per cathode totalling seven and a half (7.50) watts for the ten of them. This refers to cathode power only, not to plate or total power. The plate power is the same for one cold cathode tube as for one thermionic tube.

It is not necessary to have a filament transformer or separate battery to run the cathode in a cold cathode tube. The cathode itself can be run on a small portion of the direct current supply used for total operation of the tube. This applies also to the filament used momentarily for starting emission.

Advantages of the cold-cathode tube are: less cathode power required for operation, quick starting, longer life, and no trouble from faulty heater operation.

The disadvantages are: even though the overall power is substantially less, a minimum voltage of about 300 volts is necessary for operation at present; the present tubes are not self starting; a starting means must be provided; the tubes are slightly more complex internally. The two types are about equal with respect to cost and noise level.

One of the early tubes has been in continuous operation for 14,000 hours without any decrease in the emission.

Applications

Development work now is concentrated on other types of cold-cathode tubes. One is a preamplifier that will produce more amplification than any commercial hot-cathode tube. Sample tubes of this kind have already been produced successfully.

Another development presently under way is a cold cathode electron gun for use in cathode ray tubes for television, and in klystrons, travelling wave tubes and the like.

In the design stage is a flat, picture-on-the-wall display device for television or radar. It appears to be possible to produce brightness in such a device greater than that of any present picture tube.

Other applications include garage door openers, electronic computers where the elimination of the heater

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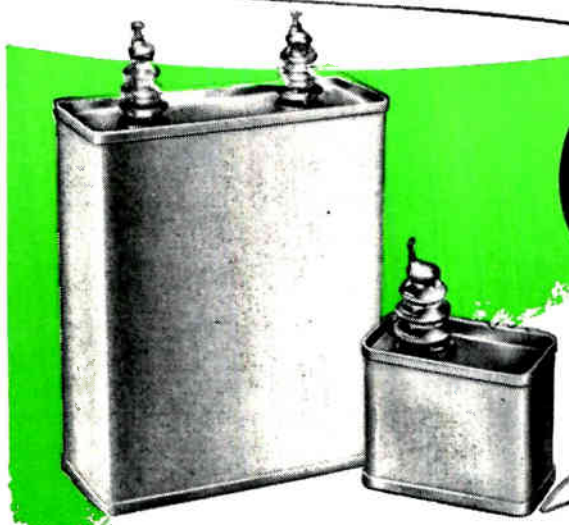

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would pay dividends in reliability and in total power drain, industrial and automation control circuits for the same reasons, telephone cables buried at the bottom of the sea where the unlimited life would be advantageous and in earth satellites where the low power drain would make operation on solar batteries feasible and where the long life and resistance to radiation from outer space would provide reliable functioning for years of orbiting.

An interesting feature of the cold cathode is its ability to sustain emission continuously at extremely low currents without danger of going out, and to start up again instantly. This offers a decided advantage when a small "keep-alive" current at adequate voltage is available. Restarting times have been measured as fast as one thousandth of a second.

Semiconductors for Strain Gages

MOST commonly used metal-wire strain gages have gage factors (dR/RS where R is resistance of the unstrained element and dR is change of resistance with strain S) between two and four. But germanium and silicon used in strain gages give gage factors of up to 150 and 175, respectively, according to the January 1959 issue of *Bell Laboratories Record.*

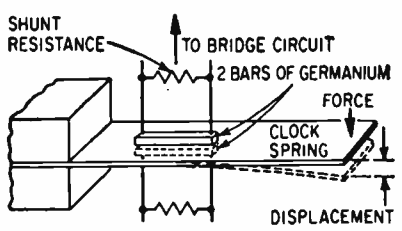


FIG. 1—Semiconductor strain gage for measuring displacement

With semiconductor gages, stress forces can be large since semiconductors are strong materials. They respond to torsional and shearing forces which wire-type gages do not.

Figures 1 and 2 show two versions of the semiconductor gages. Figure 1 is a drawing of a displacement gage while Fig. 2 shows the configuration of a torsional gage.

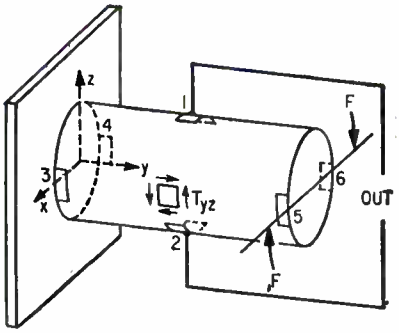


FIG. 2—Torsionol tronsducer incorporoting semiconductor cylinder

The torsional unit consists of a cylindrical crystal of germanium cemented to a solid support at one end. Electrodes one to six are attached as shown. With the proper biasing voltage, current flows from electrode three to five and from six to four. Electrodes one and two are normally neutral. But when a torque is applied to the free end of the cylinder, a voltage is generated across them. The voltage is directly proportional to torque and no balancing bridge is required.

Stripline Resistors Have Mica Base

AVAILABLE as matched loads, fixed pads, variable attenuator elements, and terminations, Stripline resistors developed by Filmohm Corp. exactly match the shape and configuration of the Stripline circuit.

A thin film of specially selected natural mica is used for the base. The resistance film is an alloy of pure metals about 50 millionths of an inch thick and sealed with a thin coating of quartz. The mica base is made as thick as the height of the copper conductor (2-mil mica for 1.8-mil copper and 3-mil mica for 2.8-mil copper). Width is equal to width of the copper and length is determined by electrical match, power and resistance.

To install the resistor, a section of Stripline is etched out. The resistor is placed on the plastic dielectric between the copper conductors. Electrical contact is achieved by using conductive silver epoxy cement to join the silver tab on the resistor to the copper strip. The final step is to adhesive varnish the resistor and contact areas.

Kitting Smooths Production Flow

Subassembly kit is prepared at kitting table

Assembling a kit. Completed subassemblies, placed back in their plastic bags, are in box at assembler's right

TIGHTER CONTROL and coordination among purchasing requirements, inventory, production schedules and quality control has been gained by Magnetic Amplifiers, Inc., New York, N. Y., with an uncomplicated procedure which the firm calls kitting.

Component parts for each subassembly and major assembly are gathered together before the assembly reaches the production floor. Parts for small assemblies are placed in clear plastic bags. Parts and subassemblies for major assemblies are boxed. The parts are delivered to production personnel in numbered and sealed kits.

Cost of the procedure, the firm reports, is at most slight. In many cases, it leads to substantial savings by smoothing work flow. It has worked as well for large and small lot production.

Kit is placed in bag with quality control routing ticket

Since all parts shortages are discovered prior to assembly, downtime while assemblers hunt for parts or go to the stockroom is negligible. Production personnel get all materials for each unit at one time and can make no mistakes in parts selection. Records are kept on a unit basis, giving preproduction quality control history of each assembly and its parts.

Shortages Noted

Two cards are placed in each kit. One is an identification and quality control routing ticket. The other is a shortage card, listing any parts missing from the kit. These eliminate any confusion on the production line.

Production control personnel determine whether incomplete kits are to be released for assembly. Normally, kits are not released unless the parts can be readily added late in assembly. The cards give added flexibility to production scheduling.

If parts of the assemblies are to be changed after the kits are released, this can be done all at once on kits still unassembled.

First step in kitting is to obtain, inspect and accumulate parts for a production run. When a reasonable inventory of open stock and specially-ordered parts is on hand, the kits are made up. Materials in the stockroom are preassigned to particular jobs, but are stored by type as well as job for inventory control purposes.

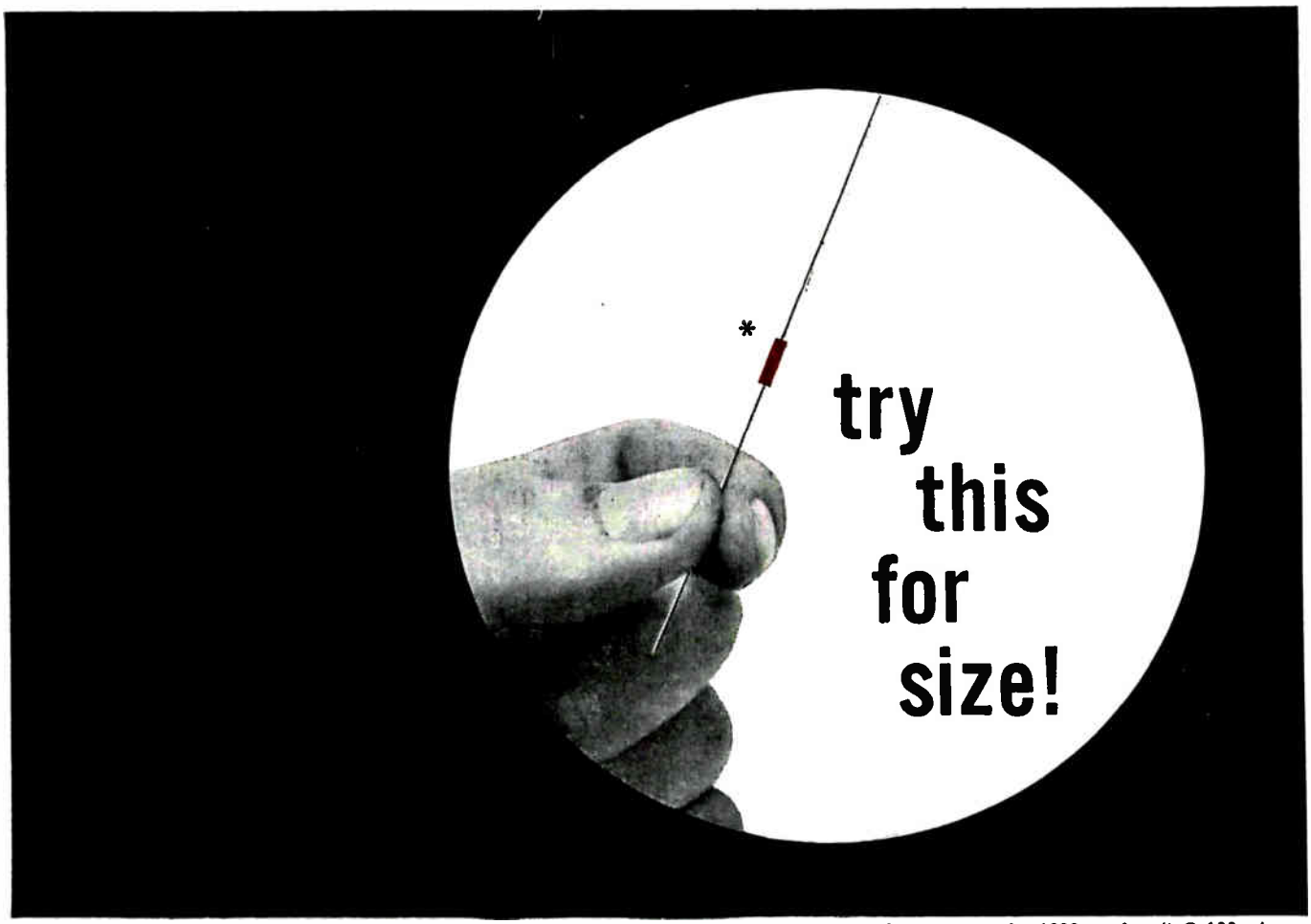
Kitting areas and tables are set up adjacent to prekitting storage areas. Kitters are guided by parts lists. The shortage cards are filled out and are also used to make up shortage lists which are referred to purchasing for a followup.

