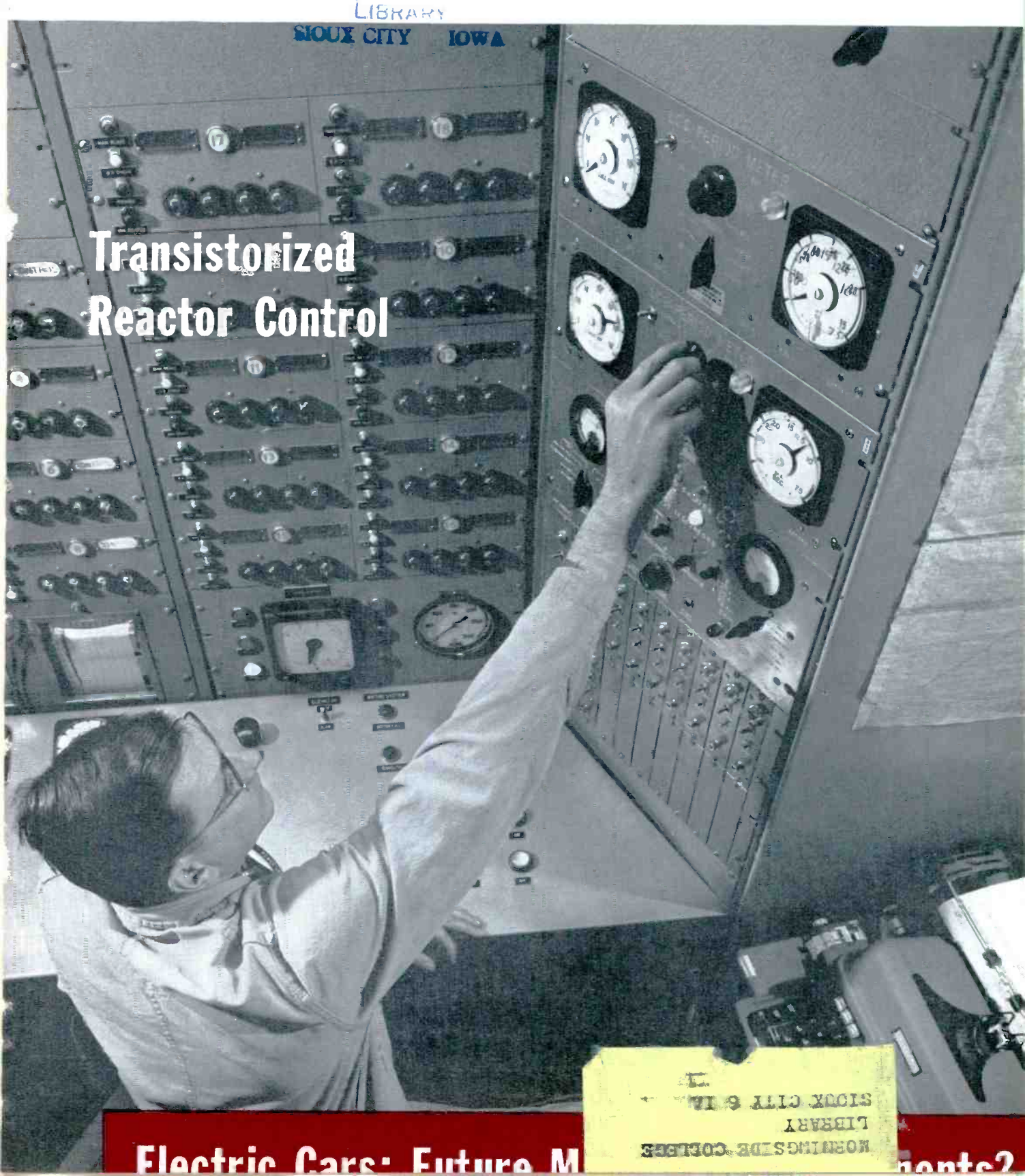
MAY 22, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 21 PRICE SEVENTY-FIVE CENTS



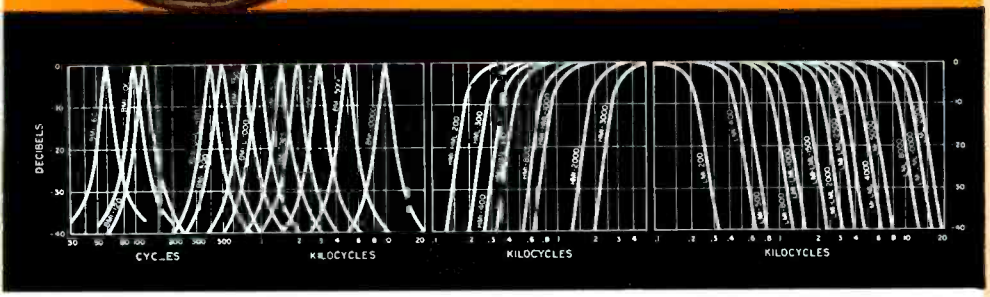
Transistorized Reactor Control

Electric Cars: Future M... ...nents?

FILTERS FOR ALL APPLICATIONS FROM STOCK

HERMETICALLY SEALED TO MIL-T-27A & MIL-F-18327

UTC INTERSTAGE AND LINE FILTERS



This standardized group of filters covers most popular filter applications and frequencies. Units are in compact, drawn, magnetic shielding cases . . . 1 3/16 x 1 11/16 base, 1 5/8 high for BMI, LMI, BML; others 2 1/2 high. There are six basic types:

BMI band pass units are 10K input, output to grid 2:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

HMI high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

LMI low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

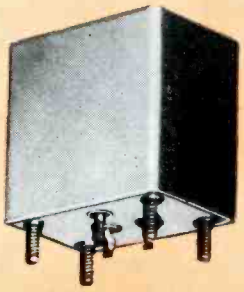
HML high pass filters are same as HMI but 500/600 ohms in and out.

LML low pass filters are same as LMI but 500/600 ohms in and out.

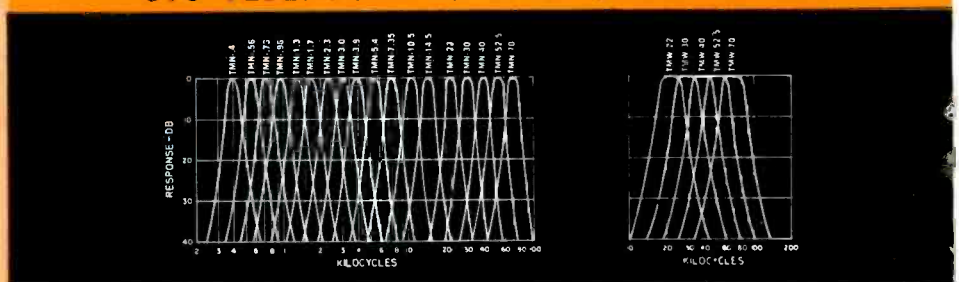
BML band pass units are same as BMI but 500/600 ohms input, output to grid, 9:1 gain.

STOCK TYPES
(number in figure is cycles)

BMI-60	BMI-10000	LMI-800	HML-300
BMI-100	HMI-200	LMI-1000	HML-500
BMI-120	HMI-400	LMI-1500	HML-1000
BMI-400	HMI-500	LMI-2000	LML-1000
BMI-500	HMI-800	LMI-2500	LML-1500
BMI-750	HMI-1000	LMI-3000	LML-2000
BMI-1000	HMI-2000	LMI-4000	LML-2500
BMI-1500	HMI-3000	LMI-5000	LML-4000
BMI-2000	LMI-200	LMI-10000	LML-8000
BMI-3000	LMI-400	BML-400	LML-10000
BMI-4000	LMI-500	BML-1000	LML-12000
BMI-5000		HML-200	



UTC TELEMETERING BAND PASS FILTERS



STOCK TYPES
(number in figure is KC)

TMN-.4	TMN-2.3	TMN-14.5	TMW-22
TMN-.56	TMN-3.0	TMN-22	TMW-30
TMN-.73	TMN-3.9	TMN-30	TMW-40
TMN-.96	TMN-5.4	TMN-40	TMW-52.5
TMN-1.3	TMN-7.35	TMN-52.5	TMW-70
TMN-1.7	TMN-10.5	TMN-70	

TMN-.4 thru TMN-1.7
1 1/16 x 1 1/32 x 2 inches
Weight ..... 3.5 oz.

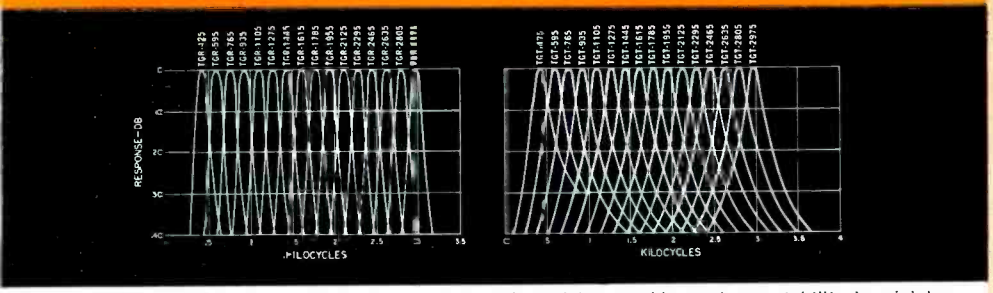
TMN-2.3 thru TMW-70
2 3/32 x 2 3/32 x 1 3/8 inches
Weight ..... 1.2 oz.

UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, 4 pin header for small Winchester socket.

TMN units are within 3 db at ± 7.5% of center frequency . . . down more than 18 db at ± 25% . . . more than 40 db beyond 1.75 and .58 center frequency.

TMW are within 3 db at ± 15% of center frequency . . . down more than 20 db at ± 50% . . . more than 40 db beyond 2.5 and .4 center frequency.

UTC TELEGRAPH TONE CHANNEL FILTERS



These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

TGR receiving filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 30 db at ± 170 cycles . . . down more than 15 db at adjacent channel cross-over.

TGT transmitting filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 16 db at ± 170 cycles . . . down more than 7.5 db at adjacent channel cross-over.

STOCK TYPES
(number in figure is cycles)

RECEIVING

TGR-425	TGR-1785
TGR-595	TGR-1955
TGR-765	TGR-2125
TGR-935	TGR-2295
TGR-1105	TGR-2465
TGR-1275	TGR-2635
TGR-1445	TGR-2805
TGR-1615	TGR-2975

TRANSMITTING

TGT-425	TGT-1785
TGT-595	TGT-1955
TGT-765	TGT-2125
TGT-935	TGT-2295
TGT-1105	TGT-2465
TGT-1275	TGT-2635
TGT-1445	TGT-2805
TGT-1615	TGT-2975

TGT CASE
1 1/2 x 1 1/2 x 2 1/2 in. 8 oz.

TGR CASE
1 1/2 x 1 1/2 x 4 1/4 in. 15 oz.

And Special Units to Your Specifications

UNITED TRANSFORMER CORP.
150 Varick Street, New York 13, N. Y.
PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

electronics

MAY 22, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 21

Issue at a Glance

Business

Engineering

Departments

Edward L. Grayson: Sales Manager for the Daven Company – a leading designer and manufacturer of transistorized power supplies, precision wire wound resistors, rotary step-type switches, attenuators and test equipment.

Ed Grayson takes the stand for electronics

Mr. Grayson, what is the principal marketing and merchandising problem you face in selling goods in the electronics industry?

My principal sales problem involves getting the message of what we're selling to the greatest number of people who can buy our products – to people that may be in a back room or engaged in new project activities – to people who are inaccessible to our sales force or to our manufacturers' representatives.

How does electronics magazine help you to resolve your sales problem?

We feel that electronics is one of the primary means to reach these engineers whom our sales force cannot contact. electronics has long been recognized as one of the outstanding media for announcing and promoting new products. For years we have advertised on the inside back cover to: (1) solidify our position with present customers, and; (2) seek out new prospects.

What "publication image" comes to mind when you think of electronics, the magazine?

Due to the fact that electronics is one of the earliest publications to serve the industry, its advertising pages have greater influence than some of the new publications that have sprung up in recent years.

electronics is the keystone of our advertising campaign because we know engineers and engineering-management read electronics first. It carries more weight with our customers than any other publication. We spend more advertising dollars in electronics than any other medium.

If it's about electronics, read it in **electronics.**

electronics

Published WEEKLY plus the mid-year electronics BUYERS' GUIDE

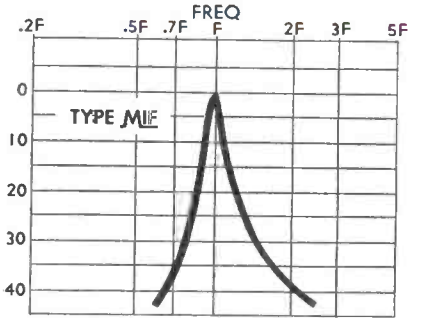
A McGraw-Hill Publication • 330 West 42nd Street, New York 36, N.Y.

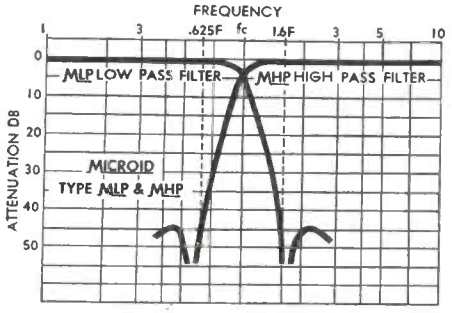
THE SHRINKING MAN'S FILTER

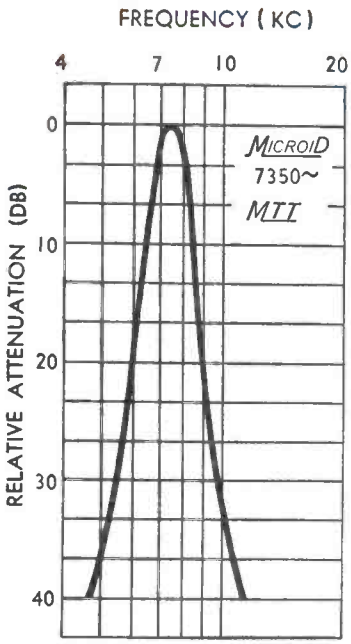
Although worlds apart in purpose, practitioners of the art of head shrinking and Burnell & Co. miniaturization engineers are both expert in reducing to size. For example, Burnell's new microminiature *MICROID* filters are particularly valuable in transistorized circuitry and only a step away from micromodule use. Range of the new Type *MTI* band pass filter is 7.35 kc to 100 kc, band width 15% at 3 db and +60% −40% at 40 db. Size is 1/2"x19/32"x15/16", weight .3 oz. Types *MLP* and *MHP* cover 5 kc to 100 kc with a standard impedance of 10K ohms. These are microminiature counterparts of the popular Burnell TCL and TCH low pass and band pass filters. The band pass filter results when cascading a TCL with TCH filter. Size is 3/4" x 1/2" x 1".

Type *MIF* microminiature interstage filters are designed for a wide variety of applications. Input impedance is 10K ohms, output to grid with a voltage gain of approximately 2:1. The 3 db band width is nominally 8%. Ranging from 7.5 kc to 100 kc, these interstage filters are provided in the same case as Type *MLP*.

Fully encapsulated, the new *MICROID* filters provide less weight, more reliability and exceed MIL specifications. We'll be glad to design and manufacture to your specifications in any quantity. Write for special filter bulletin to help solve your circuit problems.







Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

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TELETYPE PELHAM 3633

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SOUTH PASADENA, CAL.
RYAN 1-2841
TELETYPE: PASACAL 7578

electronics

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SHOPTALK . . . editorial

ECHOES OF ICAO. Take a knotty technical problem and bind it up in tangled skeins of politics and business and it comes to life as a hydra-headed monster. Such a question won't be settled in one conference. It won't be killed. It just grows a new head and turns up somewhere else.

In Montreal, last winter, a technical meeting of delegates of 31 nations voted to adopt as a standard the very-high-frequency omnirange —Tacan (Vortac) short-range air-navigation system sponsored by U. S. and already widely used throughout the world as an air-navigation aid. Also discussed was Decca, a proprietary hyperbolic navigation system currently finding increasing use as an air-navigation system, largely in the British Isles, western Europe and Canada.

After the Montreal conclave angry rumblings were heard across the Atlantic. Soon the din resembled an old-time Madison Square Garden rhubarb. The Thames-side version of "We wuz robbed" includes charges that the U. S. had packed the Montreal convention with small-nation delegates, had flown in the face of considered engineering opinion and had prejudged the issue long before the technical facts were in.

To get to the bottom of this controversy, McGraw-Hill's London office took a careful sampling of British electronics industry opinion. Then Associate Editor Janis (with an assist from McGraw-Hill's correspondent in Montreal) found out what our Federal Aviation Agency, the International Civil Aviation Organization and other informed sources had to say. ELECTRONICS brings you both sides of this issue on p 29.

Coming In Our May 29 Issue . . .

DESIGNING FOR RELIABILITY. One of the greatest causes of concern in our industry is the increasing complexity of modern electronic systems, and the commensurate increase in importance of that often-elusive and always difficult-to-obtain factor of reliability. In military electronic equipment and critical industrial equipment, reliability is a function of sound engineering during development. It cannot be achieved by guesswork or by cut-and-try methods. It must be set as a goal at the beginning of the design procedure and must be constantly evaluated during development through realistic engineering tests.

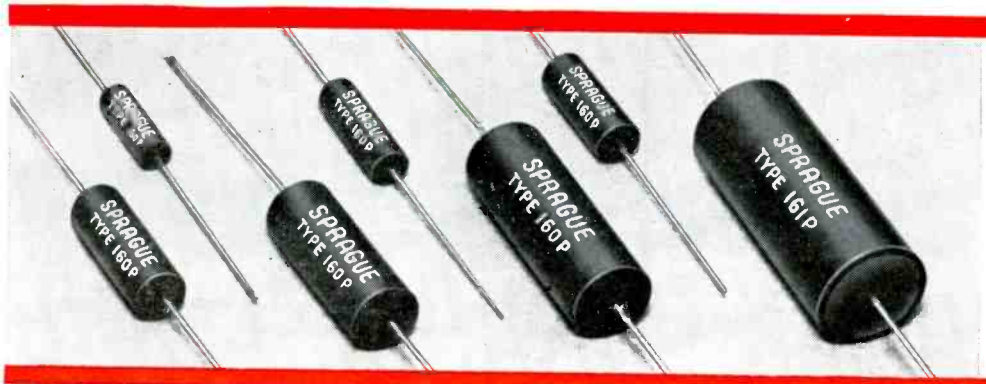
Next week, ELECTRONICS brings you a comprehensive report on the vital question of designing for reliability. In it, Associate Editor Leary discusses three interlocking factors to be considered in establishing reliability in equipment design: choice of components based on stability and reproducibility, application of components within circuits, and design of circuits themselves. You'll learn how to choose and use components, how to evaluate reliability during development, how to design circuits and systems for optimum performance. You'll want to keep and refer to this valuable report often.

MUSICAL TIMBRE. A demonstration device for illustrating the elementary principles of Fourier synthesis of a complex musical tone is described by W. S. Pike and C. N. Hoyler of RCA Laboratories in Princeton, N. J. The device is a transistorized keyboard instrument with a compass of one octave, the fundamental frequency being 250 cps. Electrical output consists of the fundamental plus the second and third harmonics. Effects of changes in the three outputs can be demonstrated audibly and visually.

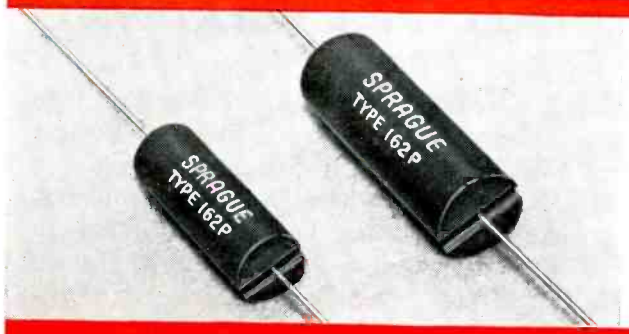
DIFILM® DUAL DIELECTRIC

gives new BLACK BEAUTY® series of small, low-cost capacitors outstanding performance characteristics

- withstand 105C operation with no voltage derating
- moderate capacitance change with temperature
- excellent retrace under temperature cycling
- superior long-term capacitance stability
- very high insulation resistance



NEW!... DIFILM Type 160P fully-molded case and Type 161P pre-molded case capacitors in 5/16" to 1" diameters for general commercial and entertainment electronics.



NEW!... DIFILM Type 162P slotted-base multi-purpose molded case capacitors for auto radios and other severe vibration applications. Slot prevents collection of moisture around leads when capacitor is end-mounted against chassis.

● New DIFILM Black Beauty Capacitors represent a basic advance in paper tubular capacitor design. DIFILM Capacitors combine the proven long life of paper capacitors with the effective moisture protection of plastic capacitors . . . by using a *dual dielectric of both cellulose and polyester film that's superior to all others for small, yet low cost, capacitors.*

● Just check the characteristics listed above. This overall performance is fully protected by HCX®, an exclusive Sprague hydrocarbon material which impregnates the windings, filling all voids and pinholes before it polymerizes. The result is a solid rock-hard capacitor section, further protected by an outer molding of humidity-resistant phenolic. *These capacitors are designed for operating temperatures ranging up to 105°C (221°F) . . . at high humidity levels . . . without voltage derating!*

For complete specifications on DIFILM Black Beauty Capacitors, write for Bulletin 2025 to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS
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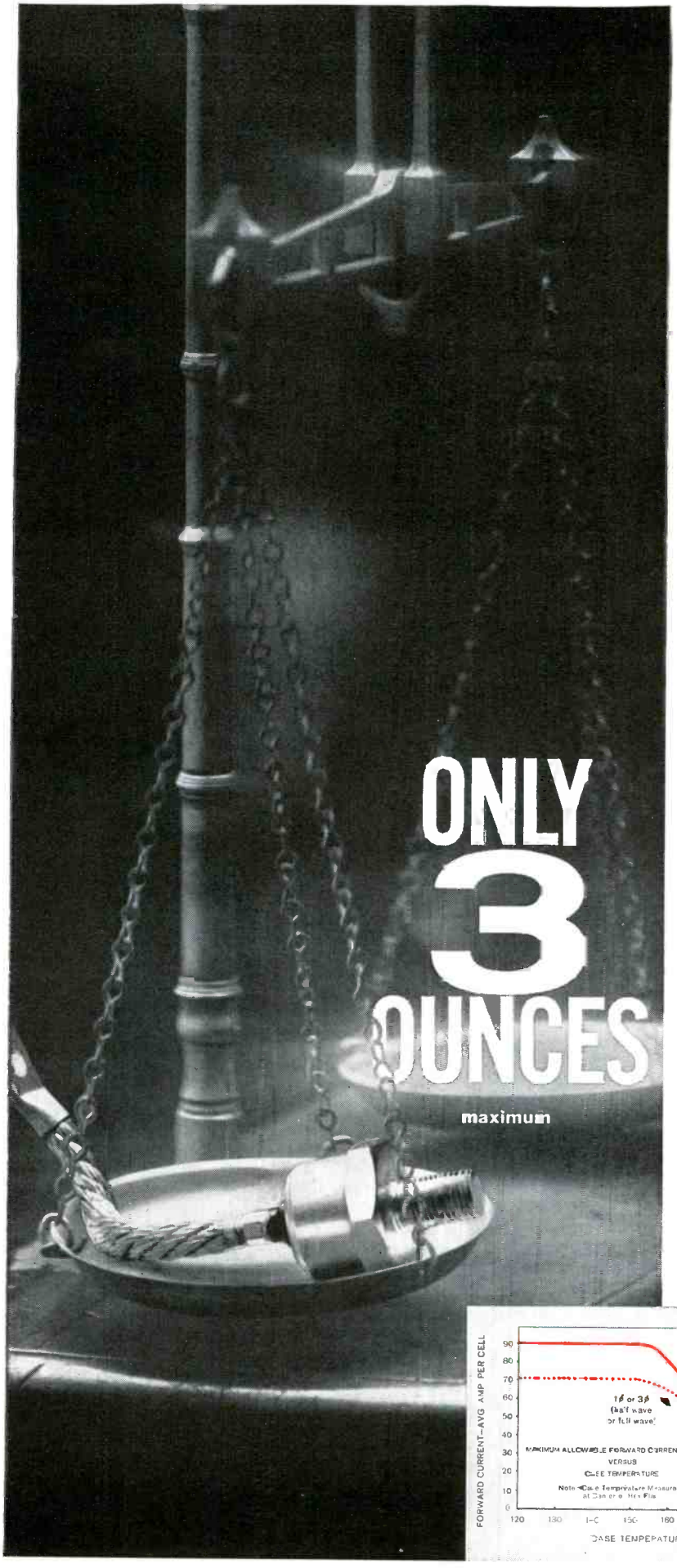


New 70 amp high-power silicon rectifier from Westinghouse

This latest Westinghouse rectifier has been designed specifically for those high-current applications where space and weight are critical. Total weight is only 3 oz., maximum.

OUTSTANDING FEATURES INCLUDE...

- Low leakage current
- High fault current
- Lightweight
- Low forward drop
- Small package (just 1" across flats)
- High current for its size and weight

ELECTRICAL CHARACTERISTICS

Maximum allowable peak inverse voltage: Operating or transient to 50 to 500 volts.

Maximum allowable dc blocking voltage: 80% of PIV.

Maximum reverse current: 30 milliamperes peak at rated peak inverse voltage.

Maximum one cycle half-wave peak rating: 1200 amps.

Operating temperature: Up to junction temperature of 190° C.

Cell forward current: See curves.

Operating frequency: For frequencies beyond 1 kc, refer to Westinghouse.

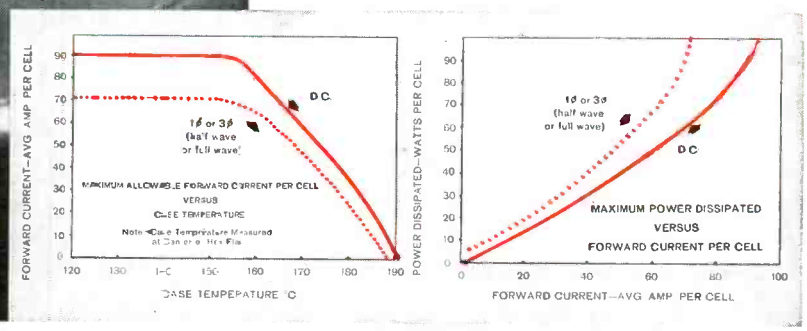
Thermal drop: Junction to case, 0.4°C/watt.

Inquiries and sample orders are invited. For complete technical data contact your local Westinghouse representative.

YOU CAN BE SURE...IF IT'S

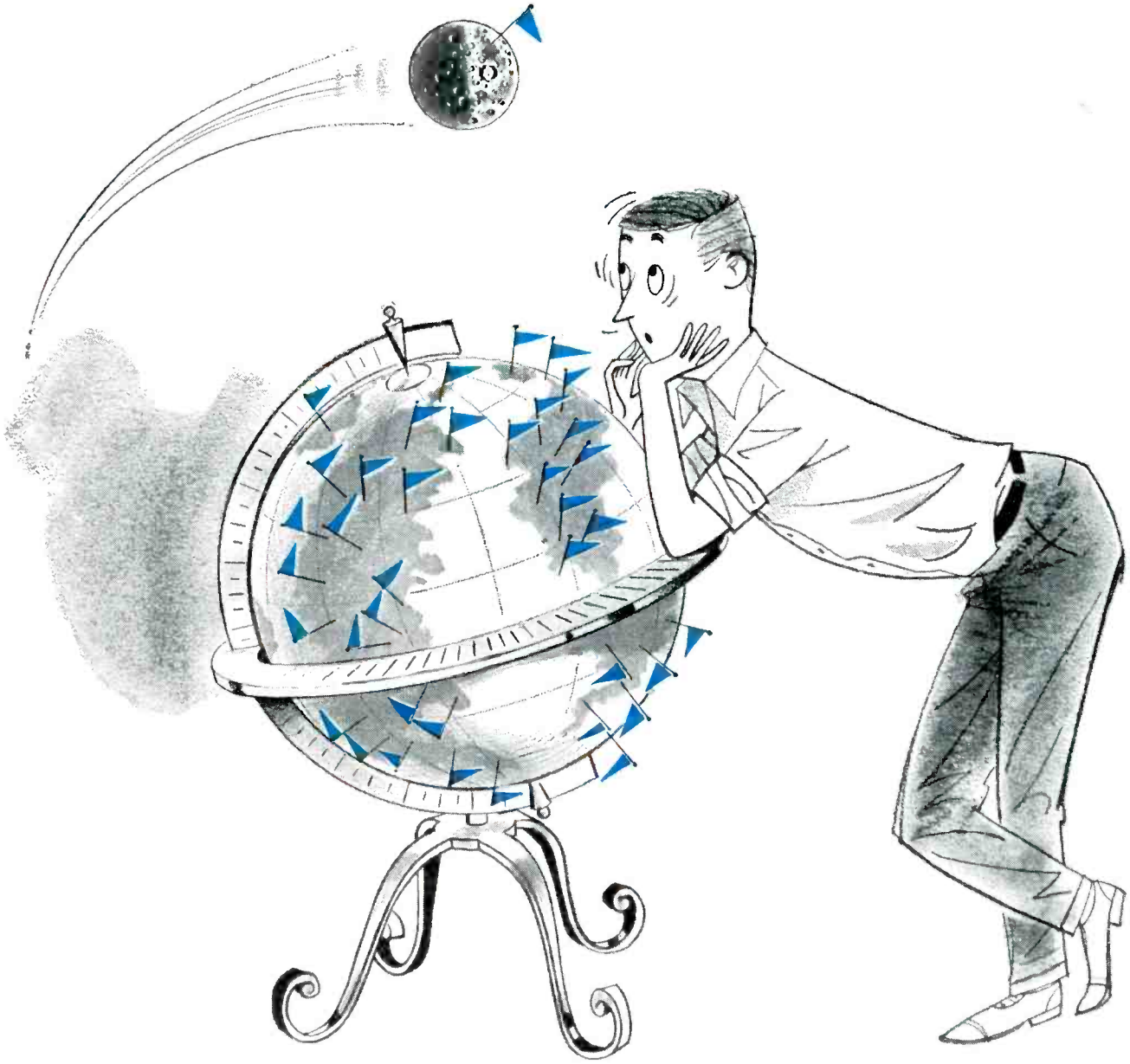
Westinghouse

Westinghouse Electric Corp., Semiconductor Department, Youngwood, Pa.



hp representatives...

Ubiquitous to the Nth



The extreme prevalence of hp field representatives is a helpful thing. This means that engineering help, new instruments or repairs can be yours wherever, whenever — and in an unreasonably short time.

Almost 200 hp field representatives are in action daily around the world — over 150 of them in America. They're factory trained men, regularly re-equipped with latest data on new instrumentation and new measuring techniques.

Their basic dedication is to help solve your engineering problems, and then keep your instrumentation cooking.

Should an hp instrument malfunction (rare) your hp rep provides factory-level field service and parts—fast!

The list alongside includes your hp rep. Call him for engineering help, new instruments, repairs or parts. And please don't be bashful. It's his job.

(Field service and parts stations shown in blue)

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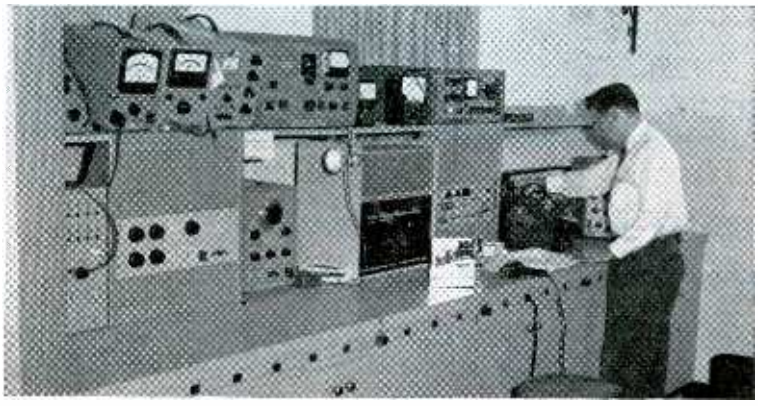
Toronto 10, Ont., Atlas Instrument Corporation, Ltd., 50 Wingold Ave., RU 1-6174. **Vancouver 2, B. C.,** Atlas Instrument Corporation, Ltd., 106-525 Seymour St., MU 3-5848. **Winnipeg, Mani.,** Atlas Instrument Corporation, Ltd., 72 Princess St., WH 3-8707.

OVERSEAS

Belgium, International Electronic Company, "INELCO S.A.", 20-24, rue de l'Hopital, Brussels, Tel.: 11-22-20 (5 Lines). **Denmark,** Tage Olsen A/S, Centrumgarden, Room 133, 6D, Vesterbrogade, Copenhagen V., Tel.: Palae 1369 and 1343. **Finland,** INTO O/Y, 11 Meritullinkatu, Helsinki, Tel.: 62 14 25 and 35 125. **France,** Radio Equipments, 65, rue de Richelieu, Paris 2éme, Tel.: RICelieu 49-88. **Germany,** Hewlett-Packard S.A. Verkaufsbüro, Frankfurt am Main, Holzhausenstrasse 69, Telefon 55 47 27. **Greece,** K. Karayannis, Karitsi Square, Athens, Tel.: 23-213 (9 Lines). **Israel,** Electronic & Engineering Ltd., 6 Feierberg Street, Tel-Aviv, Phone 4288. **Italy,** Dott. Ing. Mario Vianello, Via L. Anelli 13, Milano, Telef. 553-081. **Netherlands,** C. N. Rood N.V., 11-13 Cort Van Der Lindenstraat, Rijswijk (Z.H.), Tel.: The Hague-98-51-53 (6 Lines). **Norway,** Morgenstierne & Co., Colletts Gate 10, Oslo, Tel.: 60 17 90. **Portugal,** Senatejo Industrial, Lda., Rua do Alecrim, 46-S/Loja, Lisbon, Tel.: 3 44 46—Expediente and 36 86 43—Gerencia. **Spain,** ATAIO, Ingenieros, A. Aguilera, No. 8, Madrid, Tel.: 23 27 42 and 57 84 51. **Sweden,** Erik Ferner, Björnsonsgatan 197, Bromma, Tel.: 87 01 40. **Switzerland,** Max Paul Frey, Hangweg 27, Köniz-Bern, Tel.: (031) 63, 36 44. **United Kingdom,** Livingston Laboratories, Retcar Street, London, N. 19, England, Tel.: Archway 6251. **Yugoslavia,** Belram Electronics, 43 Ch. de Charleroi, Brussels, Belgium, Tel.: 38. 12.40. **Australia,** Geo. H. Sample & Son Pty. Ltd., 17-19 Anthony Street, Melbourne, C. 1, Tel.: FJ4138 (3 lines), 280 Castlereagh Street, Sydney, Tel.: MA 6281 (3 Lines). **Taiwan (Formosa),** Far-Eastern Company, No. 6 Nanyang Street, Taipei, Taiwan Tel.: 27876 and 31868. **India,** The Scientific Instrument Company, Ld., 6, Tej Bahadur Sapru Road, Allahabad 1; 240, Dr. Dadabhai Naoroji Road, Bombay 1; 11, Esplanade East, Calcutta 1; B-7, Ajmeri Gate Extn., New Delhi 1; 30 Mount Road, Madras 2. **Japan,** Seki & Company, Ltd., Daini Taihei Building, No. 1 Kanda Higashi-Fukudacho, Chiyoda-Ku, Tokyo, Tokyo (866) 3136-8. **New Zealand,** Geo. H. Sample & Son (N.Z.) Ltd., 431 Mount Albert Road, Mount Roskill S.1, Auckland, Tel.: 89-439. **Union of South Africa,** F. H. Flanter & Co. (Pty.), Ltd., Rosella House, Buitencingle Street, Cape Town, Tel.: 3-3817. **Argentina,** Mauricio A. Suarez, Telecomunicaciones, Carlos Calvo 224, Buenos Aires, Tel.: 30-6312-34-9087.



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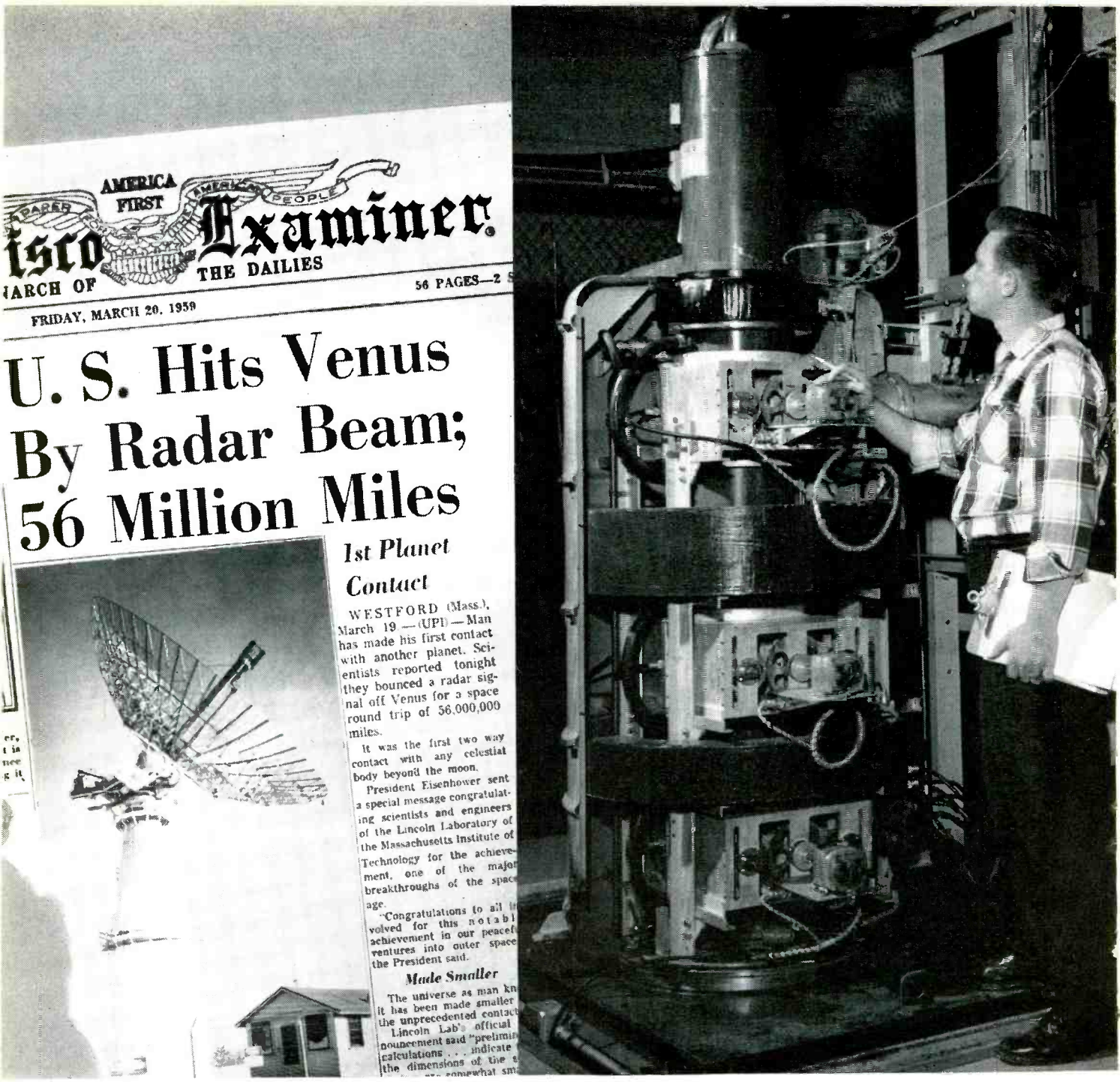


Eimac Klystron final amplifier at Millstone Hill Radar site.

EIMAC KLYSTRON POWERS VENUS CONTACT— 100 TIMES FARTHER THAN PREVIOUS RECORD!

On February 10 and 12, 1958, a high-power radar of M.I.T.'s Lincoln Laboratory transmitted and received radar signals between Earth and Venus. A round-trip of 56,000,000 miles! This historic event was man's first radio contact with another planet. It was by far the longest man-made radio transmission on record.

The final amplifier tube of this giant radar is a super-power Eimac Klystron, the same used in missile and satellite detection and tracking. Eimac's long experience and leadership in the development and manufacture of ceramic-metal power klystrons enabled the firm to design a super klystron capable of producing tremendous amounts of RF energy at the desired frequency.

In this application, as in tropo-scatter installations throughout the world, Eimac Klystrons have won a reputation for exceptional reliability and long life. Today Eimac manufactures power amplifier klystrons for ultra high and super high frequencies.

The transmitter for Lincoln Laboratory's giant radar was built by Continental Electronics Manufacturing Company. The radar was sponsored and is supported by the Air Research and Development Command of the United States Air Force.

EITEL-McCULLOUGH, INC.

Eimac

San Carlos • California

ELECTRONICS NEWSLETTER

1,000-FT DIAMETER ANTENNA for radio astronomy may be built in Puerto Rico by the Air Force. Dish would be flush with ground level, all apparatus below ground. With suitable transmitting gear added, it could be used as a radar telescope. USAF has not yet allocated funds nor decided whether reflector will be parabola or sphere. But electronic scanning will be necessary because reflector is stationary; scanning angle of 30 to 40 degrees is hoped for. According to one estimate, reflector can be built for 1/10 the cost of a fully steerable system. Other reasons for interest in low silhouette antennas: vulnerability of huge conventional structures to weather and war damage.

Cryosar, a new low-temperature computer component, has been developed at Lincoln Laboratory, MIT. Operation of the fast-switch is based on impact ionization of impurities in germanium; turn-on time is 10^{-8} seconds. Name comes from cryogenic switching by avalanche and recombination.

MAGNETIC FIELD-ULTRASONIC TECHNIQUE for probing the deep-down crystal structure of metals has yielded significant data on the movement of electrons between atoms only 100-millionths of an inch apart. A new research tool used at the University of Chicago has produced "knowledge we never had before about bismuth," said physicist Merrel H. Cohen. He said that experiments with antimony are now underway. Previously, he explained, metal crystals have been studied by X-rays and neutron diffraction and by electro-magnetic surface probing. Magnetic sound method adds a new dimension to investigations, he said.

ELECTRIC POWER can be generated by shooting electrons and ions through a strong magnetic field, with efficiencies as high as any known power generation method. That's what Joseph L. Neuringer of Republic Aviation told an American Physical Society meeting this month. According to his theoretical investigations, as much as 1 million watts could be generated by shooting a stream of plasma three times as fast as sound through a magnetic field three feet long and with poles 6 in. apart. He asserted that intensive R&D could produce large-scale plasma generators in 5 to 10 years, cited Republic's work on a "magnetic pinch" engine for space propulsion. Such an engine would shoot plasma out the rear of a spaceship; some plasma might be siphoned off and used for generating electricity.

MASER POSSIBILITIES in early-warning radar and long-range telecommunications look good to researchers, ELECTRONICS learns. Military interest centers on systems in which receiver sensitivity is the main limitation. Combination of scatter system and maser-aided receiver may fill a military need in very long-range communications. Some half dozen U.S. laboratories are exploring communications applications of maser. Researchers say that in two or three years the maser will no longer be a costly lab curiosity, but will be simpler and more rugged.

VEGA, first of NASA's more advanced boosters, will be ready for test flights by late 1960, with eight vehicles produced by the end of 1961 under a $33.5-million contract awarded to Convair division of General Dynamics. Two-stage version could put a two-ton man-carrying lab into 300-mi orbit; three-stage Vega might send 1,000-lb payload to moon's vicinity to soft-land instrument package weighing hundreds of pounds, or it could power a 750-lb payload on a planetary mission. Guidance will consist of autopilot in the second stage and inertial in the third, with a jet system for flight correction. First-stage Atlas boosters are not included in the contract.

DELTA interim launching vehicle for use in 1960 and 1961 will be produced by Douglas Aircraft under a $24-million prime contract from NASA. Delta is expected to put 250 lb in a 300-mi orbit or send 100 lb on a deep space probe, using a modified Thor as first stage. NASA says three-stage configuration will be similar to Thor-Able but Delta will have an improved radio inertial guidance system, and active control of longer coasting periods between second-stage burnout and third-stage ignition.

BETATRON is being used by a West German firm to test the welds on container walls up to 20 in. thick. The Phoenix-Rheinrohr AG unit, which uses two beams for scanning, is said to give better discontinuity definition than a conventional X-ray unit that operates on 4-in-thick materials. Betatron is housed in a bunker 102 ft long, 29 ft wide and 38 ft high. Maximum size of containers that can be tested is 80 ft long, 16 ft diameter. Remote-controlled crane trolley positions the betatron over the welds being inspected.

Parametric amplifier will probably replace a maser when MIT Lincoln Laboratory scientists again bounce signals off Venus in September. Researchers expect varactor diode-type paramp to perform as well without such maser problems as liquid helium environment and relatively narrow bandwidth.

ALEUTIAN DEW LINE SEGMENT has just gone into operation, says the Air Force. Six tropospheric scatter stations covering 1,000 mi tie in to the Alaskan White Alice network. Additional DEW Line sites are being constructed across Greenland. Main DEW Line runs from Point Barrow, Alaska, area to Baffin Island on Canada's northeast coast.

WASHINGTON OUTLOOK

DEFENSE DEPT. is considering increasing production of the Atlas ICBM from 90 missiles for operational emplacement to 160; and speeding up research and development on the solid-propellant Minuteman ICBM.

The Pentagon has some $500 million uncommitted on this year's books with which to step up the two ICBM programs. These are extra funds voted by Congress last year for military procurement which the Pentagon has yet to contract out.

Congress will surely tack on some $1 billion to the fiscal 1960 appropriation this session. The bulk of this extra money is expected to go for ICBM projects.

The recommendations on Atlas call for increasing the number of operational missile squadrons from nine to 16. The additional missiles would be equipped with American Bosch Arma's all-inertial guidance system originally designed for the Titan ICBM. Use of this system allows the Air Force to set up the Atlas missile in so-called hardened or underground installations. There is no longer a need for the exposed ratio antennas used with Atlas' earlier GE-Burroughs radio-inertial guidance system.

The Atlas recommendation was made by Air Force Secy. Douglas after much controversy within the service. Gen. Lemay, Vice Chief of Staff of the Air Force, would prefer using extra Air Force money for accelerated bomber production. Atlas has been pushed mainly by the Air Force's R&D professionals.

The recommendation to speed up work on the Minuteman, on which North American Aviation's Autonetics div. holds the guidance prime contract, comes on the heels of Defense Secy. McElroy's recent report to Congress that the project is being pushed as fast as possible.

Privately, Minuteman project officials have been protesting this claim. They have argued that the project's budget must be substantially increased if Minuteman target dates are to be met.

The Pentagon's schedule calls for the first few Minuteman missiles to be in the hands of troops in 1963. The missile is not expected to be operational in quantity until 1965. First flight of a complete prototype is not likely before 1961.

Minuteman's fiscal 1959 budget amounts to roughly $200 million—including a hike of some $114 million put into effect under pressure from Congress. The budget for fiscal 1960 earmarks $260 million for the program.

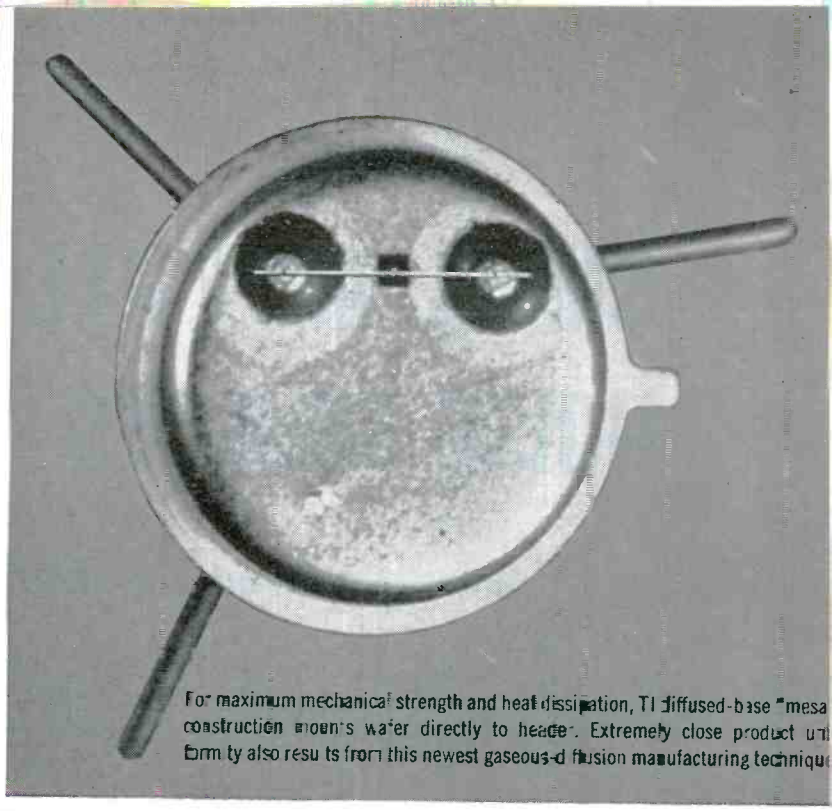
- **Private approaches** to members of the Federal Communications Commission urging transfer of a television channel from one city to another nearby are just as wrong as private approaches made during a competitive hearing for a channel permit.

  That's the ruling by the U.S. Court of Appeals in Washington, D. C., overruling an FCC decision to transfer Channel 2 from Springfield, Ill., to St. Louis, Mo. The court says private appeals made by interested parties require a special FCC hearing to determine if any commissioners or parties should be disqualified from further participation.

  Similar proceedings have been ordered by the courts in several cases involving alleged off-the-record approaches in competitive actions, where several applicants were competing for the same channel permit.

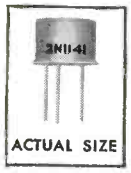
CIRCLE 13 READERS SERVICE CARD→

NEW TI HIGH FREQUENCY DIFFUSED-BASE GERMANIUM TRANSISTORS



For maximum mechanical strength and heat dissipation, TI diffused-base "mesa" construction mounts wafer directly to header. Extremely close product uniformity also results from this newest gaseous-diffusion manufacturing technique.

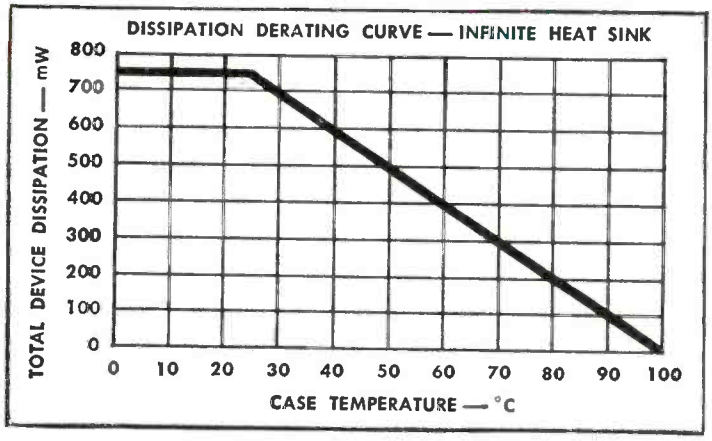
750 MC ALPHA CUTOFF • 750 mW MAX DISSIPATION



Guaranteed current gains of 12, 10 and 8 db minimum at 100 mc with new TI 2N1141, 2N1142 and 2N1143 diffused-base 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 high frequency 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 . . . 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

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
Thermal Resistance Junction to Mounting Base	0.1	0.1	0.1	°C/mW
Small Signal Short Circuit Forward Current Transfer Ratio, $V_{CB} = -10V$, $f = 1000cps$	$10\ I_C$	$50\ I_C$	$100\ I_C$	mA
	0.97	0.85	0.75	

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Until recently signal simulators for monitoring radar receivers or microwave relays were of two types. One was a big and heavy ampere eater with cumbersome auxiliary equipment; and the other was a sensitive though delicate instrument suitable only for the laboratory.

We call your attention now to the Litton 2000 series of miniature gas noise sources. The Litton 2000 for waveguide use is pictured above. It has a first cousin, the Litton 2007 designed for coaxial cable use. We call your attention because most tubes in this series are now in production and we suspect there are frustrated design engineers who will receive this announcement with keen interest.

Our gas noise sources may properly be called miniature. They require only inches of space, smaller, lighter auxiliary equipment, and small voltages and currents. Around 500 volts fires them; 100 milliamperes maintains them. These characteristics, plus others, have caused them to find numerous applications: for in-flight calibration and test of aircraft microwave receivers; as *automatic* watchdogs on airborne radar systems; and in other systems which require various immunities to vibration, shock, humidity, and temperature cycling.

The Litton family of miniature gas noise sources, like all Electron Tube Division products, was designed to solve specific end item functions. We have found that this philosophy contributes to consistent reliability: tubes do their jobs more efficiently, for longer periods of time, and at lower overall cost to the buyer. Other advantages also result. For example, these noise sources require *no* ageing-in and the L-2000 is replaceable in the field without changing the mount.

Specific frequency ranges in L, S, C, X and K bands are covered. If you are concerned with radar transmission, or with microwave data links of any kind, we'll gladly send you more information. Write to Litton Industries Electron Tube Division, Office E14, 960 Industrial Road, San Carlos, Calif.

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CAPABILITY THAT CAN CHANGE YOUR PLANNING

High Sales Mark New Reports

SALES AND EARNINGS for electronics firms continue to climb steadily as the year approaches mid-point.

• **Motorola Inc.,** Chicago, reports earnings of over $2,616,427 or $1.35 a share for the first quarter of 1959. This is nearly four times the total for the same quarter of 1958. Sales rose to $63,653,184, a rise of 56 percent over the first 90 days of last year. The firm reports sharp improvement shaping up for the present quarter as well, due to increased consumer acceptance of Motorola products and successful cost-reduction programs.

• **Texas Instruments, Inc.,** Dallas, Tex., announces sales and earnings for the first quarter this year are the highest in company history. Sales totaled $29,993,000. Earnings after taxes came to $2,400,000 or 74 cents a share. First-quarter sales for 1958 were, $20,480,000, and earnings were $1,109,000. The firm points out that 81 percent of this year's product sales will represent products placed in manufacture during the past three years.

• **Controls Company of America,** Chicago, expects sales to top $45 million this year, as compared to $33 million for 1958. Sales and earnings were up strongly in the first quarter. Total sales hit $12,753,655 as against $6,308,342 for 1958's first quarter. The company's net earnings after taxes were $645,778, or 91 cents a share. In the same period last year, earnings after taxes were $234,144, or 33 cents a share.

• **General Instrument Corp.,** Newark, N. J., reports a March sales peak exceeding $4,200,000, about 70 percent above the March 1958 figure. The company notes that during March, semiconductor shipments rose 350 percent over last year, military components rose 250 percent and electronic entertainment components were up 25 percent.

• **Standard Coil Products,** Melrose Park, Ill., reveals sales increases of 31 percent for the first three months of this year, over last year. Total came to $16,591,852 compared with $12,701,848 for 1958. Net earnings in the quarter were $390,397, or 21 cents a share. In 1958's first quarter, the firm had a net loss of $266,508. Company feeling, based on anticipated performance from new products and increasing orders, is that the rest of the year will see increases.

OVER THE COUNTER

1958 BIDS LOW	1958 BIDS HIGH	COMMON STOCKS	WEEK ENDING May 1 BID	WEEK ENDING May 8 BID	WEEK ENDING May 8 ASKED
3¾	20½	Acoustica Assocs	34	34½	38¼
1⅝	3	Advance Industries	3⅛	2⅞	3⅝
3⅛	6⅝	Aerovox	9¼	11⅛	14½
5½	15	Appl'd Sci Princet	10¼	11	12⅞
1⅛	8⅞	Avien, A	9¾	10⅛	11⅜
6¾	24	Baird-Atomic	29¼	34	42
9¾	13⅜	Burndy	15⅞	15¾	18⅞
6¾	9	Cohu Electronics	7⅞	7⅝	8⅜
11	22½	Collins Radio	38½	37	40⅜
32½	49	Cook Electric	46	46½	52½
4	7	Craig Systems	9⅝	10¼	12
17⅝	25⅜	Eastern Industries	18	18½	20⅜
1¾	8⅜	Elco Corp	8⅝	9	10¾
10½	21	Electro Instr	29½	26	31⅛
34	49	Electronic Assocs	46	45	49⅞
5	11	Electronic Res'rch	18	18	19⅝
8½	12¾	Electronic Spec Co	17¾	15¾	18¾
15¼	49½	Epsco, Inc	39½	37	43
5½	9⅜	Erie Resistor	9	9¾	11⅝
10	17½	Fischer & Porter	13⅜	12¼	14½
5½	10½	G-L Electronics	12¼	12¼	14⅛
12	27	Giannini	31¾	33½	38¼
...	...	Haydu Elec Prod	4¾	5¼	6⅞
30	39½	Hewlett-Packard	49¼	47½	53¾
23¼	48	High Voltage Eng	63	63	69
1¾	3	Hycon Mfg	3¼	3⅛	3⅞
1⅛	5⅛	Industro Trans'tor	5½	6	7⅛
...	...	Internat'l Rec'f'r	26¾	27	31⅛
...	...	Interstate Engin'g	18¾	21	25⅛
1½	4¾	Jerrold	6⅜	6⅛	6⅞
21	30	D. S. Kennedy	28¼	27¼	30⅜
3¾	29	Lab For El'tronics	33	35½	40⅜
19¼	28	Leeds & Northrup	29	31	34⅛
2	3⅛	Leetronics	3⅝	3½	4¼
5	18¾	Ling Electronics	24¾	26½	29⅝
3¼	8¼	Magnetic Amplifiers	8¼	9½	10⅝
2⅞	4½	Magnetics, Inc	5½	6⅛	7
4⅝	12	W. L. Maxson	15⅛	14½	16⅜
10⅝	29	Microwave Assocs	49	26	28½
5¼	11¾	Midwestern Instr	13⅛	12	14¼
1⅛	7	Monogram Precis'n	11¾	12¼	13⅞
3½	7¼	Narda Microwave	10⅜	11⅛	12⅝
...	...	Narda Ultrasonics	9¾	11	12⅝
9¾	16	National Company	24¼	23½	26¾
14¼	56	Nuclear Chicago	38	38	41⅜
4½	7⅜	Pacific Mercury, A	12½	12¼	14⅛
10⅛	27½	Packard-Bell	42	42	45⅝
4¼	9⅜	Panellit, Inc	7⅝	7⅝	8⅞
21	53¾	Perkin-Elmer	48¾	48	57½
11⅜	19½	Radiation, A	21	22¾	25⅛
2⅛	7⅜	Reeves Soundcraft	7½	6¾	8
13	32½	Sanders Associates	34	34	39⅜
...	...	Silicon Transistor	8½	10⅜	11¾
7	12	SoundScriber	16¾	17¼	18⅞
22¾	40	Sprague Electric	45	48½	54½
26	35	Taylor Instruments	33	32¾	35⅝
5½	15	Technical Operat'ns	20½	20	29⅜
5½	15¾	Telechrome Mfg	22½	19	24⅛
3¼	7¾	Telecomputing	11¾	12¼	13⅛
1⅛	2¾	Tel-Instrument	2¾	2¾	3⅜
8¾	16¼	Topp Industries	13⅛	15⅛	17⅛
3¾	10¾	Tracerlab	9¾	9¾	11¼
1⅛	3⅜	Universal Trans'tor	1⅛	1¼	1⅝
14¼	40	Varian Associates	37	36¼	40⅞

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.

←CIRCLE 14 READERS SERVICE CARD

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Raytheon enters new weapons systems program and offers advancement opportunities for both Junior and Senior electronics engineers with experience in the following fields:

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- Feed-back control
- Auto-pilot
- Ground support
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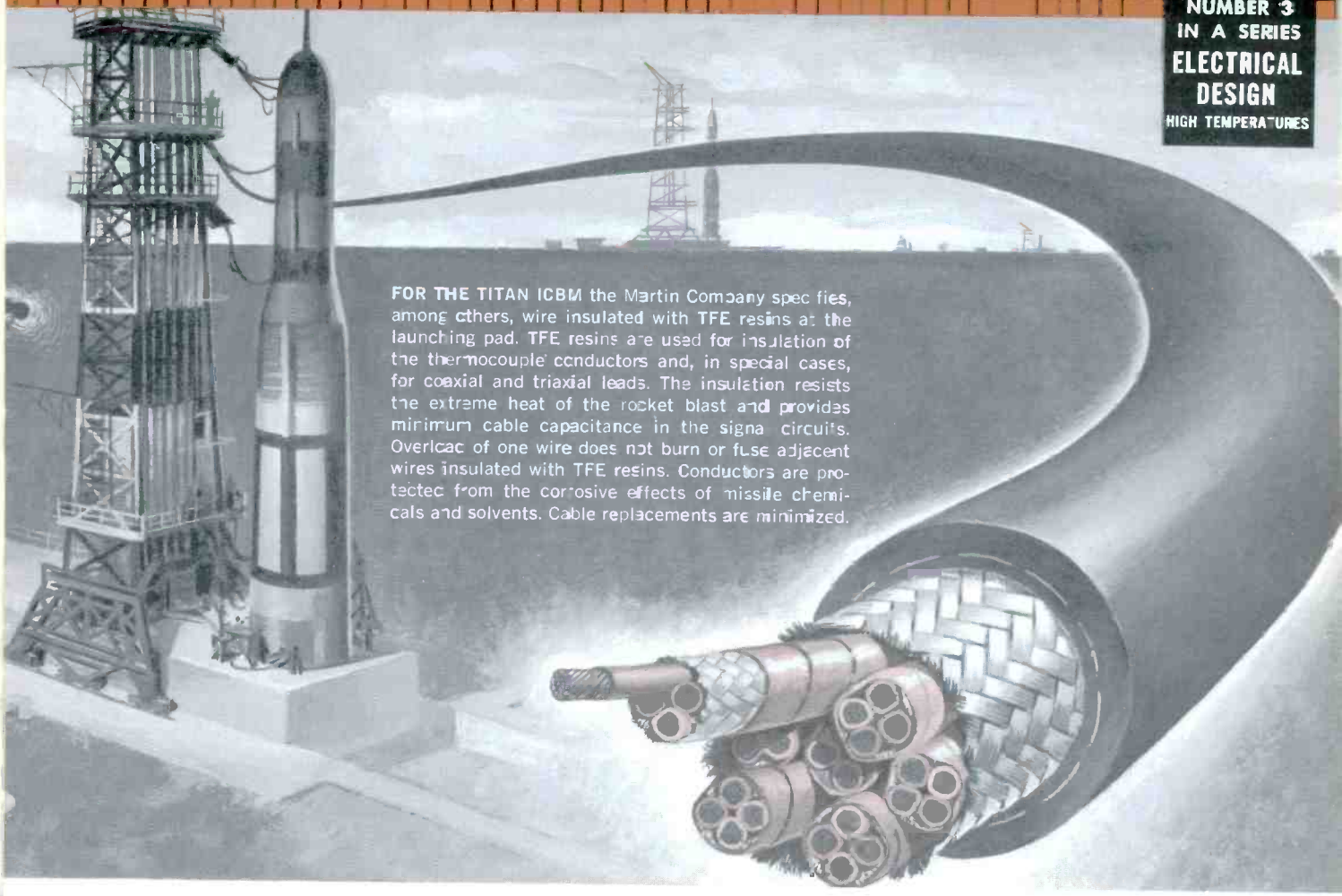

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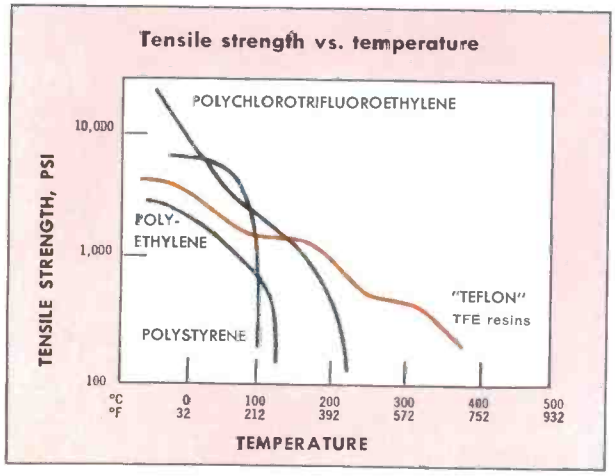
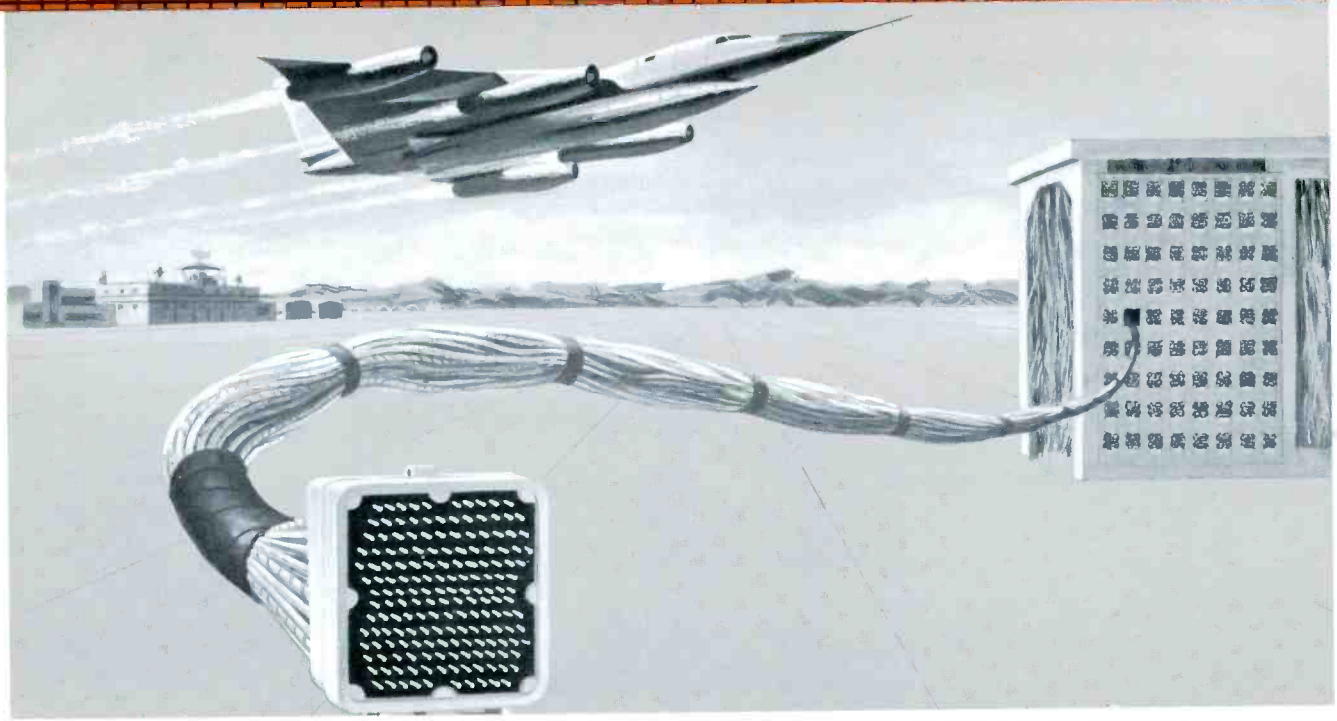
TFE resins outperform all other organic insulations in resistance to high temperatures and heat aging



TFE-fluorocarbon resins retain useful mechanical and electrical properties far beyond their continuous service rating of 260°C. In fact, these resins maintain appreciable mechanical strength even past their 327°C. (621°F.) gel point, as the curve at left shows. For this reason, wire and cable insulated with TFE resins can withstand extremely high temperatures, both ambient and due to current overloads, where other resins melt, char, burn, embrittle or cut through. In production, rapid and efficient soldering is accomplished without damage to insulation. Designers can save weight and space by reducing conductor cross sections and insulation thickness, without sacrificing power ratings. Miniaturization of entire units of equipment is made possible by the excellent thermal stability and high-temperature cut-through resistance of TFE resins. The outstanding dielectric properties of TFE resins remain virtually unchanged over extremely broad ranges of temperature, frequency and time.

OVER

Wire and cable insulated with TFE resins withstand continuous high ambients in the toughest services



WIRE HARNESS for the navigation system of Convair's B-58 bomber is insulated with Du Pont TFE-fluorocarbon resins for maximum reliability in a high ambient temperature environment. Engineers of the Sperry Gyroscope Company, which developed and is producing the B-58 bomb-navigation system, have also found that considerable cost savings are possible in the assembly of such intricate electronic equipment, because TEFLON TFE resins are unaffected by soldering temperatures. Insulations of TFE-fluorocarbon resins do not melt, flow, embrittle or shrink back even after prolonged contact with a soldering iron or solder pot.

TFE-fluorocarbon resins have a built-in safety factor. No other wire and cable insulation offers the design engineer so great a latitude in overcoming temperature problems and accidental overloads. Wire and cable insulated with these resins are generally rated for continuous service at 260°C. Yet recent tests have shown that in some cases the useful wire insulation life of TFE resins is greater than 1000 hours at 350°C. (662°F.) and 100 hours at 400°C. (752°F.). The heat-aging data below show that even after 6 months at 300°C. (572°F.) the excellent electrical properties of TFE resins are unchanged, and mechanical toughness is retained.

The reliability of TEFLON TFE-fluorocarbon resins extends through all areas of their use—in the assembly and production of equipment, in storage under any conceivable combination of environmental conditions, in actual service where their durability is often greater than the lifetime of the equipment. Wherever reliability and safety are imperative, wire and cable insulated with Du Pont TFE-fluorocarbon resins will do the job best. Often, use of this wire and cable is *the least costly way* to achieve a design objective.

EFFECT OF HEAT AGING

Results of oven aging at 300°C. (572°F.)*

	ELECTRICAL			MECHANICAL							
Exposure time at 300°C.	Dissipation Factor	Dielectric Constant	Dielectric Strength (volts/mil) ASTM D-149	Yield Stress (psi)		Yield Elongation (%)		Tensile Strength (psi)		Ultimate Elongation (%)	
				MD**	TD***	MD	TD	MD	TD	MD	TD
As received	0.0001	2.03	2930	4970	2100	74	3.8	6780	4790	190	640
1 month	0.0001	2.08	2830	3880	2290	71	2.8	5740	3670	320	910
3 months	0.0001	2.08	2890	3920	2420	75	3.0	5000	3340	300	955
6 months	0.0001	2.11	2950	3540	2320	82	2.5	4150	2430	296	982

*5-mil film samples of TFE-fluorocarbon resins Tests performed at room temperature following heat aging

**MD—Machine direction

***TD—Transverse direction

FOR MORE INFORMATION . . .

Consult your supplier of wire and cable insulated with TEFLON TFE resins for an engineering approach to your wiring reliability problems. You'll find him listed in the Yellow Pages under "Plastics—Du Pont". Or, for detailed technical data on TFE resins, write to: **E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Rm. 2524, Nemours Bldg., Wilmington 98, Delaware.**

In Canada: *Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.*

TEFLON *is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.*

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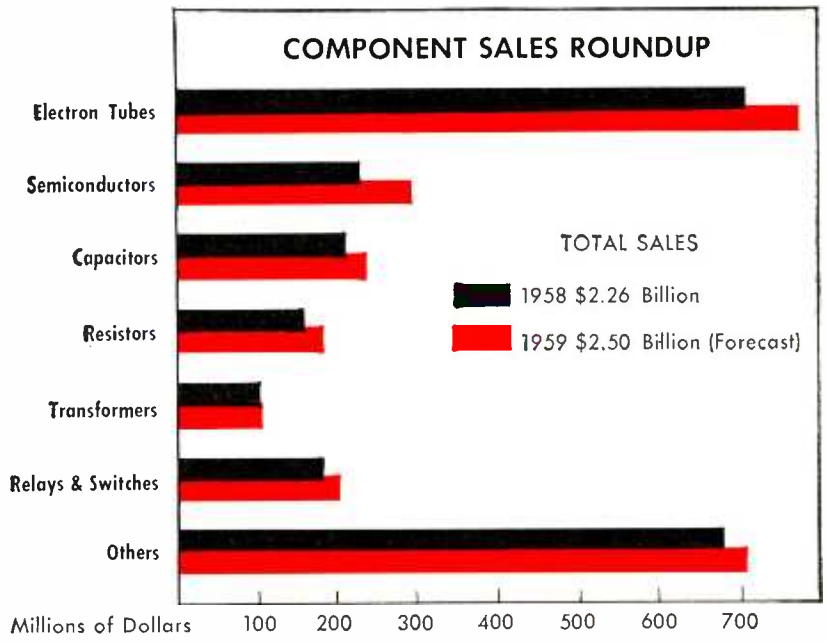

Component Sales On Rise

OUTLOOK FOR SALES of electronic components and parts in 1959 is bright. Total component sales this year should beat 1958 sales by 10 percent.

Behind the optimistic forecast is the pickup in general business activity, inventory reductions achieved last year and continued industry growth.

Estimate for 1959 component sales is $2.5 billion. This compares with 1958 sales of $2.26 billion. Estimates include components sold both for installation in new equipment and for use as replacement parts.

Semiconductors stand out among the individual components in a comparison of 1958 sales with 1959 forecasts. Transistors are scheduled for sales of $160 million in 1959, a gain of more than 40 percent over sales of $113 million in 1958. Rectifier and diode sales are expected to jump from $116 million in 1958 to $135 million this year.

Electron tube sales are expected to move up from $705 million in 1958 to $773 million with individual increases for receiving tubes, picture tubes and transmitting and special-purpose types.

Prospects are good for sales of capacitors, resistors, relays and switches. Capacitor sales forecast for 1959 is $236 million, an increase of 12 percent over 1958. Resistor forecast is $184 million, a gain of 14 percent over last year. Relays and switches are due for a 13 percent gain with 1959 sales reaching $202 million.

Transformers are expected to account for sales of $105 million in 1959, up from $101 million last year. Sales total for the other components group was $675 million in 1958. It should rise to around $705 million in 1959.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	May 1, 1959	Apr. 3, 1959	Change From One Year Ago
Television sets	92,157	111,563	+19.2%
Radio sets (ex. auto)	255,218	263,316	+70.6%
Auto sets	117,422	104,090	+195.4%

STOCK PRICE AVERAGES

(Standard & Poor's)	May 6, 1959	Apr. 8, 1959	Change From One Year Ago
Electronics mfrs.	101.57	82.28	+93.5%
Radio & tv mfrs.	112.68	97.24	+143.7%
Broadcasters	104.32	92.10	+70.4%

LATEST MONTHLY SALES TOTALS

(Add 000)	Mar. 1959	Feb. 1959	Change From One Year Ago
Rec. tubes, value	$35,286	$28,630	+37.2%
Rec. tubes, units	39,841	33,155	+39.6%
Pic. tubes, value	$13,804	$14,085	+9.2%
Pic. tubes, units	717	738	+13.0%

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We offer a complete design-engineering service based on long experience and specialized production equipment, and often are able to suggest ways and means of using some of our many stock tools to cut your costs still further.

Perhaps we can develop cost-cutting ideas for you, too. The booklet describes and illustrates the range and types of parts we fabricate. A sample, drawing or description of a part you need to produce at a low cost will give our designers a chance to work on your cost problems—at no obligation to you.

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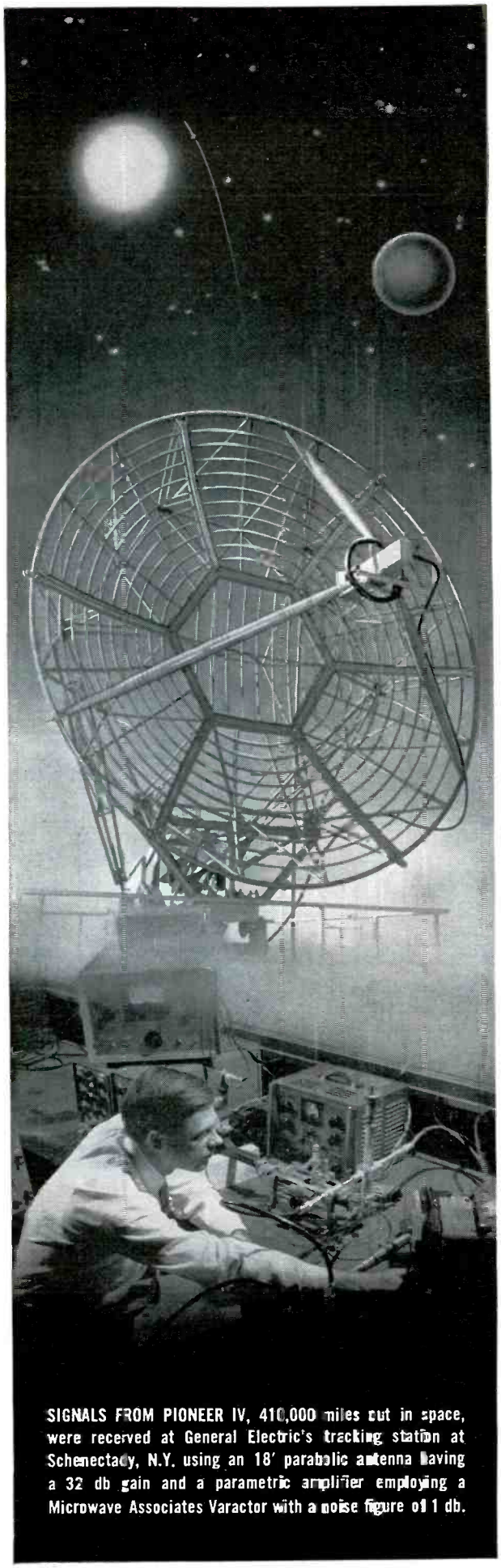

SIGNALS FROM PIONEER IV, 410,000 miles out in space, were received at General Electric's tracking station at Schenectady, N.Y. using an 18' parabolic antenna having a 32 db gain and a parametric amplifier employing a Microwave Associates Varactor with a noise figure of 1 db.

VARACTOR PROGRESS REPORT

. . . from 410,000 miles in space

Parametric amplifier using Microwave Associates Varactor made possible signal reception from Pioneer IV

The spectacular performance recorded at General Electric is another in a series of new, immediate applications reported by our customers.

Other customers are exploring applications in voltage tuned microwave circuits, reactive limiters, harmonic generators, and high level modulators.

Modulators — A big field for Varactors

It's a difficult problem to impress VHF and UHF intelligence on a microwave carrier. The varactor accomplishes this exceptionally well with signal gain in the side bands as opposed to low efficiency techniques. Varactors are excellent high level modulators for double and single band transmitters. Signal power gain is obtained since transmitting modulators are up-convertors. Power capabilities are far superior to point-contact diodes. Further, the uniformity of varactors facilitates carrier suppression through the use of matched pairs in balanced modulators.

Silicon vs. Germanium

Silicon is used in the MA Varactor because it has excellent properties at elevated temperatures, a sharper break-down characteristic and, because its low saturation current allows voltage swings further into the positive region without conduction current and its associated noise and losses. Germanium of course, cannot duplicate all these characteristics. Varactors approach master performance without need for refrigeration.

Availability

Microwave Associates was first in the field and is in volume production of over a half dozen popular types. You can get immediate delivery.

Prices

Down sharply in some instances . . . in accordance with substantially improved production yields. Quantity prices on some types now.

Microwave Associates has recently published a brochure available to those who feel varactors have potential in their applications. If you have specific questions on applications of microwave semiconductors, our Research and Development Section will be pleased to help.

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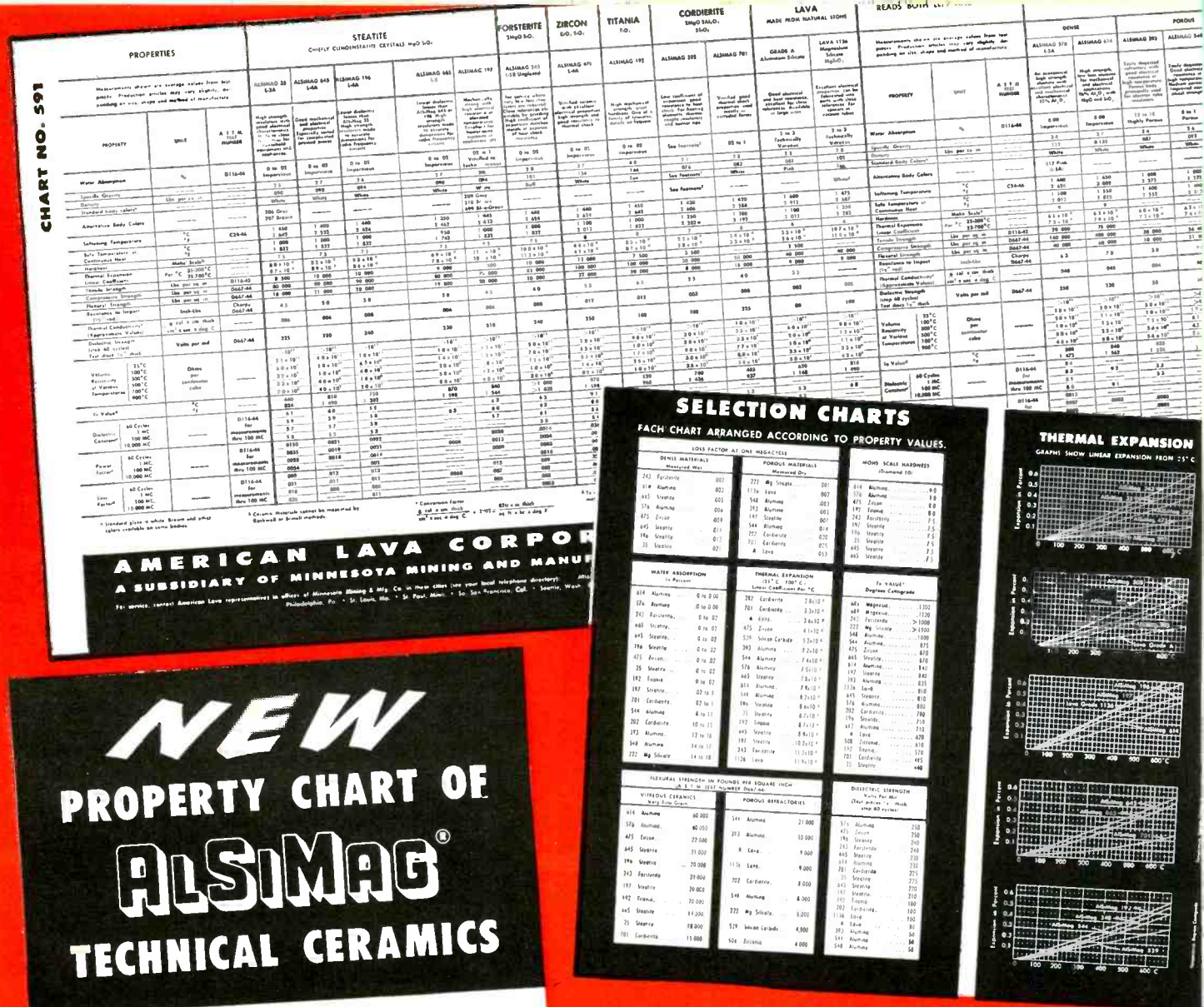

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The AlSiMag trade mark includes the widest variety of technical ceramics available from any single source . . . backed by the most inclusive custom manufacturing facilities in the industry. Now well into its second half century of leadership in technical ceramics, this is the place you are most apt to get what you want, when you want it.

WHAT THE CHART TELLS

The chart gives principal physical and electrical characteristics of the most frequently used AlSiMag compositions. If your work includes design, production or purchasing you will find this chart valuable. It is completely factual and is of convenient file size.

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WHERE ALSIMAG IS USED

AlSiMag ceramics are unexcelled in electronic and electrical applications because of their superior dielectric properties, especially at elevated temperatures. They have many mechanical and chemical applications.

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Electric Cars: Parts Market?

Battery developments and costs may determine if automakers now researching the possibility of an electric economy car get green light

THE ELECTRIC CAR, long a dark horse of the American roads, is now a bright though distant hope of automakers and battery manufacturers.

It could mean a new mass market for batteries and rectifiers. Silicon rectifiers now seem promising for such an assignment.

European interest in the electric car has been great for some time. "The operating cost of an electric car today in France is 1/6 that of a conventional car of the same weight," says electrical engineer Henri Andre, who has been driving one in Paris since 1954. It runs on the rechargeable silver-zinc battery he developed.

Yardney International Corp., which licenses Yardney Electric Co. of New York to manufacture the battery, sponsors Andre's work on the electric car.

Nickel-Cadmium Battery

Last month American Motors Corp. and Sonotone Corp. announced a joint program to develop an electric car operating on a sintered-plate nickel-cadmium battery. Major goal is development of a power plant that would be constantly recharged during operation by a small gasoline motor-generator.

George Romney, president of AM, cautiously explained that the research program would seek answers to such questions as cost, operating economy, performance, size and weight.

Sonotone says its battery requires only a few drops of water a year and lasts from 10 to 20 years, holding its charge under extreme temperature changes. The nickel-cadmium battery is said to have a relatively small size for its power output.

Many U. S. automakers are now showing interest in nickel-cadmium, silver-cadmium and silver-zinc batteries, if not actually engaged in research on electric automobiles. Automakers are also investigating new lead-acid units.

Lead-Acid Batteries Used

Right now, refinement in fabrication of the conventional lead-acid battery is putting more special-purpose electric trucks on the road. Cleveland Vehicle Co. is in production with a 3,000-lb truck which uses a 1,750-lb lead-acid battery made by Electric Storage Battery Co., Philadelphia. The truck manufacturer makes its own silicon rectifiers.

Walter Thomas, president of Cleveland Vehicle, reports the company has 42 orders so far, expects to start deliveries in about one week. He sees a short-haul fleet market opening up by the end of the year and predicts a market for 12,000 electric trucks in five years. Dairies, laundries and bakeries with short routes, but many stops, are interested in the trucks which have an 80-mi range, using a 452-ampere-hour capacity battery.

Thomas says the battery, mounted below the center of the vehicle, permits a 3,000-lb truck to carry a 3,000-lb payload. He told ELECTRONICS that the 48-volt system uses a 10 × 15 × 18-in. silicon rectifier and transformer unit. Four silicon diodes are mounted on aluminum heat sinks. Rectifier gives 53 to 63 volts automatically regulated to a maximum of 30 d-c amp, with a power factor of 87 percent and efficiency of 95 percent on a 110-volt line.