Subassemblies are kitted first because often sufficient subassembly parts are on hand before final assembly materials are received. After assembly and testing, these are routed back into final assembly kits.

Assembly Guides

Assemblers are instructed in proper assembly techniques when they receive the kits. In addition, models, assembly drawings, color photos or black and white photos are provided as guides. The models have been previously tested and approved.

Photos are used when models are



* Actual size of a 1000 mmf. unit @ 100 vdc.

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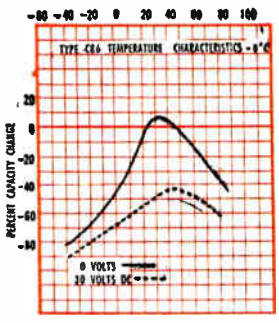

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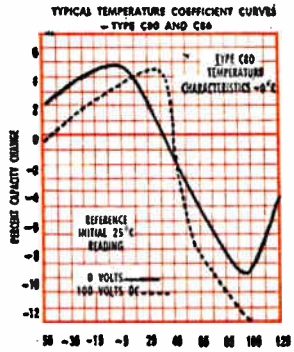

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AEROVOX CORPORATION

OLEAN, NEW YORK

CIRCLE 34 READERS SERVICE CARD

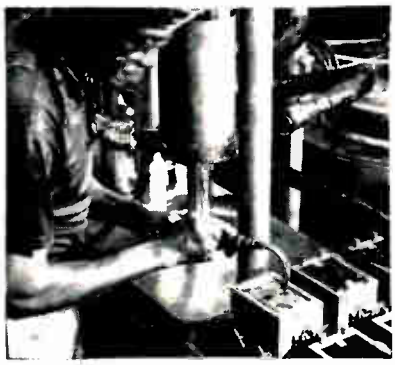
Subassemblies placed in box form major assembly kit

not available or when the lot is too small to warrant preparation of a model. The firm has a photo file covering every type of unit previously made by the firm.

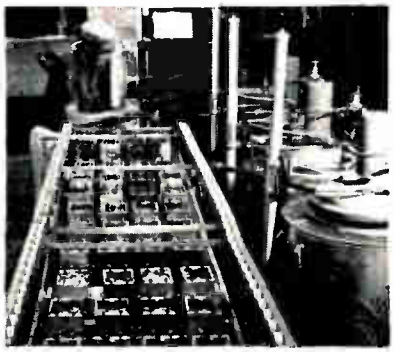
Skates Roll Potted Parts to Cure Oven

SKATE CONVEYORS are used to deliver a steady supply of encapsulated assemblies to the curing oven at Reliance Electric and Engineering Co., Cleveland, Ohio.

Subassemblies are interconnected in a bird cage frame. After test, the assemblies are locked in a



Encapsulant is pumped into mold through hose



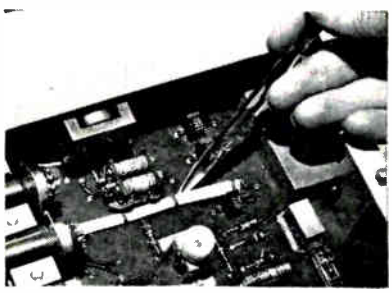
Tanks in background agitate compound

2-part aluminum mold. The molds go, 4 at a time, into a frame which rides on the wheels of a double-decked skate conveyor.

The conveyor holds 100 units. Thermosetting compound is poured into the molds at one end of the conveyor and the units are cured in an oven at the other end. The technique is used in the production of up to 2,000 motor control building blocks monthly.

Wrap-Around Rubber "Tails" Hold Wiring

WIRING BUNDLES in the Bomarc missile, made by Boeing Airplane Co., Seattle, Wash., are secured with rubber "mouse tails", tapered at one end and with a button on the other end. The tapered end of the tail is passed through a small hole in the chassis, looped around the bundle and reinserted in an adjacent hole. The button acts as a

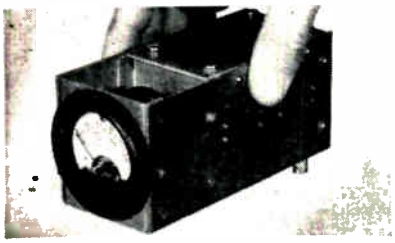


Painter shaws "mouse tail' snugging wiring ta chassis

Cutaway view of bundle secured by "mouse tail"

stop so the tough rubber can be cinched up tight. Elasticity permits the tapered end to be pulled through the hole. The rubber expands when tension is released, so the rubber becomes its own stopper. Boeing reports the tails are quicker to install and hold the bundles more securely than waxed string formerly used.

ON THE MARKET

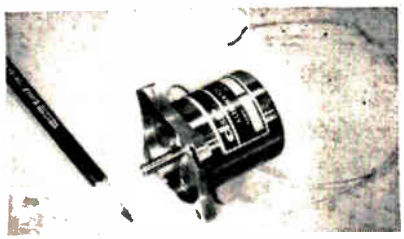


VTVM
small size

METRONIX, INC., Chesterland, Ohio. Designed to meet MIL-T-945A, model SPD-25 electronic voltmeter is especially suitable for use in aircraft, missiles and ground support equipment. It occupies panel space of only 2¾ by 2½ in. and is less than 6 in. deep. Unit is available in any range from 0 30 mv to 0/300 v. Frequency response is 40 cps to 50 kc. Input impedance is 1 megohm, 15 $\mu\mu$f. **Circle 200 on Reader Service Card.**

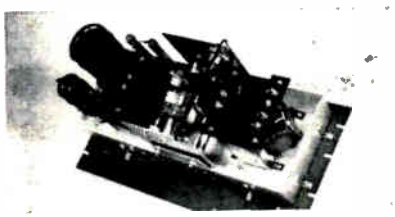
H-F Generators
light weight

D&R LTD., 402 E. Gutierrez, Santa Barbara, Calif., has developed a small light weight generator suitable for a missile power supply. Capable of being driven by a hot gas turbine or other suitable means, the model D-1309 develops 100 w of power at 6,000 cps with shaft speeds up to 60,000 rpm. Featured in the design are low internal impedance, low starting torque, low inertia, reliability. **Circle 201 on Reader Service Card.**

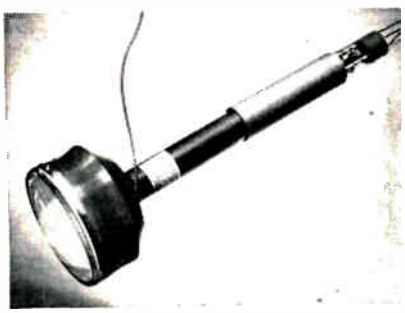


D-C Power Supply
silicon rectifier

GATES ELECTRONIC CO., 2090 Barnes Ave., Bronx 62, N. Y., announces a new line of silicon power rectifiers. Operating entirely without electronic tubes, the units consist of a double wound varnish impregnated step-down transformer,



full wave silicon rectifier, a varnish impregnated reactor and filtering network. A unique protection circuit on models 15GX and 20GX indicates when continuous ratings are exceeded by flashing overload warning light on front panel. The units are designed for rack mount, but may also be used for bench testing at slightly additional cost. **Circle 202 on Reader Service Card.**



Cathode-Ray Tube
for airborne uses

FERRANTI, LTD., Hollinwood, Manchester, Lancs., England. A new micro-spot crt is capable of resolving 5,000 lines. Measuring 5 in. across, the 5′71 CM tube has been developed for airborne applications. The spot size is less than 0.001 in. in diameter. The high resolution has been made possible by the use of an exceedingly fine screen and an entirely novel design of electron gun using two focusing elements, one of which is electromagnetic and external to the tube, while the other is electrostatic and of fixed focal length. **Circle 203 on Reader Service Card.**

Converter
analog/digital

RADIATION, INC., P. O. Box 37, Melbourne, Fla. The 12-bit Radicon converts analog information to digital (and digital to analog) for

use in modular data systems. It provides visual display and six selectable output codes compatible with most commercial digital computers. It features asynchronous operation at up to 24 kc word rate, accuracy to ±0.025 percent full-

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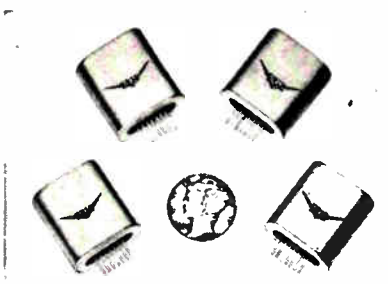
scale, and miniaturized solid-state construction. With companion modular blocks, it performs many on-line computation functions. **Circle 204 on Reader Service Card.**