Electric Storage Battery is working closely with the Cleveland firm. Recent design developments, such as the use of polyethylene tubing instead of rubber, are said to increase efficiency of the battery substantially over that of older lead-acid units.

A spokesman for ESB suggested that optimum use of an electric truck might encompass speed of about 25 mph and some 250 stops over a route of 30 to 50 mi. He claims operating cost of one to three cents a mile, low maintenance costs and the need for only a small maintenance crew.

Stinson Aircraft Tool & Engineering Co. is reportedly using a 528-lb ESB lead-acid battery to power two three-horsepower motors in a three-passenger car called the Town-About. Public utilities are reportedly interested in 100 cars—

French electrical engineer Henri Andre shows 56-cell, 256-ampere-hour silver-zinc battery that runs his remodeled Dyna-Panhard car up to 48 mph and as far as 150 mi on one charge

priced at $2,200 per car—for testing purposes. Battery is about 60 in. wide, 10 in. deep and 9 in. high.

Silver-Zinc Battery

Yardney Electric believes that new silver-zinc or silver-cadmium batteries will make the electric car feasible for the mass market, claims these push range to about 150 mi.

Andre's three-seat car now runs on a rechargeable silver-zinc battery, goes 150 mi. on one charge. The 6-hp car, a remodeled Dyna-Panhard, has a maximum speed of 48 mph, weight of 1,900 lb. Battery's 56 cells put out 80 volts with a capacity of 256 ampere-hours. Life range claimed is 60,000 mi. Battery dimensions are 2 ft 9 in. long, 2 ft 4 in. wide and 8⅜ in. high.

The car also uses an auxiliary battery of 12 volts and 20 ampere-hours for lights, horn and directional signals. Charger is carried in trunk, weighs 22 lb, including a silicon rectifier and transformer.

A Yardney spokesman says Andre is developing a new sports car that will operate on an improved silver-zinc battery giving it a 240-mi range on one charge. The new Andre car will seat two in tandem, is expected to reach 60 mph; total weight is 1,600 lb including battery weight of 352 lb. This car will be 11 ft long, 3½ ft wide and 3½ ft high.

Design eliminates gear box, clutch and differential and achieves speed control electrically. Two batteries, each about 6 × 6 in. and weighing 176 lb, will fit under arm rests and put out 48 volts, with a capacity of 300 ampere-hours.

Silver-Cadmium Battery

Although Andre's new design is based on the silver-zinc battery, Yardney says that it is pushing development of a silver-cadmium battery. Firm wants to improve the power output of silver-cadmium, which is about 60 percent of that of silver-zinc, and take advantage of silver-cadmium's four- to five-year life, compared to one or two years for silver-zinc.

Yardney says that volume production for cars would make battery cost attractive, suggests that a car owner might rent one for $15 to $25 a month, and trade it in for another when the charge runs low.

General Plate Clad Metals
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In Semiconductor Applications

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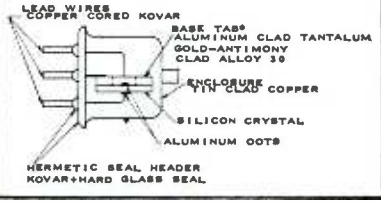
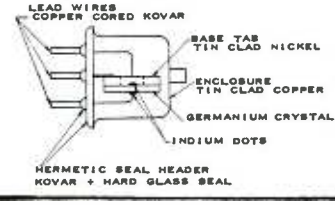
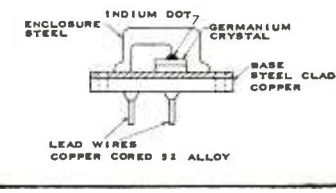
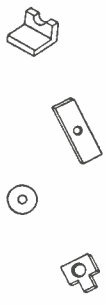


GERMANIUM TRANSISTOR



GERMANIUM POWER TRANSISTOR





I BASE TAB MATERIAL

A For Germanium (Single Clad Only)

1. Tin Clad Nickel
2. Tin Clad Alloy 30 (42% Nickel-58% Iron)
3. 63.2% Lead-35% Tin-1.8% Antimony Clad Nickel
4. 63.2% Lead-35% Tin-1.8% Antimony Clad Alloy 30
5. 63.2% Lead-35% Tin-1.8% Indium Clad Nickel
6. 63.2% Lead-35% Tin-1.8% Indium Clad Alloy 30
7. 99% Tin-1% Gallium Clad Nickel
8. 98% Tin-2% Antimony Clad Nickel
9. 95% Tin-5% Antimony Clad Nickel
10. Tin Clad Steel
11. Tin Stripe on Nickel
12. Tin Clad Titanium

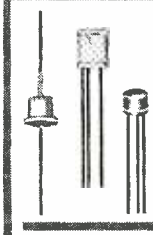
B For Silicon (Single or Double Clad & Stripes)

****Solder**

1. Gold
2. 99.5% Gold-.5% Antimony
3. 99% Gold-1% Gallium
4. 95% Gold-5% Indium
5. 99.9% Gold-.1% Boron
6. 99% Gold-1% Aluminum
7. 99% Gold-1% Arsenic
8. Fine Silver
9. 99.5% Silver-.5% Antimony
10. 95% Silver-5% Indium
11. Aluminum
12. High Purity Aluminum

BASE METAL

1. Nickel
2. Alloy 20 (40% Nickel-60% Iron)
3. Alloy 30 (42% Nickel-58% Iron)
4. Kovar
5. Titanium
6. Tantalum
7. Molybdenum
8. Silver
9. Platinum

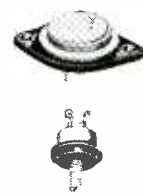


II LEAD WIRE MATERIAL

1. Copper Cored Rodar (Soft Glass Seals)
2. Copper Cored 52 Alloy (Compression Seals)
3. Copper Cored 446 Stainless Steel
4. Nickel Clad Copper Wire
5. Copper Clad Nickel Wire

III WHISKER WIRE MATERIAL

1. 95% Platinum-5% Ruthenium
2. 99% Gold-1% Gallium
3. 99.5% Gold-.5% Antimony
4. 90% Platinum-10% Iridium



IV BASE MATERIAL

1. Aluminum Killed Low Carbon Steel Clad Copper
2. Stainless Steel Clad Copper
3. Nickel Clad Steel (Nifer)®
4. Nickel Clad Copper
5. Nickel Clad Tantalum
6. Silver Clad Tantalum
7. Aluminum & Nickel Double Clad Tantalum

V ENCLOSURE MATERIAL

1. Tin Clad Copper
2. Glass Clad Nickel Silver
3. Tantalum Clad Nickel Silver

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The General Plate Clad Metals for semiconductor applications described here comprise only a partial listing. To find out more about these or other combinations to meet your specific requirements, write directly to Industrial Metals Product Manager, or request our special catalog on clad and solid metals for electronics applications.

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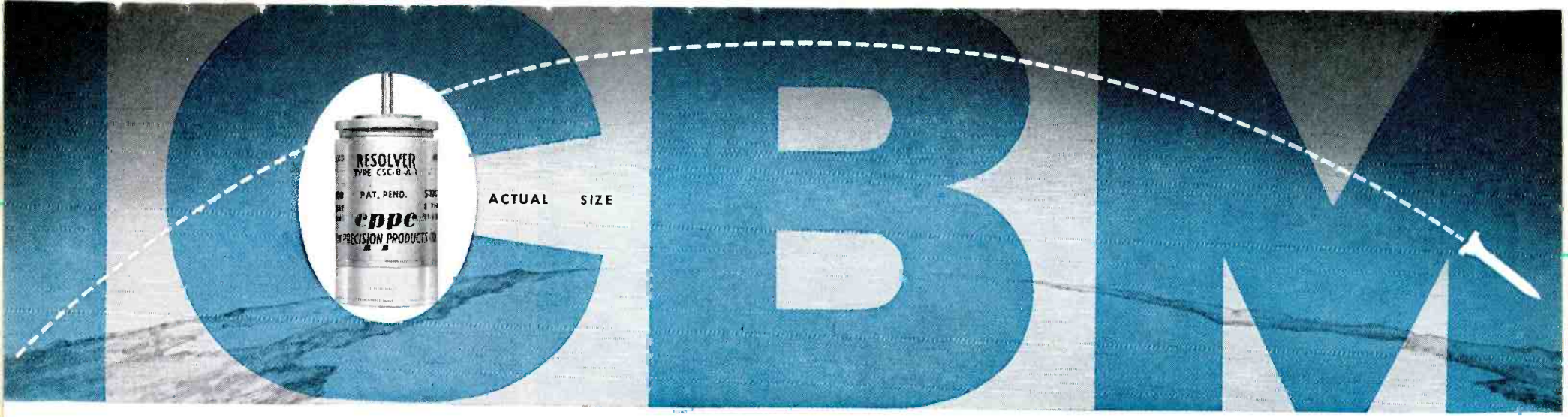

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SYNCHRO FUNCTION	CPPC TYPE	ROTOR AS PRIMARY: Input Voltage (400 ~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	STATOR AS PRIMARY: Input Voltage (400 ~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	D.C. RESISTANCE: Rotor (Ohms)	Stator (Ohms)	IMPEDANCE: Zro (Ohms)	Zso (Ohms)	Zrss (Ohms)	Max. Null Voltage (MV)	Max. Error (Min.)
Torque Transmitter	CGC-8-A-7	26	100	.54	11.8	206	8.5	—	—	—	—	—	—	37	12	54+j260	12+j45	80+j20	30	7
Control Transformer	CTC-8-A-1	—	—	—	—	—	—	11.8	.087	.21	23.5	411	9	143	24	210+j690	28+j114	250+j73	30	7
Control Transformer	CTC-8-A-4	—	—	—	—	—	—	11.8	.030	.073	22.5	393	8.5	365	64	470+j1770	81+j330	590+j190	30	7
Torque Receiver	CRC-8-A-1	26	100	.54	11.8	206	8.5	—	—	—	—	—	—	37	12	54+j260	12+j45	80+j20	—	30 sp.
Electrical Resolver	CSC-8-A-1	26	.038	.39	10.8	189	20	11.8	.080	.25	23.5	411	11	230	27	270+j630	39+j142	340+j67	30	7
Electrical Resolver	CSC-8-A-4	26	.038	.39	26	454	20	26	.030	.23	21.5	376	12	230	170	270+j630	250+j830	340+j67	30	7
Torque Differential	CDC-8-A-1	—	—	—	—	—	—	11.8	.087	.21	11.5	204	9	36	24	38+j122	28+j114	47+j13	30	7
Vector Resolver	CVC-8-A-1	26	.100	54	11.8	206	8.5	—	—	—	—	—	—	37	16.5	54+j260	19+j60	80+j20	30	7

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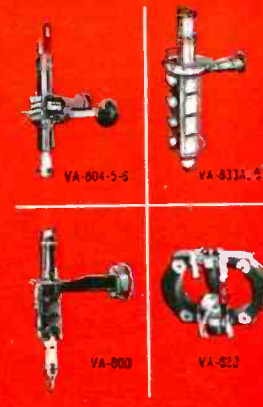

VA-800	1.7 to 2.4 kMc	10kW cw
VA-802	1.7 to 2.4 kMc	1kW cw
VA-804	4.4 to 5.875 kMc	2kW cw
VA-805	5.875 to 6.425 kMc	2kW cw
VA-806	7.125 to 8.5 kMc	2kW cw
VA-822	9.9 to 10.8 kMc	1kW cw
VA-833A, B	.47 to .985 kMc	10kW cw

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UK Presses Nav-Aid Fight

British denounce international technical meeting which approved U. S. short-range system. American officials reply to charges

MEMBER NATIONS of the International Civil Aviation Organization this month will probably receive a preliminary recommendation that Vortac (vhf omnirange-Tacan), the U. S. short-range air navigation system, be accepted as the international standard, as voted by a technical meeting last February.

U. S. observers believe the Vortac recommendation will eventually become final for practical, if not technical reasons. They say VOR (vhf omnirange) is doing a good job in the U. S. where traffic densities are much greater than in Europe, and that the worldwide investment in VOR is so great it cannot be scrapped. DMET (Tacan-compatible distance measuring equipment), these observers say, is a natural supplement to VOR and the experience of the U. S. justifies its use.

The vote in favor of VOR and DMET at the technical meeting in Montreal last February followed a bitter fight between American advocates of VOR-DMET and British proponents of the Decca hyperbolic system.

Awaiting Action

ICAO's Air Navigation Commission was expected this month to pass on the controversial recommendation to the 74 member states. After the commission hears from ICAO's members it will make its official recommendation to the ICAO Council, consisting of 21 countries, which will decide the standard.

The British Ministry of Transport and Civil Aviation is fully behind Decca, has stated that Decca answers all problems and that the "advantages of the system are unassailable." The government indicated in the House of Commons that it will continue pressing the Decca case.

A report on the meeting, published by the Decca Navigator Co., apparently with the tacit approval of the British government, suggested that the U. S. had packed the meeting to railroad its plan through.

"The list of states represented contained some curious and unexpected delegations," the document says. "South Korea, Chile, Nicaragua, Ecuador and Bolivia—none of whom had attended the 6th Communications meeting — were amongst those present."

A U. S. official told ELECTRONICS that since the 1957 communications meeting (referred to in the British statement), at which the U. S. raised the question of DMET specs, this country had educated American and foreign technicians on U. S. air navigation studies and operating experience. He said that it was proper that small nations, for whom VOR represents a sizable investment in terms of their own economies, found it in their national interests to attend the meeting after the British, "late in the game," demonstrated the Decca system and proposed it as an alternative.

Pros and Cons

Decca Navigator insists that the Decca system would be proven to be a far more accurate navigational aid than the American system, if matched to a list of requirements. Decca says DMET has not been evaluated by anyone besides the U. S. and that it is inferior anyway for use in high density traffic areas involving jets.

The U. S. position is that evaluation results have been given other countries and that a point-by-point technical comparison of the competing systems is not necessarily a practical method of evaluation.

The British have charged: "Present standards of safety in congested air space cannot be maintained with the use of VOR-DMET without seriously reducing the efficiency of air traffic control."

American observers have several answers to this: They cite compatible Doppler VOR gear (ELECTRONICS, p 29, May 1), for use at the relatively small number of VOR locations where natural or man-made obstructions cause siting difficulties.

An industry source asserts that in New York, for example, aircraft beacons will still be necessary for altitude segregation and perhaps surveillance radar too, regardless of the nav-aid used. The latter, using a polar coordinate system, he says, is more compatible with VOR than Decca.

The British claim some 200 to 300 civil aircraft have been fitted with the hyperbolic system, including BEA's Viscount fleet, BOAC's Comet fleet and other UK operators. Decca states that the number of military aircraft using the system is classified but that it "runs into thousands."

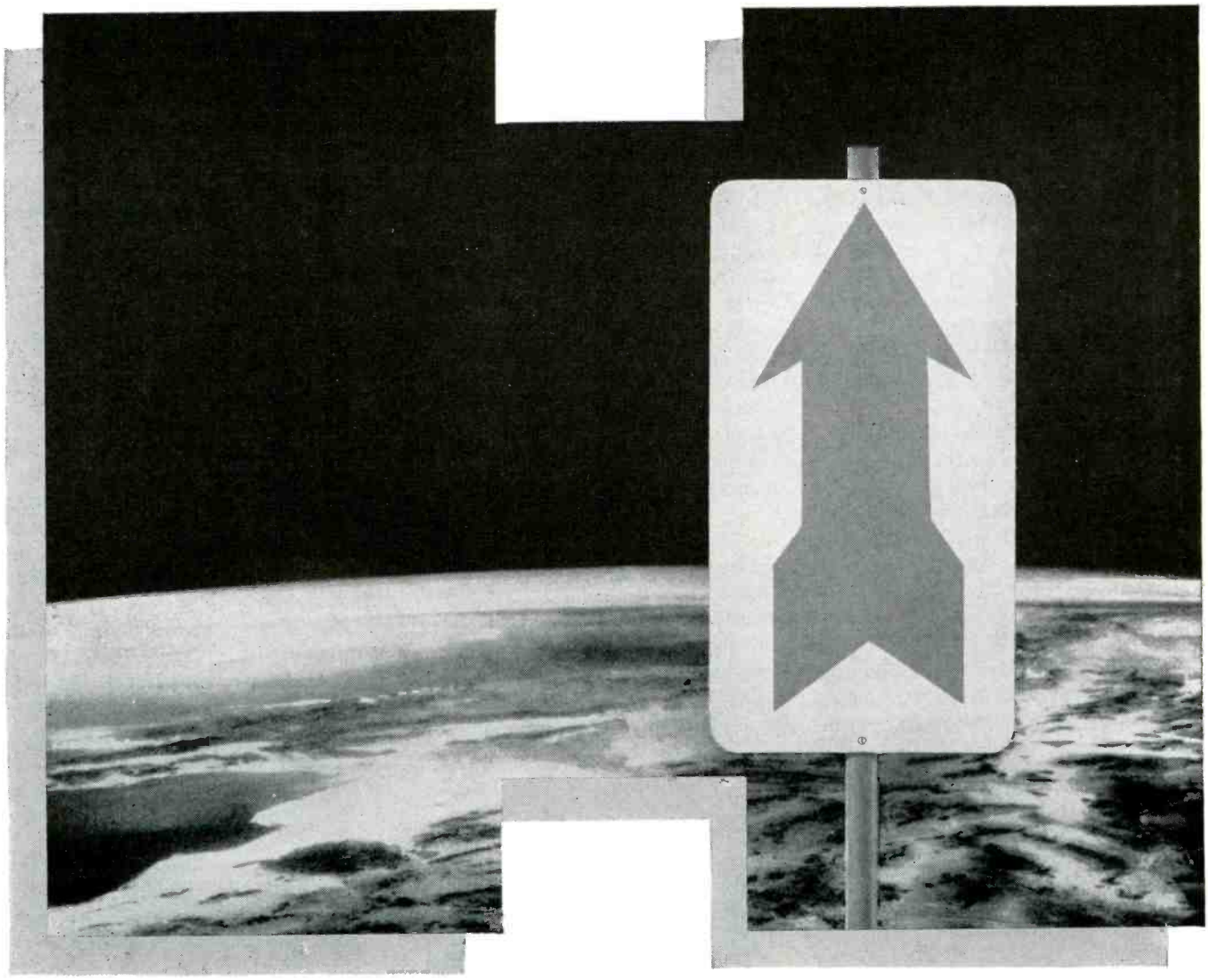
The U. S. has been getting first-hand experience with the Decca system by spending $520,000 on helicopter tests in the New York City area. When one phase of an FAA-sponsored study is completed in September, New York Airways will have logged 10,000 hours with the system. An FAA engineering helicopter has flown another 700 hours with the Decca system.

Much of the data from this experiment, says FAA, can be translated to fixed-wing aircraft—factors such as cockpit workload, reliability and stability of the system.

Electronics Helps

Using electronic office dictating machines made by T. A. Edison Industries, 10 Florida State U. stenographers transcribed 300 pages of technical material in record time

Sign of the



Southern California and Arizona from 143 miles up, *photographed from a Navy Viking 12 rocket, fired from White Sands, N.M. Dark patch at lower left is the Gulf of California.*

times

Going up... and out into space... this is one of the assignments of engineers in the laboratories at Hughes.

To meet the demands of the Space Age, a wide variety of new projects is being initiated. Here are just a few examples:

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Communications Satellites—Unique packages for space satellite applications.

ALIRBM—Air launched intermediate range ballistic missiles.

Global Surveillance Satellite Systems—To keep the world under surveillance.

Satellite Interception Systems—To destroy hostile satellites.

Meteor Communications—Scattering electromagnetic energy off meteors to establish long-range communications.

Futuristic Instrumentation Displays—Instrumentation displays for satellites and hypersonic vehicles.

Other Hughes activities are also participating in advanced Research and Development. Engineers at Hughes in Fullerton are developing new types of radar antennas which scan by electronic rather than mechanical means. Hughes Engineers in El Segundo develop test equipment which is as advanced as the equipment being tested. At Hughes Products, the commercial activity of Hughes, new ways have been found to *cast* silicon into desired configurations... and storage tubes with 21" diameters have been developed.

Today Hughes offers Engineers and Physicists the chance to work on stimulating projects in a wide variety of fields. Never have the opportunities been more promising!

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

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Write in confidence, to Mr. R. A. Martin, Hughes General Offices, Bldg. 6-D5, Culver City, California.

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Test Gear Market

Environmental test equipment sales are expected to hit $80 million this year. Needs for space, sea operations and reliability spur sales

THE MARKET for environmental test equipment will double this year, according to reliable industry sources. Two big reasons account for the expansion:

The multitude of new conditions encountered in space—and under the sea—call continually for new test parameters. Also, there is increased emphasis on reliability testing, from predesign to sample testing of the finished product.

Environmental test equipment sales for 1959 are expected to hit $80 million. Over 15 percent, or $12 million, of this amount is for the electronic portions of the chambers. Instrumentation for some chambers, however, according to Tenney Engineering, may go up to 50 percent of the total cost.

Companies making consumer products will buy 10 percent of environmental test equipment sold this year (half are electronics firms); firms making defense products, 65 percent (70 percent of these are electronics companies); government labs will buy 20 percent (60 percent of which are for electronic work); and colleges and universities, 5 percent.

Apart from the test chambers, a good $30 million to $40 million will be spent by test chamber buyers for auxiliary electronic devices to record, process and reprocess data obtained from tests.

Electronic devices bought by test chamber manufacturers and installed as part of the test gear before delivery to the customer includes complete instrumentation and control for each parameter the equipment simulates. One chamber may be capable of testing tolerance against temperature, humidity, altitude, rain and sunshine. The customer must be able to control each parameter to simulate, monitor and record the results.

Components used in electronic instrumentation include: amplifiers, sensing elements, recorders, transducers, servomechanisms, relays, timers, diodes, transistors, converters and transformers.

Extra electronic equipment the consumer will buy for handling data may run from a simple magnetic tape recorder to large-scale digital computer.

IBM Owego uses an estimated $1 million worth of environmental test equipment. Associated test gear, says a plant official, amounts to

Environmental test chamber used by Army Chemical Corps simulates altitude, temperature and humidity conditions. Chamber was built by Tenney Engineering, control console (right) was manufactured by Bristol

to Double

another $1 million—¾ bought from the industry and ¼ built locally for specific functions.

Besides data-reduction equipment, the plant uses oscilloscopes, accelerometers, visicorders, unit test equipment, relay miss testers, potentiometer linearity measurement gear, automatic read and record equipment for measuring electronic parameters, strain gage equipment and stroboscopic equipment for visual examination of vibration problems.

Buying New Gear

Hazeltine, with five major environmental test chambers and a number of small ones, has managed so far to do 95 percent of necessary reliability testing with company-owned chambers. Need for testing new parameters, however, will probably result in Hazeltine's buying eight more chambers this year.

Sperry recently installed an 18 ft × 12 ft × 14 ft chamber that simulates pressure and temperature. It can also accommodate an 18-ton vibrator. Built by Tenney, the chamber cost $½ million. It is being used for Sperry's ecm work. Sperry has a total of 78 test chambers operated by more than 100 engineers and technicians.

In today's space age, new conditions that must be simulated include: cosmic rays, solar radiation, ionized gases, solid particles, magnetic fields, space atmosphere and ionization conditions.

Environmental conditions already being simulated include: heat, cold, humidity, precipitation, wind, dust penetration and abrasion, salt spray and atmospheric pressure.

Other conditions are mechanical and acoustical vibration, shock, explosion, nuclear radiation, radio interference and high acceleration.

Improved electronic devices will increase the applicability of environmental test equipment and consequently boost electronics sales. Chamber makers are on the lookout for better instrumentation, more flexible programmers, better control devices for programmed cycles, thermistors to cover the field more adequately, and lower costs.

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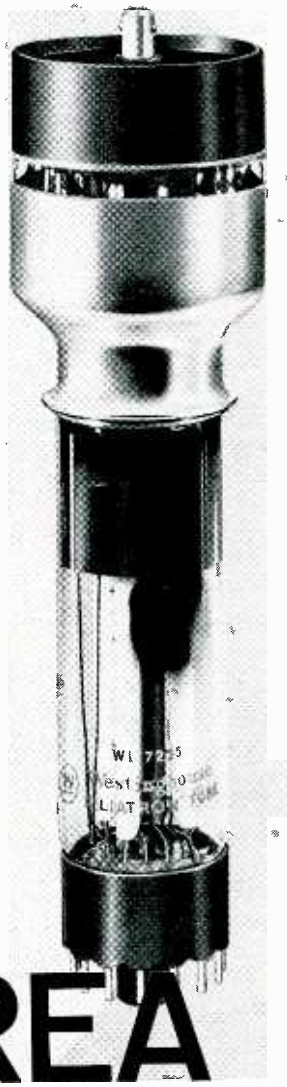

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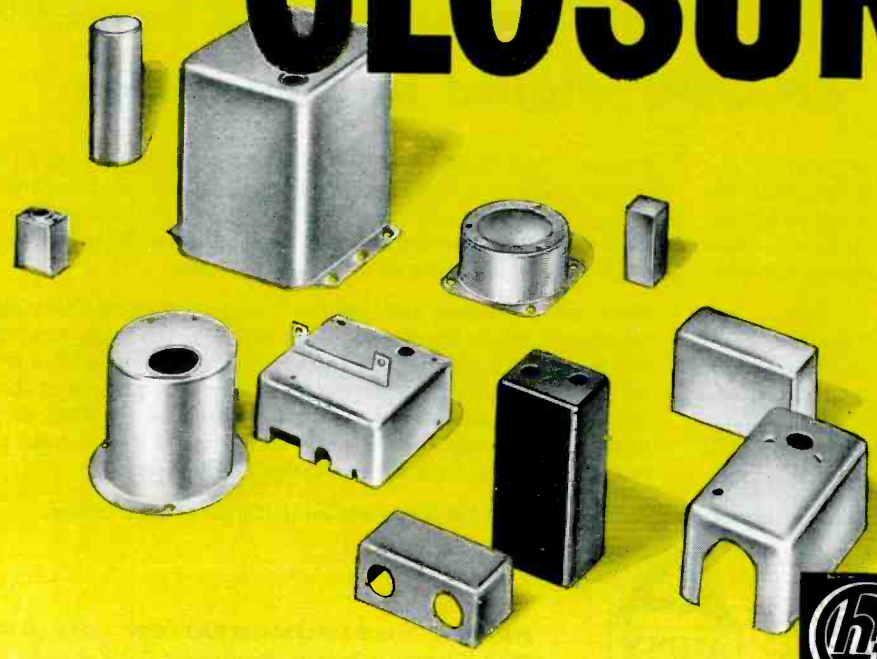

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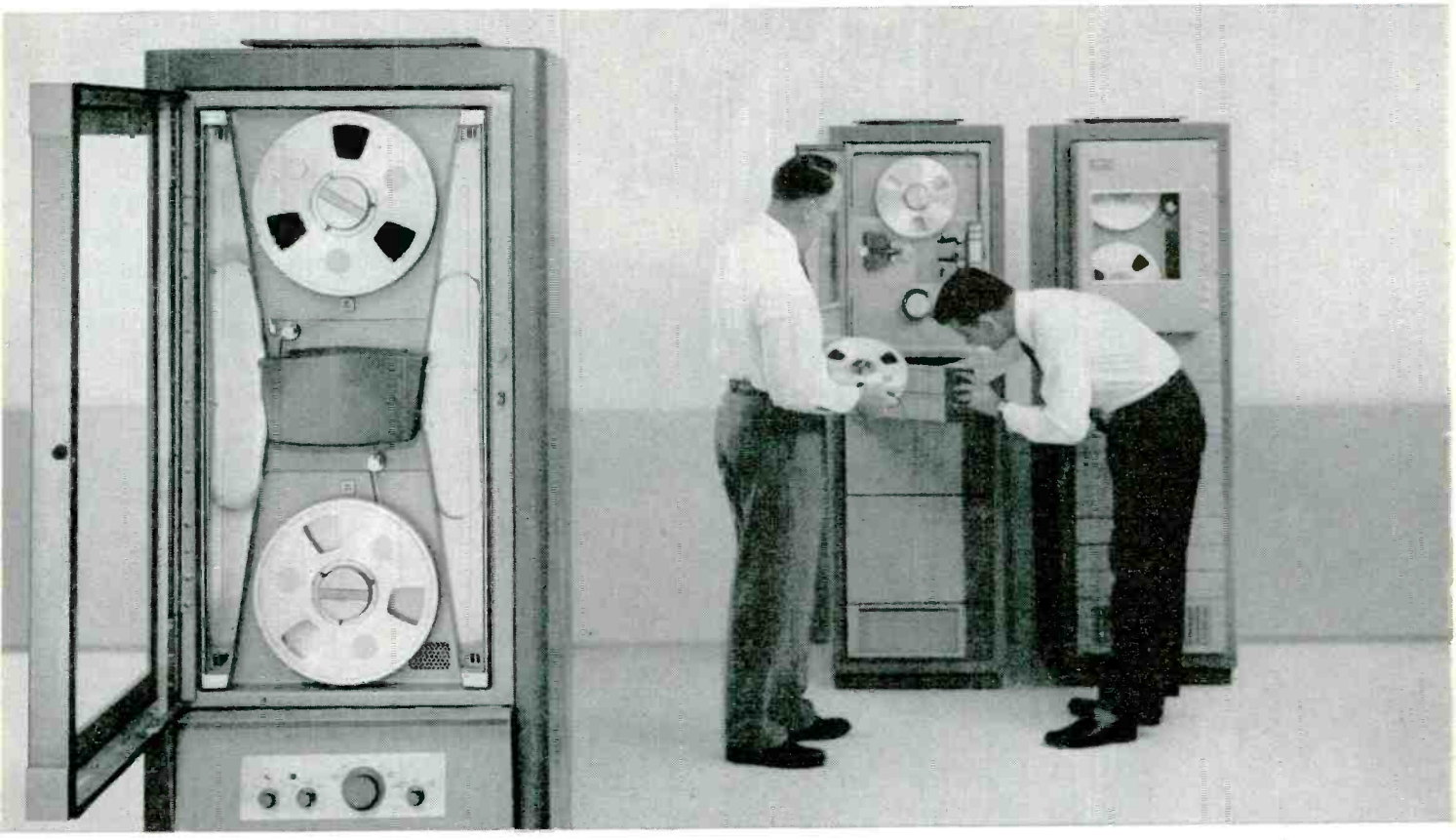
A five-foot bookshelf is a 10-minute task



for this AMPEX FR-300 digital tape handler

Yes, the Ampex FR-300 could easily "read" or "write" the digitalized equivalent of a five-foot bookshelf in less than ten minutes. Why is this important? Because today's big computers accept and present large quantities of data in a hurry. Their time may be worth as much as $1000 per hour. Keeping one waiting for data is expensive.

As the fastest available magnetic tape handler for "on-line" duty with these machines, the FR-300 maximizes utilization of high-speed digital computers. By placing two 6-bit alpha-numeric characters side by side on one-inch tape at 150 ips and 300 bits per inch, it achieves 90,000 character-per-second transfer rates.

Short, predictable start/stop times reduce buffer requirements and Ampex dependability further increases computer efficiency.

Ampex offers digital systems complete from head to tape (the sensational new Ampex Computer Tape, by the way) because a system designed as an integrated whole will out-perform those built from tape transports, magnetic heads, amplifiers and tape secured from a variety of different suppliers.

For lesser computers and "off-line" duty on such auxiliary digital equipment as converters, data plotters, printers, etc., the FR-400 and FR-200A tape handlers (not shown) provide a wide wide range of lower transfer rates. And in the background above are two fine analog recorders, the FR-100A and FR-1100, to remind you that only Ampex offers such a broad line of fixed and mobile recorders for instrumentation and control.

A folder on the FR-300 is available if you would like one.

First in magnetic tape instrumentation

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Plan Satellite Microwave Link

Program seeks to supply U. S. with needed new capability in global military communications

CONTROLLABLE SATELLITE carrying microwave radio relay equipment can provide the required new capability in global military communications, according to information from the Advanced Research Projects Agency.

Initial type of military communications satellite will carry delayed repeaters, storing messages which do not require instantaneous transmission, George Brady of ARPA told the American Rocket Society meeting last month at MIT.

Spaced Satellites

Real-time system for global coverage will consist of two series of active repeaters in high altitude orbits, one polar and the other equatorial. Three or four equally-spaced satellites in the 24-hour orbit on the equator will provide broad band microwave communication by direct line of sight transmission to all parts of the globe except extreme polar regions. A supplementary series in lower orbits will cover polar areas.

Other Uses

Radio relay stations in space will obviate many of the problems involved in land lines, h-f radio, submarine cables and scatter circuits using microwave, Brady said, pointing out the line-of-sight limitations of microwave, susceptibility of h-f radio to ionospheric disturbances, vulnerability of cables to sabotage.

Satellites will also be used to provide meteorological, early warning and reconnaissance support to military operations, Brady said. They can provide a precision navigation system that is truly all-weather. By use of Doppler radio techniques, exact location of a receiving station on a ship, for example, can be determined with reference to the point of nearest approach of the satellite.

Watching 15 Television Monitors

A complex, 15-camera closed-circuit tv installation helps speed output at Steel Company of Wales, Port Talbot, Wales. Marconi's Wireless Telegraph Co. Ltd. placed cameras in a line on one of rolling mill's outside walls. Operator gets composite view of 700 ft of track, far end of which is 1,000 ft away

MEETINGS AHEAD

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

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

June 1-3: Microwave Theory and Techniques, National Symposium, PGMTT of IRE, Paine Hall, Harvard Univ., Cambridge, Mass.

June 4-5: Production Techniques, National Conference, PGPT of IRE, Villa Hotel, San Mateo, Calif.

June 7-11: Microwave Tubes, International Congress, Verband Deutscher Electrotechniker, VDE, Brienner Strasse, Munich, Germany.

June 8-11: American Rocket Society, Semi-Annual Meeting, El Cortez Hotel, San Diego, Calif.

June 15-20: Information Processing, International Conf., UNESCO, PGEC of IRE, AIEE, ACM, UNESCO House & Palais de Exhibition, Paris.

June 15-20: Electromagnetic Theory Symposium, USSI, PGAP and PGMTT of IRE, Univ. of Toronto, Ontario, Canada.

June 16-18: Circuit & Information Theory, International Symposium, PGCT & PGIT of IRE, Univ. of Calif., Los Angeles.

June 24-26: Nuclear Instrumentation Symposium, ISA, Idaho Falls, Ida.

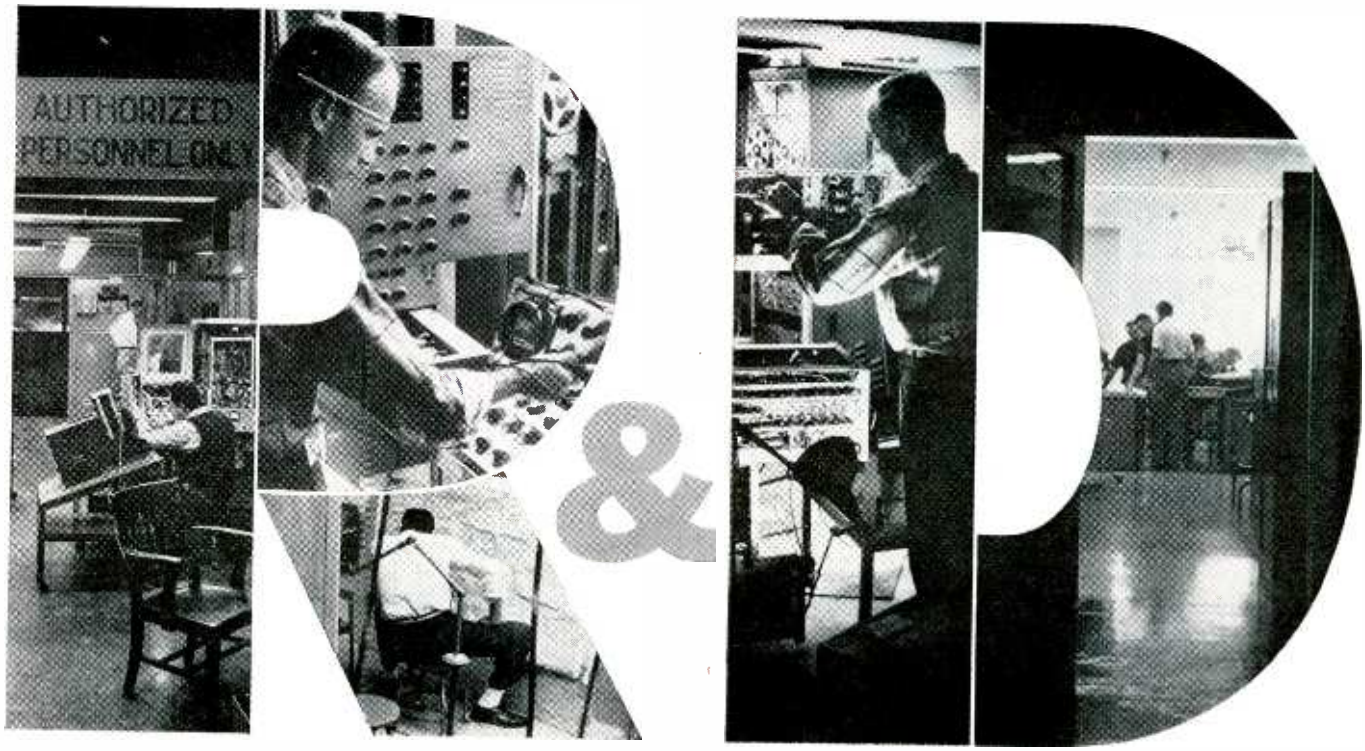
June 24-27: Medical Electronics, International Conf., UNESCO, CIOMS, PGME of IRE, Rockefeller Inst., UNESCO House, Paris.

June 29-July 1: Military Electronics, National Convention, PGMIL of IRE, Sheraton-Park Hotel, Wash., D. C.

July 1-5: Television Convention, International, British Institution of Radio Engineers, Univ. of Cambridge, England.

Aug. 17: Ultrasonics, National Symposium, PGUE of IRE, Stanford Univ., Stanford, Calif.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 80.



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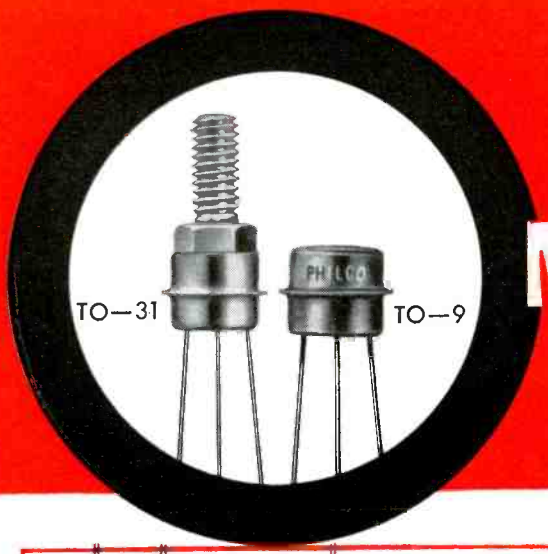
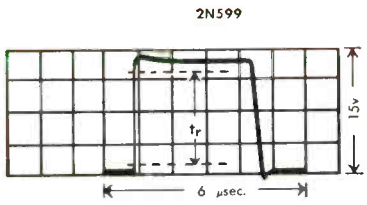


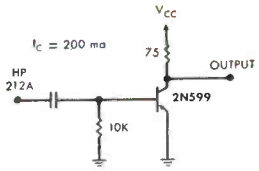
Type	Outline	Max. Readings			General Performance		"ON" Switch Performance	
		P_T mw	V_{CB} volts	I_C ma	Min. $f_{\alpha b}$ mc	Typical h_{FE} $V_{CE} = -1v, I_C = -100$ ma	Max. V_{CE}	Max. V_{BE}
2N597	TO-9	250	45	400	3	70	0.2	0.34
2N1123	TO-31	750*	45	400	3	70	0.2	0.34
2N598	TO-9	250	30	400	5	85	0.2	0.34
2N600	TO-31	750*	30	400	5	85	0.2	0.34
2N599	TO-9	250	30	400	12	105	0.2	0.34
2N601	TO-31	750*	30	400	12	105	0.2	0.34

*Peak Dissipation at 25°C=1 Watt

TYPICAL RISE TIME CIRCUIT

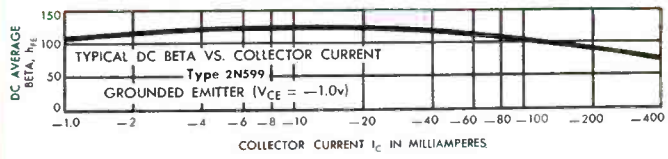


SWITCHING TIMES



TEST CIRCUIT

TYPICAL DC BETA VS. COLLECTOR CURRENT



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The high beta of these transistors at high current makes them particularly applicable to medium speed flip-flops, logic gates, drum writers and core-driver circuits. The 30v to 45v collector rating provides the high level logic swings required in many data processing equipments. The entire family is available in production quantities . . . and in quantities 1-99 from your local Philco Industrial Semiconductor Distributor.

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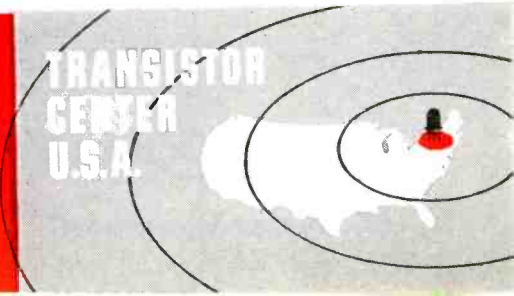


electronics

MAY 22, 1959

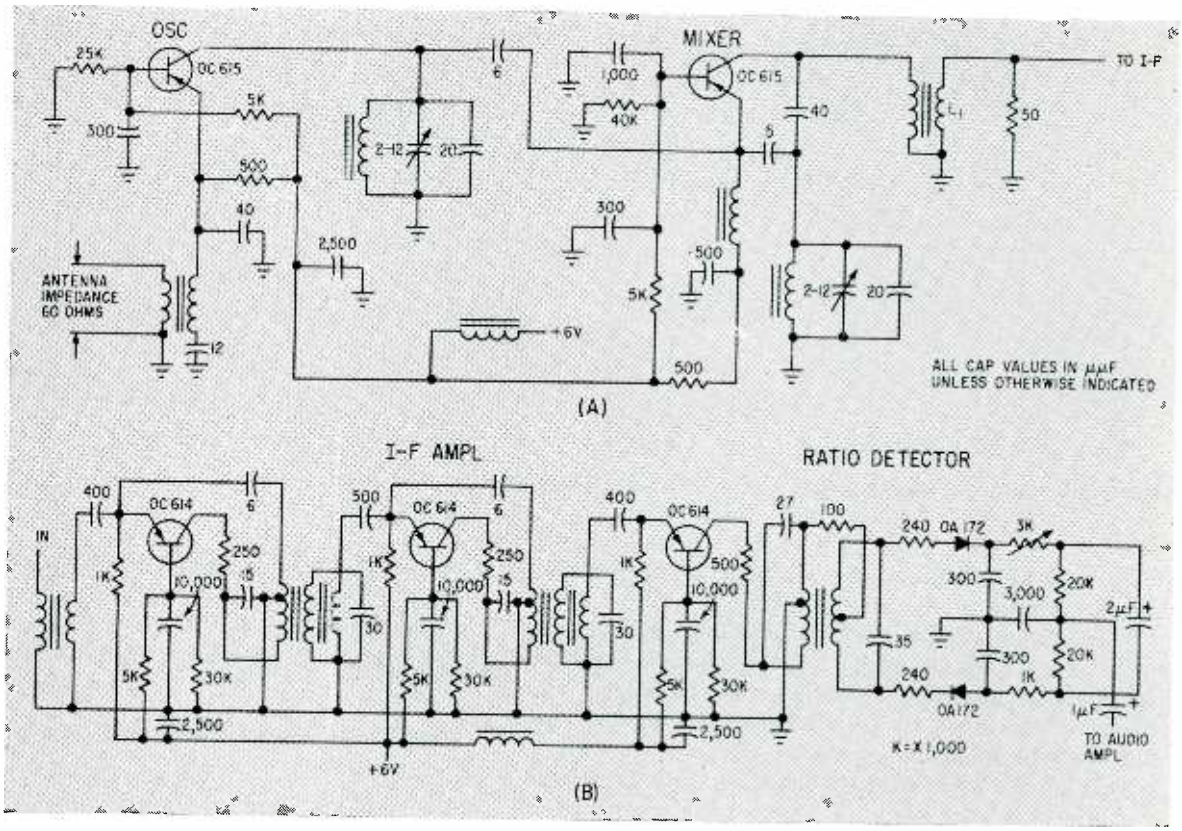


FIG. 1—Input stages, oscillator-mixer (A) and corresponding i-f amplifier (B) of vhf receiver developed by Telefunken, GmbH

European Developments In Transistor Circuits

Schematics of recently-released vhf receiver circuits, coming out of Europe, point up some interesting design details

By **RAYMOND SHAH,** Engineer, Swiss Electrotechnical Institution, Zurich

COMMERCIAL AVAILABILITY of vhf transistors has focused interest in Europe on transistorized vhf receiver circuits. Characteristics of four European-made transistors are given in Table I. These are drift transistors with a metallic screening can and a corresponding fourth connection to the can.

CIRCUITRY. Figure 1A shows an input unit developed by Telefunken, using two OC 615 transistors. The oscillator plus mixer has a power amplification of 25 db. Voltage amplification is 16 db with an antenna impedance of 60 ohms and a load resistance of 50 ohms at the output of L_1. Noise factor is 10; image suppression is 1 to 20; parasitic radiation of the fundamental is 3.5 μv and of the first harmonic is 45 μv.

The corresponding i-f amplifier, Fig. 1B, uses a common-base configuration because the neutralization is simpler and variations of transistor parameters have less influence on circuit performance. Sensitivity of the complete vhf receiver is 0.85 μv for an

←CIRCLE 40 READERS SERVICE CARD

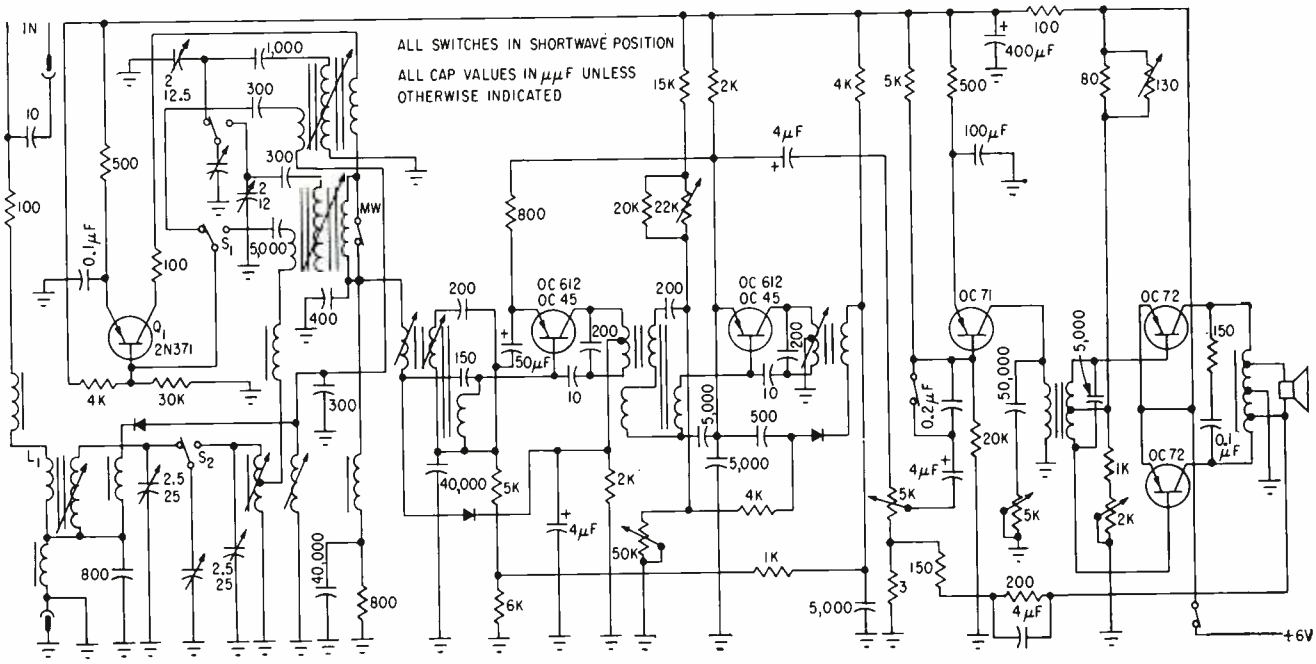


FIG. 2—Short-wave and broadcast-band receiver circuit developed by Loewe, Opta, GmbH uses RCA drift transistors

output of 50 milliwatts and 2 μv for 400 milliwatts. Eight transistors are used in all.

Some commercially available portables with short-wave and vhf bands use RCA drift-transistors 2N371 for the shortwave and 2N247 for the vhf band. One receiver, developed by Loewe Opta, GmbH, has two bands—medium and shortwave. The shortwave input circuit for 5.8 to 18.6 mc is shown in Fig. 2. Intermediate frequency and audio stages are common for medium-wave and short-wave bands. In the medium-wave position of bandswitches S_1 and S_2, the antenna signal is fed directly to transistor Q_1 which operates as a self-oscillating mixer stage. The receiver uses a total of six transistors. The shortwave sensitivity is 20 μv for 50 milliwatts output. Maximum output is 350 mw in a 7.5 by 4 inch oval speaker. Four 1.5-v cells are used. Total weight is 6 pounds.

VHF RECEIVER. Figure 3 shows the circuit diagram of a transistorized vhf receiver by Graetz KG. The input stage, oscillator-mixer and the three i-f stages use RCA drift transistors 2N247. The receiver is designed for operation in the

Table I—European-Made VHF Transistors

Mfr	Type No.	Alpha Cutoff (mc)	Current Amp Factor	Collector-Emitter Capacitance
Telefunken	OC 614[a]	60	0.990	3.5 $\mu\mu$f at 10.7 mc
	OC 615[b]	90	($\alpha'=100$)	2.5 $\mu\mu$f at 100 mc
Valvo, Mullard, Philips	OC 170[a]	70	0.987	1.6 $\mu\mu$f at 10.7 mc
	OC 171[b]	90	($\alpha'=80$)	———

a—short-wave type, *b*—vhf type. Valves at $I_c=1$ ma, $V_{ce}=6$v

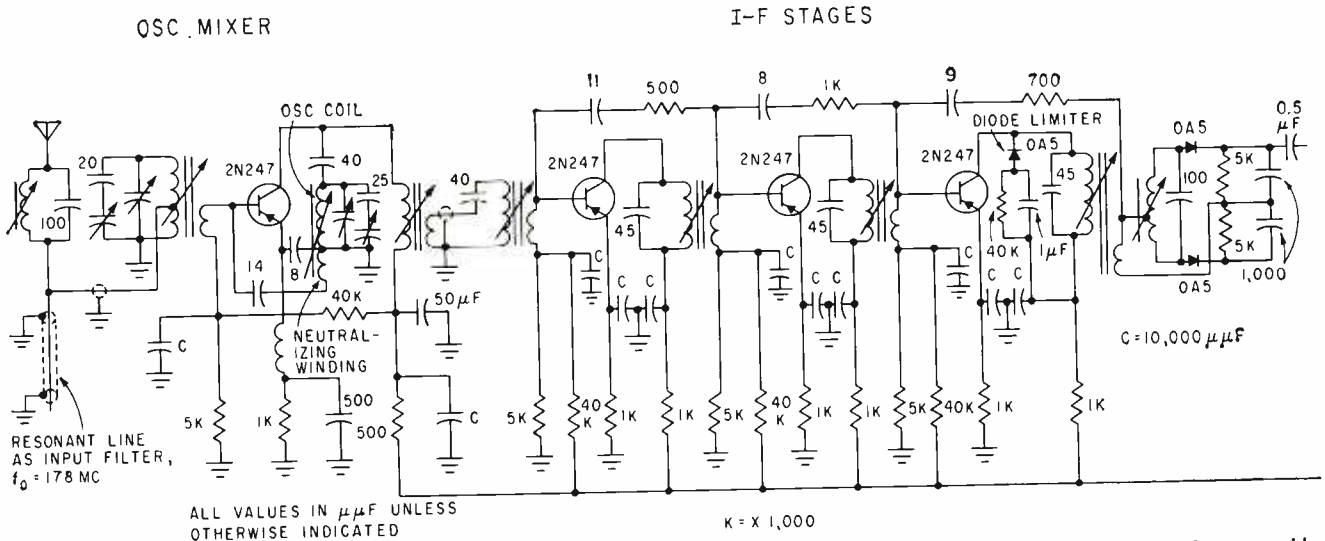


FIG. 3—Very-high-frequency receiver, developed by Graetz Kommanditgasellshaft, Altena (Westfallen). A low value i-f, 6.75 mc, provides

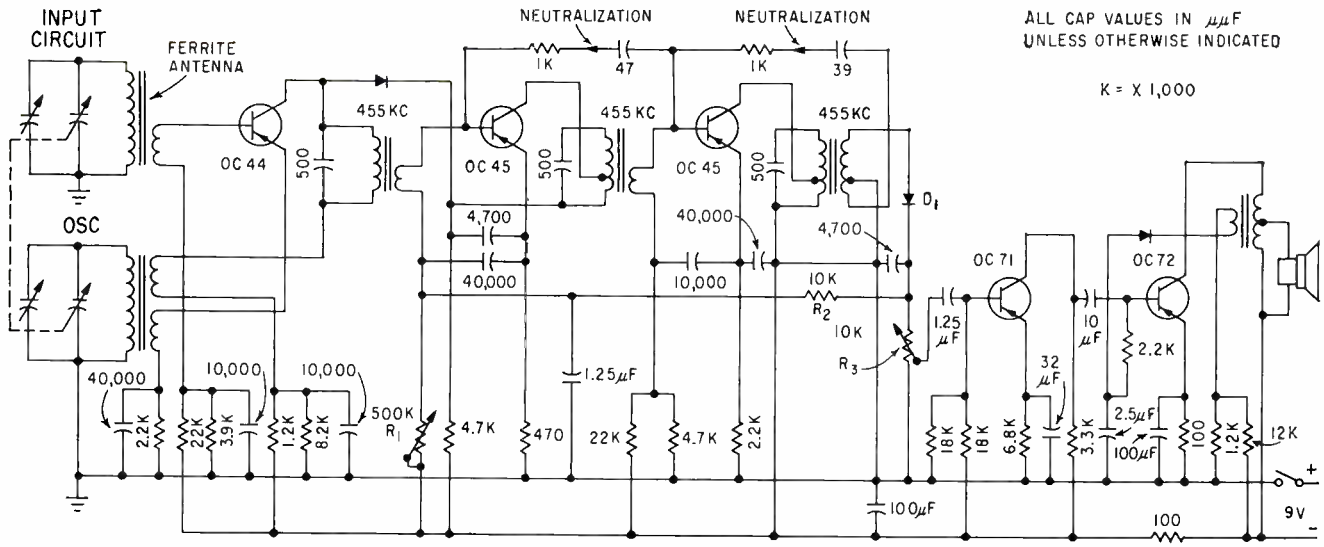


FIG. 4—Typical European broadcast-band receiver, the Peggie portable of Akkord AG

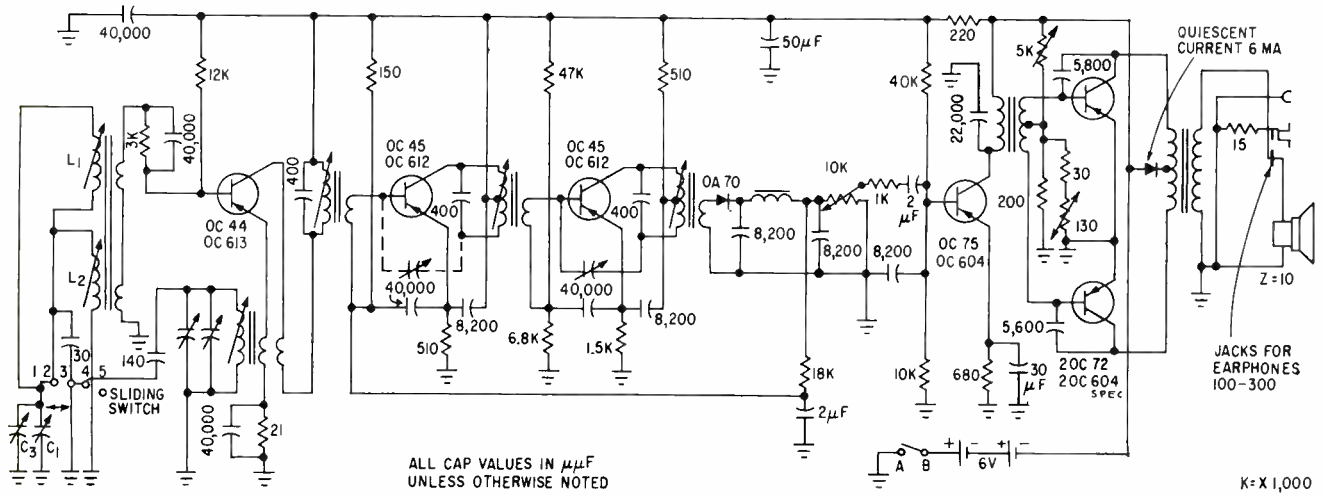


FIG. 5—Combined broadcast and long-wave receiver, developed by Braun GmbH. Sliding contacts are used for switching bands

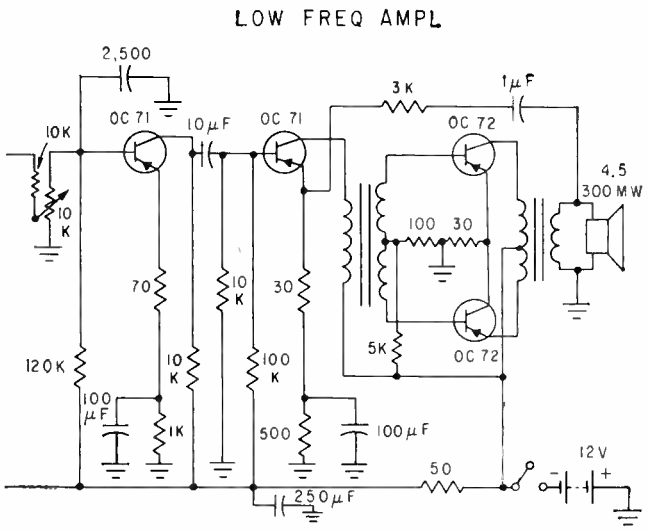
87.5 to 101-mc band with an i-f of 6.75 mc.

Input sensitivity of the circuit for a signal-to-noise ratio of 30 db is 8 μv, with an antenna input of 240 ohms and a signal having a frequency deviation of 22.5 kc. The receiver uses a 12-v battery. Current drain with full output is 55 ma.

Almost all circuits for transistorized portables having only the medium-wave broadcast band use five stages: an oscillator-mixer, two i-f's, an audio preamplifier and a power amplifier. Five or six transistors are used depending upon whether a push-pull or a single-ended output stage is used. The transistors are usually OC 44 or OC 613 for the oscillator-mixer stage; OC 45 or OC 612 for the i-f stages; OC 71 or OC 604 for the audio preamplifier stage and OC 72 or OC 604-special for the output stage.

Figure 4 shows a typical broadcast band receiver circuit as used in the Peggie portable of Akkord AG. Of special interest is the circuit consisting of R_1, R_2 and R_3 which establishes a fixed bias in the forward direction on demodulator diode D_1 for improving the detector efficiency at small signals.

One manufacturer, Braun GmbH has combined a broadcast and long-wave band receiver, Fig. 5.



optimum amplification and effective a-m suppression

Reference

(1) F. Mural, Dynamic Diode Limiter for F-M Demodulators, Electronics, p 146, Aug. 1955.

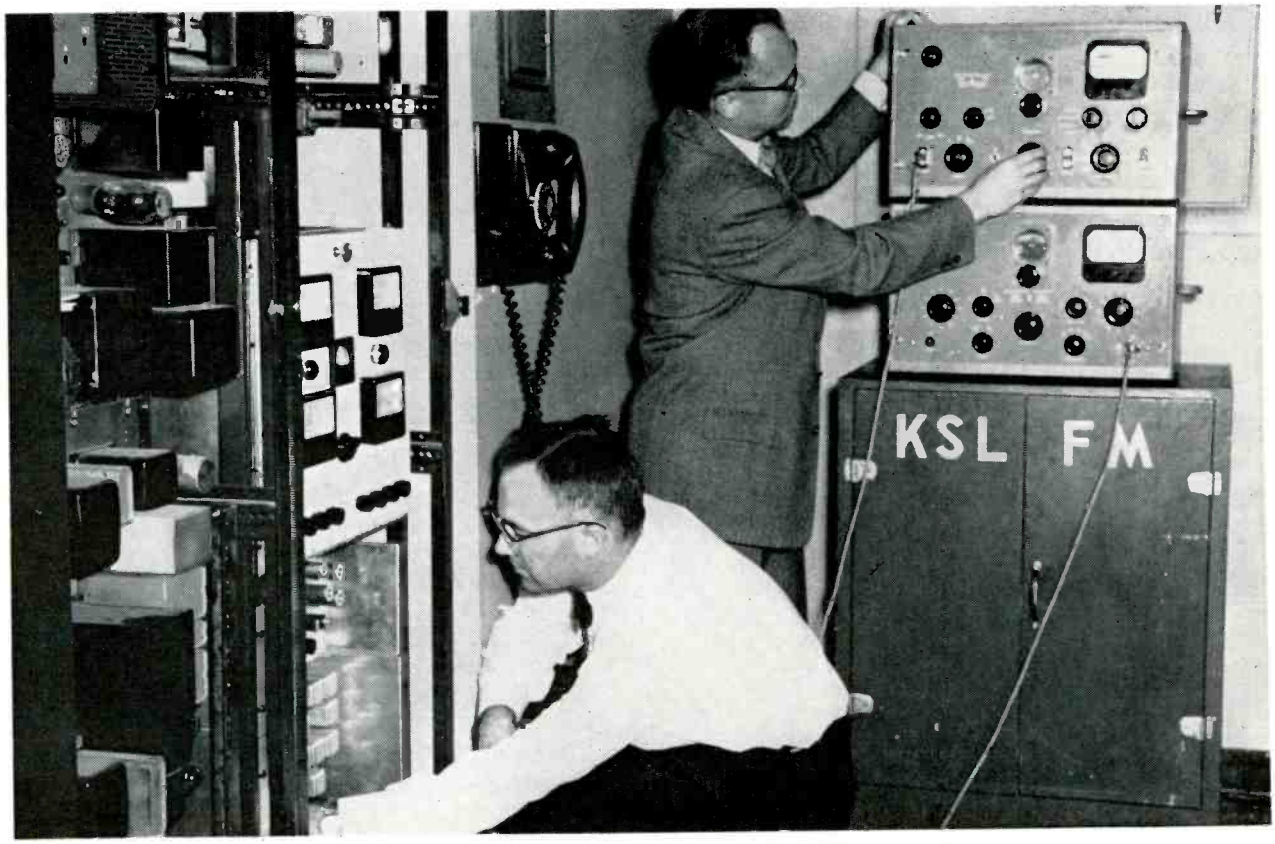
F-M Multiplexing for

Frequency-modulated transmitter in studio sends three programs on a 946-mc carrier to a broadcast transmitter on top of a mountain. At the studio, each program modulates one of the three subcarriers which ride the stl carrier

WHEN STATION KSL-FM decided to provide two additional programs, the problem arose of getting the two subcarriers carrying the programs to the station's transmitter, which is on a mountain 16 miles from the studio. The conventional approach for modifying an f-m transmitter to accommodate multiplex channels is to set up the two-channel generator near the transmitter and inject the subcarriers into an auxiliary phase modulator that is part of the transmitter's exciter. If this approach were followed, the two subcarriers would either have to be programmed on the mountain, or sent to the transmitter through additional studio-transmitter links. Since programming on a mountain is impractical, and constructing new studio-transmitter links (stl) expensive, the existing stl was modified so that it might transmit three programs to the mountain-top transmitter.

Figure 1 shows the modified stl transmitter. The main-channel audio, which formerly fed a reactance-tube modulator coupled to the transmitter oscillator, modulates a 175-kc-subcarrier generator. One of the added audio channels modulates a 65-kc subcarrier and the other added audio channel modulates a 26-kc subcarrier. Each subcarrier is supplied by a two-channel generator.

The three modulated subcarriers are applied to the screen grid of a frequency-tripler stage. This mul-



Testing the 175-kc generator of stl transmitter. Engineer at left is looking into 175-kc generator

Studio-Transmitter Links

By DWIGHT HARKINS,
Harkins Radio, Inc.,
Phoenix, Arizona

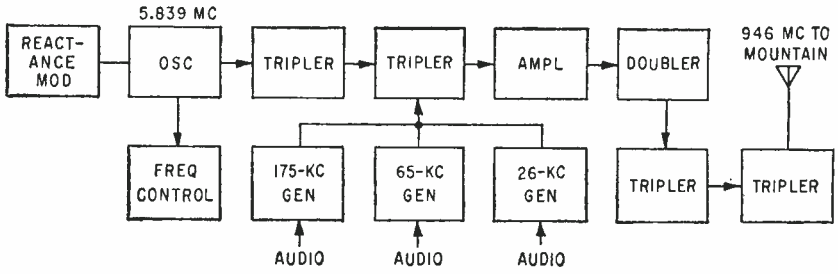


FIG. 1—Studio transmitter. Reactance-tube modulator, formerly used to modulate stl transmitter, now controls oscillator frequency

tiplier is part of the frequency-multiplying chain that increases the frequency of the oscillator output 162 times, to 946 mc at the antenna.

STL Receiver

After the stl receiver (Fig. 2) picks up the 946-mc signal, the frequency-conversion stages convert the signal to 23 mc. Wide-band i-f stages of known phase linearity amplify the signal and apply it to a ratio detector. Band-pass filters then separate the 175, 65 and 26-kc subcarriers and their respective sidebands.

After amplification, the 175-kc subcarrier passes through a limiter, a pulse shaper and a pulse-counter demodulator. The recovered audio is deemphasized, amplified to a level of about plus 10 db, and then applied to the main modulator of the mountain-top transmitter exciter.

After the 65-kc and 26-kc subcarriers are filtered, they are separately amplified to about a 1-volt level and applied to the auxiliary phase modulator of the exciter without being demodulated.

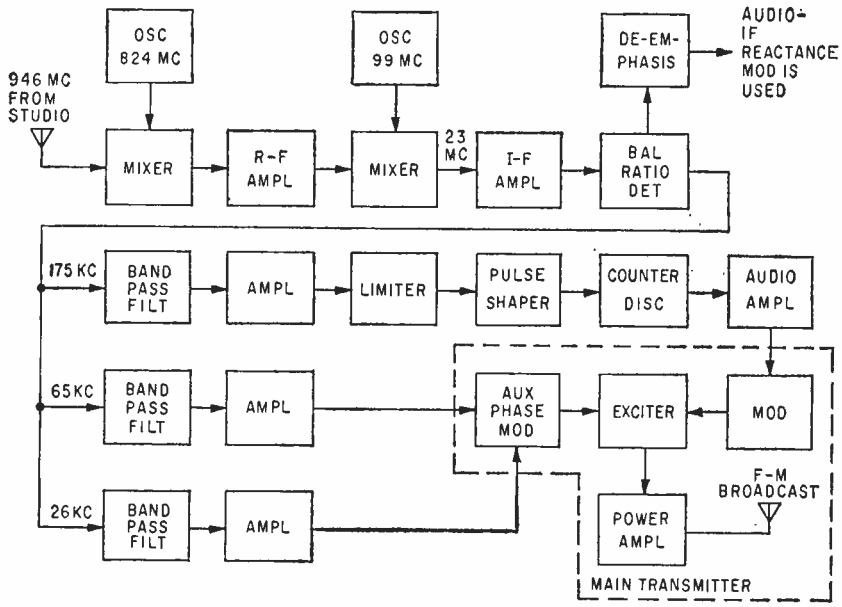


FIG. 2—Mountain-top receiver and main, or broadcast, transmitter. Receiver picks up three programs sent from studio and main transmitter broadcasts them

Design Features

The main-channel audio modulates the 175-kc subcarrier generator rather than the original reactance tube to avoid a wide swing of the carrier frequency. A wide swing is avoided because of the relatively narrow bandwidth of the lower frequency-multiplier stages. These stages cannot accommodate a signal that would consist of the 26 kc and 65-kc subcarrier frequency components, as well as the large deviations of the carrier caused by main-audio modulation.

To generate a high-quality 175-kc subcarrier, an f-m carrier of 24.0 mc is mixed with a crystal oscillator operating at 23.825 mc.

Performance

A deviation of the 175-kc subcarrier of ±17 kc deviates the mountain-top transmitter 100 percent, or ±75 kc. The 65-kc channel is set up for a deviation of ±10 kc at the stl transmitter and the 26-kc channel is set up for a deviation of ±6 kc at the stl transmitter.

Deviation of the 946-mc carrier by the subcarriers amounts to less than 5 kc. Intermodulation between the three subcarriers is so low that it is not measurable.

The reactance-tube modulator is used to control the center frequency of the 5.839-mc crystal oscillator. It is also possible to use this modulator to send audio to the mountain without creating crosstalk in the three subcarriers if the modulation level is held down. Modulation that produces a signal-to-noise level of 40 db does not intermodulate the subcarriers and provides a good channel for standby signaling or studio-to-mountain communication.

Performance measurements of the overall sytem from studio to antenna fell within the prescribed limits of the standards of the Federal Communications Commission for f-m broadcast stations.

Doppler radar techniques are widely used for precise determination of position and velocity of missiles and satellites. This automatic Doppler cycle counter suppresses noise and converts each 3.6 degrees of phase displacement into a digital pulse

By **B. E. KEISER***, Missouri Research Laboratories, Inc., St. Louis, Mo.

Digital-Counter Techniques

USE OF DOPPLER radar techniques for determining the speed of a moving object is well known. In particular, methods for surveying high altitude trajectories have utilized the Doppler principle for the past ten years.[1] The three coordinates of an object with respect to an origin on the earth can be determined by a system of the type shown in Fig. 1.

Several earth-based Doppler radar stations view the object whose trajectory is to be established. The motion of the object results in a Doppler shift which each station reports to a data-gathering center. The data-gathering center records each of its inputs on a separate channel of a magnetic tape. In doing so, it compensates for the different time delays between the receiving stations and the recorder by delaying the returns from the closer stations by the appropriate time interval.

The multichannel magnetic tape which the data-gathering center produces contains a timing reference channel on which is recorded a precise 50-kc sine wave. This reference signal prevents errors from tape expansion or contraction from entering the system.

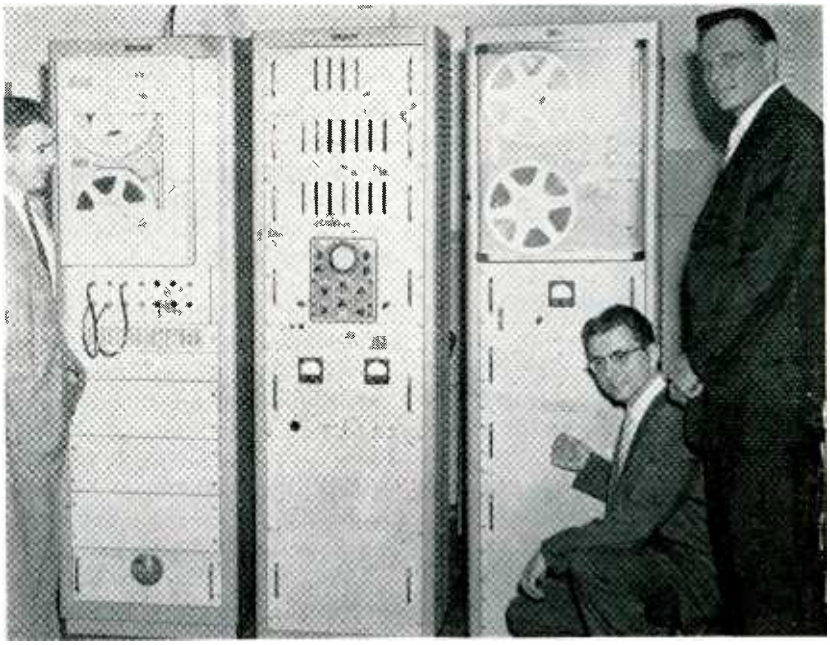
Functions

The automatic Doppler cycle counter performs two functions: it suppresses noise not at the frequency of the Doppler shift, thereby removing a significant source of error; and it converts each 3.6 deg of Doppler phase displacement into a digital pulse, thereby yielding a cycle-counting resolution of 0.01 cycle.

Output of the automatic Doppler cycle counter is a digital magnetic tape. To prevent duplication of equipment, the counter processes information from only one Doppler radar station at a time. The output magnetic tape is fed to a digital computer which accumulates the processed speed information from each of the stations and then computes the complete trajectory.

Each radar set yields only a single scalar quantity: the speed of the object toward or away from it. Information from three such stations, located at different locations on the earth, is required to establish the position of the object with respect to some known reference point.

The Doppler shift which each of the stations observes is given by



Automatic Doppler cycle counter produces magnetic tape which is fed to digital computer for processing

*Now with RCA Laboratories, David Sarnoff Research Center, Princeton, N. J.

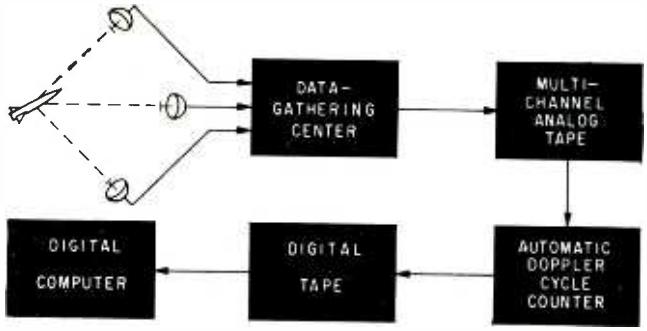


FIG. 1—Coordinates of missile's location are determined by radar

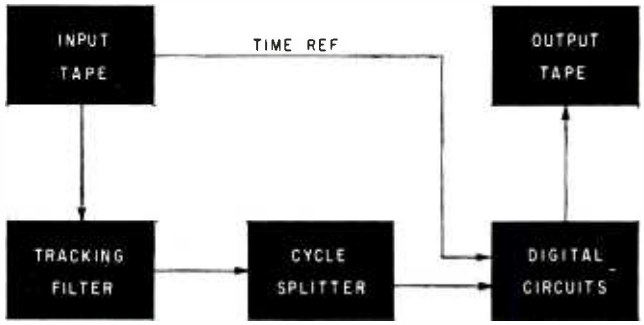


FIG. 2—Block diagram of automatic Doppler cycle counter

Increase Doppler Uses

$f_D = 89.4\ V_R/\lambda$, where f_D is Doppler shift in cps, V_R is target speed in mph and λ is wavelength in cm. This formula is merely a statement of the fact that each half wavelength of target displacement toward or away from the radar antenna yields one Doppler cycle, or 360 deg of phase displacement.

System Operation

Figure 2 is a simplified block diagram of the automatic Doppler cycle counter. The input tape channel to be processed is fed to the automatic frequency tracking filter. This is a band-pass filter with a 200-cps bandwidth. However, its center frequency varies over a wide range. Within one second after the application of a sinusoidal signal of sufficient amplitude and within specified frequency limits, the tracking filter's passband is adjusted automatically to allow this signal to pass.

Thus, the output of the automatic frequency tracking filter is a noise-suppressed version of the input. The filtered signal is applied to the cycle splitter, a device whose behavior within limits is independent of input amplitude, but which converts an input sine wave to its rotating vector representation and then registers each 3.6 deg of rotation. The output of the cycle splitter is a pulse for every 3.6 deg of an input cycle. Hence, each pulse out of the cycle splitter represents 0.005 wavelength of displacement of the object observed.

The output of the cycle splitter is counted continuously by the digital circuits, which record their count periodically on a digital magnetic tape in the 8-4-2-1 binary coded decimal system.

Automatic Tracking Filter

Doppler return signals generally contain a noise spectrum whose major components start at four or five times the frequency of the return. Such noise often results from multiple reflections from the object being observed. Noise lower in frequency than the Doppler shift also may occur. The amplitude of the interfering noise sometimes equals, but seldom exceeds, the amplitude of the Doppler sine wave. Thus the tracking filter must acquire and track the strongest signal presented to it.

Frequency shift rate is dependent not only upon vehicle accelerations and velocities, but also upon the frequency of Doppler radar operation and the relative positions of the earth-based stations.

The tracking filter accommodates itself to Doppler shifts as low as 30 cps and as high as 50 kc. Signal acquisition can occur at a maximum rate of 20,000 cps/sec. Once the signal has been acquired, the tracking filter tuning rate is automatically limited to a maximum value of 2,000 cps/sec to prevent possible tracking on noise, since all desired signals shift frequency at rates considerably less than 2,000 cps/sec for the conditions established.

The automatic frequency tracking filter resembles a superheterodyne radio receiver. One major difference, however, is that the input and output are at the same frequency while the i-f is at a higher frequency. Figure 3 is a block diagram of the tracking filter.

All input signals are brought to an amplitude level between 0.8 and 1.2 v rms by the amplitude compressor, an agc amplifier with a small but constant delay time. The modulator, a phasing type of single-sideband generator[2], is basically a frequency subtraction device in which the carrier frequency f_c is always approximately 150 kc above the signal frequency. The difference then is a nearly constant intermediate frequency f_I of 150 kc.

The discriminator is centered at frequency f_I and furnishes a d-c control voltage of one polarity for upward frequency deviations, and of the opposite polarity for downward frequency deviations.

Integrator

The integrator limits the rate at which the discriminator output changes, and thus limits the tracking rate of the device. In the event of a short-term departure of the i-f from the center frequency be-

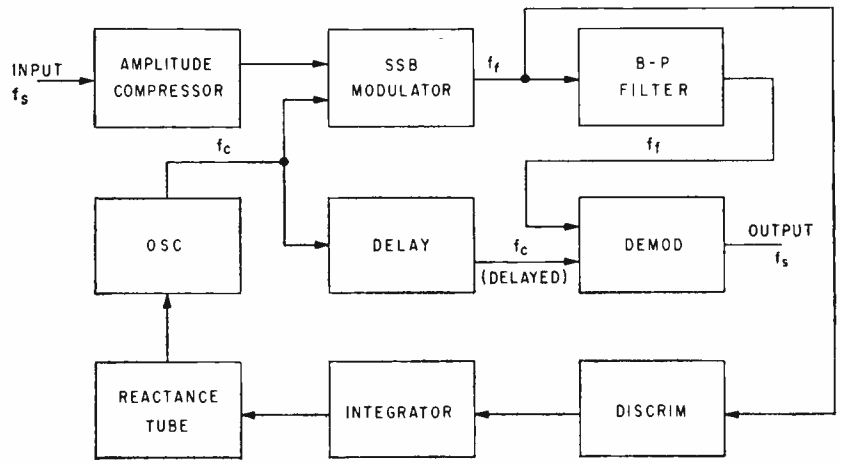


FIG. 3—Automatic tracking filter accommodates wide range of Doppler shift frequencies

cause of noise, the integrator prevents the discriminator output from causing an oscillator frequency change.

With integration of the discriminator output, a temporary loss of signal, such as might be caused by tape drop-out, results in a slow return of tracking when the signal appears again. To allow the system to retrack quickly, the integrator time constant is reduced by a factor of 10 when the filter is off track, thus permitting rapid pull-in.

The reactance tube applies the integrated control voltage to the oscillator so that the carrier frequency is properly controlled. If the carrier frequency is in error, this error appears as a shift in f_f sufficient to bring the carrier frequency to the proper value. The discriminator, integrator, reactance tube, oscillator, and modulator form the tracking loop.

Since the total frequency span to be covered is 50 kc, and the crystal filter bandwidth (which also is the tracking filter bandwidth) is intentionally limited to 200 cps, the tracking loop must have a minimum frequency gain of 250, where frequency gain is defined as oscillator deviation in cps/i-f deviation in cps. In practice, the frequency gain is in the vicinity of 5,000. This permits much tighter control of the i-f frequency and allows operation on a highly linear portion of the crystal filter's phase-frequency characteristic.

Oscillator Circuit

Of considerable importance in attaining the necessary flat amplitude response with frequency is the behavior of the oscillator's output amplitude. To maintain this amplitude constant, a special oscillator circuit, shown in Fig. 4, is used.

The smoothed signal from the integrator is applied to the suppressor grid of reactance tube V_1.

Since the gain of this tube is insufficient to provide the required frequency deviation of 10 kc per volt, its output is amplified by reactance amplifier V_2 whose plate is connected directly to the tank of oscillator V_3. Cathode follower V_4 isolates the oscillator tank from the amplitude control circuit and also from the output cathode follower which consists of V_5 and V_6, and provides an output impedance of approximately 5 ohms, suitable for driving the sonic delay line over a wide range of frequencies.

Amplitude control tube V_7 compares a rectified sample of the oscillator output with a reference voltage derived from the regulated

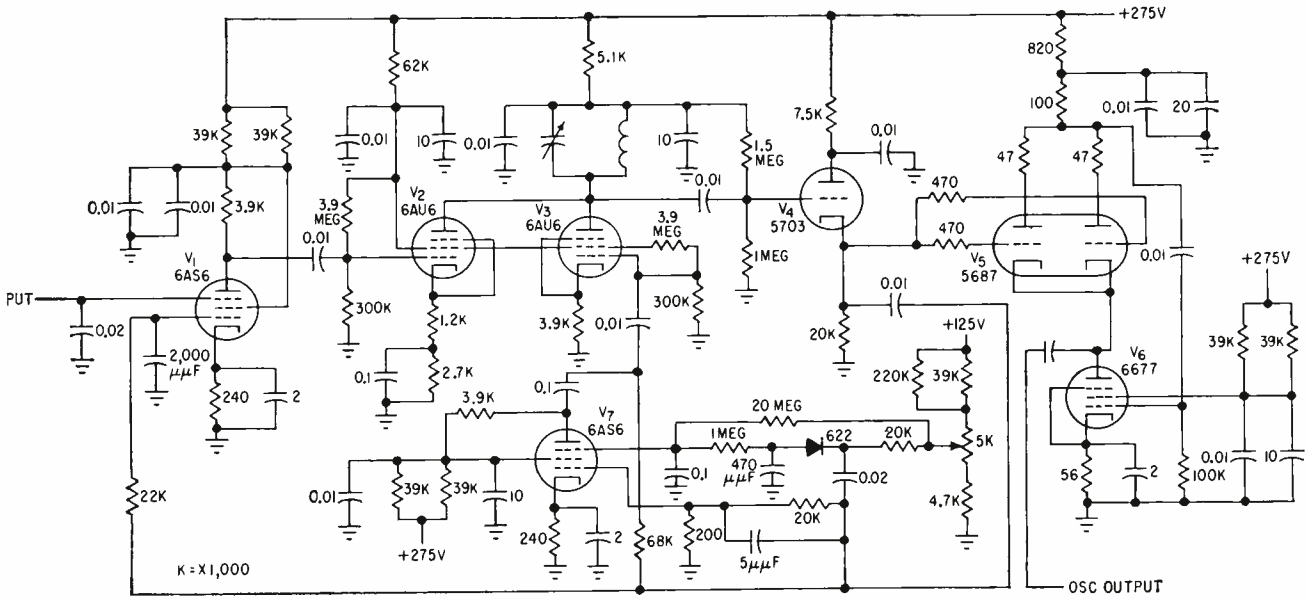


FIG. 4—Schematic of the amplitude-regulated wide-range controlled oscillator

power supply, and injects sufficient feedback signal into V_3 to maintain the amplitude at a predetermined level.

To compensate for the time delay associated with the crystal filter, the carrier applied to the demodulator[2] is delayed by a sonic delay line. The modulator then subtracts f_r from the delayed carrier frequency to yield the output frequency, which is a filtered version of the input frequency except for a small but constant time delay.

Cycle Splitter

Achievement of a 0.01-cycle resolution in Doppler cycle counting requires that each 3.6 deg of the input cycle be registered by the equipment. This registering must be done whether the input frequency is fixed or variable. To achieve this, the system shown in Fig. 5 is used.

First, the signal from the tracking filter is split into two components 90 deg apart in phase by two wide-band phase-difference networks[3], designated α and β. Each of these networks is built as shown in Fig. 6A. Resistor and capacitor values are chosen such that the phase difference between the outputs of the two networks is maintained at approximately 90 deg throughout the frequency range of interest as shown in Fig. 6B.

Although the phasing networks appear quite simple, they are accurate to ± 1 deg over the entire frequency span of 30 cps to 50 kc, a much wider range than normally incorporated into such circuits. To maintain this accuracy, the impedance levels of the components are kept low enough to avoid the effects of stray capacitance. However, this necessitates the use of wide-band drivers having exceptionally low output impedance with balanced output.

The low source impedance is obtained by the circuit shown in Fig. 7. Tubes V_1 and V_2 provide a single phase inversion with an open-loop voltage gain of 50 and an output impedance of 10 ohms because of the pentode gain in the cathode lead of the 6U8 triode section. Closure of the loop reduces the gain to unity and the output impedance to less than 0.5 ohm over a pass-band greatly exceeding the 50-kc requirement. These networks also are suitable for driving the 150 to 200-kc phasing networks in the single sideband modulators used in the tracking filter.

The output of V_2 is connected to the V_3-V_4 combination which is identical to V_1-V_2 and provides an output in phase with the input to V_1. A trim adjustment is provided to keep the gain of the V_3-V_4 combination equal to that of V_1-V_2 thus compensating for minor variations in the exact values of the 100,000-ohm feedback resistors.

Light Pulses

Whatever the input frequency, the phasing network outputs produce a circular pattern on the screen of a cathode ray tube. One rotation of the electron beam is produced for every input cycle. By placing a mask with 100 radial lines on the face of the cathode-ray tube, an output light flux consisting of a light pulse for every 0.01 cycle of the input is produced. The light pulses are viewed by a multiplier photo-tube which converts them into electrical signals.

At relatively low frequencies, the cathode-ray beam produces a clearly defined spot on the screen, since an extremely short persistence screen is used. The P16 phosphor has a decay time of approximately 0.5 μsec. At the maximum desired input frequency of 50 kc, the required cycle-splitter output is 5 mc. The amplitude of the cycle-splitter output at this frequency on a sinusoidal basis is only about 6 percent of its low frequency value. However, by designing the phototube pick-up circuit with a high degree of clipping, a constant output pulse amplitude can be maintained up to 5 mc.