Microwave Equipment for 6 kmc band

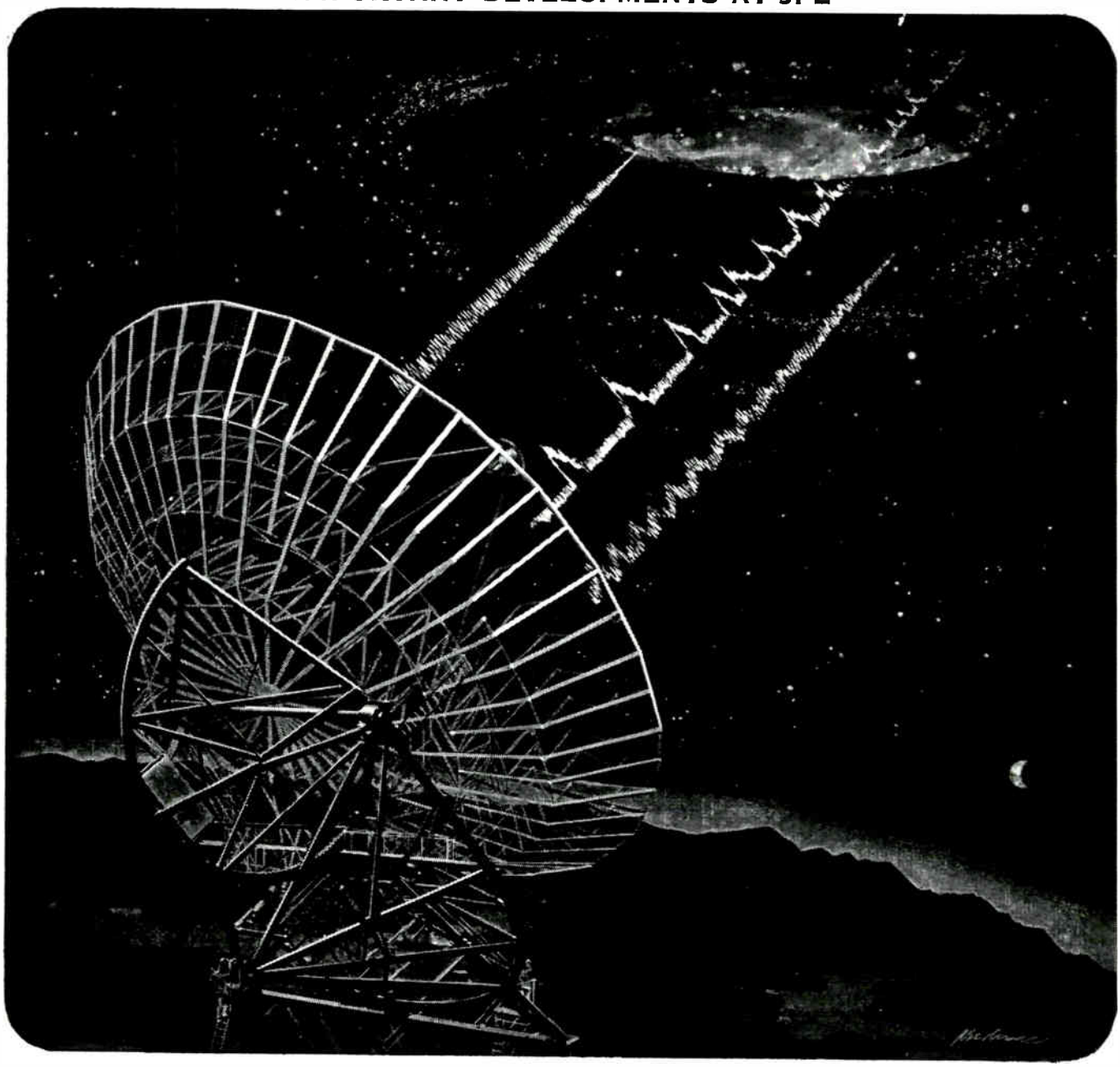
GENERAL ELECTRIC CO., Syracuse, N. Y., has introduced a new series of microwave equipment designed to operate in the 6 kmc band. This addition to the existing 2 kmc line places GE in a position to offer the communication industry a microwave line operating in both frequency bands. The 6 kmc line offers 120 channels to microwave users. The company will now offer both time division and frequency division multiplexing with its 6 kmc products and will continue to supply time division with its 2 kmc equipment. **Circle 205 on Reader Service Card.**



Logic Circuits transistorized

ERIE RESISTOR CORP., Erie, Pa., announces the first of a line of high speed transistorized plug-in modules for digital equipment and system construction based primarily upon the NOR logic. These units are designed to work at speeds in excess of 2 mc under typical loading conditions. The module is designed to fit a standard 7 pin inline subminiature tube socket. Up to 144 units may be mounted on a standard 3½-in. by

IMPORTANT DEVELOPMENTS AT JPL



SIGNALS FROM VEHICLES IN SPACE

The exploration of outer space has taken a new step forward with the completion of the new giant radio antenna which has recently been installed by JPL at Goldstone near Barstow, California. This huge "dish," 85 ft. in diameter, enables the Laboratory scientists to probe still farther into space problems.

The Goldstone antenna is presently tracking rocket probes far out in space. Information thus obtained from Explorer satellites and Pioneer space probes is being reduced and studied to provide invaluable basic data for future space programs.

The Goldstone link from space to earth will be extended from the present range of 500,000 miles to many times that figure, bringing the planets Mars and Venus within its reach.

This activity is part of the research and development program operated by JPL for the National Aeronautics and Space Administration.

jpl

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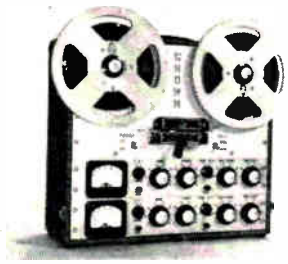
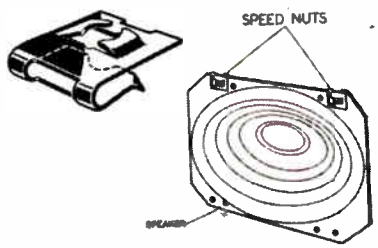
19-in. rack panel. Each module measures 0.750 in. high, 0.687 in. wide and 0.297 in. thick. Alternative packaging for other uses is available. The standard unit contains 4 inputs. **Circle 206 on Reader Service Card.**



Stereo Recorder professional type

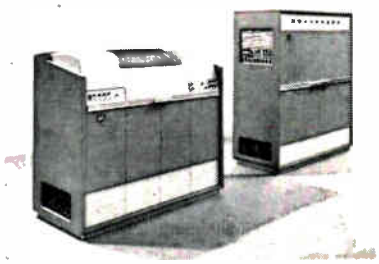
INTERNATIONAL RADIO & ELECTRONICS CORP., Elkhart, Ind., is now marketing a stereo tape recorder for satellite tracking. The machine has 14 in. reels. Speeds include 1⅞, 3¾, 7½ and 15 ips. Signal to noise ratio is claimed to be outstanding. Price is $805. **Circle 207 on Reader Service Card.**



Fasteners dual-purpose

TINNERMAN PRODUCTS, INC., Cleveland, Ohio. Four spring steel J-type Speed Nuts provide both the fasteners and the grounding of the loudspeaker to the chassis in portable tv sets. One of the new dual-purpose fasteners is quickly and easily snapped on each corner of the speaker flange. Once positioned, the fastener retains itself firmly in screw-receiving position providing an "extra hand" for the final assembly of the speaker to the chassis. The speaker is then positioned and the screws driven, completing the assembly in a matter of seconds. One corner of the lower leg of the new fastener is

turned down. This not only facilitates mounting, but as the screws are tightened these corners bite hard into the chassis to provide four positive grounding points. **Circle 208 on Reader Service Card.**



Line Printer transistorized

BURROUGHS CORP., 460 Sierra Madre Villa, Pasadena, Calif., has developed a transistorized line printer which will select, edit and print out data from a computer or magnetic tape at rates up to 1,500 lines per minute. The high-speed printer is integrated with the new Burroughs 220 electronic data processing system. It features on-line or off-line operation, buffer data storage and automatic editing —all under plugboard control. Used on-line, the printer system takes advantage of the computer's electronic speed to produce up-to-the-second reports directly from the data processor. Off-line, it edits and transcribes data from Burroughs 220 magnetic tape storage units, freeing the computer for other processing jobs. **Circle 209 on Reader Service Card.**

Servo Multiplier miniaturized

INDUSTRIAL CONTROL CO., 805 Albin Ave., Lindenhurst, L. I., N. Y. The SL-1024 is a high performance, miniaturized servo multiplier driven by d-c data. It consists of a servo loop that positions a shaft to follow a ± d-c signal, and a multisection pot for computation. Unit uses a high reliability transistor-magnetic amplifier, with all circuits sealed for maximum life. The only power required is 117 v

(Continued on p 84)

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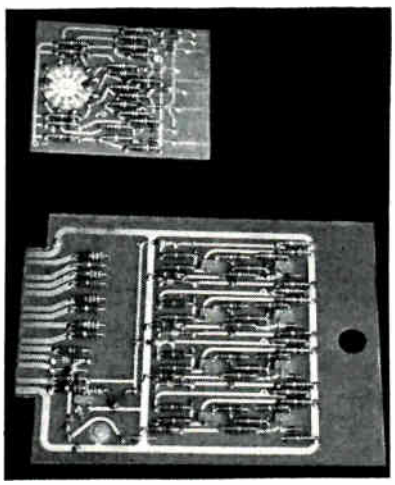
400 cps. Typical input signals are within ± 100 v d-c, with static error under 0.25 percent and full scale travel within 0.5 sec. Output position is indicated on a calibrated dial. **Circle 210 on Reader Service Card.**

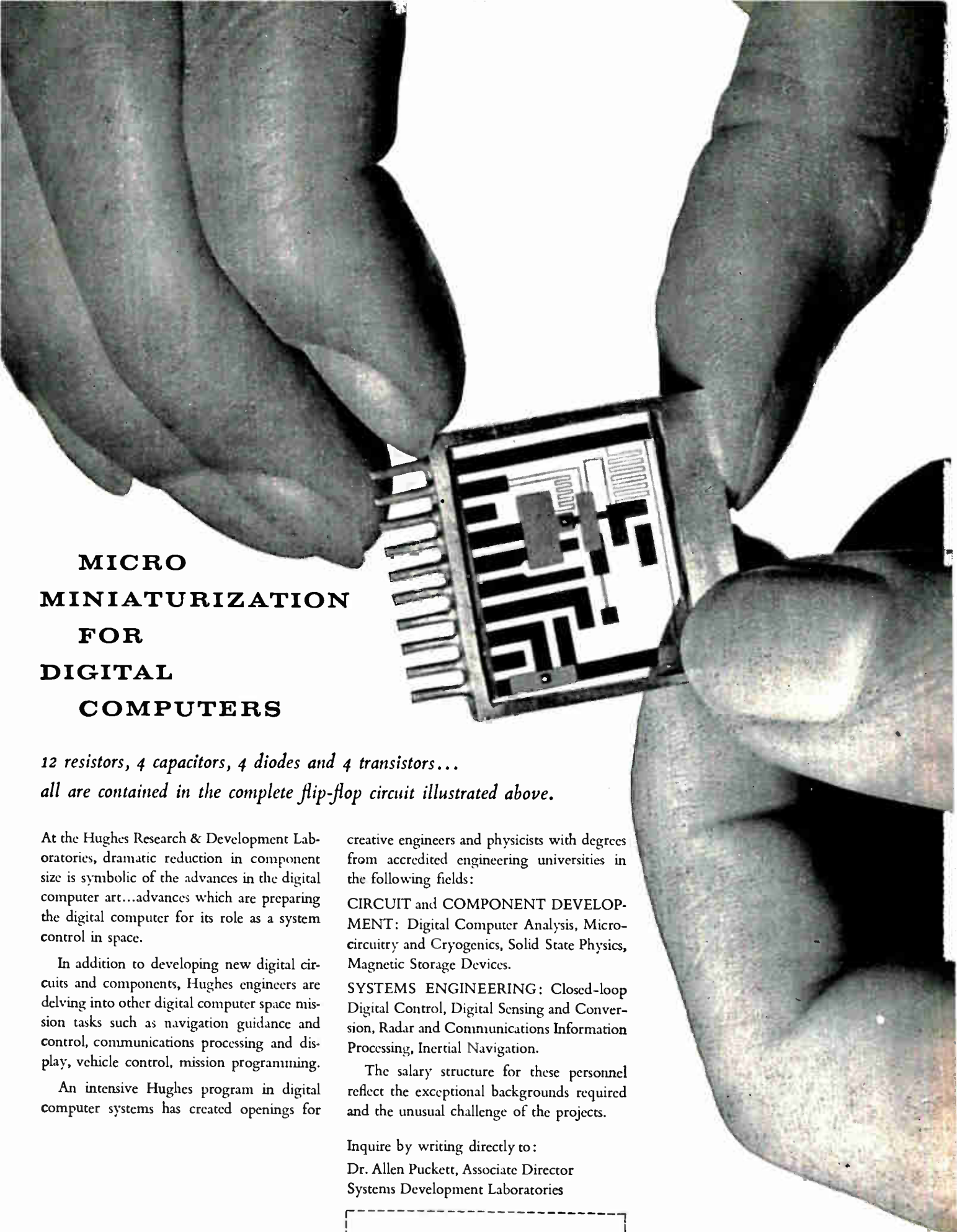


Decimal Selector for counter use

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa., announces a new decimal to four line binary code converting switch, model 319C, which can be used to preset the "complement nine" binary code directly into their model 190A or 312 transistorized binary decimal counters. The selected decimal number is converted into four line binary code and is controlled by four diode "gates" at the output points. With "complement nine" presetting, the carry pulse from the last decade can be used as a "stop" pulse in a counting operation and no resetting is needed. **Circle 211 on Reader Service Card.**

TWT Amplifier for modern radar

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif. The VA-125 is a one megawatt, 2.7-3.0 kmc, twt amplifier for modern radar. It gives systems engineers greater freedom in radar design. A broadband, high gain, liquid cooled twt pulse amplifier, it is intended to cover a large portion of the S-band without tuning and is for use in coherent high power radar appli-



MICRO MINIATURIZATION FOR DIGITAL COMPUTERS

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

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

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

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

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

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

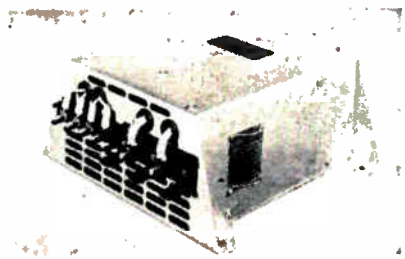
The salary structure for these personnel reflect the exceptional backgrounds required and the unusual challenge of the projects.

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

HUGHES

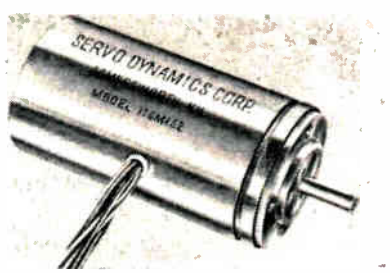
Hughes Aircraft Co.,
Culver City 15, California

cations. The x-ray shielding is provided as an integral part of the VA-125 and its accompanying VA-1503B focusing electromagnet. Useful bandwidth is 375 mc and power gain, 28 db. Pulse beam voltage is 110 kv and pulse beam current, 60 amperes. **Circle 212 on Reader Service Card.**



Converter transistorized

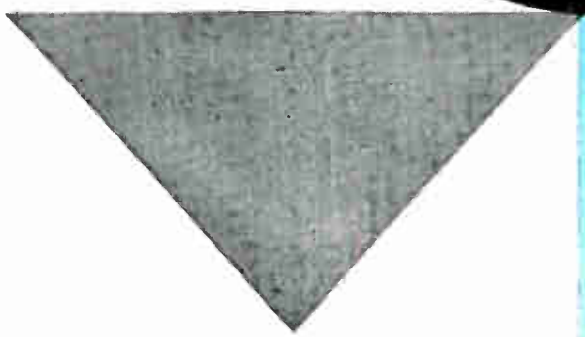
ELECTROSOLIDS CORP., 13745 Saticoy St., Panorama City, Calif., announces a new transistorized converter. The transformer-rectifier unit is constructed of PN-junction type diodes to effect a weight saving that results in a 200-ampere unit weighing only 17 lb. The 28-v unit accepts three phase input power at 400 cps, 115/200 v. Model W-1328 converter uses solid state components throughout, with operating life expectancy in excess of 50,000 hr. **Circle 213 on Reader Service Card.**



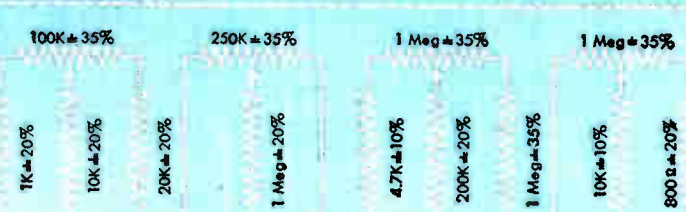
Motor Generator size 11

SERVO DYNAMICS CORP., Somersworth, N. H. Manufactured in 400 cycles, the model 11GM152 motor generator is designed to operate between 6 and 200 v. The no load speed is 6,000 rpm with a power input of 3.5 w at 0.053 ampere. Effective resistance is 3,780 ohms. Output shafts are designed to customer requirements. Linearity is

Cost Savings Higher Reliability your job... and Centralab's



TYPICAL MODEL 5



Model 5 Radiohm®

1/4 watt multiple miniature variable resistor

(Component Density = 16.2 per cu. in.)*

up to 4 *variable* and 9 *fixed* resistors on a single steatite plate measuring 2¼" x ¾" x 15/32", including knobs . . . proportionally smaller when fewer variable resistors are required.

ECONOMY: Installed cost is considerably lower than larger variable resistors and separate fixed resistors. Substantial savings result from reduced production assembly costs.

RELIABILITY: Steatite bonded resistance elements assure high stability and noise-free operation. Conservative ratings provide an extra margin of safety under maximum load or severe environmental conditions.

VERSATILITY: The Model 5 Radiohm® is available with one to four variable resistors, with horizontal or vertical mounting brackets, plug-in terminals for printed circuit boards or wire leads for metal chassis.

SUPERIOR KNOB CONSTRUCTION: Unusual design permits adjustment with internal or external hexagon wrench, screwdriver, or by fingertip.

SPECIFICATIONS:

Resistance Range: 1000 ohms to 5 megohms, linear taper.
Wattage Rating: ¼ watt at 70° C. ambient.
Breakdown Voltage: 1250 Volts RMS, between adjacent sections and to bracket.
End Resistance: Less than 1% of total.
Rotational Life: Less than 5% resistance change after 250 rotations.
Initial Torque: 2 inch ounces average.

Write for Centralab Bulletin EP-539 giving full specifications on the Model 5 Radiohm® series.

***Cubic inch, rather than cubic foot, is used to provide a more realistic and more readily visualized standard of comparison.**

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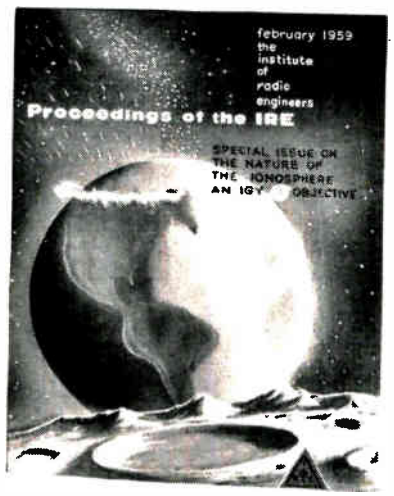
0.5 percent. Ambient operating range is −65 C to +200 C. Body length is 1.875 in. **Circle 214 on Reader Service Card.**

VOM Analyzer highly sensitive

WESTON INSTRUMENTS, Division of Daystrom, Inc., Newark 12, N. J. Model 980 Mark II analyzer, a highly sensitive and extremely sturdy volt-ohm-milliammeter, was engineered to provide for a wide range of test measurement applications in the electrical and electronic fields. It has a d-c sensitivity of 20,000 ohms v, and an a-c sensitivity of 1,000 ohms/v. It offers accuracy within 2 percent full scale d-c and 3 percent a-c. Range and function-switching is greatly simplified by use of a single dial control. The Cormag mechanism protects the instrument against magnetic disturbances, and electrostatic shielding assures accurate measurements at high d-c voltage. **Circle 215 on Reader Service Card.**

Analog Computer all solid-state

SOUTHWESTERN INDUSTRIAL ELECTRONICS Co., 2831 Post Oak Road, Houston 19, Texas. The CM-2 analog computer is an all solid-state unit which can reliably perform all-purpose mathematical computations. It consists of operational amplifiers, logarithmic networks and scaling potentiometers. Use of transistors and magnetic amplifiers in place of vacuum



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"The Earth and its Environment" by S. Chapman, U of Colorado

"The Constitution and Composition of the Upper Atmosphere" by M. Nicolet, Radio and Meteorology Institute, Belgium

"The Normal F-Region of the Ionosphere" by D. F. Martyn, Radio Research Labs. CSIRO, Australia

"The Normal E-Region of the Ionosphere" by E. V. Appleton, U of Edinburgh, Scotland

"The D-Region of the Undisturbed Ionosphere" by J. J. Gibbons & A. H. Waynick, Penn State U

"The Distribution of Electrons in the Ionosphere" by J. O. Thomas, U of Cambridge, England

"Motions in the Ionosphere" by C. O. Hines, Defense Research Board, Canada

"Meteors in the Ionosphere" by L. A. Manning & V. R. Eshleman, Stanford U

"Atmospheric Whistlers" by R. A. Helliwell, Stanford U & M. G. Morgan, Dartmouth U

"Radiation and Particle Precipitation upon the Earth from Solar Flares" by L. G. B. Biermann & R. Lust, Max Planck Institute for Physics and Astrophysics, Germany

"The Very-Low-Frequency Emmissions Generated In The Earth's Atmosphere" by R. M. Gallet, National Bureau of Standards

"The F-Region During Magnetic Storms" by K. Maeda, Kyoto U & T. Sato, Shiga U, Japan

"Aurora Phenomena" by E. N. Parker, U of Chicago

"Rocket Observations of the Ionosphere" by H. Friedman, U. S. Naval Research Lab.