The information counting and converting circuits take the cycle-splitter output, which ranges from 3 kc to 5 mc, and present it to the output tape handler as binary-coded digital outputs in the 8-4-2-1 system.

Time Intervals

Basic timing intervals of 0.01, 0.1 or 0.5 second can be selected by the operator. These timing intervals are obtained from a 50-kc reference signal which is recorded on one of the channels of the input tape. The time mark generator

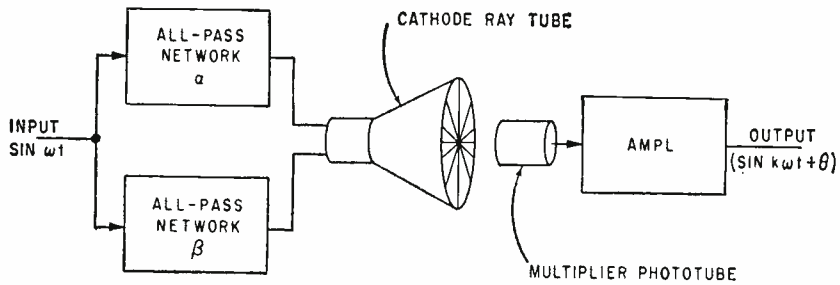


FIG. 5—Cycle-splitter arrangement provides frequency multiplication and digital conversion

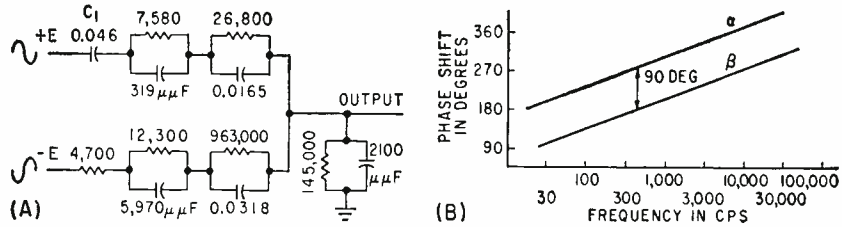


FIG. 6—Networks such as shown in (A) are designed to maintain outputs at close to 90-deg phase difference over wide frequency range. Characteristics are shown in (B)

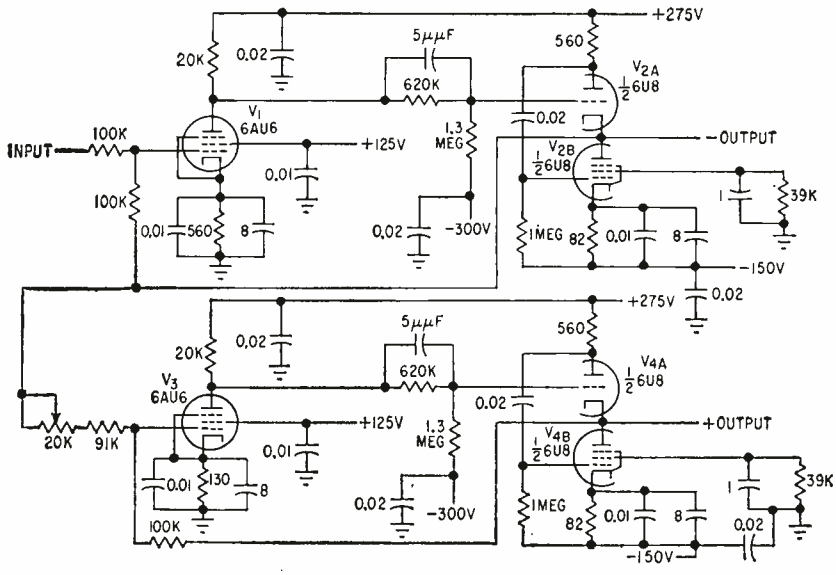


FIG. 7—Wideband driver has low output impedance with balanced output

counts reference cycles to produce the basic timing interval and also produces the same delays as those which the information-bearing signal encounters in passing through the tracking filter. These delays consist of two types: a fixed delay, equal to that of the crystal filter and produced by a sonic delay line, and a variable time delay, equal to that of the phasing networks and proportional to the period of the incoming frequency. The variable time delay is produced by delaying the time mark an amount equal to a predetermined number of cycle-splitter output pulses. Thus the timing accuracy of the system is maintained to a high degree of precision.

The timing interval counter determines the number of time marks which have occurred since the beginning of a run for reference purposes, and this number is recorded on the output tape with each block of information.

The information counting and converting circuits consist of two counter banks preceded by a reflexing switch. The reflexing switch is an electronic switch with a 15-mc switching capability. It serves to channel the information pulses into one counter bank while the other counter bank is read out to the output tape. This is necessary since the information pulses come from the cycle splitter continuously at rates up to 5 mc. None of these pulses may be lost or a cumulative error will occur. One counter bank alone is insufficient, since this requires completion of the entire read-out operation in less than 0.2 μsec.

Clock Oscillator

The delayed time mark is used to start a clock oscillator. This is a free-running multivibrator whose period is adjusted by the time interval selector so that it produces approximately fifteen periods per timing interval. The clock oscillator drives the sequencer, which is a scale-of-15 ring counter used for readout of the information counting circuits and the time interval counter.

The reflexing switch channels information pulses to one of the counter banks while it causes the other one to be read out. The delayed time mark causes the reflexing switch to change from one state to the other, which it does at the beginning of each new timing interval.

The output is in the 8-4-2-1 binary-coded decimal system and since high speed counters generally do not operate in this system, converter circuits utilizing diode matrices are provided.

The digital output is recorded on tape on a non-return-to-zero basis. This requires an additional channel containing sprocket pulses which tell the tape reader when a new bit of information occurs. The sprocket pulse generator is basically a coincidence circuit whose input is the clock oscillator pulse and which produces an output depending upon the presence or absence of the appropriate sequencer pulses and the card mark pulse.

The card mark generator produces an output pulse every sixth timing interval by means of a scale-of-6 counter. This informs the card punching mechanism in the digital computer that six time intervals have elapsed, and that a full card of cycle count information has thus been punched. Upon receipt of the card mark, a new card is inserted into the card puncher. The output tape contains six channels: one each for the 1's, 2's, 4's, and 8's, plus card mark and sprocket pulse channels. Thus the output tape reads out serially the number of Doppler cycles which a given Doppler radar station observed during a given time interval, within 0.01 cycle.

Computing Trajectory

The numbering of each timing interval permits the digital computer to compare the observed distance traveled, as recorded at each observation station, with the distance traveled during the same interval at every other observation station. From this information, the trajectory can be computed.

Error from the approximation in designing the all-pass phasing networks can be held arbitrarily low if network complexity is no barrier. The phasing network components have a 1-percent accuracy. This produces short-term cycle count errors of less than 0.005 cycle.

Total noise and distortion in the tracking filter components, such as modulators, demodulators, and amplifiers are kept well below 6 percent.

The work reported in this paper was done under Army Ordnance Contract No. DA-23-072-ORD-1170.

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(2) D. E. Norgaard, The Phase-Shift Method of Single-Sideband Signal Generation, *Proc IRE*, 44, p 1718, Dec. 1956.

(3) D. K. Weaver, Jr., Design of an RC Wide-Band 90 Degree Phase-Difference Network, *Proc IRE* 42, p 671, Apr. 1954.

Table I—Characteristics of Micromodule Transistors and Diodes

Germanium *pnp* Transistors [a]	Absolute Maximum Ratings V_{CB}	I_C	V_{EB}	I_E	P_C	Typical Characteristics f_{ab}	h_{fe}	C_C (all @ $V_{CB}=-6$v)	I_{CO} (@ $V_{CB}=-12$v)	I_{EO}	Other Values
General Purpose [b]	−15v	−15ma	−0.5v	+15ma	80mw @25C	12mc @ $I_E=1$ma	50 @ $I_E=1$ma	10μμf	−2μa	−1μa @ $V_{EB}=-0.5$v	
Med Speed Switch [c]	−20v	−100ma	−9v	+100ma	120mw @25C	12mc @ $I_E=1$ma		10μμf	−2μa	−1.5μa @ $V_{EB}=-2.5$v	$V_{CE}=-0.1$v @ $I_B=-0.4$ma $I_C=-10$ma
Small Sig 30-mc amp [d]	−30v	−10ma	−0.5v	———	120mw @25C	———	50 @ $I_E=1$ma	2μμf	−1μa	−1μa @ $V_{EB}=-0.5$v	PG = 20db min @ 30mc, $I_E=1$ma $V_{CB}=-6$v
Small Sig 70-mc amp [e]	−30v	———	−0.5v	———	25mw @45C	PG (@ $V_{CB}=-15$v, $I_E=4$ma)	C_{ob}	rb′ C_c	−1.5μa @ $V_{CB}=-5$v	NF = 5db @ 10mc $V_{CB}=-10$v, $I_E=1$ma and $R_g=500$ $V_{CE}\leqq 30$v	
Power Oscillator	Specifications not finalized. General requirements are: 70 mc, 1 watt power output at 40% efficiency					8db min @200mc	1μμf @4mc	25μμsec @16mc	−10μa @ $V_{CB}=-15$v		

Zener Diodes [f]	G-1A	G-1B	G-1C	G-1D	G-1E	Diss	T_A	G-2 (voltage reference)	Diss
Zener breakdown range (v)	5.4–6.2	6.2–8	9–12	13.5–18	20–27	1w @ 25C	−65 to 150C	Same as G–1 series, temp compensated	150mw @25C
Reverse current @25C (μa)	5 @ −1.5v	5 @ −3v	½ @ −8.2v	½ @ −12v	1/10 @ −18v				

(*a*) All max junction temperatures are 100 C (*b*) Other characteristics are similar to 2N140 (*c*) Other characteristics similar to 2N404 (*d*) Other characteristics similar to 2N384, diffused base (*e*) Diffused micro-alloy, other characteristics are similar to 2N502A (*f*) Diffused silicon. Types not listed are gold-bonded general purpose germanium diode similar to 1N277, diffused silicon computer diode similar to 1N643 and variable capacitance diode for AFC and electric tuning

Micromodule Components

Germanium transistors and silicon and germanium diodes, quartz crystals, ferrite core inductors are being made as microelements

TRANSISTORS, diodes, crystals and inductors of micromodules being made for USASRDL by RCA and subcontractors are outlined in Tables I, II and III. Some preliminary configurations are shown.

All base wafers are 310 mils square by 10 mils thick except those recessed to house tantalum capacitors, crystals, transistors and diodes. Each wafer has 3 notches on each side for riser wires. Connections are made to risers via conductive paths from components to notch land areas. There are, for example, 64 possible resistor termination positions and 1,320 possible transistor termination positions. Jumpers are printed on slightly oversized end wafers.

Wafers are pressed and fired ceramics or etched glass-ceramic. Recesses are ultrasonically ground. Additional ceramic capacitors are screened on. Resistive and conductive materials are screened on as pastes or vacuum deposited.—G.S.

Table III—Inductors* Ferrite Core

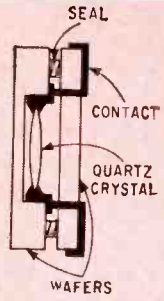
Oper Freq (mc)	Additional Data	Uses
0.455 4.3 11.1 60	Inductance range, 0.1 to 1,500 μh; maximum d-c current, 100 ma. Coils are wound on miniature ferrite toroids and fixed to wafers	R-f chokes, r-f i-f and pulse transformers, tuned circuits

* Applicable spec is MIL-C-15305A

Table II—Quartz Crystals*

Crystal Type	Freq (mc)	Resistance (ohm)
Fundamental	7	<35
Fundamental	10	<35
3rd Overtone	20	<25
3rd Overtone	45.1	<40
5th Overtone	70	<40

* Applicable spec is MIL-C-3098B



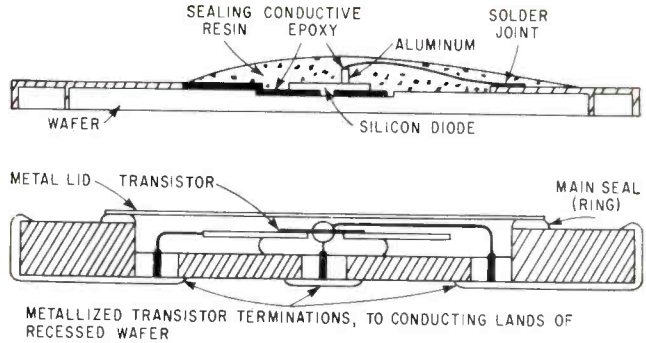


FIG. 1—Preliminary diode and transistor designs

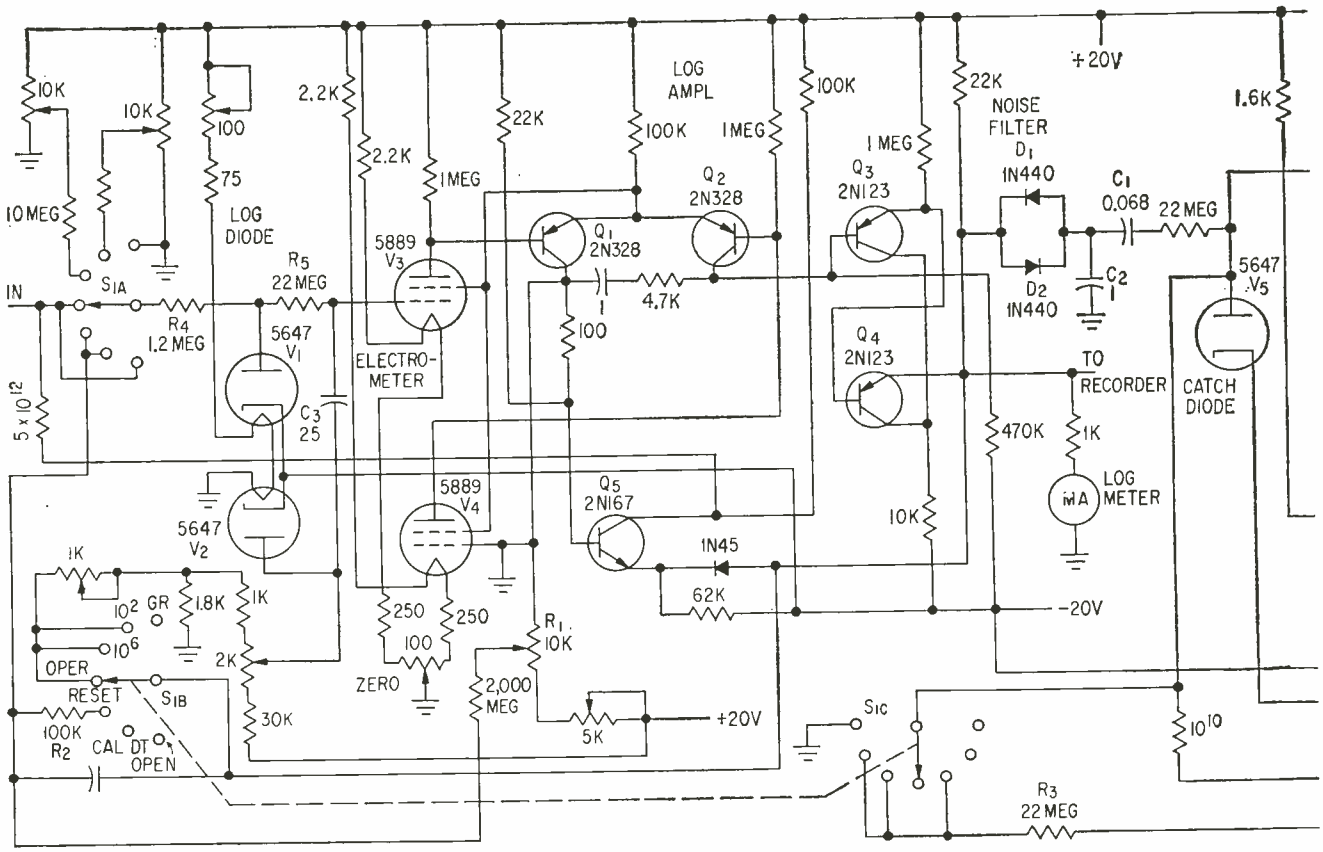


FIG. 1—Log amplifier and period amplifier are completely transistorized. Log diodes, electrometers and catching diode are vacuum tubes. Func-

Transistor Amplifiers for

Logarithmic and period amplifiers used in nuclear reactor startup ranges are transistorized with exception of log diodes and electrometers. Great saving in size, weight and power consumption is made

LOGARITHMIC AND PERIOD amplifiers are indispensable to the operation of nuclear reactors because of their wide indicating range without switching.

The log diode V_1 shown in Fig. 1 is a nonlinear element whose characteristics are sensitive to changes in cathode temperature.

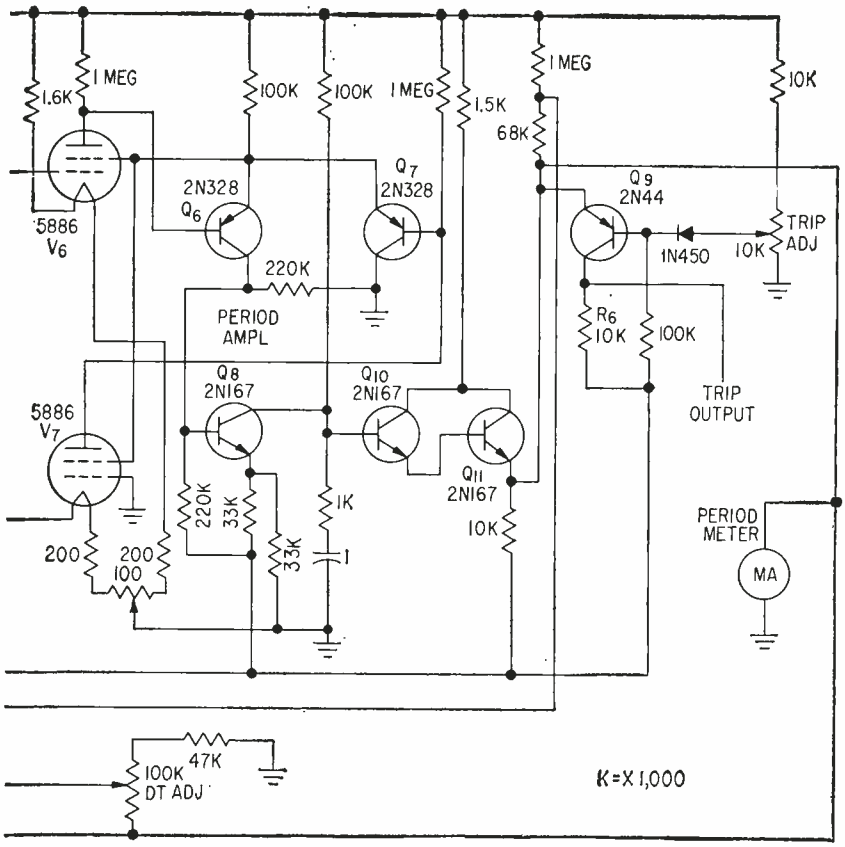
This effect can be compensated by using two diodes to balance out effects of temperature and power supply variations. When V_1 and V_2 are connected in series back to back, a constant current flows through balance diode V_2 which is large compared with the maximum current to be measured. Input flows through both diodes but the potential change across the balance diode is negligible and is included in calibration.

The log diode can be considered as a variable resistance that may vary greatly over the amplifier operating range.

Log Amplifier

As transistors with sufficiently high input impedance are not available, low-current electrometer tubes are used. Balanced electrometer tubes V_3 and V_4 drive a differential stage consisting of Q_1 and Q_2. The silicon transistors have low I_{co} and minimum temperature effects. A stable operating level is obtained by connecting the electrometers as tetrodes and supplying their screen grids from the common emitters of Q_1 and Q_2. Changes in d-c level are highly degenerated without reduction in signal gain. The current output of the differential stage is amplified by two cascaded emitter followers Q_3 and Q_4.

Calibration of the log amplifier is done in the conventional manner. For period calibration, log diode V_1 is biased nonconducting by potentiometer R_1 and the log amplifier is connected as an integrating amplifier to generate a linear ramp voltage. To discharge the circuit capacitance quickly, switch S_1 is placed in the reset position and resistor R_2 is connected around the



tion switch is used for different modes of operation

Reactor Control

By E. J. WADE and D. S. DAVIDSON*,

Knolls Atomic Power Laboratory, General Electric Co., Schenectady, N. Y.

log amplifier and R_3 is connected around the period amplifier. These resistors discharge the ramp generator in 0.1 second and the differentiating capacitor C_1 in 1 second.

Period Amplifier

This amplifier is a feedback-type differentiating circuit. The factors that determine the input current are the log amplifier output per decade, the period to be measured and the value of capacitor C_1. The output voltage depends upon the capacitor C_1 discharging resistance and the time constant of the amplifier gain.

When the amplifier is used to initiate the operation of protective circuits, it is desirable to provide a time delay before generating the trip signal. This delay is a function of the period and is met by choosing the correct time constant of the differentiating circuit. Calibration is made by applying a simulated period from the log amplifier.

To reduce noise, a nonlinear filter consisting of D_1, D_2 and C_2 is placed between the log amplifier output and the period amplifier input. The silicon diodes have high resistance at low voltage and are connected in parallel with reversed polarities. In conjunction with C_2 the filter has long time constant at low voltage decreasing until it is negligible above 0.5 v and has little effect on the tripping time.

Input resistor R_1 is in series with log diode V_1 preventing noise transients from being rectified by the diode. The filter consisting of R_5 and C_3 at the input electrometer grid further reduces the high-frequency gain.

Catching Circuit

When the log amplifier is operating at low current, diode V_1 may either not be in its logarithmic range or cut off due to transient or grid current. When the input current increases under this condition the amplifier output is no longer logarithmic but is linear. This simulates a much shorter period until the log diode reaches its operating range and can cause tripping during reactor startup.

To prevent this tripping, negative feedback is applied from an auxiliary amplifier which operates only when the signal output is slightly reversed. This circuit has negligible effect during normal operation. If the output signal reverses, indicating a diode current less than 10^{-12} amp, the feedback maintains the log diode current at 10^{-12} amp thus preventing the log diode from operating outside its logarithmic range.

The period amplifier uses catching diode V_5 in a low-impedance feedback loop to improve recovery time for input reversals due to switching transients or negative periods.

Trip Output

The trip output circuit consists of transistor Q_3 biased by an adjustable potential applied to its base. When the emitter is driven more positive than the trip setting, the transistor conducts and the output goes positive generating a trip signal. Grounding or opening the trip circuit also causes tripping.

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Reducing Distortion

Grid-plate transfer characteristic of class-B amplifier is linearized to eliminate harsh odd-harmonic distortion. Linearization is accomplished by compensation networks having a nonlinear transfer function. Networks are determined graphically. Compensated amplifier distortion is 2.6 percent.

By **BERNARD SKLAR,*** Republic Aviation Corp., Farmingdale, N. Y.

REDUCED POWER consumption and miniaturization of components make the use of class-B amplifiers economically desirable in audio systems. However, true class-B operation results in such harsh odd harmonic distortion that it is useless for moderately good fidelity. The primary cause of the generation of odd harmonics in the class-B output is the nonlinearity of the grid-plate transfer characteristic.

To design a linear class-B audio amplifier, where the output waveform is the exact replica of the audio input, it is necessary to linearize the curved transfer characteristic of the class-B stage.

It is possible to compromise between the low distortion of class A and the high efficiency of class B by operating in class AB. Or, improved linear operation can be insured by applying negative feedback to the amplifier. Also, a stage of tandem compensation or predistortion can be used to exactly counteract the original distortion.

The first two techniques produce linearization at the expense of output power. However, tandem compensation can linearize the class-B output with hardly any loss of power.

Compensating Network

Figure 1 shows a compensating network which is reasonably independent of tube parameters and can operate on a voltage without consuming appreciable power. Voltage E_1 is the bias for the class-B stage, E_2 is more positive than the bias and E_3 is more positive than E_2. Voltages E_2 and E_3 provide bias for diodes D_1 and D_2. At low levels, where E_2 and E_3 prevent diode conduction, the input signal at terminals AB sees a simple voltage divider consisting of R_1 and R_2.

As the signal goes more positive, voltage e_g increases. When e_g equals E_2, diode D_1 conducts. This changes the voltage divider from a simple R_1 plus R_2 configuration to R_1 in series with the parallel combination of R_2 and R_3. The grid-leak resistance part of the voltage divider has been decreased in value and the voltage across it is now a smaller ratio of the total signal. When the signal goes still more positive so that e_g is equal to E_3, both diodes conduct and the voltage at terminals CD is an even smaller ratio of the total signal. The network requires a minimum of two diode branches for satisfactory performance.

To present a fairly constant impedance to the preceding stage, R_1 should be a high value. As R_1 is increased a smaller portion of the signal at P will appear at the grid of the final stage. Therefore, a compromise must be made when selecting the values of R_1 and R_2 to avoid too high a signal voltage at P. The compromise values of R_1 and R_2 are 300,000 and 1,000,000 ohms respectively.

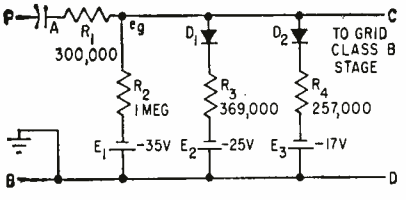

FIG. 1—Basic network used in compensator. Two are needed in amplifier

Graphic Solution

Figure 2 illustrates the graphical method for determining the remaining resistors. The grid-plate transfer characteristic of one half the push-pull 6L6 output is plotted. The origin corresponds to the grid biasing voltage. Although a bias of −45 v represents cutoff, −35 v is used as the quiescent grid voltage so that the compensation network is not required to linearize the severest portion of curvature in the transfer function. By using a small amount of transfer-characteristic overlapping, the output operates in the class-AB region rather than absolute class B. Loss in efficiency is small.

Then, the 6L6 transfer curve is approximated by three straight lines, taking care that the low level lines represent the curve as accurately as possible. A straight line is drawn from the origin to the point of maximum output (3) on the transfer function. Now, the technique is to change the abscissa scale so that the 6L6 function from the origin to 1 can be compressed into the portion of the straight line from the origin to 1′. The first portion of the nonlinear transfer function, before either diode conducts, becomes the first segment of the linearized function.

Points 1 and 2 show where the function must change slope and

* Now with Hughes Aircraft Co.

in Class-B Amplifiers

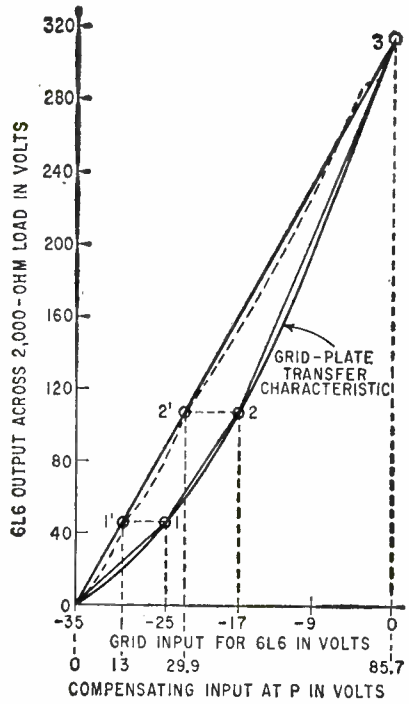

FIG. 2—Graph used to find diode bias voltage and resistors in compensator

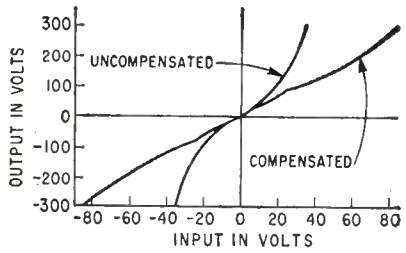

FIG. 3—Comparison of compensated and uncompensated push-pull 6L6 transfer characteristics

dictate the bias conditions for the diodes (−17 v, − 25 v). The graph is now used to calculate the resistance in series with each diode. The curve segment from 1 to 2 must be compressed and its slope changed so that it approximately matches the line segment from 1′ to 2′. The curve from 2 to 3 must be compressed and its slope changed to match the line from 2′ to 3.

In Fig. 1, when e_g equals −25 v, the voltage at A is found by $(A - e_g)/300{,}000 = (e_g + 35)/1$ megohm. When e_g is at −25 v, A is at − 22 v. This means the input at P is 13 v (−22 + 35). On the abscissa scale of Fig. 2 the horizontal distance from the origin to 1′ must equal this input of 13 v. This information is used to complete the new input scale on the abscissa.

When e_g equals −17 v, point 2 is forced to lie on 2′. From the new abscissa scale, point 2′ represents a voltage of 29.9 v at the input P of Fig. 1. Now, A is at −5.1 v (29.9 − 35) and

$$\frac{A - e_g}{300{,}000} = \frac{e_g + 35}{1\text{ meg}} + \frac{e_g + 25}{R_3}$$

gives R_3 equal to 369,000 ohms.

When e_g is equal to zero, P is at 85.7 v and A is at 50.7 v. Using

$$\frac{A - e_g}{300{,}000} = \frac{e_g + 35}{1\text{ meg}} + \frac{e_g + 25}{369{,}000} + \frac{e_g + 17}{R_4}$$

gives R_4 equal to 257,000.

The dashed curve on Fig. 2 is the static characteristic experimentally obtained from a compensating network and a 6L6 in tandem. This is a fairly good approximation to the desired straight line. Two of these compensating networks are required in each amplifier.

Another way of viewing this compensation is illustrated in Fig. 3. Each half of the original push-pull transfer characteristic is broken up into three sections. Each section by itself is almost linear. As the signal increases and a new section takes control, it takes control at a lower gain. The entire transfer function is stretched out and follows the same direction specified by the initial segment.

Clamping Effect

Looking at the compensating network in Fig. 1, an analogy can be made between it and a typical clamping circuit. When the input to the network at P goes positive, it first sees a long time constant through the capacitor and the high resistance. As the signal increases and the diodes conduct, the impedance from e_g to ground is lowered causing the time constant to decrease. The capacitor is charged quickly during this short time constant (high positive signal). When the polarity of the signal reverses, neither diode conducts, and the impedance from e_g to ground remains high. During this period the capacitor discharges slowly due to the long time constant. The result is somewhat of a clamping effect.

When the signal goes positive again the capacitor retains most of the charge and acts like a series battery. This effect clamps the output e_g more negatively than is realized from static calculations. Keeping each grid more negative reduces the output of each tube and permits the

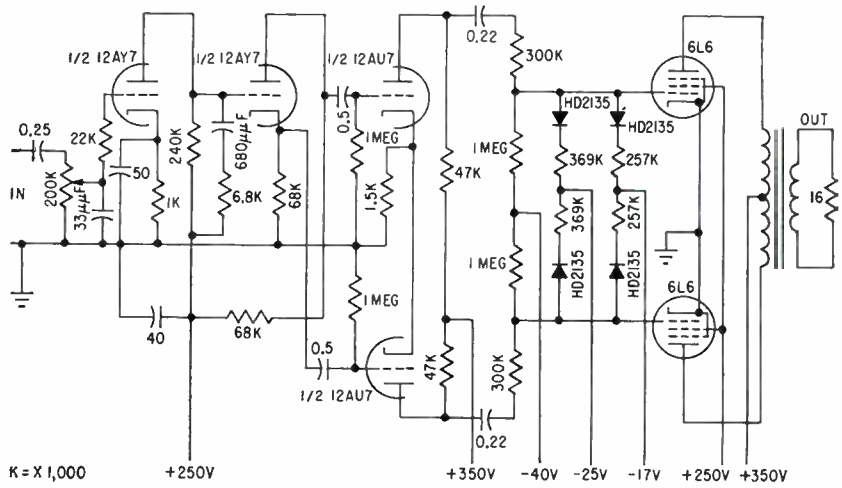

FIG. 4—Compensated amplifier delivers 16 w with 2.6 percent total distortion at 47.6-percent efficiency

tubes to go into cutoff prematurely, preventing the exact alignment of each half of the grid-plate transfer function.

To make the dynamic transfer function as linear as the static one, the sharp difference between the time constant for a high positive signal and that for a negative signal must be reduced. The reduction in clamping is accomplished with leakage across the diodes. Instead of a constant leakage path, a variable resistance is utilized to simulate ideal conditions. This variable resistance is achieved through the proper selection of diodes. Rather than choosing diodes with high back resistance, diodes with moderate reverse leakage characteristics are selected. The effect is that of a variable resistor shunted across the diode.

Diode Characteristics

The diodes used in the compensation network should have high conductance in the forward direction so that the resistance of the conducting diode can be neglected in the network design. In reverse direction the diode should be characterized by an initial high resistance and a resulting leakage current of about 1 microampere, until a back voltage of 18 v is reached. Any greater reverse voltage should cause breakdown and the diode should be able to operate in the breakdown region without being damaged. Eighteen volts is chosen because it is the largest reverse voltage across either diode during any positive signal excursion.

Table I—Percent Harmonic Distortion at 1 Kc

Harmonic Distortion	Uncompensated Amplifier	Compensated Amplifier
Total	13.0	2.6
2nd	1.5	0.78
3rd	11.5	2.1
4th	0.3	0.22
5th	1.8	1.2
6th	0.23	0.29
7th	0.85	0.12
8th	0.05	0.13
9th	0.21	0.34
10th	0.05	0.055
11th	0.04	0.14

Using such a diode in the compensation network of Fig. 1 will result in the linearization predicted by the static calculations. The leakage will not affect operation during any positive signal swing. Only when the signal goes negative and the reverse voltage across D_2 is increased beyond 18 v will there be a leakage path capable of reducing the time constant to a value near the time constant for high positive signals. The loss of bias at e_g will be approximately 1 v (R_2 times 1 microampere) which is small enough to be disregarded.

Compensated Amplifier

Figure 4 is schematic diagram of a compensated amplifier. The diodes have a leakage current in the order of 10 microamperes at a reverse voltage of 18 v. To compensate for the loss in grid bias caused by this leakage current, the bias voltage for the class-B stage is made 5 v more negative than its design value of −35 v.

The uncompensated amplifier, the compensated amplifier without the compensating networks and with −35 v bias at the grids of the output tubes, delivers 14 w at an efficiency of 48.7 percent when operated at peak performance. The output waveshape of the uncompensated amplifier is shown in Fig. 5A. Because the amplifier is not biased exactly at cutoff, the transfer characteristic for the uncompensated amplifier (Fig. 5B) has a less harshly distorted output than for true class-B operation.

When the compensated amplifier is operated at peak performance it delivers 16 w at an efficiency of 47.6 percent. The loss in power efficiency due to compensation, 48.7 percent to 47.6 percent, is negligible. The compensated amplifier output waveform is shown in Fig. 6A. Figure 6B shows the linearization of the transfer characteristic accomplished by the tandem compensator.

As shown in Table I, the total distortion of the uncompensated wave in Fig. 5A is 13 percent, while the total distortion of the compensated wave in Fig. 6A has been reduced to 2.6 percent. Distortion reduction, with similar retention of power efficiency, can be achieved with any class-B amplifier by use of properly designed tandem compensation. In the case of class-B_2 operation the compensation must precede the driver stage.

Applications

In applications such as commercial broadcast transmitters, portable radios and mobile communication systems, high efficiency is required and sacrifice of fidelity is undesirable. In these applications this linear type class-B audio amplifier proves useful. Even in home amplifiers and public-address systems, where power economy usually is not a prime consideration, the linear class-B output has advantages. The lives of the output tubes are lengthened due to the little current drawn at no signal level. Also, it is possible to design these amplifiers with the same power output as their class-A counterparts, using smaller transformers and smaller output stages.

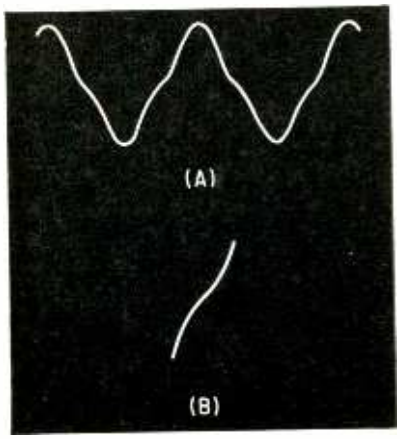

FIG. 5—Uncompensated amplifier output (A) and transfer characteristic (B)

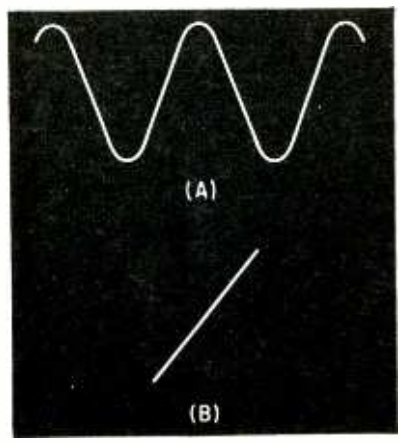

FIG. 6—Compensated amplifier output (A) and transfer characteristic (B)

Radioactive Sources

Table lists characteristics of materials used in noncontacting thickness gages employing the principles of nuclear radiation detection

By W. HARRISON FAULKNER, JR., Vice President, Engineering and Development, Tracerlab, Inc., Waltham, Mass.

SINCE INTRODUCTION of the beta gage for thickness measurement, a wide variety of radiation source-detector combinations has been devised. As new isotopes have become commercially available at prices which allow their general use, a wider selection has been developed.

The radiation source selected must emit radiation of energy such that a measurable part is absorbed by the material being measured. Table I shows typical sources used. Emitters of beta radiation are generally used for less dense materials.

Detectors used in thickness gages are generally absorption or backscatter type ionization chambers or scintillation detectors. They must be built to withstand severe operating conditions as they may be used in hot, dusty and humid plants, frequently sprayed by corrosive or abrasive materials.

The formula for converting material thickness in mils into mg/cm² is: mg/cm² = spec grav of mat'l × thickness in mils × 2.54.

Table I—Radioactive Sources for Thickness Gages

Source Material and Symbol	Type Radiation	Half Life	Form of Activity Quantity	Measured Material Thickness, mg/cm²	Gage Applications
Carbon 14 C^{14}	Beta	5,500 yr	Various 1 millicurie	0–5	Early pliofilm gages
Promethium 147 Pm^{147}	Beta	2.6 yr	Powder 5–50 millicurie	0–15	Thin films and tissues
Krypton 85 Kr^{85}	Beta	10.3 yr	Gas 350 millicurie	0–70	Light paper and thin plastics
Thallium 204 Tl^{204}	Beta	4 yr	Crystalline 100 millicurie	0–75	Same as Kr^{85}
Cerium 144 Ce^{144}	Beta	290 days	Crystalline 10–50 millicurie	0–200	Short half-life limits use
Cesium 137 Cs^{137}	Beta	30 yr	Crystalline 10–50 millicurie	0–130	Papers and foils
Radium D+E $Pb^{210}+Bi^{210}$	Beta	22 yr	Powder 1–10 millicurie	0–250	Paper, plastics, light foils
Strontium 90 Sr^{90}	Beta	25 yr	Crystalline 20–200 millicurie	0–600	Heavy paper boxboard, thin metal, rubber
Thulium 170 Tm^{170}	Gamma	127 days	Powder 1–100 millicurie	100–500	Metal foils and strip
Ruthenium 106 Ru^{106}	Beta	1 yr	Crystalline 10 millicurie	200–1,300	Rubber, plastic laminates, heavy web mat'l
Strontium 90 Sr^{90}	Brems-strahlung	25 yr	Crystalline 0.25–1 curie	500–1,000	Heavy metals, steel, copper, aluminum
Iridium 192 Ir^{192}	Gamma	74.4 days	Metal 50–500 millicurie	500–1,000	Limited by short half-life
Cesium 137 Cs^{137}	Gamma	30 yr	Crystalline 50–500 millicurie	1,000–20,000	Level and density gaging of liquids
Cobalt 60 Co^{60}	Gamma	5.27 yr	Wire or pellets 1 mc–1 curie	2,000–200,000	Dense mat'ls such as 1-in. steel
Radium Ra^{226}	Gamma	1,620 yr	Crystalline 1–50 millicurie	2,000–200,000	High-density mat'ls

Correlation Devices

Electronic devices using correlation function can detect signals so immersed in noise that they are indistinguishable when ordinary equipment is used. Article describes operating principles of autocorrelators, crosscorrelators and associated devices known as radiometers

By **HAROLD R. RAEMER**, Staff Engineer
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DETECTION OF SIGNALS buried in noise becomes a problem of increasing importance as the requirements of communications and radar equipment become more stringent. A class of devices will be described that uses the mathematical concept of the correlation function to detect these relatively indiscernible signals.

A correlation function is the long time average of the product of two functions of time. For example, if one voltage waveform is represented as a function of time by $V_1(t)$ and another represented by $V_2(t-\tau)$ (where τ is the delay time) are continuously multiplied and the product $V_1(t)V_2(t-\tau)$ fed into a low-pass filter, then the filter output closely approximates the true mathematical correlation function. When $V_2(t-\tau)$ is the function $V_1(t)$ delayed the amount τ, the device is called an autocorrelator. If $V_1(t)$ and $V_2(t-\tau)$ are totally different functions, the device is called a crosscorrelator. In both cases the output is a function of delay time τ.

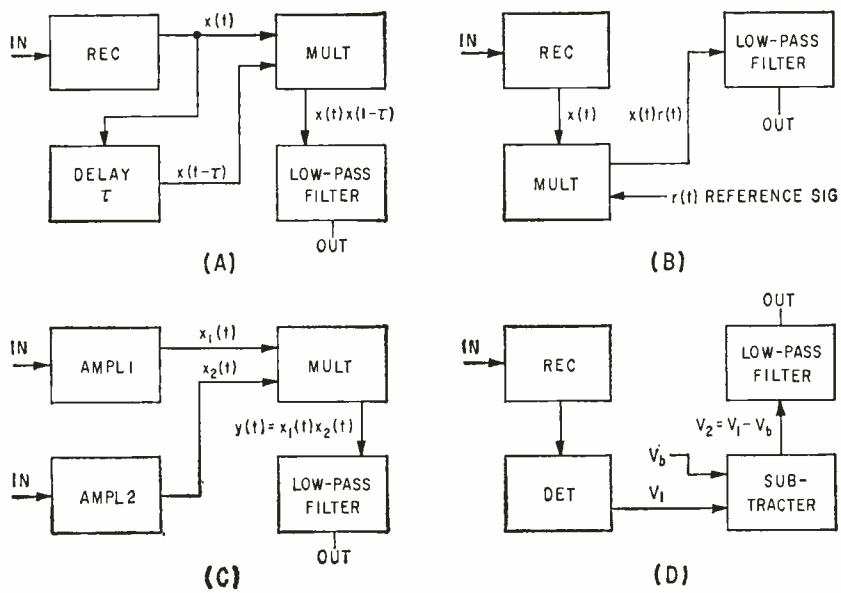

FIG. 1—Autocorrelator (A) is used in a superheterodyne. Crosscorrelator (B) is a synchronous detector using reference signal resembling expected signal. Two-receiver radiometer (C) detects aperiodic signals. Subtraction-type radiometer (D) subtracts stored noise signal from expected signal plus noise

Autocorrelators

The autocorrelation function of a sinusoidal voltage $V_1(t) \sim \sin(2\pi ft + \phi)$ is proportional to $\sin(2\pi f\tau + \psi)$. That is, the function is a sinusoid in τ with the same frequency as that of $V_1(t)$.

On the other hand, the autocorrelation function of random noise decreases rapidly with τ and drops to negligible values when τ exceeds the value τ_c called the correlation time of the noise. The crosscorrelation function of signal and noise, which also enters the output, is negligible for all values of τ.