"Earth Satellite Observations of the Ionosphere" by W. W. Berning, Aberdeen Proving Grounds

"Exploration of the Upper Atmosphere with the help of the 3rd Soviet Sputnik" by V. I. Krassovsky, Institute for Atmospheric Physics, Moscow

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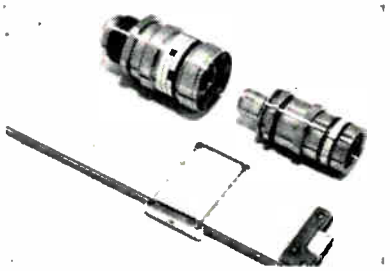
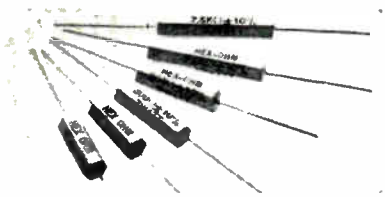
tubes provides the reliability and ruggedness needed for industrial applications. An integral programming board inside the cabinet facilitates programming of functions. **Circle 216 on Reader Service Card.**



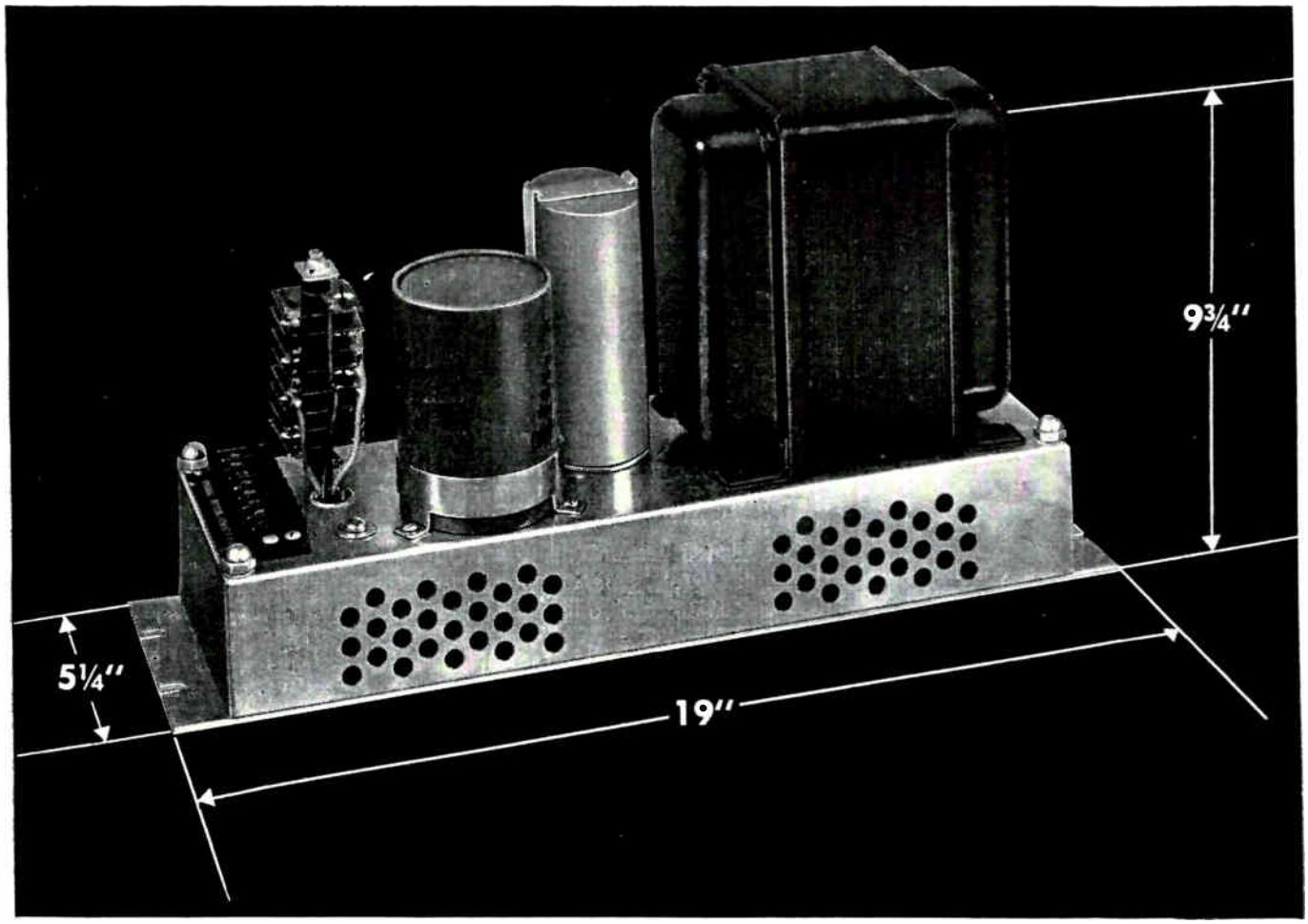
Quick Connector
light in weight

E. B. WIGGINS OIL TOOL CO., INC., 3424 E. Olympic Blvd., Los Angeles 23, Calif., has developed a new Inst-O-Matic connector compatible with existing exotic and cryogenic fluids in the missile and rocket field. It has an expanded temperature range of −320 to ±650 F due to the development of a new sealing design. **Circle 217 on Reader Service Card.**



Wire Wound Resistors
hexagonal case

BRADFORD COMPONENTS, INC., 65 South Ave., Salamanca, N. Y. A new ceramic wire wound resistor series, Hex-Ohms, are precision resistors with efficiencies equal to many of the high priced units. The resistance wire is uniformly wound on a fiber glass core and sealed into the hexagonal ceramic case with a special moisture resistant silicone cement. The ceramic case is an excellent insulator capable of withstanding 1,250 v break-down tests. The new hexagonal design provides very good heat dissipation so that the



Sola Constant Voltage DC Power Supplies are designed for intermittent, variable, pulse or high-amperage loads.

Sola packs 6 amps of 300-watt regulated dc power into 5¼ inches of relay-rack space

Looking for a source of regulated dc power that fits into a small space? You'll probably find that the Sola Constant Voltage DC Power Supply offers what you want.

This compact unit has exceptional performance characteristics, too — it delivers current in the "ampere range," regulates within ±1% even under a ±10% variation in line voltage, has less than 1% rms ripple, and even tolerates dead shorts. It is 80% efficient and has a very low static output impedance.

How's it done? Sola managed it through a balanced assembly of three complementary components . . . a special Sola Constant Voltage Transformer is teamed up with a semiconductor rectifier and a high-capacitance filter. Electrical characteristics of the transformer maximize most of the advantages of the rectifier and filter, while virtually eliminating all their disadvantages. The resulting regulated dc power supply is simple, highly reliable, compact and moderately priced.

These benefits are exhibited by the entire line of Sola dc power supplies. Sola has designed and produced hundreds of ratings to meet requirements of equipment manufacturers. The company is set up to handle specific needs for custom-designed units in production quantities. A Sola sales engineer can supply all the facts. In addition to this custom service, Sola currently stocks six models ranging from 24 volts at six amps to 250 volts at one amp.

For complete data write for Bulletin 7B-CV-235

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

SOLA

CONSTANT VOLTAGE TRANSFORMERS

REGULATED DC POWER SUPPLIES

MERCURY LAMP TRANSFORMERS

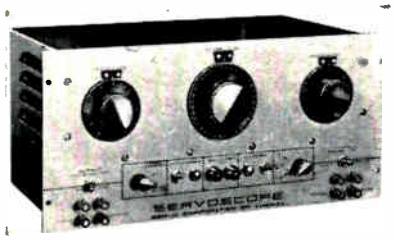
FLUORESCENT LAMP BALLASTS

A DIVISION OF BASIC PRODUCTS CORPORATION

units operate at lower temperatures than other type resistors. They are made in 4, 5, 7, 10 and 12 w sizes within 10 percent tolerance. **Circle 218 on Reader Service Card.**

Electronic Counters
solid-state units

THE REDFORD CORP., Lake Luzerne, N. Y., has available electronic counters for both laboratory and production control service. Taking advantage of the newest developments in semiconductor circuitry, the line assures highly reliable operation. Other features are compact size, low current usage, easy installation and silent performance. Counting rate is 500 pps or less. **Circle 219 on Reader Service Card.**



Servo System Analyzer
for rack or bench

SERVO CORP. OF AMERICA, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. Measuring phase, transient response and gain, the new model H Servoscope facilitates fast, accurate plotting of Nyquist, Bode or Nichols diagrams. It covers frequency ranges 0.1 to 2.0 cps and 1.0 to 20 cps, and provides phase measurements to ±1 deg accuracy. Direct reading of both amplitude and frequency plus direct readout of phase log simplify operation. Frequency accuracy is ±5 percent of setting, rather than

of full scale. Model H generates sine wave and modulated carrier waveforms. Weight is 30 lb. Price is $1,785. **Circle 220 on Reader Service Card.**

Composite Metal fully preplated

AMERICAN SILVER CO., 36-07 Prince St., Flushing 54, N. Y., has available a new composite metal possessing all the superior qualities of conventional clad metal strip, yet priced substantially lower than clad metals. Thermo-Lay strip is a hard, dense layer of metal electrolytically deposited, then heat-treated to achieve a metallurgical bond to a base metal strip, and finally rolled to finished thickness and temper. It is of especial use to the electronics-electrical industry for such applications as contact wiping arms, switches, contact points and springs, flexible wave guides, terminals, and tuners. **Circle 221 on Reader Service Card.**

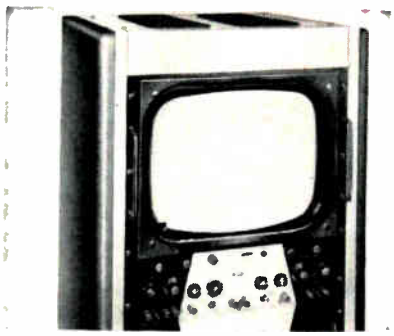
Pulse Transformers encapsulated

TECHNITROL ENGINEERING CO., 1952 E. Allegheny Ave., Philadelphia 34, Pa., announces a new series of miniature encapsulated pulse transformers wound on high permeability ferromagnetic cores. The T series have a range of pulse widths from 0.1 to 25 μsec for vacuum tube or transistor blocking oscillator and interstage coupling applications. **Circle 222 on Reader Service Card.**

Servo Amplifier fully potted

BULOVA WATCH CO., Woodside 77, N. Y. For continuous operation in a temperature range of −55 C to +125 C, the AMP-298 servo amplifier utilizes all silicon resistors. Fully potted, the new amplifier of-

fers: (1) maximum power output of 12 w, (2) 40 v rms into a 160 ohm center-tapped load, (3) voltage gain of 1,000 at a constant input impedance of 50,000 ohms, and this gain can be easily adjusted by an external resistor. Unit requires only 28 v d-c power, operates from a carrier of 400 cps ±20 cps and meets MIL-E-5400 and MIL-E-5272A. **Circle 223 on Reader Service Card.**



Oscilloscope large screen

EASTERN PRECISION RESISTOR CORP., 675 Barbey St., Brooklyn 7, N. Y. Designed for use with telemetering and data processing equipment, this large screen oscilloscope features a 17-in. crt. Component parts can be removed and mounted in any standard 19-in. rack. Both the X and Y axis have 1 percent linearity. Other features include: magnetic deflection, constant deflection sensitivity, hand calibrated controls, small spot size and high resolution. Amplifier response is rated at 10 mv sensitivity up to 500 kc, with accurately calibrated time base system for both driven and recurrent operations. **Circle 224 on Reader Service Card.**

Toroidal Inductors hermetically sealed

ARNOLD MAGNETICS CORP., 4613 W. Jefferson Blvd., Los Angeles 16, Calif., announces the series 782 miniature toroidal inductors. Units have an inductance value from 0.1 millihenry to 500 millihenries, with a useful frequency range of from 10 kc to 100 kc. **Circle 225 on Reader Service Card.**

Delay Timer
plug-in type

G. C. WILSON & Co., Huntington, W. Va., announces an electronic delay timer completely self-contained in a steel can with octal radio type plug for mounting and wiring connections. The timer employs a unique circuit to control the breakdown of gas tubes and to provide timing delays from 0.003 to 300 sec unaffected by variations in line voltage. It requires no warmup and consumes less than 2 w. Unit can be provided with either a spdt relay or 3 pdt relay, or can be furnished to operate a relay external to the timer. **Circle 226 on Reader Service Card.**

A-C VTVM
10 cps to 4 mc

REPUBLIC ELECTRONIC INDUSTRIES CORP., 111 Gazza Blvd., Farmingdale, L. I., N. Y. Model VA-104 a-c vtvm incorporates such features as long life electrolytic capacitors as well as output jacks permitting the use of the instrument as a high gain, 4 mc wide-band amplifier with a maximum gain of 50 db. Voltage range is 0.001 v to 300 v in 12 ranges. Overall accuracy is ±2 percent. **Circle 227 on Reader Service Card.**

Literature of

MATERIALS

Paper-Base Laminate. Synthane Corp., Oaks, Pa., has prepared a new engineering bulletin on grade EP-22, a paper-base, epoxy resin laminate and one of its latest products especially designed for printed circuit and other electronic applications. **Circle 230 on Reader Service Card.**

COMPONENTS

Deposited Carbon Resistors. The Kidder Co., 24 So. Springfield Road, Clifton Heights, Pa. Bulletin 100 describes computer-type ½ w deposited carbon resistors which are designed to combine accuracy, long stability and economy for close tolerance application. **Circle 231 on Reader Service Card.**

Magnetic Circuits. The Indiana Steel Products Co., Valparaiso, Ind. A recent issue of *Applied Magnetics* presents a detailed discussion of permanent magnetic circuits. **Circle 232 on Reader Service Card.**

Transistor Types. Philco Corp., Lansdale Tube Co. Division, Lansdale, Pa., has published a brochure giving a brief description of the company's transistor types designed for reliable performance, stability of operation and long life. **Circle 233 on Reader Service Card.**

Delay Lines. Control Electronics Co., Inc., Huntington Station, N. Y., is now offering a handy form for the specification of lumped and distributed constant delay lines. **Circle 234 on Reader Service Card.**

EQUIPMENT

Bobbin Winder. Boesch Mfg. Co., Inc., 45 River St., Danbury, Conn. Bulletin BW2 covers the design, operation, standard and optional equipment and outstanding features of a fast, versatile and completely automatic winder for bobbins, solenoids, resistors, re-

the Week

lays and similar coils. **Circle 235 on Reader Service Card.**

Radar Data Processing. Burroughs Corp., 6071 Second Ave., Detroit 32, Mich. A recent brochure contains descriptions of the function, capabilities, performance and future possibilities of the AN/FST-2 SAGE coordinate data processing system. **Circle 236 on Reader Service Card.**

Fans and Blowers. McLean Engineering Laboratories, Box 228, Princeton, N. J. A new 36-page catalog features packaged fans, blowers, and accessory equipment used in conjunction with the cooling of electronic or electrical apparatus. **Circle 237 on Reader Service Card.**

Power Supplies. Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y. A 34-page catalog covers a line of power supplies for laboratory and industry. Units described are guaranteed by the company for five full years. **Circle 238 on Reader Service Card.**

FACILITIES

Testing Facilities. United States Testing Co., Inc., 1415 Park Ave., Hoboken, N. J. Included in bulletin 5801 is a detailed description of the company's engineering facilities and services, which cover a broad range of subjects, from environmental studies to electronics, instrument calibration, and reliability testing and failure analysis. **Circle 239 on Reader Service Card.**

Cryogenics. Stearns-Roger Mfg. Co., 660 Bannock St., Denver 17, Colo. A 12-page brochure covers in text and pictures the extensive activities and services of the company in the specialized fields of ground support facilities for missiles, cryogenic engineering and handling equipment, and nuclear engineering and manufacturing. **Circle 240 on Reader Service Card.**

Directors Head Departments

AN UNUSUAL management feature is paying off for Calvideo, independent West Coast tv picture tube producer. It's this: Each member of the closed corporation's board is also a department head.

With annual sales approaching $5 million, Calvideo recently moved into a new 40,000 sq ft building in Compton, Calif. Firm's optimistic business outlook as a producer of tubes for monitoring, radar, camera pickup, etc., is evident in plans for a 20,000 sq ft wing to the building on the 2.5 acre lot. Construction of the new addition will probably occur in 1960.

President Steve Tidick, 37, (at left in picture) started business in '51 with 15 employees making 35 cathode ray tubes daily. Now his hand-picked youthful management staff (average age 36), all of whom got their early training with major tube companies, supervise 200 workers. By end of 1959's first quarter, production will be 1,000 crt's daily, not counting special-purpose tubes.

Sales manager Gil Sherman (shown at right) reports Calvideo has its own truck fleet (prominently displaying the company's emblem) for distribution of its goods. Calvideo serves 16 states. Though sales are now mostly in the West and for export, the company is prepared to branch out nationally.

Sixty-five carts on a 136-ft track, controlled by a timer, convey tubes to and through the baking oven, greatly cutting down on manual labor. The oven operates on a treadmill and permits automatic cycling of tubes. Tubes are fired face down, neck up, allowing freer escape of gases to make a clear tube. Plant also has an overhead conveyor belt, saving both time and space.

Calvideo Electronics Corp. of Hawthorne, Calif., founded in 1958, will continue functioning as a separate entity. This plant makes components and test equipment for guidance and detection systems for the radar industry.

Dolberg Advances at Philco Corp.

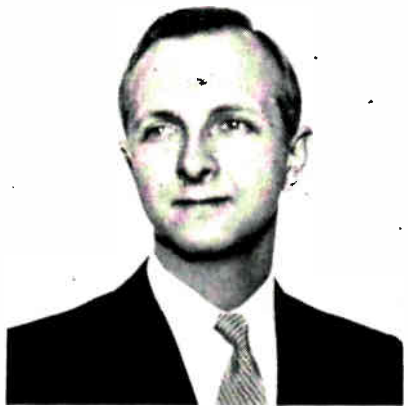
CHARLES E. DOLBERG has been named manager-systems management planning for Philco Corporation's Government and Industrial Division. He will report directly to S. C. Spielman, director of engineering, and continue in his present capacity as manager of air traffic control engineering.

Since joining Philco in 1942, Dolberg has been engaged in research, development and management of such projects as microwave communications, airborne and ground radar systems, video data processing, military television, underwater devices and missile fusing. He also holds eight patents dealing with radar equipment.

Ampex Promotes William T. Frost

WILLIAM T. FROST, engineer with the video development unit of Ampex Corporation's Instrumentation Engineering Department, has been promoted to staff engineer.

Frost joined Ampex in July, 1958, after 10 years with the British Broadcasting Corp. in London. While there his research work contributed significantly to the science of magnetic recording, particularly with respect to high frequency signals.