For delay times τ far in excess of τ_c, the output of the low-pass filter of the autocorrelator will show a sinusoidal variation with τ of frequency f even though the sinusoidal signal is too weak relative to the noise to be perceived in the original waveform.

An autocorrelator for use by a conventional superheterodyne receiver is shown in Fig. 1A. The applicability of this device is limited to detection of essentially periodic signals, which can always be considered as sums of sinusoids, in any kind of noise that has a continuous spectrum over a broad band of frequencies such as thermal and shot

Detect Weak Signals

noises of a radio receiving system.

A limitation of the autocorrelator is the difficulty of using it at r-f or i-f. It is operated after detection where small signal suppression has already occurred, thus reducing the realizable gain in signal-to-noise ratio.

Crosscorrelators

The crosscorrelator or synchronous detector illustrated in Fig. 1B

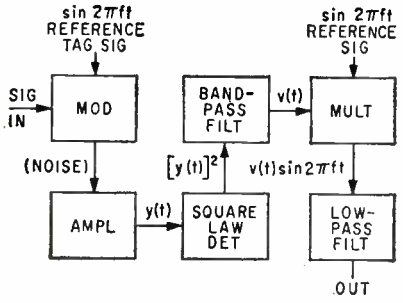

FIG. 2—Dicke radiometer combines received signal with reference signal, then uses duplicate of reference signal to produce large output at filter

uses a reference signal $V_2(t-\tau)$ generated in the receiver that closely approximates the expected signal $V_1(t)$ which is accompanied by a random-noise waveform $n(t)$.

The filter output contains the crosscorrelation function of $V_1(t)$ and $V_2(t-\tau)$ and that of $V_2(t-\tau)$ and $n(t)$. Theory shows the latter to be negligible compared to the former, providing the delay time τ is adjusted so that $V_2(t-\tau)$ is essentially the same as $V_1(t)$.

The essential requirement in the successful use of a crosscorrelator is sufficient prior knowledge of the expected received signal waveform to generate a reference waveform that nearly duplicates it. In pulsed radar this knowledge is available since the prf of the transmitted signal is known and a reference pulse of the same prf can be generated.

The delay time τ must be slowly varied until a large output appears at the filter indicating coincidence between target pulses and reference pulses. This is substantially a conventional radar range gate with low-pass filtering, as the delay time which will produce coincidence varies linearly with range to target.

The crosscorrelator is operated after the second detector where small-signal suppression has already degraded performance.

Two-Receiver Radiometer

In some applications it may be required to detect signals that are not even approximately periodic or whose period is too long to allow detection by an autocorrelator (such as in radioastronomy applications). If not enough is known about the signal to construct a reference waveform for a crosscorrelator, then no conventional correlation technique will extract the signal from the noisy background. A two-receiver radiometer which is a variation of the autocorrelator may be used in this case. As shown in Fig. 1C, this device uses two independent receiver channels whose outputs are multiplied together and the product fed to a low-pass filter.

The signal voltage is the same in both channels excepting a possible adjustment in delay time due to a difference in time of arrival. However, the product of the noise waveforms in the two channels, originating from two independent sources, will average to zero over a long time. The noise in each channel is independent of the signal itself and in the ideal case, the low-pass filter output is the square of the signal stripped of noise.

Regardless of the nature of the signal, the two-receiver radiometer operates on it as if it were periodic and the radiometer were an autocorrelator with delay time equal to a multiple of its fundamental period and much greater than the correlation time of the noise. The radiometer is operable at intermediate frequencies giving it a practical advantage over conventional correlators.

Dicke Radiometer

The Dicke radiometer is a variation of the crosscorrelator designed to detect a signal of unknown form. As shown in Fig. 2, its principal feature is a low-frequency reference signal that may be a sinusoid or square wave of a few cycles per

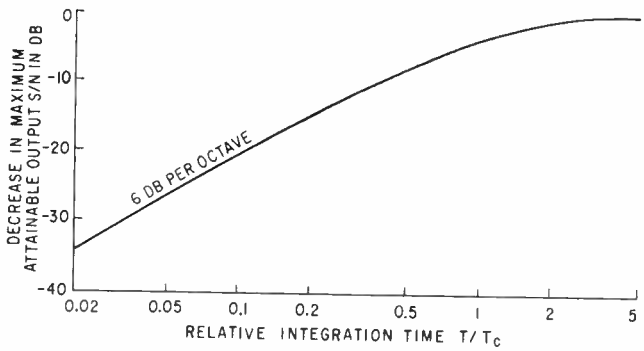

FIG. 3—Attainable signal-to-noise improvement is function of the ratio T/T_c

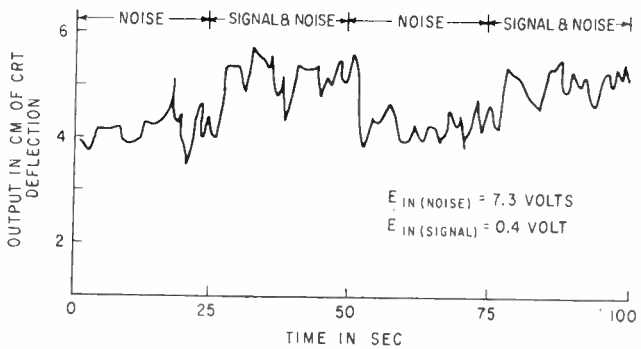

FIG. 4—Experimental waveforms showing actual improvement in signal detectability obtained with crosscorrelator

second. The reference signal is introduced in the r-f circuit before the mixer where the largest contribution to receiver noise occurs. The reference waveform modulates the incoming signal. The modulated signal is amplified, square-law detected and filtered to pass the desired signal band about the reference frequency. The bandpass filter output is multiplied by a duplicate of the reference signal and the multiplier output is low-pass filtered.

This radiometer is essentially a crosscorrelator that puts a "tag" on the r-f signal so that it can be recognized at a later stage. Crosscorrelating the tagged signal with a duplicate of its tag produces a large output. Receiver noise is introduced at a stage following the tagging process and being untagged does not produce a significant output.

Subtraction Radiometer

The subtraction-type radiometer (Fig. 1D), which is not a correlator, is the simplest of all detection devices. Unfortunately its drift problem does not allow it to perform as well as other radiometers and correlators. It consists of a conventional square-law or linear second detector that delivers the video or audio signal plus noise to an adder, together with the stored pure-noise detector output, V_b. The pure noise is subtracted from the signal-plus-noise output and the difference is fed to a low-pass filter. The filter output will be significantly high only if a signal is present.

If the devices described computed correlation functions in the rigorous mathematical sense, their possibilities would be unlimited. Realities severely limit the accuracy with which the correlator or radiometer can make this computation and therefore limit the theoretically attainable improvement in signal-to-noise ratio.

All correlator limitations are associated with the integration or low-pass filtering stage. To approximate the correlation function as accurately as possible, the longest R-C filter time constant T_c, and the longest possible itegration time T, should be used. The former is for a faithful computation of a true mathematical integral and the latter relates to the infinite integral called for in the actual correlation function. Figure 3 shows the theoretically attainable improvement to be an increasing function of the ratio T/T_c and to be as large as possible for values equal to 3 or greater.

The two design objectives may therefore be mutually incompatible. Integration time T is always limited by the duration of the signal to be detected. As shown in Fig. 3, for a fixed value of T, increasing T_c to a value greater than $T/3$ will reduce the fidelity of the integration process and will detract from performance. One third of the maximum time allowed for the computation at one value of delay time τ is the optimum value of time constant. If τ must be searched for over a wide range of values throughout the duration of the signal, the realizable improvement may hardly be worth the trouble.

To circumvent this limitation, a number of parallel correlator channels, each searching over small values of τ, will decrease the required search rate for a given and fixed available search time T. This method increases the attainable signal-to-noise improvement by a factor which may be as large as the number of channels.

For evample, suppose the range of τ to be searched is 2,000 μsec and the total signal-to-noise ratio improvement attainable with a correlator is only 2 db. Incorporating 10 correlator channels with each assigned a range of τ values of 200 μsec could increase attainable improvements to as much as 12 db.

Figure 4 illustrates the actual improvement in radar signal detectability that was obtained with a crosscorrelator. Although the realizable gain in signal-to-noise ratio falls short of the idealized theoretical prediction, the increased signal visibility is of significant magnitude.

What Tests Show

Tests performed with the simulated two-receiver radiometer shown in Fig. 5 substantiated the essential correctness of the theoretical results regarding improvement in detectability of signals.

The tests showed that as the theory predicts, the degree of improvement in signal-to-noise ratio is not significantly affected by increasing the observation time as long as the original observation time is at least 2½ times as large as the low-pass filter time constant.

Tests also showed that the minimum detectable signal decreases with increasing low-pass filter time constant at a rate of −5 db per decade.

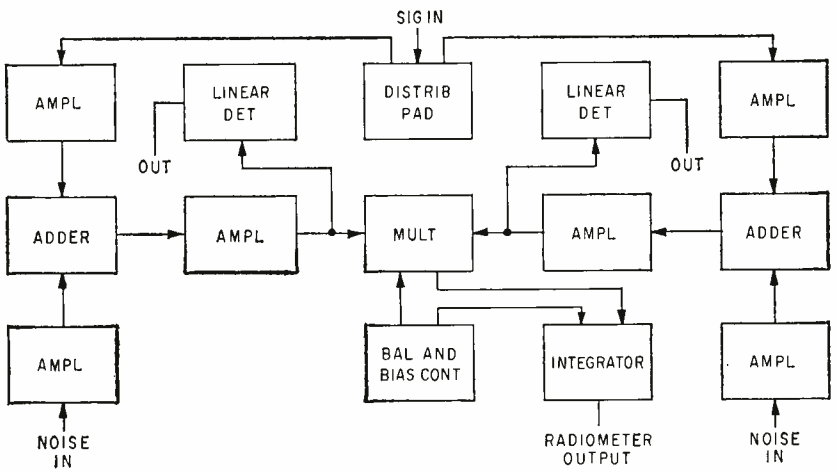

FIG. 5—Simulated two-receiver radiometer used to test agreement with theoretical predictions

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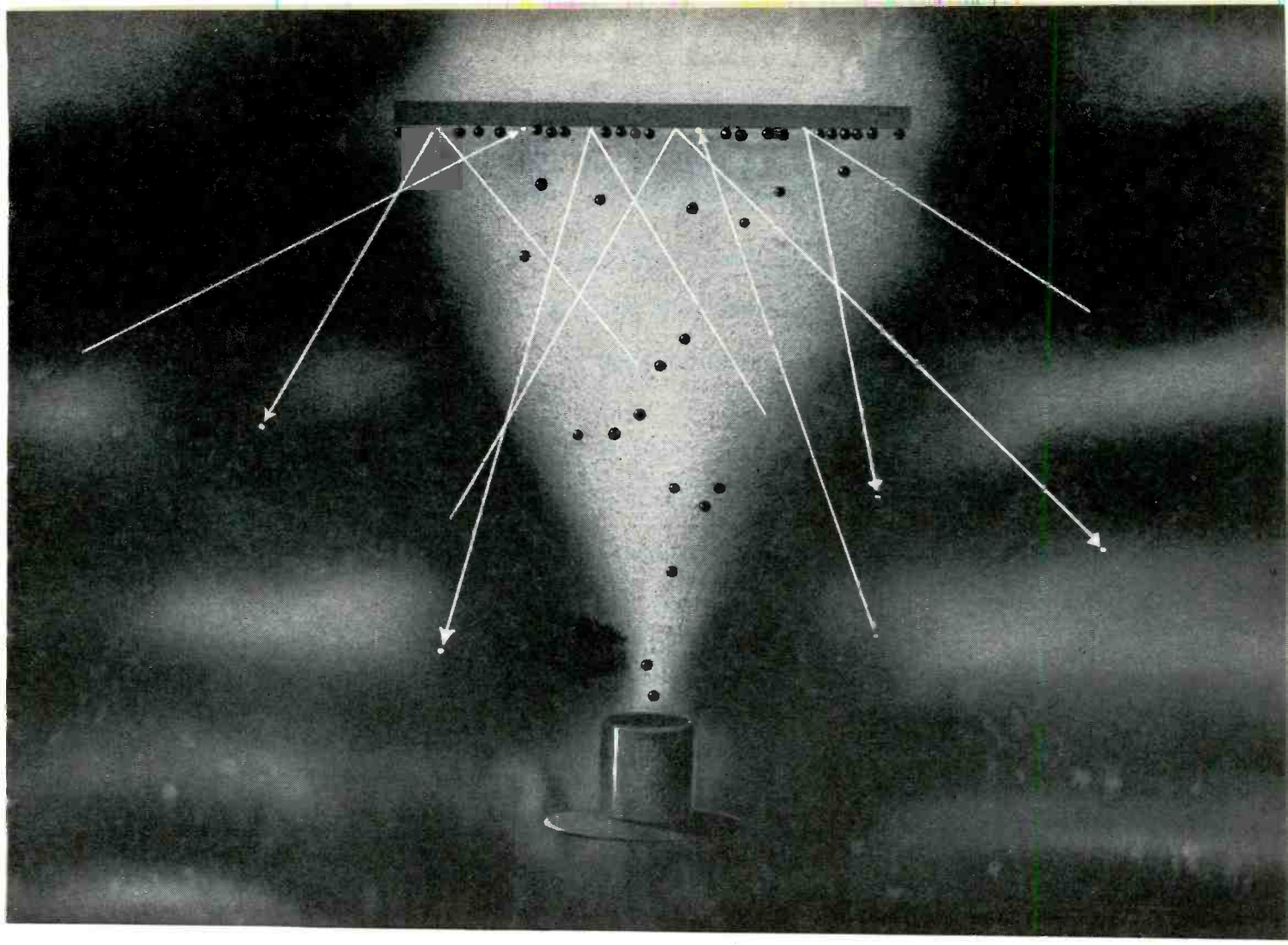

Report from IBM *Yorktown Research Center, New York*

ULTRA-HIGH VACUUM AND THIN METALLIC FILMS

The superconducting properties of a metallic film are significantly affected by its purity. A group of scientists and engineers at the IBM Yorktown Research Center is studying problems involved in producing superconducting thin films by vacuum deposition techniques. The immediate objective is to produce thin films with superconducting characteristics equivalent to those of pure bulk material.

In conventional vacuum metalizing, a chamber is evacuated to a pressure of 10^{-6} mm. Hg, the metal is heated to vaporization temperature, and a thin metallic film is condensed on a substrate. During this process, gas molecules remaining in the chamber contaminate the film. For example, if the deposition rate were such that the thickness increased by 100Å per second, the gas impurity in the resulting film could be as much as one atom for every 75 metal atoms.

One way to decrease this contamination is to work in a higher vacuum. Newly developed techniques, using an all-metal ultra-high vacuum system, permit the use of working pressures as low as 10^{-10} mm. Hg, thus decreasing the amount of gas present in the film by a factor of 10,000.

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Finding Radar Blind Spots

Charts simplify solution of problems associated with moving target indicator radar systems when target moves in a passing course

By BUD M. COMPTON
Tech Rep division, Philco Corp.

and FRED DUCHARM,
U. S. Air Force, Hamilton Air Force Base, Calif.

WHEN A TARGET'S radial motion between transmitter pulses is zero or any multiple of a half wavelength, the return echo cannot be distinguished from that of a fixed target by an mti (moving target indication) radar receiver.

These blind speeds may be shown to be a form of Doppler effect. For common coherent mti radars, the blind speed interval is $V_B = \lambda \times prf/102$, where V_B is the blind speed interval in knots, λ is the wavelength in cm, and prf is the pulse repetition frequency in pulses per second.

In practice, an mti receiver's velocity response depends upon whether the target is flying a radial or passing course. In the first case, the target's ground speed and radial speed are equal. Thus the ground speed may be used directly in determining mti response. Passing courses pose problems because the radial component of a target's velocity differs from the ground speed and is continuously changing.

A system of graphical aids has been devised for simplifying the solution of passing course problems. The charts are most useful when it is desired to site radars, analyze evaluation test flights and prescribe aircraft in-flight control criteria.

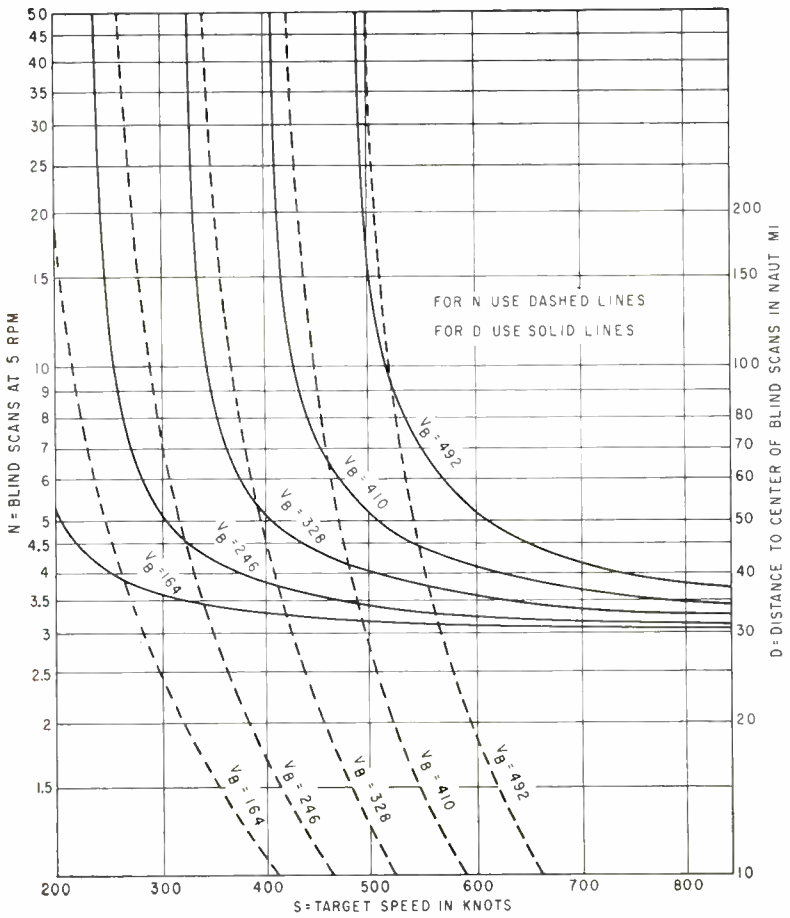


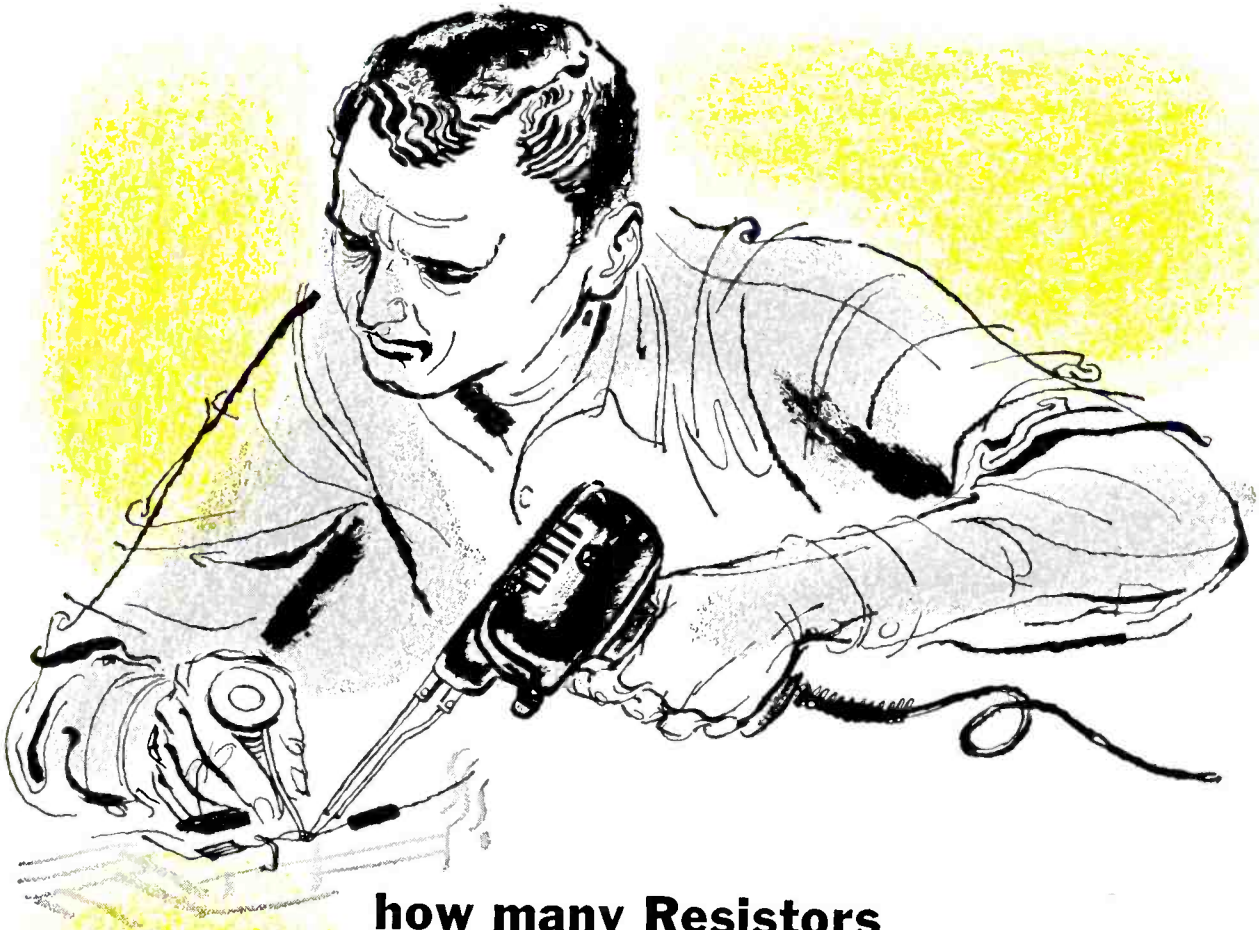
FIG. 1—Chart determines blind speeds and scans within range of expected traffic

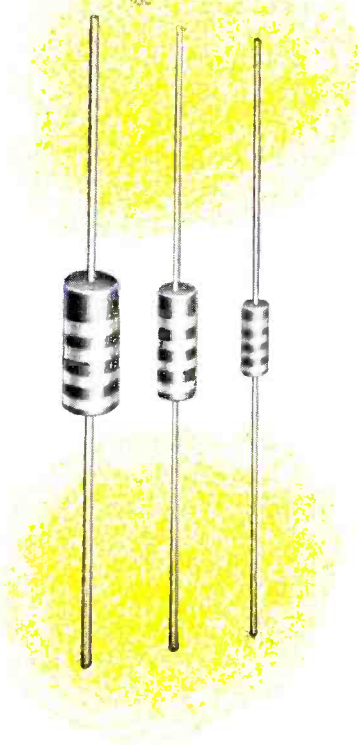
Typical Problem

Charts can be drawn to suit a particular situation. Figure 1 is intended to solve problems generated by a nearby airway. In this example, the traffic passes 30 nautical miles from the radar station. The dashed lines are solutions for N, the number of blind scans or missed points, from the relation $N = 1.35 \times 10^5 \, S \, [1/(S^2 - V_B^2)^{3/2}]$, where S is the ground speed of the target. In this equation, the radar antenna is assumed to be rotating at 5 rpm. Solid lines are plots of D, the distance to the points at which the blind scans take place, from the relation $D = 30 \, S/(S^2 - V_B^2)^{1/2}$.

A typical problem would be to find the range at which a 300-knot target will pass through the 246-knot blind speed of an L-band radar with a prf of 360 pps, and the number of blind scans that are expected as the target passes through this blind speed.

Find the intersection of the solid-line curve for $V_B = 246$ in Fig. 1 with the 300-knot target speed line. Read the range D at the right-hand margin to be approximately 52 nautical miles. Find the intersection of the dashed-line curve for $V_B = 246$ with the 300-knot target speed line and read the scale at the left margin. This shows 7 blind scans to be expected as the target passes through the blind speed at a range of 52 miles.





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Double Integrator Finds Distance

By T. R. NISBET Solid State Electronics Dept., Lockheed Aircraft Corp., Palo Alto, Calif.

SUBMINIATURE pentode is used in double integrator circuit to measure distances up to 150 ft from information supplied by an accelerometer. A transistor operates as a voltage trip, providing a pulse when the measured distance reaches a preset value. Two other tubes may be used to provide velocity and distance information for recording.

Accuracies of ±3 percent of distance are obtained over periods ranging to 3 sec in ambient temperatures between zero and 50 C.

Circuit Operation

Stability is reached in about 2 minutes after a switch is closed that applies filament and grid bias voltages. Referring to the block diagram in Fig. 1, the square-wave oscillator provides energizing voltage for the accelerometer a-c bridge and, when rectified, compensating voltages for the circuit.

The a-c signal from the accelerometer is rectified and fed to the first integrating network, whose output is fed to the grid of pentode V_1. Tube V_1 is used as constant-current device to charge the second integrator to a voltage representing the second integral.

The voltage-trip is a unijunction

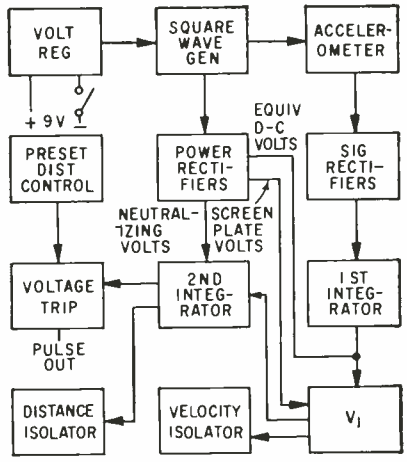

FIG. 1—Two tubes can be added to double integrator to get velocity and distance information for recording

transistor that fires when the voltage on the second integrating capacitor reaches a predetermined level. A pulse is produced at a time that corresponds to distance.

In Fig. 2, R_1 and C_1 perform the first integration. Capacitor C is the second integrating capacitor.

Resistor R_2 controls the trip point of Q_1, causing C_2 to be charged to a known voltage before measurement begins.

By using a local oscillator to energize the accelerometer and provide the various d-c voltages, the circuit can remain indefinitely in a state of readiness, without being subject to d-c drift problems. The earth's gravitational pull has no effect on the circuit until measurement begins, and a simple control can be inserted in series with R_3 to compensate any proposed angle of trajectory.

Use of a ballistic switch to start the oscillator makes the equipment automatic.

Adjustment

The accelerometer, which is of the slide-wire type, is energized in an a-c bridge that is adjusted to produce a null when the instrument experiences deceleration somewhat greater than the maximum deceleration expected. The bridge output voltage is proportional to (acceleration experienced)—g sin θ + (maximum deceleration allowed for), where θ is the angle of the trajectory with respect to horizontal. The last two terms are compensated by an equivalent d-c voltage (at R_3) in opposition to the rectified a-c signal from the accelerometer. The equipment can thus be adjusted for positive or negative accelerations or velocities, but only for posi-

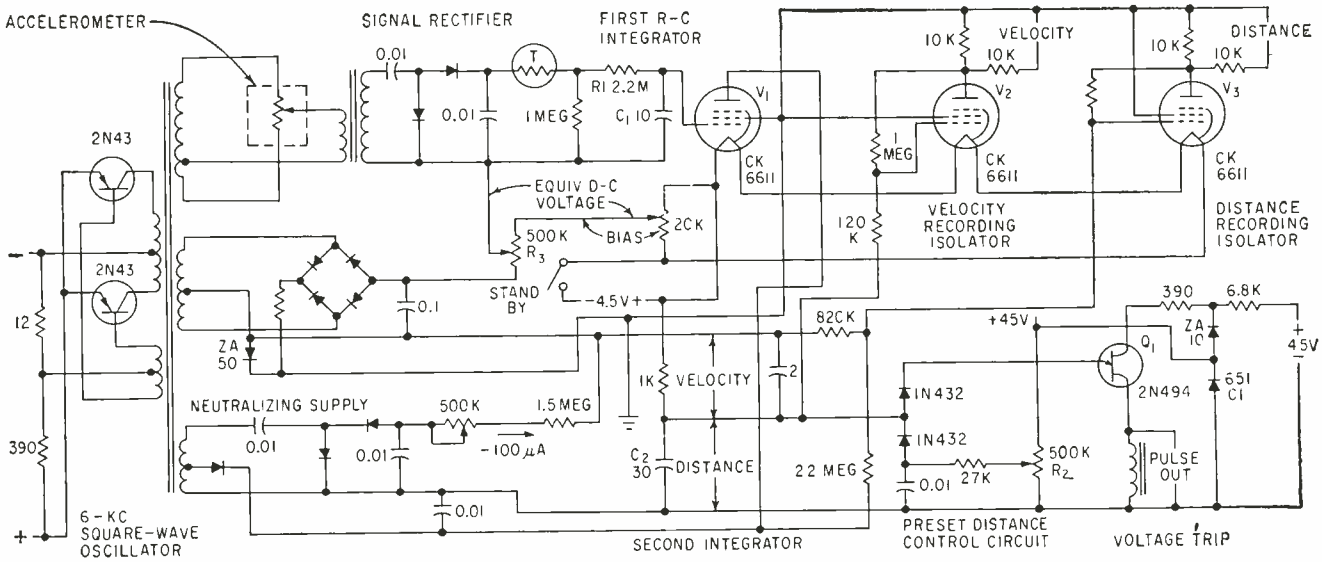

FIG. 2—Unijunction transistor is triggered when accumulated charge on C_2 reaches level analogous to preset distance

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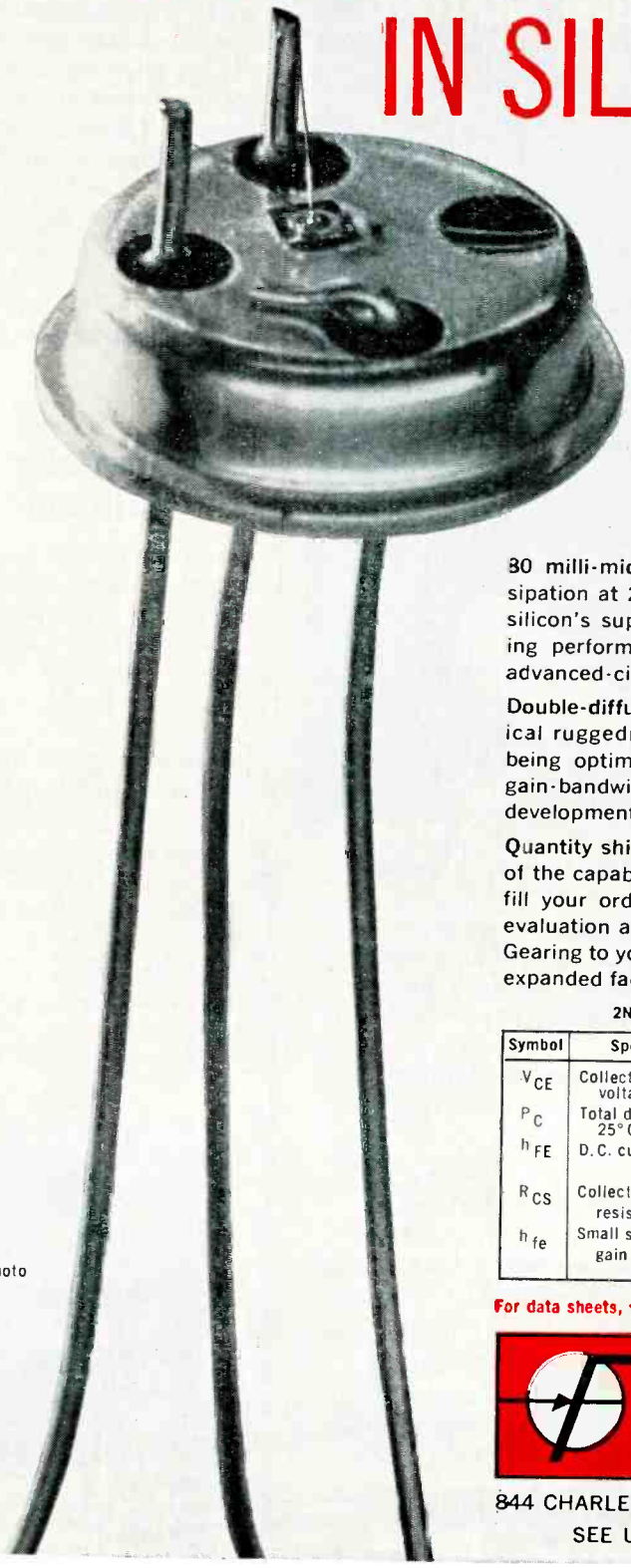

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P_C	Total dissipation at 25° C. Case temp.	2 watts		
h_{FE}	D.C. current gain		2N696—20 to 60 2N697–40 to 120	I_C=150ma V_C=10v
R_{CS}	Collector saturation resistance		3.5 Ω typical 10Ω max.	I_C=150ma I_B=15ma
h_{fe}	Small signal current gain at f=20Mc		5 typical	I_C=50ma V_C=10v

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tive distances.

Before the object has begun to move, anode current of V_1 is about 100 μa. To prevent this current from charging the second integrating capacitor, it is neutralized by an equal and opposite current.

Performance

Perfect linearity is not achieved, mainly because of variations in tube transconductance over the operating range of 100 to 600 μa. Repeatability, however, is within ±3 percent of distance over the temperature range. Paper capacitors are used for C_1 and C_2, with a ±3 percent variation in capacitance over the temperature range. The first integrator is slightly overcompensated by a thermistor, and the second integrator is uncompensated.

C-W Doppler Radar for Airliners

SUCCESSFUL flight tests of prototype Doppler radar navigation system for jet and turbo-prop aircraft were conducted by the Radio division of Bendix Aviation. Self-contained, long-range navigation system is expected to fulfill requirements of many airlines now phasing into operation of jet and turbo-prop aircraft.

System

The system uses an antenna that does not require gyro stabilization for pitch and roll of the aircraft or use of rotating machinery to steer the antenna.

The radar is an f-m/c-w type op-

Frequency tracker (left) and transmitter-receiver of Bendix f-m/c-w Doppler navigation radar for jets and turbo-props

erating at 8,800 mc. Modulation technique is said to eliminate the problem of altitude holes normally associated with Doppler radar not of the pure c-w type.

Coherent demodulation techniques permit operation with one-half watt of transmitted power.

The system meets requirements of ARINC specification 540, which sets forth requirements of airlines for self-contained Doppler radar navigation systems.

The basic system provides the pilot with drift angle information up to 40 deg left or right within $\pm\frac{1}{2}$ deg. Ground speed from 100 to 1,000 knots is provided within 0.6 percent plus one knot. The equipment operates at altitudes to 50,000 feet.

System Components

The antenna is a flat, four-beam planar array, permitting installation in shallow recesses in the fuselage or wing. A sequential switching circuit senses Doppler frequency shift in each of the four beams. Switching is accomplished by ferrite rotators, which eliminate need for mechanically rotated switches.

The transmitter with its power supply and the receiver are contained in a single package, with the modulation and beam-switching circuitry. Except for the klystron, the unit is completely transistorized. The frequency tracker, which determines Doppler frequency shift in each beam, and the computer, which derives ground speed and drift angle, are contained in another package. The unit is completely transistorized and uses printed circuitry.

The indicator is a dial type display of drift angle and a three-drum digital display of ground speed. The control panel is designed in accordance with RTCA-SC-46 specifications for installation in an overhead panel in the cockpit.

Total weight of all system components is about 60 lb.

In addition, a separate computer will be available to provide distance-to-go and distance left or right of desired course. An additional indicator will be available with this computer to provide steering command information.

Microwave Switch Uses Faraday Effect

DEVELOPED for a radio-relay system for transcontinental communication, a new rotation switch described in the April 1959 Bell Laboratories *Record* makes use of the Faraday effect. Purpose of the switch is to switch in a duplicate standby oscillator if either of two key local oscillators in the relay station malfunctions. Since the standby oscillators are in operation at all times, their output must be terminated and fully absorbed. The two local oscillators operate at 6049 and 6301 mc, respectively.

The switch developed incorporates a ferrite rod. Since ferrite interacts strongly with microwaves, it is possible to produce large rotation effects using small amounts of materials in practical waveguide structures.

The Faraday effect may be demonstrated by referring to Fig. 1. A linearly polarized wave is made to interact with a specimen of ferrite. The ferrite is magnetized in the direction of the axis along which the wave is traveling. As the wave passes through the ferrite, its direction of polarization is rotated as indicated in the left sketch in Fig. 1. Total angle of rotation is determined by what fraction of the wave penetrates the ferrite; by length of the interaction region and by magnetic state of the ferrite. If the ferrite is only partially magnetized, the amount of rotation is about proportional to the net component of magnetic strength of the material in the direction of propagation. This component can be changed by varying the strength of the d-c field.

Nonreciprocal Rotation

Sense of rotation in the drawing is clockwise as viewed in the direction of the d-c field. Direction of propagation of the wave does not affect the sense of rotation. Looking in the direction of the d-c magnetizing field, it can be seen that the polarization is in the clockwise sense no matter whether the wave is traveling toward or away from you. This characteristic is termed nonreciprocal.

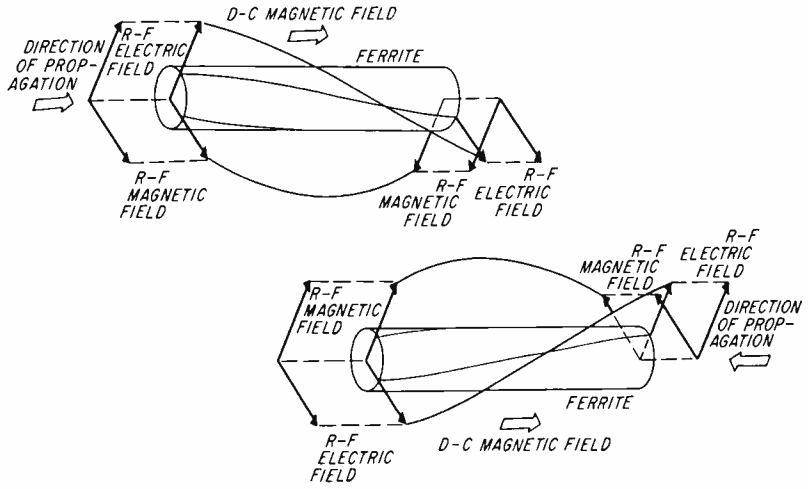

FIG. 1—Direction of rotation for an advancing portion of the wave is clockwise, viewed in the direction of the d-c field irrespective of the direction of wave propagation

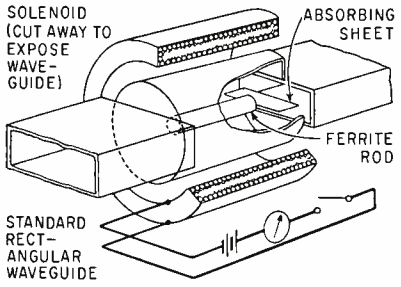

FIG. 2—Simplified Faraday rotation switch. Solenoid supplies d-c magnetic field to produce 90 deg. of rotation. Sheet of absorbing material suppresses the reflections

Basic structure of the switch is shown in Fig. 2. A section of circular waveguide containing a ferrite rod is connected between sections of a transmission line made up of rectangular waveguide. A longitudinal d-c magnetic field is supplied by an external solenoid. Current in the solenoid is adjusted to produce exactly 90 deg of Faraday rotation. The switch is in the on position when the d-c field is off and there is no rotation. But when the field is applied, the incident radiation is rotated and arrives at the output end oriented at 90 deg with respect to the polarization for which propagation can take place in the rectangular guide. In this polarization, the radiation interacts with the two broad faces of the guide whose spacing is only half that of the narrow faces. Since this spacing is less than the cutoff half-wavelength, the radiation is reflected fully.

In the off state, the wave undergoes an additional 90-deg rotation so that it arrives at the input end polarized so as to be transmitted freely into the input guide. It can be said that in the off state, the switch reflects. For some applications, presence of reflected radiation is undesirable. In such cases, this radiation can be suppressed by inserting a properly oriented sheet of absorbing material into the switch as shown in Fig. 2.

Disadvantages

Two serious limitations to practical use of the device illustrated in Fig. 2 are as follows: First, the angle of rotation is required to be extremely close to 90 deg for the off state. This means that the current supply to the solenoid must be controlled accurately. Second, the circular waveguide and ferrite assembly must be cylindrically symmetrical to within very close tolerances.

These disadvantages are taken care of by an effect resulting from the nonreciprocal rotation factor described previously. This additional effect is an interference phenomenon present whenever there is any

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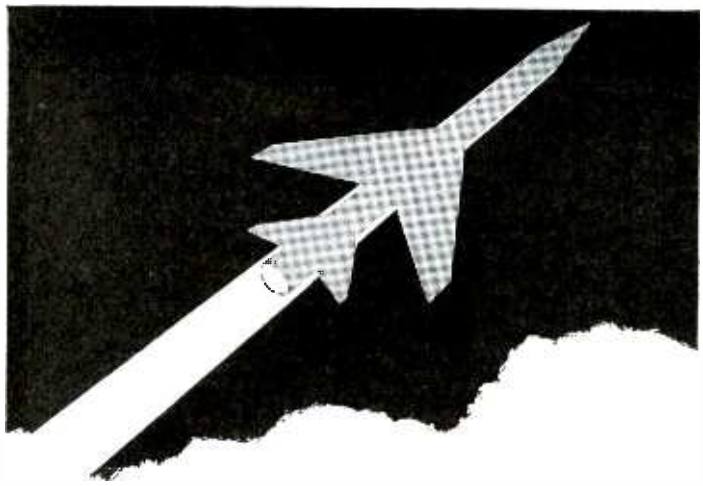

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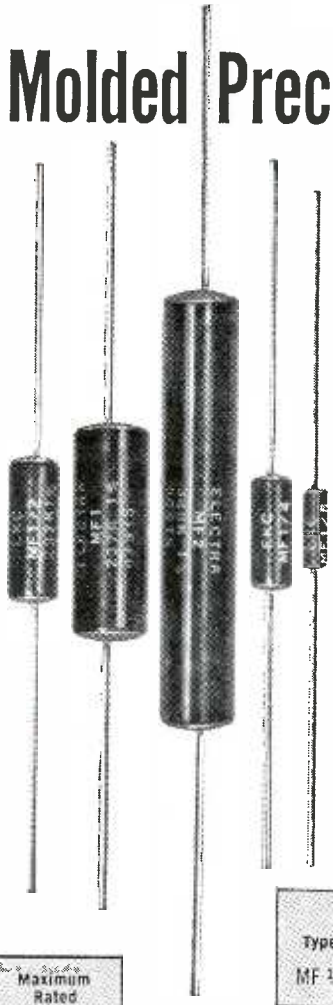

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0 ± 50 PPM/°C.	T-2
0 ± 25 PPM/°C.	T-5

Proposed MIL-R-10509C specification calls for temperature coefficient measurements from —55°C to +165°C. The lowest temperature coefficient is 0 ± 50 PPM/°C. Code T-2 meets this requirement. Resistors in code T-5 are production tested over a range of +25°C to +105°C. Special temperature coefficients—Code T-3, 0 to +100 PPM, and Code T-4, 0 to —100 PPM—are available for special applications.