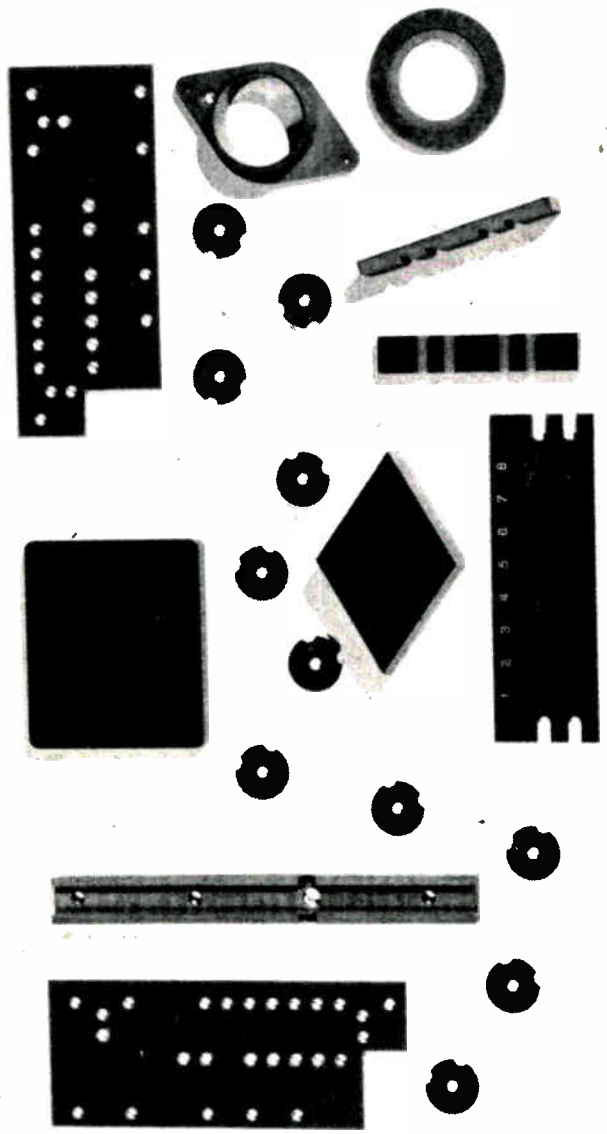


Mark Products Hires Mueller

ANDREW A. MUELLER recently joined Mark Products Co., Morton Grove, Ill., as plant manager. In this capacity he will direct the production and engineering departments of the firm.

Mark Products specializes in the design and manufacture of antenna systems for communications services including parabolas for microwave point to point and heliwhips for mobile use.

Mueller has previously been em-



Fabricated by CDF. Near the presses that produced the Dilecto laminates, these paper-base parts were machined to close tolerances by CDF specialists . . . quickly, accurately, economically for the purchasers. This is a random selection from the five grades described in the table below.

CDF Dilecto® paper-base laminates for the workhorse insulation jobs

For everyday mechanical-electrical parts that receive tough punishment and must have excellent physical and dielectric properties at low cost, the CDF phenolic paper-base line is outstanding.

Economy. CDF paper-base grades machine readily into intricate parts. Some are flame-retardant. Others are especially adaptable for punching. All are economical for the value delivered.

Fabrication Facilities. CDF has excellent and extensive plastics-fabrication facilities for turning out finished Dilecto parts to your specifications—better and more economically than you can do it yourself. Save the time and trouble of intricate fabrication by using CDF's specialized facilities.

See Sweet's, Electronics Buyers' Guide, and the other directories for the phone number of the CDF sales engineer nearest you. Or send us your print or problem direct, and we'll return a recommendation of the right Dilecto grade for your need.

CDF makes Di-Clad* printed-circuit laminates, Diamond‡ Vulcanized Fibre, CDF products of Teflon†, flexible insulating tapes, Dilecto‡ laminated plastics, Celoron‡ molded products, Micabond‡ mica products, Spiral Tubing, Vulcoid‡.

*Trademark of Continental-Diamond Fibre Corporation
†Du Pont trademark for its TFE-fluorocarbon resin

CONTINENTAL-DIAMOND FIBRE
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Typical Property Values—Dilecto Paper-Base Laminates in Sheet Form

	X-13 (NEMA X)	XP-13 (NEMA P)	XX-13 (NEMA XX)	XX-13 FR (Fire-retardant) (NEMA XX)	XXXP-28 (NEMA XXXP)
ROCKWELL HARDNESS (M SCALE)	100	95	110	108	90
TENSILE STRENGTH lw (1000 psi.)	20	12	16	17	12
FLEXURAL STRENGTH lw (1000 psi.)	27	16	17	20	18
COMPRESSIVE STRENGTH (1000 psi.)	40	25	35	41	22
WATER ABSORPTION (% in 24 hrs.) 1/16" thickness	3.5	3.0	1.4	1.2	0.6
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (°C.)	120	120	120	120	120
DIELECTRIC STRENGTH perp. to lam. (VPM)	800	800	650	700	800
DIELECTRIC STRENGTH parallel to lam. (Kv.)	50	50	60	70	75
DISSIPATION FACTOR at 1 mc, Cond. A	0.042	0.038	0.034	0.038	0.027
DIELECTRIC CONSTANT at 1 mc, Cond. A	5.5	4.6	4.7	4.8	3.6
ARC-RESISTANCE (seconds)	8	4	4	10	10
INSULATION RESISTANCE (megohms) ASTM D-257, Fig. 3	100	100	1,000	1,000	600,000
AIEE insulation class	A	A	A	A	A

ployed by the Glenn L. Martin Co., Baltimore, Md.; A. C. Nielson Co., Chicago, Ill.; and Chicago Aerial Industries, Chicago, Ill., as chief, Engineering Laboratories.

TI Moves Region Sales Office

TEXAS INSTRUMENTS INC. has moved its eastern region sales office from New York City to Elizabeth, N. J.

This region office will coordinate the efforts of its own staff of TI sales engineers and those headquartered in district offices—one in Garden City, Long Island, N. Y., headed by J. F. Hegarty (picture), and another in Camden, N. J.

R/S Electronics Names Isabeau

APPOINTMENT of John Isabeau as senior project engineer at R/S Electronics Corp., Palo Alto, Calif., was recently announced.

Isabeau specializes in the engi-

neering of both conventional and transistorized models of high-frequency electronic devices and will be assigned to the company's Electronics Division. He was formerly associated with the Zenith Radio Corp., Chicago, Ill., as a research engineer.

News of Reps

Snelling-Bogossian Co. of Hamburg, N. Y., is the new selling agent for DuMont scientific instruments in upper New York State. Rep firm replaces Edward A. Ossmann and Associates in all upstate N. Y. except Putnam and Rockland counties. These two counties have been transferred to **Gawler-Knoop Co.**, of Roseland, N. J., DuMont instrument rep for the greater New York, northern. New Jersey, greater Philadelphia, and the District of Columbia areas.

General Transistor Corp., Jamaica, N. Y., recently named two sales rep organizations to handle its products. **Charles W. Lienau & Co.**, of Silver Spring, Md., will cover Virginia, Maryland and the District of Columbia; and **McLoud & Raymond Co.** will serve in Colorado, Wyoming, Utah, New Mexico, southeastern Idaho and El Paso County in Texas.

The line of wave filters, toroidal and magnetic components and lumped-constant delay lines of Wahlgren Magnetics, Pasadena, Calif., will be represented by the **G. S. Marshall Co.**, of San Marino, Calif.

Radiation Counter Laboratories, Inc., Skokie, Ill., has appointed the **Hyde Electronics Co.** of Denver, Col., as representative in Montana; Wyoming; Idaho, south of Idaho County; Colorado; Utah; New Mexico; western Kansas; and in El Paso, Texas.

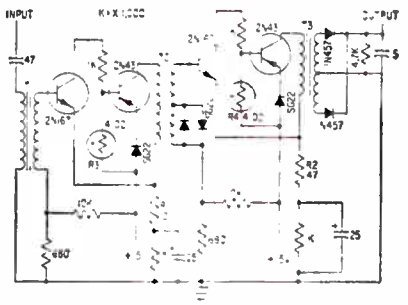
Aerol Associates of Beverly Hills, Calif., are now the sales reps in thirteen western and southwestern states for electronic connector manufacturer, H. H. Buggie, Inc., Toledo, Ohio.

COMMENT

Case of a Substitute Amplifier

Since the article ("Voltage Comparator With High-Speed Switches," p 56, Jan. 30) was sent to your magazine, the authors, J. W. Higgenbotham and H. H. Douglass, have begun using a different and better a-c amplifier. They feel that the article does not properly reflect this advancement in the state of the art unless a diagram of the new a-c amplifier is substituted in place of the one you now have, Fig. 3.

Accordingly, I am sending you a quick drawing of the new diagram which we would like to substitute for Fig. 3.



The amplifier consists of a pair of 2-transistor complementary-coupled stages, coupled by a transformer. Each stage employs heavy d-c feedback to control the d-c operating point, plus a smaller amount of a-c feedback to control gain.

The problem of leakage-current amplification, common to all d-c amplifiers, has been eliminated by placing a diode in the emitter of the 2N43 transistor and connecting a thermistor from the supply voltage to its base. This technique ensures that the second transistor can be completely cut off by the first transistor, even at maximum rated junction temperature.

Experience has shown this configuration to be exceptionally stable and flexible. Wide variations in input impedance and voltage gain are possible merely by changing the value of feedback resistors R_1 and R_2.

WILLIAM B. WELLING

THE MARTIN CO.
BALTIMORE

One Best Bet in 1959

. . . I would like to take this opportunity to add my congratulations to all the others you have received on the revised format of ELECTRONICS.

DONALD T. WORTHINGTON
ROME AIR DEVELOPMENT CENTER
ROME, N. Y.

A Confusion of Corporations

We have noted with pleasure your mention of Narda Ultrasonics stock on p 19 of your Jan. 16 issue (Financial Roundup).

You now list the stock quotations on the common stock of Narda Microwave, and since there seems to be some confusion between the two companies, we feel it would be of interest for you to list the common stock quotations on Narda Ultrasonics, which are entirely separate and distinct quotations from Narda Microwave.

GERALD B. VEGA
NARDA MICROWAVE
NARDA ULTRASONICS
MINEOLA, N. Y.

Reader Vega's point is well taken, and the editor of our financial pages assures us that we will start carrying listings for both stocks in the near future.

Kudo

I would like to compliment you on the accurate and quite readable condensation of my paper ("Storage Tube Has Symmetrical Guns," p 60, Jan. 2).

I would also like to thank you for the opportunity to publish the results of our development, and for the speed with which the article was published.

MICHAEL F. TOOHIG
ITT LABORATORIES
FORT WAYNE, IND.

The thanks are ours, and bounce right back to author Toohig for having provided us with an article of great interest, articulately presented in the first place, and accompanied by the finest in cooperation.

The pleasure was ours . . .

complete systems

missile tracking
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airborne instrumentation
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experienced in any of our basic pursuits in military electronic systems. Please write H. C. Horsley, Dept. E.

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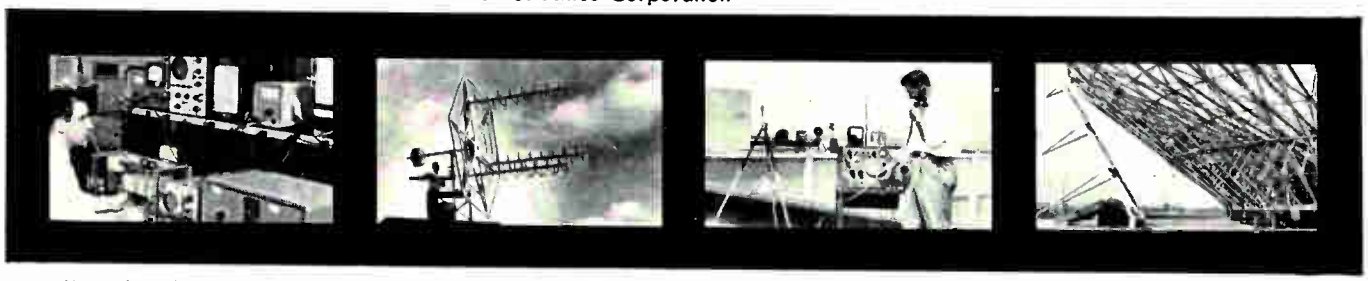

Measuring phase stability vs. temperature during pratatype equipment develapment

Develapmental helical antenna, part af saphisticated new directian-finder system

Pattern measurements—vital ta develapment af micrawave dish antennas

60′ parabalic receiving antenna far missile telemetry and tracking

ENGINEERS SCIENTISTS ERCO

a pioneer and one of the leading producers of electronic flight simulators, is increasing its engineerng activity to include volume engineering programs in the fields of analog and digital computer techniques, telemetry, transistor applications and light/optical scanners. It is also rapidly expanding its research and development operations in the fields of ionospheric propagation & UHF communications.

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CIRCUIT DESIGN
(ALL LEVELS)

BSEE, far transistor circuitry, application, analog and digital computer techniques, DC amplifiers, simulation, telemetry and design of systems and components.

BS in Physics, plus experience in one or more of the following: optics, hydraulic instrumentation, human engineering, numerical analysis, computer techniques.

AERODYNAMICIST

BS in Aero E, plus 3 years' experience in aerodynamics, preferably in airplane stability control, power plants, performance or simulation.

TECHNICAL WRITERS

BS in EE or Physics, or equivalent, plus 2 years' experience in the preparation of operational and maintenance, manuals and engineering reports concerning electronic systems and components.

RESEARCH AND DEVELOPMENT PROGRAMS

IONOSPHERE PHYSICIST

BS degree plus 3 to 5 years' experience in the study of ionospheric phenomena. Familiar with present state-of-the-art of upper atmosphere and have an understanding of present programs using rockets and satellites for studies in E & F regions and beyond. Will work with radiation problems spanning VLF to VHF region of spectrum with emphasis on HF backscatter techniques and their applications to communications. Will design and conduct field experiments.

GLOBAL COMMUNICATIONS SPECIALISTS

BS degree plus 5 to 10 years' experience embracing theoretical as well as practical knowledge of communications systems design involving F-layer ionospheric propagation techniques. Working knowledge of modern high-power HF transmitters and HF receiving Systems.

ELECTRONIC PHYSICIST

BS degree with 3 to 5 years' experience in diffusion pump high-vacuum techniques and have an understanding of classical gas discharge physical phenomena. Will conduct laboratory investigations of simulated upper atmosphere experiments.

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Write in complete confidence to:
Dr. Paul Doigan, Div. 27-WE
ADVANCED ELECTRONICS CENTER
AT CORNELL UNIVERSITY

GENERAL ELECTRIC
Ithaca, New York

ELECTRONIC and ACOUSTICAL

ENGINEERS WANTED

By Electro-Voice, Inc.

For research, development and design. Excellent opportunity for advancement and interesting work in rapidly expanding company. Write: Vice President for Engineering, Electro-Voice, Inc., Buchanan, Michigan

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NEED ENGINEERS

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NUCLEAR PHYSICISTS

THEORETICAL PHYSICIST to evaluate radiation effects on complex electronic airborne systems and components and perform theoretical experiments in nuclear physics, cosmic radiation, astrophysics, magnetic phenomena, tropospheric properties. Goal of assignment: To further understanding of basic physical environment encountered by advanced weapons systems. Must have advanced degree in Physics and three years' experience in nuclear radiation physics. Knowledge of reactor testing techniques essential.

704 PROGRAMMER ANALYST to study data flow diagrams and write the differential equations of a circuit diagram. Should be familiar with transforms, numerical analysis, nuclear shielding techniques, and construction of a mathematical model of a nuclear reactor. Assignment entails: investigating analog and digital real-time control systems using high-speed electronic digital and/or analog computer; shielding of components from nuclear radiation. Must have M.S. in Physics and at least two years' experience in control systems analysis and/or nuclear shielding techniques.

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.075	7000	3.25
.1	1500	.25
.1	2000	.65
.1	2500	.69
.1	3000	.50
.1	3000	1.19
.1	4000	1.29
.1	5000	1.30
.1	5000	3.25
.1	7500	.89
.1	7500	3.95
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.5	1500	.59
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.5	4000	3.25
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8	1500	3.65
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10	1000	3.45
10	1400	2.25
10	1500	4.35
10	2000	6.50
10	2500	10.95
10	2500*	6.25
10	4000	20.95
10	5000	PUR
10	6000	52.50
12	660VAC	4.25
12	1000	2.95
12	2000	6.75
13.5	4000	21.25
14	660VAC	4.25
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15	600	2.95
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15	1500	6.35
15	5000	PUR
20	330VAC	3.25
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.00003	600	.24
.00003	1200	.28
.00003	2000	1.25
.00003	2500	.35
.000047	2500	.30
.00005	600	.23
.00005	1200	.29
.00005	2500	.33
.00005	3000	1.25
.000051	5000	1.75
.00007	2500	.26
.000075	5000	1.45
.0001	600	.24
.0001	1200	.27
.0001	2500	.36
.0001	5000	1.95
.00015	600	.23
.00015	2500	.33
.00015	5000	1.95
.0002	600	.23
.0002	1200	.29
.0002	2500	.34
.0002	5000	1.95
.00025	600	
.00025	1200	.19
.00025	2500	.35
.00025	5000	1.95
.00027	1200	.27
.00027	2500	.36
.0003	600	.23
.0003	2500	.36
.0004	600	.23
.0004	1200	.29
.0004	2500	.29
.0004	5000	1.95
.00047	2500	.40
.0005	600	.23
.0005	1200	.29
.0005	2500	.39
.005	3000	1.25
.0005	5000	2.45
.005	7500	2.95
.0062	3000	1.25
.00068	2500	.28
.00089	1200	.28
.001	600	.23
.001	1200	.32
.001	2500	.49
.001	4500	1.65
.001	5000	2.25
.001	8000	3.98
.0015	600	.23
.0015	2500	.53
.0015	5000	2.25
.002	600	.27
.002	1200	.39
.002	2500	.63
.002	5000	2.25
.002	6000	2.40
.0024	5000	2.25
.0025	600	.28
.0025	1200	.43
.0025	2500	.65
.003	600	.31
.003	1200	.52
.003	2500	.73
.003	3000	1.65
.003	5000	2.25
.004	600	.29
.004	1200	.49
.004	2500	.91
.005	600	.35
.005	1200	.45
.005	2500	.98
.005	3000	1.65
.006	600	.36
.006	1200	.55
.006	3500	1.65
.0062	2500	.94
.0075	3000	1.75
.008	600	.35
.008	1200	.57
.01	600	.48
.01	1000	.50
.01	1200	.69
.01	1250	.69
.01	2500	.94
.01	800	6.95
.012	1200	.64
.014	600	.45
.014	1200	.64
.015	600	.55
.015	2000	1.75
.02	600	.21
.02	1200	.99
.025	600V	.55
.02	2000	.98
.024	2500	1.10
.03	2000	1.50
.03	600	.65
.03	1200	1.18
.03	2000	1.50
.039	600	.67
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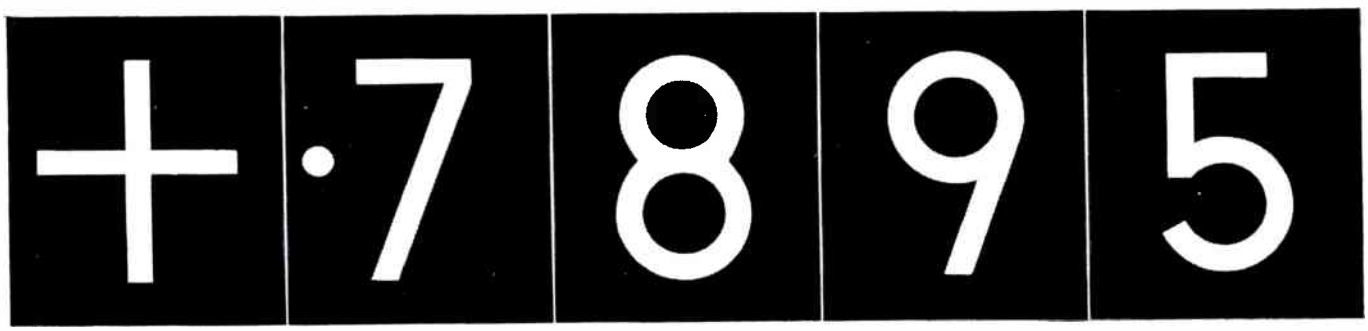

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Model 401B DC 4-digit

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GOING STEADY!

...DESIGNERS AND RCA-6AU6, A PREFERRED TUBE TYPE

SPECIFY RCA PREFERRED TUBE TYPES

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