*Parts Per Million Per Degree Centigrade (100 PPM equals 0.01%)
**The T.C. code marking is combined with the code for the date of manufacture

Electra **MANUFACTURING COMPANY**
Electronics Division
4051 Broadway, Kansas City, Mo., U.S.A., Phone: WEstport 1-6864

amount of rotation. It occurs only in a structure essentially free of dissipative materials. Therefore, the element that absorbs the radiation reflected from the switch in the off state must not be located inside the rotator structure.

The interference effect alters the switch behavior in the following manner: First, the switch goes abruptly into the off state at values of rotation much smaller than 90 deg. It remains off over a wide range of rotations, thereby relieving the strict requirement on strength of the d-c field. In addition, the effectiveness of the switch is made to depend essentially on dissipative properties of the ferrite rather than on the mechanical precision of the circular structure.

The completed switch was designed to exploit the interference effect. In addition to the basic components, it contains irises, tuning screws, a small permanent magnet, shield and dielectric tubes. Each of these components serves a particular purpose in taking advantage of the interference effect.

Stabilizer Control of Capacitor Dielectrics

POLAROGRAPHIC METHOD for control of stabilizer concentration in capacitor dielectrics has been developed at Bell Labs for use in Western Electric manufacturing plants.

Technique is also research tool in study of aging of capacitors, Paul D. Garn and Mary C. Bott told American Chemical Society meeting in Boston.

Degradation of paper capacitors is retarded by adding stabilizer to wax or liquid with which paper is vacuum impregnated for greater capacitance, dielectric strength.

Anthraquinone is most widely used in Bell System for stabilizer, is added to mineral oils or chlorinated diphenyl or chlorinated naphthalene, among the common dielectric materials.

Solubility, gravimetric and spectrophotometric methods are currently used for quantitative determination of the anthraquinone in batches of dielectrics.

Polarographic method, researchers said, offers single method for routine control of stabilizer concen-

tration in all types of dielectrics. Solvent consisting of 3:2 mixture of chloroform and methanol with 4% hydrochloric acid yields well-defined wave for anthraquinone, will dissolve sufficient quantity of each of the dielectrics.

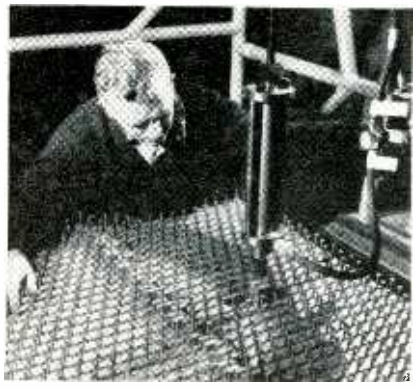
Diffusion current, compared with current from standard solution containing the impregnant, is proportional to the concentration. Hydrochloric acid shifts half-wave potential of anthraquinone to less negative value, hence away from interference from reducible components in dielectric material. Blank current is obtained by use of magnesium instead of hydrochloric acid.

Static Inverter Ups EL Panel Outputs

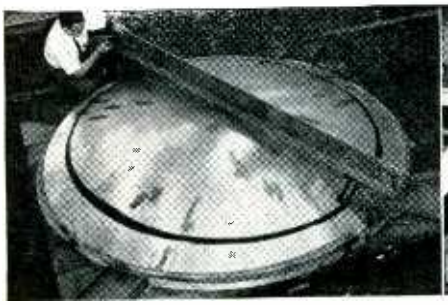
MAIN PORTION of a system developed by Magnetic Amplifiers, Inc., to increase level of illumination of electroluminescent displays by a factor of ten times is a static high-frequency power inverter.

The inverter, in addition to converting d-c to a-c, steps up current frequencies to levels ranging from 2,000 to 10,000 cycles. Stepped-up frequency is one of two methods commonly considered for increasing the brightness of EL panels. The second technique is to raise the voltage. This is sometimes desructive to the panel after a temporary rise in brightness is obtained.

Silver-Coated Lens



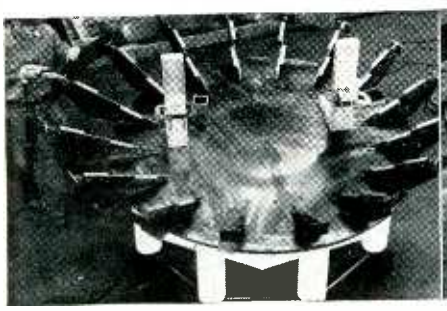
Plastic silver-coated lens developed by Sperry Gyroscope Co. for the Talos missile guidance radar is composed of 4100 cells. The lens is molded of plastic-impregnated fiber glass and coated with silver to make it electrically conductive. Aluminum cores forming the grid structure are molded into lens and then removed with a pneumatic ram



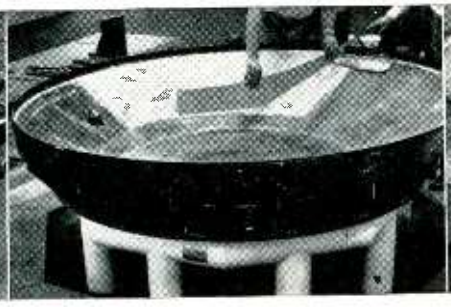
Paraboloid face mold with plastic-topped female templates

Reflective surface is flame-sprayed on painted face mold

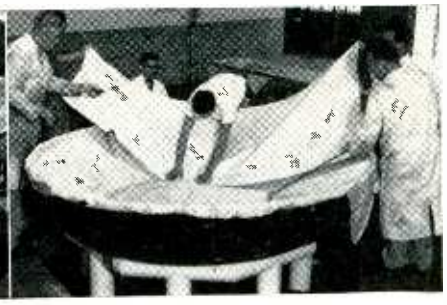
Resin is spread over each layer of glass to wet next layer



Perimeter fence is mounted on rear structure mold



Checking rear structure mold. Boresight locating pin is at left



Joints between sheets of glass cloth are carefully fitted

Glass Cloth, Resin Form Big Dish

By B. SOKOL, Senior Mfg. Research-Engineer, Republic Aviation Corp., Farmingdale, N. Y.

REINFORCED PLASTIC radar reflectors are now in production for the Tartar shipboard missile. They are 8 feet in diameter, weigh 330 pounds and have a flame-sprayed metallic aluminum reflective face.

Because of accuracy and strength required, the reflector is considered as being a large plastic tool. The load bearing rear structure is prefabricated and heat cured. The reflective face is separately made and the rear unit joined to it directly on the paraboloid face mold.

Raytheon Manufacturing Co. supplied the face mold and 3 checking templates. Balance of the tooling was designed and fabricated by Republic. Production of the initial unit followed the following procedure:

The face mold was mounted on a specially designed base, leveled to the required water line, checked against lofting templates. Discrepancies were corrected. A perimeter fence was constructed and mounted on the water line.

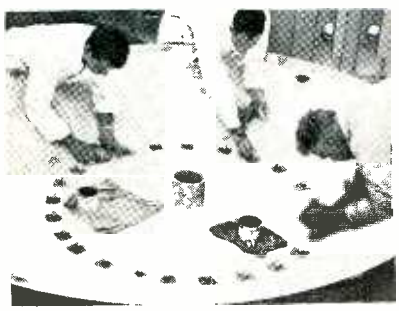
The fence-mold joint was filleted with zinc chromate paste and parting agent was applied, followed by a coat of ice-phobic material-resistant paint. After the paint dried, metallic aluminum was flame-sprayed on the mold surface to a thickness of 0.005 to 0.01 inch.

The sprayed aluminum was wetted with epoxy laminating resin (Trulite L-100, a proprietary formulation) and the laminate built up. The completed face structure was trimmed to the fence.

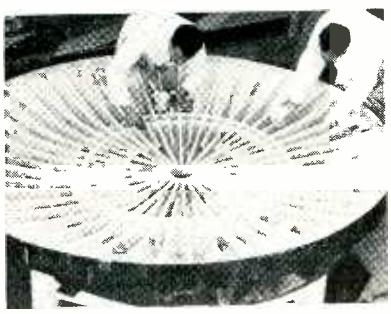
The rear structure mold was made and all its joints filleted with epoxy paste resin and cured. The borescope tube, previously laminated, was placed on its locating mandrel. The rear structure was laminated, cured, trimmed and drilled with all necessary holes. The previously laminated center tube, aluminum fittings and steel nut plates were bonded in place. All laminations were 150/164 glass cloth and resin.

Lofting templates were used to lay out the ribs on molded flat laminate sandwich panels. Ribs were cut, sanded, dry fitted to the rear skin and bonded in place. Glass tape and resin reinforced the bond.

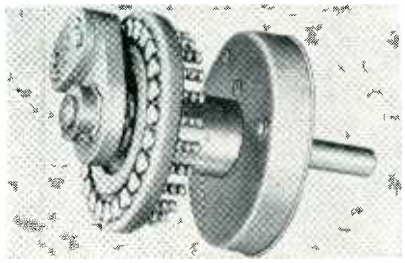
The completed rear structure was cured in an infrared oven. After cooling, 3 perimeter tooling



Mounting nut plates and protective caps are fitted to rear structure

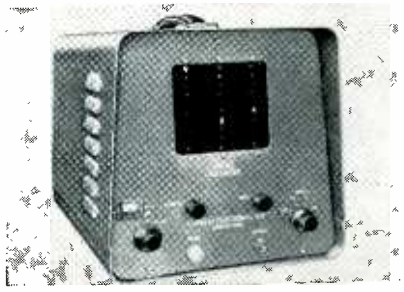


Internal structure is shown here during assembly



Switches anticorrosive

THE DAVEN CO., Livingston, N. J., has developed switches with gold-laminated contacts and slip rings for use in extremely corrosive atmospheres. In tests on the type 11-CM-32 (a single-pole, 32-position, shorting type switch), the unit was suspended in a sulphur atmosphere at 45 C for 245 hours. Initial contact resistance reading before suspension was 0.001 ohm to 0.002 ohm. After completion of the tests, it was still only 0.0021 to 0.0025 ohm. **Circle 205 on Reader Service Card.**



Digital Voltmeter covers 0-1,000 v d-c

FRANKLIN ELECTRONICS INC., Bridgeport, Pa. Model 410 general-purpose digital voltmeter covers a range of 0 to 1,000 v d-c. It utilizes an all-electronic circuit and provides an accuracy better than 0.5 percent of full scale. A three-column, vertical readout is used. Price is $490. **Circle 206 on Reader Service Card.**

Lacing Cords & Tapes variety of finishes

ALPHA WIRE CORP., 200 Varick St., New York 14, N. Y., announces a complete line of 76 round lacing cords and flat braided lacing tapes made of nylon, dacron and fiberglass. Round types have diameters

They look great going out

...but how about 6 months from now?

2" SHORTER THAN THEIR PROTOTYPES! New RCA "VC" 110° Picture Tubes offer high reliability in slim-style very compact TV Sets.

One sure way to *preclude* early-hour field failures is to specify performance-proved RCA "VC" (very compact) 110° picture tubes for your TV design. But, you ask, how can one say that brand new "VC" Picture Tubes are "performance-proved"?

Here's why...RCA "VC" 110° types employ the same heater-cathode assembly that has been used and *proven for reliability* over the past decade in RCA Picture Tubes. Now commercially available in the shorter "VC" 110° designs are the RCA-17DKP4 and RCA-21EQP4, all-new premium types. They utilize conventional 110° components and circuitry. And, with only slight changes in focusing-voltage control, they are unilaterally interchangeable with previous 110° types.

You *get* the performance you design for when you specify RCA "VC" Picture Tubes. Ask your RCA Field Representative for full information. For technical data, write RCA Commercial Engineering, Section E-19-DE4, Harrison, New Jersey.

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EAST:
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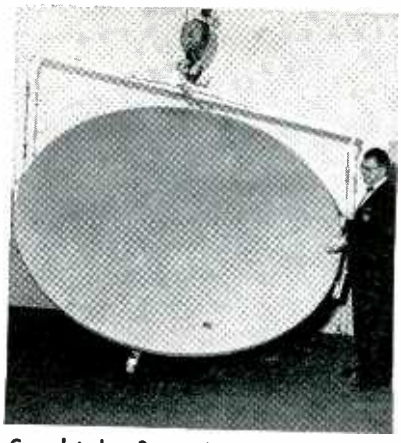
HUmboldt 5-3900

MIDWEST:
Suite 1154, Merchandise Mart Plaza
Chicago 54, Ill., WHitehall 4-2900

WEST:
6355 E. Washington Blvd.
Los Angeles 22, Calif.
RAymond 3-8361

RCA **RADIO CORPORATION OF AMERICA**
Electron Tube Division *Harrison, N. J.*

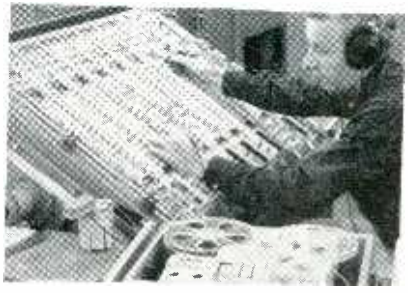
±0.026 inch. The unit was within 0.004 inch over the bulk of the reflective surface. A maximum of 0.018 inch variation was found in 2 local surface perimeter areas.



Completed reflector is shown here with the designer

The initial unit weighed 349 pounds. Design refinements have reduced weight by 20 pounds. Republic is currently producing the reflectors at the rate of 2 per month under a production order from Raytheon.

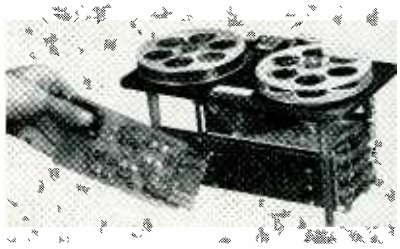
Tape Recorder Speeds Panel Wiring Tests



Recorder being used to check logic panel

TAPE RECORDER simplifies the checking of complicated wiring at Bendix Aviation Corp., Computer division, Los Angeles, Calif. An operator is shown receiving logic panel continuity test instruction from a recorder. Tape calls out which terminals a wire is supposed to connect. The operator uses a foot pedal to advance the tape after each test. Previously, a second man would stand behind the inspector and read test directions from an instruction sheet. With the recorder, it is almost impossible to skip or duplicate a test, according to the firm.

On The Market

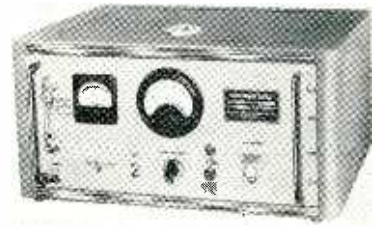


Tape Recorder miniature unit

PRECISION INSTRUMENT CO., 1011 Commercial St., San Carlos, Calif., has available a miniature tape recorder with up to 7 channels of transistorized record/reproduce electronics. Unit measures 12 in. wide, 6 in. deep, and 8 in. high, and weighs only 5 lb. Features include tape speed from 0.05 to 1⅞ ips; up to 60 hr recording; ability to withstand 10 g vibration and 30 g shock along each axis. **Circle 200 on Reader Service Card.**

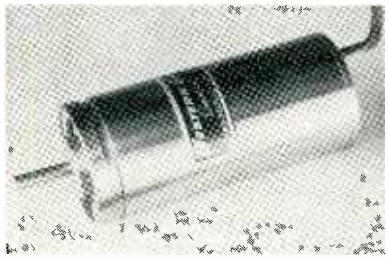
Calorimeter Bridge direct reading

ELECTRO IMPULSE LAB., 208 River St., Red Bank, N. J. Model CB-16 direct reading calorimeter bridge is completely self-contained with its own circulating system, cooling system and radio frequency dummy load and requires only connection to the regular power line. The r-f power is read directly on a 4½ in. meter in watts. A single coax dummy load is available to cover the frequency range from d-c to 10,000 mc and for the power range from 1 to 1,000 w. **Circle 201 on Reader Service Card.**



Voltage Indicator programmable

VOLTRON PRODUCTS, 1010 Mission St., S. Pasadena, Calif., announces a voltage indicator with an accuracy of 0.1 percent on d-c units, and 0.25 percent on a-c units. Instrument can be programmed either manually or automatically by the addition of external resistors. The automatic programming can be digital. Sensitivity of the indicator is 1,000 ohms per v. Minimum center scale voltage is 1 v, and the maximum is in accordance with customer specifications. **Circle 202 on Reader Service Card.**



Geared Servo Motors sizes 10 and 11

WESTERN GEAR CORP., 132 W. Colorado St., Pasadena, Calif., has available size 10 and 11 geared servo motors. The integral gearhead units can be supplied in a wide range of ratios with reductions as required up to 8,000:1. They are available with windings for 26, 55 or 115 v a-c 400 cps. They are designed to operate in ambient temperatures from −65 C to +125 C. Motors measure 2¼ in. in length. **Circle 203 on Reader Service Card.**

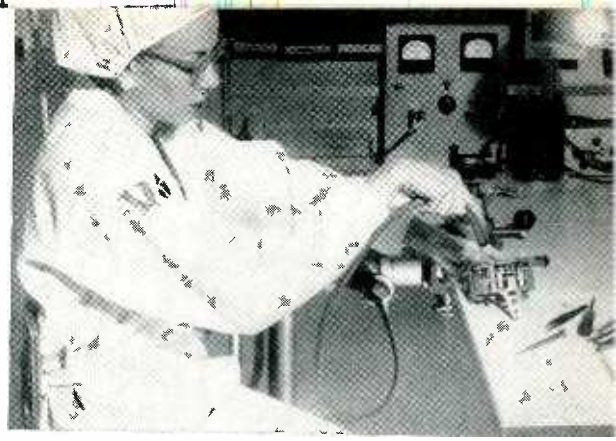
Time Delay Relay subminiature

ALTO SCIENTIFIC CO., INC., 855 Commercial St., Palo Alto, Calif. Model N17 subminiature time delay relay uses all-silicon semiconductor devices for maximum reliability. The time delay is established by RC time constant circuitry, permitting an overall standard accuracy of ±5 percent. The instrument's time delay is 0.05 sec to 60 sec, preset at the factory. Ambient temperature (operating) range is from −55 C to 71 C. Input voltage is 24 to 32 v d-c, and current drain is 50 ma at 28 v. **Circle 204 on Reader Service Card.**

(Continued on p 82)

The unseen enemy

How Summers Gyroscope guards against the invisible anti-missile



Vacuum equipment at each of the 240 individual assembly benches helps insure product reliability.

There is an invisible enemy operating in many plants producing the missile components, flight instruments, gyroscopes and other hyper-sensitive devices on which much of America's power for peace depends. The strength of this unseen foe is potentially as great as that of any anti-missile missile.

Destroyer Of Standards

This reliability destroying, efficiency reducing enemy is dust, lint and other foreign matter. The slightest air borne contaminant coming to rest unseen on sensitive mechanisms during assembly can cause serious, even fatal deviations in performance. Production was often slowed until tests showed the system to be free of dust.

Dust Moved But Not Removed

To combat the dust dilemma at the Summers Gyroscope Co. plant in Santa Monica, California, personnel donned lint free jackets and hats – walked to their work benches in shoe bags. Temperature and humidity were controlled in an attempt to achieve an environment completely free of every possible contaminant ranging from stray hairs to perspiration. However, these precautions proved only partially successful when it was found that a manual dust gathering system in the final assembly "clean room" actually recirculated dust instead of removing it.

Double Duty Production Tool

For a solution to the dust menace, Summers called upon U.S. Hoffman Machinery Corp., pioneers in the use of air as a production tool. Hoffman engineers installed a permanent stationary vacuum cleaning system which provided for necessary cleaning operations at all of the 240 individual work benches in the 12,000 square foot final assembly area. Standard attachments made this same system available for cleaning overhead and under foot, all over the plant.

Before And After

Prior to the installation of the Hoffman stationary system, relative cleanliness tests were conducted. A microscopic analysis of slides revealed lint, dust and other foreign matter in excess of quantities allowable to maintain Summers' high precision standards. A short time after the Hoffman equipment was placed in operation, the same tests showed a truly dust free "clean room".

How It Operates

Heart of the stationary cleaning system at the Summers plant is a 60 hp Hoffman centrifugal exhauster producing the vacuum. A centrally located dust separator outside the assembly rooms collects the material with large filtering area insuring thorough cleaning of the air. Hoses for cleaning are inserted into strategically located inlet valves in the piping system conveniently located throughout the areas to be vacuumed.

Benefits And Advantages

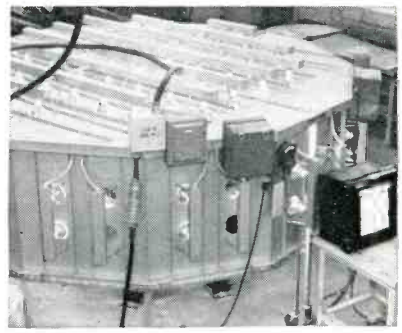
Insuring spotlessly clean work in final assembly and calibration, the Hoffman stationary vacuum system already has paid for itself. It has helped Summers Gyroscope reduce rejects, maintain high reliabilty, increase production and improve employee morale. The Hoffman system enables Summers to meet and exceed specifications in supplying inertial guidance systems, flight instruments and gyroscopes to the U. S. Air Force, U. S. Navy, the Martin Co., McDonnell Aircraft, Douglas Aircraft and the Convair Div. of General Dynamics, among others.

If you have a special cleaning problem in your plant, ask for a free engineering survey to determine the most economical Hoffman system to prevent product contamination, salvage valuable materials, insure better housekeeping and encourage operating efficiency. Write for free booklet – How Stationary Vacuum Cleaning Systems Cut Costs, Increase Plant Efficiency.

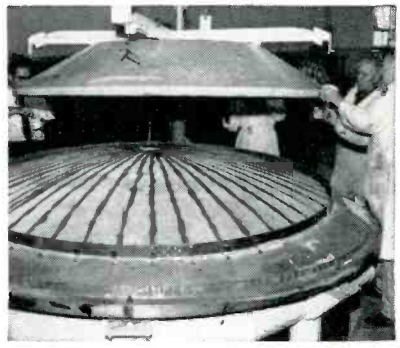
U.S. Hoffman Machinery Corp.
Dept. E-2 Air Appliance Division
103 Fourth Ave., New York 3, N. Y.

Note how the Hoffman vacuum system handles both parts cleaning, (rear) and housekeeping chores.

A final assembly area is kept dust-free by the Hoffman vacuum system.



Structures are cured in specially-designed infrared oven



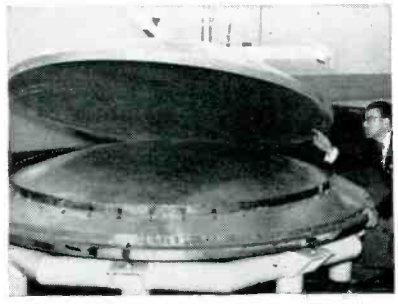
Adhesive on ribs and perimeter readies unit for final assembly

alignment holes were drilled and the structure removed from the mold.

The rear structure was mated to the face. High spots on ribs and fittings were ground to fit. Adhesive was applied to all mating surfaces and the rear structure was bonded to the face skin on the face mold. After cure, the completed structure was removed from the mold and cleaned. The borescope hole was opened, helicoils placed and the unit painted.

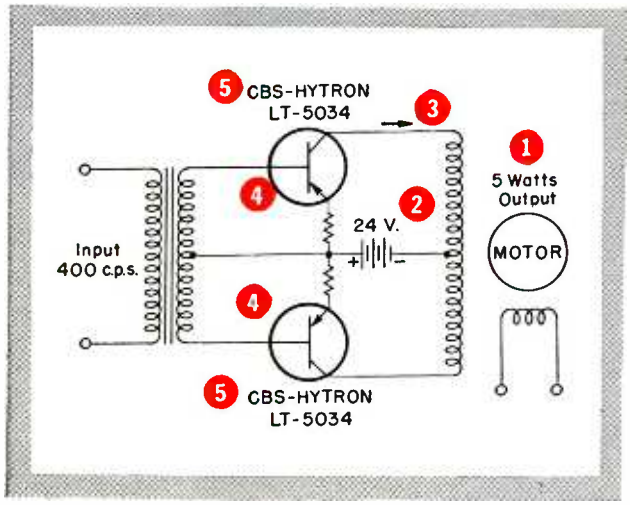
To test reflector contour, small clay balls were placed on the aluminum face mold and covered with waxed paper. The reflector was lowered onto the mold, pressing the balls to a finite gap. Height of the pressed clay was recorded relative to the adjacent mold surface.

Required surface tolerance was



After curing, assembly is lifted off paraboloid face mold

Selection of the Right Power Transistor made easy



FOR EXAMPLE:

Need a transistor for an airborne servo amplifier?

Here's how easy it is to select the transistor with optimized characteristics at minimized cost:

1. You may need 5 watts output — 2.5 watts per transistor. At 70°C maximum base mounting temperature, this equals a 10-watt rating at 25°C standard. Pick "20-Watt Group."
2. Source voltage, 24 volts. With inductive load, peak-to-peak volts approximate 48. Choose "Minimum Breakdown Voltage" of 60.
3. Input signal current, 7 ma. Power output of 5 watts divided by .707 times 24 source volts gives 300-ma. collector current. "Current Gain" of 43 is required . . . use 60.
4. For a convenient, plug-in standard package, you may want the "Diamond" version.
5. That is it . . . you have picked the CBS-Hytron LT-5034.

Use these same convenient tables in selecting the exact PNP germanium power transistors you need from CBS-Hytron's most comprehensive line: 3 power groups . . . 6 packages . . . over 100 EIA, military and special types.

And for complete data on the types you choose, write for Bulletin E-288. Ask our Applications Engineering Department for any special assistance you may want.

20-WATT GROUP

Types Available

Current Gain‡	LT-5028	LT-5034	LT-5042	LT-5051	Diamond
60	LT-5027	LT-5033	LT-5041	LT-5050	Male
	LT-5026	LT-5032	LT-5040	LT-5049	Female
	LT-5025	LT-5031	LT-5039	LT-5048	Diamond
40	LT-5024	LT-5030	LT-5038	LT-5047	Male
	LT-5023	LT-5029	LT-5037	LT-5046	Female
	LT-5022	2N157	2N157A	LT-5045	Diamond
20	LT-5021	LT-55	LT-5036	LT-5044	Male
	LT-5152	LT-5153	LT-5035	LT-5043	Female
	30V	60V	100V	120V	Packages#

Minimum Breakdown Voltage†

30-WATT GROUP

Types Available

Current Gain‡					Packages#
100	LT-5060	LT-5069	LT-5078	LT-5087	Diamond
	LT-5059	LT-5068	LT-5077	LT-5086	Male
	LT-5058	LT-5067	LT-5076	LT-5085	Female
60	LT-5057	LT-5066	LT-5075	LT-5084	Diamond
	LT-5056	LT-5065	LT-5074	LT-5083	Male
	LT-5055	LT-5064	LT-5073	LT-5082	Female
30	LT-5054	LT-5063	LT-5072	LT-5081	Diamond
	LT-5053	LT-5062	LT-5071	LT-5080	Male
	LT-5052	LT-5061	LT-5070	LT-5079	Female
	30V	60V	80V	100V	

Minimum Breakdown Voltage†

40-WATT GROUP

Types Available

Current Gain‡					Packages#
160	LT-5096	LT-5105	LT-5114	LT-5123	Diamond
	LT-5095	LT-5104	LT-5113	LT-5122	Male
	LT-5094	LT-5103	LT-5112	LT-5121	Female
80	LT-5093	LT-5102	LT-5111	LT-5120	Diamond
	LT-5092	LT-5101	LT-5110	LT-5119	Male
	LT-5091	LT-5100	LT-5109	LT-5118	Female
40	LT-5090	LT-5099	LT-5108	LT-5117	Diamond
	LT-5089	LT-5098	LT-5107	LT-5116	Male
	LT-5088	LT-5097	LT-5106	LT-5115	Female
	30V	60V	80V	100V	

Minimum Breakdown Voltage†

‡Minimum large-signal current gain: 40-watt group at 1.0 A, 30-watt group at 0.75 A, 20-watt group at 0.50 A.
†Minimum breakdown voltage, collector to base with emitter open.
#Five packages: diamond, female industrial with solder lugs or flying leads, and male industrial with solder lugs or flying leads.

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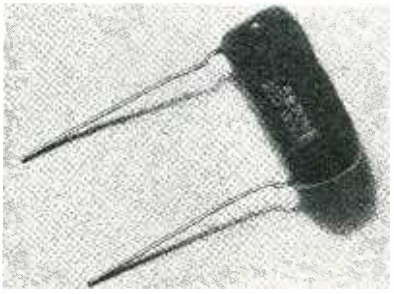
CBS-HYTRON, Semiconductor Operations, Lowell, Mass.
A Division of Columbia Broadcasting System, Inc.

Sales Offices: **Lowell, Mass.,** 900 Chelmsford Street, GLenview 4-0446 • **Newark, N. J.,** 32 Green Street, MArket 3-5832 • **Melrose Park, Ill.,** 1990 N. Mannheim Road, EStebrook 9-2100 **Los Angeles, Calif.,** 2120 S. Garfield Avenue, RAymond 3-9081.

of 0.017 in. to 0.050 in. and tensile strength of 10 to 70 lb. Flat braided types have widths of $\frac{1}{16}$ in. to $\frac{1}{4}$ in., tensile strength of 30 to 250 lb. A variety of finishes for every need and meeting MIL-T-713A are available. **Circle 207 on Reader Service Card.**

Reference Packs highly stable

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Complete, miniaturized voltage reference packs capable of maintaining voltage regulation to within ± 0.01 percent are available to replace standard cells or dry cell batteries in all equipment requiring stable voltage references. Units are designed around the highly stable 1N430 silicon reference element. The devices can withstand environmental and temperature extremes, and are operable to +125 C. **Circle 208 on Reader Service Card.**



Capacitors Mylar-paper dipped

ELECTRO MOTIVE MFG. CO., INC., Willimantic, Conn. Life tests show that MPD Mylar-paper dipped capacitors, tested at 100 C with rated voltage applied, have yielded a failure rate of only 1 per 716,800 unit-hours for 1 μf. Since the number of

4400° F in Three Minutes

NEW

Production Tantalum Sintering Furnace

- ***Large 6″ I.D. x 10″ Heating Element***
- ***Automatic Protective Devices***
- ***Operates at 10^{-5} mm Hg or with Inert Gas***

Connect water, power, air and drains to the NRC Model 2915 and you're in business. That's just the first convenience you'll experience when you use this new refractory-free resistance furnace to produce tantalum capacitors.

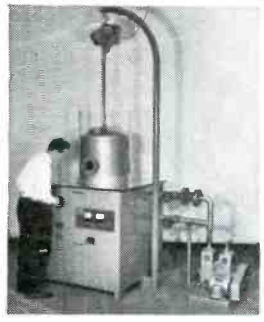
Loading, unloading, and cleaning are quick and easy. With one finger you can raise the spring-loaded stainless steel cover and lift out the top heat shield assembly. For cleaning, the heating element and other shield assemblies can be removed in less than 30 minutes. Every square inch of the stainless furnace chamber is accessible. Graphic control panel simplifies operation.

The three-phase cylindrical heating element offers long, trouble-free life because of its rugged construction, three point support, and ample spacing from heat shields.

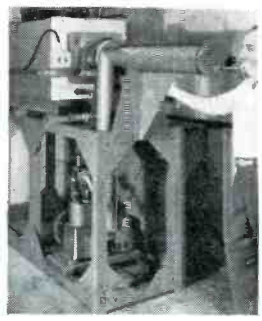
This furnace will help you make more money. Large capacity, rapid heating and cooling, and high speed evacuation increase productivity. Double glass sight port, interlocked, fail-safe pumping system and power supply protect work and heating element against excess pressure and temperature. Special circuit prevents air-releasing before work is sufficiently cool. *Send for more information today!*

SEMICONDUCTOR PRODUCTION EQUIPMENT

Low-cost standard furnace for growing single crystals of silicon, germanium, and intermetallic compounds with reliability. Grows a 150 gram crystal in about 3 hours.



Bell jar and tank vacuum metallizers, diameters 12″ to 66″, for depositing thin films to precisely controlled thicknesses of from one molecule to several mils.



Two-zone 5″ diameter muffle vacuum heat treating furnace. For annealing semiconductors and electronic parts.

NRC

NRC

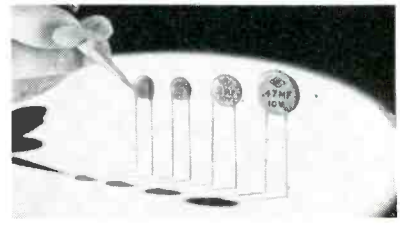
EQUIPMENT CORPORATION

A Subsidiary of National Research Corp.—Dept. 36E
160 Charlemont St., Newton 61, Massachusetts
SALES OFFICES: Boston • Chicago • Cleveland • Detroit
Houston • Los Angeles • New York • Palo Alto • Pittsburgh

unit-hours is inversely proportional to the capacitance, 0.1 μf capacitors will yield only 1 failure in 7,168,000 unit-hours. New line includes five case sizes in working voltages and ranges as follows: 200 wvdc, 0.018 to 5 μf; 400 wvdc, 0.0082 to 0.33 μf; 600 wvdc, 0.0018 to 0.25 μf; 1,000 wvdc, 0.001 to 0.1 μf; 1,600 wvdc, 0.001 to 0.05 μf. **Circle 209 on Reader Service Card.**

Relays
aircraft type

THE HART MFG. CO., 110 Bartholomew Ave., Hartford 1, Conn. Diamond H series R/S miniature, hermetically sealed aircraft type relays are now available with AN type connector mounting arrangements. Extremely sensitive, 4 pdt relays with excellent temperature (200 C or higher), shock (50 g or more) and vibration resistances, these relays are used in missiles, ground and airborne computers, jet engine controls, automation control systems, and similar applications requiring utmost reliability. **Circle 210 on Reader Service Card.**



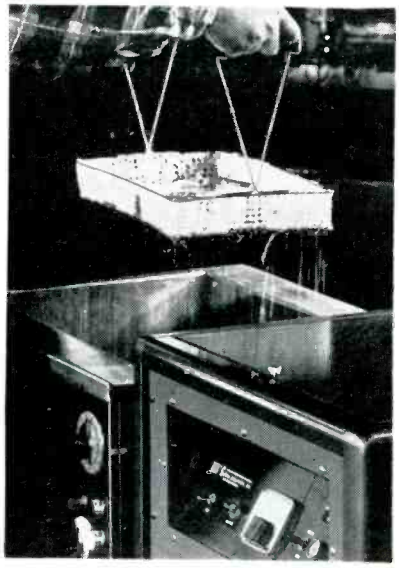
Ceramic Capacitors
ultraminiature

CENTRALAB, a division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc., has available a

new line of 10 v Ultra-Kap miniature ceramic capacitors. Four capacity values are available: 0.05 μf (0.385 in. diameter), 0.1 μf (0.385 in. diameter), 0.2 μf (0.590 in. diameter), 0.47 μf (0.840 in. diameter) with a production tolerance range of +80-20 percent. The units have a minimum leakage resistance of 50 K ohms 10 v d-c. **Circle 211 on Reader Service Card.**

Stabilized Amplifier
high reliability

APPLIED TECHNOLOGY CORP., 475 Fifth Ave., New York 17, N. Y., announces a modular stabilized amplifier, using no electrolytic capacitors or glow tubes, and with an average open-loop d-c gain of over 50 million, with a minimum of 10 million. Drift is well under 100 μv for both long and short term. Output voltage up to $\pm$100 v, depending on external load. **Circle 212 on Reader Service Card.**



Ultrasonic Cleaners
modular design

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J., has developed a new line of Glennite ultrasonic cleaners featuring modular design and new high temperature ceramic transducers which are side mounted for consistent efficiency of operation. Units feature interchangeable components. Consisting of 13 different cleaners in all, five separate tank sizes and six preset

generators combine to offer industrial users distinct power categories for specific applications based upon the volume and number of pieces to be cleaned. **Circle 213 on Reader Service Card.**

Servo Indicator fast, accurate

GILMORE INDUSTRIES, INC., 13015 Woodland Ave., Cleveland 20, Ohio. Model 143 digital servo indicator indicates quickly and accurately forces, fluid flow, weights or rpm's which can be converted into a-c or d-c millivolts. Direct reading digital counter eliminates normal human errors due to parallax and interpolation of reading that can result with dials, pointers, and charts. Typical applications are the measurement of fuel flows and thrusts of jet engines on static test stands. **Circle 214 on Reader Service Card.**

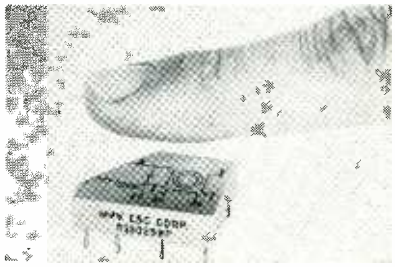
A-C Voltmeter plug-in type

METRONIX, INC., Chesterland, Ohio, announces an a-c electronic voltmeter designed for plug-in use with a remote meter. Model SPD-22 will measure from 10 mv to 300 v rms full scale sensitivity, depending on the input voltage deter-

mined by the built-in attenuator. It contains all vtvm circuitry except the power supply. It measures only 5 by 2½ by 4¼ in. With an input impedance of 1 megohm, 10 $\mu\mu$f, the SPD-22 imposes almost no load on the circuit being measured. Its accuracy is ± 3 percent with a meter of 2 percent accuracy. **Circle 215 on Reader Service Card.**

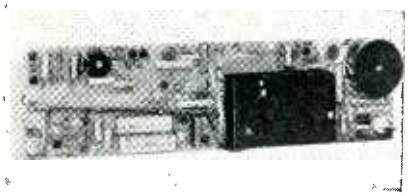
Capacitors metallized paper

ASTRON CORP., 255 Grand Ave., East Newark, N. J. Tubular axial-lead capacitors, type MQZF, hermetically sealed in metallized paper for low voltage transistorized applications, are announced. The 50 v subminiature units have a temperature range from −55 C to +85 C. Ratings are from 0.047 to 8.0 μf. Smallest size is 0.195 in. diameter and 1⅛ in. long. **Circle 216 on Reader Service Card.**



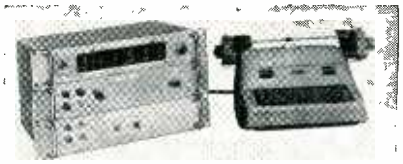
Shift Register epoxy encapsulated

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J. Model SR-104 miniature shift register is a one-core-per-binary-bit unit, with a 5 kc information rate and a signal-to-noise ratio of 10:1. Operating temperature range is from −55 C to 125 C. A 14.0 μsec, 22 v output pulse is obtained by applying a 10.0 μsec, 7 ma input pulse and subsequently a 8.0 μsec 300 ma shift pulse. **Circle 217 on Reader Service Card.**



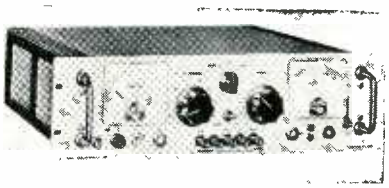
Sample-Hold System
high speed

PACKARD BELL COMPUTER CORP., 1905 S. Armacost Ave., Los Angeles 25, Calif. A solid-state sample and hold system samples a small segment (less than 1 μsec) of an incoming voltage and holds the result for conversion to digital form or for other purposes. System is constructed upon a single etched board, is self-powered, completely transistorized, and has no moving parts; d-c stabilization is provided by a silicon transistor chopper. **Circle 218 on Reader Service Card.**



Digital Ohmmeter
automatic print out

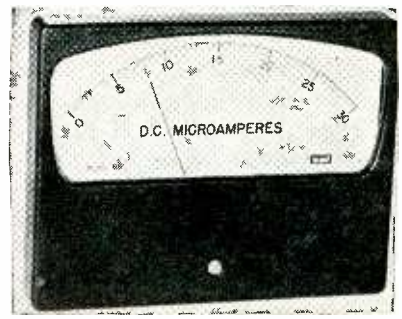
ELECTRO INSTRUMENTS, INC., 3540 Aero Court, San Diego 11, Calif. Model DOA 502 digital ohmmeter features the use of transistors and modular construction. The system consists of a 5-digit switch module, a universal power module, and an electric typewriter control module. Accuracy is 0.01 percent ± 2 digits through its range of 000.01 ohm to 10 megohms. Ranging is automatic. Readout time is 1.5 sec. **Circle 219 on Reader Service Card.**



Power Supplies
transistorized

ELECTRONIC MEASUREMENTS CO. OF RED BANK, Eatontown, N. J. By

means of a few simple external connections, these voltage regulated power supplies may be used for constant current operation. Wide range models cover the following voltage ratings: 0-7, 0-14, 0-32, 0-36, and 0-60. Narrow range models cover all popular battery voltages up to 60. Most models are available in current ratings of 0-2.5, 0-5, 0-7.5, 0-10, and 0-15 amperes. **Circle 220 on Reader Service Card.**



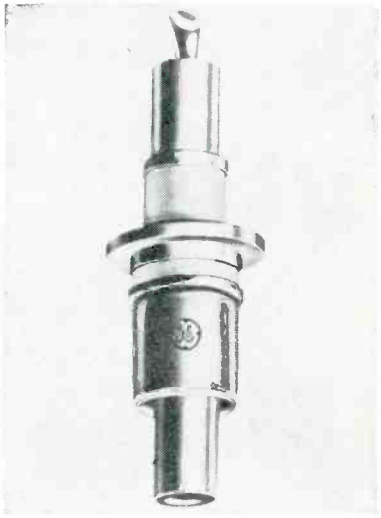
Panel Meters
6-in. units

ASSEMBLY PRODUCTS, INC., Chesterland, Ohio. D-c linearity within 1 percent of full scale is standard in a new line of 6-in. panel meters. Model 661 has a wide scale arc of 5½ in. It may be mounted in any kind of panel because its one-piece steel back shields it from magnetic fields. Sensitivities are the same as those of the smaller API panel meters, beginning with 0 to 5 μa or 0 to 5 mv. Minimum practical response time is about 100 millisec. **Circle 221 on Reader Service Card.**

Latching Relay
microminiature

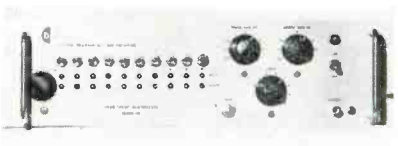
IRON FIREMAN ELECTRONICS DIVISION, 2838 S.E. 9th Ave., Portland 2, Ore., announces a new series of balanced armature dual coil microminiature latching relays. Model R650 relays exceed MIL-R-5757C specs with vibration immunities of 10-55 cps at a total excursion of 0.200 in. and 55-2,000

cps at 30 g's and shock immunities of 100 g's. With contact rating of 2 amperes resistive at 28 v d-c or 115 v a-c, the R650 has a minimum life of 100,000 operations at 125 C. The relay is activated by a 5 millisec pulse of 300 mw. **Circle 222 on Reader Service Card.**



Lighthouse Triode
improved version

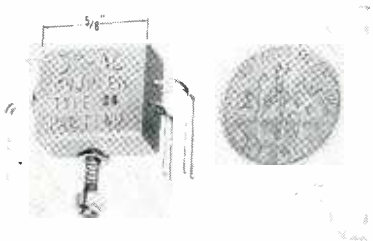
GENERAL ELECTRIC CO., Schenectady 5, N. Y., has available an improved general purpose, high-mu lighthouse triode designed for use in grounded-grid service as a r-f amplifier, oscillator, or frequency multiplier. The metal-ceramic GL-6771 is particularly suited for use as a c-w oscillator to frequencies as high as 4,000 mc. In this type service, 200-300 mw of non-squegging c-w power may be obtained. As a frequency doubler to 1,000 mc, 2 w of output power may be obtained with only 300 mw of drive power. **Circle 223 on Reader Service Card.**



Multiplexer
high speed

DIGITAL INSTRUMENT LABORATORIES, 152 S. Atlantic Blvd., Los Angeles 22, Calif., announces a high speed

transistorized multiplexer, model 115. Maximum rate of multiplexing is 20,000 samples per sec. Ten separate channels can be sampled at a rate of 2,000 samples per sec per channel. Unit can be driven either externally or internally. The number of channels, the frame rate and sample rate, are crystal controlled, and can be selected by rotary switches located on the front panel of the multiplexer. **Circle 224 on Reader Service Card.**



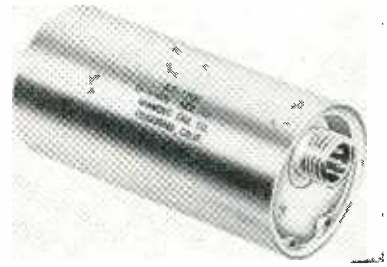
D-C/A-C Chopper microminiature

RAWCO INSTRUMENTS, INC., 3527 West Rosedale, Ft. Worth 7, Texas. Housed in a 5/16 in. by 1/2 in. by 5/8 in. metal casement, this d-c/a-c chopper features an extremely low noise level; over 2,000 hr life; —65 C to 125 C temperature range; a hermetic sealed contact closure, void of organic materials; and 150 electrical degrees minimum dwell time. The spdt units are available from stock for 6 v-400 cps excitation and on special order, in preselected frequencies from 0 to 1,800 cps. **Circle 225 on Reader Service Card.**

Attenuators rotary switched

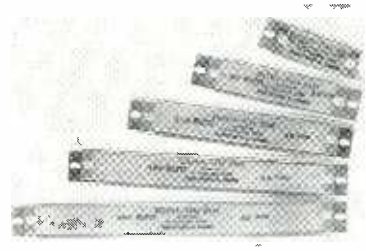
KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J., announces three new attenuators. Designated as model 40-0 at nominal 50 ohm input and output impedance, model 41-0 at 70 ohms, and model 42-0 at 90 ohms, they provide attenuation

from 1 db to 119 db in 1-db steps. They operate from d-c to 500 mc, and are useful up to 1,000 mc. Attenuation is controlled by two concentrically placed rotary switches graduated in 1 db and 10 db steps. **Circle 226 on Reader Service Card.**



D-C Accelerometers need no amplifiers

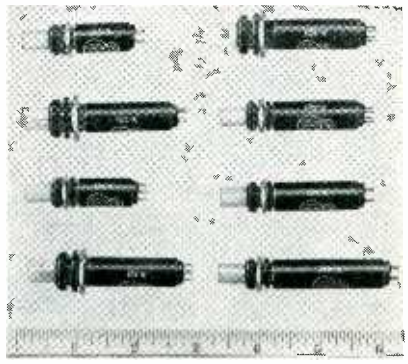
WIANCKO ENGINEERING CO., 255 N. Halstead, Pasadena, Calif. Combined in these instruments are a solid-state carrier oscillator and ring demodulator with a variable-reluctance pickup. This results in compact transducers utilizing d-c excitation and providing d-c output. Advantages include continuous resolution, 0-5 v d-c output at constant impedance, low hysteresis, excellent linearity, and high natural frequency. **Circle 227 on Reader Service Card.**



Power Resistors for flight use

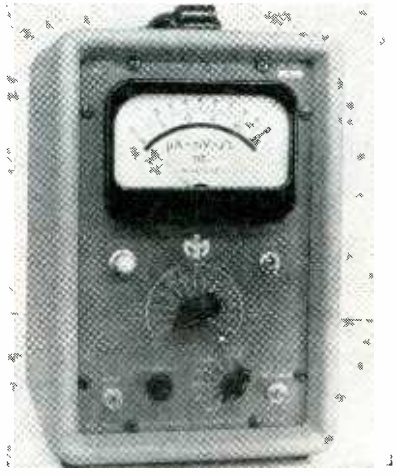
ELECTRO-FLEX HEAT, INC., 83 Woodbine St., Hartford 6, Conn. Light weight and small space requirements of new design of power resistor make possible substantial weight savings in aircraft and missile electronic apparatus. Units are designed to be mounted in direct contact with the inner surface of the chassis or case, thus 25 to 40 percent of the heat generated is directly emitted to the atmosphere. Power ratings range from 40 w to 200 w. Electrical insulation is sili-

cone rubber which is operable continuously at 450 F. **Circle 228 on Reader Service Card.**



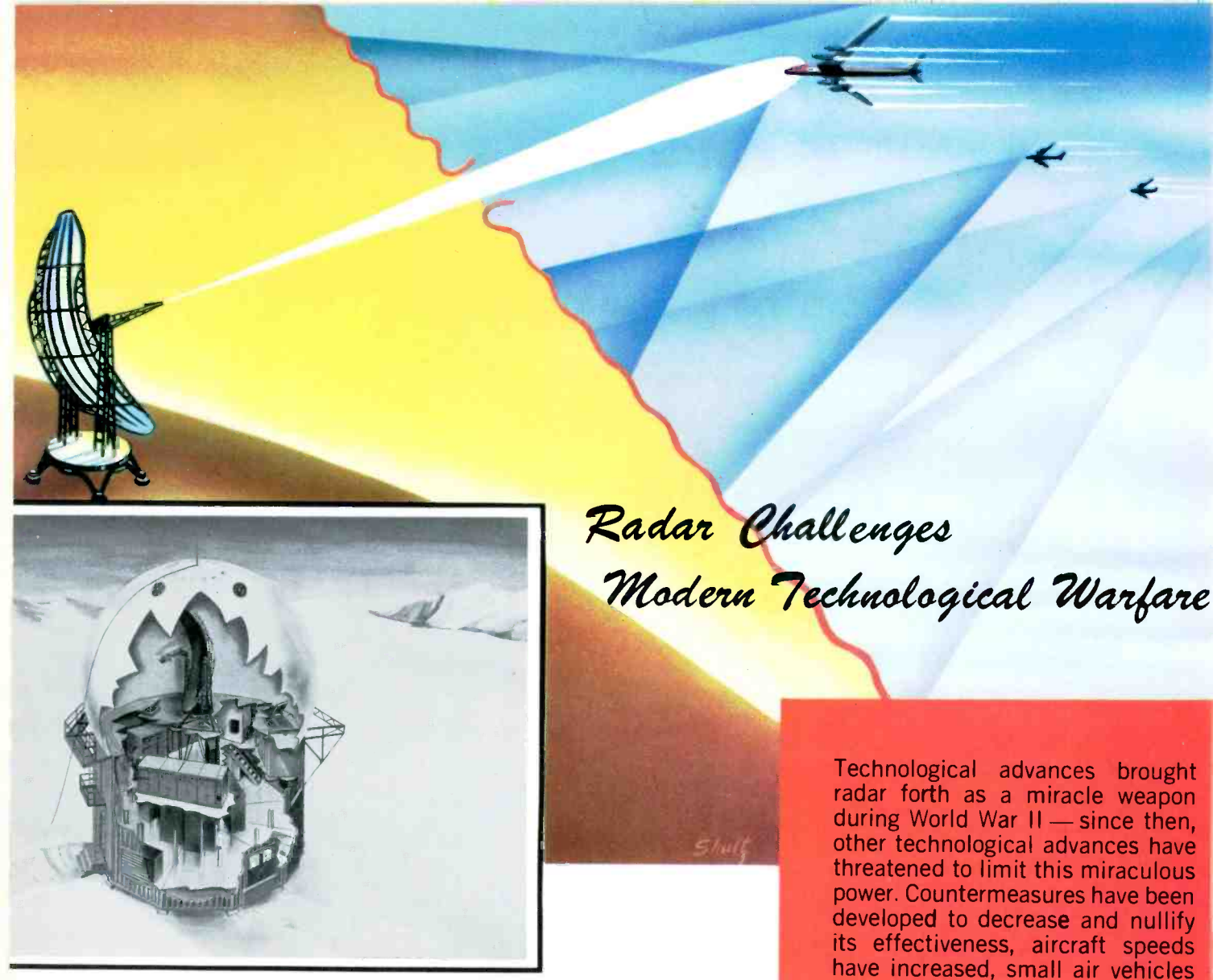
Sensitive Indicators expanded line

ENGINEERED ELECTRONICS CO., 506 E. First St., Santa Ana, Calif. The Miniseg line of sensitive indicators, incorporating built-in high-sensitivity transistorized driver circuits to operate directly from low-level signals, has been expanded to include new filament-type, high-temperature-type, memory-type, and plug-in-type units, as well as miniature and subminiature designs. **Circle 229 on Reader Service Card.**



D-C Multimeter accurate unit

MILLIVAC INSTRUMENTS DIVISION of Cohu Electronics, Inc., P.O. Box 997, Schenectady, N. Y. In one integrated instrument the model MV-77A d-c multimeter combines accurate, sensitive measurement of millivolts and microamperes with an accurate, linear-scale ohmmeter. Measuring accuracy is 1 percent of



Radar Challenges Modern Technological Warfare

Creative-Thinking Engineers Needed To Design and Develop Radar Systems

Crosley's heavy surveillance radar program covers all aspects —from the original advanced concepts to the production of equipment.

Crosley has interesting assignments in the fields of ECM, CCM, radar receivers, transmitters, indicators, micro-wave, plumbing, antennas, wave propagation, computers, primary power systems, and all aspects of radar equipment.

Mr. James T. Dale
Director, Scientific and Technical Personnel

Avco/Crosley

Technological advances brought radar forth as a miracle weapon during World War II — since then, other technological advances have threatened to limit this miraculous power. Countermeasures have been developed to decrease and nullify its effectiveness, aircraft speeds have increased, small air vehicles have been developed that require long-long range detection and tracking. Radar techniques must be developed to meet and counteract the technological advances.

AVCO/Crosley Radar Engineering is answering this challenge with new radars designed for longer range, greater accuracy, faster data handling, and greater operational capability in adverse environments.

An outstanding contribution of AVCO/Crosley radar engineering, the currently operational AN/MPS-16 Height Finder Radar, is being followed by other Crosley equipments of greater stature, including the AN/FPS-26.

The challenges of tomorrow must be anticipated and coped with today — you can be sure that AVCO/Crosley engineering is working hard to get timely answers

Dr. Wright takes the stand for electronics

What is your present work in electronics, Dr. Wright?
Vice President In-Charge-of-Operations-and-Engineering at Tung-Sol Electric Inc., a leading manufacturer of electron tubes, semiconductors, tv tubes, lamps, power supplies, flashers, selenium and silicon rectifiers.

How many people are at Tung-Sol?
Approximately 6,000.

Briefly, what is your background in electronics?
Twenty-two years with Tung-Sol.

How many years have you been reading **electronics**?
It goes back over twenty years..

Why have you continued to read it?
After all, this is a very technical and rapidly changing industry. I don't know which is more important, the editorial or advertising. They both help us to keep up with what's going on in the world of electronics.

It has been said that leading publications build a "personality" for themselves. This is a quality that cannot be measured with facts and statistics. How would you characterize the "personality" of **electronics** magazine?
It's not too highbrow, yet it's not a gossip sheet. It's an excellent middle-of-the-road job of reporting technical and business developments. ***electronics*** *does a down-to-earth reporting job.*

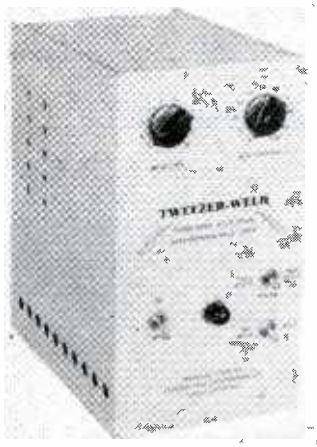
If it's about electronics, read it in **electronics**.

electronics

Published WEEKLY plus the mid-year electronics BUYERS' GUIDE
A McGraw-Hill Publication • 330 West 42nd Street, New York 36, N. Y.

ABC ABP

full scale on all voltage ranges, 1 percent of full scale on all ohm measuring ranges and 3 percent on all current ranges. The instrument has a total of 39 measuring ranges 0-1 mv through 0-1,000 v, 13 current ranges 0-1 μa through 0-1 ampere, and 13 ohmmeter ranges 0-1 ohm through 0-1 megohm. **Circle 230 on Reader Service Card.**



Weld-Timer
1-kva capacity

FEDERAL TOOL ENGINEERING CO., Cedar Grove, N. J. The T3 transistorized synchronous weld-timer of 1-kva capacity is especially suited for precision welding where contact resistance varies greatly. Welding time is adjustable by a simple rotary switch from ½ cycle (approximately 8 millisec) to 10 cycles (approximately 160 millisec) of line frequency. **Circle 231 on Reader Service Card.**

Oscilloscopes
rugged and compact

SIERRA ELECTRONICS CORP., 3885 Bohannon Drive, Menlo Park, Calif. Model 218A oscilloscopes are especially designed for continuous function monitoring of as many as seven channels simultaneously in one rack unit. Rugged and compact, the scopes provide a convenient means for viewing and evaluating complex voltages. Designed primarily for tape recording and data handling systems, they are well suited for measuring and analyzing mechanical quantities through a transducer. **Circle 232 on Reader Service Card.**

Literature of

MATERIALS

Clad Metals. Metals & Controls Corp., Attleboro, Mass. A new 8-page technical data bulletin, IND-19, describes 5-layer copper-cored Aliron for amplifier anodes and 3-layer copper-base Aliron for rectifier anodes. **Circle 250 on Reader Service Card.**

COMPONENTS

Wire-Wound Pot. Maurey Instrument Corp., 7924 S. Exchange Ave., Chicago 17, Ill., has available a complete catalog of single-turn wire-wound precision potentiometers from ½ in. diameter to 3 in. diameter. **Circle 251 on Reader Service Card.**

Rotary Switch. Chicago Dynamic Industries, Inc., 1725 Diversey Blvd., Chicago 14, Ill. A new brochure covers a unique rotary switch with wafers which lift out instantly without unsoldering or disassembling for fast, easy cleaning or instant replacement. **Circle 252 on Reader Service Card.**

Electrical Connectors. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif. A recent Hot Sheet describes the DS series miniature connectors which feature insertable contacts, silicone inserts, and crimp-type terminations replacing the solder pots. **Circle 253 on Reader Service Card.**

EQUIPMENT

Oscillographic Recording System. Sanborn Co., 175 Wyman St., Waltham 54, Mass., has published literature describing model 350 direct-writing 6- or 8-channel oscillographic recording system. **Circle 254 on Reader Service Card.**

Noise Figure Meter. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 10 No. 6-7 of the *Journal* describes the new model 343A vhf noise source which provides an essentially constant output noise power over the

the Week

range from 10 to 600 mc for use in testing 50-ohm systems. **Circle 255 on Reader Service Card.**

D-C Measurement. Kin Tel, 5725 Kearny Villa Road, San Diego 11, Calif. A single-page bulletin discusses instruments for measuring microvolts to kilovolts, micromicroamperes to amperes with stability, accuracy and simplicity. **Circle 256 on Reader Service Card.**

Instruments. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Included in Vol. 33 No. 3 of the *Experimenter* are descriptions of the new type 1650-A universal impedance bridge and the type 1205-B adjustable regulated power supply. **Circle 257 on Reader Service Card.**

Magnetic Tape Recorders. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif. Five new instrumentation bulletins technically describe a series of ruggedized, miniaturized magnetic tape recorders designed for use in rockets, missiles and other airborne applications. **Circle 258 on Reader Service Card.**

FACILITIES

Ultrasonics. Acoustica Associates, Inc., 26 Windsor Ave., Mineola, L. I., N. Y. *Ultrasoundings* is the name of a new quarterly magazine containing information of general interest in the ultrasonics field as well as about applications of ultrasonics by industry, service organizations, medical establishments and the military. **Circle 259 on Reader Service Card.**

Facilities Report. The Rex Corp., Hayward Rd., West Acton, Mass. A 25th anniversary facilities report details the growth of the organization from a single product to hundreds of highly-specialized wire, cable and plastic products used in the missile, aircraft, electronics and communication industries. **Circle 260 on Reader Service Card.**

NEW BOOKS

Transform Method in Linear System Analysis

By JOHN A. ASELTINE

McGraw-Hill Book Co., New York, 1958, 299 *p*, $8.50.

THIS welcome addition to the McGraw-Hill series in Electrical and Electronic Engineering describes an interesting excursion through the realm of linear analysis via the transform method. Written as a senior-graduate level test, it precludes that the reader is rather familiar with the classical solution of linear differential equations to fully appreciate the advantages that may accrue by utilizing transform techniques. Although concise and fleeting in spots, the volume is very well written and easy to read. It manages to get across many complicated concepts in a very clear manner.

In addition to properties and procedures involving the Laplace transform, inverse transform, Fourier series, Fourier transforms, Z transforms and Mellin transforms, useful knowledge is described relating to the analysis of electrical networks, mechanical systems and feedback systems. Special emphasis is made of the impulse function, the system function and random inputs. There are numerous illustrative examples throughout the text.

The book is well suited as a classroom and reference text as it covers a great number of topics and each chapter has many interesting problems. However, minor attempts are made to augment the abstract mathematical operations with visual interpretations. Also, references to other works are sparsely presented. Despite these few shortcomings, the book should prove to be of undoubted value to many readers.—ANTHONY B. GIORDANO, *Polytechnic Institute of Brooklyn, Brooklyn, N. Y.*

THUMBNAIL REVIEWS

A Compendium of Mathematics and Physics. By D. S. Meyler and O. G. Sutton, Van Nostrand Co., Inc., Princeton, N. J., 1958, 384 p, $5.00. Basic facts of mathematics and physics are implemented with brief, but adequate, explanations of re-

sults; proofs are omitted. Both cgs and rationalized mks units are employed.

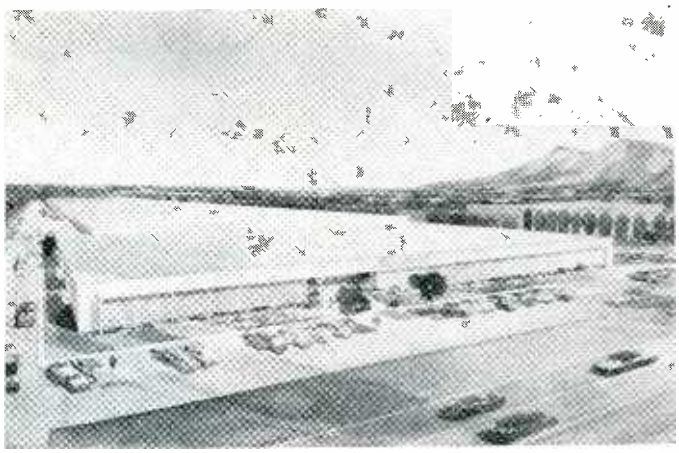
High-Quality Sound Reproduction. By J. Moir, Macmillan Co., New York, 1958, 591 p, $14.00. This excellent volume is one of the few, on the subject, written for the engineer. Reasons for choice of designs are covered along with the actual design information.

Man's World of Sound. By J. R. Pierce and E. E. David, Jr., Doubleday & Co., Inc., Garden City, N. Y., 1958, 287 p, $5.00. "This book brings together from a wide variety of sources material concerning man's speech and hearing and their use in that code of communications which is language." Chapter headings include: The Power of Sound; Waves, Frequencies and Resonators; Giving Form to Sounds; The Acoustic Nature of Speech; What Do We Hear?; Ears to Hear With; Nerves and the Brain; Defects of Speech and Hearing; Intelligibility; Quality and Fidelity; Automata and Talking Machines; Efficient Communication and Intelligent Machines. The authors have drawn freely on recent work done at the Bell Telephone Laboratories.

Basics of Digital Computers. By J. S. Murphy, John F. Rider Pub., Inc., New York, 1958, 416 p, $6.95. This three-volume set, though written for technicians, should be of value to engineers wishing to familiarize themselves with basic computer theory. Volume one covers computer arithmetic, data representation, and/or circuitry and control; volume two discusses logical elements, circuits; volume three covers large system aspects of computers, including memories, reading, writing, timing, data processing, etc.

Research and Development of New Design Method for Power Transformers. Armour Research Foundation, 10 W 35 St., Chicago 16, Ill., 1956, 292 p, $10.00. Sponsored jointly by the Signal Corps Engineering Labs and Wright Air Development Center, this report presents extensive design information for unbalanced magnetization, current-limiting, vibrator-supply, low-capacitance filament and instrument transformers. Detailed examples are given for the design of each type.

Satellites and Space Flight. By E. Burgess, The Macmillan Co., New York, 1958, 159 p, $3.95. Details of construction, instrumentation, launching, transmission of data and flight orbit of earth satellites are covered along with logical and physiological problems concerned with manned rockets and establishment of manned stations in space. Expeditions to the moon and planets are also considered.



Hoffman Building New Plant

CONSTRUCTION of a $1.5-million Los Angeles plant for Hoffman Electronics Corp. began recently on an 18-acre site in suburban El Monte, Calif.

On completion, scheduled for Sept. 1, the 109,000-sq-ft facility will serve as administrative headquarters for the semiconductor division, now in Evanston, Ill., and for producing solar energy conversion devices. The Evanston plant will continue its solar cell production, but also will be in position to expand production of diodes and rectifiers in response to a recent sharp upturn in demand, firm says.

Techniques for mass producing solar cells, which convert sunlight into electricity, were recently perfected by the company. The new plant, coupled with the Evanston output, will increase Hoffman's production of solar energy converters to 500,000 a month.

The West Coast facility, with a laboratory-type "white room" interior equipped with the latest air purification and temperature controls, also will provide for future diversification of the division's semiconductor product line.

Novick Takes Position at ESC

ESC CORP., Palisades Park, N. J., manufacturer of delay lines, pulse transformers, shift registers and associated pulse components, announces the appointment of David Novick to the post of project engineer. He will be responsible for the development of test equipment, new products, and research and development in the prototype laboratory.

Novick was previously senior engineer in the industrial products division, ITT. Prior to that, he was associated with the computer division of the Underwood Corp., CBS-Columbia and the Square Root Mfg. Co.

ITT Announces Team Project

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP. recently announced the establishment of a new unit, ITT Communication Systems, Inc., to handle the overall development, design and master planning of the Air Force communications support system (480-L).

This project will be managed by a four-company team consisting of ITT as senior member, with RCA as principal associate and Hoffman Electronics Corp. and Hughes Aircraft Co. as principal subcontractors.

The system will provide for improvement and modernization of present world-wide, long-range, point-to-point, air-to-ground and ground-to-air communications systems known as the Air Force Communications Complex or AIRCOM.

ITT's new unit, which will have its headquarters at the Garden State Plaza, Paramus, N. J., will be headed by Ellery W. Stone, chairman of the board of American Cable and Radio Corp., an ITT associate.

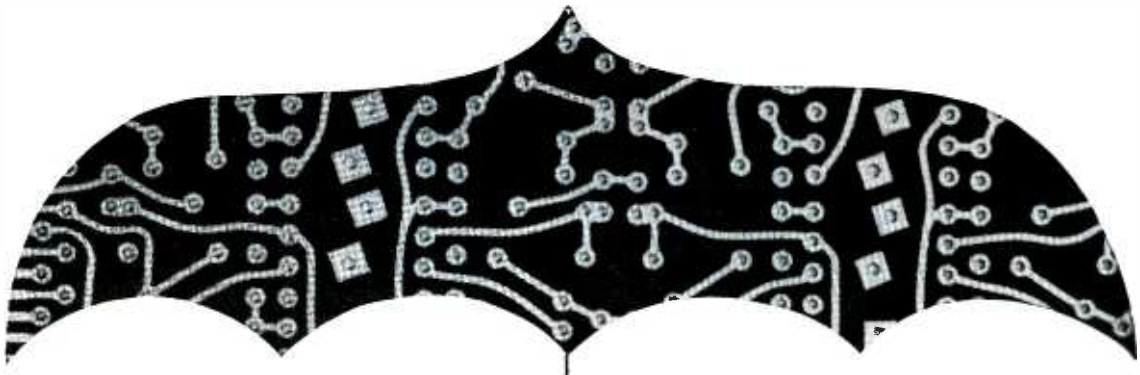
North Hills Appoints Geffe

NORTH HILLS ELECTRIC CO., INC., Mineola, N. Y., announces the appointment of Philip R. Geffe as chief filter engineer. He had been chief filter engineer at Triad Transformer Corp. and director of engineering at Hycor.

North Hills filter division specializes in advanced filter design, wideband transformers, and production of audio, telemetering and r-f filters.

Magnetico Names Division Manager

EDWARD J. DAPARMA has been appointed manager of the T. A. Division of Magnetico, Inc., East North-



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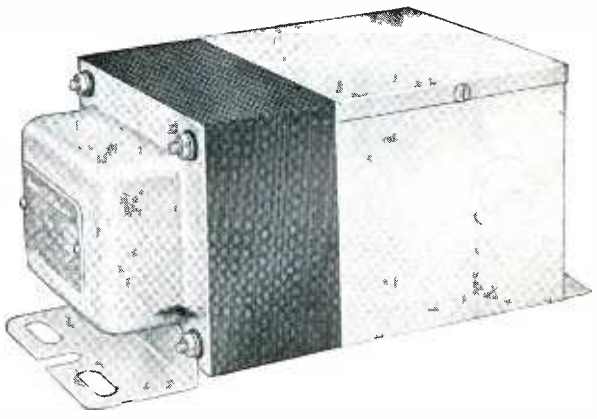

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port, L. I., N. Y. He was formerly branch head of the amplifier section of the Norden Division of United Aircraft.

In his new position, DaParma will be in charge of magnetic amplifier design and construction, and will introduce into the company a new line of transistor amplifiers keyed toward miniaturization.

GPL Appoints Consultant

R. H. CARPENTER recently joined the Avionics Division of General Precision Laboratory Inc., Pleasantville, N. Y., as special consultant on aircraft and aircraft operations. He will assist in the design of airborne and ground systems for air navigation and air traffic control programs underway at the company.

Plant Briefs

CONSTRUCTION is underway to add another 57,000 sq ft of manufacturing area to the new **Electronic Associates, Inc.,** plant at West Long Branch, N. J.

Grand Sliding Mechanisms, Inc., a new manufacturer of precision drawer and chassis slides for the electronic industry, recently went into production in Chicago, Ill.

ACDC Electronics, Inc., is the new corporate name for NYT Electronics, Inc., Burbank, Calif. Company produces inductive components, regulated power supplies, and special electromechanical devices.

Datex Corp., Monrovia, Calif., is erecting a new building which will increase working area by 70 percent. New facility, with 10,000 sq ft of floor space, is expected to be ready for occupancy early in July.

New name of Industrial Television Inc., Clifton, N. J., is **ITI Electronics, Inc.**

Induction Motors Corp., Westbury, N. Y., has changed its name to **IMC Magnetics Corp.** Company has

also acquired a new division—**Gray & Kuhn, Inc.**, Roslyn Heights, L. I., N. Y.

PAM Associates, Inc., Baltimore, Md., was recently formed to design and build equipment to test effects of shock and vibration and for noise control.

In Pasadena, Calif., G. M. Giannini & Co., Inc., has become **Giannini Controls Corp.**

News of Reps

Parrish Electronics of Denver, Col., has been appointed sales rep for Rex Corp., West Acton, Mass., manufacturers of electronic components and specialty wire and cable products for the missile, aircraft, electronic and communications industries.

Avion Division of ACF Industries, Inc., appoints **Bauman and Bluzat** of Chicago as sales rep for its commercial and military electronic components. Rep firm will cover Illinois, Wisconsin, Indiana and western Michigan.

Ferrotran Electronics Co., Inc., New York, N. Y., has appointed **William M. Hummel** of Port Credit, Ontario, to handle its line of transistor equipment and components in the Province of Ontario, Canada.

Panoramic Radio Products, Inc., Mt. Vernon, N. Y., names **Arthur H. Lynch and Associates, Inc.**, as manufacturer's reps in Florida.

Harry D. Edmiston of Dallas, Texas, is named to represent the Electronics Division of Iron Fireman Mfg. Co., Portland, Ore., in the state of Texas.

Navigation Computer Corp., Philadelphia, Pa., announces the appointment of the **James L. Highsmith Co.** of Charlotte, N. C., to represent its complete line of transistorized digital system modules in Georgia, Alabama, Tennessee, North Carolina, South Carolina and Virginia, except Fairfax County.

COMMENT

Symbols

In ELECTRONICS (p 159, Aug. 1 '58) a comment with reference to symbols was sent in by S. K. Ghandhi of the IRE Semiconductor Device Symbols Task Group. In this letter he made some statements to which I take exception.

He says *The IRE does not generate symbols; rather, it reflects the majority opinion.* This indicates a formal survey was made—of IRE members? JETEC members? Or users? Presumably only the standards committee members, since a personal poll of some semiconductor manufacturers and considerable users indicates that a few users have adopted the symbols simply because they feel bound to follow IRE standards, and that no known semiconductor manufacturer uses them. In fact, there is very good indication that two well known companies are deliberately taking exception to these standards in some cases.

He goes on to say *Symbol structure must be a logical extension of a well accepted symbol.* I could agree fully if the statement read "Symbol structure must be a logical extension of an *acceptable* symbol."

I agree with the statement that the symbol *must be capable of extension to new devices as the state of the art progresses,* providing that the symbol does not attempt to show the fabricating techniques.

A symbol is necessary for several reasons: to show the number of active terminations; to show polarity of potentials required at each termination; to indicate the category of the device, and to enable technicians and engineers to design, test and maintain equipment from the use of symbols on schematics.

My feeling is that the symbol should immediately tell a technician the general category of the device, as these symbols do for the transistor and diode

with either of these as possibilities for the Zener diode

and this as a possibility for the double-anode Zener diode.

This brings us to Mr. Ghandhi's last statement: *As you see, the very construction follows a logical course and causes very little burden on the memory.* I contend that the IRE system is not logical to the majority of users, and therefore becomes difficult and a burden on the memory.

Although I am speaking as an individual user, the users have combined national groups, and I am sure that a poll of such groups would be beneficial to the IRE in the symbol and other standards efforts. All that is necessary is that the IRE or Mr. Ghandhi ask, and we will be glad to present and comment on any proposed standards . . .

ROBERT E. ROBERTS
MOTOROLA INC.
PHOENIX, ARIZ.

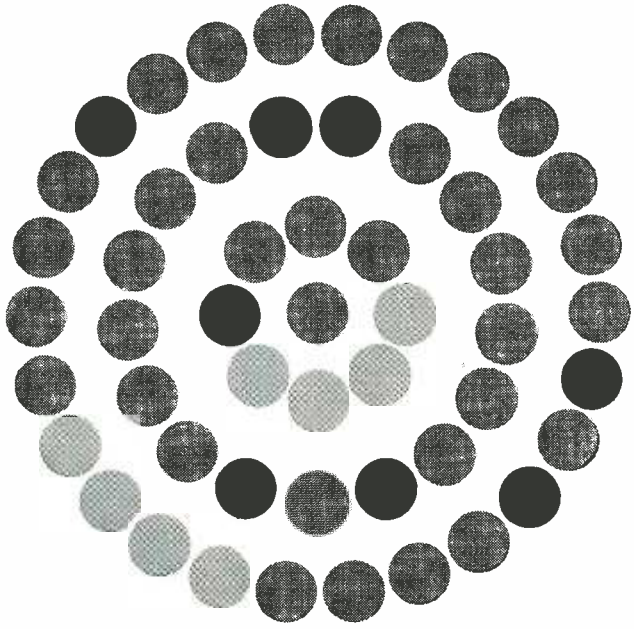
In fairness to Mr. Ghandhi, may we point out that his letter gives this as part of IRE's ground rules for standards: "A symbol should not be based on the theory of operation . . . (but) should indicate physical properties where possible . . ." He himself offers this rebuttal:

I have read with considerable interest Mr. Roberts' comments on my letter . . .

No attempt is made in the present IRE standard (or in the proposed AIEE standard) to indicate device fabrication techniques. Thus one and only one symbol is used to indicate a *pnp* transistor whether it is grown, alloyed, rate-grown, diffused, meltback, drift or mesa.

A careful perusal of my original comments will show that I was referring to the construction of the graphical symbol, and the order in which its parts are located. In an electron tube, for example, we show the suppressor grid in its location between the screen and plate. If it is internally connected to a cathode, the symbol construction also shows this.

S. K. GHANDHI
IRE SEMICONDUCTOR DEVICE
SYMBOLS TASK GROUP
SYRACUSE, N. Y.



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3K30 85.00	249B 5.00	845 8.50	5841 3.00	6352 6.00
3KP1 10.00	249C 5.00	866A 1.45	5844 .85	6438 4.75
4-65A 13.50	252A 6.00	869B 75.00	5852 3.00	6463 1.50
4-125A 25.00	259A 3.50	872A 1.50	5854 .75	6482 9.50
4-400A 40.00	262B 4.00	884 1.00	5876 7.00	6517 500.00
4C33 100.00	271A 12.50	913 10.00	5879 1.25	6626/OA2WA 2.50
4C35 12.50	272A 3.50	918 .75	5881/6L6WGB 2.50	6627/OB2WA 2.50
4E27 8.50	274A 3.50	927 .85	5886 3.50	6754 15.00
4J61 150.00	275A 4.00	931A 2.25	5894 15.00	8005 6.50
4J62 150.00	283A 3.50	959 .75	5896 .85	8013A 3.75
4X150A 15.00	287A 2.00	CK1006 2.00	5899A 4.00	8014A 25.00
5BP1A 12.50	QK-288 150.00	R1130B 10.00	5902 3.00	8020 1.50
5C22 17.50	293A 7.50	HY1269 2.00	5903 7.50	8025A 4.75
5CP1A 6.50	HF-300 25.00	1500T 120.00	5930/2A3W 3.75	9005 3.00

ALL TUBES ARE NEW, INDIVIDUALLY CARTONED, FULLY GUARANTEED

western engineers

Prices are FOB shipping point

ELK GROVE, CALIFORNIA

Orders for less than $10 cannot be processed

SUPPLIERS OF TUBES SINCE 1932

Save over 65% on NEW

BALDWIN STRAIN GUAGES

In sealed packages of 10—Price per package

A-1 $4.95 AX-5 $11.95 50 packs
A-6 5.95 C-3 6.95 20% disc.

Veeder—ROOT COUNTERS

28 V DC Electrically Operated—6 Digits
Manual Reset—For Panel or Flush Mtg.
Reg. Price over $20. NEW..... $9.95

CRAMER Running Time Meter

5 Digit—3" Rect. Panel Mounting
110/220 V—60 cycle—With capacitor furnished—NEW Save over 60%..... $6.95

Philamon FREQUENCY GENERATOR

Only 3½w x 1¾d x 3¼h.
Input: 28v DC at 0.18A
Output: 1.2V—500 cy .05%
Reg. Price Approx. $80.00..... $14.95

WESTON DC Microammeter Mod. 622

0—5 uA. 6" Mirror Scale
Reg. Price $328. Ex. Cond..... $99.50
Portable Case Lab. Standard

AMERICAN MOTORS Miniature FAN

115V—400 cycle—11,000 rpm
Fan 3" D. Motor 1¼D x 2¼L.
80 C.F.M. Save Over 70%..... $14.50

AVIONIC SUPPLY 5790 Washington Blvd. Culver City, Calif. **WEbster 3-8523**

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
PROPOSALS, $2.40 a line an insertion.
BOX NUMBERS count as one line additional in undisplayed ads.
DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

All Brand RESISTORS

Type J Potentiometers Single-Duals-Triples
Type G Miniature Potentiometers
By Return Mail . . . From Stock

LEGRI S COMPANY
391 Riverdale Ave. Yonkers 5, N. Y.

RADAR

Complete Weather Radars
Skysweep Antenna Pedestal. MPG1B. SCR 584. Automatic Tracking Radars. MPN-1B GCA. APS-10, APS-31, APS-33 Airborne. Over 1,000 Microwave items.
Navy Weather-Eye Radars
RADIO RESEARCH INSTRUMENT CO.
550 Fifth Avenue, N. Y. 36, N. Y. JUdson 6-4691

SEARCHLIGHT Equipment Locating Service

NO COST OR OBLIGATION

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components *not currently advertised*. (This service is for USER-BUYERS only).

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Locating Service
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following equipment components.

.....

.....

.....

NAME .....

TITLE .....

COMPANY .....

STREET .....

CITY 5/22/59

INDEX TO ADVERTISERS

● See advertisement in the June, 1958 Mid-Month ELECTRONICS BUYERS' GUIDE for complete line of products or services.

■

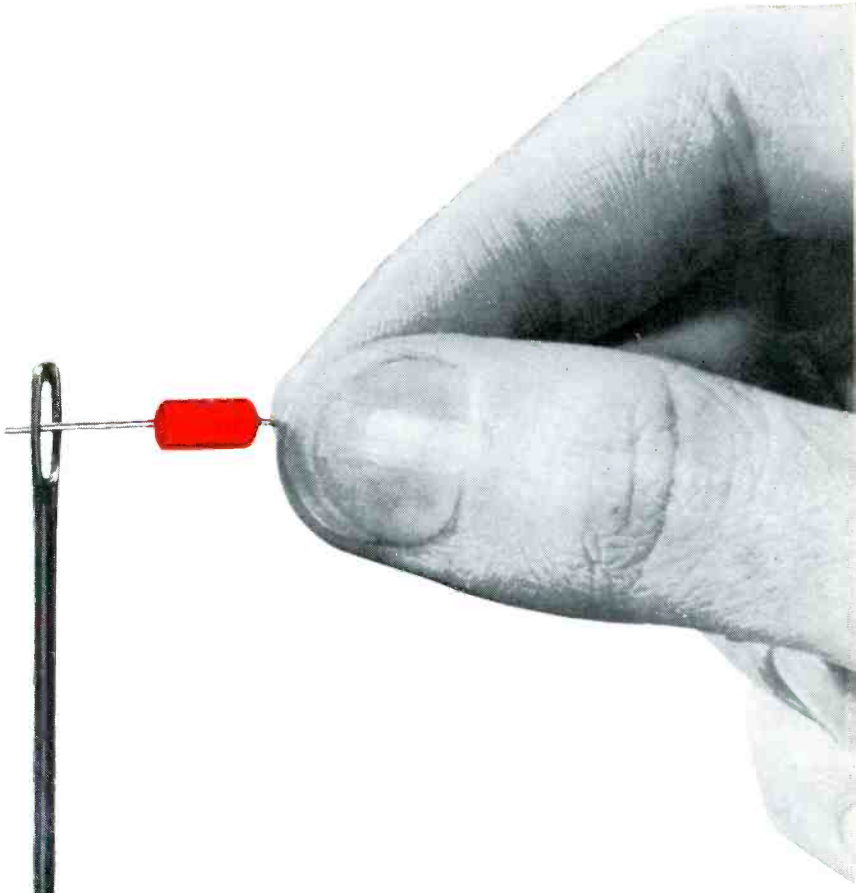
CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

- See advertisement in the June, 1958 Mid-Month ELECTRONICS BUYERS' GUIDE for complete line of products or services.

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

how large is small?



DAVEN'S NEW MINIATURE WIRE WOUND RESISTORS PROVIDE AS MUCH AS 400K RESISTANCE IN 1/4" x 5/16" SPACE

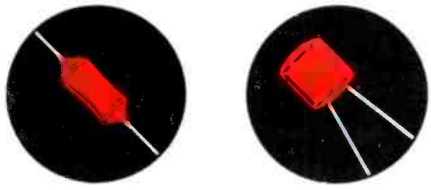
DAVEN's fully encapsulated, miniature, precision wire wound resistors offer the design and development engineer the solution to critical space limitation problems. DAVEN's advanced techniques provide the needed resistance value in a minimum of space, without sacrificing reliability. Where space conservation is a prime factor in your design, specify DAVEN miniature wire wounds.

Types and Specifications

Type	Dia.	Length	Max. Ohms	Max. Watts
1274	3/16	3/8	100K	0.25
1273	1/4	5/16	400K	0.25
1283	1/4	5/16	400K	0.25
1284	1/4	27/64	.5 Meg.	0.25
1250	1/4	1/2	900K	0.33
1170A	7/16	1/2	1.2 Meg.	0.50
1170	1/2	1/2	1.8 Meg.	0.50

• Fully encapsulated • Meet and exceed all humidity, salt water immersion and cycling tests as specified in MIL-R-93A, Amendment 3 • Operate at 125°C continuous power without de-rating • Can be obtained in tolerances as close as ±0.02% • Standard temperature coefficient is ±20PPM/°C.

THE DAVEN CO.
Livingston, N. J.



Special temperature coefficients can be supplied on request.

Write for our new resistor catalog.

IN DISPLAY STORAGE TUBES...

RCA provides the widest selection!

World leader in display-storage-tube development and manufacture, RCA offers industry an extensive line of display-storage-tube designs.

For example, RCA offers display-storage-tube types that can provide displays having high brilliance, high contrast, and very good half-tone shading. There's a choice of types with single writing or multiple writing guns, and with overall or selective erasure. And there's a choice of either magnetic or electrostatic deflection. Writing speed can be tailored to your specific application.

So regardless of your display-storage-tube application, remember this about RCA Display Storage Tubes: Commercial types are readily available; in addition, a variety of developmental types can be obtained on a sampling basis. If you are an equipment manufacturer, get in touch with your RCA Field Representative for complete details.

PARTIAL LIST OF RCA DISPLAY-STORAGE-TUBES

RCA TYPE	BULB DIAMETER inches	DISPLAY DIAMETER inches	DEFLECTION TYPE	NUMBER OF GUNS in addition to viewing gun	TYPICAL CHARACTERISTICS	
					WRITING SPEED in./sec.	BRIGHTNESS footlamberts
7183	5■	4.0	Magnetic	1 writing	50000	1500
7315	5	3.8	Electrostatic	1 writing	3000	2750
7448	5	3.8	Electrostatic	1 writing	300000	2750
C-73788°	7	5.2	Electrostatic	1 writing	50000	750
C-73904°	5	3.8	Electrostatic	2 writing	75000	2750
C-73922°	7	5.2	Electrostatic	1 writing 1 erasing	8000	750
C-73931°	7	5.2	Electrostatic	2 writing	50000	750
C-73938°	5	3.8	Electrostatic	1 writing 1 erasing	12000	2750
C-73964°	5■■	3.8	Electrostatic	1 writing	300000	2750

°Developmental type.
■Has flying leads for screen and backplate.
■■Has integral external magnetic shield. Max. tube diameter is 5.6 inches.
Information on types similar to those listed above but with writing speed tailored to your requirements will be furnished on request. In types with 2 writing guns, the writing speed of one gun can be different from that of the other.

Your RCA Field Representatives are here to help you

GOVERNMENT SALES

- Newark 2, N. J., 415 S. Fifth St., HUmboldt 5-3900
- Dayton 2, Ohio, 224 N. Wilkinson St., BAldwin 6-2366
- Washington 6, D. C., 1625 "K" St., N.W., DIstrict 7-1260

INDUSTRIAL TUBE PRODUCTS SALES

- Newark 2, N. J., 744 Broad St., HUmboldt 5-3900
- Detroit 2, Mich., 714 New Center Bldg., TRinity 5-5600
- Chicago 54, Illinois
  Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900
- Los Angeles 22, Calif.
  6355 E. Washington Blvd., RAymond 3-8361

RADIO CORPORATION OF AMERICA
Electron Tube Division — *Harrison, N. J.*